CRITICAL FACTORS OF SUCCESSFUL COMMERCIALISATION OF UNIVERSITIES' R&D OUTPUTS: THE PERSPECTIVE OF UNIVERSITY LEADERS IN MALAYSIA

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Abstract

The Ministry of Education Malaysia aims to accelerate the commercialisation of research and development outputs under the Shift 7 of the Malaysia Education Blueprint 2015–2025 for Higher Education. Despite much emphases and supports for commercialising the R&D outputs from universities, the success rate is still low at 3.4%. Few past studies indicated that university leaders play an important role in increasing the commercialisation rate. Hence, this study identifies and describes the critical factors that lead to successful commercialisation of R&D outputs from the perspectives of university leaders. Eight university leaders were interviewed to gather their lived experiences. The eight critical factors revealed by the respondents are the availability of resources, researchers' motivation and commitment, the university's management support, the control and ownership of property rights, R&D product and market readiness, entrepreneurial culture, partnership with industry, and government support and motivation. This study found there is a difference in ranking of the critical factors between public and private universities in Malaysia.

Keywords: critical factors, successful commercialisation, universities, Malaysia, university leader

1.0 Introduction

The Ministry of Education (MoE) Malaysia aims to accelerate the commercialisation of research and development (R&D) outputs under the Shift 7 of the Malaysia Education Blueprint 2015–2025 for Higher Education, through the introduction of various efforts in the universities (Ahmad et al., 2012; Ismail et al., 2015; Sirat et al., 2010). Despite much emphases and supports for commercialising the R&D outputs from universities, the success rate is still low at 3.4% in the year 2010 (Chandran Govindaraju & Wong, 2011; EPU 2015) which is below the government's aim of 5% by year 2020 (EPU, 2015). In a recent mid-term review of the 11th Malaysia Plan, the outcomes on commercialisation of R&D outputs were still limited (EPU, 2019). A past study supported above mentioned by indicating that the commercialisation of universities' R&D outputs has gained growing relevance and importance (Markman et al., 2008). The universities are the primary engine in enabling transformation towards a knowledge-based economy for a nation. In the same year, research universities in Malaysia have pioneered in stimulating the commercialisation of their R&D outputs (Ramli et al., 2013). Hence, there is a need to examine the critical factors that lead to successful commercialisation of R&D outputs of universities in Malaysia and recommend efforts that can be taken to enhance its success rate.

In addition, the Malaysian University and University Colleges Act 1971 was amended in year 2012 by changing the definition of university education to:

> *"…education provided by a University or University College at the preparatory, undergraduate, postgraduate, or postdoctoral level and includes research and development and the commercialisation of such research and development."*
>
> Universities and University Colleges (Amendment) Act 2012, para. 2.

There are 20 public universities and 91 private universities in Malaysia (JPT, 2019). Both public and private universities

have the roles of providing quality education and commercialising their R&D outputs as an additional mean of income source and at the same time, to ensure a higher rate of return from R&D fund invested by the government. Scholar asserted that private universities have respond efficiently to the market demands (Balan, 1990) by offering courses demanded by the market and responding to the needs of economy and society (Patrinos, 1990). Few past scholars added by stating private universities prefer to offer high private benefit programmes while the role of research is less importance (Johnstone et al., 1998; Wan, 2007; Wilkinson & Yussof, 2005). Thus, it is interesting to examine the similarities and differences of critical factors in commercialising R&D outputs between public and private universities in Malaysia.

Past studies also indicated that university leaders play an important role in determining whether a university's R&D outputs can successfully be commercialised (Gao & Haworth, 2016; Weckowska, 2015). University leaders in Malaysia are tasked to commercialise the R&D outputs as one of the university's key performance indicators (MOE, 2015). Therefore, the aim of this study is to examine the similarities and differences in critical factors of successful commercialisation of universities' R&D outputs from the perspective of public and private university leaders in Malaysia.

2.0 Critical factors for the commercialisation of R&D outputs

Prior researches conducted overseas, namely in the US, the UK, Australia, Korea, Japan, and Taiwan, have outlined various factors that contribute to successful commercialisation of universities' R&D outputs (e.g. Gao & Haworth, 2016; Hsu et al., 2015; Jung et al., 2015; Lee et al., 2017; Kalar & Antoncic, 2015, Shibayama, 2015; Soetanto & Geenhuizeh, 2015; Sompong et al., 2014; Striukova & Rayna, 2015; Symeonidou et al., 2017). Although many factors were presented in the above studies, a combination of factors is important than concentrating on individual factor separately (Conceicao et al., 2002). Hence, the factors identified in this study include the availability of resources, researchers' motivation and commitment, the university's management support, R&D product and market readiness, entrepreneurial culture, and partnership with the industry. Another variable, government support and motivation in terms of policies and funding, was also deemed critical to the commercialisation of universities' R&D outputs in developing countries such as Malaysia (Brimble & Doner, 2007; Kumar et al., 2015). In addition, in developed countries, the control and ownership of property rights has affected successful commercialisation of universities' R&D outputs (Swamidass, 2013). The eight factors are further elaborated in the following sub-section.

2.1 Availability of Resources

The first and foremost, successful commercialisation of universities' R&D outputs is affected by resource availability, which includes human resources, institutional resources, financial resources, and commercial resources (Hsu et al., 2015). San et al. (2012) listed limited funding and restricted investments as the factors that hinder R&D outputs from being successfully commercialised. The commercialisation of universities' R&D outputs is commonly resource-restrained; hence the acquisition of external funding is essential. Therefore, sustainable government investment is crucial, especially in Malaysia (Ahn & York, 2009). Besides funding, Ahn and York (2009) stated the need for more capable staff to become involved in future research and subsequently contribute to the successful commercialisation of R&D outputs in universities. Human resources play a role in achieving this end since competent personnel for handling R&D output commercialisation is a major factor and are a most valuable strategic resource. However, it is important to note that personnel from different backgrounds may practice different approaches. Nevertheless, new talent also provides new expertise, ideas, and knowledge. Availability of industry partners, networks/contacts and market also contribute towards successful commercialisation of universities' R&D outputs (Ismail et al., 2015).

2.2 Researchers' motivation and commitment

Besides resources, Jain et al. (2009) found that university researchers have developed hybrid professional identities; they have a central primary academic role involving teaching and learning, undertaking research and development, and holding a secondary role in commercialising their R&D outputs. Hence, it is important to acknowledge the importance of the hybrid professional identities underlying the researchers' motivation and commitment to successfully commercialise R&D outputs (Lundström & Stevenson, 2002). Past researchers stressed that the motivation to engage in the commercialisation of R&D outputs is more about conducting successful R&D, receiving a good academic reputation in their research field, and providing contributions that advance their research, rather than ensuring financial return per se (D'Este & Perkmann, 2011; Siegel et al., 2003). However, the researchers' motivation to successfully commercialise R&D outputs can be improved through proper designed incentive systems (Siegel et al., 2003). In addition, the researchers' support in providing information and knowledge on the R&D outputs to the industries is vital. In most cases, the researchers are the inventors and innovators of those R&D outputs; hence being more accustomed to the R&D outputs enable expedited in commercialising them (Thursby & Thursby, 2003). Thus, the commitment of the researcher to continuously become involved in the commercialisation of R&D outputs is an important factor that determines whether the endeavour will prove successful. On the other hand, the industry can increase the motivation and commitment of researchers by giving financial returns (e.g. royalties, licensing fees etc.) to the researchers if they have successfully commercialised.

2.3 University's management support

Gao and Haworth (2016) asserted that the university's management support is one of the key factors for the successful commercialisation of R&D outputs. The university's management supports such as policies (Swamidass, 2013), technology transfer office (TTO) (Debackre & Veygelers, 2005), and performance measures (Siegal et al., 2007) that support commercialisation of R&D outputs. Policies include establishing organisational ambidexterity within a university, developing a dedicated R&D commercialisation centre, allowing university researchers to hold shares and/or directorships, and providing rewards and incentives. Establishment of TTOs (Ambos et al., 2008) and compensations such as royalties, licencing fees and academic promotional opportunities (Siegal et al., 2007) would incentivise university researchers to commercialise their R&D outputs. Recognition of collaborative research, contract research, consultation, and networking, would encourage university researchers to embark in commercialising their R&D outputs. However, it is challenging to find a general performance measure framework that would provide a basis for comparison and improvement to the current systems in universities (Eggnik, 2012).

2.4 R&D product and market readiness

Other than the three critical factors mentioned above, past scholars have asserted that the newness, superiority, and uniqueness of R&D outputs are the main motivations that spur industry in taking universities' R&D outputs to market (Nordin et al., 2016; Wang et al., 2012). However, some R&D outputs require further development which requires further funding. 99.2% of the total company establishments in Malaysia are Small and Medium Enterprises (SMEs) (SMECorp, 2012) with limited financial and human resources. Thus, SMEs prefer technology that are readily to be manufactured into marketable products (Nordin, et al., 2016). Hence, R&D outputs or products that are at the final stage and require less further development i.e. ready for mass production will have a higher chance of commercialisation. Besides R&D product readiness, market readiness is also essential. According to Khademi et al. (2014), market orientation and an understanding of the customer are keys to the successful commercialisation of universities' R&D outputs. In other words, the researcher needs to identify the right industry partner to collaborate with whereas the industry partner to identify its end customers (Slater & Mohr 2006; Khademi et al., 2014).

2.5 Entrepreneurial culture

Entrepreneurial culture refers to the university's general environment and its institutional principles, beliefs, and values that contribute to the successful commercialisation of universities' R&D outputs (Datta et al., 2015; Hsu et al., 2015; & Siegel et al., 2003). According to Hsu et al. (2015), R&D outputs' commercialisation highly dependent on the unique institutional factors that build an atmosphere and form its unique tradition or culture, which is an uncommon resource. Entrepreneurial culture often relates to organisational revolution, for example, the eagerness of researchers to dynamically look for new R&D outputs (D'Este & Perkmann, 2011; Kirchberger & Pohl, 2016). Furthermore, the industry's strong commitment to the R&D outputs is also a facilitating factor. Therefore, it is important that universities and industries share a clear common goal, and high flexibility in negotiating commercialisation agreements (Siegal et al., 2003).

2.6 Partnership with the industry

Past scholars have shown the importance of a partnership with the industry in commercialising universities' R&D outputs successfully (Bozeman & Gaughan, 2007; Arvanitis et al., 2008; Soetanto & Geenhuizen, 2015; Striukova & Rayna, 2015; Yee et al., 2015; Fujikawa et al., 2016). Adams et al. (2001) stated that partnership with universities has become particularly important to industries, especially the SMEs. Geuna and Muscio (2009) further indicated that industry knowledge has impact in escalation of the current scale of universities' R&D commercialisation. Thus, the university-industry collaboration is important (Lee, 2000; Yee et al., 2015). In contrast, Veugelersa and Cassiman (2005) posited that university-industry collaborations might not necessarily result in successful commercialisation of universities' R&D outputs due to the high uncertainty and high information asymmetries between the collaborators.

2.7 Government support and motivation

Governmental support is an important element for stimulating R&D projects and for commercialising universities' R&D outputs. It encourages universities and companies to conduct challenging, high-risk research with uncertain outcomes, especially in developing countries (Liefner & Schiller, 2008; Rasmussen, 2008). The government can directly influence the commercialisation of universities' R&D outputs by providing basic research funding, promulgating of products, and developing of process regulations. Besides that, indirect government influence through financial and tax regulations might encourage industry to commercialise universities' R&D outputs. Rasmussen (2008) revealed how government policies are structured to provide resources (including funding) in commercialising universities' R&D outputs, encouraging innovation, and creating networks between universities and companies. The World Bank (2000) reported that universities in developing countries heavily rely on funding to compete with developed countries in academic and research. Empirical studies also supported the notion that in developing countries, governmental support and motivations such as policies and funding are essential to encouraging universities' R&D commercialisation (Brimble & Doner, 2007). 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 SMEs and their success in commercialisation of universities' R&D outputs.

2.8 Control and ownership of property rights

Last but not the least, the control and ownership of property rights also critical in ensuring success in commercialising universities' R&D outputs. The control and ownership of property rights refer to the ability to obtain the property rights of the new R&D outputs and as an option for the researchers to protect their researches through patents. A past research has asserted

that embryonic R&D outputs, university's control, and ownership of the R&D outputs have contributed towards successful commercialisation of universities' R&D outputs (Swamidass, 2013). Intellectual property (IP) rights are less important for advanced R&D outputs. Shane and Stuart (2002) found that protecting R&D outputs has increases the commercialisation rate of universities' R&D outputs. Furthermore, the industry ownership of universities' R&D outputs (Li et al., 2008), and a wider scope of property rights protection (Wagner & Wakeman, 2016) have contributed towards its success in commercialisation while the likelihood of imitation R&D outputs can be reduced.

3.0 Research Approach

This study applied a qualitative research approach, utilising an inquiry process of understanding based on a distinct methodological inquiry that explores social or human problems (Creswell, 2014). In particular, the respondents' lived experiences, opinions and expectations were captured in this study (Patton, 2002). The selection of the respondents (see Table 1) was based on purposive sampling to ensure in-depth understanding (Patton, 2002) of the critical factors that contribute to the successful commercialisation of universities' R&D outputs. Leader in research-intensive universities were selected as the respondents of this study which include both public and private universities in Malaysia. Semi-structured face-to-face interviews were conducted at different times and location to capture the 'experiences' of respondents (Yin, 2014). Each interview lasted for about an hour. The respondents were asked using a set of interview questions developed to address the proposition developed for this study (see Table 2 for interviews questions and Table 3 for the propositions tested in this study).

Table 1 List of universities interviewed

Respondent	University Code	University Type	Position
R1	U1	Public	Deputy Vice Chancellor
R2	U2	Public	Manager of TTO
R3	U3	Public	Deputy Vice Chancellor
R4	U4	Public	Deputy Vice Chancellor
R5	U5	Public	Manager of TTO
R6	U6	Private	Manager of TTO
R7	U7	Private	Manager of TTO
R8	U8	Private	Deputy Vice Chancellor

The narrative data (audio) were converted to partially processed data (transcripts). In order to validate the data, the transcribed interview data were e-mailed to the respondents to obtain their feedback (Patton, 2002). Then, NVivo version 12 software was used as a tool to analyse and code the validated data by means of analytic themes established using typical content analysis procedures and comparative analysis, as suggested by Miles et al. (2014). The analysis compares the similarities and differences of critical factors for successful commercialisation of universities' R&D outputs in Malaysia between public and private universities' leaders.

Table 2 Key interview questions for universities' leaders

No	Interview questions
1	Can you share on the direction and vision of your university in terms of commercialising its R&D outputs?
2	What policies do your university have in supporting the commercialisation of R&D outputs? What are the factors considered during development of the commercialisation policy?
3	What are the critical factors for successful commercialisation of universities' R&D outputs?
4	Are there any challenges that your university faced in commercialising your R&D outputs? If yes, please elaborate further.

Table 3 Propositions tested in this study

No	Propositions
1	How do the availability of resources explain the critical factor for the successful commercialisation of universities' R&D outputs?
2	How do researchers' motivation and commitment explain the critical factor for the successful commercialisation of universities' R&D outputs?
3	How does university's management support explain the critical factor for the successful commercialisation of universities' R&D outputs?
4	How does R&D product and market readiness explain the critical factor for the successful commercialisation of universities' R&D outputs?
5	How does entrepreneurial culture explain the critical factor for the successful commercialisation of universities' R&D outputs?
6	How does partnership with industry explain the critical factor for successful commercialisation of universities' R&D outputs?
7	How does government support and motivation explain the critical factor for successful commercialisation of universities' R&D outputs?
8	How do control and ownership of property rights explain the critical factor for successful commercialisation of universities' R&D outputs?

4.0 Comparison of critical factors of successful commercialisation of R&D outputs between public and private universities' leaders in Malaysia

The similarities and differences of critical factors contributing to the successful commercialisation of universities' R&D outputs between public and private universities' leaders in Malaysia are discussed in the following sub-section. Interviewing of the eight respondents from public and private universities' leaders revealed the eight factors that contribute to the successful commercialisation of universities' R&D outputs. Figures 1 and 2 show the tree-map generated from NVivo software where the size of the box indicates the frequency and its importance as viewed by the universities' leaders.

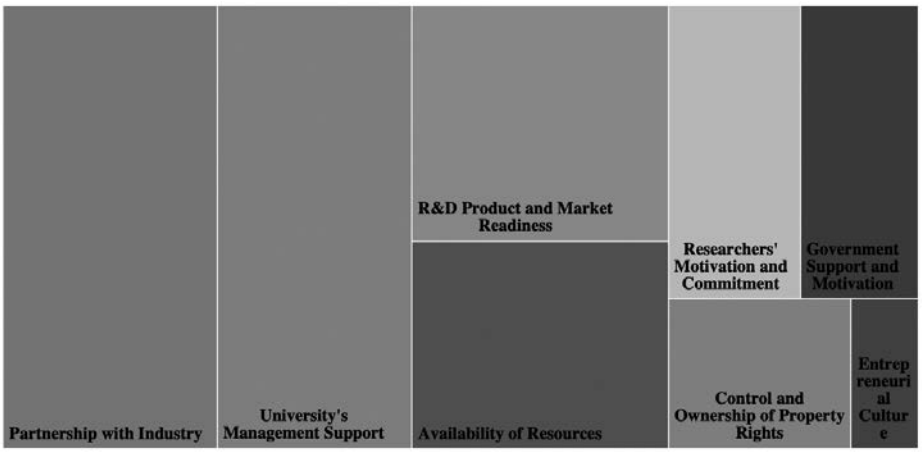


Figure 1 Tree map of nodes from the public universities' leaders' respondents

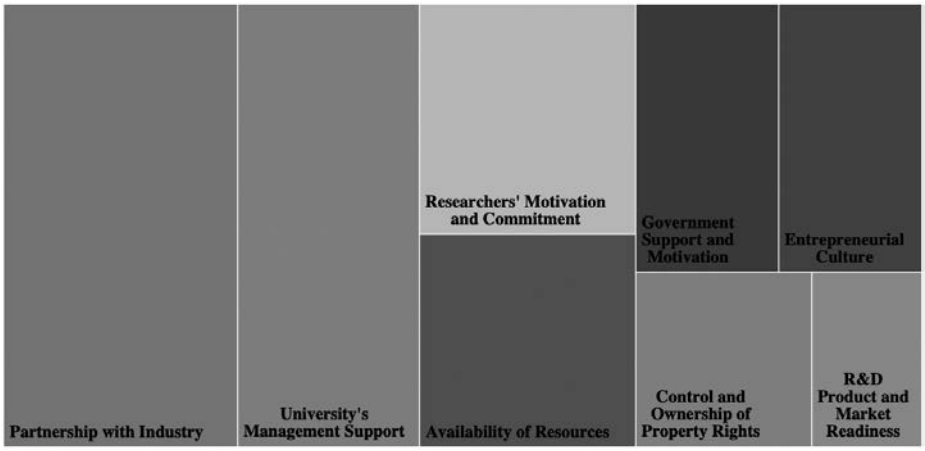


Figure 2 Tree map of nodes from the private universities' leaders' respondents

4.1 Similarities in critical factors contributing to the successful commercialisation of R&D outputs

Interview finding revealed that two factors ranked as the utmost critical in successful commercialisation of universities' R&D outputs. All respondents from the public and private universities' leaders (R1 to R8) revealed that partnership with industry was the utmost critical factor follow by university's management support. R3, R2, and R8 commented that the best way to capitalise on research and commercialisation activities is to work together with the industry partner because the industry is in a much better position in bringing the R&D outputs to market. "*Universities do not have the same capability of understanding market demands as compared to the industry*", said R4, R5 and R6. R3 commented that '*it should be the industry that comes in and assists the university to take the product to market.*' Hence, it is important for university researchers to forge a strong relationship with their industry partners (R7).

In U8, one of the performance indicators for a university is its number of strategic industry partners. R8 elaborated that the type of strategic industry partners refers to the '*kinds of large scale and long-term partnership we have, such as MoU or MoA.'* In addition, R7 commented that the commercialisation of universities' R&D outputs would be easier if the initial researches have industry partners. One of the strategies adopted by U3 and U1 is that "*most of our research must indicate that we are working with industry partners towards a solution*". Most industries begin with a small problem to build trust and confidence in a partnership. Once trust has been established, the industry will move forward and work closely with the university. For example, in Taiwan and Korea, as mentioned by R1, '*the industry has confidence in the universities and they really go to the universities for solutions.*' Hence, it is important to have a close collaborations with industry partners by building trust and confidence with them from an early research stage.

The interview with universities' leaders' respondents revealed the motivation for a possible partnership is important. One of the motivations is the sharing of facilities for R&D activities. For example, in U1, the industry set up a joint facility in the university campus to carry out R&D activities. To make the campus more vibrant with the presence of industries, U3 rented out spaces for the industries in their campuses. Another motivation is to obtain funding from government agencies to support the commercialisation process. R2 commented that '*they come for collaboration and solutions because the government funding strategies i.e. the pre-commercialisation activities funding has changed. This motivates them to come to us to get patent, upscale, mass production.*' Besides that, R5 added that '*those that need us most are the people who want to tap into our resources to gain access to government grants. All grants use the triple helix concept.*' In other words, the mechanism of funding by the government has encouraged the industry to work closely with universities.

Besides partnership with the industry, another critical factor that was considered by all universities (i.e. U1-U8) is the university's management support. The support from the university includes support from the top management, research support, the environment, the talent, and the process of commercialisation of R&D outputs. The top management of public universities (i.e. U1, U2, U3, U4 & U5) had introduced a new position i.e. the Deputy Vice Chancellors in Industry and Community Linkages to enable a closer relationship between the university, the industry, and the community. In contrast, private universities i.e. U6, U7 and U8 support commercialising of R&D outputs by putting the responsibility on the Deputy Vice Chancellor of Research and Innovation. Furthermore, all universities have introduced a policy for commercialisation of R&D outputs. R1 commented that this policy '*aims to do what it does best; to provide an avenue for the university to commercialise R&D products.*' R6 added that the '*policies are intended to provide support, guidance, and framework to enhance the researcher's productivity.*' Hence, the policy serves as a clear support to the aims and processes of commercialising R&D outputs. The policy also defines IP and describes how universities should manage it including stakeholder involvement.

Furthermore, all selected universities (public & private) have a commercialisation unit and an IP office to support the researchers in commercialising their R&D outputs. These offices assist the researchers in managing grants, protecting IPs, licensing processing, and preparing agreements. R3 commented that '*one of the things that we assist them with is protecting the IP. The IP could be a form of patenting, copyright, trade secret, etc. and we assist them to look at the patent search, and the filing of patents.*' In addition, all public universities (i.e. U1, U2, U3, U4 & U5) have allocated some funding (e.g. prototype funding) for researchers. However, no funding has been allocated for private universities (U6, U7 & U8). Hence, private universities need to depend on external funding (e.g. the industry and government) to further develop their R&D outputs. Besides that, commercialisation offices also provide platforms for researchers to find suitable industry partners through local and international trade exhibitions, pitching sessions, and technology matching sessions. The office also assists in matching the market to the researcher when it comes to commercialising their R&D outputs.

Other than that, all universities (U1 to U8) also provide training programmes to enhance skills of the researchers, as commented by R6, '*academic researchers may be lacking the "business" language required to "sell" their ideas or products.*' Hence, all universities (U1 to U8) somehow provided training programmes for researchers to develop their skills in speaking the "business language". For example, according to R3, '*we organise trainings for our researchers. It could be anything from IP to all the way to commercialisation. We do trainings in-house, and we invite speakers from TPM, MTDC, to share the commercialisation pathways and how to pitch products.*' U1 has organised various programmes such as the technopreneur programme, spinoff programme, and accelerated programme. R1 commented that '*we created these programmes for researchers to take technology out across this valley to reach a point where the industry would be ready to take it up.*' In the case of the selected private universities, the researchers are given time off annually to do external work. This is to encourage the researchers to nurture a closer relationship with the industry.

4.2 Differences in critical factors for commercialisation of R&D outputs

From the tree-map nodes (Figure 1 and Figure 2), the interview findings showed that university leaders from public universities have different views as compared to private university leaders. The following subsection discusses the differences in critical factors for the commercialisation of universities' R&D outputs and its reasons.

4.2.1 Public universities' leaders' perspectives

The interview findings from public universities' leaders' respondents (R1 to R5) revealed that R&D product and

market readiness are the most critical factor after partnership association and the university's management support. The ability to penetrate into a market through differentiation strategies or creation of a new market is important to ensure the success of the R&D outcomes commercialised and later, its sustainability. R&D in the commercial sector is very market-driven and problem-focused. However, the R&D in universities mostly begins with fundamental research and is later developed into applied research. R5 commented that '*researchers just do research without looking at market demand. The technology may be obsolete when it is completed and so they need to start on another product*.' On the other hand, R1 elaborated that '*generally, our industry is not ready for new technologies or innovation*.' This is because most of the industries in Malaysia are SMEs. R1 added '*the small size of our industries cannot absorb new technologies. We have previously tried to give them early-stage technologies, but they become really stuck. They just do not have the capacity to absorb it*.' Besides that, R3 commented that '*our SMEs are not ready to invest in developing IPs. That is why a lot of SMEs that come to us are mostly shopping for technologies*'. The SMEs prefer technologies ready for market and unwilling to invest in further product development. Hence, the universities and industries rely on the government to provide grants to help them invest in the R&D product development.

Another critical factor mentioned by the public universities' leaders' respondents (U1 to U5) is the availability of resources. All public universities' leaders' respondents (R1 to R5) mentioned that most of the resources to support R&D activities are already available. These resources include the management of R&D, funding, facilities, infrastructure, and equipment. However, there are limited resources that push R&D outputs towards commercialisation. This is because the commercialisation of R&D outputs requires another round of funding to support its activities. R4 commented that '*commercialisation costs money, and scaling up costs money. Both are not cheap. Bringing certain ideas, and a proof of concept to the table can cost a lot.*' For example, in U3, R3 commented that '*the researcher could ask for spaces such as a small-scale facility but the university does not have the money to allocate for such facilities.*' R3 added that '*the university does not have the resources or the investment to commercialise on its own.*' Hence, the selected public universities have no choice but to work together with industries and government agencies to gain access to the resources required for commercialising their R&D outputs. For example, U1 has recently set up an industry pilot plant together with an industry partner. They set up joint facilities with U1 to commercialise their R&D outputs. In addition, as mentioned in the previous subsection 4.1, public universities also work together with industry partners to gain access to government funding.

The remaining critical factors mentioned by the public universities' leaders are the researchers' motivation and commitment, government support and motivation, control and ownership of property rights, and entrepreneurial culture. Since public universities have been receiving funding from the government, they do not place much concern about the sustainability of the university. Hence, according to all public university respondents (R1 to R5), commercialisation is always something that is above and beyond their job task. Furthermore, R3 commented that '*it is not even our duty or responsibility to take a product to market. Because our role is to research and teach.*' However, the partnership with industry and support from the university's management have pushed public universities towards commercialising their R&D outputs. The demand from the industry has forced and motivated the researcher to become involved in this venture.

4.2.2 Private universities' leaders' perspectives

The universities' leaders' respondents from the private universities (i.e. R5 to R8) mentioned researchers' motivation and commitment, availability of resources, and entrepreneurial culture, as the critical factors for commercialising R&D outputs. Respondents from the private universities, R5 to R8, agreed that the motivation and commitment of the researchers are critical to commercialising R&D outputs. The selected private universities relied heavily on the researchers to commercialise their products. Furthermore, they believed that the availability of resources also contributed towards this aim. However, R7 commented that '*generally, our R&D cannot be compared with that of Research Universities because they have grants.*' In other words, the pri-

vate universities do not have enough funding to commercialise their R&D outputs as compared to research universities. They are dependent on their limited internal funding while need to compete for external funding. Hence, the entrepreneurial culture within the private universities is critical to achieving this end. R8 commented that '*one of the key challenges to promoting the idea of knowledge transfer in a broader sense is that it can benefit the society and this is worth more than just a generic financial price tag.*' Thus, the setting and communication to foster entrepreneurial culture are critical to motivating researchers to commit and search for resource availability, so that they can commercialise their R&D outputs.

The remaining critical factors mentioned by the respondents are government support and motivation, control and ownership of property rights, and R&D product and market readiness. Government funding and schemes are one of the important motivators. R8 commented that '*if the government were to create schemes that matched funding, this would draw the interest of academics and the industry as well.*' All respondents agreed that the industries and the researchers would always stay motivated if funding is promised.

In addition, all respondents shared that university management is sceptical at the thought of paying for the IP filing fee (R5 to R8). University researchers are not experts in exploiting the IPs filed. Interview finding revealed that IP is often not negotiated at the initial stage of collaborations but only negotiated when the IP is about to be commercialised. For example, R7 commented that '*the industries fund the research. However, a disadvantage is that you could lose some IP positioning.*' Thus, there is much disagreement between the university and the company regarding IP ownership, which could jeopardise the partnership and commercialisation of R&D outputs. The R&D product and market readiness factor was the least important factor for private universities. This is because the industry partnership will eventually lead to the development of the R&D product that the industry needs (R7).

5.0 Discussion and Conclusion

Governmental support and industry involvement through collaborations are much needed to motivate and expedite the R&D commercialisation process in Malaysian universities especially in a developing country context. Despite that, the R&D outputs should contain ground breaking ideas or leading-edge technologies, so that they could be positioned as niche products that are differentiated from their competitors. A market needs analysis is crucial to determining the success of commercialising universities' R&D outputs. There is a need for a centralised national unit to perform a stock-take of universities' expertise, equipment and R&D outputs; to exploit the opportunity commercialising fundamental academic research; to identify new and emerging research areas; to develop sustainable business models; to undertake market research; and to monitor/audit the commercialisation of universities' R&D outputs.

Furthermore, the knowledge on commercialisation should be incorporated into science and non-science course curricula in Malaysian universities. The passion to innovate and an enterprising culture should be cultivated among the younger generation to propel our nation to a greater height. MoE should encourage multi-disciplinary courses that provide holistic education and foster the development of soft-skills, innovation skills, creativity, and analytical thinking. Last but not the least, the innovative entrepreneurial culture needs to be promoted and nurtured in universities whilst ensuring that a mentoring and coaching systems are in place. These efforts will greatly benefit Malaysia's human capital development and nation building.

This study has presented the critical factors for successful commercialisation of universities' R&D outputs in Malaysia from the perspectives of public and private universities' leaders. Each factor cannot exist by itself because they are intertwined with each other. Therefore, the ability to ability to converge and combine the factors as presented will help to escalate the successful commercialisation of universities' R&D outputs to a much greater height while contributing to the nation's economy. Hence, it is suggested to further the study by examining the interactions among the critical factors for successful commercialisation

of universities' R&D outputs. In addition, multivariate correlation analysis is recommended for future researchers to consider or as our future study when the environment is much more developed in future with availability of larger population for testing.

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