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Proposing a Conceptual Framework on Factors to Develop Successful University Industry R&D Collaboration in Malaysia

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Abstract

R&D collaboration between university and industry is very important as a result of the changes of economic environments and technologies. Currently, universities act as important external institutions for industries in order to enhance their innovations by implementing R&D collaboration. This is due to the benefits of these activities to both institutions involved in the collaboration. However, in Malaysia, the level of collaboration is still low and it is difficult to determine the success of collaborative projects. Because of these issues, the researcher aims to determine the factors that contribute towards the development of successful university-industry R&D collaborations and, at the same time, to suggest the best practices should the collaborative stakeholders are implemented. This study is based on the review of the findings generated from previous researches done in this field of study. Results show that there are three factors that contribute to successful R&D collaboration, namely contextual, process and organizational factors. These factors can be used to establish a successful collaboration and lead to effective outcomes beneficial to the country and the societies.

Keywords: University-industry R&D collaboration; contextual factors; process factors; organizational factors

1.0 INTRODUCTION

Due to globalization, more collaboration needs to be developed in order to become competitive at global environments. R&D collaboration provides various benefits to the collaboration stakeholders and societies. For examples, this kind of collaboration helps industry sectors to encourage innovation and competitiveness (Audretsch *et al*., 2012; Hanel & St-Pierre, 2006; Okamuro, 2007), thus, leads to more profits. Universities can enhance their academic results (Philbin, 2008; Dooley & Kirk, 2007) and, at the same time, enhance their sources of funding (Lee, 2000; Patil, 2012; Schuentze, 2001). Currently, in Malaysia, the number of university-industry collaboration is still few (Hamisah Tapsir *et al*., 2010; Malairaja & Zawdie, 2008; Chandran *et al*., 2009; Aslan, 2006). The issues in the university-industry collaboration are not prominent basically due to the mismatch between both institutions involved (Hamisah Tapsir *et al*., 2010). These issues can be solved by implementing the best practices towards successful university-industry R&D collaboration. According to Thune (2011), the university-industry collaboration performances, especially in determining the success factors, have only been discussed in a few studies. Hence, this study will provide a review on the factors that contribute to successful collaboration, as described by the previous researchers. Therefore, in this study, the best practices that should be implemented in Malaysia in order to establish effective university-industry R&D collaboration are proposed.

2.0 LITERATURE REVIEW

2.1 Success Factors

In order to gain benefits from established university-industry R&D collaboration, both partners should look for effective ways to overcome obstacles in the collaboration (Lee *et al*., 2010). Okamuro and Nishimura (2011) and Mora-Valentine *et al*. (2004) focus on two factors - contextual or contractual and organizational factors - to solve collaboration barriers towards successful R&D collaboration. Other than that, Thune (2011) adds process factor as another relevant element that contribute to successful collaboration between university and industry. In short, the relevant factors used to establish successful R&D collaboration are contextual factors, organizational factors and process factors.

2.1.1 Contextual Factor

Contextual factor refers to the elements needed to establish R&D collaboration between the collaborating partners. This factor is significant during the early process of agreement to establish collaboration between the partners (Valentine *et al*., 2004). In this

study, there are three elements included under contextual factor, namely partners' selection, geographical proximity as well as knowledge and experiences in establishing R&D collaboration between university and industry.

Selecting suitable partners is an important element for successful university-industry R&D collaboration (Barnes *et al*., 2002; Chin *et al*., 2011). In Malaysia, there is still a lack of proper strategy implemented by university and industry in selecting suitable partners (Chin *et al*., 2011). A study indicates that most companies in Korea look for partners from universities within their personal network. On the other hand, in Japan, companies select their partners through academic meeting, university transfer centre and publication (Hemmert *et al*., 2008). According to Fiaz *et al*. (2011), a company's openness is important in choosing suitable R&D partners. 'Openness' refers to the capability to share technical knowledge between companies and their collaborating partners. On the other hand, Mora-Valentine *et al*. (2004), Nokkala *et al*. (2008) and Dunowski *et al*. (2008) consider reputation as the most important factor to select a partner. According to Mora-Valentin *et al*. (2004) the reputation of potential partners can be determined based on the information gathered about them that portrays their positive image. For instance, academic researchers' reputation, such as the capability to develop world class research, can influence big companies to collaborate with them (Seigel *et al*., 2007). Another study shows that, on top of reputation, criteria mostly preferred by companies to select suitable collaborating partners are personal relationships and competence (Dunowski *et al*., 2010). Generally, the partner's research and technical capabilities are recorded as the most frequently considered factor in selecting partners for collaboration (Howell *et al*., 2008). Most suitable partners are those involved in previous collaborations (Mora-Valentine *et al*., 2004; Cyert & Goodman, 1997).

Previous experience in R&D collaboration can help to develop trust (Nokkala *et al*., 2008; Okamuro & Nishimura, 2011), opportunities and familiarity between partners (Thune, 2011). This will increase the probability of both partners running the R&D collaboration smoothly (Nokkala *et al*., 2008) and increased opportunities for successful research projects (Thune, 2011). According to Bruneel *et al*. (2010), the experiences obtained while involved in collaboration has positive relations to lower the orientation-related barriers but will lead to increase the barrier related to Intellectual Property 'IP'. Other than that, knowledge and experience gained during collaboration with industry can also help university to increase understanding about the motive of collaboration (Thune, 2011). A study comparing the university-industry collaboration environments between Japan and Korea indicate that companies in Japan are more experienced in this kind of collaboration. This gives rise to a higher number of experts, which, in turn, leads to more successful collaborations (Hemmert *et al*., 2008). Furthermore, a study conducted by Kaymaz and Eryigit (2011) based on academics perception shows that previous bad experience could reduce the possibility (-0.08, $p \leq 0.01$) of universities to establish collaboration with the industrial sectors. In addition, Hall *et al*. (2000) demonstrate that having previous experiences in research collaboration with universities will help researchers to gain and understand the basic knowledge generated from such activity more effectively.

Another contextual factor that should be considered is proximity. Based on a research conducted by Thune (2011), the proximity of collaboration refers to the geographical proximity, such as proximity between partners that can be regarded as physical distance between both research partners (Mansfield & Lee, 1996). Institutions that are closely located have higher possibility of establishing new research collaborations (D'este *et al*., 2011). A study based on the collaborations between manufacturing firms and universities in Canada shows that proximity is an important element of a successful collaboration as 70 percents of the firms that establish R&D collaboration with universities are located within 100 km (Hanel &St-Pierre, 2006). Another study by Gracia *et al*. (2010) indicates that 71.6 percents of such collaborations are established with partners located within the same states. The possibility of a successful collaboration will increase when the partners are located in the same area due to convenience and effectiveness in communication that will give better results (Thune, 2011). Geographical proximity also plays important roles to increase the strength and outputs of university-industry collaborations (Santoro, 2000). Furthermore, geographical factors are also shown to have significant influences on the establishment of a spin-off company (Kamariah *et al*., 2008).

Additionally, a research conducted by Laursen *et al*. (2011) concludes that geographically proximity between collaborating firms and universities is not significant. This shows that geographical proximity is not the only factor required to create a successful collaboration. Their study indicates that the collaboration potential can be increased due to low cost of interaction as well as trust developed through social proximity, which is more achievable when the firms are closely located to the collaborating universities. On the contrary, Mora-Valentin *et al*. (2004) argue on this factor by demonstrating that there is no significance between geographical proximity with the successful R&D projects. This is also supported by a study conducted in the Europe, where geographical proximity is not indicated as the factor affecting the R&D collaboration (Nokkala *et al*., 2008). Results from this study show that the location of collaborating partners is not an obstacle in establishing successful R&D collaborations. Instead, only meetings can influence the success of R&D projects. Okamuro & Nishimura (2011) also agree that geographical factor is not significant. This is demonstrated by their findings, which state that location of both institutions has negative significance on the contractual and organizational factors in establishing collaborations.

2.1.2 Organizational Factor

Organizational factor can be defined as the elements needed in order to develop an agreement for R&D collaboration between the collaborating partners (Mora-Valentine *et al*., 2004). This factor is suggested by several researchers, such as Thune (2011) and Mora-Valentin *et al*. (2004). Thune (2011) supports that formalization, commitment and resources are the elements that should be considered under organizational factor. Many studies have focused on the importance of trust between both partners in collaboration (Fiaz *et al*., 2011; Mora-Valentine *et al*., 2004; Geyskens *et al*., 1996; Bruneel *et al*., 2011; Dooley & Kirk, 2007).

Commitment from the key person is required in managing R&D collaboration between university and industry. The key person plays important roles to establish and conduct the collaboration (Thune, 2011). Geyskens *et al*. (1996) divide commitment into two types, which are affective commitment and calculative commitment. Affective commitment refers to the tendency of the channel members to continuously maintain their collaboration with a specific partner, while calculative commitment measures the degree to which the channel members experience is needed to maintain the relationship. Results of a study show that institutions with high commitment can help to overcome the barriers in research collaboration (Lee *et al*., 2010). Furthermore, the commitment of collaborating partners has positive influences on the establishment and management of the R&D collaboration (Philbin, 2008) as well as on the development

of successful research collaboration between university and industry (Abeda *et al*., 2011). A study by Abeda *et al*. (2011), which is done based on research collaboration in Universiti Teknologi Malaysia (UTM), shows that commitment is one of the best success criteria that can be implemented to reduce the barrier regarding IP conflicts in collaboration. This factor can lead to successful collaboration. From this study, collaboration requires strong commitment from both collaborating partners in order to fulfil the terms and conditions stated in their agreement. Commitment also estimates the chance and interest of both partners to maintain the collaboration in the future (Philbin, 2008). In a study conducted in Malaysia, more than half of the respondents believe that the lack of commercialized research findings is caused by issues related to commitment among academicians (Kamariah *et al*., 2008).

Besides that, resources and skills are also required by companies to develop R&D projects (Brostrom & Loof, 2008). This is due to the high cost and the need for skilful personnel (Hanel & St-Pierre, 2006) to establish successful R&D collaborations. On the bright side, R&D collaboration with university can help companies to increase their resources (Brostrom & Loof, 2008), mainly financial and human resources (Finne, 2003). While Thune (2011) and Chin *et al*. (2011) support that both financial and human resources are important in an effective collaboration, infrastructure is also important that should be considered in establishing a collaboration (Chin *et al*., 2011; Link & Scott, 2011). In Malaysia, Universiti Malaya (UM) implements an effective system to manage their R&D, commercializes their findings and enhances initiatives to improve their current infrastructures and facilities needed for research activities (MASTIC, 2008).

In R&D collaboration, results indicate that researchers, project sponsors, PhD students, R&D department and senior management, as well as program and project leaders are human resources that are usually involved in collaboration (Chin *et al*., 2011). Gracia *et al*. (2010) group these human resources into researchers, technical staff and students. From another study, the probability to increase the number and quality of research findings is significant when the universities have efficient researchers (Banal-Estanol *et al*., 2011). On the other hand, MASTIC (1998:2008) determines researchers from various academics qualification, technician and support staff as important human resources in establishing R&D activities. The structure of human resources explained by MASTIC is shown in Figure 1.

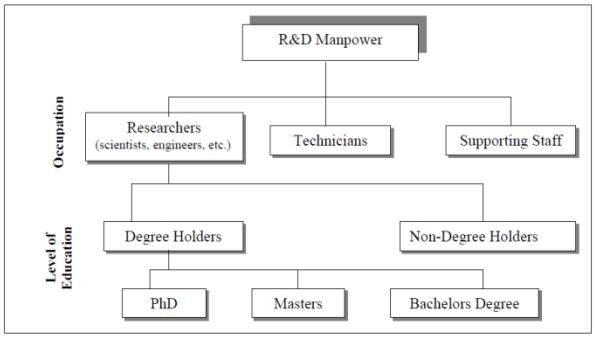

Figure 1 R&D Manpower in Malaysia

According to Hamisah Tapsir *et al*. (2010), the Government of Malaysia (GOM) has increased the amount of funding for research activities, which is 3.9 billion, in the Ninth Malaysian Plan (RMK-9) compared to RMK-8 (2 billion) and RMK-7 (1 billion) in order to improve such activities. For example, in RMK-9, the (GOM) has provided the highest amount of financial support to Universiti Putra Malaysia (UPM), which is RM229.7 million for R&D and commercialization of activities (MASTIC, 2008). A study indicates that the possibility to implement successful research collaboration will increase when the company receives additional financial supports (Okamuro, 2007). Other than that, a study in the United States (US) shows that financial supports for R&D have positive impacts in increasing the amount of income generated from licensed activities and also in producing more inventions or findings (Lanch & Schankerman, 2003). For universities, funds received from the industry can help them to raise the number of patents and enhance commercial activities (Kamariah *et al*., 2008; Gulbransen & Smeby, 2005). According to Gulbransen & Smeby (2005), the possibility of a professor to implement R&D activities that contribute to patents is 1 percent when he or she does not receive any financial support from industry, while the percentage is estimated to be 7 percent when industry provides financial support. However, a study refutes this view by demonstrating that financial supports received from industry have negative relationships with the number of patents produced (Hottenrott & Thorwarth, 2011). This study also indicates that negative results are obtained in terms of number of publications when university research is funded by industry, while there is a positive relation when the university receives financial support from the government sectors (Hottenrott & Thorwarth, 2011). According to this study, the amount of money spent by industry on university research will reduce 0.8% of the number of publications produced. However, a study conducted by Banal-Estanol *et al*. (2010) argues on this finding because the results show that the amount of funds received by a university positively influences the quality and quantity of the publications. According to their research, academic researchers who receive fund and do not establish collaboration with firms produce 14% more publications than the number of publications produced without financial supports. However, when academic staffs are funded while they are establishing collaboration with a firm, the amount of publications is predicted to increase up to 25%. Based on this report, it can be concluded that the number of publications will increase when a university establishes collaboration and receives financial support.

Financial support also has positive significance toward the creation of new ventures (Markman *et al*., 2004). Wayne and College find that the amount of industry and federal funding for university R&D sectors has positive significance on the number of spin off companies created, while only federal funding has positive significance on the amount of university licenses granted. Results of another study also indicate that, when a university gains a large amount of financial supports from the industry, that university has high probability to improve the number of spin off companies developed (O'shea *et al*., 2005). Furthermore, some researchers have focused on public subsidy for R&D activities provided by the government in order to increase university-industry collaboration, such as Okamuro & Nishimura (2011) and Hanel & St-Pierre (2006). A study conducted among software, microelectronics and biotechnology companies in Japan shows that a subsidy is not only an important source of funding, but it also has significant impacts in developing trust, commitment, motivation and communication during collaboration with universities (Okamuro & Nishimura, 2011). Moreover, previous results also signify the importance of subsidy for R&D activity, which will lead to the establishment of collaborations between firms and universities (Hanel & St-Pierre, 2006).

As an addition, according to Fiaz *et al*. (2011), the principle of trust is an important basis in developing collaboration activities. In the context of collaboration, trust refers to the firm

belief in the integrity and reliability of the other partners, whereby an action from one partner will make the other exposed (Doney *et al*., 1998). A high level of trust can be shown through respect towards the partner's abilities, commitment for mutual benefit and the partner's openness, as well as honesty in reaching the objectives (Dodgson, 1993). This research also indicates that trust is argued to assist learning between research partners. In a situation where the trust between partners is low, a company needs to carefully monitor and manage the other partners' behaviour to avoid partner opportunism (Geyskens *et al*., 1996). Bruneel *et al*. (2010) believe that trust allows the collaborating partners to cooperate in research confidently in a manner that their research partners will treat them fairly and help them to solve any problem that may occur during the collaboration. They also believe that trust can help to lower the orientation and transaction related barriers in collaboration. Some studies have indicated that trust has positive significance toward the establishment and management of the R&D collaboration (Philbin, 2008), the efficiency of the research arrangement (Nokkala *et al*., 2008) and the success of tacit knowledge acquisition during the collaboration (Sherwood & Covin, 2008).

2.1.3 Process Factor

The elements included under the process factor are important to ensure that R&D collaboration between university and industry can be implemented smoothly and successfully. The effectiveness of R&D collaboration process can lead to the achievement of both partners' objectives. This factor can help to overcome the barriers in collaboration through the implementation of four variables indicated in this research, which are efficient project management, effective boundary spanning, spin off companies and improved communication between both partners.

Management skill is one of the important elements that contribute to a successful collaboration (Philbin, 2008). This skill influences both institutions to achieve successful collaboration indicators, such as quality, budget and schedules (Philbin, 2008), thus, leads to the commercialized patents produced from research activities (Kamariah *et al*., 2008). Furthermore, successful collaboration also depends on the skills and experiences of the project managers (Thune, 2011) and the collaboration agents (Philbin, 2008). These agents need to manage and connect the collaboration team from different levels in order to ensure that the collaboration runs smoothly (Philbin, 2008). According to Dunowski *et al*. (2010), a successful R&D collaboration can be achieved through the involvement of top management in the collaboration process. Majority of companies involve their top management during the established collaboration with university sectors.

Another important factor that can be used to determine the success of R&D collaboration is effective communication between partners (Chin *et al*., 2011; Barnes *et al*., 2002). Communication has positive roles in increasing successful R&D collaboration (Fiaz *et al*., 2011) and gaining new information through research collaboration (Nokkala *et al*., 2008). Communication is defined as a process where the information, concepts and ideas are exchanged between individuals in different organizations (Mora-Valentine *et al*., 2004). Solving communication problems between partners can help to increase the understanding and improve knowledge gained from each other (Barnes *et al*., 2002), encourage or maintain the collaboration and trust (Chin *et al*., 2011), contribute to problems sharing and disseminate knowledge between both partners (Abeda *et al*., 2011). This can help to create successful R&D collaboration due to the effective exchange of information and ideas between the collaborating partners. Pertuze *et al*. (2010) outline several practices that can be used to improve the communication between university and industry in establishing collaboration such as:

- Conduct face-to-face meeting to develop routine communication.
- Encourage personnel exchange. This can be implemented by exchanging university personnel with those from the industry, and vice versa.
- Visit by university researchers to the collaborating companies. Frequent visits and interactions with the companies' personnel can help to generate the best project results.
- Company can use media, such as telephone and video, to communicate with other collaborators.
- Teleconference is one interesting alternative that can be used by companies as well as universities to communicate in order to exchange ideas and strategies.

According to Hazlina *et al*. (2011), effective communication through meeting sessions between university and industry personnel is the best way to develop a successful collaboration (the highest mean score: 3.92). Meeting is the best communication channel to monitor and manage the progress of a research collaboration project (Philbin, 2008; Purteze *et al*., 2010). Personal meeting is the only significant factor that can influence the success of R&D collaboration (Nokkala *et al*., 2008). Effective communication also can influence the process of innovation and reduce the cultural barriers between both partners involved in research collaboration (Lee *et al*., 2010). 90% of university researchers who establish successful projects indicate that they do not have communication problems between the partners or the supervisors involved. On the other hand, 66.7 % of those with unsuccessful collaboration face a communication problem with the supervisors, while 40% indicate that they have a communication problem between the collaborating partners (Butcher & Jeffery, 2007).

Other than that, boundary spanning is also one of the important ways to implement successful university-industry R&D collaboration. This is the best mechanism introduced today in effort to encourage or promote the collaboration (Lee *et al*., 2010; Purteze *et al*., 2010), implement effective innovation and promote internal information to external group or member (Lee *et al*., 2010), improve entrepreneurial activities among the academics (Fassin, 2000), and commercialize R&D finding (Lee *et al*., 2010; Hamisah Tapsir *et al*., 2010). In boundary spanning, the boundary spanner plays important roles to obtain knowledge (research outputs) from the outside sources and disseminate it within the firm. Based on the information gained from the industry, the boundary spanners will provide feedback to the university researchers to ensure that the research is in line with the company's needs and requirements (Pertuze *et al*., 2010). Boundary spanner is the person who plays intermediate roles between university and industry in order to transfer knowledge during collaboration between them (Siegel *et al*., 2007). In Malaysia, researchers have found several mechanisms, which lead to the establishment of research hubs that focus on commercializing university research findings, such as Innovation and Commercialization Centre (ICC) as well as University Business Centre in Universiti Putra Malaysia (UPM) (Hamisah Tapsir *et al*., 2010).

Another example in Malaysia is Universiti Malaysia Pahang (UMP), which establishes a university-industry centre (Normah, 2011). This centre acts as a platform for researchers to commercialize potential products generated from research activities, as well as for small entrepreneurs to start new business.

It also attracts both Malaysian and foreign industries to join in the commercialization of UMP's technology and innovation. This can help UMP to generate funds through deliberate projects, commercialized products, and services rent. In the US, many boundary spannings have been developed to encourage or improve the collaboration activities (Lee *et al*., 2010). There are several examples of boundary spannings, which are:

- Technology Transfer Office (TTO)
- Industry-University Corporative Research Centres
- Industry Liaison Office(ILO)
- Research Park

Introducing units or centres of excellence is a good practice that can be implemented by universities today to improve collaboration activities with industrial sectors. A study on the relationship between the size and age of Technology Liaison Office (TLO) in the US with the number of inventions and income generated from licensed activities shows positive significant results. The analysis indicates that an increase of 10% of TLO size will lead to an increase in the amount of licenses revenue and research products of 3% and 2.5% respectively (Lanch & Schankerman, 2003). Currently, public universities in Malaysia have established several units or centres of excellence in order to promote and develop successful collaboration with industries. Table 1 shows several examples of units or centre of excellence established in some public universities in Malaysia determined by (Hamisah Tapsir *et al*., 2010):

Table 1 Unit or centre of excellence in malaysian public university

Public university	Units/ Centre of excellence
USM	Corporate and sustainable Development Division, Research Creativity and Management Office and Academic Affairs and International Department
UTM	Research Management Centre, Bureau of Innovation and consultancy and Academic & Internationalization Office.
UKM	Industrial relation Department, *Unit Inovasi*, UKM Perunding Sdn. Bhd and Unipeq
UPM	Centre of Academic Development and Research Management Centre
UM	Institute of Research Management and Consultancy (IPPP), Centre for Industrial Training & Relations (CITRA) and *Bahagian Komunikasi Korporat* (BPK)
UITM	Centre for UITM-Industry Linkages and Institute of Research, Development and Commercialization
UIAM	Alumni & Career Services Division
UUM	Research and Innovation Development, Development and Maintenance Department and Entrepreneurship Development Institute
UMS	Centre of Research & Innovation and Centre for Consultancy & Training Services
UDM	*Unit Komunikasi Korporat* UDM
UPSI	Research Management Centre
UTHM	Research And Innovation Centre and *Pusat Perhubungan Korporat dan Antarabangsa* (PEKA)

The modern method used to develop and exploit the inventions produced by a university is through spin off companies. These companies play important roles to commercialize research findings produces by the universities (Hamisah Tapsir *et al*., 2010). Google and Genentech are a few spin off companies developed by universities that have been successful in gaining large amount of revenues i.e. billions of dollars from commercial activities (Wennberg *et al*., 2012). Today, many universities in this country have developed their own spin-off companies, such as Usains Holding Sdn Bhd (USM) and Uni-Technologies Sdn Bhd (UTM) (Hamisah Tapsir *et al*., 2010; Malairaja & Zawdie, 2008). Spin-off companies also help students to gain working experiences through internship schemes and increase financial sources for university research projects (Taheri & Geenhuizen, 2010).

■3.0 PROPOSAL FOR THE BEST PRATICE TO DEVELOP SUCCESSFUL UNIVERSITY - INDUSTRY COLLABORATION IN MALAYSIA

In this study, there are three factors that can help to establish successful university-industry R&D collaboration in Malaysia. These factors are supported by previous researchers, such as Thune (2011), Okamuro & Nishimura (2011) and Mora-Valentine *et al*. (2004). These factors can also help the collaborating stakeholders to determine the best practices that should be implemented in order to develop an effective collaboration. Based on the reviews, the variables that should be understood and practiced by the collaborating partners are explained in Figure 2:

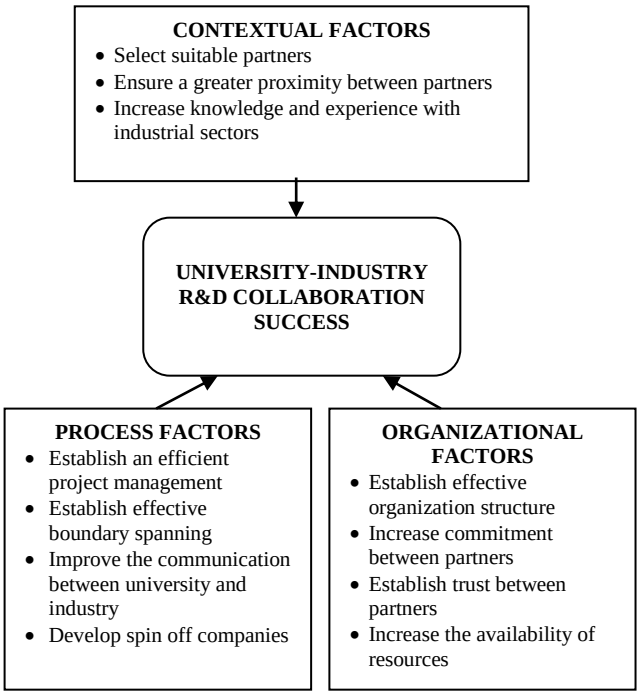

Figure 2 Success factors for university-industry R&D collaboration

■4.0 CONCLUSION

The purpose of this paper is to discuss the factors that contribute to the establishment of successful university-industry collaboration, especially in R&D collaboration. Although some researchers have discussed several factors to develop a successful collaboration, the number of studies that focus on this field is still insufficient. Reviews show there are three types of factors that can lead to the development of successful R&D collaboration between university and industry, namely contextual, organizational and process factors. This study may help to increase the stakeholders' (university, industry and government) understanding, thus, enable

them to form and manage an effective R&D collaboration, especially in Malaysia. Other than that, this study can also provide ideas to policy makers and the government to develop conducive collaboration environments. This is important because effective collaboration can yield great outcomes and benefits to the country and the society.

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