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Practice of Triple Helix (TH) Model in Malaysian Research Universities (RU)

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Abstract. *Innovation is one of the key elements of countries' competitiveness. In the face of continuous world economic changes, the Triple Helix Model (University-Industry-Government) relationship allows many countries to improve and accelerate their innovation processes. In developing countries, which are in transition towards innovation-based economies, such as Malaysia, Triple Helix (TH) can serve as a tool to speed up this transition. This paper explores the implementation of Triple Helix to discover the extent of collaboration between companies and universities both on a global scale and particularly in Malaysia. The study uses a quantitative methodology based on an integrative analysis of literature, secondary data and results of a survey, conducted among four Malaysian research based universities. The research finds that the average performance of Malaysian research based public universities in the Triple Helix system is generally good. For individual universities this study finds that the National University of Malaysia (UKM) has performed above average, while University of Malaya (UM) shows below average performance among major research universities in Malaysia. The findings of this research highlight the need to solve the identified problems in parallel with implementation of the open innovation concept in university-industry collaborations.*

Keywords: *Triple Helix, Research University (RU), Technology Commercialisation, Innovation, Malaysia*

1. Introduction

Many authors have attempted to measure TH and RU concept separately in the context of ASEAN or other South-East Asian countries (Noordin, Mohamad & Shuhidan, 2015; Phuc & Matsuura, 2016). However, to the best of our knowledge, no studies have discussed University-Industry-Government linkages of Triple Helix model considering four large Malaysian Public Universities in the recent past. TH can be recognized as an engine of economic growth, which induces a sustainable economy by creating a milieu of competition among universities, firms and government (Wignaraja, 2013). RU is a powerful compound for TH model and the development of the innovation driven nation (Afonso, Monteiro and Thompson, 2012). The TH process fosters competition and builds up the competitiveness. Various studies have previously investigated the components of TH which build national innovative capacity (Bercovitz & Feldmann, 2006). Therefore, now it is important to recognize how the different agents of the TH interact in the development of the RU of emerging nations like Malaysia.

The recent global Competitiveness Index shows Malaysia moving from efficiency driven stage to innovation driven nation slowly but steadily (Eleventh Malaysia Plan

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2016-2020). However, the findings of our research show that the foundations remain a little bit shaky in some aspects of innovation strategies, especially in the development of entrepreneurial university culture from research universities. It is no time to be complacent. Using the famous TH model (Etzkowitz, 1990), this research eases policy makers of Malaysia to understand and identify strengths, weaknesses and regional standings of RUs of the country.

In this study the framework of TH and RU model are used for measuring the performance of research universities while explaining the overall innovation system. Empirical primary data from the period 2017 have been analyzed using the quantitative methodology. The overall findings of the current study exhibit, all major RUs in Malaysia are in a league of their own in University Industry Collaboration (UIC) domestically, while displays lack of diversification in the international arena. The domestic-international gap in UIC readiness is reasonably deep across all RUs in Malaysia.

The practical implication of the current study advocates that, since its creation of project RU, Malaysia has made significant treads. But sprouting from a loose association in the TH model to a tightly knit group will require stepping up efforts, starting with narrowing the performance gaps among the RUs specially in technical and technological transformation. This research firmly believes, using a TH model in RU framework can understand and reduce this gap effortlessly for emerging economies like Malaysia.

The rest of the paper is organised as follows: section 02 – literature Review, section 03 – Research Design, section 04 – Overview of RU in Malaysia, section 05-Quantitative Method, section 06 – Result & Discussion, section 07 – Policy Suggestion, and finally section 08 – Conclusion.

2. Literature Study

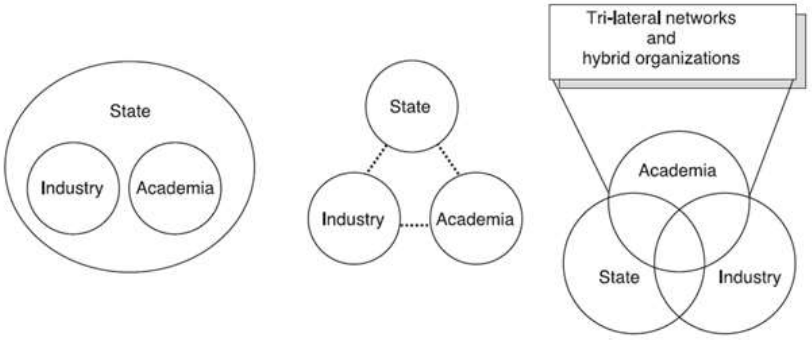
This section is divided into two parts. The first part describes the theoretical background of the Triple Helix (TH) model. The second part contains a discussion of the TH model and the RU in the context of Malaysia.

Theoretical Background of TH Model

TH model places importance on business as well as on the knowledge-based economy, which accelerates economic development. According to Shapira, Youtie, Yogeesvaran, and Jaafar (2006), there are two types of knowledge outcomes, innovation and economic performance, where the latter is led by innovation and influenced by the external sector, i.e. business factors.

Triple Helix (TH) Model

The traditional role of universities changed when the U.S. government's focus turned to the knowledge-based economy from the introduction of the Bayh-Dole Act in 1980 (Leydesdorff & Meyer, 2006; 2007). Etzkowitz (2003) identifies four stages in the emergence of the triple helix: internal transformation in each helix, influence of one helix upon another, creation of a trilateral network and interaction among them and the recursive effect of networks on spirals and on the larger society. Figure 1 shows the evolution of the Triple Helix.



Source: Etzkowitz (2003)

Figure 1.
From Estistic and laissez-faire to Triple Helix

There are barriers and enablers of successful implementation of the triple helix model for innovation. Razak & White (2015) regard bilateral mutual benefit of universities and industry as a benefit of collaboration as a whole. On the other hand, the mismatch of culture, norms and values may act as barriers as well as enablers.

Research University (RU) concept

Research University otherwise often called as Entrepreneurial University (EU), which is a core concept of the Triple Helix model. This special act for regional development. Though RU and EU are used interchangeably, there is a little difference between them. The university follows a transition path to become entrepreneurial, i.e. teaching role, research role and entrepreneurial role. Therefore, RU is the second phase of turning a university into the EU. A RU connects it tenure into research and publication, whereas EU includes commercialization of research product with the rest of the aim of the university, i.e. teaching and research and earn a profit (Etzkowitz, 2014).

Entrepreneurial academicians conduct researches and commercialize their products. The industry helps university by providing sufficient fund through contract and receives low-cost technology. Government creates a bridge between university and industry in some cases through policies. Government also establishes incubations. On the contrary, civil society (public) helps other three helices to interact properly by their quality demand. They also help in production and co-networking (Afonso, Monteiro & Thompson, 2012).

Yusof & Jain (2010) specify three research categories of university-level entrepreneurship. These categories are the entrepreneurial university, academic entrepreneurship and university technology transfer. Academic entrepreneurship (AE) is a component of the entrepreneurial university (EU) which is the ultimate output of RU initiative. The more the academic entrepreneurship orientation, the more the technology transfer activities.

To reach the decision about collaboration, there should be a balance between universities' mission for knowledge dissemination and industry revenue. Otherwise, universities' mission may be hampered. Barriers to collaboration are related to different motivations, university administration, conflict over intellectual property ownership and barriers to developing local technologies through local expertise (Ramli & Zainol, 2013). This barrier can be overcome by joint ownership.

To increase entrepreneurial activities, Etzkowitz (2014) suggests training students for analysis of projects and planning for commercialization. As a result, regional

development as well as the internationalisation of universities will be ensured.

Triple Helix and Research University in the context of Malaysia and other developing countries

During 1981-2005, potential growth of science and technology in Malaysia was static (Wong & Goh, 2010). Universities have since been gotten priority in terms of collaboration with industry and government. In 2007, Malaysian universities were positioned within either the statist or lassiez-faire TH categories (Razak & Saad, 2007).

In the spirit of 'neo-liberalism', Malaysian universities were being restructured (Mok, 2013). Still UIRC was low in Malaysia. The authors find that UIRC activities are only 2% -3% of total external collaborations. Factors accelerating sustainable research product commercialization among Malaysian academic researchers are knowledge, skills and personal traits of the researcher; creation of ideas, development, packaging and promotion of the research product; commercialization paths; building competitive advantage in the market; selecting business partners; nurturing relationships with business partners and facilities and support (Ismail, Nor & Sidek, 2015).

A study on the relationship between individual researcher's work environment and their engagement with academic entrepreneurship in Thailand shows that commercialization of academic entrepreneurs' research outputs plays an important role for social changes (Sooampon & Igel, 2014).

However, university-industry linkages are not favourable in Thailand but public universities encouraged entrepreneurial activities (Intarakumnerd & Schiller, 2009). Korean universities have little contribution in knowledge generation in commercialization though academic entrepreneurship is changing (Sohn & Kenney, 2007). National University of Singapore is being entrepreneurial and is the playing role of economic development (Wong, Ho & Singh, 2007). Therefore, it is noticeable that other developing countries are also in transition path based on university-industry collaboration specially turning RU based Triple Helix model. Therefore, this study on Malaysia will help other developing countries to follow our findings.

3. Methodology

The research design is based on the literature review, secondary data, survey and interview results. The literature review as a basis for research questions and the questionnaire in combination with analysis of survey results allows answering research questions and filling in the research gap. This study uses mixed methods focusing quantitative in nature in order to fulfill the research objectives. First, the literature related to university-industry collaboration is considered. Then, features of different initiatives taken by sample public universities using secondary data sources related to the case of Malaysia are illustrated. Subsequently, on the basis of the need of the study, a questionnaire has been developed and data collected in Malaysia between May to July, 2017. Finally, the structured email interview with an expert in university-industry collaboration in Malaysia was conducted. This study acknowledges the experts at the end of the article.

Our research questions are:

RQ-1: Which form of university-industry collaboration exists in Malaysia?

RQ-2: How are TH and RU model contributing to the economic development of Malaysia?

Research sub-questions:

RSQ-1.1 Does the reverse direction (industry-university) of knowledge transfer exist and, if yes, how is it implemented?

RSQ-1.2 What is the motivation of each side to initiate collaboration?

RSQ-1.3 What are the key problems of UIC in the context of Malaysia?
RSQ-1.4 Which solutions could better address these problems?

The form of university-industry collaboration in Malaysia will be answered by IPR, reverse direction of knowledge flow, spin-off firm related variables. The economic development through TH and RU model will be answer through increasing/decreasing percentages of variables. Coefficients of variation will also contribute in this regard. The most important, relevant variable to answer this question is a regional development through university. Another variable is university internationalization, commercialization of research output, recruitment of students and academicians in industry etc. Therefore, the dependent variables are regional development, entrepreneurship of universities, internationalization of universities. Rests variables are considered as independent variables.

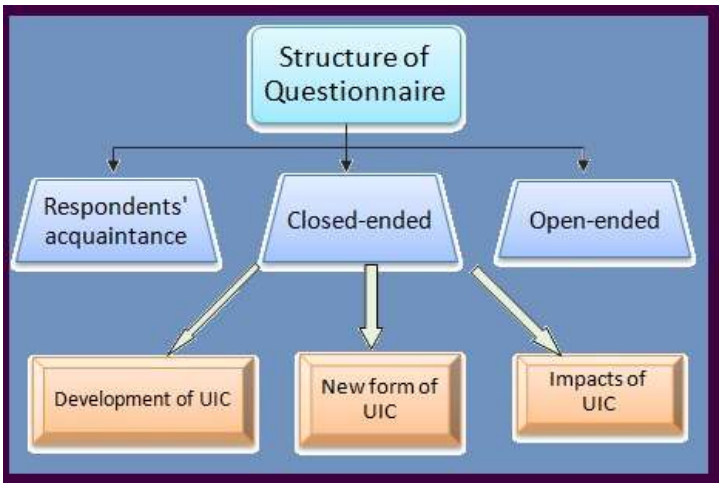
Overview of RU in Malaysia

University Technology Malaysia (UTM) was the first Malaysian university to look for market-societal driven collaborative R&D commercialization opportunities (Yusof, Siddiq & Nor, 2012). Other entrepreneurial universities in Malaysia are University Malaya (UM), National University Malaysia (UKM), University Putra Malaysia (UPM), University Sains Malaysia (USM) etc. These are the result of the Research Universities (RU) project undertaken by the Malaysian government in 2007 to enhance commercialization, increase post-graduate and post-doctoral student intake and improve Malaysia's overall global standing.

Only after three years of initializing the RU project, Malaysia's knowledge output in total number of publications has increased. Not only publications, but citation numbers also have increased (Wong & Goh, 2010; Razak & Saad, 2007). Moreover, Malaysian university researchers were recognized as 'World's Most Influential Scientific Minds', which indicated quality improvement with quantity. Malaysian researchers have collaborations with researchers of 179 nations and from these collaborations they are benefiting by producing more co-authored publications in indexed journals. Influential research fields include fuel cell technology, hydrogen energy, membrane technology, micro fuel cells, and mathematics (Chuah et al. ,2016). However, twenty public universities in Malaysia also generate commercial revenue. Between 2007 and 2015, the revenue was RM7.17 billion. The sources of revenue are research grants, product commercialization, industry funds, consultancy and professional services to industry, book publications and training, and endowments. Universities are contribution to regional development and are upgrading to 'World-class universities'(Mok, 2013; Subramonian & Rasiah, 2016; Chandran, Sundram & Santhidran, 2013).

Study Area, Sampling, Questionnaire and Data Collection

We have made a self-administered questionnaire and collected data through email and Skype. The questionnaire is divided into three parts. The first part includes designation of respondents, the second part comprises closed questions and third part comprises open questions. We construct 3-point Likert-scales for each closed question: decrease, remained stable, increase. It also contains an option 'do not know', which make it free from 'forced Likert-scale'. However, we consider it as 'missing value'. The closed questionnaire is divided into three parts, which measure (i) the development of cooperation between the university and business, (ii) new forms of University Industry Collaboration (UIC), and (iii) impacts of the UIC. We regard questions as variable and then process and analyze data.



Source: Authors

Figure 2.
Sections of Questionnaire

Malaysia has five major research universities. Among them, we have collected data from four RU, which are UM, UPM, USM, UKM. Among these RU, data were collected from those who are directly or indirectly related to research and cooperation of the university with industry. The respondents were innovation officers (UKM, USM), research officer (UPM) and deputy director (BDE) of centers of innovation and commercialization (UM).

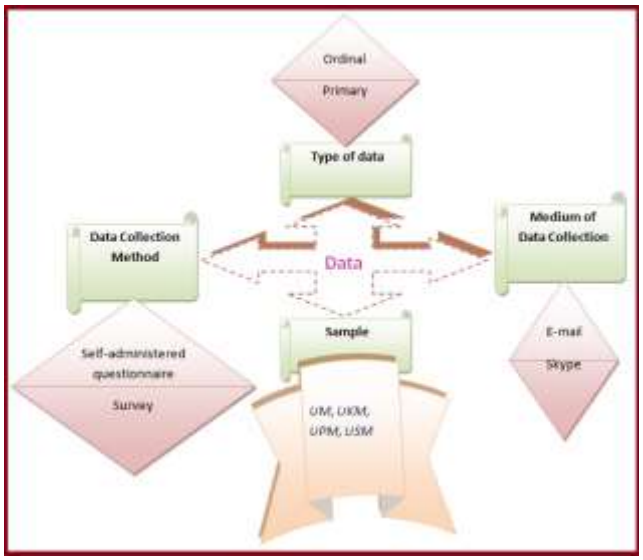


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Figure 3.
Data Collection Process

Number of questionnaires sent = 5; number of completed surveys = 4.
Response rate (of closed questionnaire) = number of completed surveys/ number of emails sent = (4/5) * 100 = 90%.

Analysis Method
Though Likert-scale is used for qualitative studies, we assign 'number' by order for each option and therefore it is effectively a quantitative approach. We use the survey method for collecting data and Cronbach's alpha 'reliability coefficient' to check the reliability of questions related to development and new forms of UIC mean, whether the questions in this questionnaire all reliably measure the same latent variable. Analysis is completed using SPSS V-20.

The four research sub-questions are addressed by this survey.
(1) Does the reverse direction (industry-university) of knowledge transfer exist and, if yes, how is it implemented?
(2) What is the motivation of each side to initiate collaboration?
(3) What are the key problems of UIC in the context of Malaysia?
(4) Which solutions could better address these problems?

4. Findings and Discussion

General Analysis (Survey)
We divide questions into three groups to assess the developmental situation of university-industry collaboration, new forms of UIC and impact of UIC in Malaysian sample universities based on recent 3 years.

To provide insight into the developmental situation, we have used 15 questions, which are considered as variables also. New forms of UIC are revealed by 12 variables and impacts of UIC include 8 variables. For all variables, the maximum is 3 except variables "Business partners have become increasingly more sophisticated in cooperation concerning the management of intellectual property rights arising from joint work with the university" and "The University has not yet been used in full intellectual property rights for commercial purposes". For both of these exceptions, the maximum is 2. That means, other variables have increased at least for one university.

The median gives more in-depth insight in the case of ordinal data. We find that average respondents find new forms of UIC and the impacts of UIC have increased. Note that, mean (which are actually weighted average) of all variables are quite high, which means average respondents think that respective variables have increased. Therefore, all averages support almost the same results.

However, the mean of universities' non-use of full intellectual property rights for commercial purposes is the lowest (1.50), which means, average number of respondents think that non-use of full intellectual property rights for commercial purposes has decreased. Besides this, failure of spin-off companies because of lack of financing or other important resources has decreased because it has also a comparatively lower mean. A decrease of both of these variables is showing positive improvement of UIC.

Though the scope of work performed by universities for companies (75%), number (75%) and diversity (100%) of industrial partners, new collaboration (100%), share of co-funded projects with industry, in the total number of university projects (75%) have increased, yet, the number of foreign partners/corporate funding has remained stable (75%) and research projects co-funded with industry has not increased much (25%). Failure of spin-off firms because of resource related problems has decreased (50%) and on the other hand, successful start-up companies established by universities' students have increased moderately (50%).

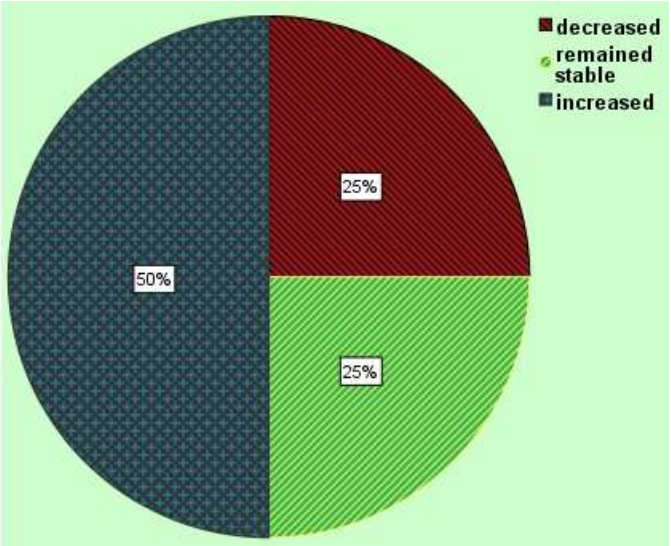

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Figure 4.
Successful Start-up Companies Established by Universities Students

Besides these, to increase interest and knowledge among students about innovation management, inclusion of courses related to innovation management in the curricula also has increased.

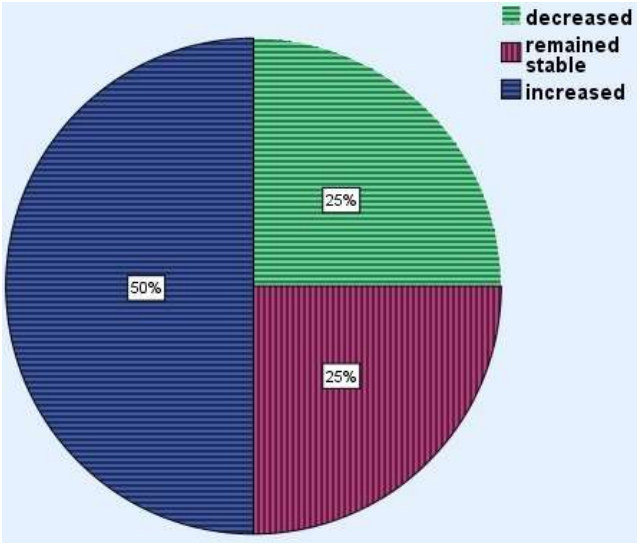

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Figure 5.
Inclusion of Innovation Management–Related Courses in the Curriculum

Failure of spin-off firms, non-commercialization of IPR and curriculum related variables shows high coefficients of variation that means the difference between minimum and maximum values of these variables are high. Except these variables, coefficients of variation are low.

Reverse-direction of U-I interaction

Reverse-direction of U-I interaction means funding or inviting researchers for R&D before employment initiated by industry. Survey result shows that 100% of respondents claim the increase of continuous collaboration has been started by industry. Besides this, 75% of respondents mention the increased concern of business partners about the management of intellectual property rights arising from joint work with the universities. Moreover, invitation from business partners to universities' research staff or students to conduct research and development that they have previously conducted in-house has increased in 75% of universities.

Other variables in the case of reverse direction do not show highly satisfactory improvement but moderate improvement. According to 50% of respondents, there is involvement of researchers/students in feasibility studies/project, before formal R&D, to verify the applicability of their ideas; recruitment of more key researchers and expert in industry; knowledge flows from university through research services of joint collaboration projects have increased. Therefore, knowledge flows from both sides, which is cross-disciplinary.

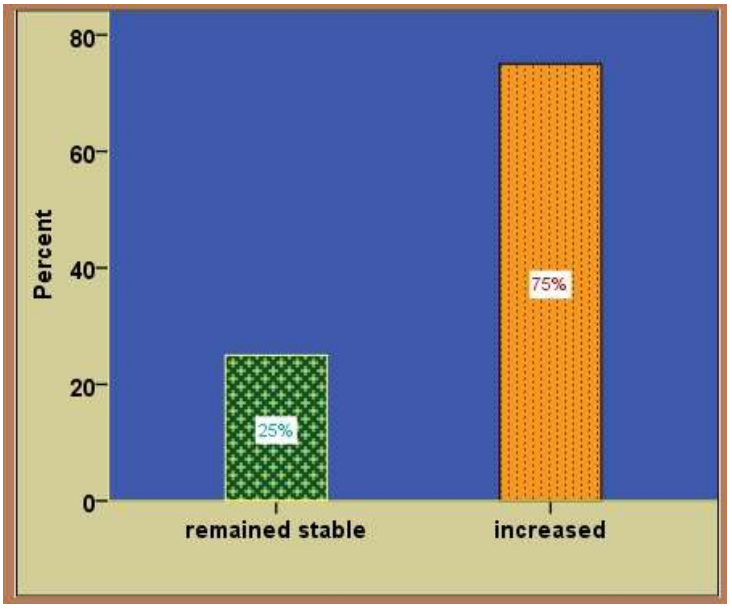

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Figure 6.
Invitation from Business Partners to Conduct R&D Activities

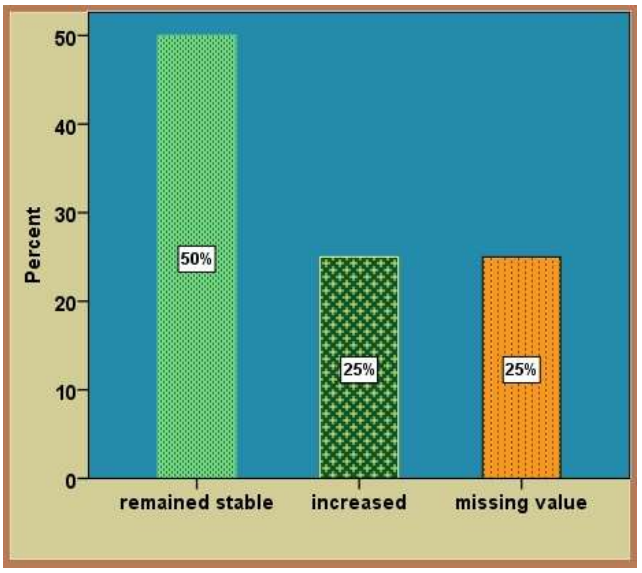
To sum up, the numbers of companies, diversity of industrial partners by size or by sector have increased in Malaysia. To foster collaboration, new organizations/programs have increased, which further fosters a process of commercialization of technologies and inventions as well as commercialization of products through selling/licensing them and by creating new business respectively. Universities organize student competitions or help to develop students' problem-solving skill for business. These steps jointly contribute to universities' internationalization. On the other hand, co-funded research projects, number of foreign partners or corporate funding, gaining profit

from selling university's IPR have not increased much. However, 50% of respondents say that the number of partner companies that are providing resources to the university without requiring immediate compensation has increased. University researchers who have taken up ideas and expertise from collaboration has also increased but universities commercialization services are inadequately resourced.

Source: Authors

Figure 7.
Inclusion of Collaborative Projects within Courses

Most of the respondents have no idea about whether ideas created in companies during collaborative projects have transferred to some of university students' ownership and whether collaborative projects are becoming a part of a curriculum within courses .



Source: Authors

Figure 8.
Ideas Created in Companies Transferred to University's Ownership

We can summarize our key findings based on survey results:

1. Reverse-direction of university industry collaboration that means knowledge flow from industry to university as university researchers have taken up ideas and expertise from collaboration.
2. Motivational factors of university industry collaboration from the university side are getting co-operation concerning the IPR management, recruitment of researchers/experts/students in industry, commercialization of technologies and inventions, sharing same equipment and laboratories, stepping forwards of university's internationalization.

On the other hand, industry's motivating factors are getting consulting services, new knowledge and technology and job representatives of business from university to improve the quality of the R&D. Business partners are becoming more sophisticated in co-operation concerning the management of IPR and they are co-funding more relative to the total number of university projects, therefore, we can claim universities resource related problems are reducing.

As business persons always look for profits, we can assume that they will not invest or collaborate without their profit. Hence, some factors work from both sides. Direct relations between business persons and researchers are fostering the collaboration. Besides this, business partners are increasingly inviting universities' research staff or students to conduct research and development that they have previously conducted in-house. If researchers/students are not sophisticated in problem solving or innovation, industry will not invite them. So, problem solving skills/innovative minds are helpful for recruitment in industry. On the contrary, it may also have the reverse effect, that means, as industry is recruiting researchers/students, more students/researchers are being interested to increase their problem-solving skill and getting recruited. In these circumstances. It is hard to specify who is responsible for the development of collaboration. However, despite industry co-funded projects increasing 75%, universities, government co-funded projects remain stable at 100%. Hence, the government role is smaller here. We may conclude that the university is the main actor in the Triple-Helix model in Malaysia and industry is second actor. Answers of third research sub-question from our aforementioned analysis are given as follows in Table 1.

Table 1.
Problems & Successes of Malaysian Research Universities

Success	Problems
1. University is providing consulting services (supported by Chandran, Hayter and Strong, 2015)	1. The number of foreign partners or corporate funding has not increased much (supported by Razak and Saad, 2007)
2. Number of shared co-funded projects among total projects have increased	2. Less increase in research projects co-funded with industry
3. Industry is acquiring knowledge from university	3. Co-operation with other companies is stable
4. Students are setting up their own business	4. Gaining profit from selling IPR (licensing etc.) is unsatisfactory
5. Involvement of research staff or students in R&D have increased	5. Innovation management-related courses are included in the curriculum have decreased in some cases. (supported by Cheng, Chan and Mahmood, 2009)

Table 1. (Continued)
Problems & Successes of Malaysian Research Universities

Success	Problems
6. Commercialization of universities' technologies, inventions and products have increased (supported by Wonglimpiyarat, 2011) 7. Use of full IPR for commercial purposes have increased (contrasted with Iqbal, Khan and Senin, 2015) 8. Universities are becoming internationalized 9. Number and diversity of industrial partners have increased by size/sector (contrasted with Chandran, Sundram and Santhidran, 2013)	

Source: Authors

Though universities have much successful steps, there are more sectors (commercialization services related to business co-operation, selection of industrial partners, recruitment of key researchers and experts in industry, informal involvement in R&D, offering job representative of business, sharing same equipment, economic exploitation of IPR, evaluating and monitoring the use of intellectual creatures, and contribution to regional industrial development), where they are improving but in a slower way. Therefore, we consider these factors as somewhat constraints and these sectors need accelerators. None of the universities performance is very bad. Still for comparison, we find comparatively good performance of UKM and comparatively bad performance of UM among 4 major research universities.

Policy Suggestions
Answer of last research sub-question leads to policy suggestion.

- Try to increase co-funded research project with industry and foreign partners.
- To increase co-operation with other companies (e.g. public administration).
- Some steps should be taken so that profit from selling IPR may increase.
- Inclusion of innovation management-related courses in curriculum.
- To increase commercialization services related to business co-operation.
- Try to get higher recruitment in industry.
- Proper economic exploitation of IPR and monitoring the use of IPR.

5. Conclusions

Malaysia is entered into the list of advance emerging economies. Our objective was to explore the features of the TH and RU in the context of Malaysian public universities and the impact of Triple Helix on NIS in Malaysia. We have found that the evolutionary Triple Helix model exists in Malaysia and bilateral collaboration (university industry collaboration) has impacted on regional development. Including a literature review, case studies and survey results, the study finds that Malaysia practices open[1] innovation in university-industry collaboration and this form is traditionally outbound, e.g., commercialization of property rights, start-up companies, providing services like consultation, research partnerships.

[1] *Open innovation in the context of University-Industry collaboration is that both university and industry use internal and external idea for innovation. As our variables show industry is hiring scientists and students from university and recruiting them to solve industry's innovation problems, they are using external ideas. On the contrary, university students' are generating idea in industry. Therefore, both industry and university are using external and internal ideas. There is less strict boundary in flow of knowledge. The commercialization of IPR, entrepreneurship (in the form of spin-of firm) are the forms of open innovation.*

Malaysian university researchers and students are being invited by industry more and more. But, recruitment is low. Though recruitment is low, researchers are recognized as the World's Most Influential research personal recently. On the other hand, as Castellacci and Natera (2013) have mentioned, technological output is positively related to growth of R&D, human capital, infrastructures, GDP per capita and openness to international trade. We find this evidence from Malaysia also by highlighting the increased commercialization of technology, innovation & products but foreign partners of universities have not increased much. Castellacci and Natera (2013) have argued that human capital has an indirect effect on the dynamics of innovation activities, but has a direct effect of sustaining the growth of GDP per capita. Therefore, we can say that collaboration of university-industry-government is contributing positively in Malaysia.

However, still there are some barriers towards improvement of TH. Universities are gaining profit from selling IPR is low. In addition, universities have less co-operation with other companies. Moreover, less increase in co-funding in research project is also a reason of barriers. Apart from these problems, collaboration helps university being internationalised. Ranking of universities are also upgrading. Our research findings support in line with the research of Ramli & Senin (2015); Ismail, Nor & Sidek, 2015); (Hamidon, Bin Suhaimie, bin Mat Yunoh, & binti Hashim, 2017); (Othman & Othman, 2017); (Din, Anuar & Usman, 2016); Wahid, Rhouseb, Mustaffa, and Rahman (2016); (Foo, 2013).

Despite these important findings, this paper has some limitations. It works with a 3-point Likert scale. Sample size is four. Therefore, future researchers in this regard should use large sample size and 5- or 7- point Likert scale. 3-point Likert scale often may be a problem regarding interval or scale. Therefore, a parametric test becomes tedious. More point Likert scale may pave the way to testing hypothesis rigorously. Further research can be directed towards helping Malaysian universities to improve collaboration more in the Quintuple Helix Framework. Future researchers can take the situation of public universities and compare with the private university's research status. In that case, a large sample size tends to help better results than in our current study.

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