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APPLYING HUMAN RESOURCE DEVELOPMENT STRATEGIES TO INNOVATION SPEED IN MALAYSIAN BIOTECHNOLOGY INDUSTRY

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By

SHABNAM HAMDI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctoral of Philosophy

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This thesis is dedicated to “my lovely father and mother”

Abstract of thesis presented to the Senate, of Universiti Putra Malaysia in fulfilment of the requirement of the Degree of Doctor of Philosophy

APPLYING HUMAN RESOURCE DEVELOPMENT STRATEGIES TO INNOVATION SPEED IN MALAYSIAN BIOTECHNOLOGY INDUSTRY

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July 2015

Chair : Professor Abu Daud Silong, PhD
Faculty : Educational Studies

This study investigates human resource development strategies to innovation speed in biotechnology industry in Malaysia. In line with the objectives, the thesis investigates strategies and capabilities (top management, and clarity of goals, skills and experience) as well as environmental factors (market and technology uncertainty) that effect innovation speed. Certainly, the new product success guarantees the survival of industry. Hence, choosing the best source of technology and managing complexities and quality is a major challenge that requires proper strategies to facilitate innovative products. To help overcome these challenges, this study examines the important role of technology sourcing strategies including, internal and external sourcing. Moreover, the roles of primary stakeholders, including government, university, supplier, and client on innovation speed is also assessed. To achieve these objectives, the study utilizes innovation speed theory combined with a number of complimentary theories, including contingency theory, resource-based view, knowledge-based view, and theory of stakeholder network influence.

A total of 227 completed questionnaires were collected from 147 biotech companies across Malaysia. A series of statistical analysis were performed to achieve research goals. The gathered data were analyzed using confirmatory factor analysis (CFA), and structural equation modeling (SEM), and logistic regression analysis using Excel, SPSS and AMOS 21.

The result supported the important role of speed-based strategy and staff related capabilities to accelerate innovation speed, when technology and market uncertainty are moderated. Additional findings revealed that, increasing quality of product in terms of customer taste and needs would increase the speed of product development. This effect increases when highly complex products are externalized. The findings also revealed that the key stakeholders, including university, supplier and client were important for innovation speed. However government's contribution to innovation speed was lower in comparison to other stakeholders. Additionally, university followed by supplier played key role in accelerating highly complex products.

This study has developed a series of theoretical contribution in field of strategic

management of new product development (NPD). This study fill the gaps of the theoretical framework by adding contingency theory of uncertainties, resource-base and knowledge base view, and network theory of stakeholder to the under-developed theory of innovation speed. Additionally, practical contribution supply a road map for the managers to set up time-based strategies by applying human resource elements such as organizational learning, knowledge-based strategies to develop an innovative product. The overall research results led to the advancement of a fresh model of speed-based sourcing in product complexity (SBSPC) to aid managers and organizations in their new product development strategies.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

MEGAPLIKASIKAN STRATEGI PEMBANGUNAN SUMBER MANUSIA KE ATAS KEPANTASAN INOVASI INDUSTRI BIOTEKNOLOGI DI MALAYSIA

Oleh

SHABNAM HAMDI

Julai 2015

Pengerusi : Profossor Abu Daud Silong, PhD
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Kajian ini untuk mengkaji strategi pembangunan sumber manusia ke atas kepantasan inovasi industri bioteknologi di Malaysia. Selaras dengan objektif kajian, tesis ini mengkaji strategi dan keupayaan (pengurusan atasan dan kejelasan matlamat, kemahiran dan pengalaman) serta faktor persekitaran (pasaran dan teknologi ketidakpastian) yang memberi kesan kepada kepantasan inovasi. Pastinya, kejayaan produk baru menjamin kelangsungan hidup industri. Oleh itu, memilih sumber terbaik daripada teknologi dan menguruskan kerumitan dan kualiti produk merupakan cabaran utama yang memerlukan strategi yang bersesuaian untuk melancarkan inovasi produk. Bagi mengatasi cabaran-cabaran tersebut, kajian ini meneliti peranan penting strategi sumber teknologi termasuk sumber dalaman dan luaran. Selain itu, peranan pihak yang berkepentingan di dalam melancarkan kepantasan inovasi termasuk kerajaan, universiti, pembekal dan pelanggan turut dikaji. Bagi mencapai objektif tersebut, kajian ini menggunakan teori kepantasan inovasi yang digabungkan dengan beberapa teori pelengkap yang lain, termasuk teori kontigensi, pandangan berasaskan sumber, pandangan berasaskan pengetahuan, dan teori rangkaian pihak berkepentingan.

Sebanyak 227 borang soal selidik telah dikumpul daripada 147 syarikat bioteknologi di seluruh Malaysia. Beberapa siri analisis statistik telah dijalankan unutk mencapai objektif-objektif kajian. Data yang dikumpul telah dianalisis dengan menggunakan "Confirmatory Factor Analysis" (CFA), "Structural Equation Modelling" (SEM) dan analisis regrasi logistik dengan menggunakan perisian Microsoft Excel, SPSS dan AMOS versi 21.

Hasil dapatan menyokong peranan penting strategi yang berasaskan-kepantasan dan keupayaan kakitangan untuk memacu kepantasan inovasi, apabila teknologi dan ketidakpastian pasaran adalah sebagai faktor penyederhanaan. Dapatan tambahan mendedahkan bahawa peningkatan kualiti produk dari segi citarasa dan kehendak pengguna akan meningkatkan kepantasan pembangunan produk. Kesan tersebut akan semakin ketara apabila produk yang sangat kompleks dihasilkan. Hasil kajian turut menunjukkan bahawa pihak berkepentingan termasuk universiti, pembekal dan pengguna adalah sangat penting dalam kepantasan inovasi produk. Namun begitu,

sumbangan kerajaan terhadap kepantasan inovasi adalah rendah berbanding dengan pihak berkepentingan yang lain. Didapati juga bahawa, peranan penting universiti diikuti pembekal memacu produk yang lebih kompleks.

Kajian ini telah membangunkan satu siri sumbangan teoritikal di dalam bidang pengurusan strategik iaitu pembangunan produk baru (NDP). Kajian ini telah melengkapkan jurang kerangka teoritikal yang wujud dengan menambah teori kontigensi, pandangan berasaskan sumber dan pengetahuan, dan teori rangkaian pihak berkepentingan kepada teori kepantasan inovasi yang kurang dibangunkan. Dari sudut praktikalitinya, kajian ini telah menyumbang satu peta kerja (a map road) kepada para pengurus untuk menyusun strategi berasaskan-masa dengan mengaplikasikan elemen-elemen sumber manusia seperti, pembangunan organisasi dan strategi berasaskan pengetahuan untuk membangunkan produk yang berinovatif. Secara keseluruhan, dapatan kajian ini telah merintis kemajuan didalam pembangunan satu model baru yang bersumberkan SBSPC (Sumber berasaskan-kepantasan di dalam kompleksiti produk) untuk membantu para pengurus dan organisasi di dalam pembangunan strategi produk baru mereka.

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"Time-based competition will be the rule of the day"

- Tyson 1997

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Finally, thanks to my lovely friends and all those who have helped me with my work and those who have been more than a help but a joy throughout my graduate program that made this work a success.

I certify that a Thesis Examination Committee has met on 31 July 2015 to conduct the final examination of Shabnam Hamdi on her thesis entitled "Applying Human Resource Development Strategies to Innovation Speed in Malaysian Biotechnology Industry" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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Declaration by graduate student

I hereby confirm that:

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Declaration by Members of Supervisory Committee

This is to confirm that:

¶ the research conducted and the writing of this thesis was under our supervision;

¶ supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

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Name of Chairman of Supervisory Committee: Prof. Abu Daud Silong

Signature _____
Name of Member of Supervisory Committee: Dr. Zoharah Binti Omar

Signature _____
Name of Member of Supervisory Committee: Dr. Roziah Mohd Rasdi

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LIST OF ABBREVIATIONS

10MP	Tenth Malaysian Plan
AMOS	Analysis of Moment Structures
AVE	Average Variance Extracted
BiotechCorp	Biotechnology Corporation
CFA	Confirmatory Factor Analysis
CFI	Comparative fit index
DV	Dependent variable
HRD	Human Resource and Development
HMR	Hierarchical Moderated Regression
IPRs	Intellectual Property Rules
IV	Independent variable
KBV	Knowledge-based View
MOSTI	Ministry of Science and technology and innovation
MSV	Maximum Shared Variance
NBP	National Biotechnology Policy
NPD	New product development
PCA	Principle Component Analysis
R&D	Research and Development
RMSEA	Root-mean square error of approximation
RBV	Resource-based View
SEM	Structural Equation Modeling
SMEs	Small & Medium Enterprises
SPSS	Statistical Product and Service Solutions
SBSSPC	Speed-based Sourcing Strategy in Product Complexity
SRMR	Standardized root-mean square residual
SHRM	Strategic Human Resource Management
NTBFs	New Technology-based Firms
IPR	Intellectual Property Rights

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The time between an initial discovery and its commercialization is defined as innovation speed (Kessler and Chakrabarti, 1996). Innovation speed was also reffered to a key capability when combined with core processes enables competative advantage (Markman, Gianiodis, Phan, & Balkin, 2005). The integration of speed-based strategies and staff-related capabilities is the key to product innovation and success (Kessler and Chakrabarti, 1996). Reducing R&D cycle and time to market to enable competitive advantage heavily depend on HRD practices such as staff-related skills and experience. To this view, scholars have suggested strategic linkage of HRD and business to enable project and organizational performance and success (Swanson, 2001; Swanson, Holton, & Holton, 2001).

Moreover, business strategy is at the center of all HRD efforts (Davis, Naughton, & Rothwell, 2004). Hence, the HRD strategy should be in line with the requirements of the business strategy to shape the future of the business to meet organizational goals (Tsai & Huang, 2008). The HRD application is applicable to all industries and organizations where human are an unavoidable resource. This includes new product development (NPD) projects that are essential to enterprises' mission and survival. In fact NPD injects lifeblood to the industries and organizations in today's competitive marketplace. Therefore, effective implementation of strategies and utilization of resources and capabilities is important to maintain the enterprises' lifeblood (NPD).

This whole process cycle of innovation speed in NPD involves environmental uncertainties and complexities. These elements force organizations to shape their structures and strategies to better deal with realities (Chen, Reilly, & Lynn, 2005). Another important factor in enterprises survival and performance is to reach consumers before competition. As stated by Tyson (1997, p. 64) in his book entitled "*Competition in the 21st Century*" , "Time-based competition will be the rule of the day" (p. 64). Being first to market provides organizations with unique positioning and sets of competitive advantages over the competition. One way of achieving this is, through fast and speedy product development process, which organizations face a great deal of challenges to speed up their new product development process (Birnbaum-More, 1993). Researchers have stressed that the success of a new product and technology depends on how fast it moves from idea to commercialization (Abbie, 2002; Kessler & Chakrabarti, 1996). However, it does not mean companies should scarify quality or ignore important procedures in developing new products in order to reach market before competition (Calantone, Schmidt, & Benedetto, 1997; Gupta & Souder, 1998). Likewise, "being fast does not mean being out of breath, it means being smart" (Jennings & Haughton, 2002, p. 3). Undoubtedly, reducing new product development lifecycle is an essential

factor for some industries such as biotechnology sector, which is divided by the rapid-change in new sciences and discoveries.

The biotechnology industry is an emerging and fast-growing industry with high potential impact on social and economic development (Zucker, Darby, & Armstrong, 2002). This field of industry is considered to be the most research-based segment (Hine & Kapeleris, 2006) and science-led industry in today's competitive global market (Abbie, 2002; Champion, 2001). Being faster than competitors for biotechnology research providers is a great advantage. Therefore, shortening NPD and commercialization timeline to introduce an innovative product to the global marketplace is believed to be an important factor for many biotech firms' survival and further gains.

1.2 Biotechnology in Malaysia

Biotechnology is a type of industry that can leverage the strength and boost the economic growth of a country. It is thought as an engine that can move a country forward. As part of the 2020 vision, the Malaysia's biotechnology is projected to reach the global market. Being one of the world's biotechnology hubs is the plan of Malaysian government. To achieve this objective, the efforts of the Malaysian Government were focused on the foundation and establishment of the new biotech firms across the country aligned with the Eighth Malaysia Plan 2001-2005.

The first step towards the implementation of the plan was achieved during 2001 by approving a budget of RM95.3 Million for National Biotechnology Directorate to initiate 47 biotechnology projects. In 2005, National Biotechnology Policy (NBP) (MOSTI, 2011) was launched to utilize and deploy county's resources to a more structured approach to take biotechnology industry forward. Aligned with the policy Malaysian Biotechnology Corporation (BiotechCorp) was established under the direction of Ministry of Science, Technology and Innovation in 2005, to ensure the smooth implementation and achievement of the NBP's entitled milestones. Biotech Corp is the main agency to develop and support nation's biotechnology firms (Malaysia, 2001). Later, the Government of Malaysia developed and initiated the Biotechnology Master Plan 2005 - 2020 to achieve its objectives. Table1-1 illustrates the BMP objectives.

Table 1-1 Biotechnology Master Plan (2005-2020)

Key indicators (BioNexus Statuse Companies)	Targets				Achievement in 2005-2011
	Phase I 2005-2010	Phase II 2011-2015	Phase III 2016-2020	Total 2005-2020	
Contribution to GDP	2.5%	4%	5%	5%	2.2%
Number of BioNexus Status Companies	25	25	50	100	210
Employment	40,000	80,000	160,000	280,000	55,904
Annual Revenue	RM20 billion	RM80 billion	RM170 billion	RM270 billion	RM14.2 billion

(Source: BIOTECHCORP, 2011)

For the 9th Plan period of 2006-2010, the policy makers had recognized that the efforts must be concentrated on innovativeness and technology development to achieve and maintain the regional leadership positions. Further with the recognition and in order to prepare the country for greater challenges ahead and remain competitive, the biotechnology commercialization fund amounting RM100 million was allocated to improve the performance of R&D companies and establishment of in-house R&D centers (Malaysia, 2006). The following figure illustrates the projected Biotech achievements between 2005 and 2020 (Figur1-1; Figur1-2):

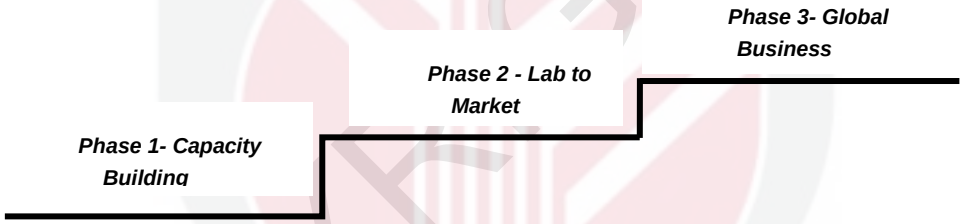

Figure 1-1 Biotechnology Master Plan (2005-2020)

(Source: Malaysia, 2010, p. 66)

In the 10th MP (Tenth Malaysian Plan), the government understands the role of higher educational institutions as facilitators that can push forward the biotechnology industry. The academia and experts in various fields of science were attracted to cooperate with the government and share knowledge and create new ideas. Aligned with the plan a special unit under the Prime Minister's Office was tasked to support "national innovation system and innovation policies and strategies". Figure 1-3 shows the "institutional structure supporting innovation and R&D" which was constructed by the Prime Minister's Office to support innovativeness in Malaysia (Government., 2010, p. 87).

Later, in 2013 a research grant of RM54.6 million for 238 biotechnology projects was approved under the ScienceFund. An additional RM27.8 million was approved for 13 projects under the pre-commercialisation stage. In line the Bioeconomy Transformation Program (BTP) was initiated by the Federal Government to maximize the chances of biotech product commercialization. The BTP's objective is to ensure generation of a

gross national income of RM3.6 billion by 2020 (Ahmad & Farley, 2013).

Figure 1-2 Biotechnology Master Plan (2005-2020)
(Source: Malaysia, 2010, p. 66)

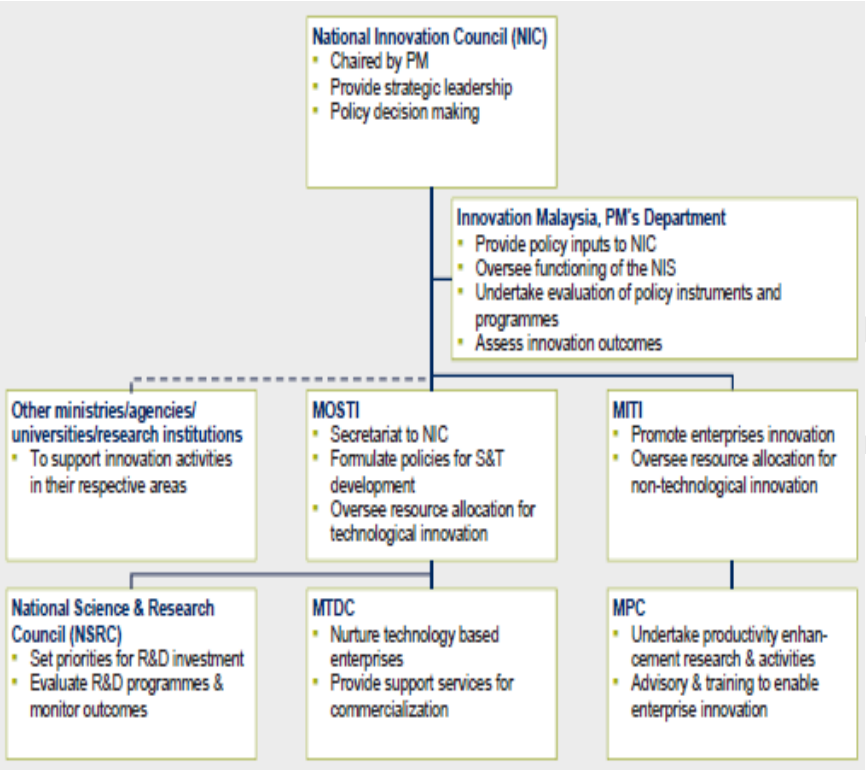

Figure 1-3 Institutional structure supporting innovation and R&D

(Source: Tenth Malaysia Plan, 2011-2015, p.85)

However, according to the reports "Malaysia's biotechnology industry suffers from the lack of quality, high-level skills and managerial capabilities" (MOSTI, 2011a, p.158). A number of researchers have also identified the lack of managerial capabilities and skilled research teams with technical know-how and commercial expertise as a major deficiency (Batterham, 2000; MOSTI, 2011a; Sainsbury, 2002). This is mainly due to Malaysia's biotech industry being relatively young, and dominant by Small & Medium Enterprises (SMEs) that dearth the necessary capabilities and expertise to develop advanced and complex products (ACCCIM, 2012).

According to the statistics the number of biotech firms has increased from 176 in 2010 (BIOTECHCORP, 2010a), to 188 in 2011 (MOSTI, 2011b). Out of all, 90 percent of the firms employ less than 50 employees and only three of them have more than 250 employees (Figure 1-4). However, the majority of these biotech industries have recently started the establishment of in-house R&D departments (ACCCIM, 2012; BIOTECHCORP, 2010a).

Figure 1-4 Biotechnology firms by size

(Source: BIOTEK, 2010, p.41)

These reports indicate that the Malaysian biotechnology firms are still in the first stage of development in a number of products that are expected to launch within the next few years (Figure1-5). This may lead Malaysian biotech companies to externalize science, technology and development of new products in order to conduct faster product development and introduce quality products to the market in a shorter period of time. These sets of activities are usually combined with in-house sourcing.

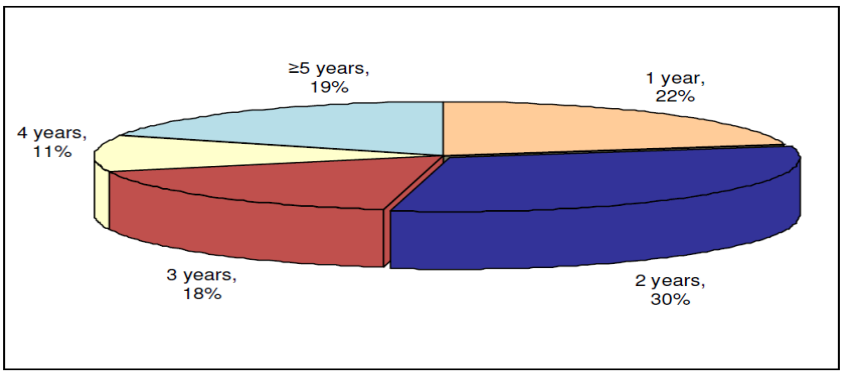

Figure 1-5 Expected time to commercialize the current R&D project/products,

(Source: MOSTI, 2010, p.135)

The above was a summary of the Malaysian biotechnology industry and the role of government in its establishment and further development. As far as the government is concerned, it has initiated its plans in most parts, however Malaysia still has a long way

ahead to run and complete the entire program. Today, Malaysia has reached the second phase of its Biotechnology Master Plan 2005-2020, while some of the key components of Phase one are yet to complete (Farid, Silong, Ismail, & Sarkar, 2011; Farid, Silong, Ismail, & Sarkar, 2012).

This critical phase requires appropriate strategies with the consideration of competitive markets and technology uncertainties in order to transfer the new products from the lab to market (Government., 2010). The revenue increase of up to 4 billion is also forecast through biotechnology projects. However, this economic vision is expected to come to reality through the development and commercialization of innovative products, which is the concern of involving key industry players and stakeholders. Arguably, there is a need for an in-depth investigation on factors influencing agile and speedy development of innovative products.

1.3 Research Gap

Innovation speed plays a key role in firm's competitive advantage and success. Speed in developing products, especially for biotechnology industries has always been a barrier, and not a desire (Canada, 2006; Markman et al., 2005), which calls for managers attention to identify factors that play key role in innovation speed. Despite the critical role of innovation speed in NPD the ongoing challenges and NPD projects failure have become the main concern of industry, governments and academia. For the past decade scholars have tried addressing issues around innovation speed. They have argued that innovation speed is a reality that facilitates capabilities needed to improve firms' performance and success.

This theory comprises of speed-based orientation factors, organizational capabilities, strategies, product factors and cost of development. However such an important reality lacks strong theoretical ground. According to Markman et al., (2005) due to the lack of sufficient empirical assessments innovation speed theory remain under-developed and in transition and therefore required more of comprehensive empirical studies. This study has contributed to the theory of innovation speed and literature by integration four theory and models as Knowledge-based and resource-based, contingency theory, and network of stakeholder influences.

So far a handfull of emprical studies have been conducted within the western economies (Carbonell & RodrÃguez-Escudero, 2009; Carbonell & Rodriguez, 2006; Chan, 2010; Kessler & Bierly, 2002; Kessler & Chakrabarti, 1996, 1999; Markman et al., 2005; Rycroft, 2007). This however is even slimmer within the Malaysian context as only a few empirical studies were identified on innovation speed and or NPD in Malaysian biotech sector (Bakar, Sulaiman, & Osman, 2012; Farid et al., 2011; Farid et al., 2012; Ignatius, Leen, Ramayah, Kah Hin, & Jantan, 2012). These limited studies mainly focus on comparing biotech and non-biotech SMEs (Bakar et al., 2012), and the role of government to accelerate biotechnology innovation, and the technology adaptation in agro-biotechnology industries (Farid et al., 2012; Farid et al., 2011), as well as the impact of technology learning in NPD within the Malaysian Fines Multinational Companies (Ignatius et al., 2012).

Within the western context, researchers have conducted broader assessments on innovation speed in relation to the specific areas such as market orientation and new product performance (Carbonell & Escudero, 2010), top management support and clarity of goals (Carbonell& RodrÃguez-Escudero, 2009), market uncertainty, and team design (Carbonell& Rodriguez, 2006b), NPD speed (Chen, Damanpour, & Reilly, 2010), human resource capital (Zhang & Yin, 2012), and radical product and radical process (Goktan & Miles, 2011). These studies provide valuable insight, however there are still gaps to fill and problems to solve. The existing studies: 1) are limited as only a few have covered innovation speed within the biotech sector, 2) miss out some of the key factors, 3) do not investigate key factors within a single research model. This study from the other hand aims to: 1) investigates major key elements that effect innovation speed, 2) specifically within the biotech sector, and 3) under a single research model, and 4) in order to produce a comprehensive insight. In sum, through an exhausting literature research this study investigates a framework consisting of 15 constructs.

Furthermore, the study takes into the consideration the speed-based strategies. These set of strategies create a triangle of tactics with human resource development at its foundation to accelerate NPD cycle time. These strategies include:

A) The achievement of speed-based strategies through staff-related capabilities such as skills and experience of R&D team (Carbonell & RodrÃguez, 2009; Kessler & Chakrabarti, 1996; Tsai & Huang, 2008) are identified as necessary elements for firm's success. These are pure human resource development elements that highly impact both firm and NPD outcomes. These HR factors coupled with the top management support and clarity of goals (Cooper, and Edgett, 2008) are expected to better aid innovation speed.

B) The quality of product is an important element of NPD. It is measured based on customer satisfaction (Kim, 2009), and calls for the adoption of proper resources to accelerate new product cycle (George et al., 2002). Product quality is improved through technology sourcing strategies. It is the concern of stakeholders, especially in Malaysian context where the industry is controlled by SMEs that lack strong R&D and engineering facilities.

C) The strategy of cooperation with the key stakeholders including government, universities, suppliers, and clients is a wise approach to reduce the development time, especially in complex technologies (Lundvall & Borrás, 1997; Wolff, 2001).

Additionally, researchers have identified a number of important factors that affect innovation speed (Carbonell & Escudero, 2010; Walker, Ruekerf, & Bonnerd, 2001). This study will investigate these factors as they influence the direct relationship between speed-based factors and innovation speed. Therefore, this study investigates:

A) Market and technology uncertainties that play essential role in innovation speed (Carbonell & Escudero, 2010; Carbonell & Rodriguez, 2006; Kessler & Bierly, 2002). According to the reports the existence of global and local technology and market uncertainties has affected Malaysia's economic and business growth (MOSTI, 2011b). Thus, predictions and investigations of environmental factors such as market and

technology uncertainties can provide certain advantages, including product/project failure prevention as well as time and cost reduction.

B) Product complexity which is quoted as an influencing factor effecting innovation speed (Ruekerf, Walker & Bonnerd, 2001). Product complexity makes the development and management of a new product harder.

C) Technology sourcing strategies are critical elements that improve development capabilities and adoption of innovative technologies (Auster, 1990; Tsai, & Wang, 2009; Xu, Huang, & Gao, 2012). Hence, choosing proper strategy could help preventing project and organizational failures (Balogun & Jenkins, 2003).

The existing studies in the field of innovation speed have provided valuable insights, but there are still gaps to fill and problems to address. In order to fill the gaps and address the issues, there is a need for a fresh and exclusive study. This study for first time attempts to examine the effect of large number of concepts and variables on innovation speed within a conceptualized research model. In line with the objectives, the research investigates strategies and capabilities (top management, and clarity of goals, skills and experience), the role of primary stakeholders (government, university, supplier, customer), and environmental factors (market and technology uncertainty) as well as technology sourcing strategies and product complexity that effect innovation speed. To achieve research objectives, the study utilizes innovation speed concept combined with a number of theories, including contingency theory, resource-based view, knowledge-based view, and network theory of stakeholder. These theories are well equipped to support the study and the mentioned factors that influence innovation speed.

1.4 Statement of the Problem

Innovation speed in new product development (NPD) is a global challenge. However within the Malaysian context, the Malaysia Biotech Master Plan (BMP) and the capacity building project (2005-2010) was initiated to facilitate the needs for industry. The capacity building plan was followed by the lab to market project (2011-2015) for the smooth transfer of biotech products. Despite the efforts and as stated by the Ministry of Science, Technology and Innovation (MOSTI, 2010), the government has only achieved 28.5% of the 2010's biotech target plan (Farid et al., 2011; Farid et al., 2012) with only 7% of new products being commercialized (Chow, 2013). This indicates that the results of biotechnology development are slow (MOSTI, 2011b) and the government is behind its biotechnology Master Plan and the defined target deadlines. So far Malaysia has failed meeting 71.5% of its planned deliverables for phase one (2005-2010) of its biotechnology Master Plan (2005-2020). This has led to further delays and uncertainties in phase two (2011-2015), which will automatically result in greater delays and uncertainties in overall (2005-2020) biotech master plan with negative impact on its expected socioeconomic advancement.

The issues around innovation speed in NPD lead to product project failures, and organizational challenges that cost Malaysia and the global businesses, governments and organizations billions each year. The fact that Malaysia and the biotech firms' worldwide struggle to address these critical issues around innovation speed; there is an

urgent need for an exclusive and in-depth study on innovation speed to tackle the problems around NPD in biotech industry.

1.5 Research Questions

The research questions of this study include:

1) What is the contribution of speed-base strategies (top-management support & goal clarity) and organizational capabilities (T-shaped and A-shaped skills, experience development) and product quality on innovation speed?

2) Is there any significant association between staff related organizational capabilities (T-shaped and A-shaped skills, experience development) and innovation speed under environmental uncertainty (market and technology uncertainty)?

3) What is the effect of product quality on innovation speed with considering the product complexity?

4) What is the effect of product quality on innovation speed with considering the technology sourcing strategies (internal and external sourcing)?

5) What is the effect of product quality on innovation speed with considering the product complexity and technology sourcing strategies (internal and external sourcing)?

6) What is the role of primary stakeholders including government, universities, suppliers and client in innovation speed?

7) What is the role of primary stakeholders including government, universities, suppliers and client in innovation speed when considering product complexity?

1.6 Research Objectives

In general, this study aimed to investigate factors contribute to innovation speed, including speed-based strategies (goal clarity, top-management support), organizational capabilities (T-shaped and A-shaped skills and development experience), environmental uncertainties (technology and market uncertainty), product factors (complexity and product quality), and technology sourcing strategies and primary stakeholders (university, government, supplier & client).

To achieve the purposes of the study the following objectives were proposed:

1) To determine the contribution of top-management support, goal clarity, A-shaped skill, T-shaped skill, development experiences, and product quality on innovation speed.

2) To determine the moderating effect of technology and market uncertainty on the relationship between top-management support, goal clarity, T-shaped skills, A-shaped skills, and development experiences on innovation speed.

3) To determine the moderating effect of product complexity on the relationship between product quality and innovation speed.

4) To assess the moderating effect of technology sourcing strategy on the relationship between product quality and innovation speed.

5) To evaluate the moderating effect of product complexity and technology sourcing strategies on the relationship between product quality and innovation speed.

6) To predict the role of primary stakeholders including supplier, client, university, and government in innovation speed.

7) To compare the role of primary stakeholders including supplier, client, university, and government in innovation speed when product complexity is moderated.

1.7 Significance of the Study

Addressing the issue of speed is important for theoretical and practical reasons. Considering the research gap and problem, the Malaysian biotech industry is required to enhance through innovation speed to maintain 2020 vision. Innovation speed is better utilized if coupled and supported by HRD activities of training, education and development. The theory of innovation speed in biotech sector may add to the body of knowledge in human resources and its practical application and adoption for the purpose of product & project success.

Theoretically, acceleration time is presumed to reciprocally tie to new technology. This research will demonstrate the phenomenon of the technology commercialization for the purpose of elimination problems in the scope of the Malaysian biotech industries. The study is driven by an interest in understanding how to apply speed-based factors to strategically manage NPD tasks.

The findings are expected to contribute to the theory of innovation speed and future research on technology development. The innovation speed theory is a multifunctional theory which makes it capable to look at barriers from different views by time reducing manner through the existing bonds in organizations (Dougherty, 1992; Kessler & Chakrabarti, 1996).

From the empirical point of view, implications lie in enabling biotech firms to position themselves and their products as first to market and gain competitive advantages (Espina & Markman, 2004; Merges & Nelson, 1990).

The review of the literature revealed that little attention was given by scholars in innovation speed in the scope of Malaysian biotech industry. This study is the first attempt to investigate the innovation speed theory with managerial perspective along with examining product characteristics and technology strategies sourcing in Malaysian biotech industry. Considering the scope of previous studies (Bakar et al., 2012; Farid et al., 2012; Ignatius et al., 2012; Lai & Yap, 2004) this study takes comprehensive, in-depth and broad approach to lead greater contribution to the Malaysian biotech industry and its of body of knowledge.

This research is expected to provide additional practical suggestions. It seeks to investigate the presumed effects of enterprise factors to the success of biotechnology innovation in Malaysia. It also opens a window of a new opportunity for biotech industries by recognizing their difficulties. Research on this issue is imperative as the competition in the marketplace becomes increasingly brutal. It is also hoped that this study will begin a research stream providing managerial guidance to systematically examine the strategic management of NPD tasks and process.

Additionally, this study practically answers the managerial question of how to strategically manage NPD tasks by speed up product development to increase quality and to decrease cost. It provides some guidelines to managers for deciding what kinds of NPD tasks should be performed in-house and what kinds of NPD task should be given to other parties.

The findings are also expected to help executives in their policies and business strategies through effective alignment of their vision and strategies with the new product development. Such policy may adopt and implement innovation speed as an important part of their R&D and products/projects process.

The results of this study will have significant implications on the biotechnology industries, especially for SMEs and new established biotech industries in Malaysia who are intending to generate and localize the technology. The discussion of the general picture of the speed-based factors would provide a brief description about the necessary assessments of NPD in order to prevent technology failure in preliminary paces.

1.8 Scope and Limitations of the Study

This research has employed advanced methods to gather and further analyses data through appropriate techniques. Although the employed methods and solid results provided valid outcomes, however, similar to every other research this study also burned a number of minor limitations. For example, it would have been better if the response rate were higher; however, considering the limited biotech population in Malaysia the response rate was quite significant. And the common method bias risk was removed by gathering data from knowledgably respondent who engaged

personally with the specific product (Tsai & Huang, 2008; Akgun and Lynn, 2002). Researcher predicts larger population would have been more beneficial, however it is unavoidable as being enforced by the industry.

Additionally, this study employed mono-method, which is based on respondents' perceptions. All mono-method studies are subject to common response bias. The cross-sectional nature of the study may add a bias in an industry with a limited population. This mainly relates to model testing, which may require additional efforts studying innovation speed across multiple industries. There is also geographical boundary in this study is carried out in Malaysia.

Although the scope of the study covers many factors within a study, however investigating a number of additional factors is beneficial that would add to this study and the literature holistically. For future researches, innovation speed with economic perspective could be examined. A shortening lifetime of new products under development is differing from one stage to another and different policies are required at each stage. This could be also considered for further study. Or even the researchers can go further and make a comparative study on customer's perception regarding early mover product and late ones.

1.9 Operational Definitions

1.9.1 Innovation Speed

Innovation as dependent variable is operationalized to a speedy process of development a product from idea to its first commercialization or introduction into the market.

1.9.2 Criteria and Scope-related Strategic Orientation

Criteria and scope-related strategies orientation are included vital decisions that are made in the firm by the top management before any action at the first stage of a project. These strategies are implemented to determine the future of the project/product in the market. For this reason, getting top management's support, clarity of goals are essential factors which could facilitate cycle of developing a new product.

- **Top management support** is operationalized as the supporter of the project that facilitates project needs. Undoubtedly, top managers have integral role in the organization and their interest to product would be helpful to speed NPD. It will be examined by how top managers support the team in order to move faster towards launching the product.

- **Clarity of the goals** is operationalized as an assessment and a clear understanding of the project's goals in the details of the research team. It will be measured by asking whether the objectives were clear, formal and stable in process of NPD.

1.9.3 Organizational Capability

Organizational capabilities have been conceptualized as staff-related capabilities which enable the firm to facilitate or prevent the firm to perform and deliver speedily several products with different characteristics to the market. In current research, cognitive skills (T-shaped and A-shaped skills) and development experience factors are adopted from previous researches.

- **T-shaped skills** refer to technical, social and practical abilities of research team members to facilitate a project. It describes about characteristics of research team members for instance sociability and communication with others and making suggestion, wisdom, expertise and specialist on their tasks and others.

- **A-shape skills** refer a series of project leader characteristics. A leader with A-shaped skills perform specific kinds of task in parallel. It explains about a leader with adequate knowledge and experiences in different fields and enable to transfer the knowledge to others.

- **Development Experience** is operationalized as appropriate knowledge and experience of research team regarding new projects. It describes about the familiarity and experience of the research team about the technology.

1.9.4 Environmental uncertainties

- **Technology Uncertainty** demonstrates the information regarding the rate of change and uncertainty in technology and range of ideas arise when a new product is achieved in the firm.

- **Market Uncertainty** indicates to market uncertainty reflected the range of change in customer taste and product features in the firm.

1.9.5 Technology Sourcing Strategies

Technology sourcing is a method by which firms acquire the R&D-related technologies both via in-house research and development activities and via external technology sourcing, such as government, universities, suppliers or other parties.

- **Internal Sourcing**, Internal sourcing, it means that NPD task are carrying out totally in-house. If the firm performs an NPD task itself, it means that they have internalized the technology.

- **External Sourcing** indicates to generate the NPD tasks fully or partially by other parties. It means that the firms preferred to perform NPD outside their

firm.

1.9.6 Product Factors

- **Product Quality** refer to product features suite to customers' need and taste in term of attractiveness, healthiness, appearance, easy using and repair in comparing other products.

- **Product Complexity** refers to radicalness and complexity of the product in terms of performing functions.

1.9.7 Primary Stakeholders

- Primary stakeholders refer to key representative teams who interested to cooperate with industry to develop a product, including university, government, suppliers and customer/client, to improve smoother and faster a new product. This variable covers a variety of cooperation in a kind of partnership, knowledge or facility sharing, funding or etc. It included 4 nominal predictors which were measured as dummy variables having cooperation (1) and no cooperation (0).

1.9.8 Control variables

Two variables were controlled for in testing the hypotheses. Demographic characteristics are common sources of extraneous variables and therefore, the effects of these variables must be controlled to enhance internal validity (Kerlinger & Lee, 2000).

- **Team size** was measured by the number of R&D project team members.

- **Development cost** was measured by the money was spent to develop a new product. Development cost is higher in some firms because they may be "pay for speed" to accelerate NPD.

1.10 Summary and Organization of the Thesis

This study proposed a giant contribution in scenario of Malaysia. With this respect, the study focuses on effect of speed-based strategies and capabilities, product quality with considering environment uncertainties (Technology and market uncertainty), technology sourcing strategies (internal and external sourcing) and product complexity as moderators. Furthermore, the importance role of primary stakeholders as government, university, supplier and customers/client were investigated to innovation speed in complex product. Finally, the last chapter (chapter5) demonstrated summarize of discussion, conclusion, recommendations for future research.

Additionally, the thesis was thoroughly checked according to Univeristi Putra Malaysian's Plagiarism Rules [Part 12 of the Universities Putra Malaysia and University Colleges Act 1971 Constitution of Universiti Putra Malaysia: Universiti Putra Malaysia (Graduate Studies) Rules 2003 (2012-2013)] by Turnitin application which is available at: http://turnitin.com/. The Turnitine result could be found as an attachment.

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