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Barrier Towards Commercialisation of Research Findings Among Science and Engineering Academicians at Malaysian Public Universities

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Abstract

Instead of performing traditional roles and responsibilities, academicians are encouraged to be involved in commercialisation activities. The commercialisation of university research findings contribute to income generation and introduce knowledge, product, or services innovation to the current markets. However, the number of commercialisations among academicians is still limited. Due to this issue, the objective of this study is to identify the types of barrier leading to difficulties for academicians to commercialise their research findings. A study of 450 Malaysian public university academicians in the Science and Engineering fields indicated that all barriers discussed in this study received a high level of acceptance. The result indicated that commitment and time barriers were the most crucial barriers, followed by orientation, experience and skills, financial support and incentives. The result will acknowledge the stakeholders for preparing them to avoid any difficulties while moving their idea into the commercialisation stage.

Keywords: Commercialisation, Academician, Barrier, Research and Development

Introduction

The traditional roles of the university are teaching and conducting research activities; nowadays, the roles change to be more entrepreneurial, known as 'third stream activity' (Malairaja & Zawdie, 2008). Commercialisation activities have become essential to develop the economy, wealth, and innovations. In Malaysia, many initiatives to enhance the commercialisation of public research and development (R&D) was introduced since the Sixth Malaysia Plan (1991–1995) (Chandran, 2010), and the Government of Malaysia (GOM) also improved their commercialised plan by increasing initiatives from the seventh until eleventh Malaysia Plan (2016–2020). One of the initiatives is TechnoFund, known as pre commercialisation fund provided by the Ministry of Science, Technology and Innovation (MOSTI). This fund was officially launched during the Ninth Malaysia Plan (2006–2010) (Abdul

Jalil et al., 2010). The fund helped develop new or improve existing products or technologies in specific areas to establish new businesses or create wealth creation for Malaysia and undertake market-driven R&D towards commercialising R&D output. Besides, recently, some R&D funds were introduced by the Ministry of Science, Technology and Innovation to support the R&D and commercialisation activities.

However, in Malaysia, commercialisation is one of the critical issues faced by the researchers. This statement is supported by Chandran et al (2009); Ismail et al (2008); Suhaimi, Abdul Halim, and Hashim (2020); there are still a limited number of commercialisation of research findings produced by university researchers. In addition, Ismail, Nor and Sidek (2015) indicated that the commercialisation of research findings among academicians in Malaysia is not progressing and encouraging. According to Thiruchelvam's (2004) study based on a survey conducted by MOSTI, from the year 1991 until 2000, only 5% of research projects were recorded as successfully commercialised. Besides, during the Eighth Malaysian Plan (RMK8), IRPA was approved around 836.9 million, leading to 2,139 projects. Assessment toward R&D projects funded by IRPA showed that only 3.4% of projects were commercialised during the period (Ninth Malaysia Plan, 2006–2010). Besides, the Ministry of Higher Education (MOHE) research in August 2008 shows that 313 R&D products are produced in Malaysian public universities. The products are estimated to have the potential to commercialise; however, results show only 58 (18.5%) products produced from that activity were successfully commercialised.

In addition, based on an interview with eight universities and industry leaders involved in a collaboration project under a government research grant in Malaysia, all the projects faced difficulty in commercialising the research findings. Most of the outputs produced from the collaboration projects were still not commercialised (Ramli, 2019). As indicated by Ansari, Armaghan, and Ghasemi (2016), a huge number of academic research findings are not moving to the production and commercialisation stage; thus, it contributes to the loss of resources. Therefore, this study acknowledges that university researchers face issues that lead to difficulty commercialising research findings. Chandran et al. (2009) indicated in Malaysia, the government provides few efforts to determine the constraints and solutions for the problem in research institutions to commercialise their R&D findings. The objective of this study as below:

- To identify the types of barriers in commercialising research findings among academicians.

Literature Review

The lack of commercialisation of research findings in Malaysia can be determined by improving the knowledge regarding the factors that lead to that problem. This study discusses four barriers in commercialising research findings: financial support and incentives, orientation, commitment, and experience and skills.

Financial support and incentives: To commercialise research findings requires a large amount of money as commercialisation activities take a long time and include more costs to develop further research findings (Yaakub et al., 2011). According to Schacht (2012), researchers are needed to spend a high amount of cost establishing commercialise activity, while a previous study indicates that 25% of the total cost was spent for this activity. Besides, Chandran (2010) mentioned that finances are a significant element for researchers to commercialise their research findings successfully. The limited amount of financial support for academic

researchers is a barrier to commercialising their research findings. As supported by Tapsir et al. (2010), the amount of financial support for public universities is still limited; it is because the funding provided by the government to universities is focused more on fundamental research. Beyadar et al (2021) and Xuyen, Huong and Huong (2020) indicated that a university depends on the limited government budget which leads to impeding academic researchers to involve in commercialisation activities.

In addition, a study explained that university faced financial limitations due to a lack of support from industry sectors (Chandran, 2010). This will lead to issues in the effort of university researchers to commercialise their research findings. This is supported by several previous researchers who allocated that the amount of financial support spent by industry sectors for the university research activity is the lowest percentage if compared to the amount provided by the government and the university itself (Hall, 2001; Hanal & St-Pierre, 2006). Besides, results indicated that the probability of university commercialising their research findings increases when the industry provides financial support for university research activities (Gulbransen & Smeby, 2005; O'shea et al., 2005). According to O'shea et al. (2005) and Powers and McDougall (2005), results explained that the financial support received from the industry has a positive significance to increase the number of spin-off companies developed. A study conducted by Gulbransen and Smeby (2005) showed that financial support received from the industry has a positive influence on the development of new companies, patents and commercialised research findings. According to them, the possibility of a professor implementing research and development activities that contribute to patents is 1% when he or she did not receive any financial support from the industry. At the same time, the percentage is estimated to be 7% when the industry provides financial support. However, Hottenrott and Thorwarth (2011) contrast with the above studies, where the study showed that they do not have any impact on the number of patents produced from university research when university researchers received financial support from industry sides. The results only showed positive relation to the number of patent citations.

Past studies agreed that financial problems have been positively significant on the problem in commercialising university research findings (Ismail et al., 2008; Ismail et al., 2012; Chandran, 2010). Based on universities' perspectives, a qualitative study showed that financial problems are the main issues in commercialising their research finding, representing 86.7% of total respondents. These studies also explain that university researchers have difficulty receiving financial support, especially during the pre-commercialisation period (Aslan, 2006; Ismail et al., 2008). A study conducted in Malaysia showed that financial issues for R&D activities influence commercialisation activities and will be barriers for researchers to establish licensed companies (Kamariah et al., 2012). Ansari et al (2016) also supported that a limited number of financial investments is an important barrier. This study based on agricultural research indicated that insufficient budget allocated by the university and the reluctance of bank to involve due to high investment risk in this sector would affect the ability of the research to move the research findings into the commercialisation stage. As indicated by Suhaimi et al. (2020), the academicians' behaviour takes advantage of the financial support to conduct research and development as important elements of successfully commercialised research findings. Nowadays, there are some financial supports in Malaysia to encourage commercialisation activities; thus, the academician should take this opportunity to transform their idea into a real product that can be commercialised into the markets.

Besides that, the incentives issue also has been discussed by previous researchers. According to Yaakub et al (2011), this issue will lead to difficulty for university researchers in

commercialising their research findings. Siegel, Waldman, Atwater, and Link (2003) lead to difficulty transferring technology from university to industry, which they believed is due to lack of incentives for academics involved in technology transfer activities. According to interview results, patents and collaboration with industry are not the criteria used to give promotion or tenure, but the institutions prefer grants and the number of publications produced by the researchers (Siegel et al., 2003). Based on Ismail et al (2008), the result explains a lack of incentives for commercialising activities in Malaysia. A similar result is recorded in some other countries. A study that compared the commercialisation environments in three countries, the US, China, and Japan, shows that the academic researchers determined that lack of incentive or reward is the barrier in commercialising research findings. To improve the collaboration and commercialisation activities, China takes initiatives to change the incentive system (Nilson, Friden & Serger, 2006). However, Malaysia recently has enhanced the efforts to provide incentives for researchers, especially in public universities. The academic researchers gained reward and recognition through patentability of their research results. Besides, to offer promotion for academic's staffs, patents are also important indicators that will be preferred (Ismail et al., 2008). Studies show that incentives affect the licensing activities (Friedman and Silberman, 2003) and revenue from those activities (Lanch & Schankerman, 2003). According to Lanch and Schankerman (2003), when the number of royalties given to researchers raises to 10%, the amount of license revenue will rise 14 per cent.

Orientation: Orientation is defined as the differences in both institutions' research and organisation culture, leading to difficulty in commercialising research findings. A study conducted in Vietnam by Xuyen et al. (2020) mentioned that university researchers are not interested in commercialisation activities, focusing mainly on education or training. In addition, Beyadar et al (2021); Ansari et al (2016); Namdarian and Naimi-Sadigh (2018) indicated culture as one of the important barriers towards commercialising research findings. Besides that, commercialisation culture and proper training, workshop or conferences should be provided to the university researchers in order to encourage, guide and support the university research to commercialise their research findings.

Past studies have determined that collaboration between university and industry can successfully commercialise university research findings (Suhaimi et al., 2020; Ramli & Zainol, 2013). Collaboration encourages commercialisation and enhances knowledge-based commercialisation by sharing resources. Universities contribute their expertise; meanwhile, industries invest a large number of fundings (Ramli & Zainol, 2013). Establishing effective collaboration will benefit both partners; it helps solve problems and share profits generated from commercialised university research findings (Suhaimi et al., 2020).

However, recently, there still lacks interaction or collaboration between university and industry; thus, the outputs produced by university researchers do not meet the industry requirement. Xuyen et al (2020) indicated a lack of collaboration between university and industry as the barriers in commercialising university research findings. Thus, the university research is still in the sample or laboratory stage; besides, it is a high risk for the industry to invest as the research outputs still do not meet the industry needs and requirements. According to a study conducted in Netherlands and Mexico by Faber (2001) based on firm collaborative projects to develop new products, the result mentioned that when a firm establishes collaboration with external institutions, this poses several problems and challenges to manage the projects. It is stemmed from the differences in culture, aim, work practice and strategy implemented by both collaborating partners.

Some studies have discussed the different goals between both partners and differences, which would lead to barriers. The university's main goal is knowledge (Patil, 2012; Rohrbeck and Arnold, 2006), but it is different for the industry. Knowledge is useful for the industry if it can be transformed into a solution for a problem and can help develop competitive products for the market (Rohrbeck and Arnold, 2006). The main goal of the industry is to gain and increase profits by commercialising the products and gaining a competitive advantage (Rohrbeck and Arnold, 2006). A study conducted by Lee, Ohta, and Kakehi (2010) explained that different goals between both collaboration stakeholders encourage the conflict of interest between them in establishing collaboration. It also leads to conflicts on IP rights. In addition, a study based on a firm's new product development area has mentioned that having a clear goal is an important element to emerge with effective products. Thus, if the firm's goal and direction for the new product development are not clear, it is difficult for them to achieve an effective project (Lord, 2000).

Experience and skills: University researchers require two important skills, which are technical and entrepreneurial skills. Lack of both skills can also lead to difficulty in commercialising university research findings. Besides, lack of skills and experience to face the issues in commercialising activities are also indicated as important factors that lead to difficulty in marketing research findings successfully (Ismail et al., 2008). Namdarian and Naimi-Sadigh (2018) indicated lack of knowledge, skills and unfamiliarity with the commercialisation procedure would be disadvantageous for the researchers to commercialise their research findings.

Some studies focused on the skills of academics in TTO, which determine significant influences on constraints for a university to commercialise research findings. Technology Transfer Office (TTO) is an effective mechanism introduced today to encourage collaboration with industries (Friedman & Silberman, 2003; Lee et al., 2010) and help university researchers to commercialise their research findings (Ismail et al., 2012; Friedman & Silberman, 2003; Lee et al., 2010). A study conducted by Friedman and Silberman (2003) explained that to successfully transfer technology from the university, the important factors that need to be considered are TTO and university management. The results of this study also determined that TTO experiences have significance on the licensing activities. According to Chandran (2010), the university usually lacks skill and expertise in managing TTO; thus, this will impact their invention management and the information that is transferred to industries. This issue also promotes the barriers in establishing collaboration between universities and industries. When this happens, university researchers will face the problem of commercialising their research findings.

Commitment and time limitation: Studies conducted by Aslan (2006) and Ismail et al. (2008) showed that in Malaysia, the problem in commercialising university research findings is based on the issues of commitment within university researchers. Business higher education forum (2001) indicates that the academics commitment issues in establishing collaboration between university and industry are due to academics' time limitation. University time is limited, and academicians have some responsibilities to fulfil. This is supported by previous studies that explained that academicians have limited time to focus on collaboration and commercialisation due to their responsibilities toward teaching and students (Tapsir et al., 2010; Business higher education forum, 2001). Commercialisation activity is also taking a long time to successfully market the products to end customers (Yaakub et al., 2011).

Besides, studies in Malaysia also showed the same results. Ismail et al. (2012) indicated that this issue would encourage or enhance the problem to university researchers in commercialising their findings and developing license companies. According to Yaakub et al. (2011), even university researchers show concern about commercialisation; however, they face issues of time and knowledge to establish collaboration with industry sides.

Methodology

This study implemented a quantitative research method. The data was collected through a survey questionnaire and analysis done through SPSS. Descriptive analysis (frequency and mean analysis) was conducted to answer the research objective. The level of acceptance is based on the range means discussed by Allam et al. (2020), as in Table 1.

Table 1. Mean range score

Acceptance level	Mean score
Low	1.00 – 2.33
Medium	2.34 – 3.67
High	3.68 – 5.00

In this study, the population consists of the academicians from Science and Engineering Faculties at Public Universities in Malaysia. The questionnaires were distributed by email and 450 responses were received. The 450 respondents involved in the actual study met the sample size suggested by previous researchers, Krejcie and Morgan (1970) and Sekaran and Bougie (2010). The research instrument measured variables on a five-point Likert scale, from strongly disagree to strongly agree. The operationalisation of the variables and the questionnaires in this study are shown in Table 2.

Table 2. Research Variables and Items

No	Variable	Item
1	Financial support and incentives	High amount of cost needed to commercialise research findings Reliance on government budgets Insufficient financial support from the government Limited financial resources allocated to commercialise research findings by university Lack of investment of the industry in basic research Inadequate budgets allocated for applied research in the university Lack of incentive structures (non-financial incentive) such as staff recognition
2	Orientation	Different mission between partners where the university mission is knowledge while industry mission is to generate profits University is focused on providing education while the industry is focused on producing competitive products University research is oriented towards pure science or basic research, while the industry is oriented towards applied research Lack of commercialisation culture among university researchers Lack of awareness among university researchers on commercialisation of research findings Lack of awareness of industry actors toward technologies produced in universities
3	Experience and skills	Lack of technology and technical skill among researchers Lack of entrepreneurship skills among university researchers Lack of prior experience in commercialisation of research findings Lack of experience dealing with the industry Lack of interaction or communication skill among researchers Researchers lack familiarity with the commercialisation process
4	Commitment and time limitation	Due to lower urgency, a university researcher takes a longer time to finish research than an industry researcher University researchers have rather limited time for research as they have other academic matters to be concerned of Insufficient commitment from researcher toward commercialisation

Results

In this study, the internal consistency reliability of the variables was assessed using Cronbach's coefficient alpha. Table 3 presented the Cronbach's coefficient alpha results for the types of barriers in commercialisation. The results show that all variables received Cronbach's coefficient alpha of more than 0.60. Cronbach's value for financial and incentives was 0.831,

orientation (0.791), experience and skills (0.844) and commitment and time limitation (0.646). The Cronbach's alpha value for overall items in the instrument was received (0.891). Thus, it explains that the research instrument is reliable to the context of the study.

Table 3. Cronbach's coefficient alpha of the types of barriers in commercialising university research findings

Variable	No. of item	Alpha (α) value
Financial support and incentives	8	0.831
Orientation	6	0.791
Experience and skills	6	0.844
Commitment and time limitation	3	0.646
Total	23	0.891

Respondents' Characteristics

This study involved 450 respondents, consisting of 150 lecturers from sciences and 300 lecturers from engineering fields. Table 4 showed that most respondents were Malay (86.67%), followed by Chinese (6.89%), others (4.22%) and Indian (2.22%). In addition, female lecturers represented 50.67% meanwhile male lecturers were 49.33%. Besides, almost half of the respondents were aged between 31 to 40 years old (42.67%). As for the level of higher education, 80.89% of lecturers have a PhD, while 17.56% have a master, 1.11% a degree, and only 0.44% represented by 2 respondents have a diploma as their higher education level. The results also indicated that 24% of respondents have 11 to 15 years of working experience, followed by 1 to 5 years (19.33%), 6–10 years (18.67%), more than 20 years (18.45%), 16–20 years (16.22%) and only 3.33% have below 1 year of working experience. Finally, the majority of respondents (74%) involved in this study have no experience being involved in commercialisation; meanwhile, 26% have experience in commercialising their research outputs. Some types of commercialisation are produced by the respondents, such as licensing, software, services, patent, product, new plant variety, copyright, robotic services, and industrial design. Based on the result, it can be concluded that patent is the most frequent type of commercialisation by academicians, followed by licensing and copyright.

Table 4. Demographic Statistics (N=450)

	Demography	Frequency	Percentage
Ethnic	Malay	390	86.67
	Chinese	31	6.89
	Indian	10	2.22
	Others	19	4.22
Gender	Male	222	49.33
	Female	228	50.67
Age	Below 30 years old	7	1.55
	31–40 years old	192	42.67
	41–50 years old	161	35.78
	51–60 years old	73	16.22
	Above 60 years old	17	3.78
Faculty	Science	150	33.33
	Engineering	300	66.67
Academic	Diploma	2	0.44
	Degree	5	1.11
	Master	79	17.56
	PhD	364	80.89
Working experience	Below 1 year	15	3.33
	1–5 years	87	19.33
	6–10 years	84	18.67
	11–15 years	108	24.00
	16–20 years	73	16.22
	More than 20 years	83	18.45
Experience involved in commercialisation	Yes	117	26.00
	No	333	74.00

Descriptive Analysis

Table 5 indicated the percentage and mean analysis for the types of barriers that influenced the university researcher to commercialise their research outputs successfully. The result showed that commitment and time barriers was the most important barrier with total mean score 4.0748, followed by orientation (4.0704), experience and skills (3.9744) and financial support and incentives (3.9572). All variables received a high acceptance level, with a mean score above 3.68, as suggested by Allam et al. (2020). Analysis of each item determined that almost all of the items received a high level of acceptance. The higher mean score was university researchers have rather limited time for research as they have other academic matters to be concerned about, 89.6% agree and mean score, 4.4289. Then, followed by lack of prior experience in commercialisation of research findings (85.5%, Mean: 4.2822), lack of investment of the industry in basic research (80.6%, Mean: 4.2422), high amount of cost needed to commercialise research findings (80.90%, Mean: 4.2333), the university is focused

on providing education while the industry is focused on producing competitive products (79.50%, Mean: 4.2089) and different mission between partners where the university mission is knowledge while industry mission is to generate profits (79.20%, Mean: 4.2022). Only two items received the moderate acceptance level and considered the lowest percentage of agreement among the academicians. These two items were lack of interaction or communication skills among researchers (58.9 %, Mean: 3.6356) and lack of technology and technical skills among researchers (53.20%, Mean: 3.4644).

Table 5. Result of Descriptive Statistics – Type of barriers to commercialise university research

Items	Percentage of agreement (%)	Mean
High amount of cost needed to commercialise research findings	80.90	4.2333
Reliance on government budgets	77.80	4.0933
Insufficient financial support from the government	56.50	3.7244
Limited financial resources allocated to commercialise research findings by university	67.80	3.9089
Lack of investment of the industry in basic research	80.60	4.2422
Inadequate budgets allocated for applied research in the university	67.40	3.8644
Lack of incentive structures (non-financial incentive) such as staff recognition	63.10	3.7644
Lack of incentive structures (financial incentive) such as bonus, profit sharing, cash prize or promotion	65.50	3.8267
Financial support and incentives (total mean)		3.9572
Different mission between partners where the university mission is knowledge while industry mission is to generate profits	79.20	4.2022
University is focused on providing education while the industry is focused on producing competitive products	79.50	4.2089
University research is oriented towards pure science or basic research, while the industry is oriented towards applied research	72.40	3.9822
Lack of commercialisation culture among university researchers	78.40	4.1000
Lack of awareness among university researchers on commercialisation of research findings	67.80	3.8200
Lack of awareness of industry actors toward technologies produced in universities	77.70	4.1089
Orientation (total mean)		4.0704
Lack of technology and technical skill among researchers	53.20	3.4644
Lack of entrepreneurship skills among university researchers	78.20	4.1133
Lack of prior experience in commercialisation of research findings	85.50	4.2822
Lack of experience dealing with the industry	80.00	4.1711
Lack of interaction or communication skill among researchers	58.90	3.6356
Researchers lack familiarity with the commercialisation process	80.50	4.1800
Experience and skills (total mean)		3.9744
Due to lower urgency, a university researcher takes a longer time to finish research than an industry researcher	70.50	3.9089

University researchers have rather limited time for research as they	89.60	4.4289
have other academic matters to be concerned of		
Insufficient commitment from researcher toward	69.80	3.8867
commercialisation		
Commitment and time limitation (total mean)		4.0748

Besides the barriers in Table 5, the academicians also identified some other barriers towards the commercialisation of research findings. The weightage for commercialisation in key performance index (KPI) is much lower compared to journal articles, lack of support from the industry in terms of instruments and equipment, university policy and support system for commercialisation is insufficient. In addition, the lack of government focus on determining the strategic direction of local research, intellectual property issue where the university is too demanding in ownership of IP, university research focuses on basic or fundamental research and with no strong benefits to university researchers, lecturers are expected to do everything, and the university-industry collaboration is extremely uncommon in Malaysia compared to other countries, issues in the administrative bureaucracy and lack of R&D in the industry.

Discussion and Conclusion

Orientation is determined as the most important barrier for university researchers to commercialise their research findings. The academicians believed that different missions and objectives among university and industry would lead to conflicts for them in commercialising. A clear mission and objectives are important; university and industry should share a common goal because the conflict of understanding among them will encourage failures towards the commercialisation activity (Ismail & Sidek, 2019). Houweling (2017) supported that understanding the partners' work mode and objectives is crucial for successful commercialisation. As agreed by the respondents, university and industry still lack understanding about each other's roles and responsibilities. In addition, there is still a massive gap between both institutions; they do not talk to each other and lack trust among them; thus, it encourages barriers towards commercialization. Namdarian and Naimi-Sadigh (2018) and Ismail and Sidek (2019) stated that collaboration between university and industry is recommended for commercial research findings. Research conducted by Ramli (2019) says the university is encouraged to change its current culture; instead of performing the traditional roles, academicians should be ready or be prepared to establish collaboration and commercialisation activities with the industry. However, both institutions need to solve the collaboration gap and limitations to produce research findings that meet the industry or market requirements and have the potential to move into the commercial stage. Namdarian and Naimi-Sadigh (2018) explain that collaboration with industry will enhance the research quality and capital and positively encourage commercialisation of university research.

Instead of culture, the time constraint is also one of the important barriers. This is supported by Yaacob et al (2011), and Vanderford and Marcinkowski (2015). To be involved in commercialisation activities, academicians need to complete their main roles and responsibilities: teaching, research, supervising students, consultation, attending workshops or conferences; thus, it limited their time involved in commercialisation activity. As agreed by the respondents, lecturers are expected to do numerous things to meet their KPI. In addition, a respondent mentioned that teaching activity took too much time, especially the present online teaching and learning activities due to Covid-19. Ismail and Sidek (2019) indicated that instead of implementing their traditional roles, academicians need to sacrifice and spend their

time learning about the commercialisation process. The issue of workload among the academicians should be avoided (Houweling, 2017). To transform the idea into commercialising products, the university needs to support the potential researchers by reducing the workloads (Leisyte & Sigl, 2018) or providing sufficient incentives (Yencken & Ralston, 2005), changing promotion system and policies (Namdarian & Naimi-Sadigh, 2018). Few respondents mentioned that insufficient bonus, incentives, and salary are barriers that influence the academicians interested in commercialising activities. Enhancement of these elements helps to motivate university researchers and boost their commitment. As confirmed by Wahab et al (2020), academician commitment contributes to commercialisation activity. Time limitation also encourages the lack of prior experiences in commercialising among academicians. Based on the results, 74% of academicians in the Science and Engineering fields have no experience in commercialisation. As stated by one respondent, the commercialisation culture is not yet fully instilled among university researchers. Vanderford and Marcinkowski (2015) stated that lack of commercialisation background contributes to a significant barrier. Thus, to encourage the involvement of academicians who lack experience in commercialising activities, the university should prepare them with accurate knowledge and skills by organising training or workshops to educate and increase their awareness of commercialisation. As confirmed by Ismail et al (2015), academicians' technical and entrepreneurship knowledge and skills significantly influence the successful commercialisation of research outputs.

Lack of investment industry in basic research and high cost to commercialise the research findings are other important barriers that influence the commercialisation activities. This is consistent with Namdarian and Naimi-Sadigh (2018) and Schacht (2012). To conduct research that can be moved to production or commercialisation requires huge investment, such as for the purchase of equipment, materials, cost of research and development activities. However, a respondent stated that the industry is not interested in investing and taking the risk. As supported by Yaacob et al (2011), the limited number of financial supports leads to difficulty for the researcher to purchase the equipment; thus, it demotivates the researchers to move into commercialisation.

This study will significantly benefit the body of knowledge and give some inputs to the stakeholders. University researchers can acknowledge the barriers that lead to difficulties for them to commercialise their research output. Understanding the barriers help them have proper preparation to face any challenge during the process of commercialisation. Besides, university and policymakers can benefit by adopting the result as ideas to provide the best practices, proper guidelines, or planning. However, this study involved only Science and Engineering academicians from public universities. Future researchers are suggested to focus on a private university. Further research on the solution factors to reduce the barriers in commercialising should be conducted; thus, it can help reduce the barriers and enhance the number of commercialisation university research findings in the market. An in-depth study based on the academicians who have experience in commercialisation is the best suggestion to get more details based on actual experiences. Conducting this study is important as the commercialisation research findings will benefit the university, industry, society, and the nation.

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