

Critical Success Factors for Malaysian SMEs and Large Companies in Commercializing Universities' R&D Outputs

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Abstract Commercializing universities' R&D outputs is a major management challenge and there are limited studies to describe this phenomenon from the perspective of companies' management. Experiences of six small and medium size and four large companies' management's respondents are gathered through semi-structured face-to-face interviews. Twelve critical success factors revealed by the respondents, namely R&D product and market readiness, good partnership with university, researcher's motivation and commitment, availability of resources, government support and motivation, control and ownership of intellectual property rights, university's management support, entrepreneurial culture in the university, an open communication and trusting relationship, researchers' skills, a risk taking attitude, and existence of performance measures as important to commercialize the universities' R&D outputs in Malaysia. The different views from the management of small and medium size, and large companies are also discussed in this study.

Keywords Critical success factors, commercialization of universities' R&D, SMEs, large companies

I. Introduction

Commercialization of R&D outputs either from universities' and/or companies' R&D activities have contributed to the economic growth of a nation and society (Kirchberger and Pohl, 2016; Perkmann et al., 2013; Viale and Etzkowitz, 2010). Commercializing universities' R&D outputs has also provided companies with a competitive advantage against their competitors in

Submitted, September 6, 2019; 1st Revised and Accepted, November 27, 2019

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the market (Kang et al., 2013; Wagner and Wakeman, 2016). In Malaysia, various efforts have been made to improve the commercialization rate of universities' R&D outputs (Govindaraju, 2010; Sirat et al., 2010). However, the recent mid-term review of 11th Malaysia Plan reported that the achievement of the targeted outcomes in commercializing R&D outputs was limited despite a considerable amount of efforts taken to ensure its success (EPU, 2018). The government has urged the universities to continue exploiting the Public-Private Research Network, and link with companies to improve commercialization of universities' R&D outputs for market expansions (EPU, 2018).

Commercializing university's R&D outputs is a major management challenge and there are limited studies to describe this phenomenon from the perspective of companies' management. Fiedler and Welpé (2010) also delineated that it is important to address the issues and challenges in commercializing university's R&D outputs to the marketplace and profiting from the technological innovation.

A study by Chun et al. (2015) reported that the difference in the firm's size does affect the R&D's commercialization efficiency. Small and medium size (SME) and large companies faced different challenges in commercializing universities' R&D outputs (Fiedler and Welpé, 2010). Hence, there is a need to investigate the Critical Success Factors (CSFs) of commercializing universities' R&D outputs from the companies' management perspectives. The different views from the management of SMEs and large companies are also discussed in this study, and these are expected to be valuable to universities' management and researchers in managing future commercialization activities.

II. Critical Success Factors in Commercializing Universities' R&D Outputs

There are twelve Critical Success Factors (CSFs) that are discussed in this section namely (1) R&D product and market readiness, (2) good partnership with university, (3) researcher's motivation and commitment, (4) availability of resources, (5) government support and motivation, (6) control and ownership of intellectual property rights, (7) university's management support, (8) entrepreneurial culture in the university, (9) an open communication and trusting relationship, (10) researchers' skills, (11) a risk-taking attitude, and (12) existence of performance measures. First and foremost, the readiness of the R&D products developed by the universities and the readiness of the market to accept these new R&D products is crucial. Thursby and Thursby (2002; 2003) found that university's R&D are either too basic or do not align itself to the company's strategy. On the other hand, if the R&D output is too complicated or highly sophisticated, the companies especially the SMEs will find it too difficult

to absorb mainly due to the expertise on specific R&D outputs which might not be at the same level of understanding or knowledge. As such, linking the universities' and companies' strategies and capabilities, and selecting a suitable target market segment including the readiness (and preparedness) of the market, have contributed to the success of commercializing universities' R&D outputs (Cooper and Edgett, 2010; Slater and Mohr, 2006).

Secondly, having a good relationship with universities has become increasingly important to companies when commercializing their R&D outputs (Adam et al., 2001). Past scholars revealed that consistent and good partnership between companies and universities is the key for success in commercializing universities' R&D outputs (Fujikawa et al., 2016; Ismail et al., 2015; Soetanto and Geenhuizen, 2015; Striukova and Rayna, 2015; Yee et al., 2015). However, according to HM Treasury (2003), companies and universities are not natural partners. The high-information asymmetries between companies and universities have been characterized as high uncertainty by Veugelers and Cassiman (2005). Thus, the relationship between universities and companies need to be managed well to mitigate the asymmetries.

The university's researchers also play an important role in establishing a partnership for their R&D outputs to be commercialized (Boehm and Hogan, 2013; Clarysse et al., 2011). Universities' researchers are required to develop hybrid professional identities that includes teaching, learning and research, and commercializing their R&D outputs (Jain et al., 2009). Lundström and Stevenson (2002) stressed it is important to acknowledge the hybrid professional identities and the underlying researchers' motivation and commitment in commercializing their R&D outputs. Other researchers further elaborated that researchers' motivation and commitment will accelerates the speed of commercialization and sustain further developments required at the later stage (D'Este and Perkmann, 2011; Siegel et al., 2007; Thursby and Thursby, 2003).

Besides the above mentioned, availability of resources is also essential in ensuring the success of commercializing universities' R&D outputs (Dhewanto and Sohal, 2015; M'Chirgui et al., 2016; Nordin et al., 2016). According to San et al. (2012), the factor that obstructs the commercializing universities' R&D outputs is limited financial resources. However, O'Shea et al. (2007) indicated that companies and governments funds play a strong role in commercialization of universities' R&D outputs. Besides funding, Eesley et al. (2013) asserted that personnel that manages the commercialization activities should have entrepreneurial experiences, marketing and management skills, and good foresights in exploiting new inventions and innovations. Additionally, universities with experienced researchers and industry liaison/technology transfer personnel in universities will show better performance in commercializing universities' R&D outputs (O'Shea et al., 2007). In addition,

technology transfer offices play an important role to accelerate the speed of commercializing universities' R&D outputs (Hsu et al., 2015).

Apart from the above mentioned, government also plays a major role to support and motivate the university researchers to be more engaged with companies to increase the efforts to commercialize their R&D outputs (Striukova and Rayna, 2015; Tartari et al., 2014). The government can directly influence R&D commercialization by providing funding for basic research, promulgating of products and developing process regulations, while indirectly influencing financial and tax regulations. Chang and Chen (2004) attested that government support in the form of grants and interest-free loans have a stimulating effect on the performance of companies in either undertaking R&D themselves and/or commercializing universities' R&D outputs. In addition, the government should provide the inventors (person, persons, or employer) with the rights to the inventions to encourage cooperation between university researchers' and companies.

Shane and Stuart (2002) found that protection of R&D inventions has increased the success rate in commercialization. The control and ownership of intellectual property (IP) rights entail the possibilities for researchers to protect and safeguard the research through filing for patents or other means of protection. Giving universities the control and ownership of IP rights have contributed to the successful commercialization of universities' R&D outputs (Colyvas et al., 2002; Wagner and Wakeman, 2016). There is also a past study that indicated companies' ownership of universities' R&D outputs also enhances its success rate of commercialization (Li et al., 2008). Nerkar and Shane (2007) further elaborated by stating comprehensive scope has attributed to IP rights protection, increased the success of commercialization, and reduced likelihood in imitation of the R&D outputs produced.

Past researchers asserted that universities' leadership and their management's support is another critical success factor in commercializing universities' R&D outputs (Gao and Haworth, 2016). The university's management needs to prevent cultural bias and potential conflicts of interest, where academic and commercialization of R&D outputs activities should be separated (Van Burg et al., 2008). However, the inflexibility and bureaucracy associated with the management of universities have often been viewed as probable barriers (Blumenthal et al., 1996; Siegel et al., 2003). The university's management that establish inflexible rules and governing procedures on commercialization of R&D outputs may provide little opportunity for researchers to agree with potential companies. Moreover, support from university's management include buying out teaching hours, providing monetary rewards, and recognizing the efforts in professorial promotion also important (Collier, 2007).

The influence of the entrepreneurial culture has been recognized as a factor that contributes towards the successful commercializing universities' R&D

outputs (e.g. Datta et al., 2015; Hsu et al., 2015; Siegel et al., 2003). The entrepreneurial culture drives the entrepreneurial orientation of the university. According to Hsu et al. (2015), the entrepreneurial culture serves as a rare resource that helps commercializing the universities' R&D outputs. Therefore, it is very important for university's management to implement university-wide mechanisms with the aim of fostering the entrepreneurial culture (Datta et al., 2015; Hsu et al., 2015). University could foster the entrepreneurial culture through proper motivation schemes, interdisciplinary research and entrepreneurial development programs.

Open communication and trusting relationship among companies and universities are vital (Fontana et al., 2003), and need to be managed well. The goals of the university are to disseminate new knowledge that is critical to the social and economic development to the country (Djokovic and Souitaris, 2008). In contrast, the ultimate goals of a company are to enhance its competitive advantage and maximize shareholder return (Porter, 1985). Hence, clear communication to partners are vital to avoid any misunderstanding, doubt, distrust and the risk of failed partnership (Li, 2005). Open communication will lead to a trusting relationship between partners. Bleeke and Ernst (1991) asserted that trusting relationships enable partners to obtain high efficiency and to avoid conflict. Past studies have shown that trusting relationship takes time, however, it is worthwhile objective in the long term (Santoro and Saparito, 2005).

Besides the critical success factors mentioned above, the researchers' skills are essential when commercializing their R&D outputs. Golish et al. (2008) found that there is a significant difference in success rate between researchers with an academic versus an industrial background in commercializing their R&D outputs. University researchers with industrial background are equipped with commercial knowledges, such as market evaluation, business plan preparation, venture capital and team collection, and space and equipment assembly.

Past studies shown that having a risk-taking attitude by its management is vital to companies' strategic growth and survival (Eisenhardt 1989; Zahra et al. 2004; Sanders and Hambrick 2007). Companies deliberately commercialize universities' R&D outputs to gain a competitive advantage against its competitors, generate profit from additional product lines, and at the same time, risk a high probability insufficient return from capital investments (Cabralés et al., 2008). However, the association between the management's risk-taking attitude and commercializing universities' R&D outputs varied depending on its context or situation (Guo and Jiang, 2019).

Last, but not least, the existence of performance measures is critical for commercializing universities R&D outputs (Al-Mubarak et al., 2013; Payumo et al., 2012). The existence of a performance measurement system ensures the success by stimulating and guiding the companies when commercializing

universities' R&D outputs. However, due to the differences between SMEs and large companies, where SMEs use less formalized R&D procedures, and their networks have different characteristics (Spithoven et al., 2013). Hence, the performance measures for commercializing universities' R&D outputs are expected to be different for SMEs and large companies.

III. Research Approach

The qualitative research approach was deployed in this study to retain the holistic and meaningful characteristics of real-life events by studying the subject matter in its social contexts (Creswell, 2014). In particular, the views of the respondents were gathered through semi-structured face-to-face interviews. Face-to-face interviews were conducted to gain an understanding of the factors that will result in the success for commercializing universities' R&D outputs. Semi-structured interview questions were adopted to capture the respondents' lived experience, opinions, and expectations (Patton, 2002).

Table 1 List of industries' interview respondents

Respondent	Position	Field of Business	Type
P1	Manager	Engineering	SME
P2	CEO	Healthcare	SME
P3	Director	Engineering	SME
P4	Founder	Human Resource	SME
P5	Researcher	Engineering	SME
P6	CEO	Aquaculture	SME
P7	Researcher	Pharmaceutical	Large company
P8	CEO	Pharmaceutical	Large company
P9	Director	Plantation	Large company
P10	Manager	Biotechnology	Large company

The interview sessions were conducted at different times and locations and lasted for about an hour each. The selection of respondents was based on purposive sampling (Creswell, 2014) where six small and medium size, and four large companies' management are interviewed (see Table 1). The interviews were audio-taped for transcribing purposes. The transcribed interview data were e-mailed to the respondents. Their feedback was then obtained to further validate the data (Patton, 2002; Yin, 2014). The transcripts were analyzed and evaluated

via a comparative analysis, as suggested by Miles et al. (2014). The analysis of data was undertaken using thematic coding using the NVivo version 12 software as a tool (Miles et al., 2014; Yin, 2014).

IV. Perspectives from SMEs and Large Companies

The tree-maps generated using Nvivo 12 (refer to Figure 1 and Figure 2) show the CSFs from the perspectives of SMEs and large companies' respondents. The size of the box indicates the frequency and importance viewed by the respondents. Both SMEs and large companies' respondents indicated that R&D product and market readiness is the utmost important CSF for commercializing universities' R&D outputs. All respondents (P1-P10) revealed that they are very clear on the types of products or technologies needed for their business. Hence, as commented by P10, '... the industry will know what they need and what is good for them, whether it is commercially viable or not.' However, P10 highlighted that 'when university researchers do innovation, they are not doing it based on the market or customer's needs. They are doing it by chance.' P3 added that 'as you see, you might be ready, your knowledge might be ready, but in the real world, it is not ready.' In other words, the respondents (P1-P10) prefers R&D products that are ready for the market when commercializing universities' R&D outputs. However, it was found that SMEs' respondents placed more importance on the same CSF than large companies' perspectives. This was due to the capability differences between SMEs and large companies where SMEs could not afford developmental cost when commercializing universities' R&D outputs. While large companies have more resources in developing the universities' R&D outputs.

In addition, SMEs respondents believed in having good partnership with university are the important CSF after R&D product and market readiness. The SMEs' respondents (P1-P6) revealed that main reason was due the limited R&D capabilities and resources. Hence, the SMEs respondents depend heavily on the good partnership with the university to gain access to R&D capabilities and resources especially funding, talents and facilities. For example, P6 asserted that universities have the expertise that can add tremendous value to their business in relation to R&D. P6 added by saying 'if SMEs want to do R&D, but they do not have the capabilities to conduct R&D, it is good to work with the university.' The SMEs respondents also praised the university researchers who actively applying for government grants together to support the partnership.

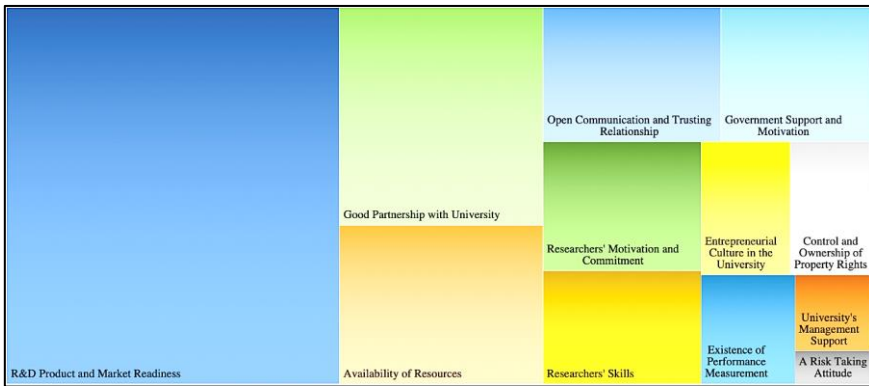


Figure 1 Tree map nodes from SMEs' respondents' perspectives

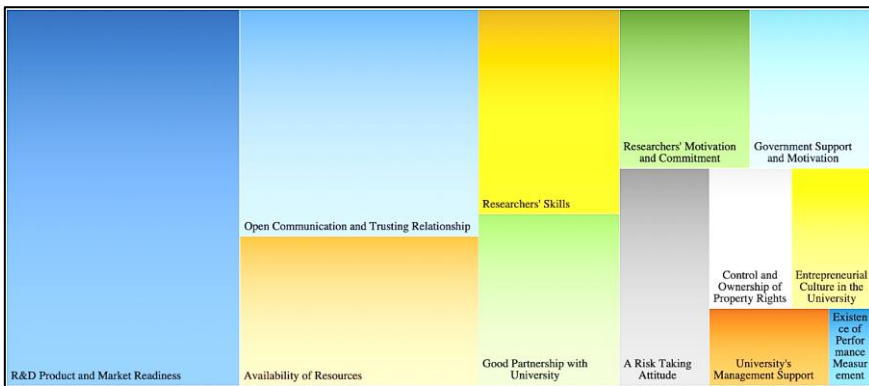


Figure 2 Tree map nodes from Large companies' respondents' perspectives

On the other hand, the large companies' respondents (P7-P10) revealed that open communication and trusting relationship is the most important CSF after R&D product and market readiness. The large companies' respondents prefer open communication and trusting relationship than good partnership with university. The large companies' respondents expect both researchers and companies must keep informing each other on the progress whether it is research progress or the business progress for commercialization. For example, P8 commented that 'one of the integral parts in industry and universities is to be able to realize any R&D project and to commercialize is to update the progress to each other.' The universities often failed to inform the companies about the different stages in R&D, while the companies often failed to trust their research partner. These misconceptions and miscommunication between both parties have resulted in that universities are often perceived as being an organization that is not interested in doing business. Hence, the large companies' respondents

felt that both parties must treat each other as ‘research partners’ and ‘business partners’ to encourage open communication and trusting relationship.

Both SMEs and large companies’ respondents ranked availability of resources as third CSF for commercializing universities’ R&D outputs. Based on the analysis, large companies were found to have more access to resources than SMEs. Hence, it is challenging for SMEs to commercialize universities’ R&D output. SMEs need to rely on the partnership with university in order to have access to R&D capabilities. In addition, the partnership with university also leads to the access of government grants where commercialization grants require the collaboration between university and industry. Whereas, from large companies’ perspectives, availability of resources is not a challenge for them.

In addition to abovementioned, it was found that the large companies’ respondents appreciate researchers’ skills than researchers’ motivation and commitment. P5 commented that ‘... researcher cannot be too rigid in the field of study only.’ The companies especially the large companies’ respondents (P6-P10) expected the researchers to be more versatile and trans-disciplinary in order to extend their knowledge. In addition, they also expected researchers to be business minded. P9 stated that ‘... researchers can tell you the technical part, but they cannot sell.’ Furthermore, most of the time, the researchers were found incapable to pitch well to the industry as the industry unable to picture the market for the R&D output (P7). Researchers must at least have the common sense of business when commercializing their R&D outputs.

In contrary to the large companies’ respondents, the SMEs’ respondents valued more researchers’ motivation and commitment than researchers’ skill. One of the main reasons was due to limited resources of SMEs as compared to large companies. SMEs were not able to adopt quickly if there are changes in the partnership with the university researchers. The SMEs respondents preferred loyal and committed researchers for commercialization activities (P1-P6). It is important that the individual researcher works closely with the SMEs in order to produce the intended results as it is the combination of people that are important which constitutes success of the partnership and not the organization or institution. Similar to large companies, the SMEs respondents also expects open communication and trust with researchers when commercializing R&D outputs.

In addition, it was found that large companies’ respondents are relatively higher in risk-taking as compared to the SMEs’ respondents. As shown in Figure 1, risk-taking is the least mentioned by the SMEs respondents as compared to large companies’ respondents. However, the existence of risk cannot be avoided especially in the case of commercializing universities’ R&D outputs. This was identified as one of the reasons the SMEs were reluctant to work with universities in commercializing R&D outputs. However, from the analysis, the SMEs’ respondents emphasized on control and ownership of property rights as

compared to risk-taking. Interestingly, the statement above is different from the large companies' respondents where the large companies' respondents believed that risk-taking is more important than control and ownership of property rights. In other words, large companies are relatively higher in risk-taking than the SMEs respondents. The SMEs respondents placed higher importance on the control and ownership of property rights as it reduces risk when commercializing R&D outputs. Besides that, in order to minimize risk, the government support and motivation were found to be more important among SMEs respondents than large companies' respondents. The SMEs respondents revealed that they received various supports from the government in order to embark on commercializing universities' R&D outputs.

From broader perspectives, all respondents (P1 - P10) mentioned risk-taking as one of the least critical success factors for commercializing of R&D outputs (see Figure 1). P10 commented that industries in Malaysia are still not willing to take risk in investing R&D products. P9 added that 'the role of industry is very selective, when they invest in technology commercialization ... we want proven technologies and take off.' In other words, the companies hope to invest in R&D outputs that are commercially viable in order to reduce the risk. P9 added that '... we cannot afford to buy technologies and try to experiment it. We want ready product.' The industry is also skeptical when investing in new technologies. However, both SMEs and large companies' respondents criticized on the entrepreneurial culture in the university. Furthermore, entrepreneurial culture is also one of the least mentioned CSF by the respondents (P1-P10).

Besides the above, most respondents also revealed that they received little support from the university's management. The companies are working closely with researchers instead of university management. Furthermore, as revealed by P9, there is element of uncertainty when dealing with university's management. In order to rectify situation, it is timely for the university to minimize the level of bureaucracy by empowering and delegating decision making to other parties (P1 and P2). Importantly, from companies' perspectives, time and opportunity cost are vital when commercializing R&D outputs. In addition, based on Figure 1 and 2, performance measures are identified as least important from all respondents. It was found that SMEs mentioned more about the existence of performance measures than the large companies. One of the reasons is because SMEs need to keep track on the record on the performance of commercializing R&D outputs in order to minimize the risks.

V. Discussion and Conclusion

Past studies examined the commercialization of universities' R&D outputs from the perspectives of industries respondents (Adam et al., 2001; Perkmann et al., 2013; and Wakeman and Wagner, 2016). This study has presented the CSFs in commercializing universities' R&D outputs from the perspectives of SMEs and large companies, and this knowledge is important in managing such activities. This study further contributed by differentiating the views between the SMEs and large companies. Furthermore, it was found that CSFs in commercializing universities' R&D outputs are intertwined and it cannot exist independently. Hence, the ability to converge and combine the factors may escalate the successful commercialization of universities' R&D outputs. Commercializing universities' R&D outputs are still at its emerging stage in the Malaysian environment. In this study, SMEs are seen to be more open and likely to collaborate/partner with universities to commercialize their R&D outputs due to their dependency on universities' R&D capabilities. SMEs management also realized that continuing to innovate, invent and commercialize R&D outputs are inevitable to gain competitive advantages against its competitors. However, the SMEs need to have a risk-taking attitude when commercializing universities' R&D outputs as compared to large companies. In addition, continuous financial and tax incentives support from government, an open communication, and a trusting partnership between companies (i.e. both SMEs and large companies) and universities are required for commercializing universities' R&D outputs in Malaysia. In conclusion, the different views by respondents on the success factors found as 'critical' formed the basic underlying understanding for universities that intend to collaborate/partner with different size of companies to commercialize their R&D outputs. The limitation of this study is it did not examine the interaction of the CSFs. Hence, it is suggested to further the study by examining the relationships of the CSFs in commercializing universities' R&D outputs.

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