

Exploring the Barriers Affecting Malaysian University Symbiosis Program in University-Industry Commercialization

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Abstract

Objectives: The purpose of this paper is to explore the barriers that could affect the University Symbiosis Program. **Methods/Statistical analysis:** Research synthesis technique and pearl growing technique are used to identify the barriers relevant to university-industry collaborative effort. **Findings:** Past studies indicated that there is a fuzzy relationship affecting university-industry collaborative effort and their commercialized outcome. Though there exist factors that could trigger university-industry commercialization, nevertheless the same factors have shown to produce different effect on the said collaborative result. Hence, there exist a suspected variable that could explain the observed fuzzy relationship between the university-industry collaborative effort and university-industry commercialization outcome. With this in mind, the University Symbiosis Program i.e. a type of university-industry collaborative effort that requires university researchers and technopreneurs to work hand-in-hand from the inception of an innovation to the final market was seen as the possible variable to the above exhortation. Based on the review of previous findings on barriers relevant to university-industry collaborative effort, this paper proposed a conceptual framework that describes the relationships between the barriers affecting university-industry collaborative effort, the University Symbiosis Program, and the final commercialized outcome. Barriers include competency, dedication, management of government funding, culture, and expectation were found to be relevant. **Application/Improvements:** This paper is expected to contribute to the body of knowledge on university-industry collaborative effort via the University Symbiosis Program.

Keywords: University Symbiosis Program, Technology-Based Product, Spin-Off, University-Industry, Commercialization

1. Introduction

The university commercialization is believed to be able to boost local economy apart from providing jobs and goods to society^{1,2}. However, the commercialization achievement in Malaysia is less than satisfactory. The Secretary General of Treasury, Ministry of Finance in Malaysia recently indicated his disappointment over the performance of research commercialization in Malaysian public universities³. Moreover, the number of patent that was used as yardstick for commercialized activity in Malaysia⁴ showed an overall poor achievement. As presented in Table 1, Malaysian researchers have a

discouraging number of patents in which they only managed to be granted 2,900 patents for the last 25 years. The higher number of patents granted to foreign researchers also seems to provide a picture that Malaysian researchers were lagged behind their foreign counterparts in commercializing research outputs⁵.

For the purpose of improving the commercialization activity in Malaysia, University Symbiosis Program was launched by Malaysian government. In the University Symbiosis Program, spin-offs were formed to commercialize technology-based products of Malaysian public universities. Technopreneurs were appointed as Chief Executive Officers in the said spin-offs in order to

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Table 1. Number of patents granted in Malaysia

Duration (five-year term)	Patents granted		
	Malaysian	Foreigner	Total
1990-1994	94	5,521	5,615
1995-1999	220	5,415	5,635
2000-2004	129	7,163	7,292
2005-2009	1,030	20,920	21,950
2010-August 2014	1,427	10,176	11,603
Total	2,900	49,195	52,095

Source: Malaysian Intellectual Property Corporation

commercialize technology-based products together with university researchers. Technopreneurs chosen for this program are newly graduated students from Malaysian research universities. Perhaps due to the relatively young age of the Chief Executive Officers, the commercialization of the said program is not easy.

Our initial search discovered that a spin-off company which has been developed in one of the public universities involved in Symbiosis Program was closed down due to certain problems. However, the relevant authorities of Symbiosis Program were not able to ensure the actual problems since they could hardly communicate with the technopreneur and university researcher of the spin-off who is no longer the researcher of the university after the spin-off has been shut down. Without knowing the actual problems, the relevant authorities may not be able to effectively improve Symbiosis Program and provide guidance to other university researchers and technopreneurs in their collaborative effort where this might causes the program eventually encounter failure. Since Symbiosis Program was funded by Malaysian government venture capitalist, the focus on barriers affecting the program is even more crucial given that it is important to maximize the return on investment for every ringgit of government's fund spent⁶. Thus far, little research has been done on this University Symbiosis Program, particularly barriers affecting it. In view of this, this paper explores the possible barriers affecting University Symbiosis Program.

2. Overview of the Malaysian University Symbiosis Program

University Symbiosis Program has started in year 2009 for the purpose of commercializing technology-based products of Malaysian public universities. In this study, two public universities involved in Symbiosis Program

i.e. National University of Malaysia and University of Technology Malaysia are selected as case studies. Our initial search found that the processes of commercialization for these two universities are similar.

The first process is the selection of university's technologies. For the technologies to be selected by the university as candidate for commercialization, they must be ready in laboratory prototype form and have the commercial potential. Ten technologies of each university will be finally chosen. Although the technologies were developed by university researchers, the ownership of technologies belongs to university.

The second process is the selection of technopreneurs as Chief Executive Officers of the spin-off companies. According to Malaysian Circular university staffs of Malaysian public university are prohibited from taking position as Chief Executive Officers in a company⁷. Thus, the Chief Executive Officers of the spin-off companies should be appointed from non-academic technopreneurs. The selection of technopreneurs begins with the announcement of Symbiosis Program in the local newspapers in order to attract Malaysian graduates who were below 35 years old to join the program. After the graduates have been short-listed, they will be called for entrepreneurial test and interview, which will mainly assess their entrepreneurial inclination as well as the ability to forecast and think out of the box. After that, the graduates will attend the induction, entrepreneurship, and commercialization courses, which intended to introduce technologies as well as to impart entrepreneurial and commercial knowledge to the graduates. These three courses will take three months to be completed. Subsequently, the graduates will be required to prepare and present business plan for technologies of their choices. Finally, a total of ten graduates will be selected for each public university.

The third process is the formation of spin-offs. Ten spin-off companies will be formed for each public university. Each spin-off company will be co-owned by the newly appointed Chief Executive Officer together with the university researcher who has developed the technology. One spin-off will be assigned to commercialize only a single technology. For commercialization purpose, the technologies will be exclusively licensed to the spin-off companies. Initial capital to set up the spin-off will be provided by the university while waiting for the grant disbursement from Malaysian Technology Development Corporation i.e. Malaysian government venture capitalist.

The spin-offs will have to repay to the university after obtaining the grant.

The final process is the spin-offs where the incubation period will begin after receiving grant from Malaysian Technology Development Corporation. The grant will be used to develop the full commercial prototype of technologies, modify appearance of the prototypes and manufacture the technologies into technology-based products. Within the incubation period, spin-offs will be expected to start selling the products and gain some revenues. Hence, the collaborative effort between Chief Executive Officers and university researchers in commercializing the technology-based products are extremely important.

In addition to the commercialization process of Symbiosis Program that has been discussed, this paper also provided the list of the spin-off companies that have been developed in National University of Malaysia and University of Technology Malaysia as shown in Table 2, and Table 3, respectively. As can be seen in the tables, the technology-based products for the two universities are associated with various fields of studies. Therefore, the study on University Symbiosis Program of these two universities might cover a different range of barriers.

3. Methods

This paper identified the barriers relevant to university-industry collaborative effort by applying the technique of research synthesis (Note: the term university-industry collaborative effort means the collaboration

between university and industry in commercialization. Thus, it also refers to university-industry commercialization in this paper). Research synthesis involves several stages. When describing the stages, this paper referred to the stages of research synthesis that suggested by^{8,9}. Firstly, the searching of existing studies on barriers relevant to university-industry collaborative effort using a high sensitivity Google Scholar search that involved the keywords such as barriers of spin-offs, barriers of university commercialization, and barriers of university-industry collaboration. Secondly, criteria should be identified and applied in selecting the relevant studies for reviewing. It is found that a spin-off may has only player from university side, or it can also has players from both university and industry sides¹⁰. In addition to the Google Scholar search, this paper employed the technique of pearl growing for the purpose of choosing the relevant studies. The pearl growing technique is to check the bibliography of the selected studies in order to identify further references of relevant studies^{11, 12}. Our research synthesis resulted in five relevant barriers as shown in Table 4. The matrix in the table served as a basis for the discussion below on barriers relevant to university-industry collaborative effort.

4. Barriers Affecting University-Industry Collaborative Effort

These are the result of analyzing past studies on barriers relevant to university-industry collaborative effort by

Table 2. Spin-off companies in National University of Malaysia

No.	Spin-off	Technology-based product	Associated field of study
1.	A1 Meditech Sdn. Bhd.	A1 BOD – A Patient Transfer Device	Medical
2.	Cell Tissue Technology Sdn. Bhd.	MyDerm TM – Autologous Bilayer Tissue Engineered Human Skin	Physiology
3.	Food Protech Sdn. Bhd.	Technology in Producing Chocolate and Confectionery Products	Chemical Sciences and Food Technology
4.	Gas Sensor Sdn. Bhd.	Carbon Monoxide Sensor	Applied Physics (Instrumental and Devices)
5.	Green XS Sdn. Bhd.	escCube – A smart City Kiosk	Engineering and Built Environment
6.	HCA Products Sdn. Bhd.	Hydroxycitric Acid – Weight Loss Agent from Roselle Mutant	Health Care
7.	Icon Pharma Sdn. Bhd.	Nata De Coco-based Hydrogel for Pharmaceutical, Medical and Cosmetic Applications	Pharmacy
8.	NXPhotonics Sdn. Bhd.	Plastic Optical Coupler (POF) for Fiber in the Home and Automobile System Applications	Photonics
9.	PV&T Technologies Sdn. Bhd.	Solar-assisted Drying System for Agricultural and Marine Product	Green Technology (Energy)
10.	Solar GE Sdn. Bhd.	Solar Charge Controller	Green Technology (Energy)

Table 3. Spin-off companies in University of Technology Malaysia

No.	Spin-off	Technology-based product	Associated field of study
1.	WCC Telco Sdn. Bhd.	Frequency Front-End System for Wireless Local Area Network, Point-to- Point Link	Electrical Engineering
2.	Gigalink Solutions Sdn. Bhd.	Antenna Array at 2.4Ghz for Point-to-Point Communication	Electrical Engineering
3.	Microclear Sdn. Bhd.	Microclear for the Treatment of Colored Water	Biosciences and Health Sciences
4.	Sono Engineering (M) Sdn. Bhd.	Novel Low Cost Ultrasound Sonoimprometer	Biomedical Engineering
5.	HQ Nutraceuticals Sdn. Bhd.	Pineapple Fibre-based Product Development for Nutraceutical	Food and Biomaterial Engineering
6.	Bioswitch Technologies Sdn. Bhd.	An Active Packaging using Smart Bio Switch Concept	Food and Biomaterial Engineering
7.	E Elements Technology Sdn. Bhd.	Energy Saving in Building Air Conditioning System	Thermofluids
8.	Membrane Technology (M) Sdn. Bhd.	Development of Pre-Treatment System for RO Drinking Water Production	Sustainable Membrane Technology for Energy, Water and Environment
9.	Photolaser Grammetry Sdn. Bhd.	3D-based Surveillance System	Photogrammetry
10.	Maxglaze Sdn. Bhd.	Nanocrystalline Ni Plating Directly on Aluminium, High Speed Electroforming	Materials Engineering

Table 4. Past studies on barriers relevant to university-industry collaborative effort

Barrier	Argument	Author
Competency	Successful commercialization needed the combination of technical and business competencies by industrial and university's players.	13,14
	Industrial and university's players were lacking in technical competency.	15
	Industrial and university's players were lacking in business competency.	17
Dedication	Industrial and university's players must have the sufficient dedication in their collaborative relationship.	16
	Insufficient dedication of university's players in the collaborative relationship.	18
	Insufficient dedication of industrial players in the collaborative relationship.	19
Management of government funding	Bureaucracy issue in government grant disbursement phase badly affected the research commercialization.	20
	Government grant disbursement issue in Nigeria.	21
Culture	Different culture that caused different value and working style between university and industry has hindered their commercial activity in spin-offs.	16
	Different value between university and industry i.e. knowledge creation and contribution vs. profit-making.	16
	Different working style between university and industry i.e. rigid vs. flexible.	22
Expectation	Different expectation between university and industry on collaborative result negatively affected their partnership.	23
	Idealistic expectation of universities towards their creation's value has prevented the partnership with industrial players.	22

using research synthesis technique. Competency is the first barrier. The spin-offs with founders from industry and university need to have a combination of technical and

business competencies to ensure the success of research commercialization^{13,14}. Unfortunately, technical competency especially the ability to develop and manufacture

product is found difficult for industrial players¹⁵ as well as university researchers¹⁶. Furthermore, industrial players and university researchers are found to be unable to master the business competency such as marketing, distributing, and selling product¹⁷.

The second barrier is dedication. In the collaborative relationship between university and industry, it is crucial to have sufficient dedication from both sides. However, the overly focus on publication activity by academicians has caused their lack of dedication in collaborative activity with entrepreneurs¹⁸. Also, the inadequate dedication of university researchers has impeded research commercialization in Malaysian university. On the industry side, the appointed entrepreneurs in spin-offs were discovered not having full dedication in developing and manufacturing research outputs that created by university researchers¹⁹.

The third barrier is management of government funding. Government funding in its grant disbursement phase is always related to bureaucracy issue which the issue had negative effect on the funded research commercialization²⁰. The bureaucracy issue is typical in developing countries. For example, the aim of Nigerian government to help farmers in terms of financial assistance by providing them the loan was less effective due to the loan disbursed to the farmers after their needed time²¹.

The fourth barrier is culture. As stated in culture is a barrier for spin-offs with players from university and industry. Different culture between university and industry has caused the actors to have conflicts in terms of value and working style. In terms of value, university researchers are concerned on knowledge creation and contribution which is in contrast to the aim of entrepreneurs who viewed profit-making as critical. In terms of working style, rigid working style of university is different from the flexible style of industry²².

The final barrier is expectation. As indicated In ²³ the collaborative result expected of university is often different from industry in their partnership in which such difference has affected the partnership in a less constructive way. In addition to the aforementioned different expectations, the idealistic expectation of academics towards its creation's value has been viewed as an obstacle to the relationship between university and industry. Universities always expected their excellent technologies could bring high number of sale. This perception has hindered the relationship with companies. In fact, as viewed by industrial players, the value of universities' technologies are not that great²⁴.

5. Conceptual Framework

This section proposes and discusses the conceptual framework for present study. For university-industry collaboration case, certain factors such as research and development intensity could result in the collaboration between university and industry. Surprisingly, the mentioned factors were also found unable to make university-industry collaboration to happen²⁵, ²⁶. For commercialization case, certain factors such as government grants could lead to the occurrence of commercialization, but sometimes, the said factors have no influence on commercialization²⁷, ²⁸. Based on these findings, university-industry commercialization might experience the same difficulty. In other words, it is somewhat hard to foresee the outcome of factors affecting university-industry commercialization. Therefore, there exist a possible variable that could explain the uncertain relationship between the factors affecting university-industry collaborative effort and university-industry commercialization. With this in mind, the University Symbiosis Program i.e. a type of university-industry collaborative effort that can result in university-industry commercialization was considered as the possible variable. Based on the barriers affecting university-industry collaborative effort that discussed above, the conceptual framework can be demonstrated in Figure 1. The framework shows the barriers i.e. competency, dedication, management of government funding, culture, and expectation which are relevant to university-industry collaborative effort will affect the University Symbiosis Program; the University Symbiosis Program in turn, will affect university-industry commercialization. As from the theoretical basis, this paper adopted resource-based theory to show the University Symbiosis Program is a unique program that needed the design of its own model. Moreover, the relationship from the barriers

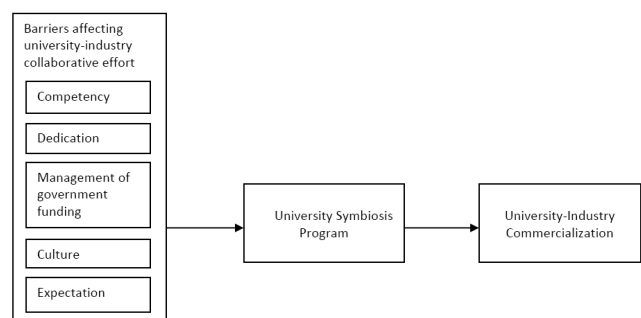


Figure 1. Conceptual Framework

to the University Symbiosis Program can be seen in contingency theory that will be discussed below.

5.1 Resource-Based Theory

In resource-based theory, the term resource is important to be identified²⁹. Generally, resources can be categorized into tangible and intangible resources³⁰. Tangible resources are physical things, while, intangible resources are non-physical things³¹. Tangible resources encompass physical and financial resources. The examples of physical resources are plant and equipment, a firm's location as well as university's invention for commercialization. For the examples of financial resources, they are sources of funding from investors, banks, or entrepreneurs. While, intangible resources include human resources with the examples such as technical and business skill, brain-power, creativity, perception as well as the experience of individual in a company. Moreover, trade secret, culture, working relationship, and the reputation of a company are considered as the examples of intangible resources³²⁻³⁸.

A study In used resource-based theory to explain the availability of resources i.e. the business skill of university's technology transfer officer, the outside guidance on university's intellectual property protection as well as the university's reward system allow the formation of spin-off. In other words, the mentioned resources are the enablers for formation of spin-off. Therefore, it seemed reasonable to apply resource-based theory in this paper to describe the availability of resources helps in creating University Symbiosis Program. The available resources for the program include technologies that are created by university researchers, Chief Executive Officers, university researchers, grant from Malaysian Technology Development Corporation, initial capital from university, and incubators. Without the combination of all the stated resources, it is not able to create University Symbiosis Program. In fact, resource-based theory is not talking about one resource, rather, it emphasizes on grouping a couple of resources³⁹⁻⁴¹.

Furthermore, existing studies adopted resource-based theory to discuss the resource utilization by a company for gaining competitive advantage. In these studies, a company was described as a combination of resources^{41,42}. Every single combination of resources is unique and dissimilar to other combinations^{43,44}. In this paper, University Symbiosis Program utilizes its available resources for the purpose of having a successful commercialization of technology-based products. Hence, University Symbiosis

Program can be described as a combination of its available resources which the program is unique and might different from other programs that seemed necessary to design its own model.

5.2 Contingency Theory

Contingency theory describes the choice of an organization structure such as adhocracy, or professional bureaucracy, or divisionalized structure is depends on contingency factors⁴⁵⁻⁴⁸. It is also known as structural contingency theory in past literature⁴⁹. Normally, contingency factors include both internal and external factors^{50, 51}. Organization size and technology using in an organization are the examples of internal factors, while, consumer preferences, competition between organizations and economy that contributed to uncertainty environment are recognized as external factors⁵²⁻⁵⁴.

In addition to the organization structure that has been discussed, the choice of an organization strategy is also relies on contingency factors⁵⁵⁻⁵⁸. In ⁵⁹ applied contingency theory in their study indicated that the commercialization strategy of an organization such as licensing to established companies, or formation of spin-offs is depends on contingency factors that the organization facing. The technology will be commercialized by using strategy (i.e. licensing to established companies, or formation of spin-offs) that expected match well with the contingency factors.

Based on the discussion above, contingency theory talks about contingency factors affect organization structure and organization strategy⁶⁰ which in other words, are the interaction relationships between contingency factors and organization structure; and between contingency factors and organization strategy. Such interaction relationships can be well described by using variables. The contingency factors are independent variables, whereas, organization structure; or organization strategy is dependent variable. The use of contingency theory in this paper is not about organization structure or organization strategy must be the dependent variable. Instead, it is the idea of independent variables affect dependent variables. In ⁶¹ used this idea of variables in contingency theory for her Doctor of Philosophy's research. She proposed a research framework that showed the factors include governmental support, rewards and benefits, performance measurement system, commitment and leadership, mutual trust, characteristics of individual collaborator, as well as communication (independent variables) affect the success of university-industry collaboration (dependent variable).

Therefore, contingency theory seemed appropriate to be adopted in this paper to show the relationship from the barriers to the University Symbiosis Program i.e. barriers affecting the success of University Symbiosis Program in which the barriers include dedication, competency, management of government funding, culture, and expectation.

6. Conclusion

This paper proposed a conceptual framework that is useful for investigating the barriers affecting University Symbiosis Program. The reviews suggested five barriers affecting university-industry collaborative effort, namely, competency; dedication; management of government funding; culture; and expectation. Through the research synthesis methodology, this paper hopes to contribute to the body of knowledge and literature in the field of university-industry collaborative effort. Secondly, it provides guidance to university's and industrial players to enhance their collaborative efforts especially commercialization that involve technology-based products. Lastly, appropriate recommendations can be made to remedy University Symbiosis Program in the light of the barriers identified, which in turn, will facilitate the commercialization program in Malaysia.

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