

Abstract ID: ICBMIS-2019-043

Systematic University Intellectual Property Exploitation for a Better Technology Commercialization

Azlin Abd Jamil¹, Kamariah Ismail², Amran Md Rasli³, Aslan Amat Senin⁴

¹ Universiti Teknologi Malaysia

azlinjamil@utm.my

² Universiti Teknologi Malaysia

m-maria@utm.my

³ Universiti Teknologi Malaysia

m-amran@utm.my

⁴ Universiti Teknologi Malaysia

aslan@utm.my

Abstract

Intellectual Property (IP) acquisition by local universities in Malaysia has become even more important after the gazette of the Malaysian Intellectual Property Corporation Act, 2002 (Act 617) enactment, however, but its commercial success rate is yet to be commended. Despite the huge government investments in the R&D sector, return-on-investment is still vague. Focusing to improve the IP acquisition system employed by universities in Malaysia and to serve as a reference model of an IP exploitation framework, the study will (1) assess the barriers or challenges held with-in the process; (2) suggest suitable IP exploitation enablers or strategic initiatives; and (3) recommend improvements to the existing system through a holistic IP exploitation framework. To achieve this goal two-layer of Delphi semi-structured interviews were conducted with experienced Researchers and managers from five prominent Research Universities (RUs) in Malaysia who were competent in the process of IP acquisition and exploitation, together with industrial funders and collaborators who have vast experience in the full cycle of IP commercialization process with the five RUs. This study does not subject to transform any existing IP policies that have been established, albeit may cause future transformation, but will take into account weaknesses that caused the incompetence. In conclusion the study found that there are six important elements that need to be highlighted towards strengthening the universities IP exploitation and commercialization, which are the establishment of IP policy, the efficiency of IP management process, the competency of IP managers, the acumen of IP commercialization, the attractiveness of IP incentives, and finally the continuous IP funding support.

Keywords: Malaysia, university, intellectual property, acquisition, commercialization

1 Introduction

Over the past decades, the proliferation of knowledge from Institutions of Higher Education (IHLs) has been a key source for the national research and innovation development. However, the intention of IP exploitation through commercialization is still embryonic due to several factors not only of product viability but of an imperfect ecosystem, i.e. the lack of production of marketable research outputs; the weakness to sustain the research output's feasibility and viability; the lack of synergy in technology commercialization initiatives between technology producers and the technology adopters; the skepticism concerning the university's ability to cause IP lapse before exploitation; and many more (Abd Rahman Ahmad, et al., 2013), which reflects the debility of IHLs towards winning the commercialization of IP. Malaysia Research Assessment Instrument (MyRA), an auditing system enforced on all research based IHLs in recognition as the leading Research University (RUs) in Malaysia has proved that the income generated out of IP commercialization has yet to be proud of (Abd Rahman Ahmad, et al., 2014; Abdullah Abu, et al., 2014; Abd Rahman Ahmad, et al., 2013). A structured mechanism needs to be addressed in order to mitigate the challenges that had hindered commercialization success.

IP is an intangible property derived from the creativity of its creator for the purpose of solving problems, where the integration of multiple IPs is translated into a comprehensive life cycle of a product that can be exploited through the commercialization process (Blackburn, R.A., 2004). Beginning with the ideation phase, followed by the verification phase, the innovation phase, the commercialization phase and finally the product maturity phase, the university's commercialization failure can be anticipated which may be due to weaknesses in any of these phases (Datta, A., 2013; Edwin Grobbink, 2012). To address this concern, this study will focus on a comprehensive process that relates to the overall life cycle of a product until it is commercialized so that the gap or failure can be minimized. Only the scope of the study was reduced to IP exploitation efforts for commercial purposes.

Knowing that the IP categories are different according to their respective criteria, hence the differences in the IP categories reflect the different ways and processes of management, which are not confined to the Patents alone that require technical inventive measures in its filing. "Patents" ownership allow inventors to prevent others from using the filed claims for their commercial purposes for up to 20 years, different from "copyright" that covers the ownership for the rest of the inventor's life plus 50 years after his death; the "trademarks" must be renewed every ten years for filing period; the "IC layout design" that expires within ten years from the earliest date of commercial exploitation but renewable; etc. In fact, all of them may be owned legally subject to the IP Act for each of the categories, limited life expectancy, and can be exploited for monetary sources. As IPs will only be valuable when commercialization efforts are in place, henceforward IP owners need to strategize structurally how to generate income out of it because it involves a quantifiable outflow. Refer Figure 1 below to get an overview of the entire product life cycle that an organization needs to emphasize in order to be successful in commercialization

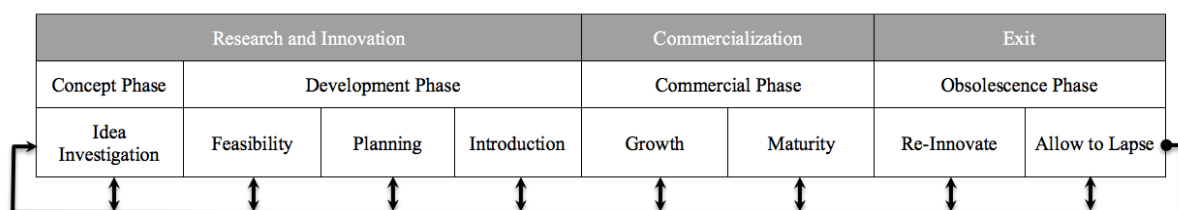


Figure 1
Complete product life cycle towards comprehensive commercialization

2 Literature review

The transformation of local Institution of Higher Learning (IHLs) has been extensively expanded (Lawton Smith and Bagchi-Sen, 2010; Etzkowitz, Mello and Almeida, 2005) from a center for education and research development with limited capital development and infrastructure (Francisco Javier Carrillo, 2015) to a more important translational platform via the exploitation of Intellectual Properties (IPs) to serve the strident demand from the industry (Tayebeh Khademia, et al., 2015; Francisco Javier Carrillo, 2015; Noor Inayah Jacob, et al., 2011). In Malaysia, the knowledge economy transformation has urged the IHLs to aggressively support the value chain of local demand by commercializing more local innovation through the empowerment of internal expertise as well as enhancing the IP governance system of innovation centers (Tayebeh Khademia, et al., 2015; Noor Inayah Yaakub, et al., 2011). In order to produce the best IP acquisition strategy or mechanism IHLs (as organizations) needs to refer to the established national IP policy in order to develop appropriate IP commercialization strategies (Abdullah Abu, et al., 2014). The IP policy itself should be the ultimate guideline in line with the current needs of the national ecosystem (Ajay Kaushik, et al., 2014), as it will form effectiveness to the arrangement of funds, manpower, infrastructure and other things necessary for an innovation ecosystem. Not only that, the IP policy should be interpreted comprehensively taking into account the role of other affiliated entities that may jointly involved in the IP acquisition and exploitation processes, as it has become a source of revenue that we need to work together dynamically, creatively and reliably (Kwon Youngkwan, et al., 2016).

A product is a solution to a problem, which is developed through one or more research processes, consisting of basic developments that are incorporated into a complete structure (Levitt, 2009). construction of a product can consist of one or several different IPs, including patent, copyright, trademark, industrial design, trade secret, and more (Kwon Youngkwan, et al., 2016). Each of these IPs needs to be studied and differentiated to avoid infringement (Lee Sooi Poh, 2010) even though the functionality of the product may be the same (Saville, C.J., et al., 2008), where the earliest creator who successfully registered its creation is entitled to the claim (Kwon Youngkwan, et al., 2016). Whether it is registered to the local database first or to the international database, regardless of its priority, the rules of IP filing is territorial and varies according to the enforcement of each country (D.S. Siegal, et al., 2007). IP properties are distinct and non-infringing in reference to the global filing system that emphasizes transparency to avoid conflict of rights (D.S. Siegal, et al., 2007). However, the success of a technology development is depends on the strengths of its practicality while being applied in the real market incorporated with some guidelines (Kwon Youngkwan, et al., 2016), thus defined the needs of the technology in the market (Melvin, 2004). Figure 2 below shows some overview on identified underlying theories related to technology commercialization.

2.1 The Underlying theories related to technology commercialization

Figure 2 below shows the basic theory related to the full lifecycle of a technology throughout its commercialization goal. The theories were used as a basis to pinpoint gaps that have not been identified which important towards achieving a holistic technology commercialization framework development. By adhering to the basic understanding of commercialization which should be an effective and productive business strategy adopted by a company towards marketing its products (Junghee Han, et al., 2017; Jisun Kim, et al., 2012; Etzkowitz, H., 2003), the gaps will be discussed to emphasize unstudied field towards the objective of commercializing a technology through the normal spectrum of a product lifecycle.

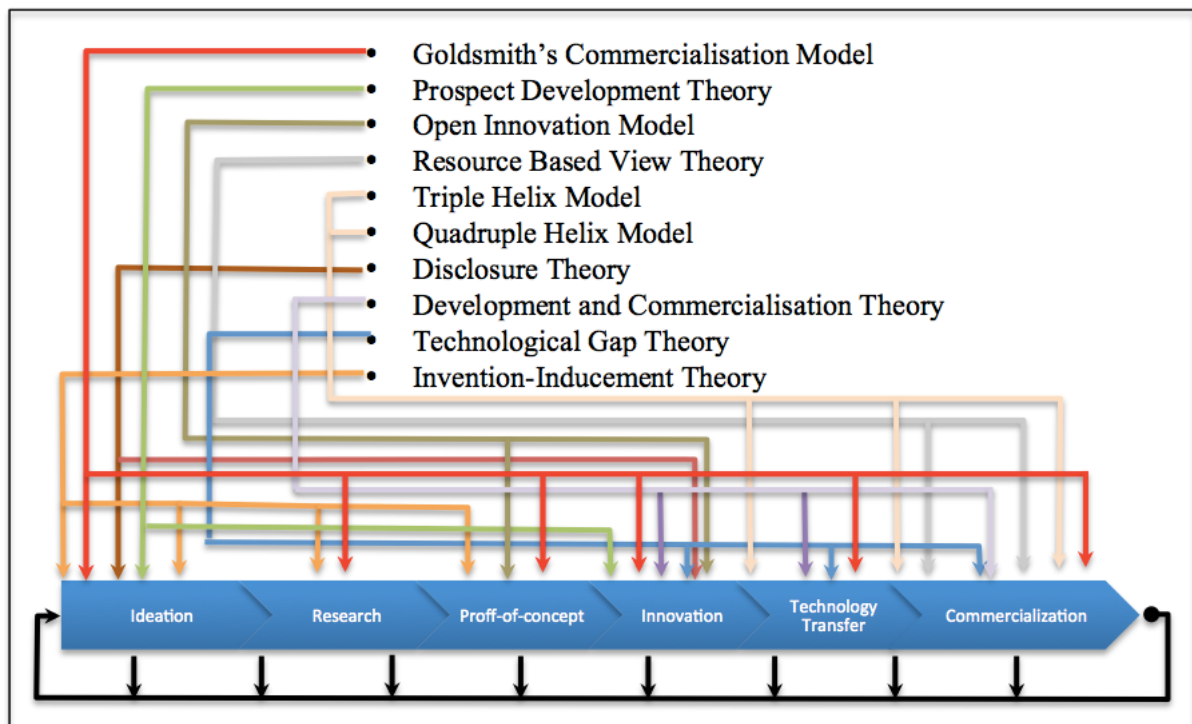


Figure 2

Underlying theories related to the technology commercialization

As discussed by previous researchers, the Goldsmith's Commercialization Model in comparison offers more flexible decision-making power in commercialization endeavor through its flexible entrepreneurial concepts presented in each of its building blocks (Gbadegeshin S.H., 2017; Hassan Emami, et al., 2015). It proposes liberation in the implementation, which allows for a reversal process if it is not found to be suitable for the next phase (Gbadegeshin S.H., 2017; Emami, et al., 2015; Saville, 2008). Although this emphasis is on the basic process of product development, in contrast to the Stage Gate model presented by Robert G. Cooper who sees the need to focus on one-to-one process and without skipping it (Cooper, 2001). This situation requires manufacturers to be more focused on the process and not just the product. Although Goldsmith's Commercialization Model seems flexible, it only emphasizes the process of transferring IP values through phases and not covering implementation policies, which has been an important part of the commercialization process in Malaysia. For example a comprehensive or holistic technology commercialization model must be in line with the Malaysian situation in which civil servants are generally restricted to engage in business, according to Act 605. Therefore, this model needs to be improved before it can be used for commercialization ecosystems in Malaysia.

Distinctive from Prospect Development Theory, Edmund Kitch emphasizes the priority of finalizing the product development first before IP filing takes place to avoid wasting investment at the expense of the IP filing process (Erik Hovenkamp, 2016). In a nutshell, this model recommend a more innovative market through product development activities without being monopolized by IP owners who have already filed their ideas, in which case other inventors can no longer develop within the same range of IP that has been filed and owned by the earlier inventor. This situation results in less competitive market conditions with limited innovation (Erik Hovenkamp, 2016). The patent filing scope too should be more focused and not too broad to allow fair ownership and to create a healthy future competition (Arnold Plant, 2012). As IP ownership is unique and cannot be shared except through proper transfer process, consequently this model indirectly encourages creative creations through the exploration of new ideas, in

which indirectly poses challenge to new market players, as more creative innovations are needed in order to fulfill the distinguished IP filing applications.

The urgency of developing new ideas proposed in the Prospect Development Theory is in line with the Open Innovation Model that emphasized the importance of firms in adopting proactive initiative to innovate by adapting new ideas into their innovation management for business enhancement (Chesbrough, 2003). The openness of new ideas denies the congestion over IP ownership issues stated by Edmund Kitch in the Prospect Development Theory as ownership can be creatively explored through a number of IP transfer processes such as sharing, consulting, merging, inheritance and so on for business improvement purposes. The main idea behind this theory is to utilize existing systems and support throughout the strength of related stakeholders to ensure commercialization success besides sustainable impact on economic growth and better performance on firm's business development (Greco et al., 2016).

As compared to previous models, the Resource Based View Theory emphasizes technology commercialization process differently via highlighting the strategy of the importance of unique, inventive, exclusive and inimitable company resources to reduce market competition (S Coleman et al., 2013; Lockett. A., 2005). It stresses that all firm's assets irrespective of whether they are in the form of knowledge, the firm should control tangible inputs in order to distinguish the unique business strategies (J. B. Barney et al., 2001). It also highlights the idea of competitive advantage, which depends on the superior internal sources which is not dependent on market and industry structure, consequently involves low price offerings, distinguished problem solution, unique invention, great return value, high quality but cheap to own product, etc., (Kumlu, 2014). As university spin-off companies in Malaysia can be categorized as new and start up at scale, this model can also serve as a reference in developing their business strategy.

In the other hands, as just important as other technology commercialization theories, the Triple Helix Model promotes the conceptual framework of interaction between three stakeholders that plays important roles. Formulated as a platform system of a set of components that have a dynamic relationship towards achieving wealth creation that is systematically materialized on a mutual agreement, referring to the relevant platforms, acts and policies (Rangaa, et al., 2012), this dynamical and hybrid theoretical approach offers a good technology commercialization strategy in addressing the shortcomings of the old commercialization platform system, which was weak in terms of marketing strategy, focusing only on long-term academic roles, entrepreneurship skills weaknesses among academics, as well as lack of co-operative networking with industry caused by obstacles to cooperate with the industry. This model also supports the role of institutions and individuals in an innovation while highlighting the development and capabilities of each element through the development of a fully integrated strategy. In the other hand, much like the Triple Helix Model, the Quadruple Helix Model outlines the importance of harmonious interactions between the four stakeholders that influence the nation's economic development, the government; community; this industry; and universities. This is a new paradigm based on the concept of the Triple Helix Model that emphasizes economic, political and social development as previously introduced by Henry Etzkowitz, 2003.

Unlike the Prospect Development Theory, the Disclosure Theory highlighted that there are many constraints that needs an intellectual property (IP) of a technology to be filed first before it is commercialized, including to secure value of the disclosure processes; to monitor what competitors and potential collaborators are doing; to incentivize researchers and employees as a source of funding; to enable licensing of own-technology; to increase freedom to operate and secure technology from others; as a focus for management best practice; as well as to be a

protection against infringement. However, if the value chain is established among these theories, it is found that the Disclosure Theory, Prospect Development Theory and the Resource Based View Theory it emphasizes the importance of common interests in ensuring that original ideas are protected under the recognized intellectual property act. Through this disclosure process, not only the technology filed can be strategically introduced to the world market, but at the same time can control market competition (Susanna 2013). Additionally, the process of IP disclosure can prevent misuse and imitation of the invention, within any country it covers, so that the investments made on the technology development are worthy (Sue A. Purvis, 2015).

Supporting the importance to technology commercialization, Rebecca Eisenberg (2001) through her Development and Commercialization Theory emphasizing the open opportunities through exploitation of used or obsolete patents, which caused uncertain commercialization outcome towards market needs. This model emphasizes on smart investment on IPs which market value begins to rise at its right market timing. Towards ensuring a business success, patents that are already a public domain are sometimes suitable to be scrutinized in order to benefit the current market, which may include IPs that were previously unsuccessful in commercialization and hence to be renewed. In order for the patent to be exploited properly, the ownership of the patent must be verified first, henceforth should be calculated carefully before any investment is placed, especially small companies with limited resources.

Furthermore, this study should also produce a smooth commercialization strategy by reducing gaps. The spirit brought through Technological Gap Theory via emphasizing the critical gaps lies in between the technology development processes and commercialization (G. Edmondson, 2012) demonstrates the need for immediate action in bridging identified gap. Although it may result in the need to change the underlying process, as long as the gap is resolved, then commercialization of the technology is considered successful for that phase. Referring to a study by Edmondson, 2012 the industry is inflexible to get convinced in being the catalyst to university commercialization activities even though there are commercialization funds offered for them to ease the effort (Edmondson, 2012). Hence, in order to lower the risk of the commercialization and higher the value of IPs, university should reduce the technology gap by exploring solution to the gaps identified.

Above all, according to the Invention-Inducement Theory highlighted that the main subject of important that differentiates the quality of a technology and its commercialization efforts is the strength of intellectual property rights (IP rights) that has been filed for the technology (Nelson, et. al, 1996). IP can distinguish the type of a business and increase the value of a business; product-based businesses differ from consulting services based businesses, whilst IP filing represents the strength of a product in the market rather than a product without IP background, because businesses that are commercializing the technology which have IPs filed are more significant than those who have not (Nelson, et. al, 1996). IP is the most important aspects to consider in planning and development of a business model. Consequently, Invention-Inducement Theory highlighted that developing product with strong paten background will benefit the most rather than the weak. Thus when there is competition between products in the market, the most powerful patent will benefit the most because the product can be innovated to generate new creations that can lead to new market exploration. Not only that, the Invention-Inducement Theory highlighted that by having a strong Patent, the ownership transfer process will be easier as the process will not have to go through a long-term ownership verification process. However, this arrangement illustrates the importance of filing a patent if the technology being pursued is expected to be disruptive innovation, and will determine success during the market process (Nelson, et. al, 1996).

As a conclusion, efforts to enhance the commercialization of technology require integrated and comprehensive attention including processes in the ideation phase, the innovation phase, the commercialization phase and finally the product maturity phase. The failure of the university to identify the holistic need for the formulation of commercialization strategies could undermine the university's IP exploitation efforts. Since some technologies which consists of a few IPs are produced in a serial manner, while some in parallel (Megumi Takata, 2011), in which the complete construction of a product relies to the IPs that needs to be developed separately before they are combined to function as a useful product, therefore, a comprehensive of complete IP exploitation management is necessary. In turn to illustrate the complete process of managing an IP, the framework of a technology commercialization has to be compiled to achieve comprehensive IP commercialization strategy.

2.2 The Interest of Malaysian Research Assessment Instrument (MyRA)

'MyRA' is stands for 'Malaysian Research Assessment Instrument (MyRA)' that serves as a comprehensive performance assessment system, developed to assess the research quality and capabilities for all Institutions of Higher Learning (IHLs) organizations in Malaysia. The MyRA system was recognized at the national level when it became the main agenda in the National Higher Education Strategic Plan (PSPTN) 2007-2020. To date, only 5 universities have been awarded as RUs in Malaysia, Universiti Sains Malaysia (USM), Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Teknologi Malaysia (UTM). In conclusion, MyRA assessed the performance of research universities in eight specialized categories including "Section A: General Information", "Section B: Quantity And Quality Of Researchers", "Section C: Quantity And Quality Of Research", "Section D: Quantity And Quality Of Postgraduates", "Section E: Innovation", "Section F: Professional Services And Gifts", "Section G: Networking And Linkages", and "Section H: Support Facilities". All eight categories set in MyRA has been benchmarked with the international research evaluation standards and are in line with world-class ranking evaluation criteria in order to enable local research outputs are eligible and competitive to the global markets (Norhaslinda Zainal Abidin, et al., 2017)

2.3 IP Filing Importance to Technology Transfer

Technology transfer is one of the most significant monetization activities for IHLs. It facilitates IPs transferred by the university (licensor) to a license for a certain period of time with a payment charge involving licensing and royalty fees that are set and agreed upon by the licensee (Etzkowitz, et al., 1995). The terms of the licensing agreement are usually under five years and renewed according to performance. According to Agnes Lenagh (2012) among the key factors that demonstrate the importance of technology transfer is that it can be the catalyst for the intellectual property (IP) development process, as it is driven by a more profitable end result; the value of the product is created to profit the organization or firm (Etzkowitz, et al., 1995; Lenagh, 2012). In order to highlight the importance of technology transfer in an commercialization ecosystem, the concept of Quadruple Helix (QHX) with university as the producer of innovation, the government as the policy enforcer, the industry as the technology exploiting and the community as the end-user, must be assessed accordingly because the interactions between all those stakeholders will define whether its implementation brings good impact or vice versa. Not only that, effective technology transfer can ensure the rights and interests of universities to be protected during licensing. Technology transfer can protect the products that wants to be exploited at the same time promote the inventor's research institutions and its commercial partners, as well as enhance the reputation of both parties when the university / industry either one or both acquires a recognition. Not only that, collaboration with industry partners can also reduce costs incurred during research and development phases via technology licensing process.

2.4 IP Filing Application to IP Corporation of Malaysia (MyIPO) (Local)

The technology commercialization frequently begins with a product disclosure by the inventor. In this situation, any research output under any categories of IP should be registered as soon as the technology's first working prototype is designed and documented on paper by the inventor. The selection of IP categories over an idea of creation should be carried out accurately through in-depth study of IP properties and its categories as emphasized by IP Corporation of Malaysia (MyIPO) (local application). This is because the IP filing process is a critical process that determines the future market of the technology during the commercialization phase. The research concludes RUs IP process flowchart as per illustrated in Figure 4.

Apparently the process of IP application in Malaysia is started with fulfilling the IP Disclosure Form, followed by the application review and IP search process by the TTO before the filing is recommended to be filed to MyIPO. The completed application will be crosschecked by the TTO with MyIPO next before the applicant is given the Letter of Acceptance and Certificate of Filing. This process is similarly done by all RUs, and takes about one week from the submission of the form comprehensively, provided relevant supporting documents and necessary information are complete. The incomplete application may cause to delay as only complete filing form and applications that are recommended by the university/patent agent is accepted by MyIPO, otherwise, the IP Disclosure Form will be returned back to the inventor/applicant for further accomplishment. In between of the process, after the completed IP Disclosure Form is received by the TTO, the TTO will forward selected the application to the selected Patent Agent in order to search for its originality and novelty, otherwise the patent search process will be carried out in-house by trained patent drafter. Once the application found novel and original, the Patent Agent/patent drafter will inform the inventor through a formal letter concerning the IP Filing Number, with a copy to the TTO, as a notification of filing. Even if the process of getting IP granted to a product invention or innovation mostly varies from a range of period of time, at least the fastest one not less than (1) year to the longest five (5) years of maturity period, once an application has successfully received the Patent Search Filing Number, it is safe now for the inventor to disclose the invention for next disclosure and marketing purposes.

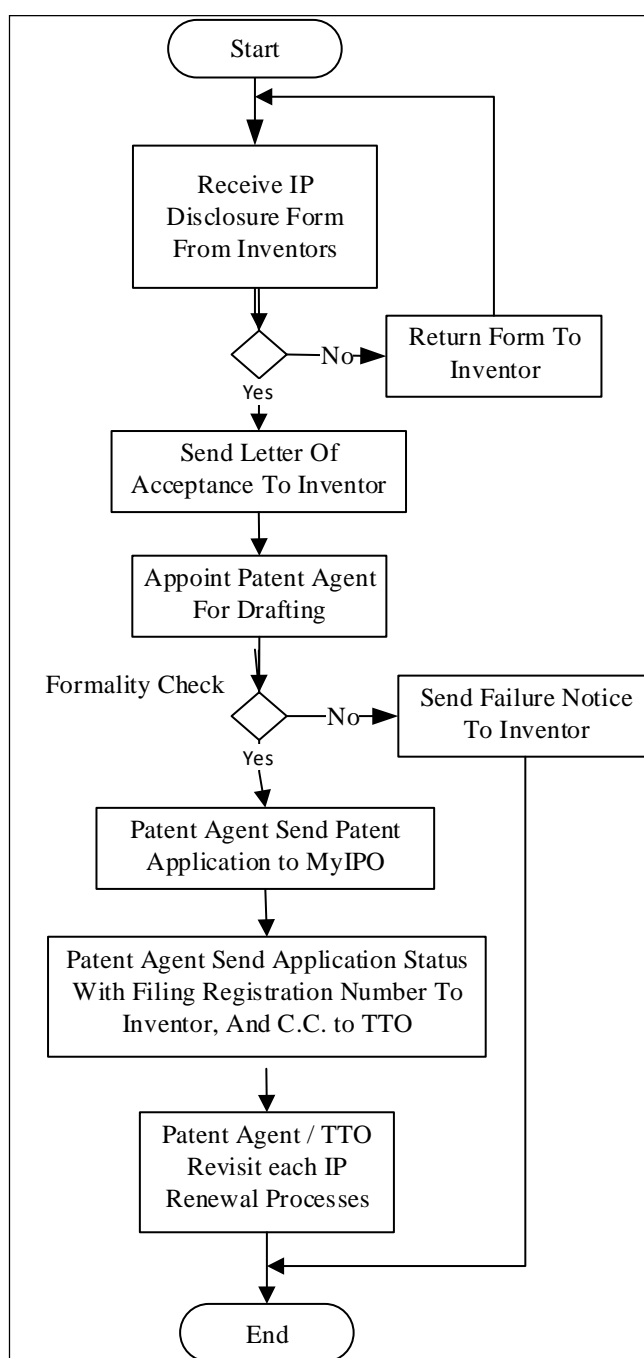


Figure 4
Local intellectual property process flowchart

Eventually, the requirement of registering IP is open at any stage of its development as long as the inventive steps are verified before registration to MyIPO / PCT. The most important action in IP protection is to complete the registration processes with the IP Office, until an IP number and certificate is obtained to ensure the complete filing process. Conventionally although an IP has been found and developed by a person or group of researchers, the absolute right of the IP registered remains to the organization, and not the personal rights of the investigator. This is because the creation is believed to have been produced by the staff of the organization using the laboratories and materials owned by the organization, albeit the laboratory equipment was procured using the government funds, hence the ownership is absolute. The emphasis to the IP ownership has to be shared and circulated to all researchers in order to avoid confusion, unless there is any legal agreement validating the ownership of the IP to be owned

by the staff/researcher. In this case, the staff together with the Technology Transfer Office (TTO) is jointly responsible throughout the filing process until the notification receipt is received from the MyIPO.

As highlighted previously, inventors or innovators should consider protecting their idea when they want to publish the idea or to make public presentations. Examples include chairing product discussion sessions, putting up posters, websites, and advertisements, grant applications etc., which may constitute public disclosure and therefore the inventors should limit the secret recipe of the IP while giving them access to the idea. The best course of action suggested to RUs researchers in prior to publicize their disclosure is to follow the commercialization patterns guided by the university's IP Policy through an immediate discussion with the TTOs.

2.5 International Application to Patent Cooperation Treaty (PCT)

More or less the same to the process of local IP filing, inventors who have the intention to register their IP in the international level should consult their TTO as soon as possible to outfit the options to the International Application Patent Cooperation Treaty (PCT). Filing to PCT is a different source of the application, not done in linear, hence can bypass the process of IP local filing. Thus because coverage of filed IP is geographical and processed according to the respective country's policies and guidelines, hence an IP is allowed to be filed internationally without having it filed at the local level first. For this initiative, it is found that all RUs adopt the importance of obtaining the approval of an international IP filing to their respective university's Board Members for filing provisions, refer Figure 5 below:

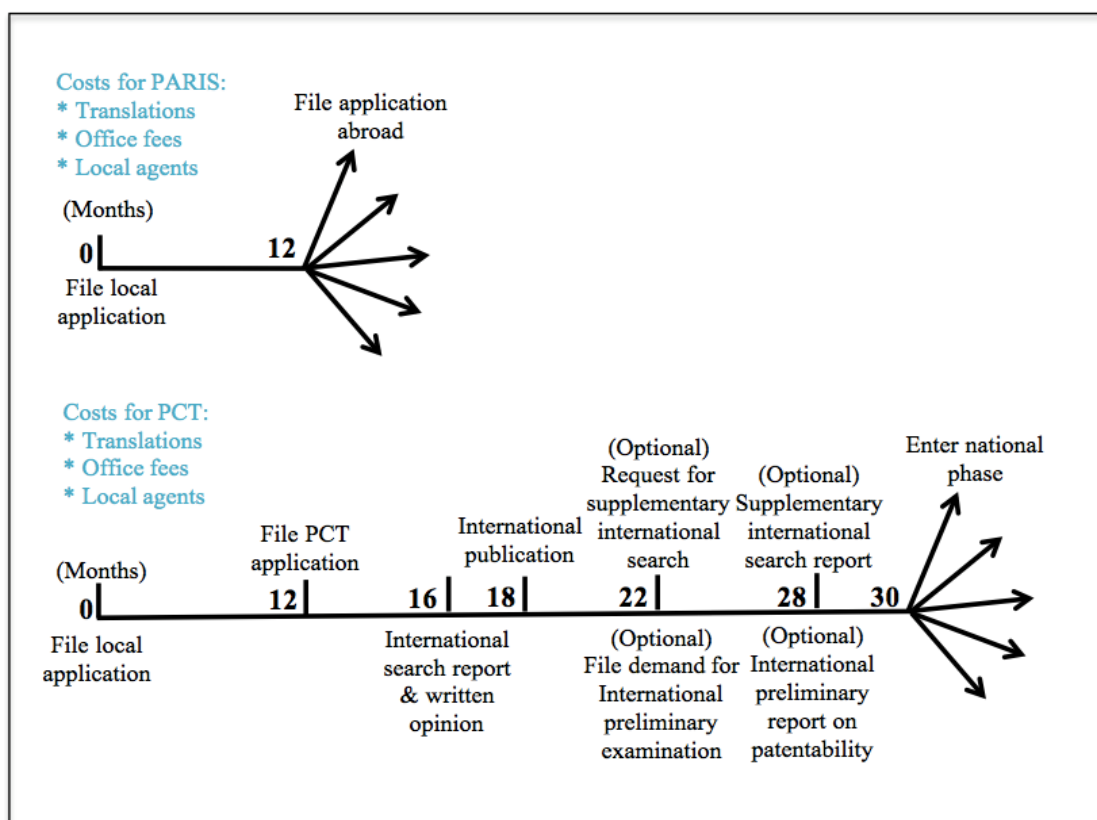


Figure 5

International intellectual property process flowchart through PCT

3 Methodology/Materials

The methodology used in this study specifically focus to qualitative study through interviewing selected population of total thirty technology commercialization experts who have vast experience in managing and experiencing the full cycle of technology commercialization with the five RUs in Malaysia, all of whom had more than five years of experience in IP acquisition. The interview process was conducted using the Delphi technique that involved two sessions, with each session involving the distribution of semi-structured questionnaire questions. This questionnaire was used to allow respondents to provide more open answers based on their own experiences. While most of the feedback gathered were about the same as all IHLs are subject to a national IP policy that has been enforced since 2009 which needs to be adhered to, but the experience of each respondent shown that there are certain qualities that need to be taken into consideration towards identifying appropriate strategies or mechanisms for the process of IP acquisition by IHLs, refer sub-chapter 4, Results/Findings.

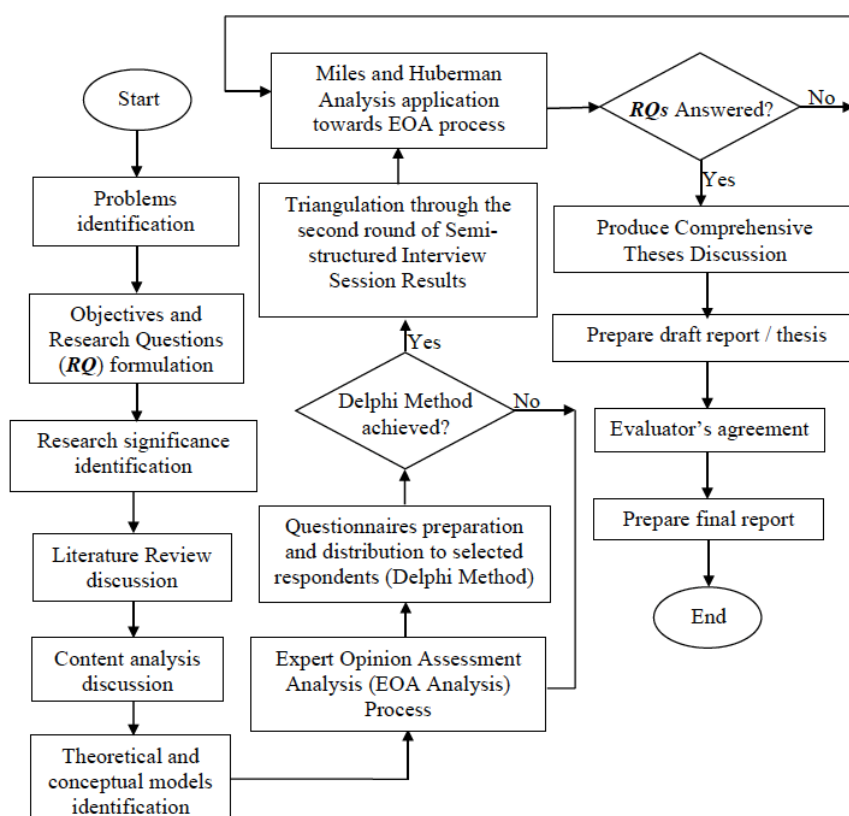


Figure 6
Research Flow Process

Figure 6 above shows the flowchart of the appropriate steps taken in reaching the objectives of this research commencing from identifying the related problems of this research until the final phase of the development of research thesis. Apparently, identifying the related problems of a research has been fundamental before engaging any further step. All data and result summarized in this study were generated from gathered opinions in the EOA and SSI. A set of research objectives was properly designed towards the formulation of the Research Questions, RQ1, RQ2, and RQ3, which had the problem, identified at the end of the study. Once RQs have been formulated, the process of recognizing research studies followed the process before a thorough literature review was done in order to structure the results of the study.

It appears that the issues and solutions that can give right impact to the process of a product commercialization extended beyond the research literature review. In order to get a broader view on the best technology commercialization strategy, two main sets of questionnaires that had been prepared were distributed using Delphi via answering the RQs. Next, two sets of data analysis were constructed according to the research objectives, and further discussed in the Data Sampling; before the final outcome presented in final chapter.

4 Results/Findings

In order to find the interests of the current commercialization ecosystem before producing a proper IP acquisition model, this study had assessed the issues encountered in the existing ecosystem to ensure betterment for the output of the study. Figure 3 below shows the relationship of the relevant entities within an IHL organization that are responsible to the IP acquisition, i.e. the “R&D Management Units” must ensure that the research conducted by the “Faculties, Centre of Excellent (COE) and Research Alliances (RAs)” can produce new IPs that are eligible to be filed and owned by the organization rather than replicating other research output that has been produced by other organizations. Additionally, when IP is transferred to other entities such as “Technology Transfer Office (TTO), Innovation Entrepreneurship Unit and Community Engagement Unit” the technical functionality of the prototype and its market acceptance should be assessed accordingly. The entity managing the IP at this stage should identify the market acceptance level, and provide appropriate entrepreneurship training to researchers who are interested in pursuing the IP transfer, aka commercialization of the product.

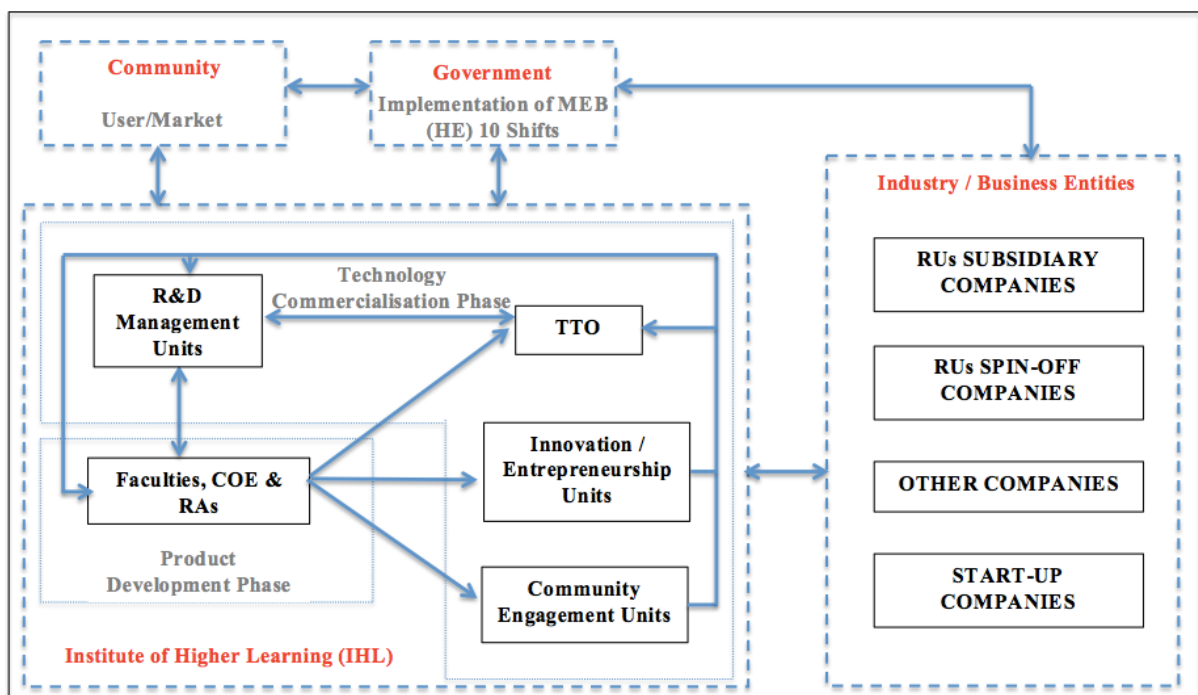


Figure 3
The relationship of the responsible entities for IP acquisition

4.1 Discussion and conclusion

Interviews with the respondents identified six important factors that had been the barriers to IP exploitation and commercialization including:

- 1) The establishment of IP policy (process foundation)
 - i) Bureaucratic and time-consuming application and approval processes

- ii) Moonlighting amongst researchers who carry out illegal income generating activities via abusing time and use of university's property and assets for their own benefit
 - iii) Unachieved income generation target through technological commercialisation revealed the weakness of the imposed policies and the guidelines
 - iv) Lack of awareness on university's policies and guidelines may cause to transgression of etiquette, violation of resolution, infringement of ownership, law-breaking, unpremeditated corruption, and may more during the commercialisation implementation.
 - v) Conflicts of commercialisation policy implementation especially on multi-field projects
 - vi) Long wait in the process of obtaining approval from the university due to a frantic and unclear policy process
 - vii) Uncertain knowledge on right policies and guidelines during the advisory session with TTOs and the researchers
 - viii) MyRA criteria limiting commercial development which classify sales of products that reach or exceed RM20million as commercial and ignore lower value achievement
 - ix) Overlapping roles between entity within university which cause difficulty to governance and confusion to stakeholders
 - x) Strategic initiatives and direction was set in line with the Malaysian Research Assessment Instrument (MyRA) set by the Ministry of Education as budget approved is according to RUs budget
 - xi) Suspension of IP filings is considered to be of no value to the current market, or is obsolete resulting in a decrease in total IP ownership.
 - xii) TTO Managers who are hired in contract basis causes instability to commercialisation success, as acquired knowledge has to be re-nurtured every time they are replaced of contract terminated
- 2) The efficiency of IP management process (organizational capability)
- i) Restrictions to public servants in holding up shares equity in companies as stated in the "Act 605 Statutory Bodies (Discipline And Surcharge)"
 - ii) Low number of commercially available products has led the university to invest more in immature and incomplete prototype testing and certification processes.
 - iii) Most research initiatives were not market-validated before embarking to the market
 - iv) Lack of technology novelties, consequently unattractive to the market
 - v) Low translation rate of IPs into commercial products or services caused by insufficient number of TTO staffs in the university
 - vi) Underestimate the importance of empowering full authority to the TTO to decide for all commercialisation related deals
 - vii) Low number of patents granted in a year
 - viii) High number of rejection of IP acquisition due to lack of novelty
 - ix) High filing cost and maintenance for non-performing IP rights
 - x) Low number of feasible IP registered caused to insecure commercialisation return
 - xi) Non-equitable intellectual property (IP) distribution rights among inventors due to lack of knowledge of IP rights
 - xii) Major customization during product deployment stage which sometimes involves long testing process before the product can exactly be launched

- xiii) Difficulties in implementing corporatisation when total autonomy power was not granted to TTO which could result to inadequate difficulty during the implementation phase
 - xiv) Product development depends fundamentally on funding availability
 - xv) Illegal research activities with no Memorandum of Agreement (MoA)
 - xvi) Achievement for MyRA on commercialisation section E and section F depends on number of university linked spin-off companies formed, and their income generated
 - xvii) Difficulties in obtaining commercialisation income data due to revenue confidentiality
 - xviii) Duplication and inaccurate data causes to unreliable report
 - xix) The process of data preparation is only available when required by top management, but is not treated as an important routine activity
 - xx) Uncertain and unscheduled demand for data collection by the ministry of education
 - xxi) Inconsistencies in data processing during the secretariat exchange may interfere with commercialisation efforts
 - xxii) There are not many models of technology that can be manipulated, hence most of IP/technology monetisation is tough and need creativity & exploration
- 3) The competency of IP managers (business and entrepreneurship)
- i) Improve process efficiency by developing online systems or IT-oriented workflows so that existing operating capital burdens can be reduced to focus on planning and strategies
 - ii) Lack of research experience and skill causing weakness in research planning and achievement
 - iii) Lack of self-financing capabilities that causes to high dependence on uncertain fund approval
 - iv) Lack of research team members or inadequate workforce led to a slowdown in planning and project implementation
 - v) Lack of quality performance validation experience resulted to poor quality of output
 - vi) Complex decision making within licensing process involving TTO and Industry
 - vii) Incomplete commercialisation ecosystem via lack of entrepreneurship training
 - viii) Weak participation by Researchers into incubation programs due
 - ix) Poor knowledge in product scale up due to funding and infrastructure limitations
 - x) Lack of business acumen amongst researchers who have produced feasible products
 - xi) Untapped to potential innovation product produced by university students as university only focuses on the potential of research staff
 - xii) Researchers deny university rights when product commercialisation did not get any investment from the university
 - xiii) Each IP is unique and requires a professional who understands the technology commercially to execute overall requirements
 - xiv) Fail to articulate unique selling propositions to demonstrate market demands
 - xv) Disagreement between researchers and industrial collaborators on matters of product improvement
- 4) The acumen of IP commercialization (feasible business model)
- i) Low number of spin-off companies cause slowdown in commercialisation

- ii) Spin-off companies pushing out immature product to commercialisation.
 - iii) Loss of trust from collaborators after witnessing the university's inability to productization
 - iv) Licensing fee amount expected is not realistic resulted from the standard IP valuation process
 - v) Low income generated from product commercialisation / technology know-how licensing
 - vi) Distrust of local companies towards local R&D capabilities caused by Euro-centric mentality
 - vii) Most of university spin-offs struggle to commercialise their technology due to resource constraints and imperfect innovative markets.
 - viii) Company reveals incorrect corporate sales value to avoid high royalty payments to universities
 - ix) Disparities between the real revenue and reported revenue as licensee attempts to reduce royalty payment to the university.
 - x) No submission of sales reports although the licensing agreement expired
 - xi) Lack of responsibility in reporting annual financial reports to LHDN and SSM as required for companies registered in Malaysia
- 5) The attractiveness of IP incentives (encouragement program/incentives)
- i) Universities do not use or install their own products for internal use
 - ii) Insufficient marketing experts in order to increase marketing success and lower the rate of failure and risks
 - iii) Low pick-up rate and interest from industry
 - iv) Long time period of market acceptance and readiness on technology-based products
 - v) Low visibility and coverage of university's own products especially through online platform
 - vi) Lack of success stories or champion to be exemplary to other researchers.
 - vii) Lack of international partnerships and collaboration
 - viii) Lack of involvement in research by industry
 - ix) Lack of funding to address finance gaps
 - x) Low visibility and access to incubator facilities and technical expertise
 - xi) Disagreement to technology and market validation process due to lack of funding and capabilities
 - xii) Difficulties obtaining regulatory certification
 - xiii) Lack of awareness on IP protection, licensing, branding and marketing
 - xiv) Lack of prototyping, productisation and market access support
 - xv) Less income incentives distribution caused by low number of new technology know-how licensed in the year, hence less Royalty and Licensee Fee captured
 - xvi) Lack of research recognition
 - xvii) Lack of international partnerships
 - xviii) Lack of promotion on university's experts list/database
- 6) The continuous IP exploitation support (funding)
- i) Limited commercialisation funding causes to high competition in funds acquisition.
 - ii) Poor grant management
 - iii) Unrealistic requirements for equipment in fund proposal, hence caused to application failure

- iv) Insufficient information in demonstrating the importance of the proposal towards identified problem and provided hypothesis that were unreliable, dubious and unsound
- v) Fail to declare the fundamental factors in the proposal caused to inappropriate or unqualified tests, methods, or scientific procedures towards achieving the stated objective
- vi) New research proposals are unlikely to pass than proposals led by well-known field experts
- vii) Researchers are too dependent on government grants, including the Research University Grant (GUP); whereby GUP is capped to only 15% in MyRA
- viii) Lack of innovation champion for the grant of private domestic and international grants
- ix) High challenges in managing R, I, C & E grants because each funding have different criteria, procedures, methods of application and management of grants
- x) Poor coordination in strategising the effort in obtaining more R, I, C & E financing
- xi) Lack of involvement by industry in carrying out University's R, I, C & E activities especially the technology licensing
- xii) Some require IPs to be owned by individuals rather than universities, i.e. fund from Cradle Fund Pt. Ltd. and SUPERB can only be awarded to applicants who highlight their own technology but are not owned by university - licensed technologies are encouraged. Licensed technology must present a university-approved licensing document to qualify for financial incentives (terms for application process apply)
- xiii) The commercialization fund outlines different criteria to be complied with by the applicants and the university community, so the applicant should present a value proposition that is of high investment / market value.
- xiv) Less successful application of private grants (Malaysia) and international grants
- xv) Lack of innovation champion on the grant of private domestic and international grants

5 Discussion and conclusion

In this section, the author discusses and summarizes all of the findings of the previous case study to draw conclusions. Six factors to consider in resolving the issues raised by the survey respondents including:

- 7) The establishment of IP policy (process foundation)
 - i) Establish a holistic IP policy that is relevant to the benefits and interests of governments, industries, universities, and communities
 - ii) Emphasis awareness on Malaysia Law and Technology commercialization related Acts like the Penal Code, Act 574, the Malaysian Anti-Corruption Commission, Act 2009 (SPRM Act 2009) (Act 694) and the Statutory Bodies (Discipline And Surcharge) (Act 605)
 - iii) Audit the IPs production to ensure quality research outputs over market requirements
 - iv) Proactive to change obsolete policies to avoid potential problems
 - v) IP Commercialization Policy protects the inventor's rights by distributing a necessary portion of profit making obtained from the commercialization activities. This could nurture entrepreneurial spirit amongst researchers and enhance commercialization and R&D development in UTM. Consequently, the inventors can

- claim their total rights towards their IPs under certain circumstances by obtaining approval from the university's Board of Directors (BOD)
 - vi) Strengthen IP Unit reliability in providing information, basic knowledge and support not only pertaining to IP filing processes, but also on R&D, IP/technology development and overall corporate strategy towards commercialization via encouraging effective interaction between stakeholders
 - vii) Establish new business model for universities laboratories to allow equipment leasing for market needs.
 - viii) Strengthen policy on contract research & international research management
 - ix) Promote Double Tax Deduction (DTD) for potential industry collaborator
 - x) Dedicated business entity can be formed to cater related activities to the ecosystem needs
 - xi) Forming a cluster (research Alliances concept) is a common practice to address certain challenges such as reducing the cost of operations and volume production using the common infrastructure, and help to form the key relationship between organizations and industries to facilitate the important interaction within the clusters.
 - xii) MyRA influence TTO to encourage filing and registrations, but yet RU has started to strengthen IP monitoring through relevant IP audits session in order to drop IPs that are obsolete and has no market value after certain years of renewal/maintenance, to optimize spending.
 - xiii) The TTO director who has completed the contract term at TTO (contract basis), which should have mastered the expertise and leadership in commercialization will continue to develop the idea of TTO-led entrepreneurship initiatives to facilitate the process of expanding knowledge of the co-administration when he was subsequently appointed to another department
- 8) The efficiency of IP management process (organizational capability)
- i) Establish a centralization of IP office that can perform key tasks related to IP acquisition
 - ii) Empower sub-committees at the sub-organization level for necessary IP filing and acquisition initiatives in order to promote efficient management to the grass-roots level.
 - iii) Design and provide an efficient support system such as the development of an online registration form and an online management system that can produce realtime reporting for easy schedule monitoring and systematic database updating to meet complex and dynamic stakeholders demands.
 - iv) Create appropriate metrics system to distinguish high value IPs aligned with the firm's commercialization needs.
 - v) Establish an efficient payment platform that makes it easier for licensees to pay licensing fees, royalties and other fees, i.e. auto-deduction from bank account, etc.
 - vi) Leverage synergy across sub-organizations and stakeholders in all processes related to IP acquisition management.
 - vii) Establish an efficient online integrated system that can be easily accessed systematically at any time
 - viii) Create proper monitoring platform for better reporting coordination between stakeholders
 - ix) Leverage synergy across Centre of Excellences from different industry and field of expertise

- 9) The competency of IP managers (business and entrepreneurship)
 - i) Conduct regular IP training and awareness programs, such as awareness of IP criteria and attributes, successful case study examples, important milestone regarding IPs, budgets involved in local and international IP filing process (Patent Cooperation Treaty (PCT), etc., to ensure consistent learning and up-to-date knowledge of IP.
 - ii) Provide efficient support system to solve problems arising on IP
 - iii) Empower collection unit team with proper negotiation creativity to win debt collection
 - iv) Encourage researchers to produce comprehensive publication impact by inculcating innovation and entrepreneurship to ease the research output exploitation
 - v) Expose researchers to reality programs or TV shows that gives real live experience and exposure
 - vi) Empower innovation productivity on human resources and human capital so that organizational strategic plans produce effective output.
 - vii) Fit the organizational positioning with the right skilled person to avoid irrelevant behavior during technology commercialization
 - viii) Invest in relevant insurance policies that covering the safety, health and welfare of staff in order to increase the trust between employees and employers.
 - ix) Inculcate entrepreneurial spirit amongst researchers to succeed inclusive socio-economic transformation
 - x) Conduct frequent training and human capital development related events so that researchers are more competitive towards dynamic market needs and changes
 - xi) Conduct pitching training session iteratively in order to get researchers familiarize and fluent with effective pitching techniques, which totally different from classroom lecturing
 - xii) Work with industries from idea to launching stages whilst supporting synergy and symbiosis model/concept (Quadruple Helix Model)
 - xiii) Create mentor-mentee incubation program for a better monitoring and catching-up
 - xiv) Creating a derivative company that can be a buffer to the direct impact arising from problems related to university commercialization activities
 - xv) Encourage systematic and proven business models implementation to every single business entities related to the university, i.e. the Lean Management, Discipline of Innovation, Business Model Canvas, strategic online marketing, etc.
 - xvi) Focus more on research results from computer faculty as ICT products have the potential to enter the market faster than other engineering-based products.
 - xvii) Promote active market driven researches to ensure ROI and ecosystems sustainability
 - xviii) Researchers are permitted to have IP rights in every innovation they develop
- 10) The acumen of IP commercialization (feasible business model)
 - i) Allow researchers to develop various products according to their expertise and market demand to increase the number of IPs
 - ii) Implement best practices in the IP management process in order to increase quality product development for higher market acceptance
 - iii) Focus more on IPs that meet market requirements as this demonstrates the readiness of an organization in facing current challenges of market demand and their level of competitiveness
 - iv) Improve monitoring and collection of licensing fee process via salary deduction

- v) Establish competent spin-off companies that can ensure firm growth and productively contribute to the market – quality over quantity.
 - vi) Offers reasonable and attractive royalty and licensing fees to promote and enhance the commercialization of university technologies
 - vii) Grant companies with appropriate privileges such as exempting licensing fee payments for a certain percentages, attractive repayment scheme, special commercialization funds, free training and entrepreneurial exposures, shared network/ collaborator database, quick access to selected laboratories and equipment (terms and condition apply), and so forth.
 - viii) Offer attractive revaluation scheme on royalty and licensing fee to encourage timely payment
 - ix) Conduct proper monitoring and documentation system process to spillover knowledge gain through spin-off companies via high impact reporting (journal, books, chapters, etc.), to accelerate the national economic growth.
 - x) Perform transparent income distribution to raise stakeholders confidents, trust and contributions
 - xi) Promote the commercialization of technology by non-inventors to avoid conflict of interest and non-directional sense of belonging.
 - xii) Collaborate with Suruhanjaya Syarikat Malaysia (SSM) in order to get fast information on company profiles and their income statements
- 11) The attractiveness of IP incentives (encouragement program/incentives)
- i) Offer attractive IPs packages to potential collaborators to facilitate end-to-end solution to product development
 - ii) Encourage the implementation of technology and market validation before embarking to technology commercialization
 - iii) Subscribe (invest) to a well-known marketing platform for selective products to create impact
 - iv) Conduct campaign of installing homegrown technologies within campus
 - v) Organize frequent business-matching forums to discuss current technology developments
 - vi) Explore new market segment
 - vii) Join and conduct exhibition programs to expose university technologies, prosper knowledge, gain exposure whilst assessing opportunities and challenges held within technology commercialization
 - viii) Increase outreach activities with industries
 - ix) Increase citation by utilizing online professional networking such as Research Gate, academic.edu, etc.
 - x) Encourage regular online marketing efforts through various online social medias and marketing platforms to promote and offer for expertise utilization
 - xi) Sustain a number of foreign researchers to offset the need for internationalization branding
 - xii) Establish consortiums between research groups and industries from the same areas, e.g. Halal Industry Consortium; Disable Community Industry Consortium; etc.
 - xiii) Invest in impactful marketing materials promotion kits to perform as the secondary material for marketing purposes
 - xiv) Establish Academic Industrial Council (AIC-Across Economic Cluster-NKEA)
 - xv) Promote Existing Accredited Laboratory in University as additional income generator

- xvi) Review current incentive scheme that related to commercialization encouragement (including e-LPPT)
 - xvii) Offers promising and attractive incentive plans to promote technology commercialization
 - xviii) Promote transparent income distribution referring to the inventor's contributions
- 12) The continuous IP exploitation support (funding)
- i) Design special funds specifically for bridge the gaps that exist within the innovation and commercialization phases to catalyze commercialization efforts
 - ii) Empower interactive linkages with grant providers, internal and external sources (e.g. CRADLE, MTDC, L2M, angel investors, etc.).
 - iii) Provide dedicated investment through funding specifically for IP development, innovation and commercialization to increase income generation through a specific planning and strategic implementation
 - iv) Train researchers through holistic exposure in fund acquiring skill
 - v) Assist the government in identifying and suggesting the type fund that are currently needed for R&D Commercialization processes, as well as preparing suitable application criteria for the fund application assessment process
 - vi) Appoint champion researchers who can lead the acquisition initiatives for international and private funding
 - vii) Aid spin-off companies with grants or loans that can pay for licensing fee to universities (which suitable) to expedite the licensing initiatives.
 - viii) Involvement in collaborative symbiosis program with other fund provider that promotes innovation competitions with a price of research fundings, etc.
 - ix) Win as much commercialization funding offered in the market like the University-Cradle Investment Fund (UCIP150), Cradle Investment Fund (CIP500), Commercialization of Research & Development Fund (CRDF), Business Growth Fund (BGF), Business Star-Up Fund (BSF) and Halal Technology Development Fund (HTDF), High Impact Program (HIP2) etc.
 - x) There are many commercialization funds offered in Malaysia (term and condition apply)

5.1 Comprehensive IP exploitation process

IP is an asset that needs strategic management and requires investment in time, money, expertise and external support that may be the catalyst for IP exploitation. Table 1 below present recommend the relevant IP acquisition related activities that have to be complied to ensure efficiency in an IP exploitation management.

Table 1
Phases of commercialization with the importance of IP exploitation

	Technical	Market	Business
	Concept Phase		
IP Ideation	Technology Concept Analysis Determine the unique physical specifications of the product through	Market Needs Assessment Determine the marketing concept and the appropriate product marketability techniques to	Venture Assessment Determine the appropriate business model towards pursuing profitable business venture of the

	the claims highlighted in the filed IP.	achieve consumer confidence on the IP	IP over time and money invested
Development Phase			
IP Feasibility	Technology Feasibility Development of a proof-of-concept model of the IP to demonstrate technical and functional possibility via performance and production verification	Market Study Quantifying market acceptance for the IP through the market segmentation, and anticipated market response or behavior towards the new product	Economic Feasibility Analyzing the financial model design towards achieving break-even of the IP commercialization taking into accounts the related debt or investment needed.
IP Planning	Engineering Prototype The process of establishing the final specification of the IP refers to the capability of prototype and production requirements according available resources	Strategic Marketing Verifying the best marketing strategy for the particular IP that offer high market opportunities and maximum profitability to businesses before being translated into key components of the business plan.	Strategic Business Plan Reflects the decisions made in the IP development planning phase and the probability of business success for a five-year financial projection design for the IP
IP Introduction	Pre-Production Prototype Introducing the marketable prototypes of the IP to the market in line with the manufacturing specification determined and large-scale production	Market Validation Assessing the IP product feasibility through market receptivity by comparing the projected business plan with the real customer feedback	Business Start-Up Integration of entrepreneurial skills among key personnel into the business planning for the IP referring to the projected business parameters
Commercial Phase			
IP Full Scale Production / Growth	Production Full-scale IP production process through an optimized manufacturing process	Sales and Distribution Sustaining product status and branding in the market through the empowerment of the IP product sales strategies	Business Growth The expansion of the company's strategic on the IP operating plans to a higher level (go global) in line with the increasing market demand
IP Maturity	Production Support Maintaining the maximum value of the IP	Market Diversification	Business Maturity Optimizing firm's profit potential via the IP

	through improved technical productization strategy and continuous production processes	Diversification strategy for the IP concerning product improvisation for changing market demand conditions	by exploring new market diversification
Obsolesces Phase			
IP Exit	Re-Innovate Improving technical specifications of the IP according to new market demand	Allow to Lapse Neglecting the improvement of product specifications and market need by allowing the IP to face obsolesces	

5.2 Centralized online-based IP acquisition and management systems

IP needs to be registered at the right time to avoid ownership infringement tendencies. This process can be improved by setting up a centralized online IP acquisition and management system that can promise real-time registration facilitation over a shortened duration towards approval stage. Through this system, the confidence and reliability over TTO will increase as the system can bridge the gaps that have been identified in the previous system.

The creation of an online system not only facilitates the data management process, but also automatically generates reporting documents, online, whenever needed. Not only are the registration processes will be easy, but also the monitoring, reporting and approval process will become more efficient as centralization allows multiple layers of heads to quickly review and approve many applications. With such facilities, the university can also indirectly drive the efforts to create efficient IP management ecosystem which thus contribute to the increasing number of local innovations and efficient development of the people's well being.

5.3 Refer, research and recommend efficiently for a sustainable productivity

IHLs need to start focusing on the development of low-hanging fruits of technologies in addition to the existing fundamental research, and to ensure the sustainability of the local research ecosystem. Some of the initiatives can be enforced through the gaps identification and bridging process via enhancing strong networking between important stakeholders i.e. the government, industry, universities and communities. This is also to highlight the development of homegrown talent in research and innovation that are useful to the community, and can be commercialized for a high-income generation. By ensuring the growth of homegrown products in the market, the local ecosystem becomes more intact and competition within local market will get lower. Besides, the strengthening of local products can boost the country's cash flow while strengthening the country's economic sector. Next, not only will national income improve, but also the social standard of living of the local community will be more stable.

5.4 The capturing of low hanging fruits products

Towards developing a local based technology, universities also need to pool local resources to fully maximize the output. This in turn should lessen the university from frequently importing foreign technology for their research use, instead of developing more homegrown technology especially for research and product development purposes, this initiative could also avoid direct impact of an influx of imported products whilst decreasing the local market competition.

In addition, to ensure its continued role as a producer of innovation, the university can also harvest low hanging fruits product from the labs to ensure continued delivery of services with exploitation of simple and short value chain products. However, at the same time, IHLs need to do benchmarking with successful international universities to complement their commercialization achievement and strategies towards local fast-track development.

5.5 Strengthening the role of TTO as reliable commercialization facilitator

IP culture should be strengthened by the TTO to the university community through frequent awareness and training programs in order to strengthen and grow the knowledge regarding IP. Such frequency can not only increase the university's confidence in the TTO, as previously discussed university students have some skeptical thoughts about the TTO's capabilities, so they must be resolved immediately so as not to become worse. TTO roles and responsibilities can be defined into a total number of services provided (quantity) as well as the level of satisfaction on services delivered (quality). Both are relatively interrelated and should be defined and refined as required. In the context of TTO's importance at the university level, they play crucial nodes delivering the university's research outputs to the beneficiaries in particular the community and industry. Although previous studies have found that TTOs need to be creative in generating income for an organization, but due to the national enactment (Act 574 and Act 605), which fundamentally prohibits income generation involvement of a civil servant, hence the university's TTO were urged to coordinate accordingly the limits and needs of IP/technology commercialization involving university staffs, as to promote an ethical and lawful processes. The strength of TTO often depends on the level of tangible and intangible resources provided by the university, hence listed below are some importance towards TTO reliabilities:

- 1) Create permanent position for the TTO through the creation of a persuasive career path can solve the problem of most contracted staff in the TTO offices, whereas this profession requires an experienced person without the constraint of contract termination. As the interaction between university and market require effective communication to ensure productive commercialization impact. Universities as a government agency or even statutory body organization have to hire highly skilled marketing administrators (the TTO) to promote commercialization effectively. Thus also to ensure sustainability and prevent brain drain
- 2) Delegate the decision making power to the TTO to make the implementation of activities more efficient than the decisions that need to be made through the long value chain, which can lead to failure of opportunities and information leakage.
- 3) Establish a liaison officer in each of the sub-organization to reachable services and to ensure prompt reporting from the sources to the top management. Initial validation is very important in order to avoid any loss during or even after the product commercialization planning.
- 4) Create synergy between sub-organization to strengthen capabilities and reduce the cost of management. This can improving the quality of delivery, as not all TTO are technologist who can facilitate the technical needs of the products.
- 5) Equip the universities with relevant policies or guidelines as to avoid power infringement by TTO. Through policy, the management will become shall be uniform, irrespective of the decision of any responsible officer

Acknowledgements

This work is partially supported by the TTO of Universiti Teknologi Malaysia, the Innovation and Commercialization Centre (ICC). The author(s) also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the quality of this paper.

References

- Abd Rahman Ahmad & Alan Farley (2013). *Funding Reforms in Malaysian Public Universities from the Perspective of Strategic Planning*. International Conference on Innovation, Management and Technology Research, Procedia - Social and Behavioral Sciences 00 (2013) 000–000.
- Abd Rahman Ahmad, Alan Farley & Ng Kim Soon (2014). *Impact of the government funding reforms on the research and development at Malaysian public universities*. Asian Social Science. Vol. 10, No. 14; 2014. ISSN 1911-2017 E-ISSN 1911-2025. Published by Canadian Center of Science and Education
- Abdullah Abu, M.Y. Sulaiman & N.A. Othman (2014). *Malaysian innovation ecosystem: a review of the literature*. Researchgate
- Ajay Kaushik, Sanjay Kumar, Sunil Luthra & Abid Haleem (2014). *Technology transfer: Enablers and barriers - A review*. International Journal of Technology Policy and Management 14(2): 133-159. DOI: 10.1504/IJTPM.2014.060152
- Arnold Plant (2012). *The Economic Theory Concerning Patents for Inventions*. Economica. New Series, Vol. 1, No. 1 (Feb., 1934), pp. 30-51
- Blackburn, R.A. (2004). *Intellectual Property and Innovation Management in Small Firms*. London & New York: Routledge
- Chesbrough, H. and Rosenbloom, R. S. (2002). *The Role of the Business Model in Capturing Value from Innovation: Evidence from Xerox Corporation's Technology Spinoff Companies*. Harvard Business School. Submitted to Industrial and Corporate Change.
- S Coleman, C Cotei, J Farhat (2013). *A resource-based view of new firm survival: new perspectives on the role of industry and exit route*. Journal of Developmental
- Datta, A., Reed, R., Jessup, L. (2013). *Commercialization of Innovations: An Overarching Framework and Research Agenda*. American Journal of Business, 28(2), pp. 147-191
- Edwin Grobbink (2012). *Strategic Commercialization*. Master thesis. University of Twente Capgemini Consulting
- Etzkowitz, H., JMC de Mello, M Almeida (2005). *Towards "meta-innovation" in Brazil: The evolution of the incubator and the emergence of a triple helix*. Research Policy
- Francisco Javier Carrillo (2015). *Knowledge-based development as a new economic culture*. Carrillo Journal of Open Innovation: Technology, Market, and Complexity (2015). DOI 10.1186/s40852-015-0017-5
- Gail Edmondson, Lori Valigra, Michael Kenward, Richard L Hudson & Haydn Belfield (2012). *Making industry-university partnerships work - lessons from successful collaborations*. Science|Business Innovation Board AISBL
- Hassan Emami & Reza Radfar (2015). *Presentation of a Novel Model for Evaluation of Commercialization of Research and Development: Case Study of the Pharmaceutical*
- HL Smith, S Bagchi-Sen (2010). *Triple helix and regional development: a perspective from Oxfordshire in the UK*. Pages 805-818. Technology Analysis & Strategic Management. Volume 22, 2010 - Issue 7: The Triple Helix Perspective Of Innovation Systems
- JB Barney, DJ Ketchen Jr (2011). *The future of resource-based theory: revitalization or decline?*. Journal of management

- Jisun Kim; Tugrul U Daim; Timothy R Anderson (2012). *Commercialization of technologies out of US universities*. Proceedings of PICMET '12: Technology Management for Emerging Technologies. Page 1756 – 1776. IEEE Conferences
- Junghhee Han (2017). *Technology Commercialization through Sustainable Knowledge Sharing from University-Industry Collaborations, with a Focus on Patent Propensity*. Received: 29 August 2017; Accepted: 2 October 2017; Published: 7 October 2017
- Kumlu (2014). *The effect of intangible resources and competitive strategies on the export performance of small and medium sized enterprises*. Procedia-Social and Behavioral Sciences.
- Kwon Youngkwan & Park Jongbok (2016). *Empirical study on the success of technology commercialization projects of firms*. The Journal of Intellectual Property, Vol.11 No.3 September 2016
- Lee Sooi Poh (2010). *Factors that determine intellectual property strategy of the firm*. Universiti Sains Malaysia MBA Program. ADW 622: Management Project
- Levitt (2009). 12manage - *The Executive Fast Track*. Retrieved from http://www.12manage.com/methods_product_life_cycle.html
- Lockett, A., Siegal, D.S.; Wright, M., and Ensley, M.D. (2005). *The creation of spin-off firms at public research institutions: Managerial and policy implications*. Research Policy 34(7), 981-993
- Megumi Takata (2011). *Study of the Process of University Technology Commercialization: the Roles and Effects of Educational Courses*. Proceedings of the 8th International Conference on Innovation & Management
- Melvin, J. D. (2004). *Technology Commercialization Manual: Strategy, Tactics, and Economics for Business Success*. Published by Med-Launch, Inc
- M Greco, M Grimaldi, L Cricelli (2016). *An analysis of the open innovation effect on firm performance*. European Management Journal, 2016
- Nelson, et al., (2014); Dahlborg, et al., C., 2013). Dilck Cetindamar (2016). *A new role for universities: Technology transfer for social innovations*. Portland International Conference on Management of Engineering and Technology (PICMET). Page 290 – 295. IEEE Conferences
- Noor Inayah Yaakub, Wan Mohd Hirwani Wan Hussain, Mohd Nizam Abdul Rahman, Zinatul Ashiqin Zainol, Wan Kamal Mujani, Ezad Azraai Jamsari, Adibah Sulaiman and Kamaruzaman Jusoff (2011). *Challenges for Commercialization of University Research for Agricultural Based Invention*. World Applied Sciences Journal 12 (2): 132-138, 2011. ISSN 1818-4952. IDOSI Publications, 2011
- Norhaslinda Zainal Abidin, Nerda Zaibidi & Khairah Karim (2017). *Strategic planning for MyRA performance: A causal loop diagram approach*. The 2nd International Conference on Applied Science and Technology 2017 (Icast'17) Proceedings 1891(1):020151. DOI: 10.1063/1.5005484
- Robert, G. Cooper and Kleinschmidt, E. G. (2001). *Stage-Gate Process for New Product Success*. *Innovation Management 2001*. Edited by Jens Arleth
- Saheed Adebayo Gbadegeshin (2017). *Commercialization process of high technology: A study of Finnish University Spin-off*. Academy of Entrepreneurship Journal Volume 23, Issue 2, 2017
- Saville, C.J. and Ismail, N. (2008). *The Commercialization of Research and Intellectual Property Assets*. A Competency Development Module
- Siegal, D.S., Waldman, D.A., Atwater, L.E., and Link, A.N. (2004). *Towards a model of the effective transfer of scientific knowledge from academicians to practitioners: Qualitative evidence from the commercialisation of university technologies*. Journal of Engineering and Technology Management 21(1-2), 115-142.

- Sue A. Purvis (2015). *The Fundamentals of Intellectual Property for the Entrepreneur*. Slide From U.S. Patent and Trademark Office
- Tayebeh Khademia, Kamariah Ismail, Chew Tin Leeb, Arezou Shafaghata (2015). *Enhancing commercialization level of academic research outputs in research university*. Jurnal Teknologi.
- Erik Hovenkamp (2016). *Patent Prospect Theory and Competitive Innovation*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2765478
- Agnes Lenagh (2012), *The importance of technology transfers*. Retrieved from: <https://www.unemed.com/blog/the-importance-of-technology-transfer>