NOTTINGHAM TRENT UNIVERSITY

Implementation of technology driven policy initiatives in emerging economies: The case of Malaysia's Commercialisation of Research and Development Fund

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Copyright statement

Statement of declaration

I certify that, to the best of my knowledge, all sources have been acknowledged in this thesis.

ABSTRACT

The purpose of this study is to investigate the impact of a policy initiative to uplift innovation capabilities among indigenous high-technology small and medium enterprises (SMEs) in Malaysia. As an emerging economy, Malaysia has actively introduced policies to propel economic development. These policies are acknowledged as powerful tools to promote industrialisation and economic diversification. As the country moves towards a knowledge-based economy, this study provides insight into how a policy comprising a financial initiative introduced by Malaysian Government has been used to enhance capabilities of indigenous small and medium enterprises particularly for innovation. This study is exploratory since it seeks to find out how firms developed and enhanced their innovation capabilities in the presence of government policy. The goal is to learn 'what is going on here' and the phenomenon in light of the innovation process and Dynamic Capabilities (DC) concepts. This study adopts an interpretative approach and uses multiple case studies with semi-structured interviews as the main data collection technique. This study relies on this technique to explore the views and experience of the selected Commercialisation of Research and Development Fund (CRDF) recipient about the impact and application of that policy initiative (i.e. the CRDF). Overall, the researcher conducted 13 one-to-one and three group interviews. The interviewees consist of key informants from firms and MTDC personnel. Two additional data collection methods: documentary analysis and observations were utilised; thus, improving the triangulation of the findings.

The findings show that the implementation of the CRDF in particular is in line with the specific objectives of the policy which is intended to support commercialisation of research outputs among indigenous small firms. This study also found that this policy initiative tends to affect the latter end of the innovation process (i.e. in particular in the exploitation phase) rather to the innovation process in general. These findings demonstrate how firms have been using funds from the CRDF to support the innovation process, especially for upgrading their capability regarding the new product development process for high technology products. The important dimension that emerged is that the CRDF is enhancing firms innovation and dynamic capabilities, especially those capabilities relating to their ability to carry out innovation. These capabilities are centred on firms' ability to respond to a changing environment by producing high technology products that meet regulatory requirements as well as customer demand.

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LIST OF ABBREVIATIONS

BSc	Bachelor of Science
CEO	Chief Executive Officer
CRDF	Commercialisation of Research and Development Fund
CSPO	Certified Sustainable Palm Oil
DC	Dynamic Capabilities
FAMA	Federal Agriculture and Marketing Authority
FDI	Foreign Direct Investment
FMCG	Fast Moving Customer Good
FRDM	Fire and Rescue Department of Malaysia
FRIM	Forest Institute of Malaysia
GDP	Gross Domestic Product
IO	Industrial Organisation
ITEX	International, Invention, Innovation and Technology Exhibition
ITEX	International Invention and Innovation Exhibition
KMD	Knowledge Management Division
MATRADE	Malaysia External Trade Development Corporation
MD	Managing Director
MNCs	Multinational Corporations
MOSTI	Ministry of Science and Technology of Malaysia
MPOB	Malaysia Palm Oil Board
MTDC	Malaysia Technology Development Corporation
NIEs	Newly Industrialised Economies
NIS	National Innovation System
NPD	New product development
NTBFs	New Technology Based Firms
PhD	Doctor of Philosophy
PRIs	Public Research Institutes
R&D	Research and Development
RBV	Resource-Based View
SIRIM	Standards and Industrial Research Institute
SMEs	Small and Medium Enterprises

Chapter 1 : INTRODUCTION

1.1 Overview

The aim of this exploratory study is to investigate the impact of technology-driven growth strategies on high-technology industrialisation within emerging economies. It sheds light on the issue of high technology sectors development in contexts of an emerging economy[1] like Malaysia. This study focuses on forms of initiatives that have been developed by the Malaysian government as part of technology-driven growth strategies. These strategies are argued to translate into industrial policies that guide development of the country. This study is not concerned with the highest level of industrial policy (i.e. why governments decide to pursue particular policies). Rather, it focuses on one part of industrial policy that is particularly applicable to the development of high-technology SMEs) in Malaysia.

This study seeks to explore to what extent a particular policy initiative influences high technology SMEs' capability to innovate in particular in the new product development (NPD) process. The policy initiative is the Commercialisation of Research and Development Fund (CRDF) which provides financial assistance for local firms to conduct commercialisation activities. It is anticipated that this study will provide critical views from firms that are the beneficiaries of the policy initiative. It also provides opportunities to investigate the policy's implementation mechanism in adapting the expectations laid out by the Government. In summary, this chapter outlines the research background, the objectives and the scope of the study. It then proceeds to the research approach and explains out the structure of the thesis.

1.2 Research background

Since starting to become an emerging industrialised country[2], the Malaysian government aspired to further economic development. In 1991, the Malaysian

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[1] A group of economies that consist of countries that experienced rapid economic growth and are progressing toward becoming developed economies in terms of industry composition. They promise huge potential for global economic prosperity (Hoskisson, 2000).

[2] Developing industrialised country is known as a country that is able to achieve stable growth in production and income by having variety of industries producing a broad range of products and varied international trade (Weiss, 2002).

government started to popularise an idea to become a fully industrialised country by 2020 (Mahathir, 1991). The Malaysian government's aspiration has marked a series of economic diversifications that much needed by the Malaysian economy in order to break away from the developing country growth trap (Siew-Yan and Mat Zin, 2006). Within this plan, the Malaysian government envisioned a strategy to develop the economy by being dependent low-cost advantage in manufacturing sectors was not sustainable (MOSTE, 1990). Abdulai (2004) argues that other countries especially from less developed economies[3] have been trying to implement the same set of strategies: attracting foreign investment for capital and technology. Consequently, Malaysia started to lose its position as a favourite destination for foreign investment especially in manufacturing sectors since labour costs in Malaysia became more expensive and other resources to establish manufacturing plants became scarcer (Ali, 1992; Siew-Yan and Mat Zin, 2006). Therefore, it was clear that Malaysia needed to embark on further economic diversification in order to achieve developed country status (Abdulai, 2004).

In light of finding a pathway to become a developed country, the Malaysian government underlined that Malaysia will continue to foster industrialisation with manufacturing sectors as the backbone of the economy but will emphasise its development of high technology sectors (MOSTE, 1990; Siew-Yan and Mat Zin, 2006). This was regarded as a planning fallacy by some, because the Malaysian government planning was influenced by avenues taken by governments in developed countries, especially Japan and South Korea (Jomo, 1994). Vogel (1991) suggests that the success story of Japan and South Korea in economic transformation could be explained by those countries' abilities to rapidly develop high technology sectors. Ali (1992) suggests it was challenging for Malaysia to repeat the success story of Japan and South Korea because the local firms in those countries were able to adopt, assimilate and innovate technology at greater pace than local Malaysian firms. Despite the critics, Ali (1992) agrees the Malaysian government decision to focus on development of the high technology sectors was the right way towards achieving a developed country status although the process is difficult, timely and costly. High technology sectors are considered the fastest growing sectors and could fuel economic development within emerging economies by promoting innovation, technological competitiveness and creation of high-paid jobs (Walsh et al., 1995).

[3] A group of economies that consist of countries that are considered lacking in terms of their economy, infrastructure and industrial base. These countries often have a relatively low standard of living due to low incomes and abundant of poverty (Chandra, 1992).

From a wider perspective, the high technology sector could foster the knowledge creation process within an economy, or *vice versa* (Fontes and Coombs, 2001). For emerging economies, the circle of knowledge creation and development of high technology sector is viewed as a prescribed formula for a country to make a leap to developed economy (Abdulai, 2004; Özcelik and Taymaz, 2008). In the Malaysian context, Shapira et al. (2006) indicate that the development of high technology sectors has been approached as the foundation for creating a knowledge-based economy. To illustrate, the intensive efforts by the government to develop high technology sectors started in the 1980s before the concept of knowledge economy was picked up by the Malaysian government policy radar in the early 2000s (Malaysia, 1991; Malaysia, 2001). The rise of a knowledge economy led the Malaysian government to seize upon the idea that knowledge could be one of the unique resources into production of high technology products (Malaysia, 2001). More importantly, the knowledge creation process through the development of high technology sectors could encourage Malaysian industries to become technology producers, and subsequently uplift their industrial competitiveness (Ali, 1992). Vogel (1991) suggests that the development of the high technology sectors in newly industrialised economies (NIEs) such as South Korea and Taiwan also went through this route. Under stringent government policy mechanisms, the high technology companies in those countries were able to climb the supply chain from being original equipment manufacturers (OEM) to become original brand manufacturers (OBM) of high technology products (Rasiah, 2011). Mani (2002) concludes that the knowledge and technical know-how gained from foreign technology transfer and improvement of the technology lead the high technology companies in South Korea to be at the forefront of the high technology sectors especially in manufacturing of electric and electronics products. However, Ali (1992) argues Malaysian industries cannot rely on this route because the technology transfer from foreign MNCs worked moderately within FDI activities. Therefore, to increase the local technology capabilities, the Malaysian government decided that Malaysian industries needed to deepen the pool of technology by strengthening their efficacy to develop indigenous technology (MOSTE, 1990; Malaysia, 2001).

According to Atkinson and Ezell (2012), emerging economies face a great challenge to promote high technology sectors. The process not only requires governments' commitment to encourage local companies to utilise technology but also to support them to develop new technology into finished products or processes (Blanes and Busom, 2004). Lee and Gaertner (1994) explain that it is not a straight forward process.

This notion has influenced governments' assertiveness to introduce a number of policies as part of technology-driven growth strategies (Blanes and Busom, 2004). However, most strategies have concentrated on the promotion of research and development (R&D) activities. Indeed, R&D activities play a vital role in technology development by trying to resolve scientific and technological uncertainty (Lee and Gaertner, 1994), but more efforts are required to commercialise the R&D outputs. The commercialisation process requires, among other things, rigorous safety testing and up scaling of the invented technology at a viable cost (Blanes and Busom, 2004). Lee and Gaertner (1994) describe the commercialisation activities as a time consuming and costly process. These factors place more challenges on local firms to succeed, hence reducing their interest in getting involved in high-technology sectors (Lerner and Kegler, 2000). Therefore, commercialisation activities are an aspect that is particularly challenging for those formulating policies in this area (Lerner, 1999).

Governmental industrial policies designed to support commercialisation activities can be categorised into fiscal approaches, e.g. grants and soft loans, and non-fiscal approaches, e.g. infrastructure and training programmes (Hill and Chu, 2006). Industrial policies using fiscal measures emerged as a common avenue to overcome market failure in commercialisation activities (Hill and Chu, 2006). Özcelik and Taymaz (2008) highlight that fiscal measures are able to reduce companies' financial burden, and increase their propensity towards commercialisation activities. For a similar reason, the Malaysian government introduced the Commercialisation of Research Development (CRDF) in 1997 (MASTIC, 2010). The CRDF is managed under the purview of Malaysian Technology Development Corporation[4] (MTDC). This scheme is offered to Malaysian SMEs for mass production of indigenous high-technology products (MASTIC, 2010). The CRDF is considered an important technology-driven growth strategy to support Malaysia's high-technology industrialisation by focusing on the development of new and emerging industries (Siew-Yan and Mat Zin, 2006).

Studies of industrial policies like the CRDF have focused largely on the supply side (i.e. intervention by the government, establishment of support structure) and concentrated less on the demand side (i.e. the performance of the beneficiaries)(Hill and Chu, 2006). In Malaysia, this notion could be considered as overwhelming because the

[4] A venture capital company under Khazanah Nasional Berhad Group.

rate of commercialisation of research outputs within public research institutes has decreased from 5.1 per cent to 3.4 per cent between 1991 and 2005 (MASTIC, 2010). Thus, it is the objective of this study to investigate and analyse the operation of CRDF. This is justified by several reasons. First, the Malaysia case offers a perspective from a mid-ranking[5] emerging economy that made advances in building up its manufacturing based economy but wants to progress to a knowledge-based economy by promoting high-technology industrialisation (Mahadevan, 2007). The CRDF is a key policy initiative set up to achieve that objective. Second, although the Malaysian government's industrial policy is important for commercialisation activities, less attention has been given to the utilisation of financial resources by awardees (Mani, 2004). Finally, the existing literature on commercialisation activities in Malaysia focuses on financial assistance for universities and research institutes (Siew-Yan and Mat Zin, 2006) rather than policies designed to support SMEs.

This study investigates the influence of governmental industrial policies on firms' competitiveness in the high-technology sectors in an effort to understand the policies' application. From this understanding, there will be a potential for improvement in both policy design and implementation. Particular attention has been paid to identifying the existence of effective business activities within firms in high-technology sectors with government supports. This aim has become a common objective of government policies in emerging economies which try to enhance the industrial institutions competitiveness from their inception. This study considers theories that try to uncover industrial institutions competitiveness in high technology sectors. Among the prominent theories from the strategic management literature that explain how firms can develop business programmes and sustain competitiveness are: the Resource-Based View (RBV) (Barney, 1991) and the theory of Dynamic Capabilities (DC) (Teece et al., 1997). These theories can be used to evaluate industrial policies that intend to promote the industrial institutions competitiveness conditional to their practicality and limitation.

[5] The World Bank recognises a mid-ranking emerging economy as economy that records low-to-middle per capita earning and rapid economic growth through development of manufacturing based industries. This economy offers less mature capital markets and above-average return for investors (World Bank, 1993).

1.3 Research question and aims of the study

The rapid economic growth achieved by emerging economies generated a huge amount of research interest into the mechanism behind the economic take-off. The main contrast in the literature has been the role of the government vs markets in catching-up development (Amsden, 1989; World Bank, 1993; Chang, 1999). Besides that discussion, scholars also provide a technology-based view that focuses on explaining how emerging economies have tried to catch up technologically with developed economies (Hobday, 2005). Developed economies can be considered as countries that are able to achieve stable economic growth through technological and infrastructural advancement (Chang, 1999). Industries in advanced economies are at the frontier of technological advancement. In this view, catching up is considered as a question of relative speed in a race involving a fixed multi-directional process (Lee and Lim, 2001). Scholars also highlight that emerging economies do not simply follow the technological development of advanced countries. They may create their own individual path which is different from the developed economies.

While many appreciate the rapid economic growth achieved by emerging economies (World Bank, 1993; Hoskisson et al., 2000), there has recently been concern that some countries have been more able than others to catch up technologically. Some scholars suggest that the success factor of these emerging economies is based on their ability to build and develop their national innovative capacity (Nelson, 1993; Porter and Stern, 2001). National innovative capacity refers to a country's prospective capacity to produce a stream of commercially relevant innovations (Porter and Stern, 2001). This capacity is not only confined to production of new products or services, but also echoes the fundamental conditions, investments and policy choices which create an environment for innovation. In this context, there is a phenomena of emerging economies performing differently in building up their innovative capacity.

In building up national innovative capacity, governments in emerging economies have implemented a number of strategies to catch up technologically. These strategies have produced different impacts and outcomes. Several researchers have identified cases where technology driven policies of emerging economies failed to achieve their objectives (Ali, 1992; Taylor, 2007; Wonglimpiyarat, 2011). The implementation of technology-driven policy initiatives in emerging economies is often associated with failure to achieve their objectives in terms of uplifting national innovative capacity (Lall and Teubal, 1998; Wade, 2012). However, little is known about what factors contribute to that failure. This is an insight which could be brought to studies on implementation of policy initiatives, especially in regard to their screening and monitoring process. Moreover, policy initiatives that have been implemented by governments in emerging economies for development of their national innovative capacity tend to have broad objectives. This has led to further inquiry about policy initiatives target groups and their application within the innovation process especially in the development of new high-technology products (Evangelista et al. 1997; Kaufman and Todtling, 2002). Indeed, these enquiries are broad concepts which need further practical explanation through empirical approaches.

This study focuses on Malaysia as an emerging economy that tries to catch up technologically with advanced economies. As discussed in Section 1.2, Malaysia has pursued technological advancement within its industries through various policies. The prominent policy initiatives involve fiscal measures such as tax relief, which has been able to attract FDI into Malaysia (Ali, 1992), enabling the country to make some technological advancement (Felker and Jomo, 2007). For example, Malaysian Government was able to attract Mitsubishi Motors Corporation (MMC) from Japan to establish a joint venture automobile project known as Proton. Initially, Proton could only assemble parts produced by MMC in Japan. Over time, it managed to develop the capability to design, test and make models of its own. In this sense, the economic transformation in Malaysia has been dependent on local firms' innovation capabilities in the design, development and manufacture of products. In fact, the Malaysian government is keen to see this kind of process spread more widely within local industries.

The overall purpose of this study is to gain insight into the extent of a policy initiative's influence on high-technology SMEs' capability to innovate, and particularly in the NPD process. Therefore, the aim is to investigate the implementation of a policy initiative to support innovation activities within SMEs. This is to be undertaken through the study of a government initiative to support SMEs to build and enhance their technological capabilities. The policy initiative tries to serve a particular purpose - to enhance competitiveness and capability of local firms by promoting commercialisation of R&D outputs. Therefore, this study seeks to find out how firms get along in the setting under review, the meaning they give to their actions and the issues that concern them. In other words, the main approach is to ask 'what is going on here?' and to investigate the social phenomenon without explicit expectations. However, as far as it is able to reveal and describe firms' experience and views of the CRDF, the study can also be regarded as description of a policy initiative to develop the capabilities of firms within the innovation process. In fact, this study strives to obtain new insights into the phenomenon of innovation support in indigenous firms.

In the tradition of qualitative research, this study commences with a number of rather broad questions, namely: 'What?', 'Who?', 'When?', 'Where?' and 'Why?'. This approach informs further theorising on industrial policies; therefore, this study seeks to address the following research questions:

1. What is the nature of innovation support in an emerging economy?
2. What is the impact of an industrial policy initiative on firm's innovation capabilities in an emerging economy?

To answer these research questions, the following research objectives are formulated:

i) to analyse industrial policy and the process of industrialisation in emerging economies
ii) to explore an emerging economy's strategies for promoting high-technology industrialisation through industrial policy
iii) to critically evaluate the effectiveness of a policy initiative in stimulating the high-technology SMEs sectors in an emerging economy

1.4 Structure of the thesis

This section outlines the structure of the thesis in order to clarify the relationship between the research problem and the selected research strategy. Brief descriptions of the chapters are presented below:

- **Chapter 1** sets the scene for the present study by providing the research background on the desire of emerging economies to develop high-technology sectors to enable them to catch-up technologically with advanced economies. It also explicates the importance and purpose of the study, research design and structure of the thesis.
- **Chapter 2** focuses on core concepts in researching development of high-technology sectors within emerging economies. This chapter explains the rationale and issues of emerging economies embarking on assembly-type industrialisation and then moving towards high-technology industrialisation. This includes contextual information about emerging economies, such as their economic performance and also mechanisms for how they choose to embark on industrialisation. This chapter also highlights and discusses the importance of industrial policies in terms of policy initiatives as tools to facilitate development of high technology sector in emerging economies. The main focus is on the availability of a support system for indigenous firm to commercialise research outputs. In this chapter, there are also sections that discuss possible relevant theories in researching firms' innovation behaviour in the presence of government support.
- **Chapter 3** outlines the methodological framework of this study, which includes the research philosophy, research design, and data collection methods and data analysis process. The chapter ends with a discussion on research validity and reliability issues of this study.
- **Chapter 4** presents ten case studies of firms that received CRDF awards. This chapter lays out the firms' background, their product under CRDF and also capabilities that they possess, namely research, production, marketing and innovation. Table 1-1 provides a brief description about each case study of recipients firms.

Table 1-1: Profiles of case studies

Case	Main business	Product under the CRDF
Bio 1	Involved in microbial research, development, and commercialisation and bio-manufacturing activities.	Bio-pesticide
Bio 2	Established as a research-based company that discovers, develops, manufactures and markets natural pharmaceutical products	Liver tonic
Bio 3	Principally engaged in manufacturing, R&D, and distributing of herbals products for health	Skin lotion
Bio 4	Specialises in producing natural health food, beverages and supplements	Anti-diabetic coffee and biscuits
Bio 5	A start-up firm that is involved in development and production of skin-care products	Shower gel
Industrial 1	Involved in a highly technical business producing aerosol fire suppression products	Fire suppression system
Industrial 2	Fabrication, manufacture and supply of fire and rescue vehicles	Portable air compressor
Industrial 3	Develop and manufacture sonic toothbrushes.	Toothbrushes
Industrial 4	Develop and manufacture hair loss solution	Hair care products
Industrial 5	Production of insect repellents	Non-toxic insect repellent

- **Chapter 5** deals with cross-case analysis. It analyses the impacts of the CRDF on each firm.
- **Chapter 6** presents and reports the findings of this study. Its interpretation is based on reviewed literature. This chapter also highlights the impacts of the CRDF and its possible limitations.
- **Chapter 7** summarises the main contribution of this study and also outlines how key ideas derived from the research can provide insight for future research in related areas. Limitations of the study are also presented in this chapter.

Chapter 2 : TECHNOLOGY DRIVEN GROWTH STRATEGIES

2.1 Introduction

This chapter sets the scene for the investigation of Government initiatives to develop high technology industries in emerging economies. This chapter describes the origin, rationales and mechanisms taken by Governments to facilitate local industries to venture, survive and develop in high technology sectors. It highlights how the state assumes important roles within those initiatives for economic development. There is a significant amount of literature on the roles of the state and research findings that are based on high-ranking emerging economies, but few studies have been conducted in the environment of mid-ranking emerging economies. This study is conducted in Malaysia as an example of a mid-ranking emerging economy, therefore, research needs to explore and understand the process and dynamic of development of high technology sectors in the presence of Government support.

This study investigates the influence of Government industrial policies on firms' competitiveness in the high-technology sector in an effort to understand policy impacts. From this understanding, there will be a potential for improvement in the policies' design and implementation. This study pays particular attention to identifying the existence of effective business activities within firms in high-technology sectors in presence of government support. Providing support has become a common objective of governments policies in emerging economies which try to enhance the industrial institutions' competitiveness from their inception. This study considers theories that try to uncover industrial institutions competitiveness in the high technology sector. Prominent theories in strategic management literature that explain how firms can develop business programmes and sustain competitiveness include the RBV (Barney, 1991) and the DC approach (Teece et al., 1997). These theories can be used in evaluations of industrial policies that intend to promote the industrial institutions competitiveness conditional to their practicality and limitation.

2.2 Emerging economies and industrialisation

Research on economic development pays particular attention to regions or countries that were able to position themselves as contributors to global wealth. It has been acknowledged that Western economies[6] are the frontiers of the world economy (Szirmai, 2012). Previous studies have reported that their contribution can been seen in terms of production of capital and intermediate goods. These goods have been enjoyed not only by consumers in the Western economies but also consumers around the world. This has influenced good economic growth amongst the Western economies. However, recent evidence suggests that the global economy started to consider progress beyond the Western economies (Amsden, 2008; Rasiah and Yun, 2009). Countries from different continents such as Japan and South Korea (Korea) have emerged as new blocks of economies that have managed to achieve remarkable progress in economic development (Akkemik, 2009).

Several attempts have been made to categorise the new block of economies. For some researchers (e.g. Hobday and Rush (2007) and Page (1994)) these economies are known as developing countries. Meanwhile, for other researchers, the term Newly Industrialised Economies (NIEs) has been used to recognise these economies (Kim and Nelson, 2000; Weiss, 2002). In an effort to refine this, Hoskisson et al. (2000) suggest that these economies could be known as emerging economies. The term covers developing countries in Latin America, Africa and Middle, NIEs in Asia and transition economies in the former Soviet Union and China. In a review of economic strategies, Hoskisson et al. (2000) underline that emerging economies might have experienced rapid and better economic growth compared to traditional industrialised economies (i.e. Western countries). Other scholars also observe the same and provide more critical perspective on emerging economies. For example, Amsden (2001) identifies problematic characteristics of emerging economies which are: 1) market (industry) is not well developed and 2) weak private sectors and 3) entrepreneurship is not well developed.

[6] Szirmai (2012) describes the Western economies as countries in Europe and North America that have been promoted manufacturing sectors as the main engine of accelerating economic growth since nineteen century such as Great Britain, Germany, Russia and the United States.

The above descriptions by Hoskisson et al. (2000) and Amsden (2001) impart further interpretations on emerging economies. Among other factors, they describe about the variation within emerging economies in terms of their growth and growth conditions. Booth (1999) supports this notion when she compares the economic performance of emerging economies in Southeast Asia in terms of per capita gross domestic product (GDP) and annual growth rate. She implies that the emerging economies performed heterogeneously based on their initial conditions before embarking on economic reform. For example, some countries showed very modest growth rate although GDP has accelerated and these countries are considered as low-rank emerging economies. Next group of countries are mid-ranking emerging economies such as Malaysia and Indonesia. The economic achievement of this group is considered better than low-rank emerging economies in terms of per capita income but grew at slower phase compared to top-rank emerging economies such as Japan and South Korea.

Despite the above heterogeneity, emerging economies have received much attention from researchers because some emerging economies were seen as trying hard to join the Western economies at the frontiers of the global economy. Page (1994) suggests researchers' interest was based on the fact that past experience showed that emerging economies were having limited economic capabilities and conditions that hindered growth. Indeed, historically, emerging economies are often associated with low-income economies that pose significant political and social risk (Booth, 2007). Prior to the 1950s, most emerging economies were resource-focused economies dependent on primary economic activities such as agriculture, mining and plantation (World Bank, 1993). Their economic yield was derived from export of commodities such as crops, tin and timber from primary economic activities (Jomo, 1993). The commodities were exported to industrialised economies in the West. Then, the industrialised countries processed the commodities into finished products using appropriate technology, largely in manufacturing (Szirmai et al., 2013). These economic activities led the emerging economies to experience low per capita income and to some extent they had been categorised as low income and poor countries (Booth, 1999).

In the beginning of the1970s, a small group of countries in East Asia managed to break away from the persistent trend of being low income and technologically backward countries (Pack, 2000; Taylor, 2007). These economies experienced a fourfold increase of per capita income over a 35-year period facilitated by industrialisation (World Bank, 1993; Taylor, 2007). The amazing achievement attracted global attention because comparatively, it took more than 80 years for developed economies to achieve the same percentage increase through the process taking place (Nelson and Pack, 1999). For some researchers, the term emerging economies started from this realisation. The World Bank considered the success of these countries as an economic miracle that deserves further investigation in order to set an example to the rest of emerging economies (World Bank, 1993).

The World Bank's interest in emerging economies has given an indication that this group of economies might bring more prosperity to global wealth. In fact, this is what is interesting about this context, because it does not only discuss countries in terms of economic status but also their anticipated progress. For example, in terms of per capita income, the top performing emerging economies like Japan, Korea, Taiwan, Hong Kong and Singapore, were to achieve developed economy status by the early 1990s (Kay, 2002). This was followed by Malaysia, Thailand and Indonesia as mid-rank emerging economies. Besides economic status, the rate of growth in certain emerging economies like Malaysia and Thailand averaged more than eight percent between the early 1980s and early 2000s (Rasiah, 2003). Furthermore, from 1980 to 1995, Malaysia, Singapore and Thailand doubled their real income per person. Compare this progress to certain developed economies, for example the United States, which managed increase of only 20 per cent (Taylor, 2007). The significant growth looks even better when compared to the marginal growth of other industrialised countries and many other regions in the world (Nelson and Pack, 1999). While the Asian financial crisis in 1997 may to some extent have overshadowed the East Asian emerging economies miracle (Nelson and Pack, 1999), nevertheless the countries' leap from poverty, economic and technological backwardness over a considerably short period of time encouraged further investigation on emerging economies. Having discussed the background of emerging economies, the next section will examine and discuss how emerging economies managed to catch-up with developed economies.

2.3 Catching up with industrialisation

One explanation for the remarkable economic growth within the emerging economies is their ability to make changes in the economic structure (Nelson and Pack, 1999). This was also the same successful recipe for developed economies' transition in the eighteenth and nineteenth centuries (Sylla and Toniolo, 1991). However, the changes in economic structure took place at a faster place within emerging economies out of necessity in order to catch-up with more advanced economies of the West (Dowling, 1997). For emerging economies, the catching-up process for industrialisation can only be explained from cases of countries that focused on primary activities prior to the rise of the manufacturing sector. The exception applies to urban-based emerging economies like Hong Kong and Singapore that possess limited geographical advantages compared to other emerging economies such as Malaysia, Thailand and Indonesia. As explained by Vogel (1991), in Hong Kong and Singapore, structural change took place in the event of diminishing of small scale agriculture activities due to its minimal contribution to the countries' economy.

Based on the initial conditions amongst emerging economies, scholars seem to have different perceptions about past, present and anticipated performance of this economic group. Scholars suggest that structural change in the emerging economies has been taking place in different configurations. Among others, the manufacturing sector has become more prevalent in replacing agriculture and primary economic activates (World Bank, 1993; Szirmai, 2012). However, there were also emerging countries that skipped manufacturing sector as a move towards economic structural change. For example, India has been concentrating on the services sector, especially in information technology (IT). One explanation could be related to resource endowment, government encouragement and opportunities (Arora et al., 2001). In the Indian case, the structural change into the IT sector was facilitated by the ample supply of English speaking engineers but low demand for their skills from the local market (Arora et al., 2001). Although the Indian case deserves attention, most of emerging economies experienced rapid and massive structural change by venturing into manufacturing sectors.

According to Amsden (2001), one of the major reasons for emerging economies to embark on manufacturing-led industrialisation is because the states' intention to catch-up with advanced economies by emulating their industrial composition through establishing manufacturing activities that produce more advanced products such as electric and electronic goods. Szirmai (2012) supports Amsden's proposition by affirming arguments on why manufacturing is essential for economic development. However, not all points highlighted by Szirmai (2012) are applicable because he only compares manufacturing to the agriculture sector, where the former might present clear productivity advantages. Pisano and Shih (2012) refine this argument based on the experience of the American manufacturing sectors. They propose that the manufacturing sector is essential in innovation process because it entails the importance of generating and utilisation of technology in the industry. This strengthens Szirmai's argument that manufacturing is more important for technology catching up compared to the service sector like the IT sector.

Scholars also discuss the catching-up process within emerging economies by highlighting the possibilities of emulating the industrial composition of advanced Western countries, which was manufacturing oriented (Kim and Nelson, 2000; Hobday, 2003; Hobday and Rush, 2007). In this context, industrialisation is acknowledged as a way of catching-up. As described by Weiss (2002), industrialisation is seen as a country's transformation process that emphasises economic diversification. From this broad overview, industrialisation was defined by scholars differently. Several studies have characterised industrialisation as a process in which the proportion of national income derived from primary activities is less than that derived from manufacturing activities (Chandra, 1992). Indirectly, this definition tries to show the share of industry in general, and of manufacturing in particular, in total economic activity is increased (Weiss, 2002). In contrast, other authors have described industrialisation as a process of change in allocating resources from low value added to more modern economic activities. Therefore, one can conclude that industrialisation can be described differently depending on the studies' context but in any case needs to focus mainly on structural change or economic diversification. For emerging economies, industrialisation is often associated with phenomena of economic performance. Indeed, industrialisation facilitates the remarkable economic performance by supporting the rapid pace of economic diversification.

The industrialisation process as a catching-up strategy has also been discussed under accumulation and assimilation perspectives (Nelson and Pack, 1999). These perspectives consider the conditions of emerging economies when they tried to establish new economic sectors; in which they lack of knowledge and experience. From the accumulation point of view, emerging economies seem to have benefited from mobility of resources by Western multinationals corporations (Vogel, 1991). The strategy was to make massive investment in physical and human capital to attract the multinational corporations (MNCs) to establish manufacturing plants.

As Southeast Asian industrialising economies, Malaysia, Thailand and Indonesia have set an example of mid-rank emerging economies that were heavily dependent on FDI for economic structural change. The countries seem to be catching-up with the top-rank emerging economies although they are still lagging behind in certain aspects of economic performance. Prior to the 1960s, the share of primary sectors in these countries' GDP was almost 50 per cent (Intarakumnerd et al., 2002; Rasiah, 2003; Jomo, 2007). At that time, with ample natural resources and the absence of other economic activities especially manufacturing activities, led to a view that these countries were complacent due to their position as commodity exporters (Booth, 1999; Jomo, 2001). This situation is contrasted to the position of top-rank emerging economies in North East Asia which saw economic diversification into the production economy as a crucial economic strategy due to limited natural resources. Therefore, the top-rank emerging economies imperative to industrialise was much greater as was their need for support from strategic partner (Jomo, 2001).

According to Amsden (2001) emerging economies in North East Asia had acquired significant manufacturing experience before embarking on industrialisation although this experience was limited to simple and light manufacturing activities. The absence of such advantage left the Southeast Asian economies behind in industrialisation since its inception (Booth, 1999). Under the same context and due to other reasons, Jomo (2001) argues that Malaysia's and Indonesia's lack of experience in manufacturing sectors during colonial period had impeded their propensity towards diversification into production economy. Nevertheless, the primary commodity production continued to dominate the Malaysian and Indonesian economies in the early years after independence. Therefore, this initial perspective of structural economic change has influenced the East Asian emerging economies to adopt different strategies towards industrialisation.

Following to this, industrialisation can be studied from several perspectives because each emerging economies possess different experiences in manufacturing activities (Chandra, 1992). In this sense, countries within emerging economies have adopted various mechanisms at different magnitudes when utilising resources from the FDI activities (World Bank, 1993; Jomo, 2007). Shin and Chu (2006) recognise this phenomenon by categorising the mechanisms into three models. Each mechanism tries to explain the FDI's roles and its interaction with local resources in industrialisation. The first mechanism is known as the nationalist model (Shin and Chu, 2006). In this model, FDI plays minimal roles in the industrialisation. Instead, the local institutions play more active role in that process. South Korea (Korea) is an example of emerging economies that adopted this model. In a discussion about Korean industrialisation, scholars have been highlighting the role of state-owned conglomerates, also known *chaebols,* compared to FDIs (Amsden, 1989; Vogel, 1991; Jomo and Togo, 2003). The *chaebols* have been playing such critical roles in South Korea's industrialisation especially in the development of new and emerging industries such as heavy industries. The *chaebols* have been acting as central institutions that provide financial and technological resources to the local SMEs under an umbrella concept. However, before the *chaebols* are able to perform that role, these state-owned institutions opted to seek foreign resources, especially financial resources. In fact, this pathway of industrialisation is often associated with high risk bearing because it involves high level of foreign borrowings.

The second mechanism is known as the internationalist model, which highlights foreign resources as the central pillars. Singapore is an example of emerging economies that adopted this model. In this model, the MNCs have been playing vital roles in industrialisation by providing most of the resources to establish and develop manufacturing activities. This includes management personnel and training. This path became more popular among very late industrialising countries because it facilitates the rapid structural change into production based economic activities. For some researchers, this type of industrialisation is considered a total relocation of MNCs production lines to countries that are able to offer cheaper labour cost. Although it is the MNCs' justification, Shin and Chu (2006) consider this strategy as complementing economic development. For the host countries, this type of industrialisation might lead to rapid increase in jobs offer, increase in the countries' GDP through export activities and diversification of the manufacturing activities within their territory. For the MNCs, this strategy meant they could produce high volume of products at a competitive price and also penetrate the local market.

The third model is known as the semi-internationalist model and Taiwan is an example of emerging economies that adopted this it. This model promotes balanced roles of local and foreign MNCs in industrialisation. However, this model does not focus on local big business groups like Korea. Instead, this model has empowered the private economy sector that mostly run by locals in the form of SMEs (Akkemik, 2009). The local SMEs then try to establish a joint-venture with the foreign MNCs in sub-contracting activities. Besides the desire of the local companies to establish joint-ventures, the MNCs are deemed to offer opportunities for technology transfer and source components from local sub-contractors.

As described above, the emerging economies could adopt different models for industrialisation which require different mechanisms to make them work. Although this could lead to comparative studies on emerging economies, scholars have highlighted a common pattern in this process (Wade, 1990; Weiss, 2013). In an analysis of industrialisation pathways, Shin and Chu (2006) highlight the important role state has played in the industrialisation process in emerging economies that have been adopting either nationalist, internationalist or semi-nationalist mode. For Jomo and Togo (2003), the active state role in industrialisation shows the significance of industrialisation in the context of under emerging economies. For instance, governments in emerging economies embrace industrialisation as an imperative national strategy for economic development. Based on this, governments have introduced a number of industrial policies to support the industrialisation.

2.4 High technology industrialisation within emerging economies

The implementation of industrial policies within emerging economies has sparked interest among researchers. For example, how governments in emerging economies justify the application of such policies in the context of an open economy context that demands minimal government intervention (Williamson, 2008). The main argument was that there should be more private sector roles in a globalised economy. Whereas, governments' roles should be confined to providing macroeconomic stability and establishing adequate legal and regulatory frameworks to encourage and sustain industrial development.

This argument becomes more prevalent under the second wave of modernisation of industries in emerging economies. After mixed outcomes of industrialisation, emerging economies once more tried to emulate the industrial structure of advanced economies. This time it was about establishing high technology industries. In fact, this can be explained by the desire of governments to develop high-technology sectors (Hobday and Rush, 2007). However, in certain mid-rank emerging economies such as Malaysia and Thailand, the government intention was regarded as a planning fallacy because the first wave of industrialisation was limited to turning local industries into assemblers of high-technology products for foreign MNCs (Hill and Chu, 2006). One weakness of this form of industrialisation is that high-technology sectors in emerging economies remain dependent on foreign developed technology (Özcelik and Taymaz, 2008). Yet, the high technology sectors are considered important for the economic development of emerging economies in order to promote innovation, technological competitiveness and the creation of high-paid jobs (Walsh et al., 1995). Again, this has created doubt especially in mid-ranking emerging economies as they try to position themselves in well-developed industries (e.g. pharmaceutical, bio-technology and advanced engineering). In most cases, these industries are dominated by large and well established firms from developed economies. In this sense, the mid-ranking emerging economies like Malaysia are seen as very late entrants into high technology sectors. In high technology industrialisation, emerging economies were facing greater challenges compared to the first wave of industrialisation because the conventional strategies of FDI are not a viable option. The main justification is about the core element of high technology sectors which is about promoting innovation within local firms.

2.5 Industrial policy and industrial development

According to Johnson (1982), the term industrial policy has changed a lot overtime. Industrial policies were once defined as direct intervention of the state in the economy by imposing direct control to large part of the production apparatus (Johnson, 1982). This definition has underpinned an understanding that industrial policy was introduced by governments to limit certain activities within industries. Recently, industrial policies are described as variety of policies aimed at creating an environment that is favourable to industry development (Hill and Chu, 2006). This recent definition is more applicable to emerging economies because the aims of the industrial policies are about supporting the industries by allocating appropriate resources for their development (Weiss, 2013).

Under the internationalist model of industrial policies, Amsden (2001) explains how such policies have been implemented to support high technology industrialisation. The Singaporean Government has been using industrial policies in form of government labs, intellectual property protection and financial incentives to encourage MNCs to set up high technology manufacturing plants. More importantly, the Singaporean government through those policies has been able to convince MNCs to set up R&D centres in that countries. Foreign companies hardly conduct R&D in emerging economies therefore the presence of active foreign R&D in Singapore indeed demonstrated the intensity of their industrial policies. The magnitudes of such governments' industrial policies have given positive impact to emerging economies in terms of uplifting their industries capabilities. For instance, the Korean government under the nationalist model seems more proactive in supporting the local big corporations through industrial policies. In the case of industrialisation in petro-chemical and steel industries, the state provides the industries with an array of incentives in the form of tax benefits, subsidised loans and up to access to limited raw materials (Shin and Chu, 2006). By having such privileges through industrial policies, big corporations in Korea have been able to rapidly develop and compete in new business areas (Yong, 2003).

The argument about the role of states in economic development has been intensified in the context of international industry development. As explained in the previous section, emerging economies such as Malaysia have embarked on industrialisation as the main route to modernising their economy. As experienced in the first wave of industrialisation prior 1990s, governments in emerging economies were again trying to rely upon policies to promote high technology sectors. This move seemed applicable because high technology sectors are relatively new industries for emerging economies. Rasiah and Yun (2009) affirm this argument based on their observation that local firms ended-up becoming assemblers of high technology products that were designed and developed in more advanced economies. For Malaysia, policies to support high technology sectors are paramount in its pathway to becoming a fully developed industrialised economy[7] (Mahadevan, 2007). Most of the policies have focused on SMEs as they constitute 90 percent of local industry (Mahadevan, 2007)

In most cases, discussion about industrial policies focused on two streams. One stream stems from proponents of neo-classical thinking of economic development. In this stream, government interventions through policies are regarded as distortions. This suggest that market drives economic development (Wade, 2012). However, in certain circumstances where government interventions work, such policies are considered as market-friendly policies. Another stream draws upon the situation where market cannot perform its roles and government tries to overcome market failure (Amsden, 1989). In fact, this concept is derived from the experience of rapid growth of top ranking emerging economies (e.g. Japan and South Korea) that emphasise the degree of autonomy enjoyed by key decision makers (i.e. policy makers) (Johnson, 1982; Johnson, 1995). In his early observation on Japan, Johnson (1982) believes that the Japanese have built their economy based on strong government intention and dependent on policy makers' discretion to channel resources of industrial development. Indeed, Johnson's observation is an appropriate case for application of policies for economic development because the country was a top ranking-emerging economy that managed to become an advanced developed economy. Besides that, Japan has set an example as a country that was affected by wars and was able to immediately make industrial breakthrough in the 1960s (Chenerey, 1988). The main justification is that the Japanese Government introduced a number of policies initiatives to build competitive industries.

Despite the exceptional experience of top ranking emerging economies, Wade (2012) still casts doubt about the applicability of policies for economic development. Wade's concern might be substantiated because emerging economies are still struggling to become developed economies after the implementation of such policies to promote competitiveness within their local industries. This case becomes more prevalent when mid-ranking emerging economies like Malaysia try to embark on more radical industrialisation; into high technology industrialisation for economic development.

According to Atkinson and Ezell (2012), emerging economies face a great challenge to promote high-technology industrialisation. The aims of this type of

[7] A country that is able to achieve stable economic growth through technological and infrastructural advancement. Industries in this type of economy are the frontier in technological advancement (Mahadevan, 2007).

industrialisation is different from ordinary industrialisation that tries to introduce and promote manufacturing activities into emerging economies (Ali, 1992). In fact, high technology industrialisation is a transition process from assembly-type manufacturing to high technology manufacturing. Nelson and Romer (1996) describes this process as a transition from simple, labour-intensive and low value-added industrial activities to those embodying more intensive use of human capital and technology. In the context of emerging economies, policies for high-technology industrialisation are targeting local firms to venture into high-technology sectors. According to the European standard, firms that venture into high-technology sectors can be recognised as high-technology firms or/and new technology based firms (NTBF) (ENSR, 2002).

For SMEs, high technology firms are characterised by mainly through R&D activities, and selling marketable products/services with a high degree of technology content. The degree of R&D activities within a firm is called R&D intensity. R&D intensity in this study is measured by innovation input factors, which are the R&D expenditures as a percentage of sales and by the human capital input, which is the number or percentage of scientists, engineers and qualified personnel in R&D of a firm (ENSR, 2002). In addition, firms belonging to some specific industry sectors characterised by being R&D intensive are considered altogether as high technology. Meanwhile, researcher considered NTBFs are superior to high-technology firms due to following characteristics (ENSR, 2002):

- develops, produces and sells products, which are based on a high rate of complex and changing technologies and/or new technologies.
- firms which, can be identified as new technology in high technology sectors, in general or in specific industries such as information and communication technologies (lCT), electronics, laser technologies, biotechnologies, scientific instruments, etc.
- They are often established in particular geographical locations such as near to universities, innovation centres and science parks.

Above all, high-technology industrialisation does not only require governments' commitment to encourage local firms to utilise technology but also to support them to develop new technology into finished products or processes (Blanes and Busom, 2004). For Smith (2015), the process of developing new technologies and utilising them into products can be regarded as an innovation process (page 87). Figure 2–1 illustrates the innovation process.

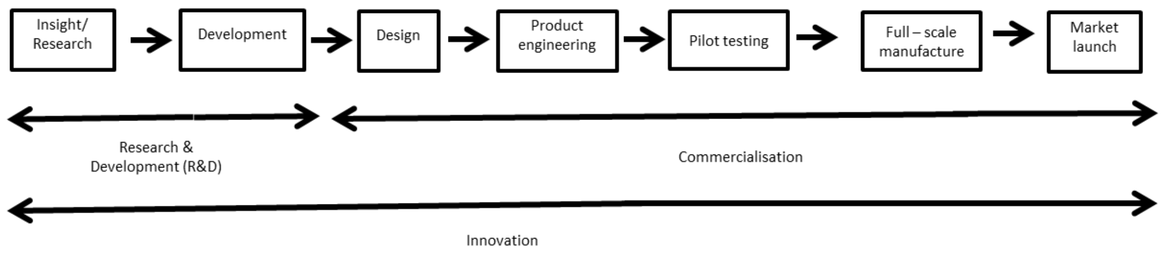

Figure 2-1: A generic model of innovation process

Source: Adapted from Smith (2015, p.90)

Figure 2–1 justifies elements that drives firms' innovativeness which are crucial for high technology industrialisation. Scholars agree that innovation is a complex process (Lee and Gaertner, 1994; Hindle and Yencken, 2004; Rasmussen, 2008). Lee and Win (2004) affirm it is not a straight-forward process but it is often simplified by the policy makers. In this process, Lee and Gaertner (1994) suggest there are two components involved: 1) technology development and 2) technology dissemination. The former component focuses on discovery of new material, technique or solution. Meanwhile, technology dissemination involves a process of bringing the output from the technology development into usage that is embedded in finished products (Lee and Gaertner, 1994). The two processes need to co-exist in order to maximise the technology utilities (Etzkowitz, 2008). However, it is quite difficult to ensure this objective is achievable. Lee and Win (2004) suggest that the technology development process is highly dependent on R&D activities. Indeed, R&D activities play a vital role in technology development by trying to resolve scientific and technological uncertainty (Lee and Gaertner, 1994). The solutions or discoveries from the research activities could be further developed into finished products or services (Palmberg, 2006). Rasmussen (2008) argues that research activities will not necessarily end up with a production of new high technological products. Yet, governments in developed and emerging economies continue to support R&D activities because it could be translated into ground breaking products by local firms (Blanes and Busom, 2004). However, more efforts are required to commercialise R&D outputs into high technology products.

In the innovation process, it is difficult to turn research outputs into finished products. Nevertheless, it is not a surprising phenomenon because most research activities have been carried out by academics in universities or researchers in research institutes, compared to private firms (Lee and Win, 2004). In universities and research institute firms, the research activities are more focused on advancement of knowledge through scientific breakthrough (Archibald and Finifter, 2003). Despite this argument, Lowe (1993) believes that research activities in universities play a vital role in the development of indigenous technology but need appropriate means to disseminate the new technology into the economy. Otherwise, there will be a gap between technology development and technology dissemination process. As a result, the development of indigenous technology would not able to contribute to economic prosperity (Siew-Yan and Mat Zin, 2006).

Scholars focusing on pathways to increase firms' innovativeness, study the routes taken by various parties globally (Rasmussen et al., 2006; Kroll and Liefner, 2008). The routes can be categorised into: 1) enrichment of R&D activities (Lockett and Wright, 2005; Lee and Park, 2006) and 2) promotion of commercialisation activities (Lowe, 1993; Svensson, 2007). Scholars tend to agree the R&D activities are mainly conducted by universities or research institutes, whilst become the target to enrich technological breakthrough (Rasmussen et al., 2006). The main objective is to increase numbers of newly developed technology, the academics and researchers are urged to conduct more research activities. Governments have played an important role in this effort by providing research funding to universities or directly to groups of researchers within universities to encourage them to conduct research in specific areas such as advanced materials, bio-technology, pharmaceuticals and oleo-chemicals (Mahadevan, 2007; Özcelik and Taymaz, 2008). The provision of research grants to academics is considered a common policy approach to promote innovation (Lockett et al., 2005). As a result, more academics in universities are motivated to engage with research activities. Yet, Rasmussen et al. (2006) argue that this route is only partially effective in developing high technology products because researchers and academics prefer to manifest their research outputs through knowledge creation. Naturally, universities are able to increase the number of academic publications, PhD graduates and patents filed (Svensson, 2007). However, Wright et al. (2006) suggest that more efforts are needed from universities to develop the research outputs further into finished products.

In recent years, universities are increasingly expected to play a more active role in the innovation process (Mian, 1997; Etzkowitz, 2008). This expectation has forced universities to find appropriate avenues to further develop the invented technology into finished products (Mian, 1997; Yencken and Gillin, 2006). Studies of commercialisation activities within universities focus on determining the best avenues for universities to proceed with commercialisation activities (Wright et al., 2006). Such avenues that have been considered include spin-off companies, contract research, licencing, consultation and partnership with industries, either with SMEs or large companies (Lee and Gaertner, 1994; Storey and Tether, 1998). Lee and Gaertner (1994) suggest that each avenue taken for commercialisation within universities had given different magnitudes about commercialisation activities. For example, certain studies focus on availability of resources and support needed for universities to proceed with those avenues (Lee and Win, 2004; Lockett and Wright, 2005). Rasmussen (2008) argues that this type of studies are only able to explain the organisations' (universities) capabilities to engage with commercialisation activities, but without explaining the details of commercialisation activities.

Above all, Atkinson and Ezell (2012) stress that emerging economies need to face the great challenge of developing the high technology sectors. The process will not only require efforts to encourage local companies to develop technology but also supporting them to commercialise new technology into finished products or processes (Lee and Gaertner, 1994). The commercialisation process requires amongst other things rigorous safety testing and up scaling production of the invented technology at a viable cost (Blanes and Busom, 2004). Lee and Gaertner (1994) consider commercialisation activities to be part of risky, time consuming and costly process. These factors place more challenges on local firms to succeed, thereby reducing their interest in getting involved in high-technology sectors (Lerner and Kegler, 2000). For these reasons, commercialisation activities are an aspect that is particularly challenging for those formulating policies in this area (Lerner, 1999).

Governmental industrial policies that are designed to support innovation activities can be categorised into fiscal approaches, e.g. grants and soft loans, and non-fiscal approaches, e.g. infrastructure and training programmes (Hill and Chu, 2006). Within that, industrial policies using fiscal measures emerged as a common avenue to overcoming market failure in commercialisation activities (Hill and Chu, 2006). Özcelik and Taymaz (2008) highlight that fiscal measures are able to reduce companies' financial burden and increase their propensity towards commercialisation activities.

In studying fiscal approaches to promote innovation through commercialisation activities, Lerner and Kegler (2000) suggest there is little consensus about the best evaluation methodologies. Lack of consensus is due to different effects of the measure; promote awardees business performance or/and innovation performance. Therefore, Salmenkaita and Salo (2002) suggest the effectiveness of fiscal initiatives could be investigated through constructive and ex-post approaches because awardees are expected to grow according to different trajectories after receiving the fund. These approaches were adopted widely by studies within developed economies (Lerner, 1999; Wallsten, 2000) and generate mixed repercussions. The studies suggest that there is often mismatched between business performance and innovation performance among the awardees (Lerner, 1999). The fiscal measure is eventually skewed towards improving the awardees' sales and profitability but there is hardly any improvement to the rate of patenting and introduction of new high technology products activities (Wallsten, 2000). Instead, the innovation activities could only be credited with allowing companies to continue with R&D activities at a constant rate (Blanes and Busom, 2004). This led to a major argument about what are the long-term and short-term effects of the fiscal measure on the awardees' innovation capabilities (Oakey, 2012). The next section will examine and discuss how to strengthen the role of firms within the innovation process when faced with a supportive Government environment.

2.6 Policy mechanism and role of government in innovation

This part of the chapter discusses how policies to support innovation affect the behaviour of firms. This section analyses relevant theories that are applicable to study of the innovation behaviour of firms in the presence of policy initiatives providing government-backed financial support. In general, policy documents for the development of high-technology sectors underscore the importance of promoting innovation activities in an economic system. In practice, this means industrial policies try to establish effective interaction between government, education and industrial institutions (Nelson, 1993) in order to influence industries to engage in innovation activities. Therefore it is reasonable to argue that governments are guided by a belief that a country could expect superior performance if they are able to promote innovation activities amongst industries. This has led to a simplistic assumption that once industries possess innovation, they might be competitive in those sectors. This linear assumption has led to a simple evaluation of industrial policies. It means that, from a government's perspective, the industrial policies are deemed to be effective when there are positive economic indicators such as GDP, per capita income and active export activities.

In recent years, policy makers have been developing policies that are more refined and rigorous. Government documents outline the objectives, aims and implementation mechanisms of those policies in clearer language. This improvement is essential in efforts to minimise the risk of government failure in economic development (Porter, 1998; Weiss, 2013). According to Kim and Nelson (2000), it is important for studies to understand that the aim of industrial policies is to promote industry competitiveness. A particular area that has been receiving a great deal of interest is the measurement of industrial competitiveness in the presence of supportive programmes. It is still unclear how these supportive policies influence industrial competitiveness, especially given the absence of detailed investigation of what is happening in the industry. It is suggested that firm level assessments could give a more accurate answer to that question than those at industry level. At firm level, an assessment of the industrial competitiveness considers occurrences within the industrial institution and their interaction with the external environment. Therefore, this type of assessment is essential to reinforce the simple evaluation of industrial policies.

Apart from considering the external factors, scholars have highlighted a number of internal factors that could influence the competitiveness of institutions. Inward-looking aspects such as firm strategies, firm activities, managerial competencies and possession of strategic assets have emerged as common competitiveness factors (Barney and Hesterley, 2006; Helfat et al., 2007; Porter, 2008). A number of studies have been building on these elements and have attempted to introduce evaluative frameworks. However, an evaluative study is not complete without underlying theories as evaluative framework (Osman, 2002; Walt, 2005; Donaldson and Lipsey, 2006). In general, theories may act as a lens for explaining how aspects of reality work and increase understanding about the context of the study. In an evaluation on the success of small firms, Fiet (2001) suggests that theory is important because it is close to truth and therefore can be used to discuss the difference between correlation in empirical observation and causation. More importantly, theories could be useful for understanding the nature of what we evaluate, and how to assign value to a programme and its performance (Donaldson and Lipsey, 2006).

This study investigates the influence of industrial policies on a firm's competitiveness in the high-technology sectors in an effort to understand the policy's application. By empirically studying interaction between policy and firm behaviour, it is possible to identify areas for improving policy design and implementation. Particular attention is paid to evidencing the existence of effective business activities within firms in high-technology sectors that can plausibly be linked to the presence of government support. This includes the concept of national innovative capacity that discusses the fundamental conditions, investments and policy choices which create an environment for innovation. In this context, we have reasons to assume that emerging economies perform differently in building up their innovative capacity. This study also considers theories in strategic management literature that explain how firms can develop business programmes and sustain competitiveness: the RBV (Barney, 1991) and the DC (Teece et al., 1997). These theories can be useful for the evaluation of industrial policies that intend to promote the industrial institutions competitiveness conditional to their practicality and limitation. The next section analyses potential organisational behavioural theories that are applicable to research innovation.

2.6.1 National innovative capacity and innovation system

Industrial policies can be acknowledged as a useful tool to intensify interaction between government and industry. With respect to high-technology industrialisation, industrial policies are an important element to promote innovation in the economic system (Hung and Chu, 2006). This process is part of an effort to increase national innovative capacity and it is partially dependent on the nature of firms and governmental institution organisations, the business environment and the way they approach technological innovation (Dodgson, 2000). Therefore, technological development cannot be viewed as a well-focused activity nor approached through a single context, but as part of a wider environment that forms the innovation system.

In building up national innovative capacity, most economies, including emerging ones, have been dependent on their capacity to establish an effective national innovation system because the optimum aim of the innovation concept is competitive (Lall, 1992; Kim and Nelson, 2000). The development of innovation within nations can be looked at from the national system of innovation (NIS), the Porter competitive framework and the Triple Helix concept. These concepts will be discussed in the following sections.

2.6.2 National System of Innovation

Many authors have defined National Innovation System (NIS). For example Chris Freeman (Freeman, 1987) defines NIS as:

> *"..the network of institution in the public and private sectors whose activities and interaction initiate, import, modify and diffuse new technologies."*

While Lundvall (1992) views NIS as:

> *"..the elements and relationship which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state...also national innovation system is a social system ... and a dynamic system."* (p. 2)

Nelson and Rosenberg (1993) on the other hand, see NIS as representation of:

> *"the set of institutions whose interaction determine the innovation performance of national firms".*

Patel and Pavitt (1994) presents NIS as:

> *"the national institution, their incentives structure and their competences, that determine the rate and direction of technological learning (or the volume and composition of change-generating activities) in a country".*

From the above definitions and descriptions, there are deemed to be three elements to NIS which can help further understanding of national innovative capacity. First, NIS focuses on the indigenous elements of a specific nation. For example the national technology, skills and knowledge, the national economy setting, the roles played by national institutions and national policies and regulations. These indigenous elements are important for local development in technologies and innovation. Second, the NIS highlights interaction between local firms and local institutions such as universities, research institutes, financial capital institutions, government agencies and other system performers within a nation. These system performers are responsible for presenting and supporting innovation in a particular nation. Third, the NIS emphasises learning factors within nations. This element imparts a view that nations might learn differently. This is based on a perception that nations use dissimilar strategic approaches and mechanisms confined to the different culture and norms of nations. To illustrate, knowledge creation, technology transfer and diffusion, development of technological skills and capacities from developed economies are not comparable with emerging economies or even less developed economies. In this sense, NIS for particular economies could be improved by learning from others and their past experiences. This learning factor is changing on the basis that policies towards innovation are not always perfect, hence policy makers learn from mistakes for continuous improvement. This includes getting feedback from innovation system actors from various levels such as universities, industries and government.

As stated above, the NIS highlights the importance of interaction between innovation performers. However, this framework is still subject to review. For example, Godin (2009) argues that the NIS is deficient in formal studies to devise measurement tools that can measure the concept and establish guidelines to empirical system mapping in emerging economies like Malaysia. There is also a notion that NIS is constrained by a narrow focus on concepts and policy practices (Fagerberg and Srholec, 2008). Other issues with the NIS approach are: 1) it offers little in the way of guidance in policy recommendations for policy makers (Lundvall, 2007), 2) it offers little operational value and is difficult to implement (OECD, 2002), and 3) it offers underdeveloped performance indicators to gauge the effectiveness of NIS in producing and exploiting knowledge.

2.6.3 Porter Competitive Framework

In Porter's seminal work, 'The Competitive Advantage of Nations', he explains why different nations gain competitive advantage in particular industries and suggested the diamond model (Porter, 1990). The diamond model as exhibited in Figure 2-2, consists of four determinants: factor conditions; demand conditions; related and supporting industries; and firm strategy, structure, and rivalry. These four determinants mutually affect each other, and a change in one of them affects all three other determinants (Porter, 1990). In addition to these four determinants, government and chance can indirectly influence competitiveness (Porter, 1990). This model also provides a framework for understanding collaboration and networking between the government sector and industry sector in the form of clusters (Porter, 1990; Wonglimpiyarat, 2006).

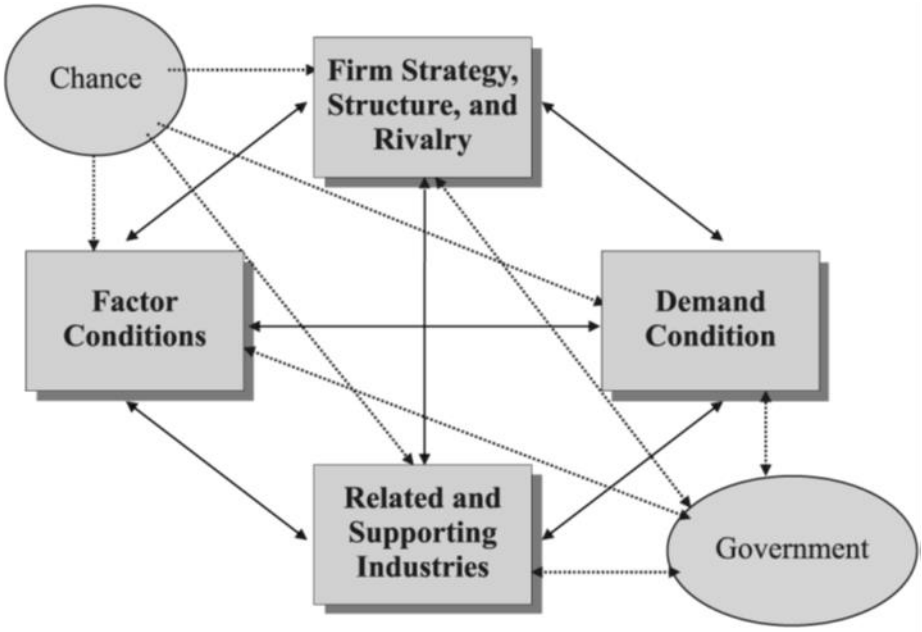

Figure 2-2: Conceptual model of Porter competitive framework

Source: From Porter (1990, p. 72)

Porter proposes that the determinants interact with each other in order to create conditions where innovation and competitiveness happen. The interaction of the determinants as follows:

i. Firm strategy, structure and rivalry

   This force affects at the elements relating to how the nation governs its policy and strategy on the formation of firms; development, organisation, support and management as well as the nature of domestic rivalry.

ii. Factor conditions

   This force affects at the elements relating to local factors-production of nation such as skilled labour or necessary infrastructure which is needed to compete in a given industry.

iii. Demand conditions

   This force affects at the elements relating to the nature of home demand for the industry's products or services. Demand conditions determine the circumstances of domestic demand for products of an industry and an increase in demand has a great influence on competitiveness. Porter (1990) believes that a big growing domestic market will encourage the producers to develop their technologies and efficiency.

iv. Related and supporting industry

   This force affects at the elements relating to existence or absence of nation's related industry and supplier industry that is internationally competitive.

These factors or determinants are accompanied by the interconnection system that creates a nation's new business ventures and enables them to compete. However, the influence of controllable factors of chance can influence the national system as well as the government's influence. Porter (1990) highlights that, although the role of government and chance in obtaining a competitive advantage is very important, these two also have an indirect influence on competition by influencing the other four factors of competitive advantage. It means that the role of government can influence and be influenced by each of the major factors for building competitive innovation clusters of region through its policies. For example fiscal initiatives incentives might influence a firm's strategies, structure and rivalry as it reduces the burden of firms in paying business tax and stimulates them to proceed with more re-investment of their profit.

2.6.4 Triple Helix Model

The other model that discusses the mechanism in building up national innovative capacity is the Triple Helix Model. This model can be considered as an extension of NIS. The Triple Helix model seeks to explore new configurations of institutional forces emerging from NIS. Its main focus is on the relationship between governments, industries (firms) and universities (Etzkowitz, 2008). Although this model emphasises the role of universities as knowledge-producing institutions in the innovation process, it does not neglect the importance of interaction between government and industries. This is based on the argument that the Triple Helix model also highlights the value of nurturing industries through the involvement of universities with researchers and government departments/agencies in ways that are best suited to the particular characteristics and creative satisfaction that is embedded in firms (Etzkowitz and Leydesdorff, 2000).

According to Etzkowitz (2008), there are two different paths or routes to reach Triple Helix which are: (1) the important role of government in controlling the industry and university in the statist model (Figure 2-3) and (2) in the laissez-faire model (Figure 2-4) where limited interaction between actors exists as university, industry and government are separated by the strong boundaries between them. In the statist type of Helix, industries and universities are both involved in specialising and working with the government in charge of developing projects and providing resources. It means on the one hand universities are largely focusing on teaching and industry and are far from intending to get involved in the commercialisation of research outputs whilst, on the other hand, the government has less control than in statist situations but plays a major role when the market is reacting well and the intermediaries are playing an important role in connecting universities, industry and government in this sphere (Etzkowitz, 2008). The evolution of statist and laissez-faire models provides hybridisation roles played by actors while maintaining their core roles and responsibilities in the Triple Helix model (Figure 2-5) to diffuse innovation. Etzkowitz (2008) highlights that in hybrid

Triple Helix model, all actors contributed to innovation and economic activities in their own right and this later resulted in the formation of competitive institutions - either industry, government agencies or universities. Based on this model, each actor plays their role as summarised in Table 2-1.

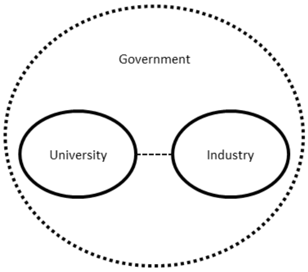

Figure 2-3:The statist model

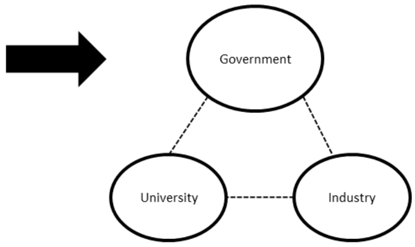

Figure 2-4: The laissez-faire model

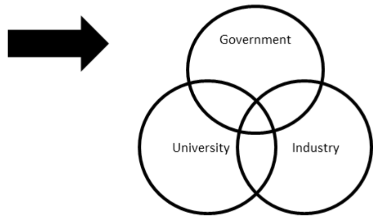

Figure 2-5: The hybrid of triple helix

Source: Etzkowitz (2008)

Table 2-1: Roles of actors in triple helix model

Roles of universities	Roles of industries (firms)	Roles of government
• Involved in economic development by capitalising their expertise and knowledge resources into something meaningful and lucrative	• Firms manage their innovation by learning through alliances and collaboration • Develop external and internal capabilities to link with buyers and suppliers	• Establish plans to stimulate innovation by encouraging public-private partnership

Source: Extracted from Lundvall (1992), Etzkowitz (2008) and Tidd and Bessant (2013)

Based on the above discussion, each actor has their own right to perform in the innovation process. From the government perspective, their role in the Triple Helix model is to create an environment to spur innovation. In the context of emerging economies, governments might play a more active role in making sure that there is effective interaction between the actors. In most cases, governments have developed a number of policies to stimulate either universities or firms to engage with innovation projects.

In the Triple Helix Model, the government is perceived as a catalyst for change. Indeed, Etzkowitz and Leydesdorff (2000) are keen to study changes within universities as a case for active government roles for change, in this context for innovation. They regard the active roles that universities play in technology transfer as an 'academic revolution'. In fact, the universities' contribution has enormous contagious effects not only for economic development but also for competitive advantage (Etzkowitz and Leydesdorff, 2000; Shane, 2004). The changing role of a university from an 'ivory tower' to a research and entrepreneurial university happened as the government realised the important role of universities in creating and diffusing knowledge, in which eventually universities become an agent of industrial innovation. The European Commission reiterates this idea by highlighting that universities could be one of the avenues for implementation of policies to facilitate transition from research to the creation of new ventures (OECD, 1998).

Under the university context within the Triple Helix model, the new ventures are known as spinoff firms or companies. In a broader context, Smith (2006) defines spinoff firms as organisations that are created by another organisation in order to exploit the technology. The exploitation refers to a phase in the innovation process that tries to commercialise research outputs form universities or research institutes. Shane (2004) in his book of Academic Entrepreneurship defines spinoff companies in a much narrower way. He describes a spinoff as a new company founded to exploit a piece of intellectual property created by the academic institutions (Shane, 2004).

Above all, an academic spinoff is a firm that is part of a university's effort to exploit the research output. It can be considered as an efficient mode of turning academic research into commercially valued products. Nevertheless, academic spinoffs are part of high-technology firms that could be actively involved in the development of new technology into finished products or processes (Blanes and Busom, 2004). In this context, it is important to note that firms can play more prominent roles in exploiting innovation alongside universities and government. Firms are deemed more appropriate entities to carry out tasks in commercialisation activities within the innovation process. The commercialisation activities consist of product design, product engineering, pilot testing, full-scale manufacturing and market launch (Smith, 2015). The government and universities could only act as catalysts for these activities by providing incentives through policies initiatives and technical expertise. Therefore, the understanding about interaction between government and firms to exploit innovation via the Triple Helix Model could be extended by recognising how industries or firms could perform their roles effectively. In strategic management literature this element has been discussed within a competitiveness framework. This framework is firm level analysis that looks into how firms can establish their business activities when government plays their role in supporting them to develop capabilities for competitiveness in various sectors including high-technology sectors.

2.6.5 Resource-Based View

Based on the discussion about the NIS, the Porter competitive framework and the Triple Helix Model (in Section 2.6.2, 2.6.3 and 2.6.4), this study recognises the needs to determine the micro-foundation of firms in order for them to engage with innovation activities. While Porter competitive framework and the Triple Helix Model highlight the environment of the firms, the RBV focuses on the key capabilities and resources of a firms to produce and exploit innovation. This includes firms ability to conduct business activities within high technology sectors. A theory for investigating firms' business activities and competitiveness would be the RBV (Wernerfelt, 1984; Barney, 1991). According to Teece et al. (1997), the RBV is an evaluative framework that focuses on profits accumulating to owners of scarce firm-specific resources rather than economic profits from external market positioning. It is firm level analysis. Resources that are valuable, rare, inimitable and non-substitutable are paramount to this theory. This inward looking framework tries to explain the superior performance of an industrial institution is related to the possession of resources. These resources are not only confined to tangible assets like physical resources but also consider intangible assets like knowledge and technical know-how of that institution (Galbreath, 2005).

Penrose (1959) initiated this approach by framing firms as a collective bundle of resources and principally set the underlying condition for conceptualising firms within resource-based premises. She refers to firms as institutions that are made up from resources and these institutions try to consolidate the resources in an effective way. This assertion also explains the importance to acknowledge that firms as organising entities that try to influence industry competitiveness. The RBV also explains that besides possessing heterogeneous resources, firms also need to have abilities to accumulate, develop and organise those assets in order to formulate and implement strategies (Lockett et al., 2009). Otherwise, the resources could be considered ineffective resources in value creation. The RBV therefore relies on the firms' efficacy and efficiency to effectively utilise the resources for firm performance (Galbreath, 2005). Another seminal study by Wernerfelt (1984) has established a positive relationship between resources and profitability. The study initiated the subsequent interest and a body of studies to build on the RBV. Barney (1991) extended Wernerfelt's work by providing a more refined and comprehensive perspective of the RBV. He argues that the selection of resources needs to be based on firms' strengths and weaknesses. As a result, he suggested the possession of certain resources might not only increase firms' profitability but also lengthen that advantage over competitors.

Another argument discussed by Penrose (1959) and Barney (1991) concerns the type of resources that could influence firms' performance. Both scholars suggest that each firm might possess different sets of resources. The possession of unique and advantage-generating resources might be considered fundamental to this model (Barney, 2001). From this one can conclude that not all resources fit into RBV framework. This concept suggests firms might be heterogeneous in their resources and this becomes a vital factor to determine the firms' competitive advantage (Barney, 2001; Alvarez and Barney, 2005). Resources can be unique if they are valuable, rare, inimitable and non-substitutable. These characteristics are known as VRIN and are explained as follows:

i) Valuable resource

Firms' resources are seen as a source of sustained competitive advantage when they are valuable. Barney (1991) suggests resources create value when they allow firms to devise and implement strategies that will improve its efficiency and effectiveness. Departing from the traditional strengths, weaknesses, opportunities and threats (SWOT) analysis, an attribute creates value and becomes a resource if it enables the exploitation of opportunities and/or the neutralisation of threats

ii) Rare resources

In the RBV framework, a firm enjoys competitive advantage when it is implementing unique value-creating strategies that are not simultaneously implemented by a large number of competitors. This is because if a large number of competitors possess a particular valuable resource, then each has the capability to exploit that resource in the same way. Thereby, all will be implementing common strategy which result in none of the firms having a competitive advantage (Barney, 1991). If most competitors hold the same valuable resource, then they will likely explore their use in similar ways, thus implementing the same value creating strategy. This would not result in any company achieving competitive advantage as a result of owning a valuable resource (Barney and Zajac, 1994).

iii) Inimitable resources

For a resource to be the source of sustained competitive advantage for firms, the resource should be difficult to emulate. In other words, if other firms understand the link between the firm's resources and its advantage, they can learn about that link, acquire the necessary resources and implement the relevant strategies. In such a setting, a firm's competitive advantages are not sustained because they can be duplicated (Barney, 1991). If valuable and rare resources are easily imitable, competitors would quickly copy them and the potential for competitive advantage would disappear.

iv) Non-substitutable

In the RBV framework, a firm's resources should be unique. That means there should not be any equivalent valuable resources that are rare or inimitable. Two valuable firm resources are strategically equivalent when each can be exploited separately to implement the same strategies (Barney, 1991). Substitutability can take at least two forms. First, although it may not be possible for a firm to imitate another firm's resource exactly, it may be possible to create a substitute, or a similar resource that enables it to conceive and implement the same strategies. Secondly, very different firm resources can also be strategic substitute with regard to their formal planning system, which can be strategically equivalent and hence may not help to sustain competitive advantage (Barney, 1991).

In short, the RBV is based on two sequential beliefs. First, resources may produce competitive advantage when they are simultaneously valuable and rare. Second, when such resources are concurrently costly to imitate and substitute, they may lead to sustainable competitive advantage (Priem and Butler, 2001; Markman et al., 2004). The ability to secure difficult-to-imitate and difficult-to-substitute resources enhances a firm's ability to generate dominant rents (Markman et al., 2004). The RBV, therefore, is an influential theoretical framework which explains how competitive advantage within firms is achieved and how that advantage may be sustained over time (Eisenhardt and Martin, 2000).

2.6.6 Discussion of the Resource-Based View

The RBV is an influential framework for explaining firms' performance. This theory could shed some light in investigation of the influence of governments' policy in promoting industrial institutions' competitiveness. In this discussion, scholars have focused on direct supports from governments in the form of financial assistance as part of industrial policies (Van Pottelsberghe et al., 2003). Financial assistance is a mechanism for handing over internal resources to the industrial institutions with the objective of working on the firms' resource based capacity (Storey and Tether, 1998). However, this theory has been criticised for its deficiency of operational practicality (Easterby-Smith et al., 2009) and this could imperil the theory's evaluative scope. The RBV framework understates the difficulty for management to predict the length of current advantage and the sources of future advantage. It assumes that firm growth is a result of selective resources accumulation and utilisation of those resources (Barney, 2001). In order to achieve firm growth, the RBV maintains that managers should only develop valuable, rare, inimitable, and non-substitutable resources. These RBV assumptions therefore suggest that managers looking for growth have to identify and classify the firm's resources, and compare how valuable these resources are relative to the competitors' resources (Teece et al., 1997). This process looks very simple, but it can be quite difficult to follow in managerial practice.

In fact, this theory is too inward looking and focuses overly on the intrinsic value of firms (Eisenhardt and Martin, 2000). By having this concentration, the RBV seems to ignore the market reaction to the firms' possession of unique and value generating resources. The RBV does not align with neoclassical economic thinking that focuses on the nature of the market structure, but from another perspective, the RBV framework could actually influence the market. By having value generating resources, firms could prevent getting trapped into existing industry structure, for example, impeding competition from established industrial institutions. Instead, by combining strategic resources, firms could be innovative by creating a new industry. This creative forces exhibits that the firms' internal activities could influence the market. In fact, what firms do internally could have impacted them externally and if firms want to have innovation, they could create or change the industries.

It is also important to acknowledge that financial assistance from governments could be a valuable resource for firms because it can stimulate firms to take business undertakings. One of the important elements highlighted in the RBV discussion concern the importance of managers' role to evaluate how valuable of the resources. That means, managers will try to evaluate firms' capability internally. However, Penrose (1959) suggests that a firm's growth should not only be confined to the internal valuation because in practice, business opportunities will emerge externally, i.e. the market will confront firms. In this context, the managers' evaluation could take place outside the firms. So, if the RBV is more dependent on internal valuation, Penrose (1959) argues that many opportunities will be neglected because managers have limited capabilities to handle these opportunities.

The above argument suggests that the RBV lacks context-specific adaptability. For example, the RBV cannot adequately explain how valuable resources like financial assistance from governments could be utilised to promote firms' competitiveness in markets (like the dynamic high technology sectors). Furthermore, in absence of business activities to seize opportunities, the RBV does not adequately explain how and why certain firms are competitive in situations of rapid and unpredictable change (Eisenhardt and Martin, 2000). This also creates ambiguity in policy evaluating framework because the principle of financial assistance concerns handing over internal resources to firms with an objective to stimulate a positive outcome (Hall and Maffioli, 2008). Hence, the inability of the RBV to explain adequately how the unique resources could be utilise to form workable business programmes as the authors of the DC concept aim to address these deficiencies.

2.6.7 Dynamic Capabilities (DC) concept

Strategic management scholars endeavour to understand the basis by which some firms are able to be more competitive. The RBV considers an inward perspective by suggesting differences in firms' performance are due to the originations possessing unique resources. Valuable, rare, inimitable and non-substitutable resources are thought to allow firms to achieve, and in some cases, maintain superior performance advantage over their rivals (Barney, 1991).

Resources include assets and capabilities. Assets are tangible, tradable and are easy to identify, thus making them easy for competitors to produce (Christensen, 1995). Capabilities on the other hand are thought of as 'routines (Easterby-Smith et al., 2009). They are established processes that a firm uses to deploy their assets and unlike assets, capabilities are intangible. Capabilities are thus difficult to measure and therefore duplicate. As a consequence, capabilities have received much attention because their characteristics make them a likely source of sustained performance difference between firms.

As the market changes, firms are required to adapt the resources they possess in order to maintain their competitive position. However, a theory that explains how firms adapt their assets in a dynamic environment was lacking, which led to the development of the DC concept by Teece et al. (1997). Teece et al.'s theory focusing on the DC concept explains how firms develop and renew their resources to compete in dynamic markets. The DC theory discussed by Teece et al. (1997) and further developed by (Teece, 2007). Eisenhardt and Martin (2000) expanded this theory to reflect the process and commonalities associated with the DC concept. Since then, there have been further extensions of the DC concept, which are either conceptual or functional.

The DC stems from the RBV (Eisenhardt and Martin, 2000; Helfat and Peteraf, 2003). DC draw heavily on how a firm absorbs and applies knowledge. In doing so, it emphasises routines (Eisenhardt and Martin, 2000) and the importance of the individual on organisational routines (Teece, 2007). Whilst DC evolved from the RBV, it is important to note that the idea of resources does not simply go away because of the introduction of the DC. Resources are central to how the DC are formed and what they reconfigure.

Peteraf (1993) suggests that the resource picking view is still important as well as complementary to DC i.e. firms can have a competitive advantage in picking resources, but they can also use these resources more effectively by reconfiguring them in the most optimal manner.

DC was first defined as the 'ability' firms use to 'integrate, build and reconfigure' other assets, capabilities and competences to address a changing environment (Teece et al., 1997) and create market change (Eisenhardt and Martin, 2000). The idea that firms possessed the ability to modify their resource base meant that they could now keep up with industry dynamics. The term 'dynamic' refers to changes in capabilities to achieve congruence with the changing business environment. Certain innovative responses are required when time-to-market and timing are critical, the rate of technological change is rapid, and the nature of future competition and markets is difficult to determine. Within the DC concept, 'capabilities' refers to, routines, norms, values or learning ability that come into existence when individuals or firms possess tacit knowledge. The capabilities component of the definition therefore emphasises the capacity of firms to appropriately adapt, integrate and reconfigure internal and external firm skills, resources and functional capabilities. Therefore, DCs are the ability or capability of a firm to change their static capabilities to match the requirements of both internal and external changing environments.

The concept of DC is relatively new and since they were introduced, scholars have attempted to conceptualise their forms (Eisenhardt and Martin, 2000; Winter, 2003; Teece, 2007; Peteraf et al., 2013). Much of the works on the DC are still centred on RBV because DC are primarily conceptual based. The lack of definitive conceptual grounding has created challenges for researchers to comprehend what they should be researching. Therefore, there is a need to operationalize capabilities in order to allow the development of the subject area especially as the prediction of firms' performance. When DC was first introduced to the management literature, they were described as the 'ability' (Teece et al., 1997). However, due to the importance placed on DC as potential sources of superior firm performance, scholars attempted to clarify the nature of this 'ability'. For that purpose, they describe dynamic capabilities as 'routines' or 'pattern activity' (Winter, 2003) and 'embedded processes' (Eisenhardt and Martin, 2000). These definitions suggest that firms' common and daily activities might influence their performance. The notion that dynamic capabilities are stable routine-like processes recurred within the literature (Eisenhardt and Martin, 2000; Winter, 2003), such that inevitably it is assumed that is how they should be defined. Teece et al. (1997) try to strengthen this concept by explaining that the capabilities component of the DC actually refers to capability of the firm to appropriately adapt, integrate and reconfigure internal and external resource and functional capabilities. This effort is trying to ensure that the DC is a comprehensive framework.

2.6.8 Discussion of the Dynamic Capabilities concept

The above explanation tries to group ideas about DC as a framework to evaluate firms' competitiveness as an alternate to the RBV. In fact, the DC framework has been refined from discussion about the RBV (Teece et al., 1997). The DC suggests that the concept of firms needs to be understood from a wider perspective. Prior to the DC concept, firms were often understood as organisations that try to gain competitiveness by acquiring unique and strategic resources. This understanding was built on the assumption that firms will maintain a certain structure and that the market remains stagnant (Teece, 2007). However, the DC concept suggests that firms need to make changes in order to address a dynamic market (Teece and Pisano, 1994). The change can be incurred in resources configuration, organisation structure and competencies in a process to identify and shape opportunities (Teece, 2007).

A wider DC perspective to conceptualise firms suggests that firms are not only comprised of resources but also capabilities. In an earlier study, Teece and Pisano (1994) viewed firms as the function of capabilities. Zahra et al. (2006) agree with this viewpoint by stating that firms are represented by a set of things that they can do which indirectly refers to firms' capabilities. Capabilities might be expressed as the capacity for a combination of resources to perform some tasks or activities through complex co-ordination overtime. At the firms level, capabilities describe what the firms can do and also representing their capacity to deploy resources toward a particular end goal (Helfat and Peteraf, 2003; Helfat et al., 2007).

A major argument underlines by DC theory concerns the importance of recognising firms' ability to execute activities as evidence that they have been utilising resources. This view is applicable to government initiatives to develop new industries because most external interventions, such as government support programmes exist as resources for the firms. It becomes more prevalent when the support programmes are meant for a specific purpose and has been implemented in a common mechanism such as financial assistance. The interaction between the supplied resources through that programmes demand that firms execute an array of activities.

For some scholars, most activities carried out by firms can be categorised as DC. However, Easterby-Smith et al. (2009) argue against this idea by suggesting that only specific activities to accommodate opportunities can be considered relevant to the DC framework. Teece (2010) addresses the discussion of the sort of activities that should appear in the DC theory by suggesting that firms' activities can be divided into three elements: 1) identification and assessment of opportunities (sensing); 2) mobilisation of resources to address an opportunity and capture value from doing so (seizing); and 3) continued renewal (transforming). Each of the clusters has been embodied by a number of sub-processes that essentially try to create and capture value from opportunities.

The sub-processes discussed in the DC are essential for firms that try to venture or have been operating in industries that are described as fast-paced and globally competitive. These industries made up of sophisticated consumer needs, technological opportunities and competition activities are constantly in a state of flux. The DC suggests that the sub-processes themselves should be evolved to cater to the dynamism of internal and external environments. The evolution of such processes might create new processes and products with is highly related to innovation concept. Based on this discussion, the DC is deemed applicable to bring new products to the market as illustrated in Figure 2–6:

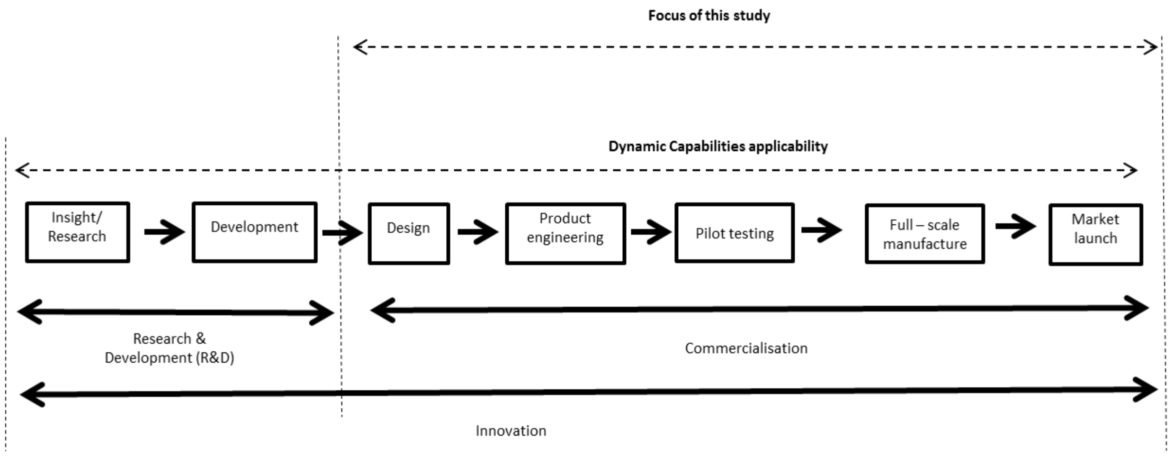

Figure 2-6: Context of the DC and focus of this study within innovation process

Source: Adapted and modified from Smith (2015, p. 90)

Figure 2-6 also explicates the application DC within industrial economic studies by shaping the capabilities into tasks that firms need to perform in an innovation process. These tasks include manufacturing activities that are crucial for production of tangible products. The manufacturing activities allow firms to respond to critical conditions shaping their business environment such as product regulation or customer feedback. The main principle is to highlight the importance of transforming static organisational capabilities or creating new ones to meet changes in the environment. In fact, both areas of DC and industrial economics try to study ways firms can be more competitive by promoting innovation in the economy. Apart from this, the DC framework tries to study innovation in a context of strategic management by connecting innovation with competitive advantage (Helfat et al., 2007). It is not surprising because as Teece (2007) stresses the DC is not designed to be comprehensive but rather aims to integrate the strategy and innovation literature and provide an umbrella framework that highlights the importance of being flexible in organising resources and managing competition.

Most scholars agree that innovation is an important element for a firm to be heterogeneous and subsequently increase the probability of being able to sustain competitiveness (Lall, 1992; Nelson, 1993; Porter, 1998). However, understanding about innovation has often been misleading. A skewed dimension about innovation is based on a narrow understanding that innovation is about intensive actions for technology breakthrough. Certainly, technological breakthrough or invention is a crucial step in the innovation process but, other steps also applicable (Yam et al., 2004). Lee and Gaetner

(1994) conceptualised innovation process by segregating the process into three stages: 1) basic research, 2) technology development and 3) technology commercialisation. The Lee and Gaertner model is known as the University Model of Technological Innovation (UTI) and was built upon innovation models proposed by Kline and Rosenberg (1986). The UTI is useful for understanding how academic research maybe transformed into commercially viable technology. Recently, Guan and Chen (2010) proposed an innovation model that describes activities required in innovation process. In their model, Guan and Chen (2010) highlight that each activity can influence others with the ultimate goal to improve firms' technological innovation performance.

In general, innovation can be considered as an interactive process to bring value into the market. In many cases, the process is initiated by technological breakthrough from research activity. This activity is followed by other activities such as manufacturing and marketing. The latter activities are deemed important in the innovation process because that process will provide feedback for further improvement. In strategic management, innovation is considered as a multifaceted capability (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting and reconfiguring firms' resources (Teece, 2007). It may involve probing and re-probing customer needs and technological possibilities. Each activity demands that firms have the ability to understand latent demand, industry structure and market. Indeed, innovation itself is a dynamic process because being able to bring invention to the markets requires a different configuration in each activities, in research, manufacturing and marketing activities. In other words, each activity need to be progressive which requires a combination of resources and capabilities to respond to changes in external environments.

Studies in industrial development classified innovation capabilities into several dimensions (Guan and Ma, 2003; Yam et al., 2004; Wang et al., 2008). Among the frequently highlighted dimensions are: (1) learning capability; (2) R&D capability, (3) resourcing exploiting capability, (4) manufacturing capability, (5) marketing capability, (6) organisational capability and (7) strategic capability. A summary of each capability is provided in Table 2-2:

Table 2-2: Description of innovation capabilities

	Capability	**Description**
1.	Learning	The capability to identify, assimilate, and exploit new knowledge
2.	Research and development	The capability that helps firms to embrace many novel technologies and approaches when developing new technological assets
3.	Resource exploiting	Represents firms' ability to mobilise and expand its technological, human and financial resources
4.	Manufacturing	Ability to transform to R&D results into products
5.	Marketing	The capability to publicise and sell products on the basis of understanding consumers' current and future needs
6.	Organisational	Capability to constitute a well-established organisational structure and coordinate the work of all activities
7.	Strategic	Capability to adopt different types of strategies that can adapt to environmental changes in order to excel in the highly competitive environment

Source: Guan and Ma (2003) and Yam et al. (2011)

The descriptions in Table 2-2 explains that innovation capabilities not only involve technological factors in a particular research field, but also bring organisation management, manufacturing, marketing and industry environment into consideration (Guan et al., 2006). In a discussion about national technical capabilities, Lall (1992) generalises the firm-level innovation capabilities into three categories: investment capabilities, production capabilities and linkage capabilities. This combination is considered as a special asset of a firm (Guan and Ma, 2003). Firms are expected to building on this asset in order to be competitive in high technology sectors.

The recent studies on innovation capabilities suggest that firms exhibit different capabilities in combination in order to contribute to the firms' technological innovation performance (Guan and Ma, 2003; Yam et al., 2004; Yam et al., 2011). In these studies, firms' innovation performance is determined based on technological innovation outcomes such as sales, innovation and product performance. Based on a survey conducted among companies in receipt support from the Chinese Government, Yam et al. (2004) found that R&D and resources exploiting capabilities are the most important innovation capabilities. Both type of capabilities are equally important because they can safeguard the rate of innovation and enhance sales growth among the surveyed firms. Under the same economic context, Guan and Ma (2003) suggest different findings. Their studies suggest that R&D together with manufacturing and marketing capabilities cannot lead to firms' sustainable innovation performance in export activities. Instead, they suggest the importance of other capabilities such as resource exploitation, learning, organising and strategic capabilities to enable a firm to acquire international competitiveness although they are classified as supplementary innovation assets.

Besides the mixed opinion on innovation capabilities combination, this study will seek the applications of those components within the innovation process under the DC framework. The main consideration is based the argument of DC concept that firms need to be progressive contingent to their internal factor such as resources and external environment factor such as competitor, customer and technology. The framework is applicable to this study because it translates the abstract concept of innovation into capabilities and resources. In addition, DC is also useful for this study because industrial policy in emerging economies always considers the next big industries/sectors for economic development. In order to do that, emerging economies need local firms that are equipped with appropriate capabilities. Within the DC framework, firms are advised to have relevant capabilities and some of that capabilities could be in the area of innovation.

2.7 Chapter summary

Malaysia is an example of a rapidly growing industrialising country[8]. It is an emerging economy that is quite successful in industrialising. This country has active industrial policies that tend to focus on fostering FDI. In this sense, the Malaysian Government perceives value in inviting foreign multinational companies (MNCs) to set up factories in Malaysia. It is possible to argue that this policy strategy has enabled the country to propel the manufacturing sectors major contributors to economic development. Until 2012, the manufacturing sectors contributed 24.12 per cent to the country's GDP with gross output of MYR908 billion (USD1=MYR4.11) (Statistic Malaysia, 2012). However, the Government realised that to become a developed country, local industries, especially those involving manufacturing, need to diversify. Diversification is understood to be related to innovation as shown by the Government's clear intention to have factories that not only assemble products but also develop them.

This chapter has examined literatures related to the development of high technology sectors in emerging economies. It is clear that there is strong Government intention to develop high technology sectors as a way of catching up with advanced economies. In this sense, governments in emerging economies can play important roles in the development of high technology sectors by the introduction and implementation of policies that try to promote innovation in local firms. However, there is no agreed conceptualisation of how such policies might work within local firms. Figure 2-7 represents the concepts and theories that have been considered in this study.

[8] A country that has in recent decades experienced a breakthrough into manufacturing and rapid export-led economic growth (Abdulai, 2004).

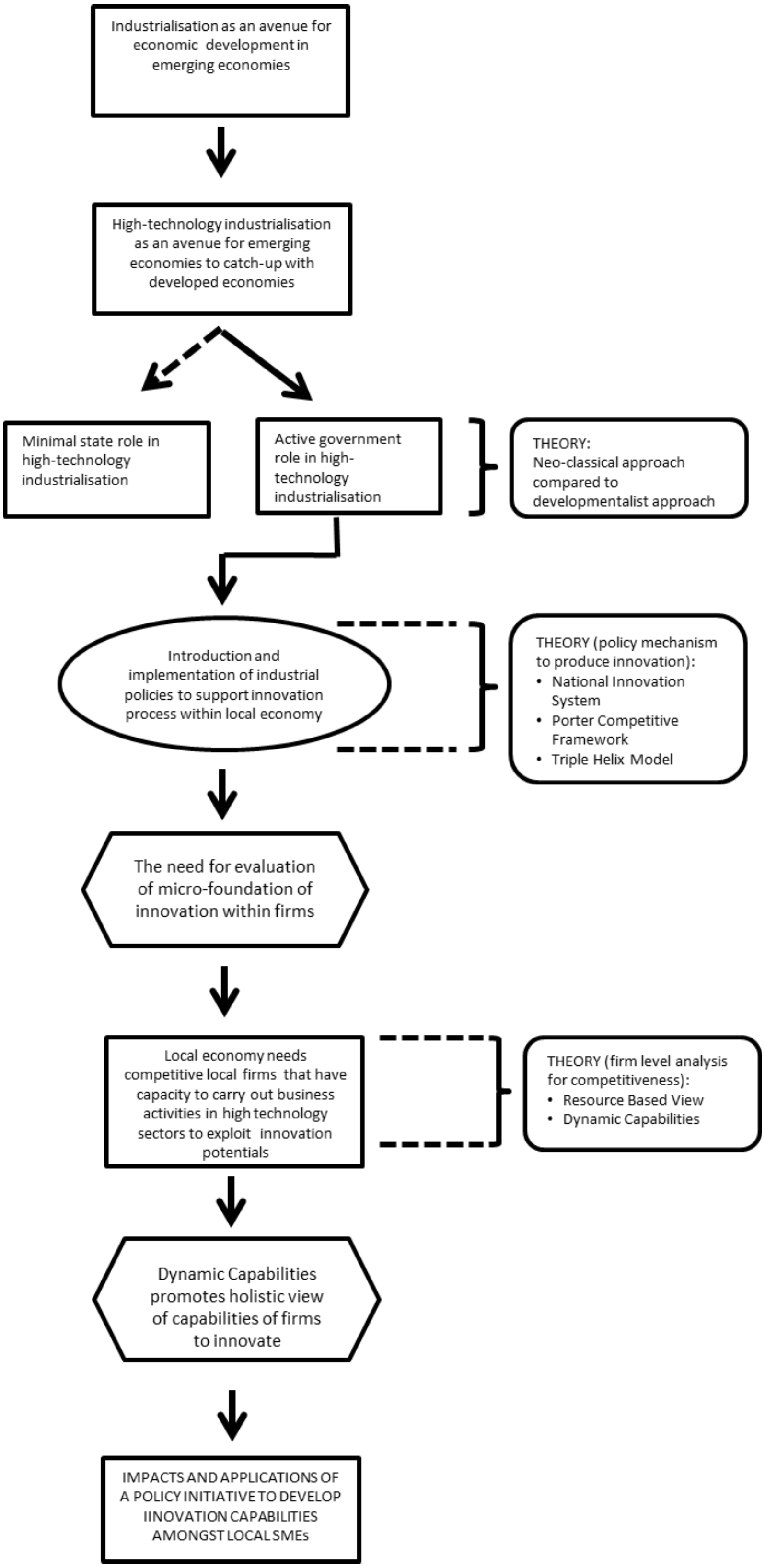

Figure 2-7: Conceptual framework

Source: Developed by the author

As stated in the above figure, this chapter also compares and contrasts theories that might be applicable for evaluating such policies aiming to promote high technology sectors. The theories are the Resource Based View and DC. This study adapts the DC and at the same time modifies the RBV. The main rationale because in emerging economies context, Government perceive in order to improve firms' innovation performance, they need to invest more in R&D activities. The Malaysian Government has been dependent on industrial policies to promote innovation but often policy makers do not have a clear idea how these policies work within firms. Therefore, investment in R&D is very blunt instrument and probably not effective. In fact, this investigation needs some sort of concept or construct to explain this phenomenon. The RBV provides internal perspective of innovating firms where they try to consider internal and external factors of innovating firms. In that case, DC is a much better way of looking at how to improve innovation. The main argument of DC is firms can spend a lot money (especially in emerging economies) but if they do not have capabilities to actually use what R&D is producing, there will be no innovation. Therefore, DC is relevant in this particular context because it promotes the understanding of firms' capabilities to execute tasks within innovation process. Besides that, DC also is a concept that just not only focus on one capability but a number of capabilities. Some of these capabilities are in R&D and some are related to other activities such as manufacturing and marketing. This means that it is just not R&D capabilities needed to improve innovation but there are other capabilities (i.e. production and selling capabilities) that play a crucial part. These capabilities interact and work together. In short, DC has the underpinnings of a strong theory. First it can show causality as several studies show how dynamic capabilities can cause a firm to have more innovative capability (Verona and Ravasi, 2003; Macher and Mowery, 2009). Second, it is measureable because it can be measured through learning outcomes (Zott, 2003) and technological innovation performances such as new products, sales performance, market share and employment (Yam et al., 2011). Indeed, some of the understanding on how capabilities have changed could be obtained from econometric analysis. It means that most of the understanding could be gained once researchers get inside firms. This perspective leads to case study approach.

Chapter 3 : **METHODOLOGY**

3.1 Overview

This chapter discusses the research design and methods used in this study. Research design is of great importance to any piece of research. Indeed, the strategy that a researcher chooses to address the research objectives and examine a specific topic can influence the quality of the results. In this process, gathering and analysing the data are critical as this study attempts to contribute a deeper understanding of government policies to promote high-technology industrialisation within emerging economies. The policies are part of government initiatives to catching-up technologically with developed economies by promoting knowledge based economy. In this context, this research investigates the implementation of a policy initiative to support commercialisation activities within SMEs. The specific research objectives are:

i) to analyse industrial policy and the process of industrialisation in emerging economies
ii) to explore an emerging economy's strategies for promoting high-technology industrialisation through industrial policy
iii) to critically evaluate the effectiveness of a policy initiative in stimulating the high-technology SMEs sectors in an emerging economy

This chapter discusses methodological issues of this study which explain the ontological and epistemological assumptions that have influenced this researcher's work. The specific research design, i.e. case study is also discussed. Case study was selected because it is an inclusive approach, allowing for triangulation of data from multiple collection techniques into a single study (Yin, 2009). The researcher sought to rely primarily on interviews with key informants as the main source of evidence (Verona and Ravasi, 2003). In addition, observation and document analysis methods are used for strengthening the findings of this study. Triangulation is argued to make the research process more rigorous, although the process is more time-consuming compared to a single data collection technique.

The research design for this study lays out the overall research plan which is comprised of four main elements: the strategy, the conceptual framework, the sources of data and the tools to be used for data collection and analysis. This will be followed by a discussion of the data collection methods, sampling technique and data analysis process. This chapter ends with a discussion of research credibility of the study. This study employs a multiple case studies within a single case study design in order to lay out data that have been collected during the field work. It treats the CRDF as the main case study and the selected recipient of CRDF support as mini-cases. This approach is exploratory because there is less explanation and discussion among scholars specifically about the CRDF although it is an example of an import policy initiative to support high technology sectors in emerging economies like Malaysia.

3.2 Research philosophy

This study investigates implementation of a financial policy initiative; the CRDF. The CRDF was introduced by the Malaysian Government in 1997 to support commercialisation activities within local firms. Despite this, information about the CRDF is limited, with reference to its implementation and lack of detailed reports of impact on its beneficiaries (Siew-Yan and Zin, 2006). In fact, the limited information on the CRDF gives an indication of the challenges related to this study. Therefore, the CRDF is considered a black box that needs examination. This study tries to justify its findings as knowledge (Sarantakos, 2013). In this respect, the research philosophies need to be clarified before any claim of knowledge can be made with certainty by researchers. Philosophical issues in research relates to the beliefs held by researchers that influence how research should be conducted, how results should be interpreted and so on (Bryman and Bell, 2011).

This study adopts a constructive ontological position which views the social world as not independent from people's perception and interpretation (Easterby-Smith et al., 2008). In this sense, social interactions are seen as essential elements in the research process. The constructivist approach relies as much as possible on the participants' views of the social phenomenon being researched and where researchers address the process of interaction among individuals (Creswell, 2013). The constructivist ontology implies an interpretivist epistemology (Sarantakos, 2013). In this respect, it is crucial for researchers to interpret what others perceive about their world. In interpreting other people's perceptions, one can assume that there is no one right interpretation of the meaning of the social world (Gill and Johnson, 2002). This approach is appropriate for exploratory research like this study. The main rationale because the researcher is principally try to understand what is the impact of a particular policy initiative to its beneficiaries. This general inquiry could be delved deeper into 'how' and 'why' investigations. This research direction facilitates the researcher to understand why something is happening compared to only being able to describe what is happening. The adoption of constructivism is also influenced by the lack of prior knowledge about the subject (i.e. the CRDF) and the complexity of the study context[9]. This condition is aggregated because the researcher's interpretation is dependent on a particular set of circumstances and individuals (Saunders et al., 2009). This study encompassed complex and unique phenomenon as it focuses on utilisation of funds for the development of high technology products by firms in technologically underdeveloped economies.

The research ontology informs methodologies about 'the nature of reality' whereas epistemology informs methodologies about 'the nature of knowledge that is to be sought' (Sarantakos 2013, p. 29). Therefore, the next step in conducting research is for researchers to determine the appropriate research methodology and methods that correspond with the ontological and epistemological concerns. Following the assumptions made by researchers in relation to ontological and epistemological aspects, there are two types of research methodologies that can be adopted: quantitative and qualitative. Both approaches have strengths and weaknesses.

This study adopts a qualitative method. This means, the study relies on this method to display the interpretation of social phenomena. The phenomena are presented based on meaning employed by the people being studied. This method advocates the use of natural settings compared to artificial ones for collection of data and generating theories rather than for simply testing them. In fact, the qualitative method is more congruent with the aims of this study: to gain insight into the operation of financial support by capturing the views of both owner-managers of the CRDF recipient and key personnel from the MTDC.

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[9] Malaysia Technology Development Corporation (MTDC) manages CRDF. All reporting on CRDF by other Government agencies (e.g. The Malaysian Science and Technology Information Centre) have been dependent on information produced by the MTDC.

Accordingly, it is difficult to reveal how the funding support functions and operates innovation support programmes in terms of its function by only deducing hypotheses from the theoretical background (Bryman and Bell, 2011). This is due to the proposition that the relationship between sources of variation are imperfectly understood and therefore not capable of clear-cut measurement. Therefore, a quantitative data collection method is then inappropriate.

In contrast, the interpretivist approach that uses qualitative methods in obtaining data is regarded as more appropriate in providing insights about firms' experiences in their innovation process. In addition, the chosen research philosophy corresponds with the argument that a quantitative approach is unsuitable when the focus of the research is to seek understanding about the nature of how firms' operate (Henn et al., 2009). In this respect, the use of highly standardised and structured quantitative research would tend to discount the experiences of CRDF recipients, and thus limit the exploration of the firms' activities. Bryman and Bell (2011) suggest that the use of qualitative methods can provide a complex picture of the process and situation as well as enhance the researcher's awareness of the relevant processing issues and the organisational environment. In fact, adopting a qualitative approach for researching the issue of innovation support programmes can capture the richness of qualitative explanation of the firms and the programmes implementers (Bruni and Verona, 2009).

In summary, in order to investigate the extent a policy comprising a financial initiative to enhance capabilities of indigenous SMEs particularly for innovation, this study adopts a qualitative research strategy to capitalise on multiple data collection techniques with the primary focus on interviews with owner-managers of CRDF recipients and MTDC's personnel. The choice of interviews as the main method of collecting data allows for a better understanding of the research issues. The use of interviews is also consistent with the ontological position of this study: the constructionist perspective, in which the understanding of the utilisation and mechanism of that support programmes relies on views, perceptions, experiences, interpretation and knowledge of the firms' owner-managers and MTDC's personnel. The epistemological position of this study is an interpretivist perspective, which suggests that the way that knowledge can be generated is through contacts made between researcher and participants, such as by interacting and listening to them, and the meaning of the fund's applicability needs to be interpreted.

3.3 Research design

Research design is an important element of research. Research design as explained by Saunders et al. (2009, p. 141), involves a number of strategies such as experiment, case study, action research and grounded theory. Research design represents a structure that guides researchers in executing research methods of data collection and in analysing data (Bryman and Bell, 2011). Research design situates researchers in the empirical world, which is concerned with how the research questions connect to the data (Denzin and Lincoln, 2008). Thus, it is important that the selected research design fits within the chosen research philosophy and methodology, particularly to avoid validity issues (Saunders et al., 2009).

Taking into account the theory building of this research and the propositions developed from the literature, a case study research strategy is regarded as appropriate for this study. Case studies are widely used for management research (Stake, 1995; Patton and Appelbaum, 2003) despite having been accused of 'lacking the rigour and the objectivity of the quantitative approach' (Patton and Appelbaum 2003, p. 6). A case study is an empirical inquiry that investigates a contemporary phenomenon within its real life context, when the boundaries between phenomenon and context are not clearly evident; and in which multiple source of evidence are used (Yin, 2009). These characteristics distinguish case studies from other forms of research design, such as, examination of contemporary phenomena in contrast to histories, the focus on the context in which the phenomena take place. In contrast to experiment or surveys which do not investigate the context very deeply and finally the use of multiple sources of evidence. Case study research is defined by Perry (2000, p. 305) as:

- an investigation of a contemporary, dynamic phenomenon and its emerging (rather than pragmatic) body of knowledge;
- being within the phenomenon's real life context where the boundaries within the phenomenon and context under investigation are unclear;
- when the explanation of the causal link is too complex for survey or experimental method, so that single outcomes are not possible;
- using interviews, observation and other multiple sources of data

The strength of case studies lies especially in their capacity to explore social processes as they unfold in organisations (Verona and Ravasi, 2003). Therefore, it can be said that within the field of organisation studies, case studies are especially appropriate in research in which the objective is to examine social phenomena that are complex (Yin, 2009). Innovation and the process of developing firms' innovativeness are interrelated fields that are individually complex. Innovation process is often evolved and case studies are seen as a way to capture it. According to some writers (e.g. Yin, 2009; Bryman and Bell, 2011), the use of case studies has numerous strengths. One of its strengths is in exploring social processes as they evolve in a business entity. A case study allows for a process and contextual understanding of the various actions and meanings that take place within a business entity/organisation. The emphasis is on understanding processes alongside their organisational and other contexts. Accordingly, case studies are appropriate for examining the research questions relating to implementation of technology driven-growth strategies such as the CRDF as an initiative by government to enhance capabilities of indigenous SMEs particularly for innovation. It means, with the case study approach, there are opportunities to look inside the firms and at their practices in particular. It is hard to pick this up from using surveys (questionnaires). Case study design also enables the researcher to look at the bigger picture. Besides that, case study also favours for the researcher to have a bit of contact with firms over a period of time which facilities multiple data collection techniques (i.e. interviews, archival data and observation). These techniques will give and in-depth and detailed picture of firms' practices and what they do for innovation. From here, the researcher could interpret why firms operate in these ways. The researcher is also able to compare information from different firms in receipt of support, allowing conclusions to be drawn about the different practices that exist between the firms.

Despite the above strengths of case study design, a very common criticism concerning of its usefulness in research is that it provides very little basis for generalisation (Yin, 2009). This criticism usually take the form of questions like how do you know that the case you have chosen is critical? (Yin, 2009). As Yin (2009) mentions, these arguments implicitly contrast case studies with surveys, where a sample can be more readily generalised to a larger universe. Thus, from a statistical point of view, a case study can be considered a sample of one, and therefore the findings cannot be generalised to a wider population. In other words, case studies cannot legitimately produce general theoretical claims and therefore are useful mainly for the initial exploration of a phenomenon which will then lead to a quantitative study to establish regularities (Stake, 1995). It has to be stressed that it is not appropriate to apply statistical criteria in order to judge the quality of research based on case studies because the principal aim of case study research is not to provide us with predictions, but to generate valuable explanations and understanding of certain phenomena. Therefore, the case study method is justified as the primary strategy to be used for this research and the data collection is through semi-structured interviews and supported by non-participant observations and documentary sources.

In this study, criterion sampling (Miles and Huberman, 1994) is adopted. By adopting this type of sampling, this study is not trying to achieve representativeness, but it is more about increasing quality assurance (Creswell, 2013). In other words this sampling tries to increase the credibility of the results by reducing suspicion about the selection of cases. This technique gives an advantage in the sense that the researcher is able to select information-rich cases based on the research focus and also avoid the issues of bias in selecting certain cases. Within the overall case study of the CRDF as an example of the implementation of a technology-driven growth strategy, two case studies of high-technology sectors have been employed: 1) bio-technology and 2) industrial products. These sectors are highly related R&D activities (Atkinson and Ezell, 2012). In addition, the firms in those sectors appear to have secured the highest number of CRDF award (MASTIC, 2010). This study focuses on the firms that were awarded CRDF funding between 2006 and 2010 as they are expected to complete the commercialisation process. During this period (i.e. from 2006 to 2010), the CRDF was awarded to 149 firms with approved grant amounted to MYR285.6 million (USD1=MYR3.08) (MASTIC, 2010).

At this juncture, the researcher had the choice of either applying single-case or multiple-case studies. According to Yin (2009), a single case study is used when the case represents a critical test of existing theory, when the case is a unique event or when it serves an exploratory purpose. The case study can introduce more than one unit of analysis, where attention is given to units or sub-units. Nonetheless, the multiple-case study designs are argued to involve more than one entity and leans towards replication logic. According to Bryman and Bell (2011), multiple-case study designs have become increasingly common in business and management research. The authors considered multiple case study designs as a 'comparative design' because multiple-case studies are largely undertaken for the purpose of comparing the cases that are included. As such the multiple-case study allows the researcher to compare and contrast the findings. This in turn encourages researchers to consider what is unique and what is common across the cases and frequently promotes theoretical reflection on the findings.

The researcher decided to use multiple-case study designs. Perry (2000) advises a minimum of two to four cases and a maximum of 12 cases. Eisenhardt (1991, p. 621) supports such statements by suggesting that *'concern is not whether two cases are better than one or four better than three. Rather, the appropriate number of cases depends upon how much is known and how much new information is likely to be learned from incremental cases*'. There is active discussion with supervisors on what are the appropriate number of case studies. Sometimes there is divergent views; there either should be several a few. However, more importantly it is dependent on how well the researcher is able to obtain access to the firms. Therefore, in light of data collected, we eventually agreed on 10 cases. It is a bit of a compromise because the researcher could have accessed more. From active discussion with supervisors, it is suggested that having ten in-depth, detailed and very informative case studies is better than having 16 cases that might be superficial. Taking a small number of cases where the researcher examines firms from different perspectives over time provides a better view of the impacts and applications of the CRDF. Therefore, there are five mini-cases of SMEs in each sector, which makes a total of ten cases. Each of the SMEs shares a common context and represents different a commercialisation status classified by the MTDC.

3.4 Data collection methods

Given the case study approach, it is appropriate for the researcher to use multiple data collection techniques in order to give in-depth representation of occurrences within firms. In this sense, this study employs triangulation technique which involves the application of several methods to collect data from different sources. Saunders et al. (2009) suggest the use of two or more independent sources of data or data-collection methods within one study is useful to ensure that the data could produce a more complete, holistic and contextual portrait of the situation. Hence, in this study the researcher use interviews, documentary evidence and observation narrative as data sources. Interview transcriptions provide the primary data source and it is triangulated by the use of documentary and observation narrative. This technique provides a better representation and consistent insight of what actually happened in the firms as the data sources corroborated with each other. It also enables the strengths and weaknesses of the various methods to be counterbalanced and a more holistic picture of organisational environment to be developed. As a result this study manages to develop consistent themes. These themes have been used to compare and contrast the 10 case studies.

Semi-structured interviews constituted the main method for collecting data. These were complemented by some non-participants observation and also by the use of documents provided by the firms. Data collection was completed within seven weeks and conducted in March and April 2014. The use of semi-structured interviews and non-participants observations in research is examined below. A later part of this chapter will discuss how the above methods were employed within the particular research settings.

3.4.1 Semi-structured interviews

This part of the chapter examines the implications of using interviews as part of the research. Interviewing is one of the main techniques to collect data in qualitative research and is useful to uncover people's perception, the underlying meaning of situations and the construction of reality (Easterby-Smith et al., 2008). It means that, the interviewing allows researchers to get the individual's perspective. This is based on the fact that an individual's perspective cannot be observed which leads to the importance of formal conversation between the researcher and the individual on predetermined topics. Accordingly, the interview method has become the principal means of understanding occurrences and processes within firms (Verona and Ravasi, 2003). In this sense, interviews can be considered suitable for this study as this data collection technique offers scope for the researcher and provided opportunities for two groups of the interviewees (i.e. owner-managers of CRDF recipients and MTDC personnel) to share their perceptions and experience of the implementation of CRDF. The interviewees from the firm and MTDC are quite senior people. This means, firms' owner-managers are able to comment and give data about firms' practices and operations. Meanwhile, for interviews with MTDC's personnel, they are well informed about the CRDF and are able to present perspectives on this particular policy initiative. In addition, interviews with MTDC's personnel are essential for validation with data gained by interviewing the firms.

Generally, there are three different types of interview that could be used in qualitative research, namely: structured, semi-structured and unstructured. Each type possesses its own attributes. Table 3-1 summarises the types of interviewing.

Table 3-1: Type of interview

Type of Interviewing	Attributes	Remarks
Structured	A range of response alternatives are provided from which participants can choose	
Unstructured	• Researchers may not have any specific questions or topics • Relies on general questions and specific questions are expected to emerge during interview process	Too flexible
Semi-structured	• Also known as in-depth interview • Could start with specific question in relation to research issues • Allows participants to follow their own thought processes	Flexible with researchers in control

Source: Extracted from Bryman and Bell (2011) and Bruni and Verona (2009)

This study uses semi-structured interviews as data collection technique. The main rationale is because this type of interview is flexible enough to allow the researcher to explore certain emerging issues in depth. The principal aim of the interviews conducted with the firms' owner-managers and MTDC's personnel was to gain understanding of the ways which the CRDF influences the firms' attempts to commercialise technology. In addition, another objective was to find out the contextual information of the firms which includes the mechanism of product development from proposed technology. Therefore, semi-structured interviews emerged as a possible choice as they allow the researcher to probe answers where the researcher wants the respondents to explain or build on their answer (Saunders et al., 2009). In this sense, the researcher was dependent on a list of prepared questions or specific topics to be covered as an interview guideline. However, the researcher has options to follow exactly the questions in the interview guide. Instead, the researcher developed general themes that represented a set of questions in order to capture the respondents' perceptions and experiences of particular occurrences. These themes (as described in Table 3-2) were used as a checklist while conducting the interviews. At certain points, the researcher asked questions that were not included in the interview guidelines as they were picked up on what was said by the respondents. Above all, the main objective of the interview guide approach is to ensure that the same general areas of information are collected from each interview session. This provided more focused conversation but still allowed a degree of flexibility and adaptability in gaining information from respondents (Easterby-Smith et al., 2015). Furthermore, as this research adopts multiple case-studies approach, the comparability of the data is another important element of the research but still something that could not be achieved through adoption of unstructured interviews.

Table 3-2: Interview themes

MTDC Personnel	Firms
• Background of interviewee/s plus organisation/division/unit • Implementation • High technology business	• Background of interviewee/s • Background of the firm • Capabilities • Product and technology • Provision of grant • Programme performance

The researcher also needs to achieve a good balance between talking and listening during the interview process. This is vital because the semi-structured interviews were not driven by the interviewer, hence they require full concentration from the researcher. In this sense, it is not practical for the researcher to be dependent entirely on note-taking, as this could distract researcher's concentration. Instead, to facilitate this situation, all interviews in this study were recorded digitally (Bryman and Bell, 2011), with participants' permission. By recording the interviews, the researcher was able to give full concentration during the interview process and to follow all the points made by the interviewees by probing their answer and trying to reach a good understanding of their views in relation to the research topic. In total, the researcher conducted 13 one-to-one and three group interviews. Each interview sessions varied in length, ranging from

60 minutes to 90 minutes. Table 3–3 and Table 3–4 are summary of the interview sessions.

Table 3-3: Firms interviews

	Interviewees/s	**Venue**
Bio-Technology		
Bio 1	Manufacturing Manager	Office
Bio 2	i) Managing Director (owner) ii)Laboratory manager	Officer & site visit
Bio 3	Chief Executive Officer (owner)	Office & site visit
Bio 4	Executive (Founder)	Office
Bio 5	Executive (Founder)	Office
Industrial Products		
Industrial 1	Admin & Finance Director (founding team)	Office
Industrial 2	i) Managing Director ii) Administration Manager iii) Production Engineer iv) Service Manager Production Manager	Office & workshops
Industrial 3	Owner	Office
Industrial 4	Business Development Director	Office & site visit
Industrial 5	i) Managing Director ii) His spouse (interpreter)	Office & site visit

Table 3-4: Interviews with MTDC personnel

Interviewee	**Scope**	**Venue**
Chief Executive Officer	Overview of MTDC	CEO Office
Director of Technology Ventures Division	Overview of funds and support programme	Meeting room
Senior Vice President	Overview of funds and support programme	Meeting room
Vice President (Monitoring)	CRDF monitoring process	Meeting room
Acting Head (Processing) Associate (Processing)	CRDF screening and processing	Meeting room

As shown in Table 3–3, the researcher has conducted three group interviews: two interview sessions with firms and a session with MTDC personnel. In this study, the group interview is regarded as emergent approach rather than deliberate approach. It means that the researcher only realised the need for group interview technique once he arrived at firms' and MTDC's offices. In most cases, interviewees requested for group interview in order to accommodate their availability and convenience. This situation applies for interview session with Industrial 5 and MTDC personnel. An interviewee from Industrial 5 invited his wife to join the interview session because he thought that she could explain more clearly due to language barrier. This group interview has provided better access to the key informants and helped with communication. Meanwhile a group interview with Industrial 2 was conducted after getting invitation from the firm's managing director. The researcher's initial plan was to conduct one-to-one interview with the managing director. With the casual invitation, the researcher managed to conduct group interview with three other managers (administration, production and service) of Industrial 2. More importantly, there is benefit in getting the interviewees together because the researcher could get more holistic picture when each interviewees were able to complement and validate each other respond to the interview questions.

3.4.2 Documentary analysis

After interviews, documentary analysis is regarded as a useful data collection technique in qualitative research (Creswell, 2013). Documents can be used to provide further evidence of the issue being researched and more importantly this data collection technique can be conducted without disturbing the research setting. In case study design, documentary analysis is important to supplement as well as to compensate for the limitations of other methods. Documentary evidence acts as a method to cross validate information gathered from other data collection techniques (i.e. interview and observation) given that sometimes what people say may be different from what people do.

This study employs two phases of documentary analysis. The first phase was conducted prior the field work[10] in Malaysia. In this phase, the researcher was dependent on secondary data from web sources and firms' financial statements. The financial statements were retrieved from Companies Commission of Malaysia. At this point, the data was sourced from the public domain. In certain cases, the web sources had given rich data such as firms' product details and management. However, for the firms that did not keep their websites up to date, available data was limited to basic information. Above all, the first phase of documentary analysis is beneficial to this study in terms of verifying essential information about the MTDC, CRDF and firms. This enabled the researcher was able to gain preliminary insights about them. These insights were useful for designing interview guides for MTDC personnel and firms.

The second phase of documentary analysis was conducted after the field work. This process was conducted in light of additional documents retrieved during the field work such as companies' profile, products' brochures and sales agreement. These documents provide more detailed secondary data such as:

- Background of the firms (i.e. information on their establishment)
- Key management personnel
- Financial condition (such as authorised and paid up capital)
- Details of the firms' product

The data from first and second phase of documentary analysis was converged to corroborate the multiple qualitative techniques. This could enhance the validity and reliability of findings.

3.4.3 Non-participant observation

During the fieldwork in Malaysia, the researcher also conducted several non-participant observations. Non-participant observation was the only option for the researcher because in most cases the researcher needed to abide by the respondents' organisational privacy policies. It means that, the researcher had very limited access to a particular activity. This means the researcher did not have the opportunity to engage in

[10] The field work was conducted between 3rd March and 28th April 2014.

participant observation. Bryman and Bell (2007) describe non-participant observation as situation where researchers observe but do not participate in what is going on in the social setting. In other words, non-participant observation is a relatively unobtrusive qualitative research strategy for gathering primary data about some aspect of the social world without interacting directly with its participants. This is where the researcher observed phenomena of interest in the environment studied to draw information which was not obtainable from other methods. In this study, the phenomena is about discovering why the rate of commercialisation decreased from 5.1 per cent to 3.4 per cent between 1991 and 2005 (MASTIC, 2010) in terms of firms' progress and development within innovation projects.

The researcher started to conduct the observation upon arriving at the respondents' premises for the interview session. It had been continuing during the interviews and post-interviews. This data collection technique helps to verify data from the documentary analysis and interviews and extends interpretation about the research setting. For example, the researcher managed to observe firms' intensity on commercialisation activities in terms of development process of high technology products (Oakey, 2012). The observation is based on the construct of the DC which explains how firms can develop business programmes and sustain competitiveness (Teece and Pisano, 1994; Teece, 2010). Within the firms' activities, the researcher focused on: 1) premises, 2) final products, 3) the equipment/machinery employed, and 4) the routine of people involved in the firms' operation such as in research and production activities. For example, in a firm (Bio 2), the researcher observed it has proper facilities for research activities. The facilities have not been under-utilised as the researcher could see people working in them by conducting laboratory work or scientific testing. Table 3-5 summarises the observations that were conducted by the researcher.

Table 3-5: Observations caption

Firms	Elements observed
Bio 1	Evidence of firm's achievement and recognition such as certificates and newspaper cuttings hanging on wall
Bio 2	• Evidence of firm's achievement and recognition such as certificates and newspaper cuttings hanging on wall • Product packaging • Laboratory facilities and activities
Bio 3	• Primary machines acquired from CRDF funding • Immediate product from the machine (not the firm's final product)
Bio. 4	Location of premises in technology incubator
Bio 5	• Location of premise in technology incubator • Products sample
Industrial 3	• Mini workshop/workstation - tools • Products sample
Industrial 4	• Production line/machines • Mini laboratory
Industrial 5	Production line

In most cases, visits to the firm's operations were conducted after the interview sessions. The researcher also had a chance to ask interviewees further questions about their premises' setting and usage of the machines. There was also additional information acquired during the observation/visit. For example with Bio 2, the researcher managed to interview the firm's laboratory manager and gained an important insight about its approach to up-scaling production. Sometimes, the researcher managed to do note-taking especially when there was an important and unfamiliar term used by the interviewees. Besides the note-taking, the researcher also prepared an observation narrative after each visit. The narrative is a one page summary that presents the visit in sub-sequential events (e.g. time of arrival, what has been seen). The researcher prepared each narrative in evening of the visit. This allowed three to four hour gap after the visit and the researcher could reflect each event in a prudent manner.

3.5 Designing the semi-structured interview guide

An interview guide was used in conducting interviews with firms (i.e. selected CRDF recipients) and MTDC key personnel. According to Robson (2002, p. 278), an interview guide is a common means for data collection in qualitative research. An interview guide lists the question or topics that are to be explored by researchers (Henn et al., 2009). This technique is often associated with semi-structured interview (Bryman and Bell, 2011), which has been used in this study. The main rationale for using the interview guide is to facilitate the researcher to be more systematic in interviewing different interviewees and it also offers flexibility (Bryman and Bell, 2011). It means that, researchers are able to probe and ask additional questions within the focus of particular subject that have been researched. In fact, this interview design anticipates and considers the heterogeneity of answer that will be given by interviewees (Easterby-Smith et al., 2015).

This study tries to incorporate the principles suggested by Bryman and Bell (2011) in preparing an interview guide. The principles and actions taken to develop the interview guides are illustrated by Table 3-6. Details of the interview guide with MTDC personnel and firms' owner-managers can be found in Appendix 1 and 2.

Table 3-6: The principles in designing interview guide

	Principles	Actions taken
1.	Record general information about the principles. This information is vital to contextualise respondents' answer	A dedicated section that asks about background of the interviewee and firms (applicable to firms only).
2.	Formulate questions or topics that help researchers to address the research question but which are not 'too specific'. Leading questions must be avoided	Interview question cover common and familiar topics such as business opportunities, challenges and firms' weaknesses.
3.	Structure the interview questions or topics in a sensible and helpful manner for researchers and participants to deal with	The interviews start with questions about the participants' background and move on to more detailed and complex questions that require participants to express their views and opinions of the research topics
4.	Use a language that is appropriate and relevant for the participants	At certain points, Bahasa Malaysia (the Malay language) is used. Thus, the problem of a language barrier is avoided and can increase the quality of the quality given by the participants.

Source: Extracted and modified from Bryman and Bell (2011, p. 467)

3.6 Pilot Study

The first phase of the fieldwork involved two pilot interviews with CRDF recipients (firms). The main reason for a pilot study was to ensure the clarity of interview questions and to address any issues that could affect data collection techniques (i.e. interview process and observation) (Bryman and Bell, 2011). Ideally, the pilot interviews should have been conducted by phone before making the trip to Malaysia. However, based on preliminary discussions, respondents preferred to have face-to-face interviews. The summary of the pilot interviews is summarised in Table 3-7 below:

Table 3-7: Pilot study schedule

	Interviewee/s' Designation	**Venue**	**Site Visit**
Firm 1	A production manager in charge of CRDF project	In a meeting room within corporate office	Yes
Firm 2	1) Managing Director (owner) 2) Laboratory Manager	1) Meeting room 2) Multiple areas within the laboratory	No

The researcher reflected upon the pilot studies as valuable for the following reasons:

- The researcher developing his skills – listening to people, asking questions and managing the interview process;
- The researcher could conduct limited non-participant observation as interviews were conducted in respondents' premises rather than unidentified places;
- Some missing points can be made available through secondary data provided by respondents. These include company's profile and products brochures;
- The researcher building up his confidence to conduct the actual data collection.

The pilot interviews were meant for refinement of questions that were going to be asked during interview. Some questions were dropped. For example, the researcher discovered that firms' owners-managers cannot describe the specific purposes of firms' establishment. Therefore, a question that asked the firms' owners-managers to explain the process of how the firms' were founded was used instead. The new question was easily understood by the interviewees. In addition some questions were restructured. For example, the question about firms' success was originally located in the section on the latter section of 'capabilities'. However, it was discovered that the interviewees tend to share firms' achievements after explaining their prior working experiences. Therefore, to ensure the flow of the participants' responses, relocating this question to earlier section of 'business background' was seen as necessary. In addition, the researcher learnt lessons from the pilot studies. Firstly, each interview session ideally should not exceed 90 minutes. The main reason is because both interviewee and interviewer might lose their concentration if the sessions last longer. Secondly, interview sessions are best conducted in a designated place (e.g. meeting room) because there is less distraction for both interviewee and interviewer.

3.7 Transcribing of interviews

During the fieldwork, the researcher managed to conduct 16 interviews; three group and 13 one-on-one interviews. All interviews were recorded with a digital recorder. All the interviews were transcribed over a two month period. The transcription process started with listening to the entire recording for each of the interviews. This process facilitated the researcher to gain understanding about the content of the interviews. It also helped the researcher to refresh his memory about the firms' context. All the interviews were transcribed by the researcher. Although it was very time consuming, it was a good exercise because the researcher became more familiar with the data. Quotations from the interviews were selected for reference in the thesis depending on their relevance to the issues on the utilisation of the CRDF.

One challenging aspect of the transcription process was the translation from Malay to English. All interviewees had the freedom to share their experience using either English or Malay. In most cases, the interviewees used English and Malay interchangeably. It is not surprising because it is the appropriate of getting rich data from the interviewees as they were able to convey all the information adequately. For easy reference to the original transcript with mixed language, all translated transcriptions have been written in the exact order of pages. By doing this, the essence of the interview in its original form is preserved for re-verification of the actual quotes (Marshall and Rossman, 2006).

3.8 Sampling of respondents

This research investigates the implementation of technology-driven strategies to promote high-technology sectors within emerging economies. Malaysia has been used as a case study in part because it is a middle-ranking emerging economy but also because of its experience in introducing technology-driven growth strategies (Mani, 2002). This study builds a case of the Malaysian government's initiative to support commercialisation within Malaysian SMEs specifically focusing on the CRDF as a policy initiative.

There are various qualitative sampling issues that have been discussed by qualitative researchers (e.g. Miles and Huberman, 1994 and Creswell, 2013). Miles and Huberman (1994) discuss about 16 types of sampling in qualitative studies ranging from maximum variation to convenience sampling. Although each type of sampling offers different perspectives about their sample and limitations, more importantly the selection of a particular strategy must fit in with other components of the study (i.e. research design).

This study employs a purposive sampling in selecting firms that fulfil the selection criteria in building a case study of the CRDF. This technique is commonly employed in qualitative research (Creswell, 2013). Devers and Frankel (2000) argues that purposive sampling is adopted when researchers try to attain a goal of enhancing understanding of selected individuals or groups' experiences, which this study is trying to do. Most of all, this sampling technique is congruent in a study that tries to develop theories and concepts by selecting information rich cases that will provide the greatest insight into the research question (Devers and Frankel, 2000). For this study, the main aim of this type of sampling is to make sure the respondents are key informants. For example the knowledge about the CRDF can be obtained from firms which possess specific criteria in this study: they have experienced the operation of the CRDF. The selection of case firms was carefully controlled for. This study used two clusters of CRDF recipients (i.e. bio-technology and industrial products) as samples because they have had experience and information about commercialisation of research output within high technology sectors.

3.8.1 Gaining access

In conducting a study, researchers often encounter issue of constraints in terms of gaining access to the people to be researched (Henn et al., 2009). In the process of collecting data, gaining the agreement of individuals in authority, such as gatekeepers, is essential to provide access to the research subject (Bryman and Bell, 2011). The gatekeeper for the CRDF is the MTDC. Within the MTDC, the CRDF is under the purview of two divisions; 1) Technology Development Division and 2) Knowledge Management Division (KMD). However, the decision to allow access is reliant upon the Chief Executive Officer (CEO) of the MTDC. For this reason, the researcher contacted the CEO via e-mail to explain the background of this study. From that initial communication, the researcher proceeded with a meeting with representatives, the Director of Business and Technopreneur Development Division and the Manager of KMD from the MTDC in London. The focus of that meeting was to discuss about the MTDC's concern about data collected from the CRDF recipients due to their bad experience with research carried out on another support programmes handled by the MTDC.

After that meeting, the MTDC assigned the Manager of KMD as a liaison. Her assignment was to act as a facilitator between the researcher and other divisions within the MTDC. This contributed significantly to the researcher's effort to gain access to the prospective CRDF recipients and MTDC personnel. For MTDC personnel, the efforts to gain access was initiated with preliminary communication via e-mail. This proved effective because the prospective respondents from MTDC got a chance to get further clarification about this research although the KMD made an effort to inform them. Besides e-mails, the researcher contacted the prospective respondents by phone in an effort to build-up rapport with them.

The effort to gain access to prospective respondents from MTDC was deemed effective through e-mails and phone. However, the access to prospective respondents within CRDF recipients required intensified effort and a different technique. In the first instance, the researcher had asked the Manager of KMD to send out invitation letters[11] to the prospective CRDF recipients to participate in this research. The letters were signed by the CEO of MTDC and the researcher's name was clearly stated as part of MTDC's

[11] Please refer to Appendix 5 for an example of this letter.

research team. The researcher also managed to get carbon-copies (soft copies) of the invitation letters. After retrieving the letters, the researcher allowed three weeks to elapse before contacting the prospective firms. The initial communications were via e-mails. However some e-mails were left unanswered and the researcher decided to contact the firms via phone from the United Kingdom. Again, this practice was vital in getting access although this study has been supported by a gatekeeper (i.e. the MTDC). In fact, most of the firms' prospective respondents seemed to prefer this practice because they got a chance to know the researcher better. Even more importantly, the researcher was also able to build rapport with them.

3.9 Data analysis

Data analysis is another challenging task in conducting qualitative research, in particular because qualitative data is non-standardised and complex in nature (Saunders et al., 2009). For Miles and Huberman (1994), methods of analysing qualitative data are not-well formulated due to the issue of validity and reliability and this has influenced the notion that no standard format exists. For some scholars (e.g. Attride-Stirling, 2001 and Creswell, 2013), qualitative data involves a large volume of information, thus it is important for the researcher to discuss the process undertaken in handling and interpreting it.

3.9.1 Methods of data analysis: Analysis of interview transcripts

This study adopts thematic analysis technique to analyse qualitative data primarily from the interviews. This data analysis technique involves identification of major themes within the transcription through open coding. The researcher initiated this process by perusing each interview transcriptions for general themes such as firms' state, firms' performance, the CRDF and product under the CRDF. Patton and Appelbaum (2003) consider this the primary step in qualitative analysis. It is also part of open coding, which refers to part of analysis that deals with labelling and categorising of phenomena as indicated by the data. These open codes were abstract and developed based on extraction of interview guides with the CRDF recipients and MTDC personnel. In most cases, the researcher assigned a tick symbol on each question or prompt question in the interview guide. As with all qualitative data analysis, the search for themes is a way to organise the data. This allows researchers to gain understanding about phenomena under study in a structured way (Miles and Huberman, 1994). Furthermore, this phase of thematic analysis offers flexibility because it requires less knowledge of theoretical foundations.

According to Braun and Clarke (2006), when an analysis is less dependent on a theoretical argument, it will become more pragmatic for different research paradigms such as realist or constructionist. However, this technique (i.e. thematic analysis) often received less acknowledgement from researchers (Braun and Clarke, 2006) although it is one of the most commonly used in analysing qualitative data. Compared to other methods of qualitative data analysis that have received considerable attention (i.e. grounded theory and discourse analysis), it can be seen that there is a lack of available detailed explanation about thematic analysis. However, Braun and Clarke (2006) argue that a great deal of qualitative data analysis is essentially thematic, thus, thematic analysis should be seen as a method in its own right.

Based on the above argument, this research advanced the analysis into deeper and more detailed themes. Next, the researcher developed axial coding. This is a second step through the data. This step was supplement by a matrix table that exhibits 36 items reflecting context, input, process and output. The researcher applied this step for each interview transcription from the firms. The items captured details of firms' activities such as research approach, technology updating and sales approach. Meanwhile, some items could act as proxies to the firms' performance, for example registration of intellectual properties and profitability. At this point, the researcher started to ask about causes and consequences, conditions and interactions, strategies and processes and looked for categories or concepts that could be grouped together. The researcher also started to recognise some clearer patterns based on theoretical arguments of underpinning theories (i.e. the RBV and the DC). From this, the researcher also made initial interpretations of the relationship between the context (the CRDF) and firms' conditions. The process of developing open coding, axial coding and initial interpretations were conducted several times especially after subsequent readings of the transcripts because often some new sub-themes emerged and required re-arrangement of axial coding. Table 3-8 summaries emerging core categories that are derived from data analysis process.

Table 3-8: A brief summary of core categories derived from data analysis

Themes Level I		**Themes Level II**		**Interpretations**
<u>Firms' State</u> • Less than 70 employees • Has been operated in highly regulated business (especially for market entry) • Managed by experienced and/or highly qualified personnel		<u>Policy</u> • Is well managed • Implemented effectively • Has facilitated innovation • Seize opportunity in high technology sector • Sufficient amount of funding • The selection of recipients is fairly rigorous • There is direct and indirect impact to the firms (the impact try to address the gap in innovation process)		• CRDF is a positive policy and well implemented • The policy facilitate the firms to fill gaps in innovation process
<u>Firm's performance</u> • Reasonable firms' profitability • Dependent on individual competencies • Completed the research phase of product development • Some managed to register patents		<u>Innovation</u> • The policy focuses on innovation (by large it is incremental but it is a mixed) • Targeted at innovation project, which most of them are product innovation • New path development (towards production)		• The CRDF's money seems to be contributing/targeting to innovation by improving and enhancing the innovation capabilities of these firms • There is innovation resulting from the CRDF's spending. Most of the innovation are incremental and possibly some radical • Innovation is happening towards the end rather than at the beginning. Therefore, the innovation is more on commercialisation (exploitation) compared to exploration (discovery)
<u>CRDF</u> • Disbursement in stages over several years • It a matching grant		<u>Firms</u> • Targeted at small firms • Malaysian owned • Still in operation and have grown		• Target the right firm (not miss-targeting) • The firm's resources have been enhanced – Yet, it is limited outcome Unlocking resources

Themes Level I		**Themes Level II**		**Interpretations**
• Firms were clear on how/where to spend the money • Substantial amount of money • Multiple usage of the money • Money usage based the firm's priority (mainly for production facilities) • Freed up firms from financial hindrance		• Invested heavily (time and money) in research (discovery) - Relatively high technology firm • (continuous improvement after entering market) • Accomplished indigenous inventions (vs open innovation)		
Product under CRDF • Variation in contribution to firms' • Has been sold (produced at industrial scale adequate for anticipated market size except for bio-pesticide) • Still requires additional steps (i.e. selling and continuous improvement) to increase products' potential		Managerial (capabilities) • Several capabilities needed to carry out an innovation project – getting ready to market • Has targeted certain capabilities • Certain capabilities have been enhanced by CRDF's expenses • Certain capabilities have been enhanced by management's competencies		• Have enhanced some capabilities but something is missing • The CRDF programme is supporting some element of a/one particular capability (i.e. manufacturing capability) but not targeting other capabilities. Yet, firms have improved other capabilities. These capabilities have not been targeted by the CRDF but have experienced improvement – (this is DC argument)
Technology • Based on invention and/or improvement of existing technology		Governance • Use the money for innovation project • MTDC is fairly cautious • Low risk investment in equipment • Freed up firms from financial hindrance – firms can concentrate of other activities		• Unlock financial resources in indirect way • Not necessary the firms could care about manufacturing but also other things • Try to affect firms' resource position but in reality it also has improved firms' capabilities; in most cases creating new path (i.e. firms are able to do task better than before)

3.10 Research validity and reliability

A frequent argument arises about qualitative research that tries to provide understanding and meaning of social phenomena is based on the trustworthiness of that research. It means that researchers have to ensure that their studies are credible (Golafshani, 2003). Tracy (2010) suggests that credibility of research is dependent on how issues of reliability and validity are being dealt with. This study needs to consider this issue although the argument is rooted in quantitative study. Indeed, reliability in an ambiguous term to define in qualitative research. In contrast, in quantitative research, this term is precisely defined. For example, Bryman and Bell (2007) refer to reliability as the ability of the results to be replicated. Meanwhile Lincoln and Guba (1985) explore this issue based on the notion that the same study could be transferred to different context and set of data.

In most cases, the nature of qualitative work is difficult to replicate or to produce results that are completely replicable. For this reason, Lincoln and Guba (1985) delve deeper into concept of reliability and contend that reliability can be described as 'dependability' in qualitative research. Dependability is useful to help qualitative researchers to defend the quality of their research, and this has to be made explicit. Therefore, for this study, the researcher has taken careful consideration to create consistent measures and processes to explore the research questions. In order to achieve this, the researcher is dependent on design of this study.

For reliability, this study focused on the interview guide, selection of the case firms and the analysis of the data. Firstly, the interview guide was carefully crafted on the basis of the literature and deliberation with documents that are available prior the fieldwork. The output was theoretically sound and practical questions. The questions were easily understood by respondents and not redundant. Secondly, the selection of case firms was carefully controlled for. The selection process is important to ascertain whether this study is valid. This study used two clusters of CRDF recipients (i.e. bio-technology and industrial products) as samples because they have had experience and information about the commercialisation of research output within high technology sectors. The firms' context reflects the major theories related to this study. The interviewees are also key informants. Lastly, this study also carefully controlled for the analysis of data. As discussed before, this study uses commonly accepted and rigorous technique to draw out the themes. In addition, Table 3-9 lays out the steps taken in this study to ensure this study is reliable.

Table 3-9: Trustworthiness approaches

Steps	**Approaches taken**	**Note**
Research context	• A thorough literature review was conducted which helped to identify and properly position this study • A sound conceptual framework has been developed	
Data collection	• Digitally-recorded all interviews • Sufficient number of cases • Respondents anonymity – help to encourage respondents to give sincere view • Interview guidelines for standardisation	• Recorded interviews reduces threat of not providing a valid description • Cases are manageable and adequate for analysis • Reduce respondents' bias

Source: Author

The above discussion on reliability is also an important element to the validity of this research. Creswell (2009) points out reliability is dependent on consistency of researchers' approach across different projects. The main way that validity is established in this study is by using a reliable process and working on existing theories and methods that are accepted in this research. For example, thematic technique that employed DC (Teece, 2007) and Generic Innovation Process (Smith, 2015) framework were used in data analysis. This study also employs triangulation technique through interviewing two different groups of key informant: the MTDC personnel and firms' owner-managers. This technique is known as data triangulation (Yin, 2009). This technique is useful for ensuring quality assurance of a case study (Stake, 1995). This technique is useful to facilitate validation of data through cross validation from the interviews.

3.10 Limitations

The approach used in this study has its limitations particularly in the cases associated with the interviewees, semi-structured interviews and firms. Firstly, there is variation in terms of interviewees' profile although they are key informants of the firms. Some of them are the owner of the firms and others are managers. This might influence their ability to articulate the commercialisation project under the CRDF because of some them are indirectly involved in that project although they are key decision makers of the firms. This makes the research strategy susceptible to the problem of producing heterogeneous insights and the relevance of the findings maybe unclear in a different setting. Besides that, this study encountered respondent bias because it relies on semi-structured interview and also due to the context of the interviewees: because they received significant funding from the MTDC, there is the possibility that respondents might give what they perceive to be the desired answer in terms of portraying positive impacts of the CRDF and roles of MTDC. The firms also might give misleading answers, representing that they were exceptional in their use of the fund. This study works this situation out by interviewing several respondents. The respondents hold different positions within firms such as managing director (MD), sales manager and production manager. Indeed, they come from different levels of management.

Secondly, this study also needed to compromise with the firms' location. Most of the firms, apart from Bio 2 and Industrial 5 are located within the Klang Valley area, which is quite close with MTDC's office. This might give those firms advantages in terms of monitoring and assistance. This area of concern can be categorised as internal validity (Yin, 2009). This study aims for internal validity rather than external validity. The main reason is because the findings of this study just concern firms in this particular area (Klang Valley) and may not be generalisable for CRDF recipients located elsewhere Malaysia. Yet, data gathered was sufficient enough to provide meaningful outcomes.

3.11 Conclusion

This chapter has presented the research philosophy adopted in this study and method employed to investigate the research questions. Since the focus of this relies on experiences, views and perceptions given both by the selected CRDF recipients and MTDC personnel, a qualitative, interpretive approach is appropriate in investigating the extent of a government support programme to facilitate commercialisation of research outputs. The main feature in the research design was the use of case studies. The main method for data collection was semi-structured interviews supported by documentary analysis and observations. Thematic analysis in light of underpinning theories was adopted as the strategy to analyse the interview transcripts. The choice of respondents in this study enables the researcher to generate meaningful explanation about a policy initiative in an emerging economy.

Chapter 4 : CASE STUDIES

4.1 Introduction

The purpose of this chapter is to present the findings of this study. The findings presented in this chapter are derived from multiple sources of data (i.e. interview transcription, documentary analysis and observation narrative). There are ten case studies of firms that received the CRDF. The CRDF is a policy initiative to support commercialisation activities within local Malaysian firms. In other words, the CRDF is a financial grant established by the Malaysian Government to fund the commercialisation activities of locally developed technologies undertaken by Malaysian-owned companies. It is a part of financial initiatives by Malaysia Government to spur research, development and commercialisation activities. In terms of eligible technologies, they can be those developed by public institutions such as universities or be the output of in-house R&D by Malaysian firms. The CRDF has the following objectives:

1) to enhance the competitiveness and capability of the Malaysian industrial sector by promoting the commercialisation of indigenous technology
2) to accelerate the commercialisation of R&D results undertaken by local universities and research institutions, companies, and individual researchers or inventors.

There are three types of CRDF grants, namely, CRDF 1, CRDF 2 and CRDF 3. Both the CRDF 1 and CRDF 2 are grants for the commercialisation of R&D output from public and private universities or Government Research Institutes by spin-off firms. The CRDF 3, on the other hand, is a grant for the commercialisation of any indigenous technologies by local SMEs. The maximum amount of the CRDF funding is MYR4 million. (USD1=MYR4.05). The case studies are made up of ten firms that received CRDF 3.

The case studies present the firms' perspective on their background, business approaches and challenges. This serves as a framework for the cross-case analysis and to present the findings from a different perspective.

4.2 Case study of Bio 1

Bio 1 was originally incorporated as a start-up firm in 1996 by a scientist, Miss Ht. She graduated from Purdue University, West Lafayette, Indiana, USA in 1994 with B.A in Psychology and B.Sc. in Neurobiology and Physiology. Upon returning to Malaysia, Miss Ht joined the MTDC in March 1995 as a Technology Development Executive. Throughout her tenure in MTDC, she was involved in various technology commercialisation development activities and founding of several companies such as Klinik Optometri UKM Sdn Bhd. In 1996, she was leading three commercialisation projects and had requested to be given a chance to concentrate on developing Bio 1. The firm was initiated as a start-up company between MTDC and Agriculture University of Malaysia (now University Putra Malaysia).

The firm has been operating in a promoted industry: biotechnology. The Malaysian Government has identified biotechnology as one of the core technologies to accelerate the transformation of Malaysia into a knowledge-based economy and an industrialised nation by 2020 (BIOTECHCORP, 2010). For this purpose, the National Biotechnology Policy was launched in 2005 to use biotechnology as an enabling tool to further develop three sectors namely agricultural, healthcare and industrial (BIOTECHCORP, 2009). From the combined efforts of developing the three sectors, Malaysia's biotechnology industry is expected to contribute 2.5 per cent of the national GDP by 2010, 4 per cent by 2015 and 5 per cent by 2020.

Under the NBP, Bio 1 is categorised as an agriculture based bio-technology firm. The firm sought to become a product development company that is capable of manufacturing products for sustainable plantation (mainly oil palm and paddy plantations) and other agriculture activities. The firm's products have been developed based on applications of microbes as fertilization and decomposition agent aimed at improving crop productivity, land rehabilitation and soil fertility. Bio 1 has been utilising four microbes in its products such as *Mycorrhiza sp., Trichoderma sp., Bacillus sp*. and *Metarhizium sp*. Figure 4-1 summarises Bio 1's products that have been marketed as bio-fertiliser, bio-pesticide and bio-remediation.

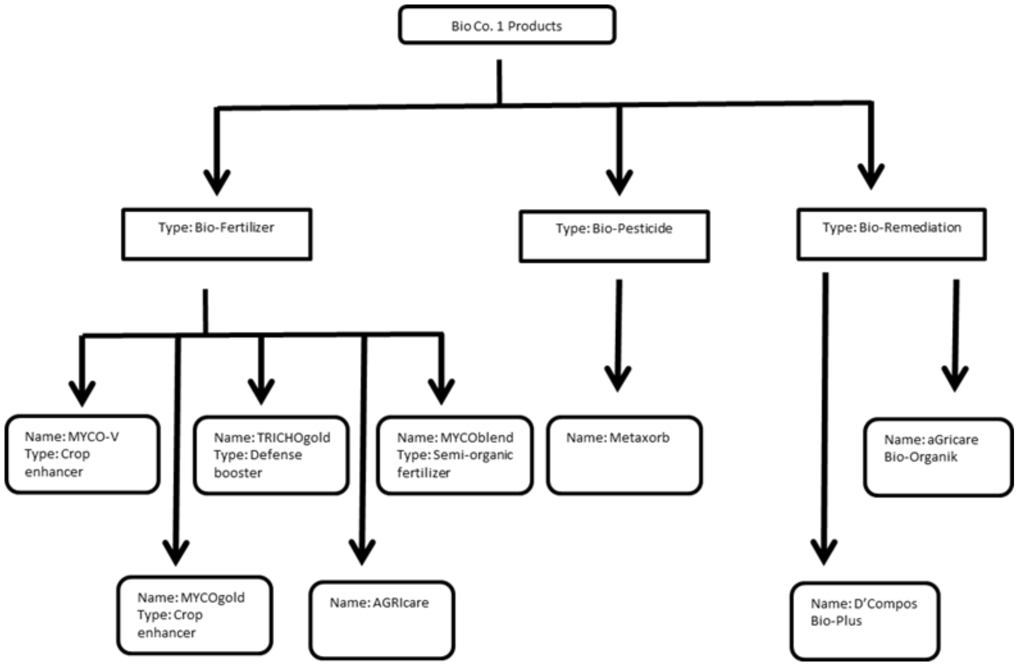

Figure 4-1: Bio 1's Products Schedule

As a science-based firm, Bio 1 has been dependent on R&D capabilities in its products' development. In fact, its first product (a bio-fertiliser marketed as MYCOgold) was developed from research on *Mycrorrhizae*[12]. The fungus' applications remain the firm's core source of technology and have provided the central path for the firm's R&D and all its strategic direction. To date, almost all of Bio 1's products have been dedicated to these applications. The interviewee, a production manager gave the following account:

> *"We just started with Mycrorrhizae. All research has been focused on this. But, actually all these are related. This one is fungus (mycrorrhizae), this one (metaxob) also fungus. The basic is the same."*
>
> (The interviewee and production manager of Bio 1)

[12] *Mycrorrhizae* refers to a group of fungus which forms a mutually beneficial relationship with plants. These fungi grow either inside of a plant's roots or attach to the surface of roots.

Besides the core technology, Bio 1 also shows capability for innovation. The firm's route in innovation has been dependent on its amplification of scientific discovery and technological breakthrough. This can be seen from its recruitment approach. In the early stage of operation, the firm established researcher positions within its organisation as reported by the interviewee:

"When I joined in 1995, I started as a researcher".

This recruitment practice has been continuing in the expansion stage. It has allowed the firm to have a pool of qualified personnel in interrelated disciplines. The firm's executive personnel comprise of universities graduates. They hold Bachelor of Science and qualified as biologist, microbiologists or agriculturists. Based on their education background, the executives are researchers by training. They are deemed to have understanding how a research based firm should work and the importance of technological breakthroughs.

The firm's capability in innovation could be witnessed in terms of introduction of new products and financial attainments. Since 1999, Bio 1 has produced eight products. As described in Table 4-1, the firm's products focus on niche a market for sustainable plantation (mainly oil palm and paddy plantations) and other agriculture activities. The main reason for this move because the oil palm industry forms the economic backbone of Malaysia. Malaysia a main producer of palm oil for the global market.

Table 4-1: Bio 1's products' usage

	Product	**Usage**
i.	MYCO –V	Crop enhancer
ii.	MYCOgold (rebranding and improvement of MYCO-V)	Crop enhancer for healthier root establishment. Dedicated to oil palm
iii.	MYCOblend	Crop enhancer that can be used on oil palm and other plants
iv.	TRICHOgold	Disease remedy by protecting plants' root against soil-borne pathogens
v.	Metaxorb	To control rhinoceros beetle infestations for oil palm plantations
vi.	D'Compos Bio-Plus	Decompose agent for rice straw. Prevent open burning

vii.	aGricare Bio-Organik	Can be used as a soil conditioner, organic fertiliser, mulches and planting media. Contains microbes and decomposed organic matter

As outlined in Table 4-2, MYCOgold was the first product of Bio 1 and it is the firm's core product. MYCOgold's development process started in 1998 when Bio 1 made improvement of technology acquired from UPM. At that time, the R&D activities had been focused on quadrupling the current *Mycorrhiza* spore concentration.

Interviewee asserted:

> *"We have a collaboration with UPM. We take Mycorrhiza's technology from them. We still produce and sell this product. It has been considered as the bread and butter although we have other products."*

Table 4-2: Bio 1's selected products' milestone

Year	Product's Name	Stage
1999	MYCOgold	Production
2003	TRICHOgold	Under development
2004	Metaxorb	Development of formulation and conduct toxicity test
2005	Metaxorb	Completion of commercial samples
	TRICHOgold	
	MYCO-V	Pilot production using the new plant
2006	MYCO-V	Product development for international market
	TRICHOgold	Product enrichment programme in bio-organic programme
2007	Metaxorb	Approval from Malaysian National Pesticides Control Board
	MYCOgold	Efficacy validation by Malaysian Palm Oil Board
2008	Metaxorb	Launching of Metaxorb

Financially, Bio 1 has experienced significant growth in term of turnover and profitability from 2005 to 2011. In that period, the firm was able to achieve average turnover growth of 44.41 per cent. The highest sales growth was incurred in between 2008 and 2009 with 115.72 per cent growth, meanwhile the lowest sales growth was in 2006 with 0.58 per cent. Bio 1 has experienced more substantial growth in profitability with an average of 93.75 per cent in the same period. The most substantial growth was in 2007 with 377.01 percent hike. Table 4-3 summarises Bio 1's turnover and profitability.

Table 4-3: Bio 1's financial performance

Year Ended	**Revenue (MYR)**	**Direct Cost (MYR)**	**Profit (MYR)**	**Fixed Asset (MYR)**	**Current Asset (MYR)**
2005 (USD1= MYR3.80)	3.09	1.07	0.33	7.43	1.27
2006 (USD1= MY3.70)	3.11	1.20	0.41	7.87	1.81
2007 (USD1= MYR3.47)	4.55	0.91	1.96	8.53	3.16
2008 (USD1= MYR3.37)	5.08	1.97	1.09	10.8	12.99
2009 (USD1= MYR3.56)	10.92	5.65	2.02	16.51	15.81
2010 (USD1= MYR3.25)	13.13	6.95	3.59	22.01	22.81
2011 (USD1= MYR3.09)	22.63	12.11	5.12	27.22	30.36

Source: Extracted from Bio 1's financial statements retrieved from Companies Commission of Malaysia

Note: Financial figures are in millions

Bio 1 can be considered a good example of successful local bio-technology companies in Malaysia. The firm recorded impressive financial attainment in term of sales and profitability. Bio 1 has also been able to file three patents from its 1st R&D plan

(1997-2006) and currently developing more products under its 2nd R&D plan (2007-2016). The firm's achievements have been recognised by several organisation involved in development of high-technology business such as Malaysian Biotechnology Corporation (Biotech Corp) and SME Bank Malaysia. Awards have been extended to Bio 1's key management personnel and products. Table 4-4 summarises the awards received by Bio 1, its key personnel and products.

Table 4-4: Bio 1's list of awards

	Award	**Patron**	**Year**
Firm level	Outstanding Investee Company	Malaysian Venture Capital Association	2011
	Award for Innovative Venture Capital Backed Companies	Malaysian Venture Capital Association	2010
	Global Award	Smart Entrepreneur	2010
	Bio Nexus Status	Biotech Corp	2007
Key personnel (The MD – Miss Ht)	Excellent Woman Entrepreneur – R&D based business	SME Bank Malaysia Berhad	2011
	Smart Entrepreneur Award	Business Productivity Network	2010
Products/ Services	Bronze award - Nutrient Recycling Strategy Decomposition of Palm Oil Green Waste	Biotech Corp	2010
	TRICHOgold – Defense booster bio-fertiliser	Biotech Corp	2009
	Metaxorb – Bio-control against rhinoceros beetle	Biotech Corp	2009

4.2.1 Context of the Commercialisation of Research and Development Fund

Bio 1 has been awarded with CRDF grant by the MTDC in 2007. Bio 1 applied for MYR5,000,000 and was approved for MYR3,200,000 because the CRDF is limited to providing 70 per cent of the total project cost. The CRDF was approved for commercialisation of a microbial based insecticide which is marketed as Metaxorb. The bio-insecticide was a new product' category besides bio-fertiliser and bio-remediation.

Bio 1 started receiving the CRDF's disbursement from April 2007. In the application process, Bio 1 needed to face stringent screening including evaluation sessions to convince the Approval Committee of the MTDC. The major query was whether the intended product can be sold. At that juncture, the CRDF helped Bio 1 to have further understanding about the market and refine the opportunity. Bio 1 had come out with five year sales projection figures, detailed out the marketing strategy and highlighted that Bio 1 had started a small scale production.

4.2.2 The product

The Metaxorb is a bio control insecticide which applies the *Metarhizium anisoplie* to control a rhinoceros beetle (Oryctes rhinoceros) problem in oil palm plantations. *Metarhizium anisoplie* is a soil-inhabiting fungus well known as a microbial agent against insects and a host-specific for the rhinoceros beetle. The product is liquid form and it needs to be mixed with certain amount of water. Then, the mixture will be sprayed on certain plantation areas such as palm shoot, heaps and empty bunches. This product is essential in Bio 1's initiatives to establishing a niche market demands in the oil palm sector that is now ready to adopt more sustainable methods of agricultural productions driven by increasing environment awareness. Oil palm plantations (i.e. big scale plantations) that have been known as heavy users of chemical-based fertilisers and pesticides. However, in recent years, there are active initiatives by custodians of the oil palm industry to promote sustainable plantations by introduction of Certified Sustainable Palm Oil (CSPO). The CSPO is palm oil that has been certified through criteria that can help reduce the negative impacts of oil palm cultivation on the environment and communities. The criteria includes implementation of Good Agriculture Practices (GAP) and Integrated Pest Management. Table 4–5 provides a summary of GAP and IPM.

Table 4-5: Summary of GAP and IPM

GAP	IPM
• Recycling of oil palm biomass and optimization of fertiliser inputs • Adapting zero burning & re-planting policy: accumulation of soil carbon in the plantation • Land management and planting of leguminous cover crops	• Effective IPM system for the management of pest, diseases, weeds and introduced species • Use of natural predators & beneficial plants • Use of barn owl to control rats • Use of natural bio pesticides • Decreased reliance on harmful chemical pesticides • Only approved chemicals are used when required

One advantage of having CSPO is that a plantation could sell the palm oil at a higher price. The interviewee gives the following remark:

> *"Right now CSPO. Plantations that use bio-products and not harmful to environment, the price would be higher. But the plantations need to get the certificate".*

Bio 1 senses the opportunity to develop Metaxorb because the product is integral with big plantation companies' effort to obtain the CSPO.

The Metaxorb is packed in 1-litre bottle and this product has been expected to fulfil big plantation companies' demand for IPM. This has been admitted by the interviewee when she said:

> *"At that time we have orders from customers for that product".*

The plan under the CRDF's project was to produce and market 5,000 litres of Metaxorb. This plan was viable because before receiving the CRDF, the production of Metaxorb had been carried out using small scale machines.

4.2.3 Product development capabilities

Metaxorb is another outcome of Bio 1's product innovation. The firm has been dependent on discovery of microbes that could be commercialised as fertilization and decomposition agents. The discoveries are the result of the firm's research and market penetration activities. Indeed, the processes are challenging and time-consuming. Although the development of Metaxorb started in 2004, the firm's capabilities in products development have been building up since 1998. At that time, the firm was starting to develop its first product by making improvement to technology acquired from the UPM. In that stage, the academic research was enhanced based on the executives' basic research that *Myhorrhiza* has been tested empirically on vegetable plants. There was no research guidance except the fundamental technology from UPM.

4.2.4 Research capabilities

The experience with their first product has convinced Bio 1 to amplify scientific discovery and technological breakthrough. This process is segregated into two sections: 1) discovery of new microbes and 2) finding quadrupling techniques for microbes' enrichment. However, developing a new bio-based agriculture products proved difficult. The firm has been dependent on processes related to identifying and integrating innovations. This process meant exploration phase of the innovation process. The executives initiated this process by scouring journals to look for scientific opportunities in term of new potential microbes. Their qualification proved applicable in this process. However, the empirical works within the academic literature are limited to certain plants only. This restricts the application of the scientific discoveries (i.e. potentially beneficial microbes). In Bio 1's case, the firm is interested in commercialisation of *Mycorrhiza.* However, the empirical works in universities does not firmly discuss which plants are suitable for *Mycorrhiza*. Bio 1 perceives this as more general application of the fungus. Therefore, the firm decided to expand their research work into field testing to determine the *Mychorrhiza*'s applicability.

In the initial stage, field testing was carried out based on the executives' basic research knowledge that *Myhorrhiza* has been tested on vegetable plants. There was no research guidance except the fundamental technology from UPM. Interviewee made remark that perhaps elaborate that process, as she said*:*

"We have taken the Mycorrhiza from UPM. And then after that we improvise on our own. Based on our knowledge, some carriers are from sand. And then we improve by developing mineral based carrier. Just a simple improvement and addition".

The first field testing was carried out on oil palm and rubber seedlings. The seedlings are owned by Bio 1's prospective customers. The result from the field testing suggested that oil palm and rubber plants are compatible with *Myhorrhiza*. Although it was encouraging, Bio 1 decided to concentrate on oil palm plantation because during that time, the local big plantation companies started to adopt the GAP and IPM.

4.2.5 Production capabilities

The firm is also deemed to have significant experience and proper facilities for manufacturing. From its inception, the firm has carried out the manufacturing activities on its own. There were no outsourced activities. This arrangement has facilitated production of eight products within ten years of operation. On average, Bio 1 spent between two to four years before a product could be sold on the market. For example, the development of Metaxorb was started in 2004 and was officially launched in 2008. The development of Metaxorb was expected to have taken a longer period because it is a totally new products. In other cases, for example MYCOblend, the product development took shorter period. This is because the product is a recombination of existing products such as MYCOgold and TRICHOgold.

As highlighted earlier, the development of Metaxorb started in 2004. The firm's research capabilities are essential in the product formulation. The main outcome was the product sample (i.e. prototype). At that time the firm did not have any production facilities except to run the production activities at laboratory scale. Indeed, the production scale in one of the obstacles for Bio 1 in the product development. This has been highlighted by the interviewee:

"Yes. We also knew that if we have the machines...We can produce more".

It became more apparent when the firm did not have an allocated budget for designated production line. The interviewee asserted:

"But at that time, we started this project with zero. Sort of no allocated budget for Metaxorb".

Still, the firm perceived the needs to upgrade the production capability from laboratory scale to industrial scale.

The CRDF fund has been used to acquire new machines that lead to the firm's capacity upgrading. Before that, for example, the old autoclave for grooming the fungus (i.e. the *Metarhizium anisoplie*) could only cater for 50 samples. Certain processes were even performed manually. The interviewee asserted:

> *"Meanwhile, we use traditional method. We done it but did not achieve our target. In small scale".*

The firm has recognised this as its weakness because the production line generated limited output, hence limiting the firm's production capacity. The newly acquired autoclave can accommodate 200 samples. In this case, the CRDF has increased Bio 1's investment capacity and manufacturing capability. However, under the CRDF's arrangement, a recipient needs to have incurred expenses before the MTDC will reimburse 70 per cent of those expenses on a claimed basis. However, Bio 1 did not have any allocated budget. As an option, Bio 1 decided to approach SME Bank[13] for a loan to cover 90 per cent initial outlay to acquire that machine. Bio 1 also made an initiative to renegotiate the terms of CRDF with MTDC pays upfront 10 per cent outlay. Then after Bio 1 took the delivery of that machines, the firm made the reimbursement application and used that money to pay out the loan from SME Bank. This occurrence is illustrated by Figure 4-2.

[13] SME Bank is a full-fledged financial institution for nurturing SMEs excellence in Malaysia.

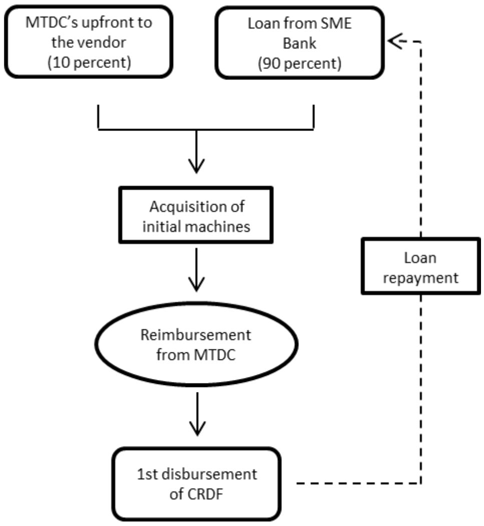

Figure 4-2: CRDF's application in Bio 1

The CRDF had facilitated the initial outlay of Metaxorb's production capital expenditure. From this initial process, Bio 1 was able to acquire additional machines via reimbursements until the CRDF has been fully reimbursed in 2011. However, the partial grant term required Bio 1 needed to be creative in administering the CRDF and production. This induced a notion that the CRDF is working but not as positively as expected. Firstly, the work of CRDF through the evaluative session helped Bio 1 in the production planning. Secondly, the firm needed to list machines needed for production of Metaxorb. The interviewee explained that, as she said*:*

> *"We need to breakdown. I need to put important equipment first. I put for production first".*

The comment explains that the firm needed to prioritise because the CRDF's disbursements were by each machine. Secondly, the machines reduce Bio 1 dependency on manual worker as the production technique became more automated. Each stage of production activities has taken less time. However, Bio 1 needed to face a bigger challenge in terms of manufacturing. The automated system required each machines to be working well. However, this has been not always the case. The interviewee commented:

> *"When one machine broken down, we have to stop the whole production".*

In order to avoid this, the machines need to meet a costly maintenance schedule. The maintenance is not only costly but also increases the production idle time thereby increasing the overhead cost.

4.2.6 Marketing capabilities

By focusing on big plantation companies, Bio 1 needed to adopt different approaches especially in getting in touch with customer for sales purposes. Sales were initiated by directly approaching plantations and estates. However, this sales approach was less effective because any decision is subject to plantation managers' discretion. The managers converged in a special group known as planters.

The interviewee illustrates that situation, she reported that:

> *"At that time, Miss Ht and I went to plantations, knocked their doors and asking 'do you want to buy'. Up to that level. Oil palm managers have an elite group known as planters".*

Based on these circumstances, Bio 1's personnel needed to join the planters group. During their monthly events, planters discuss their plantation problem and Bio 1 has benefited from this in terms of recognising unmet needs of their customer. Bio 1 also tries to maintain good relationships with planters by sponsoring souvenirs. However, the main challenge is about overcoming competition from chemical products. The chemical products are produced by big and established chemical companies such as Novartis, Synergy and Bayer. Bio 1's approach is about not directly rejecting chemical product, but instead introducing gradually substitution technique to customers. This sales technique requires Bio 1 to convince the customer to use their existing chemical up to certain threshold level and then start to use Bio 1's product. Most of the advice is derived from Bio 1 laboratory and field works.

Bio 1 has been dependent on the expertise of its specialist team (i.e. Technical Advisory (TA) team) in building up working relationship with the big plantation companies. The TA team is made of bio-chemistry or bio-industry graduates. This team is segregated into zones: eastern, southern and Indonesia. Their job is to do a site visit and sometimes requires multiple visits to convince the customer. Based on the TA's works, Bio 1 has adopted a niche approach towards product sales. In fact, the main challenge was customer penetration. The big plantation companies get used to chemical-based products and are also sensitive to cost. The introduction of bio-based products like Metaxorb requires plantation companies to change their practices and also incur additional cost. Interviewee gave the following account:

"We did not straight away reject chemical products. When rhinoceros beetle attacked the palm oil which under are three years, normally the attacked is severe. At this stage, bio-products are not able to immediately combat the attack. We advised the customer to use the chemical product until reaches threshold that customer wanted, and then use bio-products consistently. One thing we realised that bio-products cannot replace chemical products. It means that, customer cannot wipe-out chemical products. One more thing, it is not possible for us to compete with big chemical companies such as Bayer. So, we establish cooperation with planters. We talk through clients."

Indeed, Bio 1 faced challenge when trying to convince the plantations managers. They are not only cost sensitive but also have vast experience. The challenge becomes more apparent when a particular plantation has been producing 100 per cent yield. Hence, the manager of that particular planation is reluctant to make any changes. In this case, Bio 1 needed to be resourceful in putting relevant points for the manager's consideration. Bio 1 managed this by presenting a cost-benefit analysis to the customer using a different perspective. The situation is explained below:

"Sometimes we cannot deny the planters' experience. Planters often presented their claim in plantation management. Most of the time their plantations have been operating at 100 per cent yield. However, we countered that claim by offering a plan for a 110 per cent yield but with additional cost. The cost will be minimal and plantations still can make profit."

In this regard, the big plantations' demands have a large bearing on the firm's strategic path in term of demand for its products' innovation. However, this perceived demand did not guarantee market acceptance. Bio 1 needed to dedicate substantial resources to gaining access and acceptance among plantation companies. Based on their operation scale, the big plantation companies might have demanded large quantities of bio-based products. It means that, Bio 1 could have received large orders from their customers. However, this move created challenges for Bio 1. The plantation companies required product quality control and requested reliable data on product application. The main reason was that Bio 1 did not have experience in plantation and its products were new to the market.

Interviewee provided more details on the arrangement with the big plantation companies:

> *"We approached big plantation companies such as Guthrie, Golden Hope. Right now they are under Sime Darby. Then Guthrie and Golden Hope requested for product quality control. It means testing. They wanted us to test the product first. Then they would like to know whether our product could be used or not. They needed data. So, we carried out data collection for them. We did this because we wanted to sell products to them".*

As a result, Bio 1 needed to change their approach in selling one of its product (i.e. MYCO-V)[14]. The firm decided to proceed with the prospective customers' demand by conducting product testing on their site. Bio 1's main task was to conduct product testing and collect data on behalf of the potential clients. Although it was not hoped for circumstance, Bio 1 gained valuable experiences. First, the firm reorganised its resources by establishing new team known as Testing and Protocol. The interviewee recalled that by saying: *"So, at that time, what we done was to establish a team, a new team known as Testing and Protocol"*. Secondly, in terms of the product improvement. Field testing has given extra space for Bio 1 to refine the MYCO-V because the product has been developed under a controlled environment.

4.2.7 Innovation capabilities

Bio 1 also has close and good working relationships with government agencies such as Malaysia Palm Oil Board (MPOB)[15] and MTDC. The working relationship has been far more apparent with MTDC and it is probably exclusive to Bio 1 compared to other CRDF recipients. The fact that the founder, Miss Ht is the MTDC's former Technology Development executive might positively influenced Bio 1's capability in an innovation project. The provision to rent space in the UPM-MTDC Technology Centre in 1996 has been the initial association between Bio 1 and MTDC. Bio 1 was among the early tenants of UPM-MTDC Technology Centre. This association was timely because Bio 1 was a start-up firm in 1996 and thus required support from parties that could facilitate high technology businesses such as the MTDC. The provision of space in the technology centre permitted Bio 1 to access other business support services provided by the MTDC for fees.

[14] MYCO-V is a bio-fertiliser for crop enhancement.
[15] The Malaysian Palm Oil Board (MPOB) is a government agency responsible for the promotion and development of the palm oil industry in Malaysia.

Other support service in addition to the financial support from the CRDF are also crucial in development of Metaxorb. Given this product is a high technology product with high level of uncertainty and unpredictability, the firm needs capabilities to proceed with certification. This capability is intangible in nature, thus firm needs to carry out careful refinement. This capability is part of innovation capabilities and ideally it draws the product close to legislation for market entry. Although the research, production and marketing capabilities are equally important but still not sufficient to produce a favourable new path for Bio 1. The production of Metaxorb at industrial scale showed that Bio 1 is able to address the market by introduction of new product. Yet, the product's potential has been hindered by the firm's inability to observe the required legislation.

Metaxorb still cannot be sold publicly because the product needs to undergo third-party testing. The test will cost MYR156,000 (USD1=MYR3.12) and it is not eligible under CRDF funding. As result, Metaxorb is only made available to existing Bio 1 clients hence limiting its market reach. In fact, the Metaxorb is a complementary product of Bio 1 and a seasonal product for prospective customers. This means planters will look for this product if there is beetle attack. This has been admitted by the interviewee when she said:

> *"Metaxorb is seasonal product. Plantations might use it if there is attack. They would not use it as precaution. Unless, they go to plantation and found egg. If no evident, they will be hardly use it".*

This will expose Bio 1 to the threat of not getting repeat sales as bio-fertilisers. The soft-support is also needed to materialise intangible challenges in product development.

4.3 Case study of Bio 2

Bio 2 is a private Malaysian firm founded by Mr Nl in 1989. Mr Nl graduated as a pharmacist from University Science Malaysia, one of the leading pharmacy schools in Malaysia. Mr Nl is the firm's MD. He is determined to propel the firm to become a research-based company that discovers, develops, manufactures and markets natural pharmaceutical products. The products' substances are derived from local botanical plants. Mr Nl asserted*:*

"Our objective has been to focus on local herbal products".

(The interviewee, founder and Managing Director of Bio 2)

The firm's mission is to improve people's health by providing high quality herbal and nutritional products.

Bio 2 has been operated as a herbal research firm. Its main approach is to promote preventive measures healthcare. The firm has been producing 36 products. The products have been marketed as food supplements and nutritional products under different categories. Table 4-6 summarises the categories of Bio 2's products.

Table 4-6: Bio 2's product categories

	Category
1.	Liver tonic
2.	Skin and beauty
3.	Healthy heart solution
4.	Join and inflammation support
5.	Men's nutrition
6.	Women's nutrition
7.	Bone and nerve health
8.	Slimming and weight control
9.	Sugar health

10.	Ultra energy support
11.	Children health
12.	Bright eye support

In 2012, Bio 2 launched a new product category, the skin care and beauty. This category comprises of nine products. The products has been marketed by Bio 2's subsidiary, NVSB. The skin care and beauty products have been developed based on Bio 2's research on anti-aging benefits from tropical plants such as ficus tree and oil palm leaf. The main discovery of that research is the extraction of SP8 from those plants.

Bio 2 has been operated from a modest two-storey building surrounded by oil palm plantations. The premises are in 5.5 acres of industrial land and is located about 40 kilometres from the capital city. The Kuala Lumpur International Airport is 15 minutes drive from Bio 2's location. The main building houses Bio 2's administration office and manufacturing facilities. Next to the two-storeys building, there is another building that houses Bio 2's research laboratory. The firm has been experiencing modest physical expansion by acquiring new manufacturing machineries with higher capacity. Table 4-7 illustrates Bio 2's fixed assets value in the past years.

Table 4-7: Bio 2's value of fixed assets

Year Ended (31 June)	**Fixed Assets (MYR)**
2005	4.72 (USD1=MYR3.80)
2006	5.03 (USD1=MYR3.70)
2007	4.84 (USD1=MYR3.47)
2008	4.84 (USD1=MYR3.37)
2009	4.92 (USD1=MYR3.56)
2010	4.58 (USD1=MYR3.25)
2011	4.12 (USD1=MYR3.09)

Note: The financial figures are in millions

The firm has been operating in a highly regulated business. As a producer of consumable products, the firm is bounded by regulations that try to safeguard consumer from harmful products. Given that parameter, Bio 2 has experienced significant growth in terms of turnover and profitability from 2005 to 2011. In that period, the firm was able to achieve average turnover growth of 20.84 per cent. The highest sales growth was incurred in between 2010 to 2011 with 32.65 per cent growth, meanwhile the lowest sales growth was in 2008 with 1.69 per cent. Bio 2 has also experienced more substantial growth in profitability with average of 211.33 per cent in the same period. The most significant growth was in 2008 with 643.73 percent hike. Table 4-8 summarises Bio 2 turnover and profitability.

Table 4-8: Bio 2's financial performance

Year Ended	**Revenue (MYR)**	**Cost of sales (MYR)**	**Profit (MYR)**
2005 (USD1=MYR3.80)	4.45	0.28	0.12
2006 (USD1=MYR3.70)	5.02	3.11	0.03
2007 (US 1=MYR3.47)	5.57	3.82	0.23
2008 (USD1=MYR3.37)	6.68	3.36	1.70
2009 (USD1=MYR3.56)	8.60	3.61	3.40
2010 (USD1=MYR3.25)	10.17	4.12	4.29
2011 (USD1=MYR3.09)	13.49	4.98	6.90

Note: The financial figures are in millions

The firm sees the local market as its target. Indeed, local sales represents 80 per cent of its total sales. The firm also perceive the importance of overseas markets. The overseas market is made of consumers in Thailand, Indonesia and Vietnam. For both markets, the customers are made of entities such as clinics, pharmacies and hospitals.

4.3.1 Context of Commercialisation of Research and Development Fund

Bio 2 was awarded with CRDF by the MTDC in March 2006. Bio 2 applied for MYR1,200,000 (USD1=MYR3.70) and was approved got MYR600,000 (USD1=MYR3.70). However, the firm only received MYR100,000 of the approved amount. The CRDF was approved for commercialisation of a novel anti-human Hepatitis-B agent from botanical plant, *Phyllanthus ninuri*. The product has been marketed as a liver tonic under traditional medicine. It is known as Hepar-P.

In the application process, the firm justified its interest in CRDF based on several points. First, there is demand for this product due unmet clinical needs among people suffering from liver illness. Second, the firm has been in control of manufacturing and supply of raw material. Indeed, the firm owns botanical farms and any shortage will be compensated by local growers.

4.3.2 The product

Hepar-P is Bio 2's core product. This product contains active compounds extracted from a local herbal plant called 'Dukung Anak' or scientifically known as *Phyllanthus ninuri*. The product is said to possess a cure for Hepatitis-B. The product's development process began in 1997 after Mr Nl's experience with a family member's illness. The firm spent seven years developing the product. The product has been sold in capsules. Each bottle contains 25 capsules. The current market price is MYR60 (USD1=MYR3.47). The product has been granted Malaysian Patent Protected Composition in July 2007.

The product has been consumed by patients with liver illness in government hospitals. The product is listed in governments hospitals although this product is yet to prove its medical claim of effectiveness on liver illness. It means that the participating hospitals do not prescribe Hepar-P as a drug. Instead, patients consumed it as traditional remedy under doctors' discretion. The product is still under clinical trial and the CRDF is meant for this purpose.

4.3.3 Research capabilities

Bio 2 started building its research capabilities based on Mr Nl's experience as pharmacy student. Mr Nl's research experience was extended by having a discussion with his former lecturer from School of Pharmacy, USM. The discussion focussed on the basic skills and philosophy of research as Mr Nl put it:

> *"I said about is on how things are done. It is not actually the exact details but on basic philosophy on how to develop herbals product".*

Indeed, the discussion was fruitful to provide the firm with basic guidance in carrying out research. The discussion has been developed into a collaboration between the firm and USM.

The collaboration has promoted the firm's research capabilities for 15 years. In fact, the collaboration was timely because at inception Bio 2 did not have expertise and proper facilities for laboratory works (i.e. for research). The interviewee explained:

> *"At that time, we did not have good facilities. We did not have any facilities, I would say".*

The collaboration offered access to resources for research activities such as research facilities and human resource. The firm started its first research project by employing USM's students as part-time researchers.

Besides the consultation, a working relationship with the USM facilitated Bio 2 research activities by provision of laboratory facilities. Mr Nl recalled:

"We needed to use their facilities".

Although it was useful, the firm did not have full access to the equipment which hindered its research potential. Nevertheless, the experience with USM amplified the firm's attitude towards the research discipline. As the interviewee put it:

"Now, every product, we have go through a very thorough research in terms of efficacy, safety and even quality aspect".

Mr Nl takes research very seriously and he is even the head of the research department. Mr Fy has been assisting Mr Nl in the running of the research department. The department is made of seven researchers qualified with Bachelor degrees.

The standardisation process has been the department's major technological breakthrough. This process is the fundamental process of products development. Bio 2 claims the standardisation process will deliver pure and consistent content for every batch of productions. This process was developed to overcome challenges in production: inconsistent content of raw material. The interviewee explained:

"For herbals product, we need to be able to quantify because inconsistency of the raw material. So, we are not going to get the same thing, even though we do the same process to process the certain raw material/plant".

This comment shows that the main output of standardisation process is a scientific technique to quantify the contents of raw material. For example, the firm claims that each capsule of Hepar-P is standardised to contain two active ingredients (i.e. Corilagin 10 mg and Phyllanthus Flavonoids 45 mg).

4.3.4 Production capabilities

The firm is also deemed to have significant experience and proper facilities for production. From its inception, the firm has carried out the manufacturing activities on its own. There were not outsourced activities. The production experience was gained in the early stage of the firm's development. At that time, the firm was producing animal health products. Then it diversified into its current business activity: pharmaceutical and herbal production.

Since diversification, the firm has practiced sequential production technique. This means the production capabilities have been developed in stages. It starts to prior full scale production and it takes place in the research department. The firm set up a laboratory scale production line in that department. The design of the line is identical with the line managed by production department but with lower scale production. It acts as trial runs. Here, the firm recognises any possible discrepancies and makes necessary improvements. Here, the firm could adjust the product formulation and come out with a sample for quality control.

Then the same set of production capabilities are exploited in higher capacity production lines. The lines are managed by a production department which includes quality control personnel. The main objective of these lines is to produce products at industrial scale and meeting Good Manufacturing Practice. Obviously, the firm has been dependent on the experience of production team and sufficient numbers of suitable machines. The firm has a well-structured manufacturing department made of supervisors and technical employees. Even though some of them are not highly qualified, they are well-trained. The interviewee explained:

> *"Most of them, we proudly trained them. Actually, we can't afford very qualified people. We trained them. They learned most of skills here".*

Their skills in production have helped the firm organise high scale production.

Bio 2 also implements progressive upgrading its production facilities. Mr Nl quantifies the firm's spending by saying*: "We upgrade our machine. We spend less than a million a year"*. The spending is meant for additional machines for capacity upgrading. It means that, the new machines have been used to perform the same task but in more efficient ways. Mr Nl added:

> *"Rather than new type of machines, mostly to upgrade capacity".*

4.3.5 Marketing capabilities

The firm promotes the basic concept of prevention rather than treatments in its marketing effort. As the interviewee put it:

> *"Broadly we talking about nutrition and preventive approach to improve health".*

This has been the firm's selling point. However, it is not sufficient because the firm needs to compete with overseas products. Indeed, the overseas products possess reputation in the market because they have been produced by reputable pharmaceutical companies.

Bio 2 also has the same marketing objective: to build its own brand. It is a challenging task because acceptance of local products is low. Talking about this issue, the interviewee said:

> *"The biggest challenge is the customer acceptance of local product is low. Yes, that's why we need to work very hard explaining to customer about our background, the process and everything".*

It means that marketing effort aims at trying to get people to know the firm.

4.3.6 Innovation capabilities

The MD, Mr Nl initiated the firm's innovation quest by having a strong mind set on coming out with finished products. In that process, meeting stipulated regulation becomes part of it. The firm is in a good position to be in this highly regulated business because it has been managed by a pharmacist. Mr Nl explained*:*

> *"I think my background as a pharmacist helps me a lot. By setting that we are going to developed finished product, then we get to know the requirements".*

Although Bio 2's products are herbal-based, nevertheless they need to proceed with efficacy testing before making any medical claims.

As an herbal product, Hepar-P needs to undergo efficacy tests. The test is meant for greater acceptance among consumer and medical practitioners. Nonetheless, the product has been sold as a traditional medicine without efficacy tests. Sales were recorded at 26 million capsules (The Star, 2013). Although sales were encouraging, the firm wanted to expand the market. The firm perceived the clinical trial will boost Hepar-P's sales. The interviewee commented:

> *"We can sell with no claim and therefore the acceptance is not so high. But, if we have completed the clinical trial with good result, then we can claim. Consumer will accept this".*

Therefore, Bio 2 decided to proceed with clinical trials as the efficacy tests. The test is essential because the firm needed to proof Hepar-P's benefits and effects.

The firm's decision to proceed with clinical trials imposed greater challenge compared to research activity. The trials is a time consuming process because it has to be totally independent. The interviewee explained:

> *"When we talk about clinical trials for human, it is placebo control and double blind. That means, the doctor and the patients do not aware about it".*

That means, Bio 2 has to be dependent on doctors and patients to make the test work. For this purpose, the firm forged a working relationship with Malaysia Liver Foundation. Indeed, the MLF has been the patron for the testing and Bio 2 has been the sponsor. That means, the firm has been supplying the capsules and MLF promoted the project to its members (i.e. medical doctors).

The clinical trials have been carried out in six government hospitals for a period of 48 weeks. Bio 2 needed to sponsor the capsules for that period. Mr Nl commented*:*

> *"This firm is only involve in manufacturing of the 'drug', sponsoring the project, give the 'drugs' to the doctors".*

The trials were approved based on a predetermined number of patients (80 participants). Although the MLF has been supportive, the clinical trials faced a lot of difficulties. Among others, the nature of the clinical trial. The firm was not allowed to get details of the running trials. All arrangement were done by the appointed clinicians. However, without close monitoring, the clinician were not able to recruit sufficient numbers of patients. As a result, the trials failed although the CRDF fund was spent for that purpose.

4.4 Case study of Bio 3

Bio 3 was originally incorporated as a private company in 2004. The firm was founded by a married couple, Mr Ss and Mrs Ah. Mr Ss graduated from the National University of Malaysia (UKM) in 1975. Mr Ss pursued his studies at the University of Strathclyde, Glasgow and gained his M.Sc. and PhD in Applied Microbiology in 1978 and 1985 respectively. He served with the Malaysian Agricultural Research and Development Institute (MARDI)[16] for 27 years as a research officer in food biotechnology. His last post at MARDI was Assistant Director of the Food Biotechnology Programme, in the Biotechnology Division before opting for early retirement in 2004 to establish the foundations of Bio 3. Mr Ss is the firm's CEO.

Meanwhile, Mrs Ah is the firm's main consultant and leading researcher. All of Bio 3's products are based on findings from the research she conducted for over 25 years in the field of biochemistry. She graduated from the National University of Malaysia (UKM) in 1976 in Biology. She obtained her M.Sc. from the University of Strathclyde in 1978 and her PhD from the University of Glasgow in 1985.

Bio 3 is principally engaged in manufacturing, R&D and distributing of herbal products for health. In fact, Bio 3 was an expansion of a small scale business run by Mr Ss on a part-time basis. Mr Ss explained:

> *"Before Bio 3, we done it in small scale. No company was formed. I still working with MARDI".*
>
> (The interviewee, co-founder and Managing Director of Bio 3)

Although it was small scale, the business had produced several products and market acceptance was good because customers were attracted to scientific developments in medicine discovered by Mrs Ah. Most customers got to know about the discovery after reading about her work in scientific journals and conference proceedings. Her scientific exploration of herbs made breakthrough findings which consequently won her several local and international awards. The products have been marketed in different forms and for different usages. Table 4-9 summarises Bio 3's products.

[16] MARDI is a government statutory body entrusted to do research in food and agriculture and agro-based activities.

Table 4-9: Bio 3's products range

Product	Usage	Price
Complete postpartrum (childbirth) set	Traditionally used for relieving menstrual pain to regulate menstruation and other reproductive hormone (e.g. infertility) by regulating reproductive hormone synthesis	MYR399 per set (4 bottles X 90 capsules) MYR50 (for 90 capsules)
Healthy weight loss set	Effective for natural weight loss because of its anti-cholesterol properties	MYR125 for a set (6 bottles X 45 capsules)
PsorCare cream	Alleviates the symptoms associated with psoriasis and eczema. The cream inhibits the progression of skin diseases by inducing apoptosis (programmed cell death)	MYR150 (for 50 gm) MYR40 (for 10 gm)
PsorCare lotion		MYR120
Java tea	A healthy beverage for the whole family	MYR20 per box
TenzCare	For treatment and prevention of high blood pressure	MYR25 per bottle (45 capsules)
CaloCare	As an energy booster and natural burner	MYR5 per bottle (45 capsules)
CanCare	For treatment and prevention of cancer by helping to prevent abnormal cell proliferation	MYR55 per bottle (45 capsules)
GulCare	For treatment and prevention of diabetes	MYR25 per bottle (45 capsules)
HepaCare	For treatment and prevention of liver-related diseases by normalising enzymes levels	MYR40 per bottle (45 capsules)
BodiFends	For fatigue, coughs, sinus, joint pain, migraine and sleep problems	MYR40 per bottle (45 capsules)
GaztroCare	For healthy stomach and digestion system	MYR25 per bottle (45 capsules)

The products listed in Table 4-9 have been consumed by customers as supplements. As supplements, the products are deemed beneficial in helping prevent certain illnesses. However, the products cannot have claim on that diseases unless proven by clinical trials. Furthermore, the trials have not been in the firm's plan because the process is time consuming and costly. Mr Ss said:

> *"That will take over 10 years. It is not easy to develop drug".*

Besides that, he sees the only to exploit the research potential is through commercialisation via a commercial entity. Mr Ss added:

> *"I see, company is a right thing. By right, we just want to generate income for faster commercialisation".*

Therefore, Bio 3 could be considered a manifestation of Mr Ss's and Mrs Ah's intention to commercialise research outputs.

Mr Ss made a significant decision to focus on development of Bio 3 by tendering for an early retirement with MARDI. Since then, the firm has experienced progressive growth. The firm's operation started in two shop lot units in Bangi, Selangor. The premises are located close to UKM. In the early stage, the operation was carried out by Mr Ss, Mrs Ah and their children. Then, the firm started to grow by expanding its operation to new premises. At present, the firm owns 5 shop lots in near vicinity.

The products also have reached customers beyond Malaysia such as in Middle Eastern countries. The products' sales have translated into mixed financial performance from 2005 to 2006. In that period the firm was able to record average turnover of MYR754,042. The highest sales were incurred in between in 2009 with revenue exceeding MYR1.5 million. It was a huge growth as the sales in 2008 was recorded just above MYR500,000. Sales started to become consistent from 2010 onwards with a value of MYR700,000. In terms of profitability, the firm's performance is less remarkable with average profit of just over MYR60,000 for the 5-year period. However, most of the profit is derived from other source of income. Table 4-10 summarises Bio 3's financial performance.

Table 4-10: Bio 3's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2007 (USD = MYR3.45)	0.02	0.17	(0.13) loss	0.51	0.58
2008 (USD1= MYR3.24)	0.63	0.94	0.03	3.16	0.54
2009 (USD1= MYR3.60)	1.63	1.68	0.38	4.21	0.32
2010 (USD1= MYR3.43)	0.72	1.21	(0.03) loss	3.29	0.14
2011 (USD = MYR3.06)	0.78	1.21	0.68	2.35	0.48

Source: Extracted from Bio 3's financial statements retrieved from Companies Commission of Malaysia

Note: Financial figures are in millions

The firm operates in a promoted industry: biotechnology industry. Malaysia has been no stranger to the potential of herbal plants. Its lush rainforests are reported to be home to over 2,000 plants with medicinal value. It is with this potential in mind that Malaysia's herbal industry has been identified as one of the agriculture Entry Point Projects (EPPs) under the National Key Economic Areas (NKEAs) in the Economic Transformation Programme. This is part of strategies to achieve the standard of a developed country by 2020. The government believed in the potential of herbs in propelling the sustainability of the nation's Bio economy sector. In fact, herbs have been made into the first Entry Point Project (EPP1) for the nation's Agriculture NKEA. The aim of producing high value products totalling MYR3.25 billion by 2020.

In the same vein as the government, the firm has perceived herbals' potential to fulfil human's basic needs. This deliberation was part of market research conducted by Mr Ss before establishing Bio 3. He explained that:

> *"I've been thinking on easy business, about human basic needs. First, food and second health".*

From there, the duo (i.e. Mr Ss and Mrs Ah) tried to match their expertise in research with the market needs. Furthermore, their effort has been facilitated by family members especially their daughter who is a medical doctor. She provides fruitful inputs in terms of mainstream medical intervention.

4.4.1 Context of Commercialisation of Research and Development Fund

Bio 3 was awarded with CRDF by the MTDC in July 2007. The approved amount was MYR4,000,000 (USD1=MYR3.47). The CRDF was approved for commercialisation of cream and lotion for relief of the symptoms related to skin diseases. The cream and lotion have been marketed as PsorCare Cream and PsorCare Lotion.

Bio 3 started to apply for the CRDF after had been selling the products for almost two years. Mr Ss recalled this occasion when saying:

> *"I informed the MTDC during a presentation that the product has been produced for two years. I have done the marketing and sold them".*

The firm recorded MYR300,000 sales within the first six months of product launching. The sales were not only within Malaysia but also outside Malaysia. Mr Ss explained further:

> *"MTDC asked whether there is revenue from oversea. For MTDC it is good if product can be exported".*

The firm portrayed this advantage for the CRDF.

4.4.2 The products' and their remedies

PsorCare Cream and PsorCare Lotion are produced from extraction of a rhizome type plant known as *Zingiber zerumbet* (*awapuhi*), also known as shampoo ginger. In Malay, it is known as *lempoyang* or pinecone ginger. The plant is a vigorous species of ginger family with leafy stems growing to about 1.2 m (3.9 ft) tall. It is found in many tropical countries such as Malaysia.

The products are for alleviating symptoms associated with psoriasis and eczema. Psoriasis is a non-contagious disorder which affects the skin and joints. It commonly causes red scaly patches to appear on the skin. The scaly patches caused by psoriasis, called psoriatic plaques, are areas of inflammation and excessive skin production. Skin rapidly accumulates at these sites and takes on a silvery-white appearance. Plaques frequently occur on the skin of the elbows and knees, but can affect any area including the scalp. Since psoriasis symptoms are essentially a result of excessive skin cell production, PsorCare works by slowing that process and speeding the death of the excess cells. PsorCare comes in three types as summarises by Table 4-11.

Table 4-11: Types of PsorCare

Types	Descriptions
Black PsorCare	• Extra strength formula • Slightly coaltar smell • It may not be suitable for use in the work place • It lasts longer on skin and is the most effective
Brown PsorCare	• Medium strength • Milder smell • Needs to be used frequently (i.e. every 3 hours)
Yellow PsorCare	• Regular strength • Has a pleasant lemon-grass smell • Suitable for all people (e.g. elderly people, toddlers and babies)

4.4.3 Product development capabilities

PsorCare cream is another outcome of Bio 3's product innovation. The firm has been dependent on discovery of chemical compounds in herbals plants that could be commercialised as consumable products. The discoveries are the result of the firm's research activities. Indeed, the processes are challenging and time-consuming. However, there are also other activities that are vital to making the product successful such as market penetration and production activities.

4.4.4 Research capabilities

Bio 3 has been dependent on its capability to unveil herbal plants' potential in product development. The firm's capability has been building on the founders' (i.e. Mr Ss and Mrs Ah) research skills and expertise. As stated earlier, both of them holds a PhD in a field related to Bio 3's core business. In fact, the firm was established in a way to exploit the duo's working and intellectual experience. Mrs Ah is known as a prominent researcher in the field of biochemistry. Her first international award, the Commonwealth Award was received in 1982 while she was still a student. Since then, she has registered four patents, written several books on cancer and published and presented more than 100 papers in national and international journals and conferences.

Most of Mrs Ah's discoveries were based on research carried out in collaboration with National University of Malaysia (UKM). She is a professor in the School of Biosciences and Bio Technology, Faculty of Science and Technology. Her research was facilitated by consistent financial resources. The interviewee explained:

> *"The grants are from various resources. Grants for research".*

The grants were awarded by government agencies such as the Ministry of Science Technology and Innovation and also the private sector like the Asian Development Bank and National Cancer Council Malaysia. Although the grants were awarded to the university, Mrs Ah was the main beneficiary because she was the team leader for those projects. The funds have enriched Mrs Ah's research.

As a leading researcher and lecturer, Mrs Ah also supervised research students at Master and PhD level in biochemistry. She has been involved in large scale research activities. In any one time, Mrs Ah handled several research projects and it is in the nature of the biochemistry field that each research project is related especially in empirical techniques. This has allowed multiple research outputs, which are then quickly transferred into finished products via Bio 3. Mr Ss explained:

> *"Of course sometime research is not 100 per cent complete. Actually, it is not going to be perfect. But through company, it is faster to commercialise".*

In fact, most of Mrs Ah's research is focused on possible development of remedies for illness from herbs. Mr Ss added:

> *"She did research. Not only on cancer but others like skin diseases and diabetic".*

Besides Mrs Ah as the firm's lead researcher, Mr Ss also conducts his own research but on a smaller scale compared to Mrs Ah. His research focus is on infamous local herbal plants such as *eurucoma longifolia* (or commonly known as *Tongkat Ali* in Malay) which is claimed to have medical value. Mr Ss explained:

> *"In a herb, there are number of chemicals. I need to discover that".*

It has been a refinement process of previous discoveries during Mr Ss' tenure in MARDI. His aims are to discover a single chemical compound in herbs that can be used by drug companies to develop medicines. Mr Ss added:

> *"In Tongkat Ali, there is an active ingredient known as eurocomanon. Just extract that, then becomes single chemical".*

This process has been carried out using proper laboratory equipment such as a gas chromatography (GC)[17] machine. He said:

> *"We use GC machine to recognise the chemical".*

The refinement process in research activities has facilitated the discovery of other possible medical values of a well-researched herbal plant.

Mr Ss's research also tries to come out with procedures or operational plans for extraction of that active ingredients. This is important because the potential customer (i.e. drug companies) requires standard content of active ingredient. Using eurocomanan as an example, Mr Ss explained:

> *"I need to check whether in raw or extract, the standard. For example, eurocomanon 0.1 gram, the price is USD2,000. Like the Japanese, they want eurocomanon not less than 1 per cent".*

[17]GC is a common type of chromatography used in analytical chemistry for separating and analysing compounds that can be vaporized without decomposition. Typical uses of GC include testing the purity of a particular substance, or separating the different components of a mixture (the relative amounts of such components can also be determined).

It means that, Mr Ss's research has been extended to discover a standard fractionation process. However, the firm's initiative to discover herbal potential through research has been hindered by limited funds and human resource. The firm required more qualified staff in chemistry because most of the research work focuses on the extraction process. As an alternative, the firm engaged a private laboratory to conduct certain chemical tests. Although it is costly, it easier because the firm does not need to employ more chemists.

4.4.5 Production capabilities

The firm is also deemed to have proper facilities for manufacturing. The firm has been carrying out the manufacturing activities on its own. The production started since Mr Ss and Mrs Ah were running the firm as a part-time business. Mr Ss recalled:

> *"After seeing the potential, I expanded the operation. Even before Bio 3, I have purchased a small scale warehouse for production".*

From there, Bio 3 has been expanding its production activities by acquiring other warehouses in the near vicinity. At present, it has five premises. Besides physical expansion, the firm perceived the needs to acquire more machines to cater for market demand. This has been admitted by Mr Ss when he said:

> *"Products have been sold but quite slow. As for warehouse, it is all right. But we still lack of machines, such as grinding machine".*

Mr Ss discussed this challenge with his colleagues. One of his colleagues works with the MTDC and suggested Mr Ss to apply for the CRDF.

Indeed, the firm treated the suggestion to approach the MTDC for assistance as an opportunity to expand its production activities. Mr Ss explained:

> *"MTDC would not give cash money. But in terms of machines".*

This was appropriate and timely because firm's main intention was to upgrade its production facilities. Mr Ss added:

> *"The grant is for upgrading our facilities".*

The firm tried to match the MTDC's requirement and its needs. In fact, before applying for the CRDF, Mr Ss made efforts to know the CRDF in details. Mr Ss knew CRDF was meant for production. Therefore, he appointed a production consultant to prepare a document that proposed production planning. This paperwork highlighted the required machines for higher scale production of PsoCare cream.

The CRDF fund was used to acquire new machines that lead to the firm's capacity and quality upgrading. There are two type of machine that were acquired using the CRDF money: 1) direct contact machines such as extractors and 2) heating machines such as boilers. One of the contact machine is a fridge dryer. The fridge dryer was acquired from the United States at a cost of MYR1.2 million.

The fridge dryer has influenced the firm's production significantly. Mr Ss stressed this by saying:

> *"A lot of improvement in production. Before this, we could not dry grinded herbals properly".*

Indeed, before acquiring the fridge dryer, the firm was dependent on conventional drying technique (i.e. using heat) by using an oven or drying them under the sun. The fridge dryer offers more effective drying mechanism by using sub-zero humid extraction at minus 60 degree Celsius. This mechanism preserves the substance of herbals that are sensitive to heat and subsequently improves their quality. The outputs of the fridge dryer are also consistent in terms of texture and quality. Another advantage of the fridge is in terms of its capacity. At one run the fridge can accommodate 25 kg of grinded herbals. It has been a significant increase because the conventional drying techniques could only accommodate 5 kg of grinded herbals.

4.4.6 Marketing capabilities

Bio 3's products have been sold via direct sales (i.e. customer walking in or on-line ordering). The firm does not have dedicated retail outlets. However, its products are also made available in herbals shops by non-appointed retailers. The retailers purchased Bio 3's products in bulk for a discounted price and sell them in their shops. Although the firm did not have allocated budget for marketing, its products have reached the target market. In most cases, potential customers get to know the products after reading articles in newspapers. Interestingly, the articles were not in advertisement sections but included in the science and technology section[18]. Mr Ss explained:

> *"There was an article about Mrs. Ah's research claim on cancer. Suddenly in a day, we had sales of MYR10,0000".*

One reason is because most of the firm's customer have some kind of critical illnesses such as cancer, diabetes and skin disorders. So, they seek products like Bio 3's to cure that illness. The customer becomes more attracted because the products were backed-up by scientific research by an academician from a university.

Bio 3 did not participates in trade exhibition. Yet, the firm has been able to attract other businesses as its customers. This is part of the firm's business-to-business approach. In most cases, the businesses learned about Bio 3 by referring to the firm's website. Mr Ss explained:

> *"There is a Japanese customer interested in our Tongkat Ali. Firstly, they refer to our website".*

The firm's website has been an important mean for interaction with customers. Most information about the firm, product and discovery is available on its website. After learning about the firm, the businesses became more convinced about the products based on their scientific evidence. Mr Ss added:

> *"The Japanese get interested because of scientific evidence. We did not simply sell product and claim. We give all the data and evidence".*

[18] Some mainstream newspaper in Malaysia have science and technology section that discusses about latest technology and discovery. It includes discovery by local universities.

In this case, the Japanese customer did not just purchased the product but conducted test on them. Mr Ss further explained:

> *"After that purchased, they conducted test".*

After the test was proven, the Japanese customer placed additional orders. This has provided products testimonials. These testimonials were posted on the firm's website and also have been highlighted as selling points by postings in newspapers and magazines.

4.4.7 Innovation capabilities

Bio 3 started its quest for innovation based on Mr Ss's and Mrs Ah's research expertise. This has been integrated with unmet clinical needs amongst people that have illnesses. Besides that, the firm sees the importance of acquiring more and new knowledge on herbals. Indeed, research by Mr Ss and Mrs Ah is an important element for this purpose. However, the firm also sees knowledge updating amongst its employees. Although the employees are not highly qualified, they are experienced in manufacturing, which is important in production of herbal products. Therefore, the firm sends its employees to short courses. Mr Ss explained:

> *"We send them to courses. The courses are for general knowledge about herbs".*

One of the regular training places is Forest Institute of Malaysia (FRIM). Courses in FRIM focus on presenting the latest information on herbal plants that have medical value.

Bio 3 also has been trying to diversify its business into more upstream activities. This includes production of single compound that can be used as raw materials in the pharmaceutical industry. Mr Ss quoted:

> *"I see a potential oil for fragrance. Means, supply one compound only as raw material".*

Indeed, research on certain plants such as ginger has uncovered that potential. Mr Ss added:

> *"There is many elements in a plant. If we run in a machine, there are several peaks. This is a good sign for chemical A and B".*

Indeed, the firm owns appropriate laboratory equipment for chemical analysis. However, the firm's plan for upstream activities has been hindered by lack of human resources. Bio 3 is a small firm with fewr than 10 employees. Furthermore, Mr Ss thought he had enough with this business due to his age when he said:

> *"I'm old".*

This factor has led to slow decision-making within the firm although there is potential for the firm to expand.

4.5 Case study of Bio 4

Bio 4 is a firm that was founded by Ms Aj and Mr Yf on 30th December 2008. It was a start-up firm within FRIM-MTDC Graduate Bio Entrepreneur Development Programme (FMBioSis)[19]. Bio 4 is Malaysian company which specialises in producing natural health food, beverages and supplements. The establishment of Bio 4 is a manifestation of the duo's interest in business. Ms Aj as the interview explained:

> *"I am really interested in business. Even, while completing my bio-medical degree, I plan to establish my own lab services".*
>
> (The interviewee, co-founder and co-owner of Bio 4)

Ms Aj is a graduate of National University of Malaysia (UKM). She holds a BSc. in bio-medicine since 2007. She had a brief working experience with a company that was involved in a business of supplying bio-medical equipment such as blood testing kits. This was a year prior to the establishment of Bio 4.

The firm has been operating from a technology incubator known as FRIM-MTDC Technology Centre. Bio 4 has established its operations in this premises by having a management office and also a storage for its stock. In this premises, Bio 4 started to produce two consumer products: 1) wholesome fibre biscuit and 2) white coffee with noni and stevia[20]. Table 4-12 exhibits details of the products.

[19] FMBioSis is a joint programme to develop qualified young graduates to become bio-entrepreneurs by commercializing locally developed research technologies. In this programme, Forest Research Institute Malaysia (FRIM) is the technology provider while MTDC is the sponsor as well as the business developer trainer.

[20] This product is pre-mixed instant coffee.

Table 4-12: Bio 4's products

<table>
<tr><th>Product</th><th>Highlights</th><th>Note</th></tr>
<tr><td>Le’Natura wholesome fibre biscuits</td><td rowspan="2">• Made from natural and healthy ingredients such as wheat bran and oat
• Fortified by with polysaccharides from the Noni fruit and stevia leaves which act as natural sweetens</td><td>Regular retail price:
MYR 8.00</td></tr>
<tr><td>Le’Natura white coffee with noni and stevia</td><td></td></tr>
</table>

The products have been sold in hypermarkets such as Tesco and Giant starting 2010. At present, the products are made available in 118 outlets (hypermarkets) throughout Malaysia. Bio 4 put more effort into selling the wholesome fibre biscuits compared to the white coffee. Ms Aj disclosed this when she says:

“For sales, we focus more on biscuit”.

In terms of price, the regular retail price of MYR8.00 is considered reasonable because it is based on competitors’ price that is between MYR7.00 to MYR10.00. Bio 4 has been trying to ensure that its products reach the targeted customer: consumers concerned about their health and choosing health lifestyle and diet[21]. This is huge aim for a start-up like Bio 4. Indeed, this has been translated into satisfactory financial performance. Table 4-13 summarises Bio 4’s financial performance.

[21] A diet with no added sugar.

Table 4-13: Bio 4's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2009 (USD1= MYR3.60)	Nil	10, 727	(65, 712) loss	922	20, 154
2010 (USD1= MYR3.43)	210	1, 400	25, 712	3, 972	4, 514
2011 (USD1= MYR3.06)	2, 621	9, 018	70, 983	3, 498	396, 729

Source: Extracted from Bio 4's financial statements retrieved from Companies Commission of Malaysia

As shown in Table 4-13, Bio 4 started to make profit in 2010 and subsequently in 2011 after suffering significant loss in 2009. However, this was not compelling because the firm was managed to complete the products' development in 2012. The interview recalled this as she said:

"Products were completed in 2012".

That means, the firm were able to find other sources of income such as financial grants in addition to selling the biscuits or coffee. The firm also started to accumulate significant amounts of current assets in 2011. This is made of stocks of raw material for production activities. Meanwhile, the firm's fixed assets included office fixtures and fittings in the FRIM-MTDC Technology Incubator.

4.5.1 Context of Commercialisation of Research and Development Fund project

Bio 4 started to apply for the CRDF when it joined the FMBioSis in 2008. It was a lengthy process as both Ms Aj and Mr Yf needed to attend two weeks courses and come out with a business plan. After several levels of screening, the firm was awarded with the CRDF of MYR1,484,400. The grant was for a specific project of commercialisation of anti-diabetic food and beverages. The agreement for the grant was signed by Bio 4 with the MTDC on June 2009. The agreement ran for a period of two years starting from the date of signature until June 2011. However, after approaching the tail-end of the agreement, Bio 4 applied for an extension and MTDC granted another year making the project tenure became three years. This project is expected to produce consumable products.

Under the CRDF funding, Bio 4 has been trying to integrate outcomes from research conducted by FRIM. The research was on the usage of poliscarida food fibre from a fruit that is known under several names, such great morinda, Indian mulberry, beach mulberry or cheese. The scientific name of this fruit is Morinda Citrifolia and in Malaysia it is known as *mengkudu* or *noni*. The main objective of that research was to discover the active ingredient in *mengkudu* as an agent to control the sugar level in human blood. This research could be considered successful as it won a silver medal in Malaysian Technology Expo in 2013.

4.5.2 Product development capabilities

In terms of product development, Bio 4 has been focused on integrating the active ingredient from *mengkudu* into consumables. The main target of the proposed consumables are people that are concerned about their health, in this case people with diabetic illness. For Bio 4, there were several options of consumables such as biscuit, beverages (coffee or tea) and food supplements, as Ms Aj said:

> *"We proposed drinks, crackers and food supplements".*

The proposal was based on market survey conducted by the firm. Ms Aj added:

> *"If based on what we see and researched on, most of the customers are 30 (years old) and above. Most of them are Chinese".*

This group of target customers are deemed to have distinctive preferences in their diet but often consume coffee and biscuits. Based on this, Bio 4 started to develop formulas (recipes) for baking biscuits and preparing the beverages.

4.5.3 Research capabilities

Bio 4 has been building its research capabilities based on the expertise of a researcher from FRIM. The researcher is Ms Mm and she has held a PhD from King's College London since 2006. Her area of expertise is on anti-diabetic science and toxicology. At this moment she is the lead researcher for the bio-activity programme of FRIM. Bio 4 started to build its researcher capabilities when Ms Aj and Mr Yf were attached to Ms Mm during the FMBioSis. During that attachment, the duo learned the basic extraction process for the active ingredients within *mengkudu* at a laboratory scale. This process is fundamental to ensure the quality of the final product because in most cases the active ingredients might be ruined. From here, Ms Mm keeps improving the extraction process and as a scientist she is deemed to be researching in the right direction.

Besides the research on extraction, the firm also tried to build on research capabilities centred on product development. For instance, Ms Aj spent most of the time on observing the right formulation (recipe) for biscuits and coffee. For instance, with biscuits, the main challenge was to make the consumable different from the competitors. Ms Aj illustrated this as she said:

> *"Our product going to be different but competitors also did not use sugar as sweetener. Therefore we use natural sweetener from stevia leaves (herbs). No one do this with biscuit".*

It means that the firm was trying something new. Indeed, it was a challenging task and Bio 4 took four years to complete it (i.e. coming out with the right formulation). Another initiative by the firm to build its research capabilities was to seek advice from experts in other institutions, in this case from University Technology Malaysia. The interviewee recalled this when she said:

> *"We failed in previous attempts. We did not get the right texture. So, we refer to UTM".*

It was a cross-institutional initiative with the expert from University Technology Malaysia also having collaboration with researchers from FRIM.

4.5.4 Manufacturing capabilities

As a start-up firm, Bio 4 was really keen to explore options for production activities. At that time, Ms Aj and Mr Yf were in the process of developing the product's texture and struggled to make up time for other activities, especially production. Therefore, the firm decided to build its manufacturing capabilities based on the expertise of a contract manufacturer. For that purpose, Bio 4 approached Noraini Cookies Worldwide Sdn Bhd (NC)[22]. NC is a well-known company for producing cookies and biscuits for seasonal occasions in Malaysia. After negotiations, Bio 4 appointed NC as a contract manufacturer for its wholesome fibre biscuits. Under this arrangement, NC agreed to produce the biscuit formulated by Bio 4.

As explained above, the biscuit was formulated based on a recipe that substitutes sugar with natural sweetener and without using butter milk. This was an unusual formulation for NC and required proper adjustments in terms of production techniques. This situation was described by the interviewee as she commented:

> *"This company is expert in biscuits making. But, we would like produce biscuits for health. Biscuits that do not use sugar and butter".*

At that juncture, Bio 4 still could not comprehend the appropriate production technique because the changes in ingredients were indeed problematic to the NC. Yet, both decided to proceed until they might achieve the desired outcomes. It has been a reciprocal process where Bio 4 came up with a modified formulation and NC ran it in its production line. This process took place over three years.

Besides the challenge of the product texture, Bio 4 also has been facing challenges with its workforce. For Ms Aj, budget has been the main hindrance as she said:

> *"We do not have enough man power. It could be due to our budget constraint".*

[22] NC was founded in April 2003, specialising in manufacturing variety of cookies. NC was downsized from NE (founded in 1994) in order to produce halal cookies with premium quality.

4.5.5 Marketing capabilities

Bio 4 started to build its marketing capabilities based on market research that was conducted by an agency. The cost of the market research was MYR40,000 (USD1=MYR3.17) and it was covered through provision of the CRDF fund. The market research was vital for Bio 4's plan to penetrate the market as it provided useful insight such as information about competitors, price and packaging. Besides that, the firm also observed the market by conducting site visits to retailers of the products. From both avenues, Bio 4 recognised that its products are best distributed through retail chains such as hypermarkets. Based on that finding, the firm tried to get listed with hypermarkets.

The first initiative was to make contact with the management of the hypermarkets. Bio 4 was in a fortunate position because most of hypermarkets welcomed new suppliers. Furthermore, the hypermarkets were willing to facilitate SMEs like Bio 4. Ms Aj contacted relevant personnel in the hypermarkets' headquarters and set appointments with them. Bio 4 decided to approach well-established and well-known hypermarkets such as Tesco first because they have a proper screening system that the firm could learn from. As the interviewee explained:

> *"We contacted their HQs. Then set appointments. Hypermarkets first and then small retailers".*

As a small firm, Bio 4 was privileged for getting its products listed in the hypermarkets as part of Malaysian Government's initiatives to support small and medium firms to penetrate markets. In return the hypermarkets may receive incentives from the government in form of tax exemptions.

Bio 4 also tried to develop its brand in the consumer market. The firm's effort has been facilitated by fund from the CRDF. The interviewee provided the following comment:

> *"Before, when we have the grant, we put advertisement in newspapers and radios – The Sun and Metro. At that time our sales are OK".*

This shows the advertisement expenses from the CRDF is paramount to the firm's operation.

4.5.6 Innovation capabilities

As a participant of FMBiosis, Bio 4 has a close working relationship with FRIM and MTDC. In fact, the Director General of FRIM is one of Bio 4's board of directors together with Ms Mm, a researcher from FRIM as well. The MTDC and FRIM involvement in Bio 4 is considered important because the firm might get better access to soft supports from them. For instance, Bio 4 often faces challenges to market its products to industrial markets (i.e. business to business). The interviewee recalled this experience as she said:

> *"When there are problems like marketing, we contact MTDC. This year we plan to get our product into hospitals and airlines such as AirAsia. They will bring us to that customer".*

It means that MTDC and FRIM will act as a bridge between Bio 4 and prospective business customers. In most cases, the business customers are more sophisticated compared to customers from consumer market. They might demand a higher quality product but with minimal cost. This situation has stimulated Bio 4 to make continuous product improvements to suit demand.

Bio 4 also received assistance from other government agencies entrusted to facilitate local firms. Bio 4 has been actively involved in programmes organised by agencies such as the Federal Agriculture and Marketing Authority (FAMA) and Malaysia External Trade Development Corporation (MATRADE). The interviewee provided the following comment:

> *"We always looking for export opportunities. We engaged with several agencies such as FAMA and MATRADE".*

For Bio 4, these programmes are important for its operations because they provide opportunities for market expansion especially into overseas markets.

4.6 Case study of Bio 5

Bio 5 is a start-up firm and was incorporated under FMBioSis. In fact, this firm is a spin-off company from FMBioSis and is primarily involved in commercialisation activities focusing on extraction and formulation of natural ingredients from local plants primarily herbals. The firm was founded in 2009 by two graduates, Miss Ja and Miss Df. Miss Ja graduated from University Malaya with a BSc in Bio-Health Science. Miss Df holds a Masters degree in Environmental Science from University Malaysia Sarawak (UNIMAS). The duo met in the introductory programme for FMBioSis in 2008. Before applying for FMBioSis, Miss Df had a brief working experience as a marketing executive with a fast moving consumer good (FMCG) company in Sarawak.

The duo got interested in FMBioSis after reading an advertisement in a local newspaper. The interviewee, Miss Df recalled this when she said*:*

"Actually, the MTDC advertised this programme in a newspaper. Then we applied".
(The interviewee, co-founder and co-owner of Bio 5)

The programme received exceptional response from graduates, with 400 applicants for just 40 places. After a successful application, Ms Ja and Ms Df attended a ten day course co-organised by FRIM and MTDC. Miss Df explained further about this course as she said:

"The course run for ten days. They explained the technology that available for commercialisation".

In that course, the duo was exposed to technology developed by researchers from FRIM. In that, Miss Ja and Miss Df started to develop a business plan to commercialise a particular technology. At that juncture, Bio 5 did not exist yet because each proposal was prepared for a sole-proprietorship. In the final stage of the course, the committee considered Miss Ja a potential entrepreneur based on her business idea. However, her idea for a spa business was conceptual without a product. The interviewee explained:

"In her business proposal, Ja proposed spa business. The committee seemed liking it and she started looking products".

At that time Miss Df was able to develop a preliminary formulation for a healthcare product. Based on that, the committee suggested for the duo form a partnership to commercialise body products for a spa business. Based on that advice, Miss Ja and Miss Df started working together and formed Bio 5.

As an FMBioSis firm, Bio 5 was given the option to operate from FRIM-MTDC Technology Centre. Miss Ja and Miss Df decided to take up this opportunity and the firm has been operated from this centre since its inception. The provision of this infrastructure is another privilege of being one of FRIM's spin-off companies as well as access to FRIM's research expertise. The technology centre was established in 2010 and is part of MTDC's Technology Centre network. The FRIM-MTDC Technology Centre houses firms that are involved in businesses related to life sciences and herbal products. The centre is sited on 4 acres of land offering 47,500 sq. ft. of let-able space. The centre consists of technology garages and enterprise space from 600 sq. ft. and above.

The firm's main products are body care products, such as body scrub, body wash and body lotion. The firm perceived potential for these products based on consumer inclination to avoid chemical based body care products. In most cases, the chemical based products were used by spa operators due to cost savings. The chemical based products were manufactured at a large scale by well-established companies. Their production scale is translated into the products' pricing. However, there is unserved market for consumers that prefer natural products for spa experiences at affordable prices. The interviewee explained:

> *"Our focus is on spa products". Bio 5 saw this as an opportunity and decided to serve it with its products.*

The interviewee added:

> *"Most of spa operators use products from Bali (Indonesia). For high end spas, they prefer products from the United States or France. A bit pricy".*

In addition to products' price, Bio 5 recognised that spa services are expensive compared to home treatment. Therefore, its products are meant for the niche market of consumers who prefer home treatment. Table 4-14 summarises Bio 5's products.

Table 4-14: Bio 5's products

	Product	Description
1.	Softening body scrubs	Enriched with softening properties of plants extracts. Packed in a tube with 250 ml of cream.
2.	Aromatherapy body wash	For skin cleaning. Packed in a bottle with 450 ml of liquid.
3.	Whitening hand and body lotion	For general usage. Packed in a tube with 250 ml of cream.
4.	Herbal feminine wash	For women's cleansing needs. Packed in a sprayed bottle with 150 ml of liquid.

Bio 5's products as described in Table 4-14 are free from chemicals and sold individually. Besides the ordinary sizes, the products are also packed in a smaller size of 50 ml. This range of packaging is known as travel/trial pack. Meanwhile, for the ordinary sizes, the products are packed in more presentable packaging and have been marketed as VVIP gift set range. The products' main target is ordinary body care consumers who had experience with spa services. The interviewee explained:

"So far, we have our customers are spa-goers. Mostly, we sell direct to them".

It means that the firm tries to establish a niche market for its products. The products are priced in between MYR25 to MYR50. For the interviewee, the prices are considered acceptable when she said:

"Our products are affordable".

With that price, the firm has managed to get repeat sales from its customers.

Bio 5 started to make progress in 2012 after receiving repeat sales for its products. Miss Df provides the following comment:

"We have repeat customers. So far 2013 and 2014 surviving on the sales".

However, prior to 2012, the firm did not manage to get any sales. In other words, the firm was struggling in the early phase of its operation. Table 4-15 summarises Bio 5 financial performance.

Table 4-15: Bio 5's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2009 (USD1= MYR3.60)	Nil	15,943	(80, 846) loss	922	13, 858
2010 (USD1= MYR3.43)	Nil	24, 496	84, 580	692	252, 843
2011 (USD1= MYR3.06)	580	16,544	77, 292	7, 539	136, 292

Source: Extracted from Bio 5's financial statements retrieved from Companies Commission of Malaysia

The firm's financial performance in terms of profit did not reflect its operation. It is because profit in year 2010 and 2011 were derived from provision of funding from the CRDF. The interviewee provides the following comment:

"The grant was fully disbursed and we fully utilised it by 2012".

Besides struggling to make sales, Bio 5 managed to upgrade its facility in FRIM-MTDC Technology Centre by establishing a spa centre that cost MYR500,000. This is a considerable achievement as the firm was expanding physically and tried to capitalise the infrastructure for its operation. By having the spa centre, the firm provides other services such as beauty care that is complementary to its core business producing body care products for spa.

4.6.1 Context of Commercialisation of Research and Development Fund

Bio 5 was approved for CRDF of MYR1,169,4000 in January 2009. The CRDF was approved for commercialisation of formulation and development of spa beauty care products. The main ingredients of the products are natural local (Malaysian) essential oil and plant extracts. This grant is part of FMBioSis programme. The grant was supposed to run for a period of two years from June 2009 to June 2011. However, due to certain circumstances, Bio 5 was granted a year extension that ran until June 2012.

As a participant of FMBioSis, Bio 5 received full guidance for the CRDF's application procedure from FRIM and MTDC. Miss Df considered the CRDF a privilege when she said:

> *"We are lucky to join this programme – FMBioSis. They have allocated fund for this programme".*

Furthermore, the firm did not face a stringent evaluation process because the evaluation committee of the CRDF was convinced by the proposed technology. The interviewee added:

> *"They did not ask about technology".*

This has given the firm a head-start for the commercialisation project. However, the committee did have concerns about the commercialisation project, especially about market for the proposed products. Miss Df recalled this when she said*:*

> *"About the market, they concern about similar products in the market".*

As a rationalisation, the firm explained how the proposed products are different from existing products in the market. One of the rationale is on the products' unique ingredients – plant based ingredients that are toxin fee with no animal testing.

The fund was approved based on a mechanism that Bio 5 will receive the approved CRDF fund in stages. The first disbursement was in 2009, meanwhile the final disbursement was in 2011. The fund was also approved based on an agreement that the firm needed to contribute 10 per cent of the approved amount of MYR1,169,400. However, the MTDC has been flexible on this as the interviewee said:

"So far, MTDC did not ask for that 10 per cent".

However, the MTDC did not disburse the CRDF's fund directly to the firm. Instead, it was disbursed to FRIM as the caretaker. Then, Bio 5 needed to request the CRDF's fund from the FRIM within the FMBioSis programme.

4.6.2 The products' and their remedies

The products under the CRDF are the only products of Bio 5. The main reason is because the firm is a start-up firm within the FMBioSis programme. The main objective of Bio 5 is to develop these products in order to reduce usage of chemicals in body care products. Therefore, the products have been marketed as herbal based body care products. The main feature of the products is the smell of kaffir lime. The smell is authentic to Southeast Asia body care products. Miss Df explained this as she said:

"The smell is tailored to locals. Smell of kaffir lime".

This also makes the Bio 5's products different from other body care products in the market. She added:

"Normally, spa products carry lavender smell".

More importantly, the smell of kaffir lime is not derived from chemical based fragrance. In fact, the technology embedded in the product is extraction of active compounds in kaffir lime that produce the smell and preserves them within the products.

In 2006 and 2007, the technology was showcased in International, Invention, Innovation and Technology Exhibition (ITEX)[23]. At the event the technology received considerable attention and won the Silver Award. The technology also received FRIM Best Research Awards in 2012.

[23] ITEX is an annual event for local and international inventor and research scientist to present their invention and innovation to a business community keen to on commercializing unique inventions.

4.6.3 Product development capabilities

Bio 5's products are a combination of research activities carried out by a researcher from FRIM and a business concept proposed by Miss Ja and Miss Df. The firm has been dependent on the discovery of active ingredients/compounds in local herbal plants. The main focus has been on kaffir lime although the firm also considers other plants such as galangal and cinnamon. The process of product development was initiated by incorporating the output of research on kaffir lime and product formulation (i.e. liquid and texture).

4.6.4 Research capabilities

The firm's research capabilities have been building on expertise from FRIM. Under the FMBioSis's arrangement, FRIM assigns a researcher to Bio 5. In fact, the researcher is the technology owner and has played active roles in the firm. The researcher owns 10 per cent of the firm. The researcher, Miss Na, is a scientist and she has held a PhD from University Putra Malaysia since 2004. She also obtained a bachelor degree from University of Waterloo, Canada in 1985 and a Masters of Science from National University of Malaysia in 1996. She has been working in FRIM for 23 years and her current designation is Senior Research Officer.

For the duo (Miss Ja and Miss Df), the research work is not uncommon for them because they had experiences in laboratory work while completing their bachelor's degrees. The firm started to build research capabilities first, then other capabilities, because it needed to conduct testing of raw materials (i.e. herbal plants). The main objective was to determine the level of heavy metals in batches of raw material and decide the tolerable level. It means, the firm was experimenting with raw materials for production. The interviewee explained:

"We spent a lot for research. We compare raw materials".

In this sense, the cost of raw materials is part of research expenses and was derived from CRDF fund. This process is crucial in order to determine which raw materials (i.e. herbal plants) are compatible with Bio 5's intended final products.

At the start, the firm tried to build its research capabilities by setting up procedures for standardisation of extraction. Indeed, it is a vital but challenging task because the raw materials were sourced from different places, thus they vary in saturation of active compounds. The interviewee explained:

> *"We concentrate on testing of raw materials. From there, we choose which product is suitable for the formulation".*

Besides the laboratory work, the firm also managed to build its research capabilities by controlling the quality of the raw materials right from the beginning as the duo were involved directly in harvesting the herbals plants. As Miss Df put it:

> *"In preparation of raw material, we did it by ourselves. We went to Maran, cut the plants".*

From this, Miss Ja and Miss Df were able to acquire further knowledge about the technology because they did not have exposure to crops planting.

Besides the knowledge of crops planting, the fieldwork also proved important in the firm's effort to discover more plants that are beneficial. Besides the kaffir lime, the firm's other discovery is on a plant that beneficial to cure minor bruises. The scientific name of the plant is *Chromolaena odorta*, which is locally known as *'kapal terbang'* plant. This discovery was facilitated by the FRIM when the duo uncovered this plant while visiting a FRIM research site. After the discovery of the plants, the firm started to study the possibility of producing a consistent extract of active ingredients. In this case, the firm's scientific partner has played an active role by conducting further laboratory work until she found the right formulations and techniques. After discovering the formulations, Bio 5 made efforts to send them out for further testing to MPOB and FRIM itself. The interviewee cited*:*

> *"After having the final formulations, we sent them to MPOB and of course FRIM for testing".*

The firm perceived the testing to be another important element in building-up the firm's research capabilities because MPOB and FRIM provided feedback that was used for further improvement.

4.6.5 Production capabilities

Bio 5's manufacturing activities have been concentrated on their products' formulation for texture. In this sense, the firm is deemed to be less experienced in production activities. In most cases, the firm did not get a right and balanced formula. The main reason was the products were not compatible with production fabrication (i.e. dispenser nozzle) and packaging. This process had been continuing for two years between 2009 to 2011. Besides the products' formulation, Bio 5 also started to consider options for production activities as their main concern was about facilities. The interviewee explained:

> *"We don't have facilities for mass production".*

At that juncture, the firm was considering establishing its small scale production facilities. However, this option was not viable for Bio 5 due to several circumstances. Firstly, the production activities in itself are a complex process that requires certain expertise and experience which Bio 5 was lacking. Secondly, the scale of small production facilities was considered uneconomical as the firm will be committed to higher overhead cost due to additional costs such as payroll for employees. As an alternative, Bio 5 was also considering contracting-out the production of its products.

Bio 5 decided to engage with a third party manufacturer to manufacturer the body care products. The manufacturer is Nutra Herbs. Nutra Herbs is involved in manufacturing of health and skin care products. This manufacturer also acts as a consultant for product formulation, product packaging and product knowledge by conducting seminars and consultation. Nutra Herbs main clients are large and start-up firms like Bio 5. As a contract manufacturer, Nutra Herbs receives payments from Bio 5. For Bio 5, the fees for contract manufacturing was derived from CRDF funding. Under this arrangement, Bio 5 starts to build its manufacturing capabilities as the firm has been actively involved in certain parts of production such as product formulation and preparation of raw material. The interviewee explained:

> *"We have a manufacturer which is very experience in production of kind of products".*

Bio 5 also got access to Nutra Herbs' production facilities and had the opportunity to learn about the production activities. Among others, the firm realised that the production lines required a certain texture of final product before final packaging into tubes or tubs. This has been explained by Miss Df as she said:

> *"We provide the raw material and formulation. Then, they will mix them and proceed with packaging. We suggested but after they are not suitable, we changed".*

In this instance, firms kept trying to improve the products' formulation to suit Nutra Herbs production requirement.

4.6.6 Marketing capabilities

Bio 5 started to develop its selling capabilities in a seminar organised by FRIM. The firm launched its products in that seminar, which was attended by researchers and members of the business community that have been involved in herbal industry. Miss Df recalled that event as she said:

> *"When we started the production, we joined FRIM's seminar for soft launched. There invitation for VIPs and we managed to showcase our product together with another company".*

From there, the firm started to place advertisements in local newspapers and health magazines. The interviewee added:

> *"And then we went to TV, magazine and newspaper".*

These are the firm's main avenues to establish its presence in herbal based health care products. The firm has also been actively participating in exhibitions and events that were organised by FRIM and MTDC in all over Malaysia.

In most cases, Bio 5 managed to sell its products to customers within consumer markets after receiving publicity in newspapers, magazines and television programmes. The sales took place during exhibitions and events. The interviewee explained:

> *"After we appeared in magazines, paper and TV (Selamat Pagi Malaysia), I had more sales during events".*

The interviewee sees the events as essential for Bio 5 to know their prospective customers. Besides that, the duo (i.e. Miss Ja and Miss Df) were able to interact with the customers and answer their enquiries. More importantly, from that event, Bio 5 discovered an important insight about market penetration for body care products as Miss Df explained:

"This kind of products are more on smell sense".

Indeed, products scent is an appealing factor for body care products. Bio 5 also discovered that, it is not easy for customers to convey that information unless the seller (i.e. the firm) makes an effort to build a relationship with them there. Miss Df added: *"We get close to the customer".* Based on this, Bio 5 keeps participating in exhibition and events. Recently, Bio 5's products were showcased in in an exhibition in Tanzania. However, the duo did not present in that event and Bio 5 was represented by the Chief Executive of FMBioSis Group[24].

The firm's products have been sold in the consumer market. The firm's customer in consumer market is deemed to prefer distribution channels that are easily accessible. For the purpose of serving its customer, Bio 5 has established three distribution channels. Table 4-16 explains this further.

Table 4-16: Bio 5's distribution channels

Distribution channel	Description	Notes
Stockist	Made up of spa operators and shops	
Distributor	Made up of domestic establishments and small boutiques	Distributors need to place minimum order (quantity)
Social media	Online sales	Additional charge for postage

Source: Interview transcription with Miss Df

[24] The FMBioSis Group consists of firms that participate in FMBioSis programme.

Based on Table 4-16, Bio 5 implements three pricing levels. The standard price is applied to online sales. Meanwhile for stockists and distributors, they are invoiced at a discounted price with a standard selling price. Then, stockists and distributors will sell Bio 5's products at the standard price with a fixed profit margin.

4.6.7 Innovation capabilities

Generally, Bio 5 has a close working relationship with its technology provider, FRIM. This relationship allows the firm to have further information about research activities that have been carried out by researchers within FRIM, and especially with its scientist partner, Miss Na. For instance, Bio 5 might add another product based on research by FRIM on plant extracts for hair care. Miss Df recalled this possibility when she said:

> *"People asking about shampoo. Actually, we have it in our lab".*

From this, it means that the opportunity for further product development has been influenced by the expertise of Bio 5's technology provider.

The firm also managed to establish working relationship with a well-known product developer. The developer is Ge and this company has been involved in development and production of body care products. Ge's main ingredient is sea cucumber and it is a variation of Bio 5's approach. Miss Df explained:

> *"They are interested in our product but requested to add on something of their interest".*

This seems to suggest that Ge is a competitor of Bio 5. However, they share the same mission of popularising non-chemical body care products. Based on this, both Bio 5 and Ge have started preliminary work combining their extracts from plants (i.e. from Bio 5's formulation) and animal (i.e. from Ge's formulation) sources.

4.7 Case study of Industrial 1

Industrial 1 was established by two siblings, Mr Ob and Mr Hb. It is an engineering based firm and has been involved in a highly technical business producing an aerosol fire suppression product. Before establishing Industrial 1, the founders were involved in the same field of business as a distributor of overseas fire suppression products. The products were produced by large and established fire-fighting companies such as Toyo Inc. from Japan and other United States-based companies.

After spending 16 years supplying and installing various international brands, Mr Hb decided to start his own product. As a start, in 2001, he proposed to a German based company Dynamit Nobel Defense GmbH (DNFG) to rebrand a product. The product was an aerosol fire extinguisher and is marketed as Dynameco. Then, the product was rebranded to Aerohub. From there, Mr Hb, Mr Ob and their former partners started doing the marketing. They secured several installation contracts with building owners. They were able to meet DNFG's sales targets and were entrusted to hold stocks on behalf of DNFG. However, due to personal and business conflicts, Mr Hb and Mr Ob opted out from that venture.

Since their exit, the DNFG based product remains with the former venture. As a result, Mr Hb and Mr Ob's venture was left without a product. Furthermore, the former venture has dominated the market for fire suppression systems in Malaysia because it has gained international and local certifications. However, Mr Hb and Mr Ob believed in the potential of the technology (i.e. aerosol fire suppression system). The duo believed that they could improve the product and manufacture it under their own brand instead of being an original brand manufacturer (OBM). However, they also realised that the new venture will be a business operating in a market with high barriers to entry due to the certification process.

Industrial 1:
Company Facts At A Glance

- Year started: 2005
- Ownership: Private
- Authorised capital: RM10,000,000
- Paid-up Capital: RM6,000,000
- Annual sales:
  - Financial Year 2008: RM5,314,850
  - Financial Year 2009: RM361,758
- Number of employees: 60
- Technology focus: Environmentally friendly aerosol fire suppression system
- Number of patents: 1

After their exit, Mr Hb was still determined to develop his own product. In 2005, his aspiration became a reality when a product under Industrial 1's brand was launched. The product has been marketed as Aerohub. Since then the firm started to grow progressively. At present, the firm has 60 employees with 15 of whom are engineers. The engineers gained proper and significant working experiences with established engineering companies before joining Industrial 1. For example, the General Manager, Mr Sh is an engineer who graduated from a Korean university and gained his experience with Samsung.

The firm's facilities are comprised of a management (corporate) office and a warehouse. The facilities are located in different areas. The management office is closer to the capital city, Kuala Lumpur. Meanwhile, the warehouse is in light industrial area closer to Malaysia's main port, the Port Klang. The warehouse houses machines for manufacturing and test equipment for in-house testing of products.

Industrial 1 has been approachable about its customer base. For the past years, its major clientele was private entities operating outside Malaysia. These entities own strategic and purpose-built buildings or facilities such as airports and oil rigs. However, in recent years, there has been a progressive shift in its clientele. The firm just started receiving more customers from Malaysian government departments and government statutory bodies such as universities.

4.7.1 Context of Commercialisation of Research and Development Fund

Industrial 1 was awarded with the CRDF by the MTDC in April 2007. The approved amount was RM2,893,000. The CRDF was approved for commercialisation of condensed aerosol fire suppression system. The system is marketed as Aerohub. The main components of the system are an aerosol generator and trigger switch.

In the application process, Industrial 1needed to face stringent screening including evaluation sessions to convince the Approval Committee of the MTDC. The firm applied for the CRDF based its advantages from being the local manufacturer for the product. Furthermore, the firm also holds a patent on the chemical mixture to extinguish fire. Based on that niche, the firm was able to convince the MTDC. However, the approval for the CRDF was conditional on the product's certification by the Fire and Rescue Department of Malaysia (FRDM). The product was not certified until 2011. That means, the MTDC was not able to make any disbursement as normally practiced.

4.7.2 The product (technology) and its use

The technology embedded in Aerohub is not totally new. Instead, the aerosol based fire extinguisher system has been used globally. So, this product is Industrial 1's initiative to develop a local product based on existing technology. However most of products from overseas are chemical based and could be harmful to human health and the environment. This is another niche where Aerohub offers its differentiation. Aerohub has been developed using local organic ingredients. It makes Aerohub friendly to living things and the environment.

The technology embedded in Aerohub became a major competitive advantage for Industrial 1. It is also a reason for patenting. The technology is dependent on a special mixture of extinguishing agents. The agent produces a chemical reaction that extinguishes fire by breaking fire chains (oxygen and hydrogen) and absorbing heat to a level where there will be no re-ignition. This scientific application leads to two ways of fire extinguishing techniques: 1) total flooding and 2) local flooding. Total flooding is extinguishing the fire by flooding the protected area with the agent. Whereas, local flooding is discharging the agent directly at the source of fire.

The complete unit of the product is called Aerohub generator. The generator is very compact and can be placed inside protected enclosures such as control panels, distribution boxes and communication hubs. Operation of the generator can be electrical, electrical manual, thermal automatic or thermal with temperature control. Table 4-17 exhibits Aerohub's potential installation places.

Table 4-17: Aerohub's potential installation places

Sector	**Areas**
Telecommunications	• Exchanges • Radio base station • Telco cabins • PABX room
Defence	• Telecommunication bunker • Barracks • Field units • Military mobile base container
Power utility	• Transformers • Switchgear • Distribution box • Transmission station
Infrastructure	• Data centre • Computer room • Server room • AHU room
Oil, gas & petrochemical	• Oil platform • Refineries • Research facilities • Barges

4.7.3 Product development capabilities

The Aerohub is the outcome of Mr Ob and Hb's aspiration to start their own product, under their own name. This means they would like to become the first local company to develop and manufacture a fire suppression system. The firm has been dependent on a set of capabilities in the product's development.

4.7.4 Research capabilities

Industrial 1 research capabilities have been dependent on a reverse-engineering technique. The technique was applied to the overseas' product, Dynameco. The first step is about knowing the product's details, especially the substance of the extinguishing agent in the product. The interviewee admitted this by saying:

> *"Of course, during Dynameco, they did not tell us what is the content, material and where the product came from".*
>
> (The interviewee and administration director of Industrial 1)

Then Mr Hb decided to research on his own based upon his knowledge as a firefighting product distributor. He was motivated to own a product. The interview explained further*:*

> *"Hb thought, I know this product and can improve it".*

At that time, he believed that the reverse engineering pathway might lead him to product ownership.

The reverse engineering process had been going on for at least two years, from 2001 to 2003. It was a precarious process as described by the interviewee when he said:

> *"It was try and error".*

Indeed, it was a risky quest because neither of the foundation team members has a chemical background. The only intervention by a chemist was on the testing.

4.7.5 Production capabilities

The firm is also deemed to have proper facilities for production. For the initial setup, production was carried out manually. It was low scale production activity. The main reason for this was because the firm wanted to minimise its capital and operation expenditure. The output from the manual production was mainly for product demonstration and certification purposes. At this stage, production was not a priority for the firm. However, this condition changed when the firm started to generate revenue from overseas sales. Since then, their production capabilities become more relevant to the firm's pursuit to upgrade the production capacity from pilot testing scale to industrial scale.

According to the interviewee, production capabilities are essential but he believed the firm might gain them progressively by acquiring more machines. He provided the following comment:

> *"We done it manually before. Then, we go for semi-auto".*

For that purpose, the firm has moved from one premises to another and finally moved to a sizeable warehouse to cater for the production needs. The interviewee recalled that experience by saying:

> *"Then we moved to Klang. We relocated to Klang because we will receive the machines".*

The relocation is significant to the firm's production capabilities as it has provided more space for higher capacity production line.

The firm's plan to upgrade the production line capacity was hindered by high capital expenditure. Among others, the firm needed to acquire a boiler, steel fabrication and mixture machines. This situation became more demanding because the firm did not have production experience or collateral for commercial borrowings. The interview gave the following statement:

> *"Borrowing from banks is not an option. Which bank going to believe? We have no track record, no proven income".*

As an alternative, Industrial 1turned to Ministry of Science and Technology of Malaysia (MOSTI). Then MOSTI steered the firm to the MTDC.

The CRDF fund has been used to acquire new machines that led to the firm's capacity upgrading. The interviewee explained further:

> *"We moved to Klang because machines from CRDF will arrive".*

However, the acquisition process through the CRDF was complicated because Industrial 1 was unable to meet the grant's financial commitment (i.e. 30 per cent of total costs). Instead, the firm needed to negotiate the grant's term with MTDC. The interview recalled:

> *"We justify to MTDC, why don't pay the 30 percent to the supplier. Let us run our production".*

The firm requested to alter the financial commitment. This occurrence is illustrated by Figure 4-3.

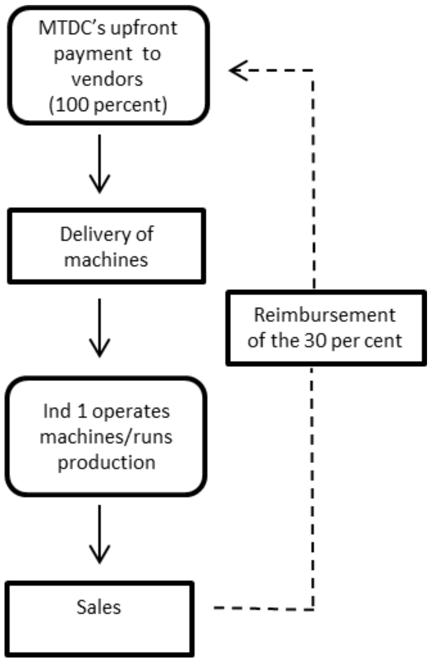

Figure 4-3: CRDF's application in Industrial 1

The CRDF has facilitated the initial outlay of Aerohub's production capital expenditure. In this process, MTDC extended its involvement by being a guarantor to Industrial 1. The interviewee explained:

> *"MTDC called the supplier that we intend to buy the machines. We have special meeting with the supplier and MTDC. MTDC gives assurance to the supplier that MTDC will pay directly to them".*

From this initial process, Industrial 1 has been able to acquire additional machines via an external investor from South Korea. The interviewee explained:

> *"By May, we got fully auto lines. We work together with our Korean partner. They invested in us about MYR12 million of equipment".*

This acknowledgement shows that the CRDF is also working towards uplifting the firm's production expertise.

4.7.6 Marketing capabilities

The marketing capabilities has been building on experience of the founders as a distributor of overseas products. The interviewee explained:

> *"This is niche part of the brothers. They are able to convince others because their marketing capabilities. They used to a distributor of firefighting equipment".*

Their experience in marketing overseas products gave them a good foundation for marketing their own product. They got to know their market before the product was launched.

Firstly, they recognised that there is a potential huge demand for this type of product. This is due to the minimum requirements for firefighting systems. The interviewee explained:

> *"But under the Uniform Building By Law, the minimum requirement is water sprinkler".*

The regulation suggests that non-residential buildings could get certification for occupancy by having the water sprinkler for firefighting system. However, in practice, certain building owners need to be cautioned about the risk of just having water sprinklers. Water sprinklers are essential but not sufficient for after-incident preservation. This has been explained by Mr Rm:

> *"The building owners need to decide where to install water sprinkler or fire suppression. If install aerosol, it will extinguish fire and not damage equipment".*

This shows there is a gap in the market. However, market acceptance is still dependent on the usage of buildings. The product niche is large local utilities and communication companies such as Tenaga Nasional Bhd and Telekom Malaysia. These companies own sensitive equipment such as servers and generators.

In the early stage of product launch, Industrial 1 was trying to establish Aerohub brand to prospective customers by conducting demonstrations. The interviewee recalled this experience by saying:

> *"What we built the product and approached people for demo".*

The product's demonstrations have been an important element in building up Industrial 1's marketing capabilities. The demonstrations were also meant to obtain product testimonials and provided ice-breaking sessions to establish relationship between the firm and customers. The interviewee added:

> *"When go for marketing, it will dependent whether customers like me. No use if we talk too much".*

The demonstration sessions were really useful in building up Industrial 1's reputation for marketing purposes.

The firm was continuously conducting product demonstrations for marketing purposes although it was not able to secure any sales from local markets. The main hindrance factor has been product certification from the local authority, the FRDM. Ironically, the firm has been able to get the product certification from Bureau Veritas[25]. As a result, the firm shifted its focus to the markets outside Malaysia. Despite that, the

[25] Bureau Veritas is a global company involves in testing, inspection and certification service. However, the testing was conducted in Malaysia by its branch.

firm perceived that the local market might offer better opportunities in term of sales volume and consistency as well as quicker payment. The interviewee explained:

> *"Our sales was not encouraging. Definitely not enough. Furthermore, overseas, it takes long time to get payment".*

Although poor local sales was discouraging circumstances, the firm learned a lot from that marketing technique using product demonstration. Firstly, Industrial 1was able to gain more information about its local prospective customers. The interviewee describes them as unique by saying that:

> *"In this kind of situation, we need to go to the right people. People that can decide and take risk in the sense of knowing the product is good although without FRDM certification".*

This account also indicates that there was a slight chance for sales in Malaysia provided they meet with suitable local customers. Secondly, the firm also learned a creative way to penetrate the local market. The interviewee gave the following account:

> *"In Malaysia, we cannot directly supply to PETRONAS[26]. But PETRONAS purchased oil rig cabins from Singapore. We supply our product to Singapore, they install them and the cabins will be delivered into Malaysia. We need to work the other way round".*

4.7.7 Innovation capabilities

Industrial 1 started its quest for innovation based on the duo's (i.e. Mr Hb and Ob) ambition to develop and market their own product. However, the firm needed to overcome high barriers to enter into the market. A significant barrier was the local certification from the FRDM although the product has been certified by Bureau Veritas. It was a challenging and time consuming task because it involves external parties (i.e. the regulators). It involved a series of testing. Still, it was a vital process because it uncovered the product's legitimising circumstances.

As a start, Industrial 1 tried to finding a party that understands the product. Apparently, there was a group of academics from the School of Material Engineering, University Malaysia Perlis interested in the technology and product. The university

[26] PETRONAS is a Malaysian oil and gas company.

offered its laboratory for testing purposes. The firm recognised this as an opportunity. So, they invited the FRDM and Standards and Industrial Research Institute of Malaysia (SIRIM)[27] for a testing session. However, neither FRDM nor SIRIM allowed the use of local testing protocols. Instead, they agreed to use an international protocol.

The first testing in University Malaysia Perlis was not successful because Industrial 1, FRDM and SIRIM interpreted the international protocol differently. The interviewee recalled:

> *"We with our interpretation. FRDM with its interpretation, SIRIM with its interpretation. So, there was no common ground".*

Then, the firm organised the second round of testing in its own facilities but the outcome was the same as the first testing. Since then, this became the major problem. From 2006 to 2009, the firm was blacklisted and not granted further testing.

There was another option to overcome this problem. The firm could proceed with testing abroad with well-established testing bodies such as TÜV SÜD from Germany or Lloyd Material Testing from United Kingdom. Then, the local authorities will match the certification However, this option was not viable for Industrial 1 because the testing is too costly. The interviewee explained further:

> *"For our part being a local manufacturer, who would be our tester? We don't have testing body that could do. We could go to Singapore, and conduct there. There is also TÜV from Germany. In the UK, we could bring to Lloyd. But we cannot afford. We do not have money. MYR200,000 or MYR300,000 or even MYR600,000".*

The firm did not have an allocated budget for that. So, Industrial 1 had to be dependent on FRDM and SIRIM. However, there was no facilitation from the bodies.

Here, the firm needed to be persistent in bridging the gap between FRDM and SIRIM. Industrial 1 changed its strategy. One way was to gain more support for its innovation quest. The interviewee explained:

> *"We made a lot of noise. We pull a lot of strings. At the same time, we apply the CRDF, SME, and SJJB".*

[27] SIRIM has been entrusted by the Malaysian Government to be the national organisation for standards and quality, and as a promoter of technological excellence in the Malaysian industry.

In 2009, the firm was chosen to participate in *Skim Jejak Jaya Bumiputera*[28]. The ultimatum of this programme to the firm was an opportunity to make a presentation before the Prime Minister of Malaysia. The Prime Minister requested that FRDM and SIRIM facilitate Industrial 1.

From them, Industrial 1 started to get facilitation from FRDM and SIRIM. The bodies re-started their testing programme with the firm. Finally, at the end of 2009, the firm was able to gain product certification. By having the certification the firm has been able to secure government central contracts to supply and install its product in public buildings. In 2012, the contract was valued at MYR2.5 million and increased to MYR30 million in 2013.

Besides the government contract, the success in product certification has led to more achievement for the firm. The firm started to receive investment from private investor. The investment in the form of shares is meant for product diversification. One of the latest is the handheld fire extinguisher that uses the same application as the Aerohub.

[28] SJJB is a Government program serves as a catalyst to speed up listing of Bumiputera companies with good track record and having potential to be listed in the stock exchange.

4.8 Case study of Industrial 2

Industrial 2 is an engineering company based in Puchong, Selangor Malaysia. It is located approximately 30 km from Putrajaya, the Federal Government of Malaysia Administrative Centre. The firm was established by a team of entrepreneurs and engineers in 2002. Prior to that, the founding team gained their experience in various sectors such as public service, fire and rescue department and steel fabrication plants. One of the founder is Mr Yd. He served Singapore Fire Service and Shell Eastern Petroleum for 18 years. He also gained experience in manufacturing and trading of firefighting equipment with a Singapore based company for more than eight years.

The firm's mission is to be a major player in the following areas:

i. Fabrication, manufacture and supply of fire and rescue vehicles
ii. Service and repair of fire fighting vehicles
iii. Provision of training for personnel involved in fire and rescue industry

Industrial 2:
Firm facts at a glance

- Year started: 2002
- Ownership: Private
- Authorised capital: MYR5,000,000
- Paid-up Capital: MYR1,500,000
- Number of employees: 30
- Technology focus: Bodywork fabrication including maintenance, repairs and parts
- Core business: Special vehicle manufacturing and trading

The firm has been fabricating several products such as fire engines, ambulances and other rescue equipment. It is a high barrier to entry business. As Mr Yd put it:

> *"This is high barrier to entry business. That means, you cannot wake up today and decide to start a company to manufacture fire engines, ambulances and fire trucks".*
>
> (The Managing Director of Industrial 2)

Industrial 2 possessed basic knowledge of this industry, technical skills and leads to a basic customer base prior to its establishment. All of these came from a combination of the founding team members' personal experiences and networks. The firm also formed strong alliances with manufacturers of equipment like Iveco-Magirus from Italy.

The products are varied in design, specification and costs. Essentially, the variations are subject to customer specification. Mr Sa, the production manager explained:

> *"It depends on the needs. Majority of our product depends on customer specification. Based on customer needs".*
>
> (The production manager of Industrial 2)

Since inception, Industrial 2's clientele consisted of Malaysian Government departments such as Ministry of Health, Fire and Rescue Department and Civil Defence Department. In most cases, dealing with clients has been conducted through public tender or direct negotiations with respective departments. Table 4-18 summarises project that have been undertaken by Industrial 2:

Table 4-18: Projects undertaken by Industrial 2

Clients	**Fabrication Output**
Ministry of Health	Ambulance
	Hearse vehicle
Fire and Rescue Department	Decontamination tender (truck)
	Lighting Unit (truck)
	Recovery Truck
	Accident Unit (Van)
	Fuel tank trailer
	Rapid intervention unit (motorcycle)

In 2010, Industrial 2 was awarded a central contract from the Ministry of Health to supply 78 unit of ambulances worth MYR21,380,000. The contract was honoured in July 2011. Revenue from government contracts has been translated into mixed financial performance from 2005 to 2006. In that period the firm was able to record average turnover growth of 24.09 per cent. The highest sales growth was incurred in between 2009 and 2010 with 152.22 per cent. Meanwhile between 2005 and 2006, the firm's revenue decreased by 38.53 per cent. The same percentage decrease was also reported between 2007 and 2008. Industrial 2 experienced more substantial growth in profitability with average 45.19 per cent. The most substantial growth was in 2009 with 119.88 per cent. Table 4-19 summarises Industrial 2's financial performance.

Table 4-19: Industrial 2's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2005 (USD1= MYR3.80)	9.16	7.20	0.52	0.16	6.90
2006 (USD1= MYR3.75)	5.63	4.18	0.06	0.18	4.12
2007 (USD1= MYR3.45)	7.54	6.03	0.21	0.19	2.60
2008 (USD1= MYR3.24)	4.54	3.10	0.11	0.12	4.27
2009 (USD1= MYR3.60)	5.11	3.16	0.26	1.25	6.27
2010 (USD1= MYR3.43)	12.87	10.31	0.26	1.09	7.61

Source: Extracted from Industrial 2's financial statements retrieved from Companies Commission of Malaysia

Note: Financial figures are in millions

In recent years, the firm has been trying to diversify its fabrication products. One example is to get involved in fabricating and manufacturing breathing compressors for local and international markets. It also provides intensive training on the usage of including servicing and maintaining the breathing compressors. Another product is stainless steel commercial kitchen equipment.

4.8.1 Context of Commercialisation of Research and Development Fund

Industrial 2 was awarded with CRDF by the MTDC in 2007. The approved amount was MYR3,927,000 (USD1=MYR3.47). The CRDF was approved for commercialisation of its breathing air compressor, which is marketed as the Pyramid BA Compressor. This product is an outcome of the extension of its engineering fabrication activities.

The information about the CRDF was gained based on the firm's intention to start the firm's own products. The project to develop Pyramid BA has been a new undertaking by the firm. The service manager, Mr Ry said:

> *"This is stand alone. It is not our main. Part of our business".*
>
> (The service manager of Industrial 2)

The main objective of that undertaking is to produce a locally developed portable compressor because the existing products have been produced by overseas' companies. Mr Ry added:

> *"Because I think right now, nobody has done it. Existing products come from Europe".*
>
> (The service manager of Industrial 2)

The project is also based on customer feedback that prefers local products. This point persuaded MTDC to award CRDF to Industrial 2.

4.8.2 The product under the CRDF

The idea for the product development came from the firm's experience in the service compressor business. Mr Ry, the service manager explained:

> *"That idea came when we doing the servicing (compressor) jobs. Actually, before I joined, the firm has offer service for compressor maintenance".*
>
> (The service manager of Industrial 2)

The product is a portable high pressure compressor for breathing air. The main product's utility is to recharge/refill compressed air into a tank attached to the breathing apparatus. The product's primary target market is the commercial sectors such as diving centres. It could also be used by fire and rescue services for their on-site operations.

For Pyramid Compressor, the firm continues to practice 'make-to-order'[29] production. It is based on customer demand. This product can be seen as the firm's attempt to diversify its clientele from government departments to the commercial/private sector. Mr Ry, the service manager explained:

> *"We produce and sold them (compressor). But sometimes there is (government) tender. But, we try to go to diving centres".*
>
> (The service manager of Industrial 2)

The product is a compact and mobile version of a regular compressor. Even the quality of air produced by Pyramid BA is better compared to the output of a regular compressor because it uses a different filter and lubricant.

4.8.3 Research capabilities

In product development, Industrial 2 has been dependent on its ability to proceed with new combinations of components and materials. The firm is an end user of inventions by its suppliers. That mean, the firm has been acquiring technology from its suppliers. Most of the suppliers have showcased their latest products in international exhibitions. The firm participated in the exhibitions and used it as a platform to learn about the latest technology and materials in fabrication works. One of major exhibitions is Interschultz and the firm has been a regular participant. Mr Yd, the MD explained:

> *"We go to exhibitions. The big one is Interschultz. Cannot cover in a day. There are many manufacturers and suppliers".*
>
> (The Managing Director of Industrial 2)

One of the example is in building external structures of a fire engine. For a while, the firm used steel profile for the external structure. Steel profile is a strong material but for fabrication, Industrial 2 needed to carry out a lot of welding works. Then, the firm approached an Interschultz's participant, Iveco-Magirus from Italy. Iveco-Magirus is the pioneer in fabrication of aluminium profile for fire engines.

[29] A business production strategy that typically allows consumers to purchase products that are customized to their specifications. The make to order (MTO) strategy only manufactures the end product once the customer places the order. This creates additional wait time for the consumer to receive the product, but allows for more flexible customization compared to purchasing from retailers' shelves.

The firm has upgraded its knowledge through acquisition of newer material from renowned manufacturers like Iveco-Magirus. However, this approach is not comprehensive because the firm received limited technical information about the materials. Mr Yd added:

> *"Sometime we buy new things (material). But, we must know how to operate, service and maintain it. But, we don't know".*
>
> (The Managing Director of Industrial 2)

Therefore, the firm decided to send its staff for training with the suppliers. The training focuses on technicality of material such as volume calculation and installation.

The firm's research capability has been extended in Pyramid BA. In the market, portable compressors do not have indicator for filter maintenance. Indeed, the filter is the essential component of a compressor to control air purity. However, the indicator technology has been used in an ordinary (stationed) compressor. This technology facilitates maintenance of the compressor. Industrial 2 recognised this existing technology while conducting compressor servicing jobs.

4.8.4 Production capabilities

The firm's production capabilities have built on the technical experience and knowledge of the production manager, Mr Sa. He gained experience in fabrication and production of rescue vehicles from several renowned companies such as Morita Pte Ltd and Fabristeel Pte Ltd in Singapore. He is also a pioneering staff member of Industrial 2. Mr Sa has been assisted by Mr Ry, a qualified mechanical engineer.

The duo's production experience is applicable in production planning. Essentially, after a successful tender bidding, the production team headed by Mr Sa creates production charts that present plan details such as timeframe, overall target quantity, weekly target quantity and coordination with suppliers. This is where the firm started to plan for mass production. Mr Sa quoted an example of a government contract to supply ambulances:

> *"The customer needs 60 ambulances in eight months. So, we have to plan. One week how many vehicle can we produce. We also need to coordinate with chassis manufacturer. Normally, I do the planning".*

(The production manager of Industrial 2)

After the planning, the production team proceeded with drawing and prototyping. This is part of production strategy to minimise production error. The drawing will be presented to customer for approval.

The firm also applies the same technique in production of Pyramid compressors. The production process has also been facilitated by proper machines. The machines increase production capacity. For example, in the production of 60 ambulances, the interviewee explained:

> *"We need to go for volume. I will programme for six vehicles. If we use manual drill, maybe take half an hour. But, using punching machine, less than five minutes".*

(The production manager of Industrial 2)

Although there are several production techniques, the firm decided to proceed with the technique that suits the machines' specification to save production time. This technique also requires minimal touch from manual workers. That means, each manual workers will have their speciality.

One of the machines is the turret puncher. This machine was acquired in 2011 and it has been used to cut steel and aluminium profiles. Since then, the production has become more efficient. The interviewee provided the following comment:

> *"This machine improve our production – quality and time. Before this, we could do 50 pieces in two days. With the machine, it takes about half an hour".*

(The production manager of Industrial 2)

The machines also increase quality of outputs in terms of finishing and design. The cut profile becomes neater and can be customised into several designs.

4.8.5 Marketing capabilities

The firm focuses on government procurement as its target market. That means, Industrial 2 has participated in bidding for government contracts. There are two types of bidding process: 1) direct negotiation and 2) open tendering. In most cases, Industrial 2 has participated in open tendering due to the Government's preference.

Under open tendering, the firm submits its proposal based on guidelines stipulated in the tender documents. After assessments, the government will offer contracts Industrial 2. The contracts highlight details such as specification, expected delivery time and pricing. Indeed, the contracts have been quite rigour, as Mr Sa explained:

> *"We cannot negotiate the price anymore".*
>
> (The production manager of Industrial 2)

However, there is still room for a negotiation between the firm and government in terms of design and equipment. The firm has used this platform as its marketing initiative to convince the customer (i.e. government) about its ability to undertake the contracts. In most cases, the firm needed to ask for a variation order on the agreed contracts due to unforeseen circumstances such as discontinued equipment. The interviewee explained:

> *"Let say this is the latest model. Maybe government specs was one year ago. Then when the tender was awarded, the spec are different".*
>
> (The production manager of Industrial 2)

The firm has been dependent on its negotiation skills in order to convince the clients. One of the techniques is to offer better quality equipment although the firm needed to absorb the additional cost. The interviewee further explained:

> *"We need to bound by the contract but sometime suppliers give us different brand of equipment. Of course, we have to propose better equipment and we have to absorb the cost".*
>
> (The production manager of Industrial 2)

This negotiation technique raises the firm's reputation amongst its clients.

Industrial 2 has also been dealing with direct negotiation tenders with governmental statutory bodies such as universities and the private sector, such as charity organisations. In these negotiations, the firm needed to be more proactive in its marketing efforts compared to open tendering. In most cases, the firm tries to propose a solution for clients that have limited budget for their needs. For example, a university requires a light rescue vehicle for emergency management. The university has allocated MYR150,000. However, it is not viable as explained by Mr Sa:

> *"We say that MYR100,000 alone is for chassis. The excess of MYR50,000 is not enough for equipment".*
>
> (The production manager of Industrial 2)

In this case, the firm did not ignore the client's circumstances, instead it tries to customise the equipment according to the budget.

In dealing with the direct negotiations contracts, the firm has been dependent on its capability to communicate with clients about their needs. This is another way to convince the customer about Industrial 2's capability in fabrication business. Effective communication is another of Industrial 2's initiatives to get to know the clients better. Mr Sa added:

> *"Maybe the client already has equipment. So, we try to customise based on that".*
>
> (The production manager of Industrial 2)

In addition, the firm treats any customers' enquiries seriously. The interviewee recalled:

> *"We went to Terengganu on six hours drive because the client faxed us a piece of paper. Even, the client asked – you came down because of that? Then the client said, you are very serious. We always try to attend the customers' enquiry".*
>
> (The production manager of Industrial 2)

Again, it is about reputation.

4.8.6 Innovation capabilities

Industrial 2 also has a close and good working relationship with manufacturers and suppliers of equipment. This working relationship allows Industrial 2 to access the latest technology in firefighting and rescue. This relationship has been developed into alliances with the suppliers. This is also one of the firm's strengths. Mr Yd explained:

> *"By our self, we are not strong. We have alliances. Alliances means we represent them. For example, we represent Iveco-Magirus. Iveco-Magirus is the largest manufacturer of fire fighting vehicle in the world".*
>
> (The Managing Director of Industrial 2)

The alliances were formed based on mutual interest between Industrial 2 and its partners. The partners needed an agent in Malaysia to distribute their products and for after-sales service. The alliances also allow Industrial 2 to become an exclusive distributor for the partners. At present, Industrial 2 represents 12 partners. Table 4-20 summarises the alliances.

Table 4-20: Industrial 2's partners

Partner	Headquarter	Product/Service
Iveco-Magirus	Italy	Complete range of firefighting and rescue vehicle
Morita	Japan	Complete range of firefighting and rescue vehicle
Hilton Engineering BV	The Netherlands	Hydraulic platforms and rail road vehicles
Plastisol	The Netherlands	Glass reinforced polyester bodywork for fire and rescue vehicles
Tyron	United Kingdom	Flat tyre protection
Barth Feuerwehrtechnik	Germany	Hose maintenance equipment
L&W Compressor	Germany	Breathing air compressor
Smith Detection	United Kingdom	Gas detector system
Trelleborg	Sweden	Chemical protective suit, fire protective suit and decontamination system
Code 3	The United States	Light bars and warning light system
Nederlands Instituut Fysieke Veiligheid	The Netherlands	Training and consultancy for firefighting and rescue personnel

Besides the overseas partners, Industrial 2 also has good working relationship with local government agencies such as FRDM. In fact, upon development of Pyramid BA, Industrial 2 decided to forge a working relationship with the FRDM by sending a prototype to a FRDM's training centre. Mr Ry, the service engineer explained: "

When we develop it, sent to FRDM. Let them use it first... They use it".

(The service manager of Industrial 2)

The main feedback was on air quality. The Pyramid BA needed to achieve a certain level of air purity and pressure. This has been the main challenge: to develop a portable compressor for breathing apparatus like the Pyramid BA**.** Therefore, the firm needed to conduct air purity testing.

The test needed to be carried out by an independent testing body. Indeed, the testing has held back the product's potential. This has been admitted by Mr Ry when he said:

"Testing for air purity is difficult. This project was handed over to us by previous team. We are the last".

(The service manager of Industrial 2)

It means that the firm attempted to do the testing prior to 2008. The test has been challenging because there was no testing centre with proper equipment for that testing. Mr Ry added:

"We went to a lot of places and all of them did not want to do the test. SIRIM[30] *does not have proper equipment".*

(The service manager of Industrial 2)

The test requires a specialised equipment that needed to be calibrated once a year. Still, Industrial 2 was determined to conduct the test and decided to approach TÜV[31]. However, the TÜV also did not have calibrated test equipment although it has the expertise to

[30] SIRIM has been entrusted by the Malaysian Government to be the national organisation for standards and quality, and as a promoter of technological excellence in the Malaysian industry.

[31] TÜV is a testing body responsible for safety testing. Their work is to validate the safety of products of all kinds to protect humans and the environment against hazards.

conduct the test. Therefore, Industrial 2 decided to deepen the working relationship into a partnership with TÜV.

The partnership with TÜV was focused on finding a solution for the testing equipment. The service manager recalled:

> *"TÜV is like SIRIM but from Germany. So, I went to TÜV and discuss. They can do but still need equipment".*
>
> (The service manager of Industrial 2)

From here, the first attempt was to use test equipment owned by Industrial 2. However, the test equipment was not calibrated and TÜV was also not able to find a source for doing the calibrating. After several deliberations with TÜV, the firm decided to acquire new test equipment that was certified by the testing body. The firm allocated funds from the CRDF to acquire the test equipment. After acquiring that equipment, the firm conducted preliminary trial runs by itself. After that, Industrial 2 conducted a series of tests in the presence of TÜV inspectors. The service manager explained:

> *"TÜV came over because they need to certify. They came and witnessed all the steps from A and Z. Monitor, taken photos, then record".*
>
> (The service manager of Industrial 2)

The tests produced positive outcome. This occurrence is illustrated by Figure 4-4.

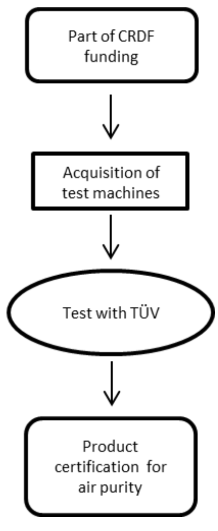

Figure 4-4: CRDF's application in Industrial 2

4.9 Case study of Industrial 3

Industrial 3 was established in 1999 by Mr Jm. Prior to this, Mr Jm worked as a clerical staff member in a subsidiary of Agriculture Bank of Malaysia (Agrobank) in Kuala Lumpur. He was in charge of marketing the subsidiary's products. He left the bank and was involved in a catering business supplying perishable goods to schools and hospitals. Mr Jm established Industrial 3 as his quest to develop and manufacture his own brand of toothbrushes. Mr Jm is the firm's founder and owner. Mr Jm's original idea was to develop a fingertip toothbrush.

The idea for a fingertip brush was popularised in 1998. The main features of this product is it does not have a shaft, for making it easy to carry and keep. Actually, it is a soft and elastic cap; that fits all fingers. Since 1999, the firm has developed several products that fall under three categories. Table 4-21 summarises products that have been developed by the firm:

Table 4-21: Industrial 3's products

Category	Models	Features/Details	Retail Price
Fingertip toothbrush	Ameba Beautie	Suitable for adult individual.	MYR66 for 12 units
	Ameba Luvvie	Extra soft bristle is friendly to delicate baby gums.	MYR72 for 12 units
Specialize Packs • Oral SPA Sonic brush • 3 - cleaning head • Flosser kit • 1 AA battery	Inter-dental Pack	Design for users wearing bridges and braces.	MYR 125.00 (local) USD 52.00 (international)
	Crooked Teeth Pack	Design for users with crooked teeth which is hard to clean using ordinary brushing tool.	MYR 03.00 (local) USD43.00 (international)
	Delicate Gums Pack	Design for infant with sensitive teeth and delicate gums which require extra care while cleaning.	MYR108.00 (local) USD45.00 (international)

Refill brush head packs Specially designed for Oral SPA Sonic toothbrush. Contains 6 replaceable brush heads	Gentle	Made with gentle and trilobal filaments in double layer.	MYR46.00 (local) USD19.00 (international)
	Soft http://www.oralspa.com/go/system/mod/product/opr/view/code/G66DTP1	Made with soft and trilobal filaments in double layer.	
	Hard http://www.oralspa.com/go/system/mod/product/opr/view/code/G99DTP1	Made with hard and trilobal filaments in double layer.	

Generally, the price of the products is higher than ordinary tooth brushes and oral care products available in the market. The firm operates in the fast moving consumer goods sector. This sector is made up of huge famous brand names such as Oral-B, Colgate and others. These brands produce general products that have a short shelf life and are purchased by consumers on a regular basis. In this sense, the firm tries to penetrate this market with its product. Indeed, the firm found it to be a difficult task due to the price. The price has also become a hindrance for the firm making ti difficult to use ordinary distribution channels such as retailers. However, the firm has been able to establish its own market via government procurement. The firm has been appointed as the supplier of fingertip toothbrush to Prison Department of Malaysia. The brush has been used by prisoners across Malaysia. Government procurement has been the major contribution to firm's sales followed by direct sales to customers. The sales have been translated into mixed financial performance from 2007 to 2011. In that period the firm was able to record average turnover of MYR160, 000. The highest sales were incurred in 2011 with turnover exceeding MYR300,000. It was a huge growth as the sales in 2010 was recorded just above RM100,000. However, in terms of profitability, the firm's performance is less remarkable because it has been running at loss. Table 4-22 summarises Bio 3's financial performance.

Table 4-22: Industrial 3's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2007 (USD 1= MYR3.45)	0.05	0.03	(0.27) loss	0.83	0.24
2008 (USD 1= MYR3.24)	0.21	0.17	(0.31) loss	0.55	0.50
2009 (USD 1= MYR3.60)	0.11	0.17	(0.35) loss	0.49	0.18
2010 (USD 1= MYR3.43)	0.12	0.22	(0.27) loss	0.40	0.20
2011 (USD 1= MYR3.06)	0.31	0.26	(0.41) loss	0.32	0.52

Source: Extracted from Industrial 3's financial statements retrieved from Companies Commission of Malaysia

Note: Financial figures are in millions

The firm has also been granted intellectual property protection for its products and process (i.e. machining). In 2009, the firm was granted with two patents. The first patent is on production technique based on Mr Jm inventions related to the on design of the jig[32]. The second patent is for the design of the fingertip toothbrush. Unfortunately, the firm claimed that the design was infringed by its client and legal suit has been launched. In 2009, the firm filed another patent for a vibration model of toothbrush, flosser, inter-dental brush and dental stain remover holder. For this, the firm has also been recognised for its inventions. For example, in 2010, the firm was awarded with a Gold Award for its toothbrush in 21st International and Invention and Innovation Exhibition. In the following year, the firms was awarded with a Gold Award for its vibrating apparatus in the same exhibition

[32] A jig is a type of custom-made tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchangeability in the manufacturing of products.

4.9.1 Context of Commercialisation of Research and Development Fund

Industrial 3 has been awarded with CRDF by the MTDC in February 2007. The approved amount was MYR1,800,000. The CRDF was approved for the commercialisation of a sonic[33] toothbrush. The toothbrush is the firm's core product. The sonic toothbrush is marketed as Oral SPA.

The firm got to know the CRDF after failing to develop the toothbrush. The failure was due to several problem such as battery leakage and design that could not resist vibration from a motor embedded in the toothbrush. Indeed, the development cost was costly and at the time, the firm ran out of money. The firm has experienced that several times but the worst was in 2005 after it invested MYR850,000. Then, the firm decided to seek assistance from government agencies and private entities for financial assistance. In that process he attended a programme organised by the Ministry of Science, Technology and Technology which offered a dialog with the Minister. Mr Jm posed questions to the Minister about the government's initiatives to assist SMEs involved in innovation. From that dialog, the firm was steered to the MTDC. The firm received the CRDF's money two months after application.

4.9.2 The product (technology) and its use

The Oral SPA is another sonic toothbrush in the market. The product's concept has been in the market for a while. In fact, the Oral SPA is built-in coupling system provides a line of professional oral hygiene solutions. The main component of this system is the sonic toothbrush and others are detachable heads, such as a flosser, inter-dental brush and stain remover.

The Oral SPA has been developed based on existing technology in the market. The technology was developed by modifying certain mechanism of equipment used by a dentist. The basic concept is to apply oscillation on handheld equipment (i.e. toothbrush)

[33] Sonic toothbrush is subset of electric toothbrush. The toothbrush makes rapid, automatic bristle motions, either back-and-forth oscillation or rotation-oscillation (where the brush heads alternates clockwise and counter clockwise rotation), in order to clean teeth. Motions at sonic speeds or below are made by a motor.

for teeth cleaning. The oscillation becomes an important mechanism in the sonic toothbrush and each brand in the market varies by its oscillation speed. Generally, sonic toothbrushes have frequencies that range from 200 to 400Hz, that is 12,000 to 24,000 or 24, 000 to 48,000 movements per minute. In most cases, producers of sonic toothbrushes try to develop a product that has higher oscillation than the competitors. However, Industrial 3 has taken a different approach by not focusing on oscillation for Oral SPA. Mr Jm gave the following comment:

> *"SonicCare is currently using technology that produces 35,000 oscillation per minute. But I do not go to that level because it causes splattering".*
>
> (The interviewee, founder and owner of Industrial 3)

Although, high oscillation is important but consumers do not have the best of the product. This is a weakness of products in the market which Industrial 3 tries to address.

Oral SPA offers product differentiation by implying a new way of brushing teeth. Mr Jm explained:

> *"Today Sonicare (Philips Sonicare) is the biggest player in sonic brush industry. When you brush your teeth, it only does 2D brushing, x-y. But, today I'm giving 3D brushing".*

Oral SPA sonic brush applies knocking for teeth cleaning. The firm claimed that knocking or jabbing is the third brushing horizontal and vertical brushing motions. The knocking motion is deemed to elevate teeth cleaning because it will hit the concealed part, for example the side of the teeth. Mr Jm explained further*:*

> *"Today I give you 200 times knocking. It will increase the probability 200 times to hit side of the teeth".*

Besides the brushing mechanism, Oral SPA also offers another convenience to customer; the brush only needs one AA size battery to operate.

4.9.3 Product development capabilities

The firm has spent more than ten years to develop Oral SPA. The product's development process was initiated after the firm redesigned the fingertip toothbrush in 2003. The product's design has been amended from time to time due technical faulty such as vibration and brush locking systems. The firm's product development capabilities have been building through product failure. Even, when the product one was withdrawn from market because of its faulty.

4.9.4 Research capabilities

Industrial 3 has been dependent on its capability to design and redesign the product as an approach to building its research capabilities. As a start, Mr Jm approached a group of students from University Technology Malaysia (UTM) and asked them to design the fingertip toothbrush. However, it was a poor start because at that time, Malaysia industry had limited ability in product design. Mr Jm recalled:

> *"I did not expect in year 1990s, we are short of software in product designing. They did not teach that in our local universities".*

As an alternative, the firm engaged with a Malaysian student that graduated from an American university. However, the outcome was the same, although the firm spent MYR200,000 on him. Finally, the firm engaged with Mr Jm's daughter whom was studying engineering in a local university.

In the initial stages, the product designing was carried out based on existing products in the market, mainly the sonic toothbrush manufactured by SoniCare (Philips SoniCare). The firm reverse-engineered the SoniCare product and found opportunities to make improvements. The first improvement was on the vibration mechanism produced by a motor. After a number of trials, the firm discovered that the motor needs to be repositioned, from the handle to the brush section. Mr Jm explained:

> *"My motor is at the brush. Others is here. It is wrong design because it creates loading".*

The load prevents constant flow of power from the motor. It is a quite significant discovery that was coupled with a more compact design of the motor.

After solving the vibration problem, the firm needed to find a way to improve the brush locking system. Since the motor is relocated closer to the brush, it generates robust vibrations that imperil the brush locking system. The locking system becomes loose due to the vibration. Again, the firm conducted a series of test and found there was a flaw at the joining section of the brush lock. The join was not as elastic as it needed to be. However, it was not an easy fix because the firm needed to come up with a functional spring. At that juncture, the firm expanded its search for a solution because there was no supplier of tooth brushes that made that kind of spring. Therefore, the firm decided to approach a spring manufacturer in the auto industry. The spring manufacturer customised a stainless steel spring for Industrial 3. Another amendment to solve the locking system was to change the design of brush handle from plastic to metal.

4.9.5 Production capabilities

The firm needed to face greater challenges in production compared to designing Oral SPA because its production required a special tooling for the tufting[34] process. The firm scouted for a contract manufacturer but was discouraged by their response. Mr Jm recalled:

"I asked local manufacturers about tufting process. But they turned me away".

However, the firm learned an important insight from the manufacturers: a new type of machine is essential. From here, the firm started to build its production capabilities by learning more about machines. Machines for tufting are made by several companies like Zoharansky AG[35] from Germany. Indeed, machines are an important element in the firm's production quest. Therefore, Industrial 3 decided to approach Zoharansky for advice.

[34] Tufting is a process of punching filaments into holes and locking them in.

[35] Zoharansky is a supplier of injection moulding tools, automated solutions, final packaging machines, tufting and shearing machines for brushes and brooms.

Industrial 3 started to build its production capabilities by having a working relationship with a supplier. Zoharansky was cooperative but a required substantial amount of investment from Industrial 3. Mr Jm recalled:

"They want me to spend MYR200,000".

The investment was to fabricate jigs for CNC auto-tufting machine. The firm proceeded as advised but the machine was not able to produce the desired outcome. As a result, the firms needed to work on the design to accommodate the machine. However, for the firm, it was not an option because the failure was in the machine by Zoharansky. It took four years for Industrial 3 to resolve this problem. Again, Mr Jm experimented and simulated possible solutions for designing the jigs. In 2004, the firm proposed a plan to Zoharansky. Mr Jm recalled:

"I watched a Chinese TV programme and discovered a simple technology that I can use to produce the jigs. Then, I quickly send e-mail to the German boss and asked him to sign a NDA with me. Then we proceed".

It took Zoharansky nine months to build the CNC auto-tufting machine and deliver it to firm. Indeed, the machine became a catalyst for mass production.

4.9.6 Marketing capabilities

Industrial 3 tried to establish a niche market for Oral SPA. It was an immense ambition because as a FMCG producer, the firm faces competition from big brands. After spending five years in product development, the firm decided to make its debut into the market. The firm was convinced that sales via retail chains such as hypermarkets and pharmacies would not be encouraging. Mr Jm commented:

"We need to get niche market but not through hypermarkets".

Therefore, in October 2004, Industrial 3 showcased Oral SPA in an exhibition called Malaysia Goods Expo in Kuala Lumpur. This was the firm's first attempt to build its marketing capabilities by establishing its brand to customers. During the exhibition, the firm received positive acceptance. Mr Jm recalled:

"I did well in the exhibition. Even my neighbouring booth also helped in to sell".

Indeed, it was encouraging but the firm needed to do more. However, this plan was halted due to failure in design.

After a bumpy start, the firm decided that their marketing activities should be in a form of market testing. That means, the firm initially tried to follow the norm for FMCG's producers: mass production and selling. Jm explained:

> *"Then I realised the important thing is, I need to do market test. Market testing cannot be 10 or 30 pieces. I must go at least few thousand pieces".*

However, the firm was caught in a financial trap because it spent most of the fund on production and was left with nothing for market testing. This plan was mulled over in late 2006 and therefore it was timely when the firm was awarded with the CRDF in early 2007.

The CRDF facilitated the firm's plan for market testing. The fund has been used to sponsor Cyber Apprenticeship Programme[36] in the form of goods (i.e the Oral SPA). The firm did benefit from this sponsorship when the customers gave feedback on the product because customers prompted notice of a possible technical failure in the brush locking system. In addition, the sponsorship enable the firm to learn more about its potential market. A key lesson is that their market penetration is dependent on product testimonials. This testimonial is an important element to create awareness about the Oral SPA brand.

The sponsorship was fruitful and the firm was convinced to build its marketing capabilities through alliances with professionals in oral care industry, the dentists. With reference to building the Oral SPA brand through dentists' network. Mr Jm explained:

> *"Actually when dentists say something, it carries weight. Secondly, whatever go through dentists has a good image. Thirdly, they are professional".*

The alliance was made possible through another alliance with a university for market testing. This time with two lecturers from the Faculty of Dentistry, University Malaya in Kuala Lumpur.

[36] This programme was managed by a university for students to do networking for sales.

4.9.7 Innovation capabilities

Industrial 3 has been consistent in its quest for innovation. It keeps updating to the latest technology in the market. Ironically, as starting point, the firm committed to information that is easily accessed. Mr Jm commented:

> *"Google is very important. I think every person need to have time for Google. I spent 3 hours a day for Googling".*

However, it does not stop there. Instead, Mr Jm will translate the information into practice by having a small scale workshop in his office.

Besides that, the firm focuses on specialisation in product development. In most cases, the firm tries to integrate innovation from its suppliers and partner. Mr Jm explained:

> *"We never think doing all the process by ourself. We are going into trouble if we do them all".*

For example, scientific research has been carried out by its partners. This also applies for most of the Oral SPA's components. Mr Jm further commented:

> *"The partners will do the components and we will assemble".*

Indeed, the outsourcing is not only cost saving but also allows the firm to have the best quality components.

4.10 Case study of Industrial 4

Industrial 4 started its operations in 1989 and its principal activity is providing hair and beauty care services. The firm was founded by Madam Th who is a trained beautician from several French beauty academies. She also benefited from her working experience in beautician centres before embarking on Industrial 4. The firm was started as a different brand. Since then it has been rebranded until it is known as the current brand. The main reason for rebranding is because its operation have evolved from being a retailer to a manufacturer of products within the beauty care industry. Initially, the firm operated a treatment centre for hair loss and skin ailments. From this, Madam Th started to develop products formulations.

The firm's initial operation was handled solely by Madam Th. Then her son, Mr An, joined Industrial 4 as the Business Development Director. Mr An is the interviewee and he worked in an advertising firm before joining Industrial 4. For him, it was about growing Industrial 4 as family business and he sees the potential of herbal based beauty care. The firm had operated in two premises, one of which is located in Bangsar, Kuala Lumpur, quite a strategic location. However, the firm decided to sell the other premises because it wanted to concentrate more on product development than its retailing business. The interviewee, Mr An recalled this by saying:

> *"We used to operate in Jalan Tunku Abdul Rahman but we sold that off.. We also want to spent time in building our own brand".*
>
> (The interviewee and Business Development Director of Industrial 4)

Although it has been a small scale operation, the firm manages to produce several products. Table 4-23 summarises Industrial 4's products.

Table 4-23: Industrial 4's products range

Product	Usage	Price
Premium hair enhancement set	The set contains four products that cleanse, condition, treat, rejuvenate and stimulate hair scalp to promote new hair growth	MYR349.60
Moisturising shampoo	Cleanses and rebalances hair scalp	MYR59.90
Nourishing conditioner	Smoothens and nourishes hair for prolonged shine and radiance	MYR59.90
Hair follicle revitaliser	Repairs and reactivates scalp and promoting hair growth	MYR199.90
Hair cream	Styles and protects hair	MYR49.90
Hair styling liquid	Hair care	MYR69.90

The products listed in Table 4-23 have been distributed through retailers and distributors. The firm also concentrates on on-line sales for direct buying through its saloon. However, the first two avenues have been the major sales contributors especially for the Middle East market as Mr An explains:

"Our main market is the Middle East".

In fact, more than half of its sales went to overseas market. The products' sales have been translated into moderate financial performance. Table 4-24 summarises Industrial 4's financial performance:

Table 4-24: Industrial 4's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2005 (USD 1= MYR3.80)	0.84	0.05	0.04	1.32	0.72
2006 (USD 1= MYR3.70)	0.86	0.11	(0.06) loss	1.31	0.04
2007 (USD 1= MYR3.45)	0.94	0.04	0.02	0.88	0.31
2008 (USD 1= MYR3.24)	0.81	0.06	(0.04) loss	1.39	0.08
2009 (USD 1= MYR3.60)	0.57	0.05	(0.08) loss	0.70	0.53
2010 (USD 1= MYR3.43)	0.69	0.09	(0.14) loss	1.26	0.59
2011 (USD 1= MYR3.06)	0.04	0.07	0.02	1.18	0.65

Source: Extracted from Industrial 4's financial statements retrieved from Companies Commission of Malaysia

Note: Financial figures are in millions

In terms of competition, Industrial 4 sees itself as not competing in fast moving consumer market. The interviewee admitted this as he said:

"We are not fast moving consumer goods (FMCG)".

Instead, the firm claimed it only bears a few competitors such as Anita Herbal and Yun Nam. Even so, a competitor like Yun Nam does not manufacture its own product. Instead, it has been dependent on a contract manufacturer. Whereas, in the recent years Industrial 4 managed to produce the products listed in Table 4-23 by itself.

4.10.1 Context of Commercialisation Research and Development Fund and the products

Industrial 4 was awarded with CRDF by the MTDC in January 2008. The approved amount was MYR3,759,900. The CRDF was approved for commercialisation of an organic-based hair re-growth system. The fund had been reimbursed in stages and the final reimbursement was in 2011. The expected product is a complete hair enhancement system. This is made up of hair care products such as treatment shampoo, treatment conditioner, hair revitalizer and styling cream.

As described in Table 4-23, Industrial 4's products are herbal based. At present its products are for hair care purposes and the firm is planning to expand the products range to body care as well. Generally, people have tendency to associate herbal based products with an unpleasant smell. This has been admitted by interviewee as he said*:*

> *"Some people say that herbal products smell funny. Yes, they smell funny but the effect is the same as other commercial products".*

Based on this, Industrial 4 tries to develop herbal products that have appealing smells. It means that, the firm tries to establish its niche within a herbal products' market. Mr An added:

> *"We go for more commercial appealing formula. That means, at the end of the day, it would not have funny smells".*

Another important element of Industrial 4's products is about their application as body care products. It means how the products' perform when applied to our body. The interviewee explained:

> *"The unique product is radical. Radical in the sense, they are common products. For example, shower gel, it is about bacteria control. With this control, our products may let customers to be odourless up to 24 hours".*

This where Industrial 4 tries to be different to its competitors. It other words, the firm's technology is dependent on discovery of active ingredients in herbal plants to control bacteria.

4.10.2 Product development capabilities

For Industrial 4, the main step in the products' development is to be able to formulate a mixture ingredients and blend them for the formation of hair shampoo, cream and other products. This requires the expertise of a chemist. However, as a small firm that has limited financial resources, Industrial 4 could not afford to hire a qualified chemist. In fact, Industrial 4 was not keen to hire a chemist as explained by the interviewee:

> *"We tried to do shampoo and conditioner, we need to go outside – hiring chemist. When talking about hiring chemist, it is like bringing outside to your work. Maybe the chemist does not understand what we do".*

The firm anticipated that there will be conflict of ideas with a chemist. In certain ways, a chemist might give advice that is against the firm's practices. This was proven right when the firm only managed to work with a chemist for short period of time (i.e. two months). Mr An admitted this when he said:

> *"We had a chemist and within two months he found that he could not work with us".*

Therefore, Industrial 4 decided not to be dependent on external expertise for their product formulation.

4.10.3 Research capabilities

Industrial 4 has been dependent on Madam Th's experiences and enthusiasm in unveiling herbals plants' potential in product development. It is not surprising because the development process is dependent on an individual's ability to recognise beneficial herbal plants. The interviewee, Mr An Industrial 4's Business Development Director explained:

> *"Yes, she formulated it. Special process that formulated that products. It is technology by itself".*

However, the firm's R&D has been confined to a series of trials and not entirely dependent on scientific discovery. In explaining this, the interviewee quoted an example when he said:

> *"The R&D is meant for making sure the products are working in certain ways. For example aloe vera and carrot juice. Maybe it does not work for hair but might work for something else".*

This process has taken a long time to discover herbal plants' appropriateness. He added:

> *"It took us four to five years to get the R&D right".*

Once discovered, it has been used as a base formula for not only a product (i.e. hair shampoo) but also other products such as shower gel and hair conditioner.

The base formula was tested on Madam Th's willing test subjects: immediate friends and relatives and later extended to loyal, long-term customers who gave her glowing reviews about the products. The main objective of the R&D was to formulate something that is safe and fell within customers' realm of comfort. However, the process was lengthy because the base formula could not be finalised until they received product feedback from industrial customers (i.e. retailers).

4.10.4 Production capabilities

Industrial 4 was dependent on a contract manufacturer to produce its products. The interviewee explains:

> *"So, basically we are giving out our formula to other manufacture and they will come out with final products".*

The main reason was because the firm wanted to minimise operating costs by not hiring employees for the production line. The firm also was not able to allocate significant capital expenditure for machines for production activities. Therefore, contract manufacturing has been a viable option.

However, the main intention of the firm was to have an industrial scale production line. Mr An added:

> *"But we felt that we need to control certain aspect of the production. I think in 2008, we got opportunity to control and commercialise the whole thing, with MTDC".*

In fact, the CRDF is very important to Industrial 4 as it has been used to acquire machines for production activities. However, for the firm, the process of acquiring the machines was not straight-forward. The main reason was that the machines should meet a certain standard of Good Manufacturing Practices. For that purpose, Industrial 4 appointed a consultant for designing, acquiring and testing the machines. Under this arrangement, the CRDF fund went straight to the consultant and in return Industrial 4 received certified production plant. Figure 4-5 illustrates this occurrence.

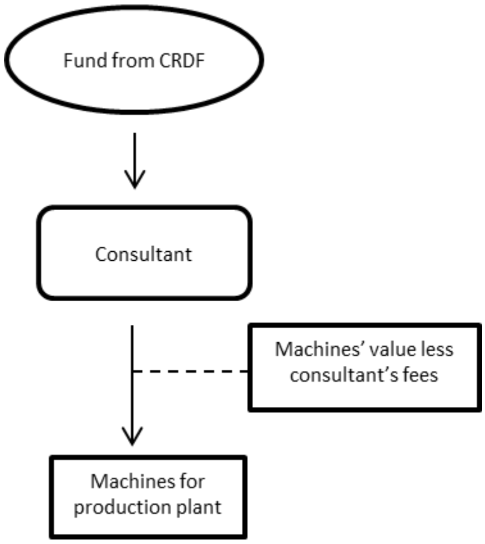

Figure 4-5: CRDF's application in Industrial 4

The machines have enhanced Industrial 4's production capabilities by being able to carry out the production at industrial scale. Mr An provided this comment about the utilisation of the machines:

> *"If not we still need to do contract manufacturing. It opens up for us – OEM and all other businesses".*

It means that, the scale of production has been improved. From there, the firm was also able to change its business strategy. Firstly, it did not have to be dependent on contract manufacturer for production activities. Secondly, the firm has been able to become a full-fledge manufacturer of herbal based body and hair care products.

4.10.5 Marketing capabilities

Industrial 4 products have been sold through various channels with most of the sales generated via retailers and distributors. The end users might pick up the firm's product through that channel. However, there is also the possibility that the firm's products have been rebranded with the retailers' brand. Industrial 4 started to build its selling capabilities by gaining the retailers' confidence. The firm's most common avenue is to participate in trade missions organised by the MATRADE[37] as Mr An explains:

> *"We participated in a trade mission organised by MATRADE. MATRADE invited us to go to trade mission in Jeddah, Saudi Arabia".*

From this exhibition, the firm started to learn about its target market. This market is comprised of a number of professionals involved in retailing businesses (i.e. medical doctors who own pharmacist chain) although majority are retailers that requires products in bulk. Mr An quotes an example a regular customer from Qatar that he met during a trade mission:

> *"She has pharmacy and she went back. She actually buys a lot from us".*

Therefore, firm was building its sales capabilities through this avenue.

Another important element for Industrial 4 in building its sales capabilities was about gaining insight about how its product might be accepted by customers. Mr An explains:

> *"We actually sceptical about it and excited to see how the market responding to it".*

Therefore, the firm decided to conduct market testing before launching any product. However, the market testing was not conducted on end-consumers. The market testing had been conducted on retailers because they are critical about the products; the interviewee added:

> *"Through our retailers because they give you the harshest criticism".*

[37] MATRADE is a government body entrusted to promote and develop Malaysia's exports to the world.

For instance, Industrial 4 has a regular industrial customer from Pakistan. This customer owns a retail chains and its biggest concern is on price. The interviewee recalled this client when he said*:*

> *"In certain area, our client wanted their product to be sold at a certain price".*

Although Industrial 4 also is price-sensitive, it tried to accommodate customer's demand. In that particular case, Industrial 4 decided to supply certain products in bulk (i.e. shipped in a large container). Then, that particular client will be repacking the products accordance to their needs.

4.10.6 Innovation capabilities

Industrial 4 has been trying to make product improvements by conducting trials in its salon. This is another initiative to ensure that its products meet certain standards of customers' preferences. Indeed, customers from the salon may provide feedback about Industrial 4's product. However, this type of feedback gives minimal impact on products' improvement because customers often get attracted to beauty care services that they received in the salon. A more important factor influencing the firm's capabilities to do product improvement is the size of customers' budget for products. Mr An reaffirmed this when he said:

> *"Clients will give us a budget price. So, we will work based on that budget price".*

From here, Industrial 4 tries to develop the intended product from very beginning with the budget constraint. In most cases, these customers are retailers that prefer to repackage the final products and sell them under their own brand names.

In most cases, Industrial 4 is willing to serve retailers through bulk ordering. However, the retailers tend to be meticulous about the products which includes the selection of raw materials. The interviewee added:

> *"It moves according to clients' requirement. Everything are itemised according to their purpose".*

In this context, Industrial 4 sought options for material and production. This process has driven Industrial 4 to become proficient in developing herbal based body care products.

4.11 Case study of Industrial 5

Industrial 5 is a Malaysian owned firm that was founded by Mr Hk in 1998. The firm has been operated in an industrial area in Seremban, Malaysia. The industrial area is located about 70 km from Kuala Lumpur, the capital city of Malaysia. In this industrial area, Industrial 5 operates in two premises which are located near to each other. Mr Hk is a serial entrepreneur and prior to 1998 he had been involved in several businesses mainly in trading (i.e. such as grocery shops and shoe traders). Mr Hk is also an inventor as he has been trying to come out with something new in the market. For example, he invented an equipment for making soft-boiled eggs. Mr Hk admitted this as he said:

> *"I made an equipment for half boil egg that has been used in local restaurants. The equipment is still in the market but does not have copyright".*
>
> (The interviewee, founder and Managing Director of Industrial 5)

In addition to this equipment, he is also in a process of designing a safety electrical socket. This socket bears safety features to protect against inappropriate usage of electric sockets especially by children.

One of the firm's breakthroughs is a household product for mosquito/insect repellent. This is a non-toxic repellent that was developed using extracts of plant oils. This product was developed based on anticipation that non-toxic mosquito/insect repellent is essential for countries with tropical climates like Southeast Asia and parts of Africa. Indeed, countries with tropical climates are prone to disseminate tropical disease. Insects such as mosquitoes and flies are by far the most common diseases carriers or vectors. Industrial 5 has developed the formulation into several products. Table 4-25 explains the details of Industrial 5's products.

Table 4-25: Industrial 5's products

Product	Details	Retail price
Mosquito repellent	20g X 2 pieces	MYR8.90
	20g X 6 pieces	MYR21.90
Cockroach repellent	20g X 2 pieces	MYR8.90
	20g X 6 pieces	MYR21.90
Dual function vaporise and green liquid	Green 45 ml liquid	MYR16.90
Dual function vaporise and electric green mat	20 pieces of green mat	MYR9.90
Green liquid (repellent mixture)	45 ml liquid	MYR11.90

The products have been sold in Malaysia and overseas' market such as in the African region (distribution office in Lagos, Nigeria) and Middle East (distribution office in Amman, Jordan) regions. Despite being able to export its products, Industrial 5 was struggling to make profit as exhibited in Table 4-26.

Table 4-26: Industrial 5's financial performance

Year Ended	Revenue (MYR)	Direct Cost (MYR)	Profit (MYR)	Fixed Asset (MYR)	Current Asset (MYR)
2005 (USD 1= MYR3.80)	0.52	0.27	0.01	0.43	0.20
2006 (USD 1= MYR3.70)	0.70	0.34	(0.06) loss	0.40	0.27
2007 (USD 1= MYR3.45)	0.71	0.35	(0.02) loss	0.36	0.33
2008 (USD 1= MYR3.24)	1.07	0.66	0.86	1.81	1.05
2009 (USD 1= MYR3.60)	1.53	0.86	(0.02) loss	1.65	1.81
2010 (USD 1= MYR3.43)	1.13	1.09	(0.41) loss	5.10	0.80
2011 (USD 1= MYR3.06)	1.66	1.46	(0.17) loss	4.70	0.98

Source: Extracted from Industrial 5's financial statements retrieved from Companies Commission of Malaysia

Note: Financial figures are in millions

4.11.1 Context of Commercialisation of Research and Development Fund and the product

Industrial 5 was awarded with Commercialisation Research and Development Fund in January 2008. The approved amount was MYR3,759,900 (USD1=MYR3.37). The CRDF was approved for commercialisation of mosquito and cockroach repellents. The main products' concept is about creating scent that will damage mosquitoes' sensors. This technicality was detailed out by the interviewee as he expressed:

> *"Mosquitoes have 6 sensors. Mosquitoes come when they sense body odour and detect human body temperature". He added "So, now we damage the mosquitoes' sensor. They cannot sense anymore".*

For Industrial 5, this is a new concept within domestic product market because the substance is not killing mosquitoes. Instead, the substance is ousting mosquitoes from certain areas by suffocating them. The product once opened will last between three to four weeks. However it is dependent on weather.

4.11.2 Research capabilities

The firm's research capabilities are a reflection of Mr Hk's enthusiasm in bringing ideas from his reading and experiences in rural living while working as a logger in the Malaysian jungle. As a logger, he endured a harsh environment including exposure to vector borne diseases such as malaria fever and dengue fever. The vector is the mosquito and people are likely to try anything to prevent diseases. Among the commonest avenues is to use of a using mosquito coil[38]. However, smoke generated from a burning mosquito coil could cause health problems. The interviewee commented:

> *"Before this, we use mosquito coil. I love reading books and found that mosquito coil made from poisonous substance".*

From this observation and his reading, Mr Hk started to form an idea about non-chemical mosquito repellent.

Then, Industrial 5 started to discover that there is possibility that mixture of certain plant-based oils could be used as a mosquito repellent. This was based on trials that had been conducted by Mr Hk himself. Altogether, Mr Hk had conducted just over 300 trials. The main objective of those trials is to discover the right combination of products to develop formulation as the interviewee explained:

> *"I tried 300 times to get the right formulation. 300 types of formulation from plants' oil".*

The main reason was because Mr Hk as the only researcher does not have formal education or training in chemistry. Therefore, his approach was purely experimentation. In this sense, the discovery process took longer than expected.

4.11.3 Production capabilities

Industrial 5 is deemed to have significant experience in production activities. All steps in the production process have been carried by the firm itself. In terms of facilities, the firm has managed to acquire 11 machines. The cost for each machine is MYR100,000.

[38] The coils are set alight to produce smoke that kills mosquitoes.

These machines are located in two separate premises. There are five machines in premises A and the remaining are located in other premises B. The machines in premises A have lower capacity compared to machines in premises B. Mr Hk explains:

> *"There, production is about 30,000 containers. Combined with machines here, capacity will be 200,000 containers".*

These machines have been used in almost every step in the production process which includes grinding (raw material), heating and pouring into containers. Even so, Industrial 5 faced challenges in operating the machines.

The first challenge was about designing the machines. Mr Hk decided to design the machines because there was no supplier in Malaysia that was able to design and commission machines in accordance with Industrial 5's needs. As Mr Hk said about needing unique machines*:*

> *"Before this, there was no machine that could do the job. Now, we need to design the machines".*

The machines are also part of Industrial 5's inventions. After having basic drawings of intended machines, suppliers will begin with those and start working on them. This means the machines were designed based on Mr Hk's ambition and limited technical expertise. It has been purely experimentation. As a result, the machines often breakdown and require regularly scheduled maintenance. Mr Hk added:

> *"The toughest is the maintenance of machine. I always need to go back to the supplier".*

This situation is unfavourable for Industrial 5 because it had to cease operation of certain production lines. The cessation made the firm operates below its capacity. More importantly, the firm is exposed to risk for not being able to supply sufficient units according to agreed terms.

4.11.4 Marketing capabilities

The firm started to build its sales capabilities by trying to introduce the product concept to the market. As a start Industrial 5 established a retail shop. However, this type of distribution channel was not effective. Indeed, it was challenging because at that time, consumers had adopted to existing product for repelling mosquitoes (i.e. mosquitoes coil). The interviewee explained:

> *"Because this was a new concept. Retailers did not like this concept because they have fixed idea. This is a new concept".*

As a result, the retail shop was forced to close. Despite this, Mr Hk was determined to introduce the product into the market. The next initiative was to create awareness amongst potential customers. This process demanded Industrial 5 to have a proper avenue to convey the appropriate information about the products. In this sense, Industrial 5 decided to try a conventional approach to selling the products.

The conventional way was to get closer to prospective customers. This includes talking and listening to their feedback. For this purpose, Industrial 5 organised promotional booths within small sized shopping malls. Mr Hk recalled this experience as he said: "Then, I went to see shopping malls, asked for space for booth. In day, rent is about MYR200". However, this initiative was also a failure because at that time (in 1998), a lot of shopping malls were closing due to the Asian economic crisis. Due to the closures, Industrial 5's movement was limited because fewer venues became available. By the end of 1998, the firm was desperately looking for other options to sell its products. The firm's efforts were deteriorating until it participated in an exhibition organised by Malaysian Chinese Business Chamber.

The exhibition was known as *Pameran Cintai Malaysia* (Love Malaysia Exhibition)[39]. In this exhibition, Industrial 5 showcased its products and was able to proceed with some sales. Mr Hk recalled this achievement when he said:

> *"I managed to sell 10 boxes with approximately 1,200 of repellents".*

[39] This exhibition is an important platform for participants to popularise their products and expose their goods and services to the multitude of consumers and purchasers domestically and internationally. The first series was in 1998.

It was an impressive number of sales and more importantly, Industrial 5 encountered a considerable opportunity when an officer from an established retailer was attracted to its product. Again, as explained by the interviewee:

> *"I also got big opportunity, received attention from Cosway[40]. A purchasing manager from Cosway likes this product because he think it is a new concept. He bought my product for trials".*

A week after that brief meeting, Industrial 5 was invited by Cosway for further discussions. For Cosway, the product was deemed effective. The interviewee perceived this as he said:

> *"If effective they will call me up".*

In that meeting, Cosway agreed to purchase Industrial 5's products but with slight readjustment in terms of branding. Cosway requested to rebrand the products and agreed to sign a long term purchase agreement with Industrial 5. Cosway has been buying from Industrial 5 for 15 years.

The firm has gained significant experience in sales activities while dealing with Cosway. Industrial 5 still sees the need to penetrate market more aggressively by making its products available in hypermarkets. However, its experience dealing with hypermarkets was not favourable compared to Cosway. The main reason is because hypermarkets impose listing fees, which Cosway does not. The interviewee provided this comment:

> *"Another thing, if this products are going to hypermarkets, we need to pay the listing fees. Cosway is easier, no listing fees".*

Yet, the firm sees that it might get better access to customers through hypermarkets. Therefore, Industrial 5 allocated part of CRDF fund to payment of listing fees with hypermarkets.

[40] Cosway is a hybrid consumer marketing company that has a global network marketing system. It operates a chain concept of stores and pharmacies.

4.11.5 Innovation capabilities

Industrial 5 also received soft supports from other government agencies such as MATRADE. The support is in a form of allocation as participants in overseas trade missions. The aim of that trade mission is to encourage local firms to explore export markets. Industrial 5 had participated in trade missions to three countries and managed to get overseas customers as explained by the interviewee:

> *"We export to Singapore, New Zealand and Jordan. I got these customers during MATRADE exhibition".*

These exhibitions had convinced Industrial 5 to try a different approach to selling their product because each business environment is in itself. Besides MATRADE, Industrial 5 also received assistance from the National Poison Centre, University Science Malaysia. This assistance was for third party testing of the poison content of Industrial 5's products. The first product received clearance and certification that its products are free from poison. This approval is essential and timely because consumers started to gain confidence in Industrial 5's products.

Chapter 5 : CROSS-CASE ANALYSIS

5.1 Overview

This chapter presents an analysis and discussion of ten case studies of selected firms that received a major financial award under Malaysia Government's policy initiatives to enhance the competitiveness and technology capability of Malaysian industrial sectors. The public financial initiative is known as the CRDF and it was launched in 1997. The main purpose of this financial grant (i.e. the CRDF) is to promote and support commercialisation activities of locally developed technologies undertaken by Malaysian owned companies. The analysis is presented by a cross case investigation of ten firms in an attempt to find out whether the CRDF facilitates innovation amongst local SMEs in terms of the development and enhancement of innovation capabilities. The purpose of the case analysis is to explore roles of this programme (i.e. the CRDF) to economic development of Malaysia in terms of promoting the knowledge based economy through innovation. The Malaysian Government is keen for its local economy to move from an economy based on assembly-type manufacturing towards a knowledge based economy where local firms can develop new high technology products and processes by themselves and not rely so much on technology developed by foreign multinational companies (MNCs). That is the purpose of policies, like the one connected to the CRDF. In this chapter, evidence from the case studies has been investigated by comparing and contrasting the then cases that reflect the firms' activities within innovation projects. This study considers innovation within the firms for projects related to the CRDF and other business activities that have been carried out by firms. These projects reflect firms' capability to carry out tasks within NPD processes. This form of analysis enables this study to provide a more detailed evaluation designed to provide a deeper understanding of Government initiatives to support innovation within local high technology businesses in emerging economies.

In this context, the purpose of this study is to get insights from the ten case studies. This analytical process has been facilitated by a conceptual approach of DC. The DC (Teece and Pisano, 1994) is applicable as it explains how firms can develop business programmes and sustain competitiveness. The DC stresses that firms' ability to introduce new products into the market rests on their distinctive co-ordinating and combining processes, shaped by the firm's specific asset positions, capabilities and the evolution paths that they have adopted or inherited. DC can be identified as processes embedded in firms. DC include capabilities that *integrate resources*, capabilities that *reconfigure resources* and capabilities that are related to *the gain and release of resources.* (Teece et al., 1997). The DC concept elucidates how firms develop and renew their resources to compete in the market. In addition, a major argument underlined by DC theory is that recognising firms' ability to execute activities is evidence that they have been utilising resources. In other words, the DC view is not confined to investigations of resources but also aims to capture the firm's ability to execute an array of activities and the capabilities they developed around utilising the resources. This view is applicable to governments' initiative to stimulate firms' innovation activities because government policies are most likely indirectly delivered through capabilities, therefore mere performance-focused approaches provide limited opportunities to learn from policies and improve them. Besides that, the DC is very often used for the analysis of government policies in technology-driven sectors. It has become more prevalent when the support programme is meant for a specific purpose and has been implemented using a common mechanism such as financial assistance.

This study develops a cross-case analysis based on themes that were identified from a series of case studies. The case studies were developed based on data gained from multiple data collection techniques (i.e. interviews, documentation and non-participant observation). The data were gained during the fieldwork conducted in Malaysia. Analysis of these case studies resulted in a number of themes. The themes were emerged from the analysis of these cases reflect the firms' background, activities and performance that represent their interaction with the CRDF. These themes also reflect changes in firms that are dynamic and contribute to their ability to innovate. The themes focus on firms' ability to possess resources and also their ability to reconfigure them. Accordingly, the themes address the main question of this study; to find out whether this particular policy initiative (i.e. the CRDF) facilitates innovation within local SMEs. The themes are:

1) firm's attributes and performance,
2) the effectiveness utilisation of the CRDF fund amongst firms,
3) exploration of emerging patterns and explanation of patterns (i.e. dynamic capabilities in terms of manufacturing, marketing and NPD activities).

Generally, this chapter reveals that the Malaysian Government's fiscal approach in terms of grant funding was able to attract and stimulate local firms to engage in NPD processes within high technology sectors: in this case bio-technology and advanced industrial products. These sectors entail commercialisation of technology as their main elements. This chapter also highlights observations on the firms that might fit with the overall purposes of the CRDF and Malaysian innovation policy. These observations are as follows:

1) the centre of attention is on the target group of this policy initiative. One major finding of the case studies is that the CRDF has been awarded to indigenous high-technology Malaysian SMEs. These local high-technology SMEs are seen as the main target because high-technology SMEs are important for catching-up technologically and they appear to be underdeveloped or rather small in the context of emerging economies like Malaysia.

2) the case studies show evidence that the CRDF facilitates high-technology SMEs to innovate. All the case studies show firms in high-technology sectors have improved their ability to carry out tasks within the innovation process in particular at innovating, because their capabilities for NPD process have been enhanced through the CRDF. These capabilities are applicable for production and market launch of new products and they become more dynamic following the CRDF. This is a result of this policy.

3) the cases also demonstrate that the spill-over impacts of the CRDF can be seen as an indicator of the development of firms' technological capability. The indirect impacts focus on firms' capabilities that have been developed through particular CRDF projects. Meanwhile spill-over impacts focused on capabilities that have been enhanced in other projects. It means that while firms were working on CRDF projects, they were also experiencing improvement in other projects. This is part of the positive indirect and spill-over impacts of the CRDF because occurrences within CRDF's project were being applied and transferred to other projects.

4) firms have experienced significant improvement in their capabilities within NPD processes. These improvements have taken place in a latter stage of the innovation process (i.e. in the exploitation phase). The improvement are dependent on several type of dynamic capabilities. This means that firms were able to develop ordinary capabilities for optimisation and then started to improve

them. The cases show that the particular dynamic capabilities that are being enhanced are associated with manufacturing aspects of NPD processes. In this sense, firms could have basic manufacturing capabilities and also dynamic manufacturing capabilities. The CRDF facilitates the firm's NPD capabilities to become more dynamic by increasing production scale, promoting product testing and enabling them to make necessary product adjustments to tailor their products to customers' needs. Indeed, manufacturing capabilities are important because firms and MTDC often see manufacturing as the bottleneck in the commercialisation of indigenous technology by high-technology SMEs. Firms' manufacturing capabilities nurtured the development of related dynamic capabilities such as research, marketing and NPD. In fact, these capabilities are relevant in the exploitation phase of innovation process. Furthermore, they are also applicable for firms to engage with full scale manufacturing and market-launch of new products.

5.2 Firms' attributes and performances

This section presents an overview of the firms' characteristics and performances. The firms' characteristics provides a contextual background of the CRDF. The case studies show that all the selected CRDF recipients are owned and run by Malaysian citizens. Therefore, the sample of this study consist of indigenous small firms (see Table 5-1).

Firstly, this study found that firms are distributed across three sectors namely healthcare, chemical and engineering (steel fabrication). Six firms are in the healthcare sector. Of those, three firms are in chemical sector and one firm is in engineering sector. The sectors indicate different types of technology development. For firms that are in the healthcare sector, four of them rely on chemical testing in their product development. Most of their business operations focus on discovery of beneficial chemical substances in herbal plants through scientific experiments. The substances are then incorporated into healthcare-therapeutics products such as body-care, skin-care and consumables (i.e. pills). One firm in healthcare sector has taken different approach to product development. The firm is Industrial 4 and it is in healthcare subsector of oral care. The firm's main approach is to proceed with mechanical testing to produce a new type of toothbrush. The other three firms are in the chemical sector including Industrial 1 and Industrial 5. These firms have been dependent on structured testing to verify the utility of chemical substance that are used as their products' main substance. The tests give indications for products' improvement. However, the tests were not conducted in scientific ways (i.e. under laboratory conditions). Instead, the firms decided to conduct the testing of the finished products on client premises as product demonstrations. The tests were conducted in an unconventional way because there was no clear guideline within Malaysian regulation for health and safety although firms still follow international protocols and standards. For example, Industrial 1 produces fire suppression system, and the firm was dependent on international protocols because authorities in Malaysia, such as Fire and Rescue Department, did not have clear guideline for testing fire suppression system that use aerosol to extinguish fire. One firm in the chemical sector adopts the same approach as firms in the healthcare sector for technology development. The firm is Bio 1 and it also conducts scientific experiments to discover the technology for product development. Bio 1 produces agro-based products such as bio-fertilisers. This firm conducts laboratory work to discover beneficial microbes that can stimulate growth of palm oil plants.

Secondly, in terms of age, this study found that the cases show modest variation amongst firms. In this sense, the case studies highlight three categories of firms: 1) long-established, 2) established and 3) young firms. These categories cover firms that were established less than 5 years, between 5 to 19 years and more than 20 years. The majority of the firms are mid-aged firms as five cases are firms incorporated between 10 to 20 years ago. There is also a pair of case studies highlight there are long-established firms as they were incorporated more than 20 years ago. The remaining three cases are fairly new firms. These firms, including two start-ups, have been in operation for less than 10 years. In this sense, the selected CRDF recipient were distinctive in terms of years of operation prior receiving the CRDF. Most of the firms have been in operation less than 10 years prior to the CRDF which applied to seven of the ten cases. In addition, this study also found two cases of start-up firms that were awarded with the CRDF at their inception. The remaining three firms, were operating for more than ten years prior to the CRDF. Of those, one case study was the oldest firm. Industrial 4 has operated for 20 years prior to the CRDF. In other words, this policy initiative (i.e. the CRDF) is particularly interesting for middle aged firms as they have to build on some priory activities to qualify.

Table 5-1: Firms' attributes

	Bio 1	Bio 2	Bio 3	Bio 4	Bio 5	Industrial 1	Industrial 2	Industrial 3	Industrial 4	Industrial 5
Sector	Chemical - agriculture	Healthcare - Pharmaceutical - Therapeutics	Healthcare - Pharmaceutical - Therapeutics	Healthcare - Pharmaceutical - Therapeutics	Healthcare - Pharmaceutical - Therapeutics	Chemical engineering (fire and safety)	Fabrication engineering (structure and mechanical)	Healthcare – Oral healthcare	Healthcare - Pharmaceutical - Therapeutics	Chemical - domestic
Age (yrs) + establishment before CRDF	19 / 8	26 / 17	11 / 3	7 / Start-up	7 / Start-up	10 / 2	13 / 2	16 / 5	26 / 20	17 / 10
Size/Employees	60	60	10	3	2	60	30	5	3	20
Paid up capital (MYR)	2, 7000, 0000	650, 000	500, 000	100	100	1, 000, 000	500, 000	100, 000	750, 000	500, 000
Product/Service	Product	Product	Product	Product	Product	Product	Product	Product	Product	Product
Market/Customer	Industrial	Consumer	Consumer	Consumer	Consumer	Industrial	Industrial	Consumer	Industrial	Industrial
Management	Scientist	Pharmacist	Scientist	Graduate Entrepreneur	Graduate Entrepreneur	Entrepreneur	Engineer	Entrepreneur	Herbalist	Entrepreneur
Support from Government- MTDC	Incubator	Non	No	Incubator + Business support	Incubator + Business support	Business consultation and network	No	No	No	No
Support from Government - Others	No	Yes – Research grant from MOSTI	Grant for academic research	Overseas and local marketing	Collaboration with RIs	Business facilitation (SJJB)	No	No	Overseas trade mission	Overseas trade mission
Barrier to entry/challenge (requires capital)	Certification	Efficacy approval (Certification)	Not known	Not known	Not known	Certification (Local)	Certification (Local)	Promotion – big brand	Not known	Listing fees with hypermarket

Source: Information gained from interviews with firms' owners-managers, firms' profile and firms' products brochure

Thirdly, firms' size in terms of number of employees, is also an important attribute of the selected CRDF recipients. This study found the selected firms tend to be SMEs. In terms of workforce, the SMEs can be categorised into three groups based on their number of employees: firms that have 1) 60 employees, 2) 10 to 60 employees and 3) less than 10 employees. The first category is represented by two Bio firms and one Industrial firm. Meanwhile, for the second category, Industrial firms are more prevalent with two Industrial firms that have 30 and 20 employees respectively. For the third category, there is a balanced composition between Bio and Industrial firms: with two Bio firms and two Industrial firms. In this sense, the firms' number of employees is dissimilar. As the firms have less than 100 employees, they could be recognised as SMEs.

Fourthly, all the firms manufacture products rather than offering services. This study refers to products as the end result of a manufacturing process which are tangible objects, compared to services which are intangible. This study found six cases of firms that produce consumable healthcare products such as food supplements, skincare, hair care and oral care. Meanwhile, three cases reveal that firms have produced products for other purposes, such as agriculture, fire and safety and domestic uses. Meanwhile, the remaining single case is a firm that produces engineering based products of metal fabrication. The sample firms operate in both industrial and consumer markets. There is significant number of firms that serve these markets. For firms that focus on the consumer market, their sales are dependent on how the firms manage to serve large markets with many anonymous customers. Firms that serve this market often use brands for differentiation and to attract customers, which supports the sales process. Meanwhile the industrial market refers to selling activities that are between businesses. For the other five firms, marketing is still important because they serve markets that are made up of a high concentration of demand within a small set of customers. For these firms, the important issue is giving priority to customer relationship management with less emphasis on branding. For example, major customers of Bio 1 are big plantation companies. These plantation companies operate large scale plantation managed by plantation managers. The managers converge in an association known as planters. Bio 1's managers often join planters in their functions and offers sponsorship for their programmes.

Fifthly, the case studies demonstrate that the sample firms are being managed by technical and serial entrepreneurs. Eight firms are being managed by personnel that have higher education qualifications such as Bachelors degrees or/and Masters degrees in either life sciences or engineering. Therefore, they are technical entrepreneurs or technology entrepreneurs. Meanwhile the remaining two firms are being managed by serial entrepreneurs; they established other business before embarking on their current businesses in high-technology sectors. The technical entrepreneurs consist of scientists, pharmacists, engineers and herbalists.

Sixthly, some of the selected CRDF recipients receive other support from MTDC and support from other government agencies. The case studies highlight that four firms receive soft support from MTDC in addition to the financial assistance of the CRDF. Three of them receive soft support through renting office space and laboratories in MTDC Technology Centres. During their tenancy in the technology centres, the three firms could also access MTDC's support services such as business and technology consultation. These services have been provided by Business Advisory and Nurturing Division of the MTDC. Meanwhile, the other firm (i.e. Industrial 1) receives additional support from MTDC in terms of business mediation and networking. This particular firm was having problems in administering the CRDF due to issues with regulators and MTDC extended its support by acting as a mediator. Apart from support from MTDC, the case studies also show several firms receiving support from other Government agencies. Their numbers are higher compared to firms that received soft support from MTDC, with seven firms in total. These firms receive soft support from other government agencies in terms participation in overseas trade missions, grants for research activities and collaboration with research institutes. Three of them have participated in overseas trade missions organised by the MATRADE[41]. There are also a couple of firms that received grants for research activities; one firm received a grant through the Ministry of Science, Technology and Innovation of Malaysia and the other firm received a grant from a university. There is also a firm that was able to establish additional collaboration with a public research institute. The collaboration was for product testing.

Lastly, the case studies also show that firms were facing different challenges or needed to overcome barriers to entry in order to sell their products to the market. Based on the case studies, there are four firms that were required to get certification before selling their products. They consist of equal number of Bio and Industrial firms, two firms respectively. They were obligated to get local certification for their products due to safety and environmental requirements and each firms embarked on different pathways towards certification. The case study of Bio 1 shows that the firm realised the importance of certification after being for it by its customers (i.e. big plantation companies). However, the

[41] MATRADE is a government body entrusted to promote and develop Malaysia's exports to the world.

firm did not manage to get the desired certificate for it's bio-pesticide product because the Pesticide Board of Malaysia requires further testing. The firm decided not to hold the subsequent testing due to financial constraints. As an alternative its bio-pesticide product was downgraded to Class C[42] bio-pesticide. As a result, Bio 1 revised their sales and manufacturing capacity due to low demand. Another case of a Bio firm shows that the firm (i.e. Bio 2) managed to utilise the CRDF fund to overcome challenges of certification. Bio 2 channelled the fund to clinical trials on product under the CRDF: the liver tonic. The CRDF fund was being used to sponsor the liver tonic for the trials. However, the firm could not complete the clinical trials because of technical problems with testers (i.e. medical doctors). Besides the case of Bio 2, the case study of Industrial 2 offers the same findings in terms of certification. Industrial 2 produces portable breathing compressors and this product has to be certified for air purity. However, the certification body (i.e. TÜV) does not have a calibrated testing equipment. As a solution, Industrial 2 decided to invest the fund from CRDF into acquisition of calibrated test equipment. With that investment, Industrial 2 managed to forge a collaboration with the TÜV for testing. As result, TÜV managed to proceed with the necessary tests and get the product certified. Another case study of Industrial 1 also highlights a certification issue. The firm application for certification of its product, an aerosol based fire suppression system was rejected by local authorities such as Fire and Rescue Department. As an alternative, the firm decided to focus on overseas markets. The firm was able to fulfil demand for this market by investing in production facilities. Indeed, the investment was derived from the CRDF fund. The establishment in overseas markets became useful testimony for Industrial 1 to re-negotiate with the local authorities.

In summary, all cases show that the selected CRDF recipients have adopted product business models rather than service business models. The majority of them are involved in the healthcare sectors. The firms are in medium aged and most of them are relatively new to the sectors that they are involved in. In terms of size, the selected firms are fairly small with the majority having less than 30 employees. The firms are technology based firms as most of their business operations rely upon scientific and technical knowledge for products development. They have been founded and run by technological entrepreneurs such as scientists, pharmacists, engineers and herbalists. There are two exceptions of firms that are being managed by business people (i.e. entrepreneur). Among the business people, two entrepreneurs basically also have technical background (i.e. they graduated with a science based degree and just started venturing into business). These sorts of people are likely to be

[42] A category of bio-products that still has small amount of synthetic chemical substance.

well qualified technically but perhaps weak on business or commercial aspects which are important for successful innovation. Because of this, majority of them received additional soft support either from the MTDC or other government agencies and this support usually meant support for selling activities (i.e. products promotion through overseas trade missions). Finally, the firms share the same challenge of products' certification for market entry and they recognised these towards the end of the product development process.

The case studies also indicate performance of the selected CRDF recipients can be observed in terms of their financial and innovation performance. Firstly, this analysis explains the firms' financial attainments. Table 5-2 explicates this further and it is based on firms' accumulated profit/loss. This analysis was conducted by summing up the firms' profit/loss over a period of time (i.e. 5 years). Then the figures were divided into that period of time.

Table 5-2: Firms' financial performance

	Bio 1	Bio 2	Bio 3	Bio 4	Bio 5	Industrial 1	Industrial 2	Industrial 3	Industrial 4	Industrial 5
Figure (MYR)	2.074	2.383	0.062	0.011	0.025	- 0.771	0.238	- 0.256	- 0.041	- 0.115
Profitability	Yes	Yes	Yes/No	No	No	No	Yes	No	No	No

Source: Analysis of firms' financial statement retrieved from Companies Commission of Malaysia

Note: The figure is in millions and with USD1=MYR3.83

For Bio firms, there are three cases of firms that were making profit. Meanwhile, the other two Bio firms were making losses. For the three profitable firms, two of them were making profit for seven consecutive years between 2005 and 2011. For the other Bio firm, its profitability was not consistent between 2007 and 2011 (five years). The Bio firm managed to be profitable for three years and suffered losses for the other two years. Meanwhile, for Industrial firms, their financial attainments are not comparable with Bio firms as only one of them was profitable while the other four firms operated at a loss. Overall, four firms are profitable and the other six firms suffered losses. One of the loss-making firms is Industrial 1. This firm is expected to make a huge leap into profitability as it has secured contracts in a Government procurement programme valued at MYR12 million (USD1=MYR3.95). Of the profitable firms, two of them were highly profitable with average annual profit of more than MYR2 million (USD1=MYR3.95). For the other two profitable firms, their profitability is much lower with annual average profit of MYR237,000 and MYR62,000 (USD1=MYR3.95) respectively. For the unprofitable firms, their losses were fairly modest, between MYR81,000 and MYR264, 000. This does only apply for four firms. The other two firms', financial attainments require further interpretation because their financial statements showed that they were profitable. However, the profit was based on provision of the CRDF grant (i.e. other income and not from sales).

Secondly, this analysis also tries to explain the firms' innovation performance. Table 5-3 elucidates this further.

Table 5-3: Firms' innovation performances

	Bio 1	Bio 2	Bio 3	Bio 4	Bio 5	Industrial 1	Industrial 2	Industrial 3	Industrial 4	Industrial 5
Innovation status	Radical	Incremental	Incremental	Incremental	Incremental	Incremental	Architectural	Incremental	Incremental	Incremental
External investment	No	No	No	No	No	Yes – machines	No	No	No	No
Intellectual properties	3 patents	1 patent	No	No	No	1 patent	No	2 patents	No	No

In terms of intellectual property, four firms managed to register intellectual property (i.e. patents). They consist of two Bio and two Industrial firms. Together, the four firms managed to file seven patents. The best performing firm is a Bio firm with three patents, followed by one Industrial firm with two patents. The remaining two firms managed to register one patent respectively. In addition to this, the case studies also show that only one firm managed to register a patent related to the designated CRDF project. The patent was granted to Industrial 1 and it is based on the discovery of a chemical substance to extinguish fire. The chemical substance has been applied to its finished products such as handheld fire extinguishers. The other patents were registered based non-CRDF projects. For example, patents registered by Bio 1 are based on discovery from research activities for the development of bio-remediation. The bio-remediation is Bio 1's another product category alongside the bio-pesticide which received CRDF funding.

Besides the intellectual property, another element of firms' innovation performance is their ability to secure external investment for their innovation projects. To date only one firm managed to secure external financing from a private firm from South Korea. The firm is Industrial 1. The financing scheme is in a form of amortisation of additional machine production activities. This firm manages to secure the financing scheme because it holds a patent on chemical formulation of the substance to extinguish fire. The substance can be used to produce different types of fire extinguisher apparatus such as hand held, fixed unit on buildings and firefighting systems in tactical vehicles (e.g. armoured and rescue vehicles). In this sense, the patent of Industrial 1 can be utilised in different ways. This is a clear advantage compared to the patents of other firms, such Industrial 3, that are based on a specific production tool (i.e. jigs). Industrial 3's patents have limited usage which are only confined to production of same product category (i.e. toothbrush). Besides that, the external investment was in the form of machines for production activities. This type of investment can be considered as secured and less risky compared to cash investment because the machines are static and tangible. As objects, the machines are deemed to be used by the beneficiary to produce quantifiable outputs. This type of utilisation could give the investor an easy and effective way to audit their investment.

Another element of innovation performance concerns the products' innovation status. The majority of the CRDF products can be categorised as incremental innovation. Eight firms are in this category. For the products that are categorised as incremental innovation, the firms managed to make modest changes to existing products that are available in the market (Smith, 2015). Firms carried out the modest changes by simplifying existing technology and applying to different forms of finished products (Bower and Christensen, 1995). For example, the case of Industrial 3 shows that the firm managed to introduce a new form of toothbrush by relocating a vibrating mechanism from the brush handle to the head. This modest modification does not make the firm's product any different to an ordinary toothbrush but it transforms the way consumers do their brushing. Meanwhile the remaining two products can be categorised as radical and architectural innovation. For the products of radical innovation, the firm was able to make technological breakthrough (Smith, 2015) by establishing a proper technique to quadruple microbes to produce a bio- pesticide.

Overall, the selected CRDF recipients can be considered as innovative firms. There is prima facie evidence that the selected CRDF recipients are technology companies as four of the ten firms registered a patent/s. This is promising because these firms are small and relatively new in their business areas. In terms of innovation performance, both sectors showed comparable achievement because two Bio firms and two Industrial firms managed to register patents. However, in terms of technology novelty, a Bio firm (i.e. Bio 1) is more exceptional than the other as its product under the CRDF can be considered as a radical innovation. The product is bio-pesticide which is a new product category in the market of predominantly chemical-based pesticides. Conventionally, pesticides are based on chemical reactions. These reactions create harmful conditions to insects such as the rhinoceros beetle. However, insects could rapidly adjust themselves to suit those conditions and become immune to the chemicals. Meanwhile, the bio-pesticide does not use chemical reaction in its mechanism as its main content is microbes. These microbes will live symbiotically with insects and could adapt themselves to the environment. Besides Bio 1, other Bio firms managed to do product improvements which can be considered incremental innovation. In short, the Bio firms are more innovative compared to Industrial firms.

In addition, the CRDF project within firms resulted in products that have been sold in the market. However, the products' contributions to firms' profitability do vary. Apart from three firms, the majority of firms were not profitable. Again, the Bio firms were better as three Bio firms were not making profit compared to four Industrial firms. In fact, the contribution of the CRDF could only be recognised if those particular products are core or integral to firms' business activities. More importantly, this finding seems to suggest that young technology companies are frequently loss-making. In addition, the profitability of high-performing Bio firms is not comparable to the profitability of an Industrial firm. Therefore, Bio firms performed better compared to Industrial firms. Besides profitability, the case studies also show firms' variation in terms of revenue growth. Generally, seven firms were able to achieve positive average revenue growth. The highest growth was achieved by Industrial 3 with more than 100 per cent growth. Meanwhile for the other six firms, their average revenue growth was from 20 per cent to 50 per cent. From this indicator, the Bio firms performed better than Industrial firms. The Bio firms recorded average revenue growth of 31.09 percent, while Industrial firms only managed to achieve 12.69 per cent. The analysis was conducted by comparing revenue recorded in a particular year to the revenue recorded in preceding year in terms of percentage.

5.3 The effectiveness utilisation of the Commercialisation of Research and Development Fund by firms

This section discusses how firms utilise funds from the CRDF. This has become a crucial point of this study because with this kind of policy initiative, the questions of what and how the fund is being used for is an important starting point. In fact, utilisation is a building block for this policy initiative as there is the possibility that the funds could be misused. This section considers the utilisation of the funds from firms' perspective (i.e. the importance) and also their business activities that reflects capabilities to complete innovation projects related to the CRDF and other innovation projects as well.

The case studies demonstrate that the selected CRDF recipients have perceived the fund differently based on their circumstances. Table 5-4 explicates this further. The first circumstance is related to the initial production scale conditions of particular products under the CRDF projects. From the case studies, six firms were just passing the exploration stage of the innovation process, where they operated at laboratory and small scale production. This means their products were prototypes, in the final stage of design and formulation. There are also two firms that were in the medium scale production stage. For these firms, their production activities were carried out manually and were not able to meet demand from customers. In other words, their products have been sold to their customers but in small volumes. Two firms were able to produce the products at an industrial scale. In fact, their products have been sold in the market for quite a while.

Table 5-4: CRDF utilisation

	Bio 1	Bio 2	Bio 3	Bio 4	Bio 5	Industrial 1	Industrial 2	Industrial 3	Industrial 4	Industrial 5
Initial production scale of products under CRDF	Laboratory scale	Industrial scale production	Small scale production	Production trials and R&D	Production trials and R&D	Prototype	Prototype	Industrial scale production	Prototype – product formulation	Medium scale production
Quantum of funding (MYR)	3, 294, 000	600, 000	4, 000, 000	1, 484, 000	1, 169, 400	2, 893, 000	3, 927, 000	1, 800, 000	3, 759, 000	3, 759, 900 (return 300, 000)
CRDF project's status	Integral	Integral	Core	Core	Core	Core	Integral	Core	Core	Core
Usage	Production	Product improvement	Production	Production – working capital	Production – working capital	Production	Product improvement	Product improvement	Production	Multiple – Mostly production

Note: The CRDF's project status refers to whether firms carry out the CRDF project as their primary or secondary business activities

The second element is about the products under the context of the CRDF projects. More than half of firms carried out innovation projects under the CRDF as their main business activities, seven firms altogether. Another three firms carried out the innovation projects as their secondary business activities. This means the products under the CRDF are complementing the firms' core products. There is also the possibility that the three firms dedicate less concentration to the products in terms of production, selling and improvement.

The third element is about the quantum of the CRDF that were awarded to each selected CRDF recipients. From the case studies, there is an indication that the CRDF can be considered as an important resource to the firms. In this sense, five firms received more than MYR3 million (USD1=MYR3.95) of funding from the CRDF. Within that, two Industrial firms received the highest amount of more than MYR3.7 million (USD1=MYR3.95). A further four firms received between MYR1 million and MYR3 million of CRDF funding. Meanwhile, the remaining firm received less than MYR1 million of the CRDF fund: MYR600, 000 the lowest amount of CRDF fund awarded.

The case studies also show firms use the fund for different activities, in particular research, production, marketing and innovation (certification). From the DC perspective, these activities are essential for the innovation process as they underline three vital elements: 1) identification and assessment of opportunities (sensing), 2) mobilisation of resources to address an opportunity and capture value from doing so (seizing), and 3) continued renewal (transforming). Each of the elements entails a number of sub-processes that aim to create and to capture value from opportunities. The CRDF funding is seen as an important resource for firms to develop their capabilities around those activities. From the case studies, this study found that firms were able to develop their manufacturing, marketing and NPD capabilities. Table 5-5 summarises the capabilities.

Table 5-5: Capabilities emerged from case studies

Capabilities	**Elements**
New product development	i) bring products closer to meeting regulations and standards ii) Recognise and improve products weaknesses
Manufacturing	i) Uplifting production scale and scope ii) Improving products quality iii) Efficiency in production
Marketing	Getting more sales volume through intensified promotions and negotiations with prospective customers

In detail, the case studies show that out of the ten firms, seven were found to be channelling the fund from CRDF to acquire machines for manufacturing activities. This group of firms consist of four Bio and three Industrial firms. Their common goal is to upgrade production capacity. However, each firm offers different observations on the process of acquiring the machines. Within this group, five of them acquired the machine in a direct way. That means, they reimbursed the cost of the machines with the approved amount of CRDF funding. However, for another two firms, they acquired machines in an indirect way. For example, Bio 1 utilised part of the funding (i.e. the first disbursement) to reimburse a bank loan. Initially, the firm took that loan to acquire machines while waiting for approval for the CRDF. Once the firm received funding from the CRDF, it was used to pay back the loan. Indeed, the acquisition of the machines was timely because Bio 1 tried to fulfil its customers' demand. The second example is the case of Industrial 1. The firm decided to negotiate with the MTDC for the money to be paid directly to supplier of the machines. In this sense, the CRDF's funding was perceived as a guarantor to the credit terms for the machines. Above all, the machines that were acquired by firms for production activities are new versions of machines that offer higher production capacity.

Meanwhile, two cases show that firms decided to use the CRDF funding for products improvement. They are accordingly a Bio and an Industrial firm. The Bio firm is Bio 2 and the funding from the CRDF was channelled for a collaboration with a third party (i.e. Malaysia Liver Foundation for clinical trials. The firm has embraced the clinical trials as essential for its product (under the CRDF) to be recognised as a drug for liver illnesses. The trials are often associated with the firm's capacity to establish a new category of product. The clinical trials are another manifestation of indirect spending of CRDF money because the trials were conducted independently by medical doctors in government hospitals with the MLF as a facilitator. Under this arrangement, Bio 2 used the CRDF funding to sponsor the clinical trials for a form of its product (i.e. herbal capsules for liver illnesses). In this sense, Bio 2 had to compromise due technical glitches such as delays in recruitment of subjects because it could not influence the trials. Meanwhile, Industrial 2 represents the Industrial firms. Industrial 2 used the CRDF funding to acquire an object (i.e. test equipment). The equipment is meant for certification. The certification is another essential element in the innovation process through which the firm tries to draw the product closer to meeting regulations and standards. In fact, the acquisition of the equipment has positively influenced the firm's working relationship with a body that oversees the regulations and standards (i.e. the TÜV).

In the case studies, there were firms that were found to be using the CRDF funding for marketing related activities. The firm is Industrial 3 and the firm's case study offers an example of the use of CRDF for intangible components but in an indirect way. The firm believed its product (i.e. electric toothbrushes) should be tested and verified by prospective customers within FMCG markets. This was the firm's priority because as a producer of FMCGs, the firm is dependent on customers feedback to determine products weaknesses and faults. The firm decided not to go for ordinary selling channels because customers would not even try any FMCGs product that do not bear brands such as Oral-B and Colgate-Palmolive. Instead, the firm found a niche way to do it by sponsoring a university's apprenticeship programme. In fact, the CRDF fund was used to cover the cost of free toothbrushes for that programme.

In short, the case studies show that the CRDF fund is being used to support innovation process within the firms. Indeed, the firms utilise the CRDF funding in different ways depending on their circumstances. Firstly, the majority of the firms had pass over the research stage of the innovation process by being able to produce prototypes of their research outputs. The prototypes were ready before the firms applied for the CRDF. In this sense, the CRDF is targeted at firms that are beyond the research stage of the innovation process. Therefore, it is not surprising but worthwhile to note that firms largely comply with the CRDF's aims: to facilitate commercialisation of indigenous technology into marketable products that could be commercially produced. Secondly, firms were managed to develop their capabilities in different activities such as manufacturing, marketing and NPD. In fact, the marketing and NPD capabilities supported in projects under the CRDF are still most closely related to manufacturing, such as testing and compliance of product quality to standards. Thirdly, most of the firms carried out the project under CRDF as their core business activities. This reflects the firms' solemnity and obligation towards that projects. Fourthly, almost all firms received a substantial amount of funding with minimum of MYR1.1 million (USD1=MYR3.95). In fact, the majority of the firms used this significant amount of fund for production activities. This reflects their judgement in terms of giving priority to hindrances to commercialise the technology embedded in their products.

5.4 Explanation of emerging patterns and explanation of patterns (i.e. dynamic capabilities in terms of manufacturing, marketing and new product development activities)

This section discusses firms' progress in terms of development of their capability to carry out innovation projects. It focuses on firms' improvement in their capabilities to carry out activities within the innovation process. The improvement is based on occurrences that firms could proceed with in comparison to occurrences that the firms could not do prior to the CRDF. The case studies suggest that the firms did more than just acquire machines; they have developed, enhanced and improved their dynamic capabilities as they managed to improve their routines within innovation process. In other words, their improvement in capabilities is not only limited to acquisition of resources and using resources effectively, but that the resources did contribute in some way to enhancing, improving and expanding their capability to innovate.

The case studies show that firms have achieved significant progress in innovation projects particularly under the CRDF funding. Table 5-6 explains this further. Besides the past attainments, firms are also looking forward to further expansions. These expansions are crucial for firms to seize opportunities in the market. The majority of the firms in the sample perceive their expansion within local market compared to overseas market. Five firms are keen to expand their product reach within Malaysian market. This group of firms is made of two Bio firms and three Industrial firms. For instance, Bio 2 decided to expand its retail shops in Kuala Lumpur, Malaysia before expanding to Thailand and Vietnam. Meanwhile another two firms, namely Industrial 1 and Industrial 4, anticipated their need to expand their local market because they have had good establishment in overseas markets but less presence in the local market. There is only one firm that anticipates expansion to overseas' market for its products. The firm is Bio 1 and its main target customers has been big plantation companies operating in Indonesia. Indeed, it is sensible because the firm managed to gain this insight based on informal discussion with its clients (i.e. managers of big plantation companies). Meanwhile, the remaining four firms have more general anticipation regarding their expansion by trying to seize opportunities either in local or overseas.

Table 5-6: Firms' improvement and expansion

	Bio 1	Bio 2	Bio 3	Bio 4	Bio 5	Industrial 1	Industrial 2	Industrial 3	Industrial 4	Industrial 5
Product improvement - mechanism	Scientific technique	In house R&D	Academic research	Research institute	Research institute	Engineering trials	Combination of latest raw material	Technical trials	Small scale trials	Small scale trials
Market expansion	Overseas	Local	Local & Overseas	Local & Overseas	Local	Local	Making another product	Local	Local & Overseas	Local & Overseas

Note: The market expansion is based on firms' future planning and location of their target customers

Besides the market expansion, firms also experienced improvements in their capabilities within the innovation process. In this context, the case studies suggest a pattern of improvement from innovation support by the CRDF. The pattern is represented by Figure 5-1. These improvements were observed based on challenges that the firms faced and capabilities within innovation process. All ten firms experienced challenges in production activities. The main issues were inability to meet customers demand in terms of quality and quantity. Table 5-7 summarises the roles of manufacturing in addressing some of crucial challenges in innovation process. The CRDF scheme has been used to target issues within production activities as most firms utilised the funding to acquire machines and financial capital for production activities. Firms utilised the machines and financial capital to uplift their manufacturing capabilities in terms of production capacity, quality and efficiency. In this sense, the cases show that manufacturing capabilities is more than having machines on the premises floor because firms need to spend a significant amount of time to build these capabilities. In fact, manufacturing is an element of the NPD process. This means that the firms managed to operate machines and they are not sitting idle. Instead firms have utilised the machines to achieve higher production scale and better quality products at optimal cost. Firms managed to do this by aligning their production techniques especially in terms of raw material management and machine operation. For machine operation, only trained workers were allowed to operate the machines. This is part of new procedures that firms introduced once they received the machines. This has become a common practice amongst all firms. Besides that, firms also managed to utilise the machines by reducing certain production steps. The main reason for this because machines were able to produce more accurate inputs into subsequent processes.

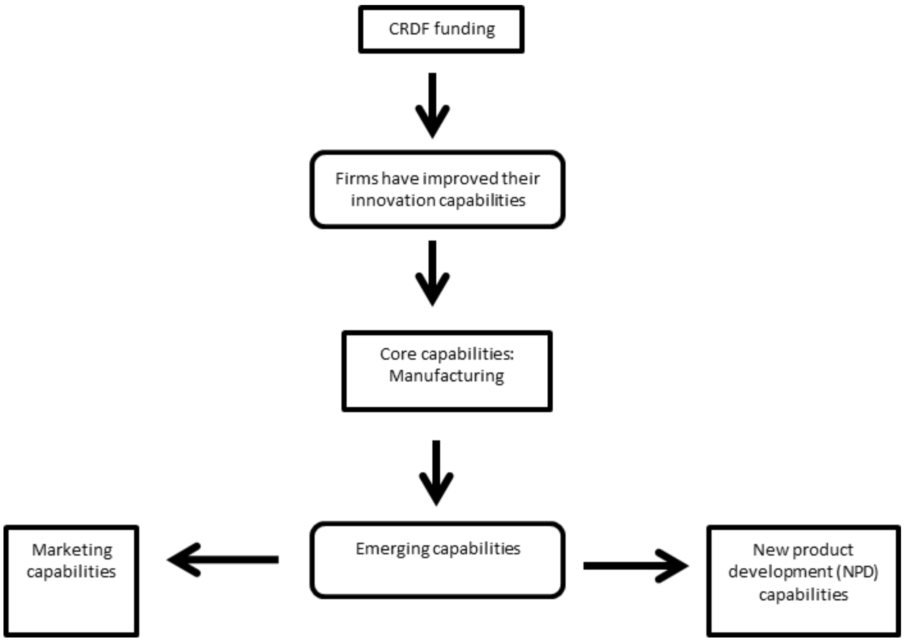

Figure 5-1: Pattern of innovation support by the CRDF

Table 5-7: Roles of manufacturing in addressing challenges in innovation process

Challenges	**Roles of manufacturing**	**Illustration/Example**
Production scale	Firms are able to produce higher volume of products to fulfil demand from customer	Bio 1 tried to cater for demand from big plantation companies for its bio-pesticide
Customer preference	Firms are able to manufacture different forms of product based on adjustments made to suit customer preference	Industrial 3 made an adjustment to its toothbrush product. Previously, the toothbrush requires two AA size battery. This caused load and the firm decided to use a small motor that reduced the battery usage to only one.
Quality and certification	Firms are able to produce the final products (not prototypes) in appropriate scale for safety and market testing	Industrial 1 was able to produce the fire suppression system for product demonstration and testing.

The first element of firms' manufacturing capabilities that have been enhanced is their production capacity. The firms' capability to carry out production at industrial scale have facilitated their market expansion. This might produce positive outcomes in their revenue stream because the firms might have higher turnover. In fact, these capabilities are important for firms to overcome the bottleneck within the innovation process. Six firms were able to uplift their production capacity. In most cases, the firms' production activities were at laboratory and small scale. This is their main barrier within the innovation process because their production capacity was small and customers had to wait for quite a while to get the products. In this sense, the cases show that manufacturing is one of those capabilities that might present a bottleneck in the innovation process; manufacturing capabilities are also linked with other aspects of innovation (i.e. marketing and NPD). Indeed, a main outcome of firms' manufacturing capabilities is production scale as well as products quality and process integration. With industrial scale production activities, firms were able to meet customers demand. As a result of capacity upgrading, firms have developed their capabilities to manage the production process, including raw material management and employees training to operate automated machines for industrial scale production activities. Prior to having the automated production system (using machines), firms managed the raw materials based on estimation, and hence production was inaccurate. Once the automated production system was installed, firms changed their practice into a more precise technique by measuring or weighing raw material because once the machine started to run, it is not safe and economical to make adjustments. In fact, firms might experience waste of raw material and other production costs if the raw material is not precisely measured before embarking on production. In this context, the firms managed to develop another set of capabilities within the manufacturing activities: this relates to firms' ability to establish a proper training system. Prior to the acquisition of machines, firms were only able to have informal training systems in place. Informal training refers to training that is based on personal coaching and provision of unsystematic guidance. This situation was enhanced once the firms' started to utilise more sophisticated machines. Most of their employees had no prior experience or knowledge about those machines. Firms started to establish proper training system by sending their production supervisors on intensive courses organised by the suppliers of the particular machines. The courses focused on machine configurations including how to utilise them effectively. This form of training was new to the firms because before this, their training concentrated on how to do manual production techniques in the right way. However, this changed once firms used training to increase their productivity. Firms also gained access to proper documentation for the training they provided, as they adopted training they provided, manuals from their respective machines suppliers.

Within the six firms, Bio 1 and Industrial 1 benefited the most from their ability to upgrade their scale of production because their customers demanded high volumes of product: plantation companies for Bio 1 and building owners for Industrial 1. Therefore, this finding highlights that it might be worthwhile to note that scale was important for the customers. In fact, the main outcome is firms might be able to increase their sales and subsequently their revenue generation. For Bio 1, the big plantation companies might have placed big orders for its product (i.e. the bio-pesticide). In fact, Bio 1's customers are made of big palm oil companies that operate in Malaysia and Indonesia. These plantation companies are known as heavy users of chemical-based pesticides and might not want to mix them with bio-based pesticide. It means that once they decided to change to Integrated Pest Management system, they might require a high volume of bio-pesticide from Bio 1. Besides the production capacity, Bio 1's capability to produce the final product at industrial scale has also influenced its capacity to determine the product packaging. Prior to this, Bio 1 was not able to finalise the form of the final product (i.e. in liquid or solid form). The main reason was because laboratory and small scale production did not give clear indication about the form of final product. At that juncture, the firm was thinking about different forms of packaging, such as the use of a bottle or box. Once the firm was able to operate machines and carry out high scale production, it discovered that the most appropriate final products would be in liquid form. From here, the firms decided to proceed with bottle packaging.

Secondly, firms were able to develop their manufacturing capabilities for product quality enhancement. This element is particularly important to manufacture products that exhibit consistent quality between batches and different forms of products that are more desirable products for customers. Five firms have experienced improvement in their manufacturing capabilities to produce products that maintain consistent quality between batches. This category of firm includes three Bio firms and two Industrial firms. In fact, four firms are in healthcare (therapeutics) sector and they share the same production technique. Their production technique have been enhanced by the use of machines that have proper monitoring indicators for production processes such as heating, drying and grinding speed. The firms could maintain production process and flow by making appropriate adjustments if they find any discrepancies. These adjustments are essential to make sure that their employees can operate the machines at their optimum level. For example, the case of Bio 3 that produces healthcare products, it requires a balanced mixture of raw materials (herbal plants). The raw materials have to be dried at constant temperature. Prior to this, the raw materials were dried either under the sun and/or at room temperature. This drying technique produced inconsistent quality of raw material because each technique resulted in different moisture level. However, this problem was solved once the firm was able to operate the new type of drying machine (i.e. fridge dryer). This machine has a dedicated function that can set temperature for drying purposes.

The firms' manufacturing capabilities to produce consistent product quality has been influenced by processing techniques to preserve composition of activate chemical substance in raw materials. Otherwise, machines still produce low quality products. In this sense, firms were able to develop their capabilities in measuring and preserving content of chemical substances in the raw materials. These capabilities are mandatory in the pharmaceutical sector because their products need to meet trade and safety standards of composition of that substance and in order to justify the products benefits claimed. Previously, firms were unable to preserve the beneficial substance because they were using conventional drying technique by heating raw materials. This is not an effective technique because the chemical substances are sensitive to heat. Instead, firms such as Bio 3 developed capabilities to operate a fridge drying machine for drying purposes. This machine dries herbal plants by discharging cold air to extract the plants' moisture. As result, the firm is able to maintain consistent quality of raw material (i.e. herbal plants) during the drying process compared to conventional production techniques. For Industrial firms, they managed to develop manufacturing capabilities to produce consistent products by operating machines that have jigs and templates. These capabilities are part of production engineering for industrial scale production. The jigs and templates possess an accurate measurement of small components of the final products. For example, Industrial 3 utilises machines that were imported from Germany to produce large numbers of toothbrushes. The firm has been dependent on the machines because they can produce uniform locking mechanisms[43] for the brushes. Prior to this, Industrial 3 was not able to finalise the design because it did not have the jigs. This outcome is not only dependent on the machines but also dependent on the firm's ability to setup the desired movement of the jigs.

In addition to the above, the case study firms also managed to develop their capabilities in terms of producing a variety of products that meet customer demand. This means firms were able to produce different types of products that have the same functions. Both Bio and Industrial firms managed to do so by differentiating their products through customisation.

[43] A locking mechanism for holding a brush with a handle that forms a complete toothbrush.

Within the Bio firms, the case of Bio 1 shows clearer evidence compared to others. Bio 1 produces bio-fertiliser and bio-pesticide for big plantation companies. The plantation companies started to expand their operations outside Malaysia, primarily to Indonesia due to scarcity of land. Bio 1 perceived this opportunity and wanted to expand to Indonesia as well. However, the firm faced quarantine and transportation problems because their products are in liquid form. As an alternative and in order to seize that opportunity, the firm decided to produce bio-pesticide in solid form (i.e. powder). This move required the firm to have slightly different manufacturing capabilities because the initial plan was to produce liquid bio-pesticide which the firm managed to do. In the first instance, Bio 1 managed to guide their workers to use different production techniques that involve additional steps to extract water and make microbes become inactive. Meanwhile, Industrial 1 represents Industrial firms and this firm is able to produce another form of fire extinguisher that still uses the original concept of aerosol application. Industrial 1 embarked on an innovation project under the CRDF for the development and production of permanent unit of aerosol fire extinguisher. The permanent unit is meant for installation in certain areas of a building, such as computer server rooms. The main customer of that product is building owners. Industrial 1 also managed to develop manufacturing capabilities to produce handheld units of fire extinguishers. The handheld unit is mobile and it is more desirable for customers in general. With the handheld unit, Industrial 1 managed to expand its customer base from building owners to fire and rescue personnel and private customers such as universities. Industrial 1 managed to develop another set of manufacturing capabilities in terms of production technique because the final product is smaller and lighter. It means, the firm managed to re-design the product and proceed with production engineering because the permanent fire extinguisher unit bears different specifications and features from the handheld fire extinguisher. In fact, the main difference is the dimension of both products; the handheld unit is smaller than the permanent unit. Another Industrial firm that manages to differentiate its products is Industrial 5. This firm produces mosquito and insect repellent. Initially, the firm only produced that repellent in gel form. However, the gel repellent is harder to produce because its production technique requires a thorough heating system. In this sense, the production cost is high, hence the firm had to sell it at higher price than its competitors. This makes the gel repellent less desirable to customers. As an alternative, Industrial 5 developed the same product in a mosquito mat. This move makes the production process simpler because the production of mosquito mats does not require thorough heating system. As a result the firm was able to reduce its production costs.

Thirdly, firms also managed to improve their manufacturing capabilities in terms of efficiency. All cases show that the firms did not expand significantly either physically or in terms of the number of manual employees that were involved in production activities. In this sense, firms managed to reduce or maintain their capital and operating expenditure although they started to expand their operation in terms of production scale and scope. At this juncture, firms are more dependent on automated production systems. However, there are two firms (i.e. Bio 2 and Industrial 3) that did not exhibit this occurrence because they did not spend the fund from CDRF for production facilities. For the other firms, they managed to conduct industrial scale manufacturing activities without relocating to larger premises. This is part of efficient operation because the firms avoided incurring high capital expenditure for physical expansion. Meanwhile the capital expenditure for acquisition of machines was covered by the CRDF. This might improve the firms' cash flow and this is important because most of the firms are relatively new in operation. In addition to minimal physical expansion, the firms also managed to develop their manufacturing capabilities to become more efficient by training their existing manual workers to operate automated production system. This applies to the majority of firms apart from two Bio firms (i.e. Bio 4 and Bio 5) because they are still dependent on contract manufacturers to produce their products. For the other eight firms, their manual workers have minimal qualifications such as education or vocational certificates, and have limited experience with the latest production system. For these workers, operating the machines is quite challenging. Indeed, this is another manufacturing bottleneck for the firms because without competent operators, machines will be idle. In this sense, the firms managed to equip their existing employees with sufficient technical knowledge to operate the machines. In most cases, the firms sent production supervisors to the suppliers of the machines for training. This was part of the agreement when the firms acquired the machines. Then, that supervisors will conduct in-house training for their subordinates within their respective manufacturing team. With skilled-employees, the firms could improve their productivity by reducing wastage of raw material and machine idle time due to inappropriate settings. The firm also could improve profitability by reducing the cost of training because in most cases, the employees experienced on-the-job training that did not incur additional cost. In fact, the cost of training for supervisors was covered by capital expenditure on the machines.

Besides manufacturing capabilities, firms have also managed to develop other capabilities: NPD for product improvement and marketing capabilities to secure more sales. It is important to note that these capabilities are closely related to manufacturing capabilities. Indeed, manufacturing capabilities are important because firms and MTDC often see manufacturing as the bottleneck in innovation projects. The case studies show that firms give priority to manufacturing activities and they are able to develop manufacturing capabilities and were able to overcome that bottle-neck. At the same time, other capabilities such as marketing and NPD emerged together with manufacturing capabilities. In this sense, manufacturing capabilities can be considered as core capabilities that firms developed from the CRDF. There is also spill-over capabilities that have been developed from CRDF and firms' competencies, in this context, NPD capabilities and marketing.

In most cases, firms' NPD capabilities are made of their ability to develop systematic testing systems, operate specialised testing equipment and recognise products' faults and weaknesses. Within firms, testing serves several purposes such as for safety and efficacy, market trials and meeting international protocols. Four firms fall under this category. Two firms manage to apply systematic NPD for safety and efficacy. Both are Bio firms, although, one Industrial firm applies systematic NPD for meeting international protocol and another firm for market trials. The first Bio firm is Bio 1 and this firm was able to intensify the systematic NPD for products efficacy. Prior to the CRDF, the firm could only conduct testing in controlled environments (laboratory setting). This was a considerable achievement because this process might indicate products' preliminary compatibility and give the firm the opportunity to refine the products. However, this process is subject to many anomalies because in most cases weather and soil conditions become important factors to determining effectiveness of the products. In this sense, Bio 1 decided to expand its systematic NPD but required cooperation from customers because the firm does not have large scale testing plots. Therefore, Bio 1 strengthened its working relationship with customers up to being able to access sites before actually selling the products. For certain sites, the testing was carried out for more than six months and the prospective customers could see the actual effects of the products. This NPD process gave Bio 1 time to make improvements to their products and customers could accept this because the process did not affect their whole operation. Indeed, the NPD capabilities has given Bio 1 adequate time to further screen its products and improve them further. The second firm is Bio 2. This firm was able to develop its NPD capabilities for products' safety and efficacy by conducting clinical trials. This trial is part of regulatory requirements for drug efficacy claims. For Bio 2, this was the firm's first attempt to claim development of a breakthrough medicine and it can be considered a huge business undertaking. This process has given the firm good experience in terms of meeting proper procedures to claim drug efficacy for certain illnesses although the outcome was not as positive as expected. For this, the firm would have to become more efficient in conducting the next set of clinical trials.

For Industrial 1, the firm was able to develop its NPD capabilities based on systematic testing based on the regulator's protocol (i.e. FRDM). This testing was to determine the firm's product efficacy at extinguishing fire. The firm was facing challenges in getting local certification for its product because there was no standard testing protocol. Before this, the firm was dependent on its founders' experience and technical knowledge of fire suppression systems to conduct tests. In most cases, this test was based on protocols that have been developed by regulators outside of Malaysia and the firm directly adopted them. Indeed, this process was challenging because the local regulator has a different interpretation of overseas protocols and the firm still needed to satisfy the regulator. This is because the regulator acts as a gate keeper before product could enter the market.

Meanwhile for Industrial 3, its NPD capabilities have developed as they channelled their focus on further improving products based on detected faults and weaknesses. This was part of the firm's initiative to improve its products to make them more desirable to customers. As a producer of FMCG, the firm has been dependent on its capabilities to conduct market testing. The testing involved getting feedback from customers about their experience when using the firm's product (i.e. toothbrushes). The customers' experience was used by the firm to determine their products' appropriateness in terms of design, agility and price. The customers consisted of two groups; 1) dentists' network and 2) consumer market. In most cases, the dentists' network had provided insight about the products' design and agility. Meanwhile the consumer commented on the pricing. Information from both groups is applicable for the firm to proceed with necessary adjustments. For example, one type of toothbrush was redesigned because consumers feel that an efficient toothbrush should use one instead of two batteries. From this, the firm made major modification to the vibrating component (i.e. motor of the toothbrush). The motor was redesigned to be smaller and relocated to tooth brush head. Prior to the market testing, the vibrating motor was located in the handle of the toothbrushes.

In two cases, firms were found to be better in their marketing activities. The firms are Bio 4 and Industrial 1. For Bio 4, its marketing capabilities were improved by intensifying negotiations with new customers that have large operations and would order its products in large quantities. In this case, the firm entered negotiations with airline companies after being able to produce the anti-diabetic biscuit. The negotiations were about meeting the potential customers' requirements in terms of the product's volume pricing. The firm was able to proceed with negotiations after being able to produce the product at industrial scale. In this process, the firm was trying to convince the airline companies that changing its product will not be costly and beneficial to their operations because some of their passengers might prefer healthy snacks such as anti-diabetic biscuits. Meanwhile, for Industrial 1, the firm's marketing capabilities were developed based on its enthusiasm to proceed with sales despite the certification issues. At that point, Industrial 1 was not able to make sales of its product (i.e. the aerosol based fire extinguisher) locally because the product was not certified for use within Malaysia. However, the firm was able to identify opportunities for sales as its product can be installed in strategic places, such as oil rig cabins. These cabins are made by fabrication companies in Singapore and are delivered to customers in Malaysia. Industrial 4 decided to approach the fabrication companies in Singapore and was able to convince them about its product based on cost and quality. The firm used benchmarking to compare its product with other products available in the market. This is part of the marketing capabilities shown by Industrial 4.

In short, the CRDF fund is not being used in research activities but for development purposes. In terms of the innovation process, the fund is not being used in the front end of innovation process (i.e. exploration phase). Indeed, this occurrence fits with the CRDF's objectives to facilitate the development of new products and production processes, and to assist participating companies to start-up production capacity. The exploration phase of the innovation process encompasses activities to move products manufacturing from laboratory scale to industrial scale. This means the fund is not being used for breakthrough innovation because the firms' main approach is improvement of existing technology or products. Firms' initiatives to improve existing technology have been influenced by the acquisition of machines and equipment using CRDF funding. In having the tangible assets (machines), firms have been able to improve their capabilities applicable in the exploitation phase of the innovation process. In most cases, the firms were able to improve their manufacturing and NPD capabilities. The cases show that firms and MTDC are treating manufacturing as a bottleneck in commercialisation of research outputs. The CRDF has provided significant resources to remove this bottleneck through provision of financial support for the acquisition of machines. Indeed, the direct impact of this support is the acquisition of the machines as the object of the investment. These machines have been used by the firms for production activities that yield spill-over effects within production activities itself and also other activities namely marketing and NPD. In fact, the spill over impacts within production, marketing and product improvement activities are the positive outcome of management role in those activities. However, it is important to note that these firms have been managed by small management teams and they might face constraints when trying to seize opportunities. At inception, they faced constraints in research activities to discover the most suitable technology for commercialisation. After that, challenges to do production engineering became another constraint. In this context, the CRDF facilitates firms to overcome production constraints. As a result, the firms were able to develop their manufacturing capabilities within more automated production techniques and rely less on manual techniques. This allows the management of the firms to have capacity that could be used to concentrate on other activities, such as marketing and product development. The main reason for this because this study looks at a particular programme where the CRDF is not the only programme meant to support innovation process within local firms. In this sense manufacturing activities are an important aspect of the innovation process that emerging economies have to master. Support for manufacturing activities is well covered by the CRDF and if firms need wide-ranging support for other business activities such as marketing, they could get it from other programmes. This means, the CRDF is targeted at particular problems and not all issues to do with commercialisation of research outputs.

5.5 Conclusion of cross-case analysis

This purpose of this chapter is to analyse the ten case studies of firms that were awarded the CRDF by the Malaysian Government. This chapter aims to identify common themes that emerged from the case studies in order to explore effectiveness of the CRDF. The CRDF is intended to provide support, guidance and a framework for the Governments' efforts to enhance the innovation capabilities of small indigenous high-technology firms. Indeed, this initiative is part of Malaysia's innovation policies that are designed to ensure technological upgrading amongst local firms.

The first aspect of cross case analysis looks at the nature of the firms that received the CRDF funding. The analysis reveals three common themes that reflects firms' characteristics. The themes are; 1) indigenous, 2) small size and 3) high technology. From the analysis of the case studies it emerged that all firms were indigenous. This finding is based on the fact that the firms are managed and owned by Malaysians. In addition, all firms were also incorporated in Malaysia at their inception. The firms also had established their business activities in Malaysia as they have premises that house their operation there. Following this, the other aspect evident from the case analysis is that the CRDF's recipients are small firms. All firms have less than 60 employees. Within that, firms that have less than ten employees make up the largest proportion of the sample, with four firms altogether. Correspondingly, it is evident from the cases that the selected CRDF recipients are high-technology based firms. This classification is based on the following attributes:

i) the type of product that firms produce
ii) the composition of their employees in terms of qualification
iii) resources that they employ in terms of equipment and infrastructure

All ten firms are high-technology based firms because they are able to develop, produce and sell products which have a high degree of technology content. Firms were found to allocate significant resources for R&D in order to develop and apply new technologies. In fact, most of their business operations rely upon scientific and technical technique for products development. In addition to the products' status, all ten firms employ people with technical background as staff. Most of the firms' technical staff are graduates from universities with a bachelors or higher degrees (i.e. Masters or PhD) in science and technology. They are deemed to be equipped with general and specific technical knowledge that relates to the firms' core activities. In certain firms, this category of employee is the majority of their total workforce. Furthermore, firms also manage to utilise technical resources such as advanced machines and equipment. Most of the machines were acquired from renowned suppliers and required people with high technical knowledge to operate them. Some of the machine are rare and outsiders are willing to pay a service fee to use them. For certain firms, they manage to have a proper infrastructure to carry out new technology based products. The infrastructure is made of appropriate laboratory settings that are run by scientists. The three themes indicate this study considers a group of firms in receipt of the CRDF. They are clearly in the target group that the CRDF should aimed for in terms of providing support for indigenous firms to commercialise research outputs. Based on the evidence here, the CRDF seems to be focused and targeted on the right sort of firms.

From the analysis of the case studies, it is also clear that the funds from the CRDF have been used to develop, improve and enhance various aspects of NPD. Most of the improvements are in the exploitation phase rather than experimental stage (exploration) of the innovation process. Several firms used CRDF funds to acquire machines and equipment. Testing equipment featured prominently. It was acquired to improve quality assurance. Similarly, machines and equipment were acquired to improve manufacturing capabilities, especially to scale-up production to higher volumes. Besides the spending on equipment, certain firms also used CRDF funds for market research to gain insight about their customers' preferences. The evidence from the case studies suggests that the CRDF funding facilitated the improvement of firms' NPD process. The funding is also targeted at firms' capabilities in the NPD process because firms' ability to carry out innovation is improved especially when it comes to the commercialisation of research. This outcome is linked to the fact that the CRDF has been focused and targeted at the right sort of areas.

Significantly, the analysis of case studies also provides evidence that the CRDF enhanced some of the firms' dynamic capabilities. The capabilities are not necessarily capabilities that are applicable to manufacture products. This means, this study found that firms have utilised the CRDF funding not just to improve their innovation capability but also their capability to respond to a dynamic and rapidly changing environment. According to Teece et al. (1997), dynamic capabilities consist of firms' ability to: 1) sense and shape opportunities, 2) seize opportunities and 3) reconfigure their tangible and intangible assets. From the case studies, the evidence suggest that firms have the ability to sense and shape opportunities when they carry out market research. The market research was based on tangible products where customers had chances to make contact with them. In this sense, firms were trying to shape the opportunities by sensing what customer needs are and identifying where exactly the demand for their products can be found (market segmentation). These activities influenced firms' decisions to make modifications to the product specifications (e.g. design, application or formulation) to meet the customer demand. Firms used the CRDF funding in order to develop their market research capability primarily by getting feedback from customers. This will enable firms to respond better to changes in external opportunities (i.e. picking up on where the changes in the market environment are occurring). Firms become more responsive to a changing market as they learn about the changes more quickly when they have good contact and feedback from customer.

Following on this, the evidence from cross case analysis suggests that firms have used the CRDF funding to develop and build links with external bodies that carry out products certification processes. This is part of firms' activities to seize opportunities and they managed to do that by offering products that are safe and meet regulatory standards. In this sense, certification and testing are quite prominent amongst firms. For this purpose, firms managed to develop systematic testing mechanism to make sure their products are functional based on that standard. The standard imposed by certification bodies were met by firms in part by having a good working relationship with these bodies. These linkages enabled firms to get approval for product certification. This achievement reflects improvements in firms' external link. This occurrence is considered dynamic because prior to this, firms often seemed to be isolated and they did not have the right sort of information about certification. The knowledge gap made firms' external links weak and this could make them less responsive to the environment. The firms could not seize opportunities even though they spotted them. Correspondingly, firms might want to respond to opportunities if they have certified products (which were approved in a particular market) by moving quickly into the market. This would help to reduce product lead time and thus improve and enhance the NPD process.

From the case studies, it also emerged that firms utilised the CRDF funding to train their employees after they have acquired machines and other equipment. In other words, the firms managed to develop their dynamic capabilities by having not only proper equipment and but also competent personnel to make effective use of it. Then, the firms manage to reconfigure these tangible and intangible assets in order to create a new set of capabilities. The tangible assets are instrumental in training and the development of further capabilities that are applicable in the NPD process. Accordingly, the firms have enhanced their ability to run machines accordance to their specification, better manage relationships with customers and suppliers, and better manage quality assurance.

From the larger context of Malaysia's innovation policy, this study highlights the challenges of commercialisation of research in emerging economies. A particular innovation support programme like the CRDF gives priority to certain stages of commercialisation process, which in this case, is the exploitation phase of the innovation process (i.e. targeted for full scale manufacturing and product market launching). Those activities in the exploitation phase, particularly at the latter part of it, received a lot of emphasis since firms are inclined to buy equipment and machines. However, firms also give considerable attention to marketing and other elements of NPD. In summary, the evidence from the case study of firms that have been studied, confirms that the Malaysian Government's CRDF programme is effective in enabling small and indigenous technology-based firms to modify and extend their resources. This has extended firms' ability to successfully undertake activities within the innovation process. The firms' ability to undertake innovation projects is more applicable in the exploitation phase of the innovation process rather than earlier phase of exploration (i.e. R&D related activities). However, the particular aspects of the exploitation phase that have been enhanced through CRDF varied from case to case. Nevertheless this programme has enabled these firms to undertake commercialisation activities relevant to the market that they are trying to address more effectively compared to the absence of the CRDF. As a result, there is compelling evidence to suggest the CRDF scheme has contributed significantly to raising the innovation capability of small indigenous and start-up technology based firms. In this process, it has met the aims of technology-driven growth strategies of an emerging economy like Malaysia. This has furthered the country's continued advancement and economic development.

Chapter 6 : DISCUSSION OF FINDINGS

6.1 Overview

This chapter discusses the findings of the thesis. The objective of the study is to analyse how a policy comprising a financial initiative has been used to enhance technological capabilities of indigenous SMEs. A government in an emerging economy introduced the policy initiative particularly for innovation. As a mid-ranking emerging economy, Malaysia has made a good progress in industrialisation (Yusuf and Nabeshima, 2009; Economic Planning Unit, 2011). However, its industrialisation is very dependent on the FDI-led manufacturing sectors and lacking in high-technology sectors (Ali, 1992; Felker and Jomo, 2007; Mahadevan, 2007). The Malaysian government perceived the importance of high-technology industrialisation as a measure to catch-up with developed countries and a pathway to become a fully developed industrialised country (Mahadevan, 2007). However, high-technology industrialisation is not a straight forward process because it not only requires a government's commitment to encouraging local indigenous firms to utilise technology but also supporting them to develop new technology into finished products or processes (Blanes and Busom, 2004; Hindle and Yencken, 2004). This aspect has influenced the Malaysian government's assertiveness to introduce and implement policies as part of technology-driven growth strategies aiming to develop high-technology sectors.

Generally, the policies that have been implemented by the Malaysian government try to support indigenous SMEs in building up their technology capabilities. The policies can be categorised into fiscal approaches, e.g. grants and soft loans and non-fiscal approaches, e.g. infrastructures and training programmes (Hill and Chu, 2006; Hall and Lerner, 2010). Of those, policies using fiscal measures emerged as a common way to overcome market failure and facilitate innovation. Fiscal measures are able to reduce firms' financial burden, and increasing their propensity for commercialisation activities (Hill and Chu, 2006). For a similar reason, the Malaysian government introduced the CRDF in 1997 as part of policy initiatives to promote commercialisation of indigenous technology. Prior to the CRDF, there were no support measures to commercialise the findings of the various research projects sponsored under the Intensification Research Priority Areas (IRPA). IRPA is a grant scheme introduced in 1986 offered to academics and researchers to conduct research in specific areas determined by the Malaysian government through the MOSTI. Basically, the CRDF is the first direct government support for commercialisation of R&D outputs. Before this, government initiatives concentrated on offering research funding to universities and research institutes. In fact, the idea of this policy initiative was proposed by a task force for Action Plan for Industrial Technology Development in 1990. The Action Plan identified five basic structural weakness in Malaysian technology development (i.e. inadequate institutional structure, low private sector participation, poor human resource base, lack of awareness and focus on critical generic technology, and lack of awareness among societies in science and technology issues) and offered 42 recommendations to develop Malaysia's innovation system (Jomo et al., 1999).

The MTDC[44] manages the CRDF. The main tasks of MTDC are to nurture technology based enterprises by providing financial assistance to companies, particularly SMEs, involved in high technology businesses and providing other support services for commercialisation of R&D outputs. The major objectives of CRDF are to enhance the competitiveness and capability of Malaysian industrial sectors by: 1) promoting the commercialisation of indigenous technology, 2) accelerating commercialisation of R&D efforts by local universities, public research institutes or companies, and 3) facilitating the development of new products and production processes, and assisting participating companies to increase production capacity (MTDC, 2012).

In addition to the CRDF, the MTDC also manages other funds that the researcher could have chosen. Table 6-1 summarises the other funds under purview of MTDC.

[44] The MTDC is a quasi-government corporation with 100% shareholding by Khazanah Nasional, the government investment arm.

Table 6-1: Funds under MTDC management

Fund	Description	Objectives	Target Group
Technology Acquisition Fund (TAF)	The fund is to facilitate eligible Malaysian companies in acquisition of foreign technologies for immediate incorporation into firms' manufacturing activities	To promote technology upgrading through introduction of modern and efficient technology in manufacturing	Small and medium enterprises
Business Growth Fund (BGF)	Focuses specifically on supporting and providing follow-on funding to successful grant recipient firms	• to provide funding for the final phase of the R&D&C value chain • to build enough "commercial" value in the company to make companies attractive for follow-on financing by VCs & other financing institutions	Government grant companies
Business Start-up Fund (BSF)	Incorporates elements of loan and equity, offering companies flexible funding	To support and encourage entrepreneurship; creation of new strategic businesses that are important and potentially scalable; and funding of supporting companies	Start-up technology-based companies
Bumiputera[45] Expansion Fund (BEF)	Provides flexible loans of up to MYR15 million without any collateral	To help Bumiputera business entities to expand their operations internationally	Bumiputera technology-based firms involved in specific technology clusters[46]

Note: The BEF targets specific group of beneficiaries, Bumiputera. Bumiputera are sons of the soil of Malaysia constituted the major population among other races such as Chinese,

[45] *Bumiputra* or 'son of the soils' is a Malay term used widely in the 1970s when the government implemented economic policies that favour the Malay and the indigenous people of Sarawak and Sabah.
[46] Such as bio-technology, green technology, oil and gas electrical and electronics, information and communications technology, nanotechnology and food technology.

Indian and others. Bumiputera's SMEs were the sector represented more than 50 per cent of the population and they continually fail to secure larger share for them in Malaysian economy includes in high technology sectors.

The researcher chose the CRDF as the primary subject because this fiscal policy initiative is considered an important technology-driven growth strategy to support Malaysia's high-technology industrialisation by focusing on the development of new and emerging industries (Siew-Yan and Mat Zin, 2006). Furthermore, studies of industrial policies like the CRDF have focused largely on the supply side (i.e. intervention by the government, establishment of support structure) and concentrated less on the demand side (i.e. the performance of the beneficiaries)(Hill and Chu, 2006). In Malaysia, performance of innovation support is a critical gap as the rate of commercialisation of research outputs within public research institutes has decreased from 5.1 per cent to 3.4 per cent between 1991 and 2005 (MASTIC, 2010). Therefore, it is the objective of this study to investigate and analyse the operation of CRDF. An investigation of the CRDF under Malaysia context offers a perspective from a mid-ranking emerging economy that made advances in building up its manufacturing based economy but wants to progress to a knowledge-based economy. The government's main strategy is to promote high-technology sectors by supporting local firms to commercialise indigenous technology sectors by supporting local firms to commercialise indigenous technology (Mahadevan, 2007). The CRDF is a key policy initiative set up to achieve that objective. The main findings of this study suggest local firms experienced improvement by becoming significantly more effective in undertaking the innovation process. Firstly, firms were able to complete the designated innovation projects under the CRDF. This is a positive outcome of this policy. Secondly, firms acquired significant resources through the CRDF by acquiring machines and equipment primarily to be used in NPD process. This study also suggests possession of machines is necessary but not sufficient condition for developing manufacturing capabilities. Sufficient conditions are manifest themselves in the way firms utilise and operate their machines. In fact, the firms' capabilities can be observed through their ability to utilise machines and equipment, and carry out tasks within a NPD process in a more efficient and effective manner (i.e. larger scale, better quality and variety of products).

6.2 Policy implementation

There was a lot of speculation about whether policies could be used to enhance local firms' technological capability (Kim and Nelson, 2000; Wade, 2012). This assertion is also applicable to the CRDF because it is a major policy initiative to facilitate innovation by ensuring research and discovery will reach the market. In Weiss's work (2013), he suggests that governments have to put significant efforts into the refinement of policies to make them more rigorous. This means policy documents need to explain clearly the objectives, aims and implementation mechanisms. This improvement is essential to minimising risk of a policy failure (Porter, 1998; Weiss, 2013). The case studies presented here establish that the CRDF has been well managed by the MTDC. This issue will be looked at first because this policy initiative aims to facilitate appropriate firms to carry out innovation projects and the MTDC as a policy implementer tries to make sure that the CRDF reaches its goals. The evidence shows that MTDC has been able to convey clearly the CRDF's implementation mechanism to the target group. Firms were convinced that CRDF's funding is meant for upgrading their ability to proceed with a NPD process although the firms anticipated other challenges in innovation projects. This was evident in the cases of Bio 1, Bio 3, Industrial 1, Industrial 4 and Industrial 5. The finding shows that firms were able to understand the CRDF's objectives confirms Siew-Yan and Zin's (2006) view that CRDF is a strategic initiative towards high-technology industrialisation.

Prior studies also highlight that undertaking innovation projects is challenging and thus often associated with firms' failure to complete that projects (North et al., 2001; Özcelik and Taymaz, 2008). For some researchers (e.g. Martin and Scott (2000) and Gurdon and Samsom (2010)), failure to complete innovation projects is influenced by factors that are linked to products and markets. These general findings were adopted by other scholars as the basis of an argument for government support for innovation projects. In this sense, past evidence seems to suggest that within government policy initiatives in particular fiscal initiatives (i.e. where money goes to firms), there is a tendency for innovation projects to never be completed. For example, a study by Özcelik and Taymaz (2008) suggests firms participating in R&D projects tend to face high risk of failure in terms of not completing that projects due to programme related factors. The study was conducted in a context of a developing economy (i.e. Turkey) and investigated the impact of a fiscal initiative (i.e. R&D grant) to encourage more R&D investment within the participating firms. That means, the aim of the initiative is to achieve a certain level of R&D investment from the firms. However, firms were not inclined to achieve the expected level of R&D investment because they anticipated the R&D grant as a substitute for private investment. Indeed, this is an unfavourable outcome of the policy initiative. This study shows more positive outcome for fiscal policy in terms of project completion. All firms were able to complete the innovation projects under the CRDF, although MTDC classified them in different categories (i.e. completed on-time and completed delay). This suggests that the CRDF has been implemented in an effective and prudent manner. The selected CRDF recipient firms possess low risk of failure in the proposed innovation projects because they were committed to those projects. Firstly, the CRDF is a partial grant; firms were only being approved for 70 per cent of the total the project cost although the maximum funding is MYR4 million (USD1=MYR3.30). Therefore, the firms needed to come up with the remaining 30 percent of the project cost in form of cash. This is the CRDF's major requirement, although the MTDC has been flexible in enforcing that condition. This structure allows the MTDC to attract firms that are willing to demonstrate their commitment towards completing an innovation project. This finding implicitly concurs with a study by Hobday and Rush (2007) that looks into initiatives by another government (i.e. Government of Thailand) in emerging economies to uplift local firms' technological capabilities. Hobday and Rush's work shows that government policies show best results when directed towards firms that have a positive attitude and commitment towards self-funding aspect of a designated innovation project. Otherwise the risk of failure will be relatively high. Furthermore, a study by Cooper (2003) showed that the matching grant structure can be considered as fund improvement. This is because programmes to support innovation projects are typically seen too generous and carry a bad reputation of being non-selective. This might expose firms for not being accountable for their designated projects.

The above finding also corroborates the views of Hsu and Chiang (2001) whose study looks into government efforts in another emerging economy (i.e. Taiwan) to support R&D activities for the advancement of domestic industrial technology. Their study was based on the basic principle underlying Taiwan's industrial technology development: that the private sector will take the lead in developing and acquiring industrial technologies with the support of and in consultation with government. In fact, the study by Hsu and Chiang (2001) shares the same context with this study: focusing on local firms to commercialise technology. Another thing shared by the context of both studies is that firms participating in sponsored innovation projects are expected to contribute required resources, such as manpower. Unlike the present study, Hsu and Chiang's study appears not to have explored the issue of financial commitment in terms of cash required from participating firms in sponsored innovation projects.

Conversely, the findings of this study shows that the MTDC establishes clear guidelines for 30 per cent financial commitment from the firms. The minimum financial commitment is calculated based on total project cost. For example, the approved CRDF for Industrial 1 was MYR1.6 million and the firm needed to contribute MYR480,000 in cash into the project. This could be considered a significant financial commitment because the firms are small in size and just started building up their sales. Indeed, within the same example, Industrial 1 struggled to come up with the required financial commitment but was trying hard to complete the innovation project. The firm's financial struggle to complete the project persuaded it to take more drastic actions, including holding a series of negotiations with suppliers and regulators. Ultimately, the firm managed to complete the project (i.e. develop and sell aerosol fire suppression) although it exceeded the projects' time period.

Literature on public support for R&D (e.g. Lerner, 1999 and Hall and Maffioli, 2008) usually discusses government policy initiatives in terms of picking winners for dedicated programmes. However, there is also speculation that the screening process in government-backed programmes might be not as well established as funding schemes managed by private investors (Lerner and Kegler, 2000). This study, however, shows that the evaluation process in a government-backed scheme is complex. This study has found out that the MTDC maintains a rigorous and effective screening process to shortlist potential recipients and subsequently to select successful firms for CRDF funding. This finding also suggests that underperforming government backed funding programmes could be strengthened by developing a structured, in-depth and multi-layered screening process to select their recipients. Indeed, this is an important process for government interventions to be constructive to overcome the market failure in commercialisation of indigenous technology (Salmenkaita and Salo, 2002). The finding on the screening process of the CRDF is summarised as per Figure 6-1:

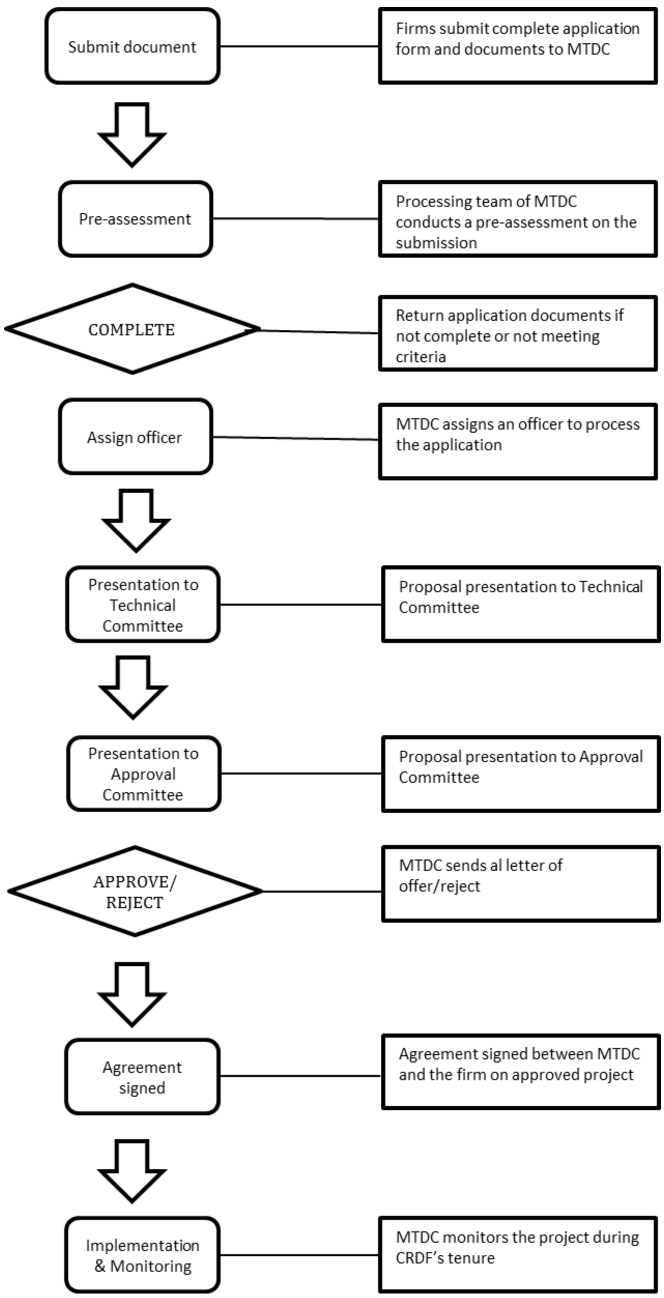

Figure 6-1: CRDF application processing

Note: This figure is extraction of documentary analysis on CRDF application standard operating procedure and interview sessions with MTDC personnel and firms' owners-managers.

The evaluation process was carried out by a dedicated team (i.e. Processing Team of Technology Ventures Division). The team is comprised of qualified executives. For example, the team leader was a trained research engineer in a Japanese multinational company. In the initial stage, each application for the CRDF is examined closely in terms of documentation, technical efficacy and governance. The process involves screening of detailed information about applicant firms including information on the financial condition, operations and human resources. Meanwhile, the technical efficacy of the proposed technology focuses its novelty and market performance projections for the product. For technology novelty, the assessment is dependent on the MTDC executives' experience and technical background in engineering, bio-technology and environmental science. For example, the executives will refer to technical journals to determine the technology's novelty. However, the screening process is not only confined to MTDC's expertise. If the technology is not within the evaluation team expertise, MTDC will appoint independent experts from universities and research institutes to assist with the evaluation of the application. For example, in oil palm technology, MTDC seeks expertise from the MPOB. This process ensures that the proposed technology is correctly deemed as new to the market.

This finding complements and at the same time contrasts with work of Wessner (2008), who also highlighted the importance of carrying out detailed assessment to select potential recipients for government-backed grants. The study by Wessner (2008) investigates effectiveness on Small Business Innovation Research (SBIR), which is quite similar to the CRDF as it allocates funding to firms in order to commercialise research outputs. However, both studies do not share the same context because Wessner's work was conducted in the United States, an advanced developed economy compared to an emerging economy like Malaysia. The findings of the present study show that the CRDF is a narrower programme compared to SBIR because the programme requires firms to have inventions and is also strictly limited to manufacturing products. In contrast, the SBIR's terms of eligibility are much looser as its recipients are allowed to spend funds in more flexible ways. This means, the use of funding by the firms is not only confined to manufacturing related activities but also services, such as registration of intellectual property. Indeed, this finding highlights the substantial difference of innovation support programmes between emerging and developed economies. Despite this difference, the studies have similar findings regarding the dependency of both policy initiatives (i.e. the CRDF and the SBIR) on internal and external reviewers for technology assessment. It means both studies acknowledge that government agencies have limitations in their scope of work and require external expertise for evaluation purposes due to the complexity of the proposed technology. This element is paramount to ensure both policy initiatives are managed in a prudent manner.

6.3 Policy target group

Studies have established that innovation projects are best carried out by an appropriate group of firms (Vohora et al., 2004; Rasmussen, 2008). For Rasmussen (2008) who looks at the Canadian Government's support for universities to commercialise research outputs found that the most suitable candidate is spin-off firms. These firms are normally new start-ups and small in size. In a similar vein, a study by Vohora et al. (2004) which was investigating progress made within innovation projects in universities highlighted that new high-technology ventures in better a position to overcome challenges in innovation projects. Vohara's study shares the same context with a study by Rasmussen (2008) by looking at progress in innovation projects within universities. Both studies are in agreement that such firms involved in innovation projects are most likely to be small in size and managed by technical personnel, such as scientists. Indeed, both studies were conducted in more advanced technological advanced countries (i.e. Canada for Rasmussen (2008) and the United Kingdom for Vohara et al. (2004)) but they both highlight the importance of firm size and special attributes. This is relevant for initiatives involving direct financial support like the CRDF due to the possibility of miss-targeting (Kaufmann and Todtling, 2002). In this sense, the findings of this study support an argument in previous studies (e.g. Rasmussen, 2008 and Vohora et al., 2004) that suggests innovation support programmes should target specific groups. Indeed, evidence from the case studies established that the CRDF has targeted and reached a specific group of firms: small, indigenous and high-technology firms. The firms are also still in operation with some of them becoming fairly profitable.

The findings of this study in terms of firms' attributes corroborate with findings from a Storey and Tether's (1998) study, which suggest that there should be designated support for SMEs in high technology sectors. Storey and Tether (1998) made that conclusion based on a study about direct financial support from national governments of European countries to local firms. In that study, they compare the impact of the policies to small, medium and large local firms that are involved in technology-based business. They recognised that direct financial support should be channelled to NTBFs rather than large firms. This study also suggests the same finding because in Malaysia, small firms that are involved in high-technology sectors are considered as NTBFs (MASTIC, 2014). This study contrasts with Kaufman and Todtling's (2002) study of direct financial innovation support like the CRDF, emphasising that policy initiatives should select superior needy firms but preference should be given to SMEs. Their study focuses on The Austrian Industrial Research Promotion Fund, a programme of direct financial support launched by the Austrian Government for R&D projects to be carried out by local firms. It concentrates on the early phase of the innovation process, i.e. R&D of prototypes. They suggested that there should be a list of problems and challenges for firms to carry out innovation projects. Their suggestion is based on the notion that there can be a mismatch between supports offered and needed, i.e. firms might have other needs than those addressed by policy initiatives. The findings from case studies suggest that the CRDF has targeted the exploitation phase of the innovation process as it emphasises manufacturing activities because for firms and the MTDC, manufacturing is the bottleneck in commercialisation of research. This is the direct impact of the CRDF and this study trying to show that the programme is doing what it supposed to do. In this sense, the programme seems to be efficient. However, this study also highlights that firms also encounter needs other than those addressed by the CRDF. This condition could be explained by the provision in which CRDF is not targeting at the most serious problems constraining firms that try to carry out innovation activities.

At this point, this study extends Kaufmann and Todtling's view because it is almost impossible for policy initiatives to produce an exhaustive list of innovation related needs. Instead, this study extends Storey and Tether's view by highlighting that the CRDF has been targeting and reaching unique small firms: high technology small firms. Firstly, the firms that had conducted research and invested significant amount of resources into that activity before applying for the CRDF[47]. This includes engineering based firms such as Industrial 1 and Industrial 2 that tried to do technological breakthrough by conducting trials, testing and reverse engineering. For other firms, each technology or product formulation had laboratory experiments. That means, the firms have been utilising a proper research infrastructure in order to identify and develop a technological breakthrough. Secondly, these firms were founded and managed by technical personnel such as scientists, engineers and a pharmacist. The managers are deemed to have good technical knowledge about technologies that have been consolidated into finished products. However, there are variation for Industrial 3 and Industrial 5 because these firms were founded and managed by inventors. Yet, the inventors are quite familiar with the research concept (i.e. trials and recombination). Thirdly, the firms were able to come out with commercialisation-ready products by completing pre-commercialisation steps such as unofficial trials for proof of concept and demonstrating that the products work accordance to their specifications. For certain firm such as Bio 1 and

[47] See Chapter 4 (Case Studies) and Chapter 5 (Cross-Case Analysis) of this thesis.

Industrial 2, this was translated into products prototypes which did not require any further adjustment.

The findings of this study also suggest that selecting the appropriate target group might be the decisive element (i.e. small high technology firms) in innovation projects. In reflecting upon the importance of small high technology firms, this finding lends some support to the study by Evangelista et al. (1997) that suggests only a small fraction of small firms innovate although in a general sense small firms are more receptive to change compared to large firms (Hobday and Rush, 2007). This means that there is certainly a type of small and medium sized firms but does not necessarily mean all small firms are high-technology firms. At this point, one primary reason that small firms were seen as the main beneficiaries of this policy initiative because they appear to be underdeveloped in the context of emerging economies like Malaysia (Abdulai, 2004). Besides that, small firms made up the majority of local firms in high technology sectors and this factor motivates Malaysian Government to support them. In addition, due to their flat organisational structure small high technology firms have the required flexibility to deal with technological changes while fulfilling customer needs.

6.4 Impacts (direct and indirect) on the innovation process

Generally, policy initiatives to support innovation have been crafted in such a way to produce certain types of impact to their beneficiaries. The outcomes of such initiatives might exist in different forms due to diverse expectations among stakeholders. There are two common forms of impact that have been identified in this study. The first type of impact is categorised as direct impact, whilst the second is known as indirect impact. The direct impact of the CRDF is related to programme's targets. The impacts of the CRDF funds (i.e. direct and indirect) could be characterised by generic innovation process as shown in Figure 6-2. The figure shows that the impact of the CRDF is happening towards the end of innovation process. The impacts are leaning towards improvement of firms' capabilities for the exploitation phase rather than to the exploration phase of the innovation process. This means that firms' innovation is more related to commercialisation than discovery. This could indicate that latter stage of the innovation process in particular manufacturing is well covered by the CRDF and if firms need support for other activities for exploration (i.e. R&D) and also other activities in the exploitation phase (i.e. marketing) they could need to source it from other policy initiatives).

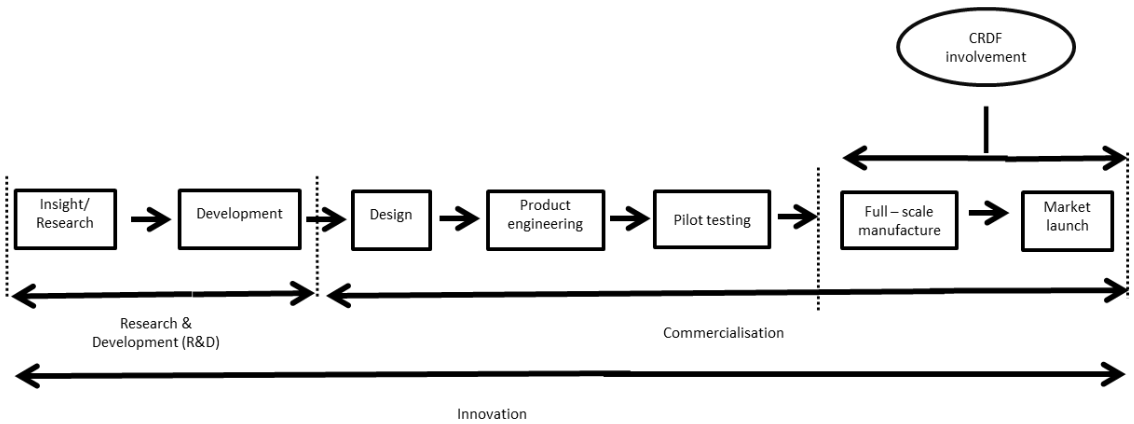

Figure 6-2. Context of the CRDF in a generic of the Innovation Process

Source: Adapted and modified from Smith (2015, p.90)

Direct impact of the CRDF have facilitated firms to fill in gaps in the innovation process essential to this study. The direct impact is related to firms' resource position. That means, the impact is immediate and tangible. In this context, firms were able to acquire objects (i.e. machines and equipment). Besides this direct impact, the study revealed that the CRDF also give indirect impact to firms innovation process. The indirect impact is understood as subsequent impact of firms' resource positioning by unlocking the financial resource from CRDF's funding. Examples of changes in firms' routines and pathways within the innovation process, found in this study are firms' ability to more effectively manage the NPD process allowing them to grow from small to large scale manufacturing. When firms operate at small scale, quality control is more about personal direction compared to more systematic quality control (by using jigs and templates).

The findings of this study suggest that CRDF has provided significant amounts of financial assistance. On average, each firm has received more than MYR1.1 million (USD1=MYR3.30) of CRDF funding. This finding is in agreement with a study by Rasmussen (2008) which suggests quantum of funding to be one of the common policy issues in supporting innovation projects in spin-off companies within universities. In that study, Rasmussen highlights that each government initiatives to support commercialisation provided significant funding to firms (i.e. in between CAD100,000 to CAD 400,000 per annum (USD1=CAD1.39) for a period of three years. This means that, upon completion of the innovation projects, the firms are in line to receive a maximum of more than CAD1 million. This amount is desirable based on anticipated maximum cost to successfully run an innovation project. Another study by Kaufman and Todtling (2002) echoes the same finding as they suggest that the limited financial capacity of SMEs is a widespread problem constraining their innovation activities. They further suggest that firms need most of all venture capital in order to be able to commercialise their inventions, and this is not covered by grants. Both studies conclude that there is no point giving out small sums of money because firms need significant amounts of money to support innovation projects. This study supports this view because this particular case of policy initiative (i.e. the CRDF) has provided significant amount of funding relative to the total cost of innovation projects carried out by the firms. With the significant funding, firms were able to establish proper infrastructure for NPD processes. In addition, the findings of this study show the effectiveness of government funding within start-up and existing firms. The significant amount of financial assistance has enhanced the small high-technology firms' resource position. The resource positioning facilitates firms to seize opportunities in high technology sectors as the immediate outcome of the fund was the acquisition of machines and equipment. Prior to the CRDF funding, firms did not have dedicated machines for production and equipment for testing the product's efficacy. The acquisition of machines allows firms to set up a proper production system that is competent and effective. The production system exists physically and could be recognised visibly. This tangible outcome fits into the firms' plan to cater for market demand by essentially producing products that are desired by customers.

This study also highlights indirect impact of the CRDF. This view is based on evidence of concurrent changes within firms when they started to utilise the machines and equipment. Firms started to develop new capabilities by learning and actually using machines and equipment. These facilities have been utilised to raise firms' production capacity and capabilities by unlocking resources for other steps in the innovation process. Indeed, the firms have been able to remove innovation bottle-necks when they increase the production scale and scope. Once this bottle-neck was removed, the firms might concentrate on other activities necessary to commercialise technology.

In most cases, before receiving the CRDF, firms' production activities were either at laboratory or small scale. This suggests that firms' production activities were dependent on manual and labour intensive processes. Conversely, by having up-to-date machines, the production processes become more automated and less labour intensive. This is certainly the case with one firm (i.e. Industrial 4). The firm was dependent on contract manufacturers for production of hair care products. This means, the firm did not have any industrial scale production capabilities because it was dependent on its laboratory scaled production line. The existence and operation of machines have elevated the firm's status from being a producer of product formulations to become a full-fledged product manufacturer. This has given production capacity to the firm which has influenced its business approach; by being less dependent on contract manufacturers and it became an original equipment manufacturer (OEM) for other merchandisers. Correspondingly, firms were able to uplift their production capabilities into industrial scale production activities and also can appreciate other benefits such as consistent products quality, products' differentiation and economy of scale.

The improvement of the NPD process has indirectly influenced the firms' selling activities in terms of their led product portfolio, distribution channels and market entry. Their proposed products are now visible rather than conceptual. As a result, firms are in a better position to enter into negotiations with potential customers because customers become more convinced about the products. In fact, customers could scrutinise the products compared instead of depending on virtual product conceptualisations. This has provided new and productive experiences to the customers; for example, when firms are willing to give out free products samples to their potential customers. The main enabler was that firms could cover and reduce the production cost per unit by depending more efficient mass production systems. Another possibility would be that firms are able to serve their strategic customers better. This type of customer might place a big and consistent purchase order for products under the CRDF.

Therefore, it is common that firms need to have large scale production capacity in order to seize the opportunity, which the CRDF has enabled. For example, for Industrial 2, its distribution channel has been improved after showing production capacity to fulfil government contracts. The firm has been able to establish a proper distribution channel by appointing smaller independent contractors for the product's installation. This type of distribution channel allows the firm to concentrate more on product improvement and differentiation. The production capacity has also expedited the firm's plan to expand its clientele from government based to private sector.

6.5 Firms have improved capabilities and showed capability for innovation

In government efforts to support innovation, the target group (i.e. local firms) are expected to experience improvement in their resources and also their ability to carry out a NPD process. More importantly this process entails firms' ability to utilise resources and translate them into a set of capabilities. This study shows evidence that firms have experienced improvement in capabilities that are closely related to the innovation process. It means that firms are better at doing innovation and these capabilities are being part of the organisation. Most of the improved capabilities are not in research development (i.e. exploration phase of innovation process) but in capabilities applicable to the exploitation phase of innovation process. This finding implicitly concurs with a study by McKelvie and Davidsson (2009) which has also established the same relationship. However, McKelvie and Davidsson propose a relationship based on discrete capabilities that could be considered independently. Instead, this study identifies the influence of resources to interrelated capabilities to bring high technology products into market. This means, capabilities in the exploitation phase are made up of reciprocal activities such as production, selling and NPD activities.

This study also establishes that in the innovation process, firms were able to utilise the CRDF funds in several ways. For example, the case studies show that firms decided to proceed with products certification in order to uplift the market potential of high-technology products. In the certification process, firms were able to increase their ability to establish external linkages with certification bodies. This could be considered as indirect type of impact of the CRDF because firms managed to proceed with certification after being able to improve their manufacturing activities. This is consistent with a study by Aldridge and Audretsch (2010) that looks at applicability of a R&D fund to innovation projects. However, their findings were rather focused on measuring innovation in terms of spending on research activities that eventually produce intellectual properties such as patents. Thus, the findings of this study complement Aldridge and Audretch's work by highlighting that the key innovation capabilities reside in manufacturing activities, as this seems to be critical for exploitation of the innovation potential. The main rationale for this occasion is that the CRDF recipients are high-technology SMEs. The SMEs are deemed to have significant research capacities because they are being managed by technical personnel such as scientists, engineers and pharmacists. Yet, they are lacking of production facilities, which influences their manufacturing capacities in terms of scale and scope. Now, firms are able to manufacture products at industrial scale and differentiate them as well. The investment in production facilities is timely and reflects firms' judgement in terms of giving their highest priority to the production stage of the innovation process because they have finalised the R&D elements of the products. The investment also reflects the firms consideration to spent the fund within scope of the CRDF which requires tangible expenditure.

The impact of the CRDF funding on firms' innovation process reflects the desirable outcomes of the programme despite government support initiatives have been extensively scrutinised by researchers (Kaufmann and Todtling, 2002). The main argument of Kaufman and Todtling (2002) is on inability for that type of support to reach its target; in this case producing innovation. The findings of this study suggest that the CRDF has been targeting at innovation projects and it has been contributing to firms essentially producing innovation. Therefore, firms were able to upgrade their innovation capabilities because in every case study, firms have used the CRDF funding to improve, enhance and upgrade their innovation capabilities. It means that firms are more capable of commercialising research as the result of direct usage of the CRDF's funding. Innovation within the firms produced new high technology products. The majority of the products are incremental innovation and there is possibly one product leaning towards radical innovation. The incremental innovation entails products that were developed by existing technology and thus are not totally new because they were discovered elsewhere in the world. Furthermore, the discovery of those technologies was not based on scientific and structured techniques. Instead, it was based on continuous testing for improvement of existing products that were available in the market (e.g. Industrial 1 and Industrial 4). In fact, the testing was carried out based on the knowledge and skills of technical employees of that firm (e.g. engineers and inventors). However, this achievement is significant to the firms because they are relatively new to the technology. More importantly, the products have been sold and have reached their target market.

The impacts also explicate the context of the CRDF within firms' innovation process as the CRDF has been involved in the later part of innovation process. This possibility reflects the purpose of Malaysian Government policies to facilitate innovation amongst local firms which includes the CRDF. Figure 6-3 sets the CRDF in the context of financial initiatives to support innovation in Malaysia.

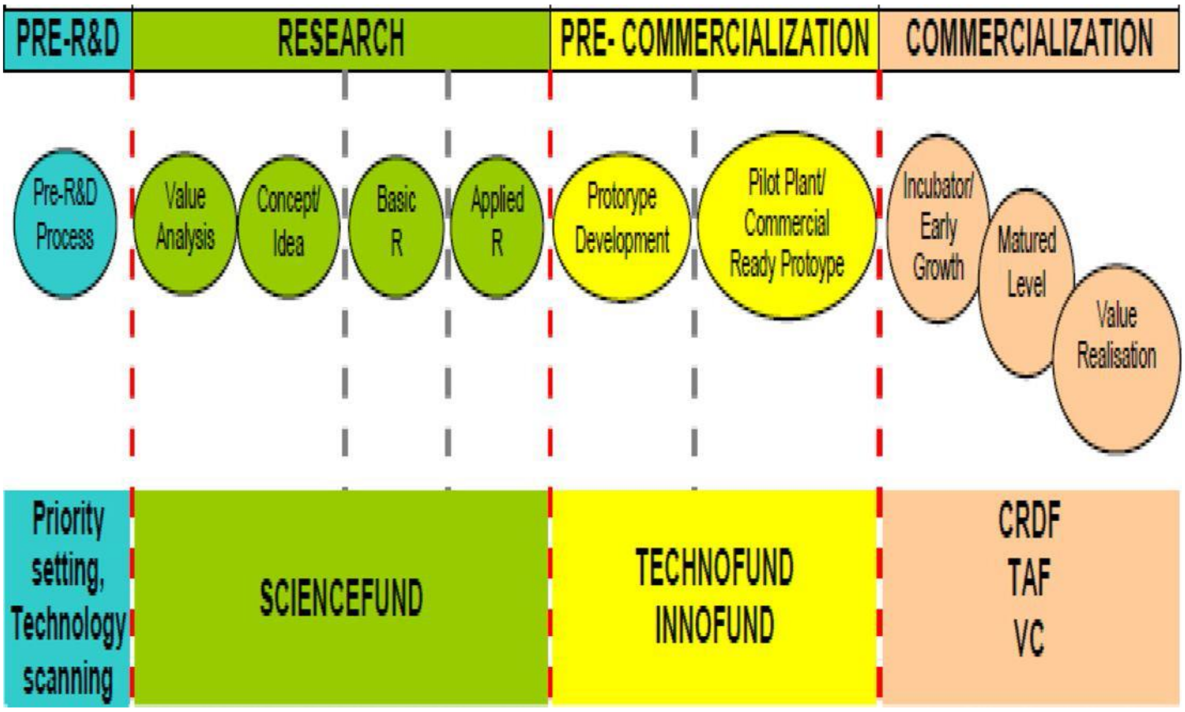

Figure 6-3: The spectrum of R&D funding and commercialisation in Malaysia

Source: This is based on findings of this study and adaptation of Wonglimpiyarat (2011, p.158)

Altogether, there is a definite pattern among the case studies that firms wanted and planned to use funding from the CRDF for production activities. In some respects, it is quite remarkable because there is anticipation that within a financial policy initiative to improve innovation, beneficiaries (i.e. firms) tend to allocate part of fund to research activities (Hall and Lerner, 2010). This is based on the notion that firms might be weak in the early phases of the innovation process. Therefore, it is expected that firms might address their deficiencies in the exploitation phase of the innovation process by investing more in research activities (e.g. employ more scientists or researchers). Correspondingly, findings of this study highlight that CRDF is a programme which is not solely meant to support the entire innovation process. Indeed, the CRDF is a focused programme to support innovation in terms of capacity upgrading. This means firms allocated funds from the CRDF to upgrade their production facilities. By doing this, firms have the ability to manage the manufacturing activities and have extra managerial resources for other activities such as marketing.

This study also shows that, in innovation process, firms are recommended to carry out interrelated tasks such research, production (manufacturing), sales and product improvement (innovation). However, there is also a lot of speculations firms especially small firms possess inadequate resources and capabilities to perform that tasks (Hindle and Yencken, 2004). The inadequacy of resources and capabilities is not surprising because firms that are involved in innovation projects are likely to need development of specific internal capacity in order to make a project successful. In fact, small firms need different types of capabilities to innovate. In the DC framework, Teece (2010) considers these capabilities to be divided into three types of abilities: 1) identification and assessment of opportunities (sensing), 2) mobilisation of resources to address opportunities and capture value from doing so (seizing), 3) reconfiguration of their tangible and intangible assets (transforming). These can be represented by Figure 6-4 below.

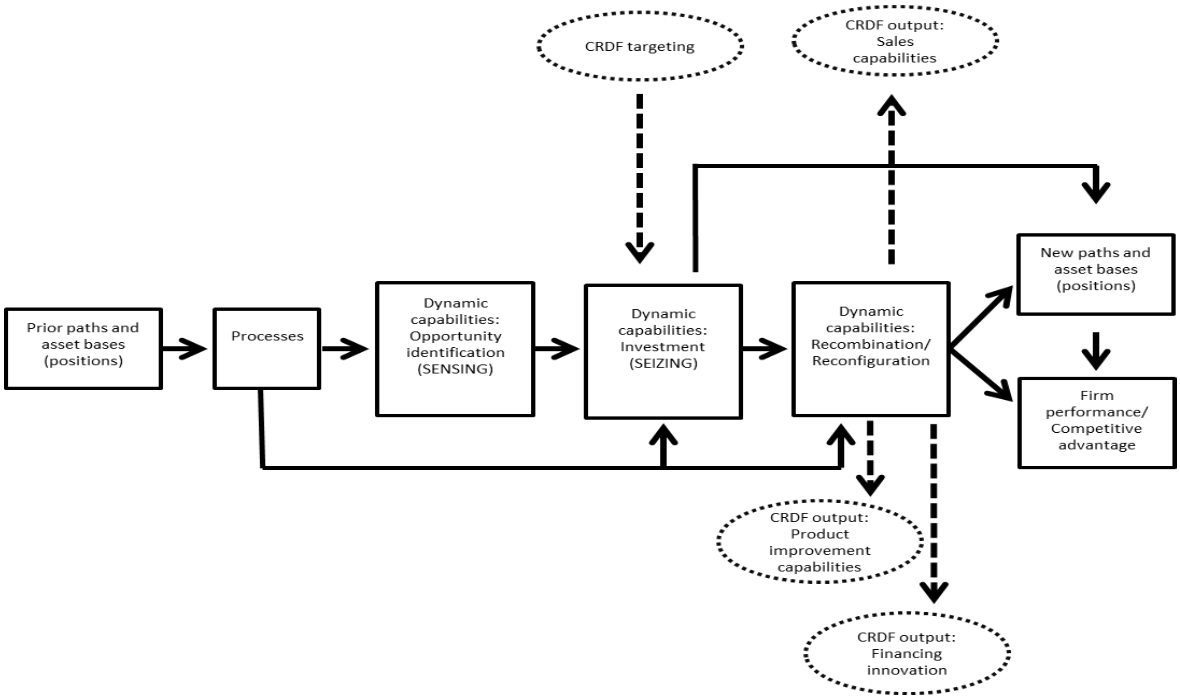

Figure 6-4: CRDF's impact on capabilities

Source: Adapted and modified from Helfat and Peteraf (2009, p.96)

This study also suggests that the CRDF has direct influence on firms' production capabilities, rather than targeting other capabilities applicable in the exploitation phase. This effect was apparent when firms were able to expand their production activities from being small or laboratory scale manufacturers to become industrial scale manufacturers within a short period of time. This finding means the CRDF would be considered as an example of generic resources (e.g. Teece (2010)) because financial resources like the CRDF are easily available and not unique. However, financial resources are clearly vital for small manufacturing based firms like the CRDF recipients to carry out innovation projects. In this type of firm, the opportunity seizing is deeply rooted in the ability to make advancements in production, especially in terms of having more efficient assembly lines and cumulative experience in more advanced production techniques. On its own terms production capabilities result mainly in increased stock pile. However, the interplay with complementing innovation capabilities and activities, it may result in the exploitation of novel opportunities.

Yet, the improvement in selling and product improvement capabilities did not happen in a vacuum although the CRDF is not targeting them. There is evidence that the CRDF removed production hindrance (hurdles). Then, with management competencies, the firms were subsequently able to try new combination of resources to exploit opportunities that exist externally. That means firms were not only able to innovate but they were also better and prepared in dealing with changing environment. The reconfiguration of resources facilitates firms to build on other capabilities for market entry activities (i.e. selling and product improvement). This may create and establish new pathways and resource positions for the firms. For example, the case study of Bio 1 shows that the firm was able to do activities that they could not do before: selling products into new markets and also securing new customers. Indeed, this is a new pathway for Bio 1. This finding is similar to Helfat and Peteraf's (2003) description of a capability. In their study of capabilities life cycle, a capability is viewed as a function of renewal in an original (previous) capability. The finding of the current study tries to expand this by highlighting that firms can develop their dynamic capabilities by reconfiguring resources through external linkages with certification bodies. The linkages entail collaboration with external parties. For example, the case study of Bio 2 suggests that the firm tried to forge collaboration with a national voluntary organisation: Malaysia Liver Foundation. This collaboration was based on the anticipated medical claim for the final products. However, the collaboration was not conclusive because the firm did not finalise products for market entry. One major circumstance emerged that most products from innovation projects need to meet Malaysian pharmaceutical regulations. In fact, this step is paramount in highly regulated industries such as chemical and healthcare. In the regulatory certification process firms were able to put extra efforts into uncovering product weaknesses and faults as their production activities have been intensified through acquisition of machines and equipment using CRDF funding. Firms managed to conduct testing aimed at making sure the products are functional, meet particular standards of particular bodies and are acceptable customers. This is important because in the past, local Malaysian firms have been dependent on foreign multinational companies (MNCs) for quality assurance

6.6 Project's risk profile

In carrying out innovation projects, firms often encounter risky and uncertain situations (Tan, 2001). This is not surprising because innovation in fact is dealing with discovery of new technologies and thus associated with uncertainty. This study tries to explain this issue in terms of CRDF spending by the firms and the market conditions. As discussed before, the CRDF spending in particular has produced tangible outcomes (i.e. acquisition of machines and equipment). The spending coupled with the firms' management competencies have enhanced their NPD capabilities. Most of the consideration is centred on production capabilities. What is more, the spending on production facilities can be considered low risk compared to investment for scientific discovery or clinical trials (Teece, 2010). Indeed, in terms of innovation process, most firms have taken less risky paths to do the innovation by investing their efforts and resources into the exploitation phase of innovation process. Furthermore, firms experienced significant improvement in their sales and product improvement capabilities. However, in this context, the investment in production facilities would not produce higher return in terms of technological breakthrough and novelty compared to investment that goes to research activities (i.e. employ more scientists and acquire of laboratory equipment). For example, Bio 2 invested the CRDF funding into clinical trials to challenge the product's status quo into a drug for liver illness. However, the firm was unable to complete the trials and the funding was halted. This case shows that investment in research (i.e. clinical trials) is much riskier but if it is successful, it would be major contribution to innovation. This is based on the fact that innovation is related towards transformation of uncertainty. Therefore, exploration phase can be considered less risky as firms need to find buyers for their innovation output. With this in mind, the MTDC sets CRDF for exploitation of research outputs which tends to be less risky decision compared to focusing on exploration.

In contrast, Aldridge and Audretsch (2010) found that certain innovation projects within university contexts were advanced through riskier pathways by skipping the endorsed avenues for commercialisation (i.e. through technology transfer office (TTO)). For them, the potential of the technologies might deteriorate due to bias on intellectual properties which is provisioned by the TTO. In fact, certain project takers perceived the bureaucracy of TTO as a boundary and tried to remove it. Whereas, the current study shows the firms did not have that privilege because they are expected to follow the CRDF's process flow. The process flows was based on the assumption that the technology embedded in the products is stagnant, which is not always the case. In fact, the technology itself is an intangible and dynamic element. This element is often associated with risk and uncertainty because it is difficult for either MTDC or firms to spot it. This finding is also applicable within the DC perspective (Teece, 2010) as it suggests that if a support programme is restricted to one function (i.e. manufacturing), there is still spill-over impacts. The support programme removes bottle-neck of manufacturing and frees firm management to do other things.

The difficulty in dealing with uncertainty also highlights potential weaknesses of the CRDF in the exploitation phase of innovation process. This weakness becomes obvious when firms such as Bio 1 try to introduce a new product into a sector of highly regulated products (e.g. bio-insecticide). For this type of product, there are additional important steps in the innovation process that need to be carried out (i.e. product registration and certification with Pesticide Board of Malaysia). This is not surprising because when dealing with potentially dangerous products (i.e. something quite new and different), there is a need for a third party test. However, the test was not covered by the CRDF. It is in the nature of a scheme like the CRDF, that some aspects of the innovation process are very hard to predict. For most other products (i.e. non-highly regulated products), a firm will not encounter this kind of problem. This hindrance has not impeded innovation but it lowering the potential of innovation.

In terms of policy, that sort of investment in production facilities is appropriate to comply with the CRDF guidelines. In this sense, the firms try to be trustworthy in how to spend the funding from the CRDF. Firms have demonstrated a high standard of probity because they have been able to justify the CRDF spending. Furthermore, it is quite common for policies like the CRDF, to have policy makers that are keen to see immediate outcomes (i.e. acquisition of new plants and equipment). Most studies consider the direct impact of funding to be crucial but also possibly controversial because there are still additional steps required to uplift innovation potential (Bruni and Verona, 2009; Guan and Chen, 2010). The findings of this study do not deny this but emphasize that the indirect impact might need equal attention because they have created new paths for the firms. In other words, the direct impact of the policy will not necessarily produce significant change in the firms' innovation process, but, it is interesting to note that the direct impacts, fit into certain part of the firms' plan within an innovation project.

6.7 Conclusion

In conclusion, the findings of this study seem to support, to fit with and complement previous research (e.g. Özcelik and Taymaz, 2008, Hsu and Chiang, 2000, Rasmussen, 2008). Firstly, findings of this study show the implementation of the CRDF in agreement with previous studies in terms of project completion as all the selected CRDF recipients were able to complete the innovation projects up to selling their products in the market. The main justification for this finding is that the MTDC manages the CRDF in a prudent way. MTDC draws clear guidelines for the firms to make 30 per cent financial contribution from the total project costs. In this sense, firms are obligated to the innovation projects under the CRDF. This finding is primarily in agreement with a study by Özcelik and Taymaz (2008) and Rasmussen (2008) and extends the work of Hsu and Chiang (2001) in terms of proposing firms' quantifiable contribution to the proposed projects. MTDC also conducts a proper screening process to select the CRDF recipients. This includes multiple-levels of screening within MTDC (i.e. internal committees) and the personnel involved are knowledgeable about the proposed technology. There is also additional screening processes in terms of technology novelty and in most cases MTDC engages with experts from other institutions (external expertise). This finding in particular complements the work of Wessner (2008) on the SBIR in the United States.

The policy initiative of the CRDF supports innovation process within firms. The CRDF fund is being used to upgrade innovation capabilities of small high technology firms. This is another finding that fits with previous studies such as Aldridge and Audretch (2010) and Hindle and Yencken (2004). This policy has upgraded firms' innovation capabilities in the latter stage of the innovation process. This finding is distinctive with existing studies (e.g. Aldridge and Audretsch, 2010) which tend to find that firms tend to improve their innovation capabilities associated with the exploration stage of the innovation process (firms prone to produce more inventions). The findings of this study clearly show that, in the case of policy like the CRDF in emerging economies, the upgrading of firms' innovation capabilities took place in the exploitation phase of innovation process. In this sense, the findings highlight that this policy initiative tends to apply not to innovation process in general but to the latter end of that process. Indeed, this finding is subject to the design of this study. Previous research like Aldridge and Audretch (2010) focused on the exploration phase and this research focused on the exploitation phase of innovation process.

Meanwhile, this study suggests firms experienced significant improvement in NPD capabilities especially in improvement of external linkages with certification bodies. Initially the case studies show that the funds from the CRDF went specifically to enhancing manufacturing capabilities. However, when this study looks into the case studies in more depth and detail, it was shown that the CRDF facilitates firms' manufacturing capabilities but it also enabled capabilities needed for the NPD process, marketing and certification. This study argues that the CRDF is part of policy initiatives that helps firms to innovate by developing and enhancing their capability to innovate. Therefore, this is more positive than simply enhancing their manufacturing capabilities alone. At the same time the CRDF has also upgraded firms' dynamic capabilities as several firms are in new pathways to do their business activities.

Above all, this study suggests that there are reasons for a policy that tries to improve Malaysian firms' capabilities to innovate in a positive light. It highlights instances and examples of firms in high-technology sectors that are becoming better at carrying out innovation related tasks. This is a considerable achievement because policies to support and enhance firms' innovation capabilities are difficult to formulate and implement. For these reasons, the programme can be deemed a success.

However, the CRDF programme has its weaknesses as it has only been used by small number of firms. In addition, there are some firms that managed to enhance their capabilities but still need to proceed with subsequent steps (e.g. certification process) to uplift the potential of high technology products. Therefore, the CRDF's overall impact is likely to be limited. As with most innovation policies, there are additional steps that could be taken to uplift innovation potential. These steps would demand additional funding and support and they are not necessarily within the current remit of the CRDF programme under the MTDC. They could be sourced from other government agencies or even from the private sector. However, as this programme seems to focus on supporting tangible outcomes, such as acquisition of machines and equipment. This brings its own limitations. For example, it will make firms put excessive concentration into manufacturing activities resulting in distracting firms so that they fail to foresee what is necessary in the whole innovation process. This is particularly pertinent to the targeted firms, i.e. small local firms in emerging economies, which would have basic production facilities, requiring significant development. Indeed, small high technology firms in Malaysia are deficient in manufacturing capabilities. As such the firms managed to organise/upgrade their production facilities from CRDF funding. Furthermore, they could consider manufacturing as a bottleneck that needs to be withdrawn but that should be done with a view of the whole process.

Chapter 7 : CONCLUSION

7.1 Introduction

The purpose of this chapter is to present the conclusions drawn from this research. It starts by reviewing the research question put forward in this study and the objectives of the study. This is followed by the findings of this study in relation to the research question. The following sections (Sections 7.4 and 7.5) respectively, present the contribution of this study and recommendation for further research on the issue of high technology sectors in emerging economies.

7.2 Overview of research

Previous research on the economic development provides useful insights on nature of development and avenues taken by emerging economies. Such studies highlight how governments in emerging economies have played and can play an active role in economic development. In this context, governments have introduced a number of policies that are designed to influence their target groups. Studies have focused on the impact of policies that have been implemented in top-rank emerging economies such as South Korea, Brazil, Taiwan and Singapore (Booth, 1999; Amsden and Tschang, 2003). There is also growing interest among researchers to investigate occurrences in mid-rank emerging economies such as Malaysia, Thailand and Indonesia (Hobday and Rush, 2007; Wonglimpiyarat, 2011). These countries are trying to emulate initiatives taken by top-rank emerging economies that were able to make a leap to become developed economies. However, a review of the literature reveals that little consideration has been given to the impact of dedicated policy initiatives to support high-technology sectors in mid-rank emerging economies like Malaysia. In Malaysia, the government launched the CDRF in 1997 to support the development of high-technology sectors.

The development of high-technology sectors is an important strategy for Malaysia to catch-up technologically with advanced and developed economies. The main rationale is because in the past, Malaysia has been successful in developing its manufacturing based industries in areas like the production of electric and electronics products through FDI. The strategy of FDI resulted in encouraging GDP growth but the country only became an assembly-type hub for MNCs. In this sense, the Malaysian government clearly recognised that if the country wants to develop further to become a fully developed economy, it has to develop high technology sectors to propel the knowledge based economy. Overall, the country needs to develop innovation capabilities for NPD processes within its local firms. This strategy entails the development of indigenous technology which became the focus of the CRDF.

This study seeks to understand the impact of the CRDF on the development of high-technology SMEs in Malaysia. This is a first step into an unexplored and important policy initiative. In particular, it seeks to analyse the objectives of the CRDF and how the beneficiaries utilised the fund within innovation projects. Thus, this thesis seeks to achieve the following specific objectives:

i) to analyse industrial policy and the process of industrialisation in emerging economies
ii) to explore an emerging economy's strategies for promoting high-technology industrialisation through industrial policy
iii) to critically evaluate the effectiveness of a policy initiative in stimulating the high-technology SMEs sectors in an emerging economy

7.3 Summary of key findings and contribution

In terms of the first objective, the findings of this study show that the CRDF is clearly targeted at uplifting firms' innovation capabilities. As such, this government initiative can be considered an example of an industrial policy. This fits into the concept of industrial policies which in turn highlights a government's role to develop industries through industrialisation (Tregena, 2009; Weiss, 2011). In this sense, this study shows that the Malaysian Government has adopted industrial policies for a knowledge based economy. This is based on the fact that this particular policy (i.e. the CRDF) focusing on technological development within small firms. In fact, this study highlights that the CRDF can be considered as a new form of industrial policies as the overall goals of the policies have changed. Previously, Malaysian industrial policies focused on attracting FDI for capital and technology. Recently, Malaysian industrial policies focus on enhancement of small high technology based firms on the ground that these firms were able to develop innovative capabilities through the CRDF. This particular policy of the CRDF focused on high technology sectors, specifically bio-technology and industrial products. Hence, the CRDF is definitely an example of industrial policies because it has contributed to the process of industrialisation by improving and enhancing innovation capabilities in indigenous high technology firms in terms of development of new high technology products. It is a particular type of an industrial policy, one targeted at innovation, high technology sectors and a specific group of local firms. Therefore, this study shows how industrial policies can be used to aid industrialisation.

The second objective of this study is concerned with the exploration of strategies adopted by an emerging economy (i.e. Malaysia) to promote high technology sectors. This objective is concerned with the nature of the strategy (i.e. the CRDF). The major objectives of CRDF are to enhance the competitiveness and capability of Malaysian industrial sectors by: 1) promoting the commercialisation of indigenous technology, 2) accelerating commercialisation of R&D efforts by local universities, public research institutes (PRIs) or companies, and 3) facilitating the development of new products and production processes, and assisting participating companies to increase production capacity (MTDC, 2012). The Malaysian Government is very keen to continuously implementing this policy initiative by increasing the total approved amount of the CRDF from MYR22.21 million (for 2003 to 2005) to MYR285.6 million (for 2006 to 2010) (MASTIC, 2006; MASTIC, 2010). This study shows that the CRDF has provided significant amount of funding for small firms to commercialise research outputs from universities, PRIs and in-house research. This study also shows that with the funding the small firms were able to complete the innovation projects up to selling their products in the market. The main justification for this finding is that the MTDC manages the CRDF in a prudent way. MTDC draws clear guidelines for the firms to make 30 per cent financial contribution from the total project costs. Besides that, the MTDC also conducts a proper screening process to select the CRDF recipients. This includes multiple-levels of screening within MTDC (i.e. internal committees) and the personnel involved are knowledgeable about the proposed technology. There is also additional screening processes in terms of technology novelty and in most cases MTDC engages with experts from other institutions (external expertise).

Another key finding is based on the analysis on the type of firms that the CRDF has been focused on. This notion addresses the third objective of this study. There is substantial evidence in this study that the CRDF is targeted at specific group of firms. This target group is a crucial element in the implementation of policy initiative which involves public money. In this instance, the CRDF has reached firms that possess the following attributes:

- indigenous
- small size
- high technology

This research shows evidence that the CRDF has targeted and reached high technology indigenous SMEs. This is an important insight into the CRDF because SMEs have played an important role in determining Malaysia's technology innovation performance. This type of firm appears to have actively conducted research activities for either technological breakthrough or improvement of existing technology. The firms are then further developing that technology until it can be integrated into finished products. This study also found that the firms are still in operation. This suggests that firms were managing to survive both risk and uncertainty in carrying out innovation projects. The evidence from the case studies shows that tangible products, rather than services, are the major outcome of firms' business activities. This means the assessment could draw on tangible results (i.e. production scale and quantity). In short, the CRDF is not miss-targeting.

This study also found out that there is a definite pattern where firms planned and wanted to utilise the CRDF fund for a NPD process. In some respect, this is surprising because in most cases, there is tendency for policy initiatives aimed at improving innovation to result in, firms allocating the funding into research activities (i.e. in the exploration phase of the innovation process). The main rationale is because firms might face limitations in their research capabilities and it is also the function of the CRDF targets. However, this study offers substantial findings that SMEs in Malaysia are quite good at inventions (discovery of new technology) but they need to improve their capabilities in the later stages of the innovation process that relate to manufacturing and marketing activities.

Under the same objective (i.e. the third objective), this study shows that the CRDF as a major policy initiative works positively in uplifting innovation capabilities among indigenous high-technology firms. There is substantial evidence that a government support programme for high technology sectors within an emerging economy has generated impact of enhancing innovation capabilities in NPD processes. These capabilities are related to manufacturing, selling and product improvement activities within innovation process. The innovation process is meant for development and production of new high technology products. In this sense, there is a possibility that the impact that is related to manufacturing activities is more prevalent because firms and MTDC view the manufacturing elements in terms of scale and scope as the bottleneck in innovation processes. It means that once this obstacle is removed, the high-technology small firms could proceed with other activities such as selling and product improvement activities. In other words, the CRDF has been directly targeted to enhance of firms' manufacturing capabilities but at the same time indirectly addressed other capabilities related to NPD process. These capabilities are particularly relevant in the exploitation phase of the innovation process (i.e. bringing products to the market). This study also revealed that in an ideal world, innovative firms should have a complete set of capabilities. It highlights there are a lot of assumptions on how to make products successful. In this context, this study suggests that the limiting factor is not the production capability. This is because firms are deemed to gain manufacturing capabilities through the CRDF funding. Certain case studies show that a product has under-performed because priority has been given to production rather than other activities such as certification. This is based on the fact that the government programme cannot address all of these capabilities. Therefore, the government programme is doing good things but it could do more in other fields. In fact, this study also found what CRDF can support and could not support.

Besides innovation capabilities, firms were also found to be better able to enhance their dynamic capabilities. This is because firms are better able to respond to the demands of a dynamic and rapidly changing environment. For example, when firms were able to establish external linkages with certification bodies and also their customers. The linkages with certification bodies facilitated firms to establish and meet products' quality assurance standards. This will ensure firms' high technology products meet safety requirements that could increase their commercial value. Similarly, linkages with customers through market research allow firms to sense the latest market demand for particular products. In this sense, this study shows a policy that works remarkably well on the enhancement of innovation capabilities in NPD processes. In the first instance, the money went specifically to enhancing manufacturing capabilities. However, when this study looks into the case studies in more depth and detail, the CRDF did help to enhance manufacturing capabilities but additionally, firms have significantly developed innovation capabilities. This is because, aside from the manufacturing capabilities, firms also managed to develop and enhance their marketing and NPD capabilities. This study argues that the CRDF is a policy that helps firms to innovate. It developed and enhanced firms' capability to innovate. Therefore, this impact can be considered as a spill-over impact of the CRDF along with enhancement of firms manufacturing capabilities within innovation process for production of new high technology products.

7.4 Contribution to knowledge

This research contributes to the existing body of knowledge in several aspects by responding to calls (Storey and Tether, 1998; Hall and Reenen, 2000; Hall and Maffioli, 2008) for greater empirical scrutiny of the innovation support programme in terms of governance and facilitation. The findings present a pattern of how a particular programme like the CRDF works and also places it within a context of emerging economies. The qualitative approach has yielded rich data on how a policy comprising a financial initiative introduced by a government in an emerging economy has been used to enhance the capabilities of indigenous SMEs particularly for innovation. The first aspect of contribution of this study is about emerging economies themselves. Most of the knowledge about technology driven growth strategies for economic development is derived from studies on top-ranking emerging economies like Japan and South Korea (Vogel, 1991; Shin, 2006). Within that, scholars agree that the strategies for economic development have been dependent on government policies to support and facilitate local and large state-owned conglomerates (Amsden, 1989; Vogel, 1991; Jomo and Togo, 2003). These conglomerates have been playing such critical roles in top-ranking emerging economies especially in the development of new and emerging industries such as heavy industries.

In contrast, this study complementing previous studies by providing richer and broader picture of technology driven growth strategies in a mid-ranking emerging economy. This study highlights how in mid-ranking emerging economies, the technology driven strategies are targeting at local and small high technology firms. The CRDF as part of these strategies aims to develop innovation capabilities of these firms for technological upgrading. These firms are indigenous and they are able to develop, produce and sell products which have a high degree of technology content. These firms are being managed by scientists or technical personnel. The small high technology firms are also managed to utilise technical resources such as advanced machines and equipment.

The second aspect is about application of technology driven growth strategies and thus contributes to knowledge about the effectiveness of this policy (i.e. technological upgrading type of policy). In most of strategic management literature, inward looking aspects such as firm strategies, firm activities, managerial competencies and possession of strategic assets have emerged as common competitiveness factors (Barney and Hesterley, 2006; Helfat et al., 2007; Porter, 2008). This study contributes to this set of knowledge by suggesting that in the context of policies for technological upgrading, firms are recommended to develop capabilities that allow them to utilise resources in order to address changing environment. The main argument of dynamic capabilities is firms in emerging economies can spend a lot of resources but if they do not have capabilities to utilise the R&D outputs, there will be limited innovation. This means, firms should have capabilities execute tasks within innovation process. This study shows that firms were able to develop a number of capabilities. Some of these capabilities are in R&D and some are related to other activities such as manufacturing and marketing. Besides R&D capabilities, other capabilities such as production and selling capabilities play a crucial part to improve innovation. These capabilities interact and work together. These capabilities are centred on firms' ability to respond to a changing environment by producing high technology products that meet regulatory requirements as well as customer demand.

The third aspect in based on the impact of policies within firms' innovation processes (Hall and Reenen, 2000; Aldridge and Audretsch, 2010). Existing studies tend to focus upon the impact of this sort of policy on the early stage of the innovation process. The early stage of innovation is known as the exploration stage and firms in this stage tend to concentrate on research activities aimed at technological breakthroughs. In this sense, existing studies found beneficiaries of such policies might experience improvements in research outputs in terms of intellectual property. In relation to this, my study contributes to existing knowledge by highlighting that innovation support programmes also affect the exploitation phase of the innovation process. The impact of this particular programme can be recognised based on firms' improvements in their innovation and dynamic capabilities within the NPD process of innovation. Table 7-1 summarises the impact of the CRDF on firms' capabilities.

Table 7-1: The impact of the CRDF on the firms' capabilities

Capabilities	Elements
New product development	Firms develop and build links with external bodies that carry out products certification processes. This is part of firms' activities to seize opportunities and they managed to do that by offering products that are safe and meet regulatory standards.
Manufacturing	i) Uplifting production scale and scope ii) Improving products quality iii) Efficiency in production
Marketing	Getting more sales through intensified promotions and negotiations with prospective customers

The fourth aspect of contribution to knowledge, this study shows it is feasible to find indigenous high technology firms that are in receipt of the CRDF and use them as series of case studies. This study also shows the potential for researchers to apply case study approach to undertake this type of research. This evidence from the case studies suggests that this approach allows for a process and contextual understanding of richer context of innovation research. The adoption of case study approach under qualitative research is also consistent with the fact that capabilities are process and presents an embedded nature (Verona and Ravasi, 2003). In this sense, this study contributes to existing knowledge by demonstrating the potential value of case studies. In particular the ability to build a detailed picture of the impact of a policy on small firms. It means, with the case study approach, there are opportunities to look inside the firms and at their practices in particular. These techniques will give an in-depth and detailed picture of firms' practices and what they do for innovation.

7.5 Limitation and suggestions for future research

While this study provides fruitful insight into the application of a policy initiative to promote firms' innovation capabilities in the context of emerging economies, it will inevitably have some limitations. The data of this study was collected from a sample of firms involved in only two technology categories (i.e. bio-technology and industrial products). The MTDC established this category based on firms proposed project in their application for the CRDF. In fact, the CRDF covers more than ten categories of technology clusters (e.g. advanced material, agriculture products, alternative energy, automotive and chemical0. This study chose firms that are involved in bio-technology and industrial products because they made up the highest number of the CRDF recipient in between year 2006 and 2010 as they are expected to complete the commercialisation process. During this period (i.e. from 2006 to 2010), the CRDF was awarded to 149 firms with approved grant amounted to MYR285.6 million (USD1=MYR3.08) (MASTIC, 2010). This study has narrowly focused on these categories only. This might lead to limited scope of coverage and might not give the clearest picture about the CRDF. The current study can be developed through an expansion of the research sample in the current policy initiative (i.e. the CRDF). By including firms from other sectors such as advanced material, alternative energy and electric & electronics, a comparative study on the impact of the CRDF could investigated in greater depth. There is an opportunity for a different sample to suggest other findings due to the nature of their business operations. Such expansion of the research sample would contribute to literature in the context of emerging economies.

This research adopts a case study approach which allows the researcher to look at ten firms in detail. However, this approach posits a question about the representativeness of the selected CRDF recipients. There is potential that future studies could proceed with a quantitative study that could perhaps pick up on points that this study raised. It is also desirable for future studies to have more case study research to enhance our knowledge and overcome limitations of a small number of case studies because the intention was to conduct exploratory research. This study uses a qualitative approach in exploring the experiences and perceptions of the selected CRDF recipients about their application the fund to business operations. Nevertheless, this data collection technique is still subject to respondent bias. This bias issue might affect the quality of this research as the respondents were aware that the interviewer was trying to investigate the CRDF, a programme that provided them with financial assistance. The respondents were also aware that they might get additional funding from the MTDC after completing projects under the CRDF. This situation might lead to social desirability effect, in which people tend to respond in ways that makes them look good. However, qualitative approaches are considered as the most appropriate for revealing the effectiveness of the policy initiative (Autio and Klofsten, 1998; Bruni and Verona, 2009). Based on this, it may be useful for future research to consider a mixed-method approach. While the qualitative data helps to increase the understanding of high technology SMEs through their own voices, statistical findings on the other hand would be useful to support recommendations for policy makers.

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APPENDICES

Appendix 1: Interview Guide for MTDC personnel

A) Introduction

1) Interviewer to provide a general introduction about project and research objectives

2) Do you consent to recording the interview for later reference? Note that the information provided is confidential and will only be reported anonymously.

B) Background of the interviewee plus organization

1) May I know your official job title?.

2) How long you have been working with MTDC?

3) What/which part of MTDC you are involved in?

- Policy making – top rank management
- Which department? – Which unit?

4) Would you elaborate about your job routine/description?

- Example of your successful milestone within this organisation
    - What do you mean by that success
    - What influence the success
    - How others see it? – Who see it that way?

C) Direction of Malaysia Technology Development Corporation (MTDC)

1) What are the main objectives of MTDC?

- Guidance – objectives; to promote technology transfer through :
    - i. commercialisation of local research output
    - ii. Acquisition of foreign technology
- How do see MTDC fulfilled that objective? :
    - Agreement signed with knowledge institutions to commercialise the R&D outputs (numbers of agreement)?
    - Is it leading to increase in high technology firm start-up and growth?
- Challenges/hurdles to achieve those objectives?

2) Which particular sectors that MTDC support?

- Why does MTDC support those sectors?
- How do you see role of MTDC's in development of those sector/sectors?

3) What sort of firms that MTDC tries to promote/support?

- Why MTDC supports those sorts of firms?
- What are the MTDC's targets for those firms? - Grow until get listed? / Sales target?
- Targets met? If not, why?

4) Do you have any success story of firm/s graduating from programme/grant under MTDC's purview?

D) Implementation of a policy

1) What are the objectives of CRDF?

2) General information about CRDF (between 2006 -2010):
   - How many applications received? Approved? Rejected – why?
   - Do you think the potential recipients aware about this grant?
   - How about promotion activities?.

3) How do you measure the performance of the CRDF?
   - Number of approval?
   - Amount of grant disbursed?

4) Do you measure the recipients' performance?
   - How? – based on particular elements like sales, technology novelty
   - Frequency?
   - By whom? – top level, operational level staff?. Staff qualification/experience?

5) How do you determine the amount of awarded grants to a particular firm?

6) Can you give examples of any **successful** CRDF projects?

   <u>Prompt</u>
   - Why it is successful? – meet grant agreement target?
   - Who was involved? – any relationship with academic institution
   - What type of business the companies in?

7) Can you give examples of any **unsuccessful/problematic** CRDF projects?

   <u>Prompt</u>
   - Why it was not successful? – Applied extension for grant agreement?
   - What type of business the companies in?
   - What are roles of MTDC in facilitating the problematic CRDF projects?

8) Can you give example of revoked grants?
   - Why the grants were revoked?

9) What is your view on performance of the present grants' recipients?
E) Government assistance for high technology business
1) What your view on government intervention to grow the high technology business in Malaysia? • Is it important? Why is it important? 2) In what way the intervention is working/not working? • Example of successful intervention – (e.g. introduction of support programme / in term of numbers) • Why do you think that intervention is successful?
F) Conclusion
1) Do you have any other comments to make about development of high technology sectors in Malaysia? 2) Thank you for your input.

Appendix 2: Interview guide for firms' personnel

A) Introduction
1) Interviewer to provide a general introduction about project and research objectives 2) Do you consent to recording the interview for later reference? Note that the information provided is confidential and will only be reported anonymously.
B) Background of the interviewee/s
1) Position/s within this company? • Present position • Former positions 2) Could give example of tasks that you have been carried out? 3) For how long you have been with this company? 4) Can you tell about your experiences? • Former attachment with other companies? • Qualification? – Formal/professional
C) Background of the firm
1) When this company was formed? • The company's objectives? • Was the company founded specifically to develop a scientific/technological innovation? • Please describe that innovation /technological breakthrough? 2) How this company was formed? • Start-up • A spin-off from another firm • A spin-off from university/research institute • Buyout • Others 3) What was the companies' owners-managers background? – for example engineering of business background – if engineering, the companies might focus more on technology

4) What is the company's core business?

- How long this company has been involved in this type of business?
- Was it evolved since the company inception? Why it evolved?
- How this company's discover this business opportunity?

5) Could you classify this company?. Primarily as manufacturing firm / producing services firm / R&D laboratories / others – explain?

6) Have you upgraded, modified or developed new technologies in the last years? When ? What did you do?

- New products
- New product specification
- New processes

7) Can you describe your customers/potential customers?

- What proportion of domestic/international?
- What portion of large/small size organization?
- What is the customers' industry sector?
- Do you sell to consumer/industry market?
-

D) Capabilities

1) Can you give example any project that was successfully carried out by the company?

2) How did the company discover this opportunity?

- After discovering the opportunity, what the next steps taken place?
- What were incorporated in the next steps?

3) Can you describe the challenges in the implementation?

- How do the company overcome that challenges?
- What are the rationales?
- Impact to the company?
- Seeking assistance to overcome? – From whom?

4) What are the company's strengths in implementing that project?

- How did the company recognize the strengths?
- What the sources of those strengths?
- How the strengths evolved overtime?
- How do the company improve them?

5) How about weaknesses?

- How did the company discover the weaknesses?

- How they evolved overtime?
- Any improvement? – How did this companies improved?
    - More investment? – In what?
    - Seeking assistance – from whom?

6) How does this company carry out **manufacturing activities**? – Ascertain the detail

    Prompt/Guide:
    - How do you organise that activity?
    - Who does it? - Team? Team composition?
    - What is your capital expenditure? Expenditure on what? – new machineries/new plant?
    - How much you spend on training?
    - What new process have you introduced (product innovation)? New product methods (process innovation)?
    - Flexibility? Customization?
    - How that activity evolved? – additional machineries

7) How does this company carry out **research and development**?

    Prompt/Guide:
    - How do you organise that activity? – collaboration with universities/acquisition of pattern
    - Who does it? – Qualification/experience of that personnel/team?
    - Where do you get the expertise from?
    - How (and when) the research and development activities evolved?

8) How this company does carries out **marketing and selling activities**?

    Prompt/Guide:
    - How do you organise that activity? – Having separate marketing function/ distribution network
    - Who handle the sales? - Qualification/experience of that personnel/team
    - How do you monitor situation of the market?
    - How this companies proceeds with this activity? - exhibition/door-to-door/marketing agent
    - How much allocated marketing budget? – Advertising- promotion?
    - How do you proceed with market research? – who is your customer? Do you record them?
    - How (and when) the marketing activity has been developed?

9) How does this company carry out **procurement activities**? [In literature known as resource allocation/resource exploitation]

    Prompt/Guide:
    - How do you ensure sufficient capital/technology for company's operation?

- Who is responsible for this activity? – What kind person: qualification/experience
- How (and when) the procurement activity has been developed? -

E) Product and Technology

1) Can you give an example of a successful product/s of this company?
   - What make the product/s successful?
     - Having narrow range of application
     - Having wide range of application
2) How many new products that you introduced (product portfolio)? – innovation capabilities
3)

F) Provision of grants - CRDF

1) How do you get to know the CRDF?

2) Why do you choose to apply for CRDF from MTDC? Did you try to get money from somewhere else?

3) The product development progress. When was awarded with CRDF, which stage was the company? –
   - Still conducting research
   - Ready with prototype
   - Filing for patent
   - Trials

   How about now?

4) Could you recall the application process? – in term of time taken for money to be disbursed after the grant was approved

5) What are the advantages and disadvantages being under this programme?

6) Do you think this company still could be succeeding without the CRDF?

7) How the CRDF project has been influenced the company core activities (relates to answer in Section B)?

8) Do you see any room of improvement to this grant? Why?

9) Are you planning to apply more grants from MTDC?

G) Programme performance assessment

1) Does the company have a strategy for proposing to CRDF?

2) If any, what would you like to change about the CRDF application process?

3) Could you describe how CRDF affected development of the company's technological base or capabilities? [manufacturing, R&D, marketing and innovation]
   - What can the company done that you think it would not be able to do without CRDF?
   - Describe how your firm would likely be different today, had there been no CRDF?

4) Do you need to undergo performance review by the MTDC?
   - How frequent?
   - By whom?
   - Did you receive feedback from the review process, how useful was it?
   - Comments on that

5) What do you see as the strength of the CRDF programme?

6) What do you see the weakness of the CRDF programme?

7) If you could change the CRDF programme, what changes would you make?

8) In the absence of this CRDF, would this company have undertaken this project?

H) Conclusion

1) How do you think the provision of the financial assistance could be further enhanced to better meet your needs?

2) Thank you for your input.

Appendix 3: Participation information sheet

NOTTINGHAM TRENT UNIVERSITY

RESEARCH PROJECT SUMMARY

Title: An analysis of technology-driven growth strategies in an emerging economy: A case study of Malaysia

What is the research project about?

This research project focuses on the role of the Malaysia Technology Development Corporation (MTDC) in supporting high-technology firms to improve their innovation performance.

It is looking in particular at the part played by Commercialisation of Research and Development Fund (CRDF) in supporting and assisting small and medium firms in high technology sectors. This research project tries to raise the need for supporting and finding ways to improve innovation performance.

Aims of the research

This research aims to analyse the effectiveness of initiatives put forward by the MTDC. This research project is hoping to discover the value of initiatives like the CRDF in helping small and medium firms develop their technology capabilities.

Who is running this study?

This research is being undertaken by Dzulkifli Mukhtar as the main researcher. Mr Dzulkifli is a PhD candidate at Nottingham Trent University (NTU), United Kingdom and a lecturer at Faculty of Entrepreneurship & Business, University Malaysia Kelantan. The research is fully supervised by the Nottingham Business School NTU and two supervisors, Dr. Michael Ehret and by Professor David Smith.

What will the company's participation involve?

Face to face interviews

Participants in this research will entail about forty-five minutes to an hour of your time to discuss your views and experience about the impact and application of CRDF and the role that your believe it plays in your organization. By agreeing to this interview process, you will enable me to gather data about the effectiveness of this initiative and provide deeper insight into how the CRDF is perceived as tool to achieve the Malaysian government's goals within high-technology sectors.

What will happen to the data?

I ensure confidentiality and anonymity. To ensure this, interviews which will be recorded with a digital dictaphone and will only be handled by the researcher and will be reviewed only at the university while maintaining strict adherence to data protection principles. All the data will be anonymised.

The hard copies of interview transcripts will be kept in a locked filing cabinet at the university. Electronic data pertaining to transcripts, notes and findings resulting from the interview process will be stored securely on the Nottingham Trent University computer system and only accessed via my password. Please note that this research is exploratory and not sector/industry specific. All information that might identify your organisation will be removed. The data will be destroyed on completion of the project.

What will happen to the results?

The results will be used in producing a PhD thesis by the main researcher and the supervisory team. It is further anticipated that several research papers will be published only in relevant academic journals based on the data collected by the researcher.

How can I find out more about this project and its results?

I will send a copy of the executive summary to all my research participants, so you will be able to read about my findings.

Contacts for further information

Please feel very welcome to contact the main researcher further information, at the following address:

Researcher:

Dzulkifli Mukhtar

Graduate School

Room 4714, Chaucer

Nottingham Trent University

Nottingham

NG1 4BU

United Kingdom

Email: dzulkifli.mukhtar2010@my.ntu.uk

Telephone: +447427660878

Researcher's Academic Supervisor:

i) **Dr. Michael Ehret**

E-mail: *michael.ehret @ntu.ac.uk*

ii) **Prof. David Smith**

E-mail: *david.smith02@ntu.ac.uk*

Appendix 4: Participation consent form

NOTTINGHAM TRENT UNIVERSITY

An analysis of technology-driven growth strategies in an emerging economy

CONSENT FORM FOR AN INTERVIEW SESSION

Name of respondent:

Please the following statements this research project.

1. I confirm that the purpose of this project has been explained to me, that I have been given information about it in writing, and that I have had the opportunity to ask questions about the research.

2. I understand that my participation is voluntary, and that I am free to withdraw at any time without giving any reason and without any implications for my legal rights.

3. I give permission for the interview to be tape-recorded by the researcher, on the understanding that the tape will be destroyed at the end of the project.

4. That I have the right to request the withdrawal of any information that has been collected from this site until the PhD final write-up commences in January 2015

5. I have the right to request to see the end product of this research

Therefore:

☐ **I wish to participate in this research project**

☐ **I do not want to participate in this research project**

Signed: Date:__________

I have explained the above and answered all questions asked by the participant:

Signed: [Researcher] Date:__________

Appendix 5: Example of an invitation letter for a firm

MTDC

Level 8 & 9, Menara Yayasan Tun Razak,
Jalan Bukit Bintang
55100 Kuala Lumpur, Malaysia
Phone : +603 - 2172 6000
Fax : +603 - 2163 7542 / 3 / 4 / 5
Website : www.mtdc.com.my

10th October 2013

Malaysian Agri Hi-Tech Sdn Bhd
Headquarters & Administration Office
No. 29, Jalan Impian Putra 1/4,
Taman Impian Putra,
43600 Bangi, Selangor,
Malaysia.

Tel : 03-8925 8681
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Dear Sir,

AN INVITATION TO PARTICIPATE IN A RESEARCH PROJECT

As part of our continuous effort to improve our services, MTDC has sanctioned a few researches to be conducted on the performance of grant recipients.

A research titled, "**An analysis of technology-driven growth strategies in emerging economies: A case study of Malaysia**" will be carried out by Encik Dzulkifli Mokhtar, a doctoral candidate from Nottingham Trent University, United kingdom.

In this regards, we are pleased to inform you that your company has been selected to participate in the exercise.

Encik Dzulkifli Mokhtar will be contact you soon. If you have any concerns or queries, please do contact Suhairi Samad at 03 2172 6039.

Thank You.

Yours sincerely,

MALAYSIAN TECHNOLOGY DEVELOPMENT CORPORATION
Dato' Norhalim Yunus
Chief Executive Officer

MALAYSIAN TECHNOLOGY DEVELOPMENT CORPORATION SDN BHD (235796-U)
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