ANTECEDENTS AND IMPACTS OF COLLABORATION IN INNOVATION COMMERCIALIZATION PERFORMANCE

By

NORHADILAH ABDUL HAMID

Thesis Submitted to the Putra Business School, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Throughout most of the past decade, innovation commercialization has been paying a substantial amount of attention to understanding the determinants of the commercialization performance of innovation in the marketplace. Although a lot of research efforts have been made, the rate of innovation commercialization is still at an alarming level in many countries. Recently, scholars of commercialization in relation to innovation have suggested that the success of innovation commercialization depends on the ability of the parties involved to collaborate with each other. Although the importance of collaboration in the commercialization of innovation is acknowledged, the understanding of this collaboration between firms and innovators remains limited.

Therefore, this study was aimed at providing a better understanding of the commercialization of innovation by: i) predicting the antecedents of collaboration in innovation commercialization; ii) examining the effect of collaboration in innovation commercialization on market performance and innovation survival; and iii) examining the mediating effect of collaboration variable; and lastly, to determine the effect of transactional capacity on the relationship between collaboration and both market performance and innovation survival within the context of the transfer of technology.
The research used two theoretical lenses, namely the transaction cost economics theory (TCE) and the resource-based view (RBV) theory. Both were adapted to explain the mediating effects of collaboration, and to explain the moderating effects of transactional capacity. A survey technique was employed to collect data from firms that receive the innovation by means of the innovation-through-technology transfer process. One hundred and four useable responses were received and further analysed using the appropriate statistical procedures was run. The research model was then tested by quantitative analysis using the partial least square (PLS) technique. The SmartPLS 3.0 was used to validate the research model and to test the proposed research hypotheses.

This study confirmed that collaboration in innovation commercialization is important for market performance and innovation survival. The empirical results of this study led to several significant findings. The findings showed that the degree of innovation uncertainty and the degree of asset innovation specificity had a positive significant relationship with collaboration. In addition, the findings also showed two other positive significant results of collaboration on market performance and innovation survival. Further, the collaboration had a positive significant mediating effect between the degree of innovation uncertainty and the degree of asset innovation, and between market performance and innovation survival. Finally, the findings indicated that transactional capacity had a significant positive moderating effect on the relationship between collaboration and innovation survival, but not on the relationship between collaboration and market performance.

The theoretical and practical contributions of this thesis are significant given the substantial findings of the model. The theoretical contributions lie in the extension of the current collaboration model. Further, this study also provided an understanding and practical suggestions on how collaboration and transactional capacity influence the market performance of firms and how the acquired innovations can survive in the marketplace.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

ANTESEDEN DAN IMPAK KOLABORASI DALAM PRESTASI PENGKOMERSILAN INOVASI

Oleh

NORHADILAH ABDUL HAMID

Februari 2017

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Sepanjang dekad yang lalu, pengkomersilan inovasi telah menarik perhatian bagi memahami faktor penentu kepada pencapaian pengkomersilan di pasaran. Walaupun terdapat banyak usaha penyelidikan telah dibuat, namun kadar pengkomersilan inovasi masih di tahap yang merbahaya di kebanyakan negara. Terkini, penyelidikan pengkomersilan berkaitan dengan inovasi telah mencadangkan bahawa kejayaan pengkomersilan inovasi itu adalah bergantung kepada keupayaan semua pihak yang terlibat untuk berkolaborasi antara satu sama lain. Walaupun kepentingan kolaborasi dalam bidang pengkomersilan inovasi telah diketahui, namun pemahaman berkenaan kolaborasi antara syarikat dan inovator masih lagi terhad.

Oleh yang demikian, kajian ini dibuat bagi menyediakan satu bentuk pemahaman yang lebih baik berkenaan pengkomersilan inovasi melalui: i) meramal faktor kolaborasi dalam pengkomersilan inovasi; ii) memeriksa kesan kolaborasi dalam pengkomersilan inovasi terhadap pencapaian pasaran dan jangka hayat inovasi; dan iii) memeriksa kesan mediasi pembolehubah kolaborasi dan terakhir, untuk memeriksa kesan moderasi kapasiti transaksi terhadap hubungan antara kolaborasi dan pencapaian pasaran dan jangka hayat inovasi dalam konteks pemindahan teknologi.

Kajian ini menggunakan dua lensa teori yang dinamakan sebagai teori Transaction Cost Economic (TCE) dan teori Resource-based View (RBV). Kedua-duanya diadaptasi untuk menerangkan kesan mediasi kolaborasi, dan
juga untuk menerangkan kesan moderasi kapasiti transaksi. Teknik kaji selidik telah digunakan bagi mengumpul data dari firma yang menerima inovasi melalui proses pemindahan teknologi. Satu ratus empat soal selidik yang lengkap diterima dan analisis dijalankan dengan menggunakan prosedur statistik yang bersesuaian. Model penelitian ini kemudian diuji dengan menggunakan teknik partial least square (PLS). SmartPLS 3.0 digunakan untuk mengesahkan model kajian dan untuk menguji cadangan hipotesis kajian.


Sumbangan dari sudut teori dan praktikal tesis ini ialah signifikasi diberikan oleh semua penemuan dalam model kajian ini. Sumbangan secara teori bergantung kepada lanjutan kajian terkini model kolaborasi. Tambahan, kajian ini turut menyediakan pemahaman dan cadangan secara praktikal bagaimana kolaborasi dan kapasiti transaksi mempengaruhi pencapaian pasaran dan bagaimana penerima inovasi mampu bertahan di pasaran.
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I certify that a Thesis Examination Committee has met on 15th February 2017 to conduct the final examination of Norhadilah Abdul Hamid on her thesis entitled “Antecedents and Impacts of Collaboration in Innovation Commercialization Performance” 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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<tr>
<td>AIM</td>
<td>Agensi Inovasi Malaysia</td>
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<tr>
<td>BiotechCorp</td>
<td>Malaysia Biotechnology Corporation</td>
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<tr>
<td>FRIM</td>
<td>Forest Research Institutes Malaysia</td>
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<tr>
<td>FMM</td>
<td>Federation of Malaysian Manufacturers</td>
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<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>IRPA</td>
<td>Research in Priority Areas</td>
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<tr>
<td>MARDI</td>
<td>Malaysian Agriculture Research and Development Institute</td>
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<td>MDEC</td>
<td>Multimedia Development Corporation</td>
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<td>MIDA</td>
<td>Malaysia Industrial Development Authority</td>
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<td>MIMOS</td>
<td>Malaysia Institute of Microelectronic System</td>
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<tr>
<td>MITI</td>
<td>Ministry of International Trade and Industry</td>
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<tr>
<td>MOSTI</td>
<td>Ministry of Science, Technology and Innovation</td>
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<td>MPOB</td>
<td>Malaysian Palm Oil Board</td>
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<tr>
<td>MSC</td>
<td>Multimedia Super Corridor</td>
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<td>MTDC</td>
<td>Malaysia Technology Development Corporation</td>
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<tr>
<td>NPD</td>
<td>New Product Development</td>
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<td>RBV</td>
<td>Resource-based View</td>
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<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
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<tr>
<td>SIRIM</td>
<td>Standard and Industrial Research Institutes of Malaysia</td>
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<tr>
<td>SME</td>
<td>Small and Medium Enterprise</td>
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<td>SMIDEC</td>
<td>Small Medium Industries Development Corporation</td>
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<tr>
<td>SLR</td>
<td>Systematic Literature Review</td>
<td></td>
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<tr>
<td>TPM</td>
<td>Technology Park Malaysia</td>
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<tr>
<td>TCE</td>
<td>Transaction Cost Economics</td>
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<td>UNIK</td>
<td>Unit Inovasi Khas</td>
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<tr>
<td>UPM</td>
<td>Universiti Putra Malaysia</td>
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<tr>
<td>UTM</td>
<td>Universiti Teknologi Malaysia</td>
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<tr>
<td>USA</td>
<td>United States of America</td>
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<tr>
<td>EFA</td>
<td>Exploratory Factor Analysis</td>
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<tr>
<td>CFA</td>
<td>Confirmatory Factor Analysis</td>
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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Throughout the years, there have been changes in the economy. The world has witnessed the decreased in the competitiveness of pioneer industries. In order for companies to survive in this new era of a very highly competitive world, companies need to be able to come up with new innovative products in order to gain competitive advantage. Companies must be able to develop innovative products that appeal to customers' demand (Ledwith & O'Dwyer, 2008). In today's market-based economy era, countries have taken the effort to increase their economic value by diffusing their scientific knowledge to a much wider sphere of industrial activities through technology transfer and commercialization. In the field of innovation management, the diffusion of scientific knowledge from universities is not a new trend. It has been growing trend since the 1990s (Mian, 2011). This strategy becomes more prominent nowadays, due to demand forces from instant customers and market requirements for new innovative products.

In Malaysia, innovation activities commercializations of R&D and inventions have a positive impact on economic development (Akoum, 2016). However, the commercialization of innovation in Malaysia is still low (11th Malaysia Plan, 2016-2020). For example, in the biotechnology industry, the level of commercialization has been reported minimal (Nagaretham et al., 2012). Researchers argue that the transfer process is one of the most crucial processes in the commercialization research agenda. However, most of the studies have concentrated on the transaction costs incurred by the innovation provider. Deeper understandings on the issues faced by the innovation receiver still need to be investigated more comprehensively (Ceccagnoli & Jiang, 2013). In addition, most of the studies on the commercialization of new inventions through the transfer of activities basically studied the issue exclusively from the perspective of technology transfer while leaving out the link between the technology generator and technology recipients (Dardak & Adham, 2014). When inventors opt to transfer their newly invented products to be commercialized, they must bear in mind that this process involves the transfer from a small to a large scale production. This process is very risky and needs a solid process of transference. In order for a firm to retain the product
manufacturing process, it is crucial that there be a continuous exchange of information between the parties involved. According to Dogra et al. (2013), the transference is not a single action performed by the transferring party towards the transferred party, but is a continuous process. In order for firms to retain their competitive advantage, it is important that they be able to capture, transfer, assimilate and apply the transferred competence. In addition, Ceccagnoli and Jiang (2013) stated that besides the imperfect contracts, the real cost of transferring technology across boundaries is also considered as part of the transaction cost.

Transferring research and development (R&D) product innovation from research institutes, such as, university to industries, is one of the best ways to bring innovation into the market for regional development and economic growth. This provides firms with greater performance by seizing on the monetary value from this innovation (Lichtenhager, 2010). Outward technology transfer is an important innovation strategy that is used to commercialize new inventions. Studies have shown that regional development and economic growth can be enhanced through this strategy (Polites et al., 2012). In addition to this benefit, the transfer activities may produce greater performance by seizing the monetary value of the new inventions (Ulrich Lichtenhager, 2010). However, current studies show that the commercialization of product innovation through technology transfer process is still at a crude level. In fact, the majority of studies confirm that many inventions are successful at the level of research and development (R&D), and in the early phase of the development of the products, but these will not necessarily lead to commercialization success (Harborne & Hendry, 2012). Even though some reports have shown positive trends in the performance of innovation commercialization by research institutions, the commercialization of innovation by external innovators through the process of technology transfer can still be improved further.

Until this day, there is a growing debate over this issue in many countries such as Europe (Jacobsson, Lindholm-Dahlstrand, & Elg, 2013), United States of America (USA) (Casper, 2013) and some developing countries like Malaysia (Heng, Senin, & Resource, 2011; Kowang, Rasli, & Long, 2014; Yaacob, Rasli, & Norezam, 2011). A research conducted by Ahuja & Katila (2001), found that acquisitions have a negative impact on the post-acquisition innovation output of acquiring firms. In fact, according to Harborne and Hendry (2012), product innovation which is successful at research and development (R&D) level, is not guaranteed to be successful during its commercialization stage. When it comes to the transfer of product innovation from R&D stage to companies for manufacturing and commercialization, this activity tends to fail. Companies are incapable to successfully link the characteristics of product innovation with the market needs. Due to the novelty of the product innovation, the firm might be
suffering from the liability of newness (Rabbiosi & Santangelo, 2013; Wang & Li-ying, 2014). As a consequence, firm may not have sufficient internal resources to capture the market needs (Mohan-Neill, 1995). Therefore, research findings on collaboration between innovator and recipient firm could help firm reduce the risk of the liability of newness of the innovation.

From the perspective of the acquiring firm, the successful development of a new product is one of the vital sources for gaining a competitive advantage (Ledwith & O’Dwyer, 2008). In today’s competitive world, a firm must be able to develop an innovative product that appeals to the customer. New product development (NPD) is viewed as the main driver for firms to enhance their performance and gain a competitive edge. To ensure that they are competitive enough in this emerging economy, most firms increasingly obtain innovations from external boundaries in an effort to reduce development time and costs. To date, acquisition activities are one of the most used strategies by industries. However, this issue is still under-researched (Kotlar, De Massis, Frattini, Bianchi & Fang, 2013). As NPD is one of the crucial processes for manufacturing companies, an understanding of the transfer characteristics of NPD, its antecedents, and its impact on the market performance of new inventions are necessary and have significant research and practical implications.

1.2 Research Context: Commercialization in a Malaysian Climate

The Malaysian government, aware of the importance of innovation commercialization today, has provided a number of agencies to support the private and public sectors in enhancing R&D activities so that these can be successfully commercialized. Historically, Malaysia’s First National Science and Technology Policy were formulated in 1986 with the objective of strengthening R&D efforts, specifically to enhance the Malaysian economy. In 1990, A National Action Plan for Industrial Technology Development was launched. This plan was developed to increase the commercialization of public R&D findings. All the policies that have been formulated after 1993 have centred more on creating an intra-firms network. In Malaysia, a programme, known as the Research in Priority Areas (IRPA) programme, was developed in the 1980s. This programme was introduced to provide funding for public R&D activities which potentially have big commercial value.

The Ministry of Science, Technology and Innovation (MOSTI), which was originally known as the Ministry of Technology, Research and Local
Government in 1973, is the general administrator of science and technology policies in Malaysia. MOSTI provides the bulk of research grants through specialized schemes including the Science Fund, the Strategic Thrusts of Research Areas program, and the TechnoFund. Its programs are currently clustered into five focus areas: biotechnology, information technology, industry, sea to space, and the science and technology core. In addition, a Nanotechnology Directorate was created in 2010 when the Prime Minister launched the National Nanotechnology statement to promote research in this field. In addition, the Unit Inovasi Khas (UNIK) was created to oversee an integrated innovation policy, and it has been entrusted with the commercialization of research findings from public research institutions and universities. UNIK is responsible for drafting the National Innovation Policy for the country, while a statutory organization, the Malaysian Innovation Agency (AIM), which was established in 2011, is responsible for driving the nation’s innovation agenda.

Besides the abovementioned agencies, another agency that is playing an important role in the commercialization of NPD is the Malaysian Technology Development Corporation (MTDC). The MTDC is a government-backed venture capital company that has been playing a major role in the commercialization and management of government funds since the 7th Malaysia Plan. A number of sectoral ministries have a role in science, technology and commercialization through research institutions which come under their jurisdiction. These include the Malaysian Agricultural Research and Development Institute (MARDI), the Malaysian Palm Oil Board (MPOB), the Forest Research Institute of Malaysia (FRIM), and the Malaysian Institute of Microelectronic Systems (MIMOS).

During the Second Industrial Master Plan (1996-2005), a cluster-based development approach was introduced. Malaysia’s first technology cluster, named Technology Park Malaysia (TPM), was formed in 1988. As the years went by, Malaysia gradually introduced other technology parks, for example, the Kulim Hi-Tech Park Malaysia (1996), the Selangor Science Park and the Technovation Park at UTM (1995), and the UPM-MTDC Incubation Centre in UPM (1997). A few incubation centres have also been developed such as the SIRIM Technology Incubation Centre in Selangor, and the Melaka K-Economy Incubator in Melaka. In 1996, Malaysia set up the Multimedia Super Corridor (MSC). This organization was developed to create an environment that is conducive for ICT and multimedia innovations. Another Ministry that is playing an equally important role in promoting innovations is the Ministry of International Trade and Industry (MITI) through its agencies like the Small and Medium Industries Development Corporation (SMIDEC), currently known as
SME Corp Malaysia, the Malaysian Industrial Development Authority (MIDA), the Multimedia Development Corporation (MDeC), and the Malaysian Biotechnology Corporation (BiotechCorp).

Although the government provides various facilities and services to support the commercialization process, the performance of commercialization is still unsatisfactory and lagging behind. According to a report in the News Straits Time dated 10th October 2014, the Malaysian Prime Minister, Dato’ Sri Najib Tun Razak, claimed that currently, Malaysia’s research and development (R&D) expenditure as part of the Gross Domestic Product (GDP) was low compared with more advanced economies, such as Japan and South Korea (New Straits Times, 2014).

From the above discussion it can be seen that Malaysia has already put much effort into enhancing the commercialization process. Unfortunately, some of the technologies that pictured a good progress and were capable of generating higher incomes for organizations, somehow ended up becoming a burden for them. The evidence shows that the number of success stories of the transformation of innovations from ideas to profit generation is typically low in Malaysia. Govindaraju (2010) mentioned that there was a sharp drop to 3.4% in the rate of commercialization recorded in the 8th Malaysia Plan compared to 5.1% that was recorded previously in the 6th and 7th Malaysia Plans. This was also supported by a report submitted to UNIK which showed that the percentage of commercialization of MPOB technologies was almost 29% compared to that of public research institutions and universities, which was approximately 10%. However, only 3% out of the 29% returned profits (Ethos & Company, 2011).

The government is beginning to address this issue, and it has been highlighted in the summary of the SME Masterplan for 2012 to 2020. This report identified the main reasons for the failure of innovation and technology adoption in SMEs as the complexity in accessing national innovation systems, low commercialization and R&D, and poor technology uptake. The adoption of innovation and technology is one of the key challenges faced by Malaysian SMEs that significantly influences their performance. One of the goals that must be met in this masterplan is an increase in productivity. The other three goals are an increase in business formation, expansion in the number of high growth and innovative firms, and intensification of formalisation. Unlike SMEs from the United States, which are stated to be seven times more productive and Singapore SMEs, which are four times more productive, Malaysian SMEs have recorded low levels of productivity of approximately one-third the
productivity of large domestic enterprises. Therefore, the outputs of SME research innovations have rarely been one of the main sources in fostering growth, employment and income in the country, besides the large companies. Malaysian SMEs cover a vast segment of the Malaysian economy, constituting 99.2% of the total number of business establishments in the country, and recent statistics indicate that SMEs contribute 32% of the gross domestic product (GDP), 59% of employment, and 19% of exports (SME Masterplan 2012-2020). Consequently, for the purposes of this research, it is critical to investigate the types of companies that are directly dealing with the new innovation commercialization process.

As stated by the Malaysian Prime Minister, Dato' Sri Mohd Najib Tun Abdul Razak, “Malaysia’s research and development (R&D) expenditure as a share of the gross domestic product (GDP) was low compared with advanced economies such as Japan and South Korea” (News Strait Times, 2014). However, the bringing of new technologies into the market requires a lot of effort and involves a number of actors. It is also requires different resources compared to the commercialization of well-known technologies because customers are not yet familiar with the new technology and will not be able to accurately voice their needs (Maarse & Bogers, 2012). Many scholars have identified the barriers and challenges in commercializing new technologies and have attempted to find what factors determine the successful commercialization of these new innovations. Most of the firms face many barriers in transforming this R&D innovation into commercial value (Ab Aziz, Harris & Ab. Aziz, 2012; Govindaraju, 2010).

<table>
<thead>
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<th>Parameters</th>
<th>Countries</th>
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<td></td>
<td>Singapore</td>
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<tr>
<td>Overall</td>
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<tr>
<td>Institutions</td>
<td>8</td>
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<tr>
<td>Human Capital &amp;</td>
<td>2</td>
</tr>
<tr>
<td>Research Infrastructure</td>
<td>9</td>
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<tr>
<td>Market Sophistication</td>
<td>4</td>
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<tr>
<td>Business Sophistication</td>
<td>1</td>
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</tbody>
</table>
Knowledge & Technology Outputs
Creative Outputs

3
15
9
5
36
37
69
59
56
42

However, it seems like Malaysia's success rate at sustaining new innovations in the market and the ability to generate profits is still low. Recently, the competitive environment has been great and Malaysia must move quickly or it will lose the opportunity, especially in the battle from ASEAN countries like Singapore, China, Korea, etc. This can be seen in the Global Innovation Index, where Malaysia is ranked overall at 32 out of 141 countries. Even though Malaysia comes first among the upper middle income economies in Asia, ranking 32nd (31st among GII 2011), with its major strengths being in market and business sophistication (where it ranks 14th and 11th, respectively), it needs to make improvements in its institutional framework (55th) and in human capital and research (42nd) to move up the ranking. The statistics show that in R&D, Malaysia does not do as well (48th), although the involvement of the private sector in the financing and performance of R&D is noteworthy (at levels above 84%, ranking 1st globally on both). One of the major contributions to this problem is the lack of collaboration among academic researchers, industries and other related organizations (Heng, Senin, 2011). Therefore, it is necessary to look at what is meant by collaboration in the context of commercialization, and to consider how it differs from R&D or new product development collaborations. A report by Ethos & Company titled, "Design of funding mechanisms to accelerate the adoption and commercialization of innovation in Malaysia" (Ethos & Company, 2011), highlighted that lack of understanding and familiarity with the technology and market led to the failure of a large Malaysian government-backed venture capital company in commercializing oil palm biomass-related technologies which had a broad prospects for domestic applications.

1.3 Research Problem

Commercialization of innovation output is identified as one of the crucial part in the development of the economy in Malaysia (Nor, 1996). The transfer of research output to the market place is also seen as the next driver of Malaysia's economic development (Heng, Senin, & Rasli, 2011). Unlike other Asian countries, like Singapore, Korean and Japan, and China Malaysia is still left behind in terms of innovation and commercialization output (Global Innovation Index, 2016). Malaysia needs to accelerate the movement of their
innovation outputs into the market and come out with sustainable innovations in order to become a developed country. In encouraging the commercialization of innovation output, the Malaysia government has provided funds and facilities through agencies such as MTDC, to foster the innovation commercialization in Malaysia.

However, despite the efforts of the government, the transfer of potential research results to the industry to develop and commercialize is still experiencing low success rates (Yaacob, Rasli, & Norezam, 2011). In addition, according to Khademi and Ismail (2013), many research ideas and results produced in universities fail to align with firm’s business strategies. This has led to the low commercialization rate reported in Malaysia’s Eleventh Plan (2016 – 2020) and Malaysia’s SME Master Plan for 2012 to 2020. A study was conducted by Heng et al., (2014), on the grant recipient firm. The results showed that these firms face difficulties in marketing their innovations. This problem is believed to be due to the fact that there are other factors that affect the success of commercialization of innovation transfer from public higher institutes or from government research institutes to the industry.

Some research suggest that lack of collaboration between innovation provider and innovation recipient become of major obstacle towards the success of research commercialization through transfer process (Dardak & Adham, 2014). In the context of technology transfer activities, Chen et al. (2014) discovered that cooperation is very important. The analysis of previous studies have found several variables that affect commercialization performance such as 1) organizational factors (financial support, training, information technology tools) (Arvanitis, Kubli & Woerter, 2008; Kim, Lee, Park & Oh, 2011; Martin-Rojas, Garcia-Morales, & Bolivar-Ramos, 2013), 2) knowledge management systems (e.g., knowledge integration, knowledge exploration, knowledge exploitation) (Frishammar, Lichtenhaler & Rundquist, 2012; Martin-Rojas et al., 2013; Yalcinkaya, Calantone & Griffith, 2007), 3) innovation characteristics (e.g., innovativeness, complexity, compatibility, relative advantage, quality) (Akroush, 2012; Chen, Chang & Hung, 2011; Cho & Lee, 2013; Yalcinkaya et al., 2007), and 4) human factors (e.g., team composition, individual factors) (Akgün, Keskin & Byrne, 2009; Černe, Jaklič & Škerlavaj, 2013; Dayan & Basarır, 2010). So far, however, there has been little discussion about collaboration between the innovation providers and recipient firms. Despite the mounting research evidence that commercialization collaboration plays an important role in improving the commercialization of innovation and their survival (Aarikka-Stenroos, Sandberg & Lehtimäki, 2014; Aarikka-Stenroos & Sandberg, 2012), however, there is still insufficient knowledge about the effect of collaboration towards commercialization performance.
In addition, previous researches on collaboration examined different types of collaboration, such as 1) cross-functional collaboration (Bercovitz & Feldman, 2011; Brettel, Heinemann, Engelen & Neubauer, 2011; Luca & Atuahene-Gima, 2007; Song, Kawakami, & Stringfellow, 2010; Song & Swink, 2009; Swink & Song, 2007), 2) firm-firm collaboration (Cousins & Lawson, 2007; Lin, Fang, Fang & Tsai, 2009; Wu, 2012; Zeng, Xie & Tam, 2010), 3) firm and customer collaboration (Lai, Chen & Yang, 2012), 4) firm and government collaboration (Zeng et al., 2010), 5) intermediaries and firm collaboration (Zeng et al., 2010), and 6) collaboration between diverse partners (Raesfeld, Geurts, Jansen, Boshuizen & Lutte, 2012). However, all these researches focused more on in-house innovations, which provide minimum emphasis at the transfer of innovation. Furthermore, most of these studies were from innovators’ perspective instead of firms’ perspective.

Another related gap exists with regard to the knowledge of collaboration constructs. Extensive research ideas on collaboration have emerged from a growing literature on the contingency theory (Luca & Atuahene-Gima, 2007); knowledge-based view (KBV) (Hemert & Nijkamp, 2013; Lin et al., 2009; Luca & Atuahene-Gima, 2007), resource dependency theory (RDT) (Brettel et al., 2011; Song & Swink, 2009; Swink & Song, 2007), network theory (Lin et al., 2009), and social identity theory (Song et al., 2010). In the area of transaction cost economics (TCE) and governance structures, the existing literature overlooked the impact of transaction attributes in understanding the development of innovator-recipient collaboration. This study, therefore, is designed to fill this void by using the TCE lens to understand the antecedence of collaboration as a governance mechanism. This leads to the selection of two attributes, namely 1) the degree of NPD uncertainty, and 2) the degree of NPD asset specificity, also known as NPD characteristics. Although market governance or hierarchical governance mechanisms have been established as being crucial for commercialization performance, a hybrid governance (collaboration) is attractive as one of the governance structures, since it puts more emphasis on governance through relational means, in addition to governance by contractual means (Nyang, Whipple & Lynch, 2010). Additionally, according to Wang & Wang (2012) the transformation of innovations into commercial products often involves tacit knowledge. It is difficult to be transferred through market-based transactions, thus, the use of collaboration as a governance mechanism can reduce the transaction cost and enhance the market performance of new invention products. Caccagnoli & Jiang (2013), showed that the real cost of transferring technology across boundaries is also considered as part of the transaction cost, besides the imperfect contracts.
Previous studies on the relationship between collaboration and commercialization performance have produced mixed results. Thus, this relationship needs to be reviewed more comprehensively by regarding transactional capacity as a moderating variable that influences the relationship between collaboration and commercialization performance. Transactional capacity in this study is a combination of dissemination capacity and absorptive capacity. Cecchagnoli & Jiang (2013) argued that if the absorptive capacity of the potential acquirer is weak, then there is a tendency for the technology acquirer’s cost of integrating external technologies to be high. This would lead to an increase in the cost and have a negative effect on the commercialization performance. Even though a number of studies have focused on absorptive capacity as a moderator between collaboration and commercialization performance (Engelen, Kube, Schmidt & Flatten, 2014; Tsai, 2009), less number of studies examined the effect of the dissemination capacity of the innovation provider on the commercialization performance of the recipient firms. The dissemination capacity is important for the alliance firms to ensure that the transfer activities are successful (Schulze, Brojerdi & von Krogh, 2014). This is because innovation involves complex and tacit knowledge, and it would be advantageous to determine the moderating effect of the dissemination capacity together with the absorptive capacity on the relationship between collaboration and commercialization performance. In addition, previous studies that examined the moderating effect of the absorptive capacity between collaboration and commercialization performance used secondary data to measure the absorptive capacity (e.g., R&D expenditure/sales). For this study, primary data were used to measure the absorptive capacity. This is because, according to the argument made by Engelen et al. (2014), absorptive capacity is a process that relates to several steps, and it is not sufficient to focus on R&D items to measure it. Dimensions, such as skills and experience, are some of the sources that can contribute more to the overall absorptive capacity of a firm.

Collaboration in innovation commercialization remains a critical gap to be addressed. The existing literature has revealed that collaboration significantly affects performance in different types of research settings. For instance, the aspects of collaboration that has been studied include 1) the supply chain (Abd Rahman & Bennett, 2009; Cao & Zhang, 2011; Fynes, Voss, & de Búrca, 2005; Gibson, Rutner, & Keller, 2002; Simatupang & Sridharan, 2005), 2) information systems (Lee, 2001), 3) academic studies (Anderson-Lewis et al., 2012), 4) health management (Baggs, 1994; Zillich, Doucette, Carter, & Kreiter, 2005), 5) organizational relationships (Ki & Hon, 2007), 6) outsourcing (Lee & Kim, 2005), 7) customer relationship management (Lin et al., 2009), and 8) product development (Kahn, 2001). Unfortunately, researches in innovation commercialization have failed to establish specific dimensions that are capable
of consistently predicting the collaboration construct. Based on the preceding
discussion, collaboration in the area of commercialization is well worth studying
and would represent a valuable contribution to the innovation
commercialization management literature.

In addition, there are serious concerns about the other commercialization
performance measurements. Most of the past studies employed financial
indicators to measure the commercialization performance of innovation. Using
arguments from Keupp, Palmié, & Gassmann (2012), commercialization
performance can be influenced by sources of variations that are unrelated to
innovation activities. The survival of innovation in the market would be one of
the alternative measurements that can be used, besides financial and market
figures, to measure the performance.

Responding to these gaps in the literature, the present study developed and
tested a comprehensive model to explore the relationships between degree of
innovation uncertainty and degree of innovation asset specificity, collaboration,
transactional capacity and commercialization performance.

1.4 Research Questions

Based on the problems mentioned above, the following were the research
questions that needed to be answered:

RQ1 How do degree of innovation uncertainty and degree of innovation
asset specificity influence firm’s market performance and innovation
survival?

RQ2 How do collaboration influence commercialization market
performance and innovation survival?

RQ3 Does collaboration mediates the relationship between degree of
innovation uncertainty, degree of innovation asset specificity and
market performance, innovation survival?
RQ4: Does transactional capacity moderates the relationship between collaboration and market performance and innovation survival?

1.5 Research Aims and Objective

The primary goal of this research is to accomplish the following objectives. These objectives are stated below.

For research question number one (RQ1):
1. To examine the relationship between the degree of innovation uncertainty and innovation commercialization collaboration.
2. To examine the relationship between the degree of innovation asset specificity and innovation commercialization collaboration.

For research question number two (RQ2):
3. To examine the relationship between innovation commercialization collaboration and market performance.
4. To examine the relationship between innovation commercialization collaboration and innovation survival.

For research question number three (RQ3):
5. To determine the mediating effect of innovation commercialization collaboration on the relationship between the degree of innovation uncertainty and market performance.
6. To determine the mediating effect of innovation commercialization collaboration on the relationship between the degree of innovation asset specificity and market performance.
7. To determine the mediating effect of innovation commercialization collaboration on the relationship between the degree of innovation uncertainty and innovation survival.
8. To determine the mediating effect of innovation commercialization collaboration on the relationship between the degree of innovation asset specificity and innovation survival.

For research question number five (RQ4):
9. To examine the moderating roles of transactional capabilities on the relationship between innovation commercialization collaboration and market performance.
10. To examine the moderating roles of transactional capabilities on the relationship between innovation commercialization collaboration and innovation survival.

1.6 Significance of the Study

Theoretically, this study contributes to previous knowledge in a number of ways. Firstly, this study offers an alternatives lens to view the concept on the transactional cost economic and resource based view theories. The transaction cost economics theory has been used extensively to examine relationship; however, few study to date, has explored any of the theories to examine the firm-innovator in any specific firm context. Secondly, this research responds to calls for innovation commercialization research to examine the factors of degree of innovation uncertainty and degree of innovation asset specificity as antecedents for firm-innovators collaboration which may influence the strength of the relationship between firm and innovator. Thirdly, this research addresses the need warranted in the existing literature to examine the innovation commercialization in a non-western context, i.e. Malaysia. Further, the review also shows that the collaboration in innovation commercialization context have been examined in the different types of relationship and focus on in-house innovation bases. A survey of the related literature revealed that, to date, few study has been conducted on innovation commercialization that involves transfer process. Therefore, it is essential to identify the impact of collaboration on this kind of innovation towards market performance and innovation survival. The analysis of the literature also shows that the previous studies on the relationship between collaboration and commercialization performance offer a mixed results. Transactional capacity may have a moderating effect on the strength of the collaboration to increase market performance and innovation survival.

From a practitioner's standpoint, this research adds to the attempts at bridging the gap between theory and practice. Concurrent with the prior research, this research helps to convey messages to practitioners concerning the crucial role of collaboration between firm and innovator in ensuring the innovation market performance and innovation survival. Furthermore, this study identifies the importance of collaboration in innovation commercialization when the degree of innovation uncertainty and the degree of innovation asset specificity is high. It is suggested that the firm with high absorptive capacity and their innovator's disseminative capacity, plays an active part in influencing the impact of collaboration on the success of innovation in the market and its survival. These findings will allow firms to build a close collaboration with innovators, along with
support for the transactional capacity of both sides in order for them to achieve maximum performance.

1.7 Definition of Terms

In order to avoid any potential confusion in the interpretation of the concepts employed in this research, the definitions of the terminologies used in this research are presented below. These definitions are used as guidelines in discussing the findings of the tested hypotheses.

Collaboration

Innovation has been defined as “to make something new” (Robert, Barker & Walker, 2005), while commercialization has been defined as “the process of acquiring new ideas, augmenting them with complementary knowledge, developing and manufacturing saleable goods, and selling the goods in the market” (Krair, 2004). The definition for collaboration was adapted from a study by Thomson (2001) and Thomson and Perry (2006) to mean “a process in which autonomous actors interact through formal and informal negotiations, jointly creating rules and structures governing their relationships and ways to act or decide the issues that brought them together. It is a process involving shared norms and mutually beneficial interactions”. Therefore, collaboration in innovation commercialization can be defined as two or more parties working together in the process of acquiring new ideas, augmenting them with complementary knowledge, developing and manufacturing saleable goods, and selling the goods in the market through information sharing, trust, business understanding, communication, commitment, decision synchronization and resource sharing, which result in greater performance than acting alone for satisfying market needs.

Market Performance

Several researchers in the commercialization of new innovations suggest that the market performance of a new innovation is associated with sales goals (Lai et al., 2012; Lin et al., 2009; Luca & Atuahene-gima, 2007; Yao, Yang, Fisher, Ma, & Fang, 2013), customer acceptance (Barczak, Hultink & Sultan, 2008; Lai et al., 2012), customer satisfaction (Barczak et al., 2008; Lai et al., 2012; Lin et
al., 2009), product market share goals (Cousins & Lawson, 2007; Lai et al., 2012; Lin et al., 2009; Luca & Atuahene-Gima, 2007; Song & Swink, 2009) and finally, improved time to market (Cousins & Lawson, 2007).

**Innovation Survival**

Innovation survival in this research is defined as how long the product innovation is sustained in the market (Astebro & Michela, 2005).

**New Product Development (NPD)**

According to Crawford & Di Benedetto (2000), NPD can be defined as the overall process of the strategy, organization, concept generation, product, and marketing plan creation and evaluation, and launching of a new product.

**Innovation Uncertainty**

In TCE, uncertainty has been identified as one of the transaction attributes that have a significant effect on the choice of a governance structure (Williamson, 1989). In this research, innovation uncertainty is captured by several measures that describe the difficulty and inability to forecast accurately the changes in the market and technology in relation to the innovation manufacturing and commercialization process.

**Innovation Asset Specificity**

Asset specificity is defined as "the degree to which an asset can be redeployed to alternative uses and by alternative users without the sacrifice of productive value" (Williamson, 1989). In this research, innovation asset specificity is represented by the specialized marketing of complementary assets comprised of availability of channels, marketing systems, logistics, branding loyalty and others that are germane to the successful commercialization of an innovation, and manufacturing skills for a prototype and those required for final mass production. Mass production favours quality, cost, speed, and reliability, whereas creating a prototype requires only a few specific skills.
Transactional Capacity

Transactional capacity in this study is refer to absorptive capacity and disseminative capacity. In particular, it is the capacity of firm to absorb the knowledge from the innovation provider and the capacity or innovation provider to disseminate their innovation to the firm.

Absorptive Capacity

In this study, absorptive capacity refers to the ability of the employees of a firm to acquire knowledge and the level of skills to implement the new process, the employees' own knowledge, and the ability of the employees to absorb, assimilate and exploit that knowledge (Javalgi, Hall & Cavusgil, 2014; Leal-Rodríguez, Roldán, Ariza-Montes & Leal-Millán, 2014; Liao, Fei & Chen, 2007; Lin et al., 2009; Sciascia, D'Oria, Bruni & Larrañeta, 2014).

Disseminative Capacity

Disseminative capacity in this study is based on the definition by Mu et al., (2010) which is “the ability of people to efficiently, effectively and convincingly codify, articulate and communicate, and spread knowledge in a way that other people can understand accurately, and finely, tactically put learning into practice”.

1.8 Scope of the Study

The proposed investigation looks at two basic theoretical consideration (discussed in Chapter Two) in providing better conceptualization of firm – innovator collaboration in an internationalization dyad, specifically in a developing country context.

- The concept of collaboration in innovation commercialization is consolidated from different broad views into a specific perspective, such as firm context.
Theoretical arguments such as transaction cost economic theory and resource base view theory have provided the basis as well as solid foundations towards extending views with regards to a different perspective, such as, firm-innovator collaboration as a governance mechanism in this study and the role of transactional capacity.

The inferences from the above theories and literature have suggested that factors such as degree of innovation uncertainty and degree of innovation asset specificity are potential antecedents of firm-innovator collaboration.

While the collaboration has received great attention not only in innovation commercialization but also in other fields of investigation, this study is focused only on firm-innovator collaboration. Specifically in innovation commercialization that involves transfer process from external innovation provider to acquiring firm for developing the proposed framework.

This study additionally consolidates and focuses on the other variables that are believed to have an effect on the relationship between collaboration and market performance and innovation survival. This study has considered transactional capacity as moderation variables in conceptualizing the new context.

Cross-industry data have been collected from Malaysia.

The proposed conceptual model has been tested to verify the mediating effect of predictor variables in the model (i.e. collaboration variable).

1.9 Thesis Organization

This thesis is organized into six chapters (i.e., introduction, literature review, hypotheses development, methodology, findings, discussion and conclusion). Chapter One introduces the background, rationale, contribution and organization of this thesis. Chapter Two presents the literature review on collaboration as well as its key outcome (i.e., performance) and the main moderating variables. Furthermore, this chapter also discusses the relevant theories that describe the impact of commercialization collaboration on commercialization performance. Such theories form the foundation of the thesis to conceptualize the research model. The next chapter, which is Chapter Three, illustrates the development of the research hypotheses based on
relevant theories and previous related literature. The methodology used in this study, including the research design, philosophy, and the research methods, are described in Chapter Four. The main findings and analyses are presented in Chapter Five and lastly, Chapter Six summarizes the answers to the research questions and concludes with the findings of this study. It also discusses the limitations of the research and suggests future avenues of research. The structure of the chapters for this study is presented in Figure 1.1.

![Figure 1.1: Structure of Chapters for this Thesis](image)

1.10 Chapter Summary

This chapter provided the foundation for this research. Its objective was to provide the reader with the rationale and logical justification for the development of the research design from the rationalization of the research to the development of the research questions and the novel contributions of the study. This chapter introduced the context of the research and briefly explained and justified it.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents a systematic review of the literature on innovation commercialization and other selected constructs relevant to this research. The chapter begins with the concept of commercialization such as its history, definition and process. The second section discusses the current status of the research on innovation commercialization. The third section highlights the issues and gaps in the literature, including an illustration of the conceptual framework of this research. Reviews of the relevant literature pertaining to the selected constructs are presented in the next four sections. This chapter concludes with a short summary.

2.2 Innovation Commercialization: ITS History and Relationships

Over the years, many studies have been carried out to investigate the commercialization performance of new inventions or innovations across countries. Commercialization is often described as one of the main drivers of economic growth and, to date, a lot of innovations are actually oriented towards their economic value (Roessner et al., 2013). For instance, a study by Cao & Zhao (2013) proved that patent commercialization has positive significant effects on economic performance. The concept of innovation has been in existence for a long time. In fact, innovation has been a part of economic development since the 18th century. Many of the innovations that are seen in the modern age today were derived over the last 150 years through the creative efforts of scientists. Roberts, Baker & Walker (2005) revealed that innovation originally comes from the Latin word ‘innovare’, which is defined as ‘to make something new’. From the literature, the definition of innovation has gone beyond that. Various authors have defined innovation according to changes in trends from time to time. Table 2.1 shows the evolution of innovation studies starting from the year 1890 to 1983 (Godin, 2010).
Table 2.1: The evolution of innovation studies

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tarde</td>
<td>1890</td>
<td>Invention, imitation, opposition</td>
</tr>
<tr>
<td>Ogburn</td>
<td>1922 a, b</td>
<td>Invention (and diffusion) maladjustment (lag)/adjustment</td>
</tr>
<tr>
<td>Bernand</td>
<td>1923</td>
<td>Formula, blueprint, machine</td>
</tr>
<tr>
<td>Chapin</td>
<td>1928</td>
<td>Invention, accumulation, selection, diffusion</td>
</tr>
<tr>
<td>Ogburn and</td>
<td>1933</td>
<td>Idea, trial device (model or plan), demonstration, regular use, adoption</td>
</tr>
<tr>
<td>Griffian</td>
<td>1935 a, b</td>
<td>Idea, sketch, drawing, model, full-sized experimental invention, commercial practice</td>
</tr>
<tr>
<td>US National Resources Committee</td>
<td>1937 a, b</td>
<td>Beginnings, development, diffusion, social influences</td>
</tr>
<tr>
<td>Griffian</td>
<td>1937 b</td>
<td>Thought, model (or patent), first practical use, commercial success, important use</td>
</tr>
<tr>
<td>Ogburn</td>
<td>1937 a</td>
<td>Idea, plan or model, design, improvements, sales, marketing, production on a large scale</td>
</tr>
<tr>
<td>Ogburn and</td>
<td>1940</td>
<td>Idea, development, model, invention, improvement, marketing</td>
</tr>
<tr>
<td>Nimkoff</td>
<td>1941 a</td>
<td>Idea, plan, tangible form, improvement, production, promotion, marketing, sales</td>
</tr>
<tr>
<td>Ogburn</td>
<td>1950</td>
<td>Invention, diffusion, adoption</td>
</tr>
<tr>
<td>Rogers</td>
<td>1962</td>
<td>Innovation, diffusion, adoption</td>
</tr>
<tr>
<td>Rogers</td>
<td>1983</td>
<td>Needs/problems, research, development, commercialization, diffusion and adoption, consequences</td>
</tr>
</tbody>
</table>

Source: Godin (2010)

Historically, innovation has been defined as invention, imitation and opposition. Godin (2008) stated that in eighteenth-century Britain, the concept of imitation was accepted as an invention because it enhanced the quality of the design and brought diversity and variety. In Table 2.1 it can be seen that the concept of commercialization had been embedded in the innovation concept starting with Griffian in 1935. However, this concept had been discovered earlier by Schumpeter (1934, pp.74) when he described innovation as the introduction of new goods, new methods and new markets. Additionally, the commercialization of innovation was also discussed by Drucker (1974, pp. 47), when he stated that the definition of innovation is beyond science or technology, and is something that is able to create value. From another perspective, innovation is seen as something that creates competitive value through the commercialization process (Ahmed, 1998). Meanwhile, from the economic perspective, technological innovation is seen as the first commercial transaction involving innovation (Ibrahim, Elias, Saad & Ramayah, 2008). Here, it has been shown that several scholars in the innovation field have
classified innovation activities using their own conceptual models of the innovation process.

Another example of the innovation process was introduced by Thore (2002), and a description of this process is given in Table 2.2.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Development and Design</td>
<td>• Difficulty or practicality of converting idea into marketable product</td>
</tr>
<tr>
<td></td>
<td>• In-house resources available for R&amp;D work</td>
</tr>
<tr>
<td></td>
<td>• R&amp;D time and cost</td>
</tr>
<tr>
<td>Production</td>
<td>• Availability of facilities, work-force and know-how</td>
</tr>
<tr>
<td></td>
<td>• Need for investments in plant or machinery</td>
</tr>
<tr>
<td></td>
<td>• Availability of raw materials, parts, and supplies</td>
</tr>
<tr>
<td></td>
<td>• Workers’ health, risks of accidents</td>
</tr>
<tr>
<td>Marketing</td>
<td>• Complementary with existing product line</td>
</tr>
<tr>
<td></td>
<td>• Potential market size</td>
</tr>
<tr>
<td></td>
<td>• Competition</td>
</tr>
<tr>
<td></td>
<td>• Availability of sales force and distribution networks</td>
</tr>
<tr>
<td>Financial</td>
<td>• Profit margin, time to break-even</td>
</tr>
<tr>
<td></td>
<td>• Product lifetime and rate of return over lifecycle</td>
</tr>
<tr>
<td></td>
<td>• Equity capital and borrowing needed</td>
</tr>
<tr>
<td>Community and Environment</td>
<td>• Location and traffic</td>
</tr>
<tr>
<td></td>
<td>• Environmental discharges</td>
</tr>
</tbody>
</table>

From these definitions, it can be concluded that innovation and commercialization are often used in overlapping ways to refer to the process of ascertaining knowledge, developing it into technologies, and transforming these into new or adapted products, processes and services to be used or sold in the marketplace. Even though commercialization has been identified as being a part of the innovation process, yet the process of commercialization itself is very immense and a thorough discussion on commercialization as one particular stage of innovation is needed.
2.3 Commercialization: Definition, Process and Relationship to NPD Process

2.3.1 Definition of Innovation Commercialization

After having reviewed the evolution of the innovation process (from imitation to commercialization), the study now specifically explores the meaning of commercialization and the models used by many authors to describe the process of commercialization. In the context of innovation, commercialization has been defined as "the process of acquiring new ideas, augmenting them with complementary knowledge, developing and manufacturing saleable goods, and selling the goods in the market" (Krairi, 2004). Commercialization is commonly defined as the competence to use technologies in products across a wider range of markets, incorporate a greater breadth of technologies in products and get products to markets faster (Wonglimpiyarat, 2009). Nevertheless, in the Malaysian context, commercialization means taking an idea to an outcome in the form of a product, service, process or organizational system to be marketed by way of licensing, assignments, spin-offs, or joint ventures (MOSTI, 2009). Thus, technology commercialization can be defined as the process of marketing a new technology or innovation to customers or users through several stages and types of networks. The successful commercialization of innovation is necessary to improve new product development performance by moving technological advances into commercial products, processes and services (Wonglimpiyarat, 2009). This process includes the commercialization of technology that is generated from within the company and technology that is procured from external sources such as other companies, federal laboratories and academic institutions (Li, 2012).

<table>
<thead>
<tr>
<th>Source</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krairi (2004)</td>
<td>The process of acquiring new ideas, augmenting them with complementary knowledge, developing and manufacturing saleable goods, and selling the goods in the market.</td>
</tr>
<tr>
<td>Wonglimpiyarat</td>
<td>The competence to use technologies in products across a wider range of markets, incorporate a greater breadth of technologies in products and get products to markets faster.</td>
</tr>
<tr>
<td>(2009)</td>
<td></td>
</tr>
<tr>
<td>MOSTI (2009)</td>
<td>Taking an idea to an outcome in the form of a product, service, process or organizational system to be</td>
</tr>
</tbody>
</table>
Commercialization is the process of bringing a matured concept to the market in order to make it a commercial success. In the traditional view of commercialization, the NPD process is divided into three steps, namely research, development and commercialization. Commercialization occurs after the launching stage (Adams, Bessant & Phelps, 2006). In this study, the main concern with regard to this perspective on commercialization is that innovations and products have no connection with the market once they are launched. According to the literature, innovations have had a remarkable failure rate of 40-50%, and this performance has not changed much over the past 20 years (Chiesa & Frattini, 2011).

2.3.2 New Product Development (NPD) and its Definition

The success of a new product is based on innovation. Firms are able to introduce innovations into the market by through a NPD process. The innovation from the NPD activity is either developed by the firm itself or by acquiring a licence, patent or joint venture (Kotler et al., 2005).

New product development (NPD) is a complex process. The process of identifying opportunities for a new product, especially a radical or really novel product, is quite difficult. Real innovations that come from the NPD process can offer novel, unique or superior solutions to users' needs, creating entirely new markets (Schmidt, 2005). It is vital for many firms to succeed in developing new products if they are to survive the competition in the market. Additionally, the global business environment of today requires high-speed product development to maintain and increase the competitiveness of companies. Millions of dollars are being spent in acquiring firms to develop new products. Thus, it is very important for companies to ensure that their new products are successfully marketed. Therefore, information plays a key role in reducing the failure of NPD (Nijssen & Frambach, 2006). In the case of the commercialization of new innovations that come from external innovators or (external R&D) through the technology transfer process, the information concerning the products and the involvement of the innovators are very critical. In general, the more innovative a new product is, the more information will be required. Hence, information about the innovation must be fed into the development process so as to increase the success of the commercialization of the new innovation by the acquiring firm.
According to Crawford & Di Benedetto (2000), NPD can be defined as the overall process of the strategy, organization, concept generation, product and marketing plan creation and evaluation, and launch of a new product. This definition seldom refers to that part of the process that is carried out by the R&D and manufacturing units. Neither does it refer to the persons engaged in the task of creating a new product. Another definition of NPD is as a process that starts from a) a motivation goal, b) moves through an idea conception phase, c) is reduced to a practice in its implementation phase, and d) is completed in a transitional phase, during which time the product becomes established (Trott, 2001).

2.3.2.1 NPD Process

Based on the above definitions, the term of NPD can be used in many disciplines of study, depending on the researcher. Hence, “NPD” can be used by those in the marketing field, while those in the technical field refer to it as innovation and also design. Therefore, in this research, the term NPD is used to describe a process that involves commercialization, which is the process of launching of a new product. From the definition above, it can be concluded that NPD is a process. For example, besides the above definition, Ulrich & Eppinger (2012) defined product development as a set of activities, starting with the perception of a market opportunity and ending with the production, sale and delivery of a product. There are many ways to develop a product, as described in the literature, and one such method is shown below in Figure 2.1.

![Figure 2.1: Product Development Process (Ulrich & Eppinger, 2012)](image)

Another process model that can be found in the literature is Cooper's (1990) Stage-Gate model (Figure 2.2). The process is designed to manage the product innovation process in order to improve effectiveness and efficiency. The process is divided into a predetermined set of stages, with each stage consisting of a set of pre-described, cross-functional and parallel activities. Each gate controls the process and is seen as a go or kill point of the process. The criteria for go or kill at each stage are either qualitative or financial. The decisions are made by the gate keepers, often senior personnel (Cooper,
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