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Examining Issues and Challenges in the Commercialization of University-Generated Intellectual Property Rights in Malaysia

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Abstract:
The commercialization of Intellectual Property Rights (IPR) stemming from public universities has consistently been a prominent agenda within Malaysia's economic plans. However, despite continuous efforts by stakeholders within the Malaysian innovation system, the commercialization success rate remains disappointingly low, falling below 10%. Hence, this paper aims to thoroughly analyse the issues and challenges surrounding the commercialization of IPR generated by public universities in Malaysia. To identify issues and challenges in IPR commercialization in Malaysia, the authors conducted a comprehensive and systematic literature review, reading and reviewing over 287 documents. In addition, the findings from semi-structured interviews conducted as part of a pilot study were triangulated to support and validate the themes derived from our qualitative content analysis. This paper examines issues and challenges in the commercialization of university-generated IPR in Malaysia from the perspectives of three Triple Helix stakeholders: the government, universities, and industries. Empirical studies from multiple viewpoints are required to verify the proposed conceptualization. The present study highlighted that a targeted focus on awareness, resources, and policies by the Triple Helix stakeholders could significantly improve the IPR commercialization rate. The IPR commercialization is a key focus within Malaysia's economic development plan, propelling the nation towards its goal of becoming a high-income, knowledge-based economy.

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INTRODUCTION

Intellectual Property Rights (IPR) commercialization is a widely accepted concept embedded in the national policies of many advanced and emerging economies. Universities have shifted their focus from solely teaching and academic research to embracing a new role in IPR commercialization, known as the 'third mission' of the university (Etzkowitz, 2003; Williamson, 2024). IPR commercialization has become a prominent agenda in driving knowledge-driven economic development (Bezanilla et al., 2020; Prencipe et al., 2020). In illustrating a dynamic innovation system, Etzkowitz and Leydesdorff (2000) established the Triple Helix Model (THM) concept to describe the university-industry-government relationship. The process of IPR commercialization is complex and dynamic, necessitating symbiotic collaborations among various stakeholders within a progressive innovation ecosystem.

As Malaysia transitions from a manufacturing and export-based economy to a knowledge-driven economy, the commercialization of IPR derived from government-funded research projects, particularly those emanating from public universities, becomes one of the country's important agendas for long-term economic growth (OECD, 2016; MOSTI Innovation Report, 2016; Kuriakose & Tiew, 2020; MOSTI STI Indicator Report, 2021; World Bank, 2021; RMK12, 2021; Pelan Strategik MOSTI 2021-2025, 2021, Buletin MCY, 2024). Although the Government of Malaysia has

introduced several policies and initiatives aimed at expediting IPR commercialization and fostering university-industry collaborations, the outcomes of these efforts have not proven to be significantly impactful.

In the case of Malaysia, previous studies addressing issues and challenges in IPR commercialization from the standpoint of Triple Helix stakeholders are still limited. Most of the prior studies published on IPR commercialization in Malaysia have primarily examined institutional factors (university-related factors) and external factors affecting commercialization (Khademi & Ismail, 2013; Suhaimi et al., 2020) such as barriers and challenges to commercialization (Ismail & Mohamed, 2016; Suhaimi et al., 2020; Ramli et al., 2021; Chandran et al., 2021), the university-industry relationship (Chandran et al., 2014; Azman et al., 2019), and the role of Technology Transfer Office (TTO) (Rahim et al., 2015). Furthermore, previous research on IPR commercialization in Malaysia has predominantly employed quantitative methods (Suhaimi et al., 2020; Ramli et al., 2021).

By conducting a qualitative thematic analysis of existing literature and drawing insights from a pilot study involving semi-structured interviews with three different stakeholders in the IPR commercialization ecosystem in Malaysia, this paper aims to achieve two main objectives: (1) to examine the issues and challenges related to the commercialization of university-generated IPR from the perspective of Triple Helix stakeholders - government, university, and industry in the Malaysian innovation system, and (2) to propose recommendations and solutions for the Triple Helix stakeholders within the Malaysian innovation ecosystem to support IPR commercialization.

The rest of the article is organized as follows: the next section provides a brief discussion on the background of the study, followed by an overview of the methodology employed. Subsequently, the study presents and discusses the results. Next, there will be a discussion on recommendations and potential solutions for all Triple Helix stakeholders in the Malaysian innovation ecosystem. Finally, the study outlines the limitations and future research directions.

BACKGROUND OF THE STUDY

It has been more than two decades since concerns about the low commercialization rate of IPR from public institutions in Malaysia were first raised. In an article titled "R & D Syok Sendiri" published in *Berita Harian*, Zaidan and Sobry (2014) highlighted that less than 2% of the 27,449 research outputs from 15 public universities were successfully commercialized in the last five to ten years. The agendas for technology development and subsequent IPR commercialization have been strategically planned since the 6th Malaysia Plan, with further reinforcement in the 12th Malaysia Plan (RMK12, 2021). As the government has continuously invested huge R&D funding for each Malaysia Plan, the number of IPR generated through R&D activities has increased exponentially. Unfortunately, the high numbers of IPR produced have not yet translated into commercially available products or services. According to the Malaysia Research Assessment (MyRA) audit report, the commercialization rate of university-generated IPR was only 4.3% in 2019 (RMK12, 2021). Furthermore, the overall rate of commercialization for publicly funded R&D projects in Malaysia, including public universities, research institutions, and Small Medium Enterprises (SMEs), is estimated to be only 5 to 10% (Abu Bakar, 2022; Ignatius, 2022). Despite various efforts in commercializing university-generated IPR, statistics indicate that Malaysia lags behind highly developed countries such as Japan or the USA, where the commercialization rate can reach as high as 60% (Ignatius, 2022). This situation indirectly suggests that various measures taken by universities and the government have not been fully effective, as the commercialization success rate still does not exceed 10% (Ignatius, 2022). In fact, in partnership with the Ministry of Science, Technology, and Innovation (MOSTI), the Ministry of Economy recently announced the implementation of initiatives to strengthen the national research, development, commercialization, and innovation (RDCI) ecosystem by bridging existing gaps (The Edge Malaysia, 2025).

The Triple Helix Model of Innovation (THM) establishes the groundwork for cultivating innovation-focused interactions among government, business, and academia. According to this model, these three stakeholders' collaboration drives

innovation within the knowledge-based economy (Etzkowitz, 2003). The THM, constituting a national innovation system, is built upon the interplay of its interconnected helices (Cai & Amaral, 2021).

The role of government in providing various resources and developing effective policies is crucial to support commercialization (Harman & Harman, 2004; Ismail & Ajagbe, 2013; Pique et al., 2018; Abbas et al., 2019). Resources such as funding (Ismail & Ajagbe, 2013), tax incentives (Wonglimpiyarat, 2017), incubation space (Chandra & Fealey, 2009; Wonglimpiyarat, 2010), and other supports are necessary to fuel high-quality R&D and commercialization activities. The government is also responsible for developing policies that are effective for the country's context, particularly from the perspective of a developing country where there are cultural challenges and resource constraints (OECD, 2014). For instance, MOSTI launched the Supercharger Series 2024, designed to revitalize Malaysia's innovation ecosystem (Shazrie, 2024).

Within the Triple Helix Model, the industry serves as a key agent for commercialization, adopting technologies stemming from university R&D and acting as an economic driver for the nation (Pique et al., 2018). The third helix, represented by the university, functions as a knowledge powerhouse, generating critical knowledge and new technologies essential for Malaysia's transition into a knowledge-based economy. The synergy and symbiotic interactions among these three stakeholders amplify their collective impact in overcoming issues and challenges in the commercialization process. The THM recognizes that each stakeholder brings unique strengths and perspectives to the innovation ecosystem (Cai & Amaral, 2021; Alnafrah, 2024).

In the context of Malaysia, research on the university-industry-government interaction for IPR commercialization is still in its infancy stage. Previous studies on the THM in the Malaysian context have used a quantitative survey approach to examine factors motivating university-industry collaboration initiatives and critical issues affecting the reverse direction of such collaboration (Afzal et al., 2018).

RESEARCH METHODOLOGY

The present study conducted a comprehensive literature search and analysis following the steps outlined by Hart (2001): (1) locating information references, (2) identifying relevant articles, and (3) locating item reviews. For the literature search, the study employed primary keywords such as such as “commercialisation” OR “commercialization”, “R&D commercialisation”, “university spin-off”, “university startup”, and “Malaysia”. These keywords were applied across various databases, including Google, Google Scholar, Web of Science, Scopus, Science Direct, Springer, Taylor & Francis, SAGE journals, and Emerald Insight. Additionally, if documents were not publicly accessible, we directly contacted authors through platforms like Research Gate and emails. The utilization of multiple databases enabled us to compile a comprehensive list of pertinent research publications. In the end, we gathered and analyzed a total of 287 documents from diverse sources, encompassing online newspapers, magazine articles, reports, agency publications, and journal articles. Based on the content and relevance of these documents to the research topic, we conducted a qualitative content analysis of the literature to identify themes pertaining to the challenges and issues of IPR commercialization within the Malaysian context. To validate these themes with the findings on IPR commercialization challenges from existing literature, we utilized content analysis and comparative analysis, following the approach recommended by Miles et al. (2014).

Furthermore, we enhanced the rigor of our literature review analysis by integrating findings from semi-structured interviews conducted as part of our qualitative pilot study. The primary aim of the pilot study, beyond verifying the literature-based findings on issues and challenges in IPR commercialization, was to evaluate whether the selected stakeholders provided relevant and comprehensive insights and to identify potential methodological challenges before conducting the full study (Van Teijlingen & Hundley, 2001; Castillo-Montoya, 2016; Majid et al., 2017). For the pilot study, we conducted interviews with three informants, each representing a distinct Triple Helix stakeholder: an academic researcher, a university startup entrepreneur, and a government venture capitalist. This approach ensured that diverse

perspectives were captured across academia, industry, and government. Since the objective was not to achieve data saturation but rather to refine the study design, a small number of informants, typically two to five, is considered sufficient, particularly for validating and refining interview protocols (Kim, 2011; Castillo-Montoya, 2016; Majid et al., 2017; Malmqvist et al., 2019; Shakir & Rahman, 2022). In the context of qualitative research, we employed purposeful sampling (Patton, 2002) to select informants for the pilot study. The selection criteria focused on individuals capable of offering comprehensive insights based on their knowledge or experience concerning the phenomenon of interest (Creswell & Plano Clark, 2011). Hence, at the time of the interviews, all informants were actively involved in the process of commercializing IPR resulting from R&D activities conducted at University Alpha.

To ensure data accuracy and enhance credibility, we recorded and transcribed the interviews using Sonix.ai. Following the methodology outlined by Patton (2002), we emailed the transcribed interviews to the respective informants for respondent validation (member checking). This iterative verification process ensured that the data accurately reflected the perspectives of the stakeholders, thereby strengthening the overall trustworthiness and rigor of the study.

The themes derived from our qualitative content analysis were systematically analysed using Microsoft Excel, which was utilized for data organization, coding, and thematic classification. To enhance the validity and reliability of our findings, we employed methodological triangulation, integrating insights from secondary data (systematic literature review) with primary data (semi-structured interviews) (Carter et al., 2014). This process allowed us to cross-validate themes, ensuring that theoretical constructs identified from the literature were either reinforced or challenged by real-world perspectives from the stakeholders. Therefore, we triangulated the data across different stakeholder viewpoints using the Triple Helix framework, engaging representatives from academia, industry, and government. This approach facilitated a diverse interpretation of issues, highlighting how various stakeholders perceive and understand the emerging themes of issues and challenges in IPR commercialization within the Malaysian innovation ecosystem differently.

To preserve confidentiality, we used pseudonyms when presenting the qualitative findings. In this paper, the academic researcher is referred to as Professor Sarah, the CEO of the university startup as Mr. Adam, and the individual representing the government venture capitalist as Ms. Susana. Professor Sarah, a senior professor at Universiti Alpha, also serves as the Chief Technology Officer (CTO) at SigmaAqua, a startup dedicated to advancing cleantech solutions for sewage treatment. Mr. Adam is the CEO of BetaMedical, a startup that specializes in the commercialization of medical technology. Ms. Susana is the Vice President of one of the commercialization fund departments at the Malaysian Technology Development Corporation (MTDC), a commercialization agency under MOSTI.

RESULTS AND DISCUSSION

The findings of this paper highlight the issues and challenges associated with the commercialization of university-generated IPR in Malaysia. These challenges are analysed from the perspectives of the government, universities, and the industry.

Government

Government policies often aim to foster innovation but can be overly idealistic, creating frameworks that overlook practical challenges. Review from the literature and triangulated with data from the semi-structured interviews, it is evident that bureaucracy, including complex regulations and lengthy approval processes, significantly hinders the commercialization of university-generated IPR.

Government policies are too idealistic

The Government of Malaysia launched the Intellectual Property Commercialization Policy (IPCP) in 2009 and established Science Funds during the Ninth Malaysia Plan (2006–2010) to incentivize academic researchers

to patent and commercialize their R&D innovations (Chandran et al., 2021). Malaysian public universities are compelled to commercialize due to policy pressures, as the evaluation of commercialization activities in the Malaysia Research Assessment (MyRA) impacts university performance and ranking (Ta et al., 2021). Universities are also pressured to generate revenues as part of the University Transformation Programme, in addition to being accountable for providing significant research productivity and quality (MOHE, 2017). While the government has adopted commercialization policies modelled after advanced economies like the US and Europe, Malaysia lacks the innovation ecosystem to adequately support commercialization activities. The current ecosystem is not yet prepared to facilitate effective commercialization. Mr. Adam raised his concern about the readiness of the Malaysian innovation ecosystem, which is not synchronized with the policies implemented by the government:

> "I don't think the university bursar understands how to support the environment, much like in the US and Europe, and how taxation contributes to technology development. In Malaysia, we don't have that ecosystem yet, but we tend to create policies by adopting the best practices from various sources. It's common in Malaysia to incorporate the finest policies […], including those from Harvard and the Ivy League. […] these become our primary policies for the startup environment, but often without the full consideration of other factors or elements."

Hence, while the policies outlined by the government are intended to enhance the success rate of commercializing university-generated IPR, both universities and industries might lack sufficient resources and infrastructure to effectively implement such policies.

Bureaucracy: compartmentalization of government's department

One of the factors hindering the progress of commercialization is bureaucracy. Hossinger et al. (2020) identified that organizational-level bureaucracy as a barrier to the commercialization and growth of university startups. Additionally, complicated and time-consuming funding application and disbursement procedures also slow down commercialization efforts (Bhayani, 2015). In the context of Malaysia, although the government has introduced a localization act to facilitate the market penetration of local technology, cumbersome bureaucratic procedures and high compartmentalization of governmental departments pose challenges to the commercialization process, especially for products and services based on new technology. Mr. Adam talked about his experience when BetaMedical dealt with a government organization interested in buying their products:

> "We simply want to inquire with the ministry about ensuring our product's utilization of the localization act. […] when we enter the market, numerous individuals express [their] interest in purchasing our product. […] in terms of grant disbursement, … the Bursar informed me that there isn't an assigned vote number for our product, given its novelty and absence of a track record. Nevertheless, we must accommodate their requests and adhere to their procedures in order for us to register under the ministry, enabling us to enter the [government] market and access the special budget."

Prof. Sarah shared her experience of being pushed from one ministry to another due to the high compartmentalization of governmental departments. This happened when her startup attempted to enter the market through government ministries:

> "So many ministries, you counted just now, about five, right? [...] in architecture, when you do product development, it goes over the wall. We don't care what happens on the other side of the wall […]. We observe high compartmentalization, even within the ministry, in their scope of work."

University

From the perspective of the university as a key stakeholder in the Triple Helix model, our findings highlight several challenges in IPR commercialization: (1) insufficient motivation among stakeholders to pursue commercialization, (2) limited resources and a lack of a robust supporting ecosystem within the university, and (3) ineffective or inadequate university commercialization policies and guidelines.

Entrepreneurial intention: lack of drive and motivation towards commercialization among academic researchers

Surveys conducted among science and technology academic researchers from Malaysian public universities have revealed several key findings: 89% of them lack time for commercialization, 85% lack entrepreneurial skills, 80% are unfamiliar with the process, and 69% lack commitment (Ramli et al., 2021). Many academic researchers perceive commercialization as difficult, time-consuming, and feel they lack the right mindset and motivation (Ismail & Mohamed, 2016; Suhaimi et al., 2020). Past research has consistently emphasized that the success of commercialization heavily depends on the attitudes, mindsets, and commitments of academic researchers (Ismail & Mohamed, 2016; Suhaimi et al., 2020; Ramli et al., 2021; Chandran et al., 2021). Professor Sarah also highlighted that her passion motivates her involvement in commercialization efforts beyond academic publication and supervising postgraduate students:

> "It was a passion that drove me towards commercialization ... I was looking for a product that I could commercialize…It's not just paper research. Paper research means you just produce paper, and then that's it with your thesis. I really push my student to create a technology."

While commercialization remains an option for advancing academic careers, many researchers will likely continue to follow the conventional path, prioritizing research publications, student supervision, and patent filings as a means of career promotion (Chandran et al., 2021).

Limited resources and innovation support ecosystem within universities

The role of the parent organization, especially through the Technology Transfer Office (TTO), in providing resources for academic researchers and university startup entrepreneurs is a critical success factor in commercialization. This is particularly crucial as startups often lack resources when starting out (Clarysse & Moray, 2004; Gübeli & Doloreux, 2005; Parmentola & Ferretti, 2018). The university's entrepreneurial orientation, incubators or entrepreneurship support program, and product market potential are positively related to university startup creation and commercialization activities (Montiel-Campos, 2018). However, Malaysia may not have yet achieved this ideal dynamic entrepreneurship ecosystem within the university setting. Past research has reported there were inadequate facilities and support to sustain commercialization activities (Jamil et al., 2015; Ismail et al., 2015).

Our interviews with Prof. Sarah and Mr. Adam provided more insights into the lack of resources and an inadequate innovation support system within universities. For instance, laboratory equipment was outdated, and funding for cutting-edge equipment was limited. Mr. Adam mentioned that:

> "What the engineering faculty possesses [lab facilities] currently represents the resources available 15 years ago, and they haven't been upgraded. …when they seek upgrades, they must await budget allocations. On occasion, there might be a budget, but it's not allocated for their department; it's designated for the [whole] school of engineering."

Prof. Sarah also pointed out that in comparison to advanced countries, there is a lack of qualified business advisors with proven entrepreneurship and technical backgrounds to coach academic entrepreneurs within the Malaysian university ecosystem. For instance, at the University Alpha's startup incubator, there is only one trainer, whereas Oxford University Innovation has at least 70 qualified advisors:

> "I attended training at Oxford back then. It was referred to as ISIS at the time, which is now known as Oxford University Innovation. Oxford Innovation has 70 qualified advisors. In our case, we have only one. They collaborate with you individually. They integrate into your team, essentially becoming a part of your advisory group".

The government's budget cut for university-generated IPR commercialization activities exacerbates the situation. Ms. Susana mentioned that her organization is no longer allocating funds specifically for university IPR commercialization:

> "Since 2019, the CRDF [i.e., Commercialization Research Development Fund] is no longer available. (…) Since the fund was discontinued, there hasn't been a dedicated fund to support university commercialization. So, numerous projects are currently stalled."

Hence, the limited resources and innovation support ecosystem within universities, including outdated laboratory equipment, insufficient funding for commercialization, and a lack of qualified business advisors to guide academic entrepreneurs, constitute a range of issues and challenges that impede successful commercialization at the university level.

University policies and implementation

In addition to varying commercialization and IPR policies among the eleven public universities in Malaysia, many of these universities lack established guidelines for forming university startups, except for the University of Malaya (Shahidan et al., 2019). Furthermore, prior research within the Malaysian context highlighted that some academic researchers expressed concerns about universities being overly demanding in terms of IPR ownership and licensing fees (Ramli et al., 2021). In addition, our research has revealed that even though public universities in Malaysia are trying to replicate commercialization models from institutions like Harvard University, there is still a significant gap in technological maturity.

> "We do understand that they [i.e., the TTO] need to generate something from their research because this business model is inspired by Harvard University. However, the maturity of the technology is significantly different, so we need to compensate." (Mr Adam, CEO of BetaMedical)

From the perspective of a government venture capitalist, Ms. Susana mentioned that there is inconsistency in policy implementation among universities regarding the formation of startups for IPR commercialization, in which each Malaysian public university employs distinct commercialization models. According to Ms. Susana:

> "Each university employs varying approaches for implementation. Some universities permit academic researchers to establish startups freely, while others prohibit such activities entirely. There is no consistency in policy across all universities."

In certain universities, academic researchers are allowed to independently establish startups without the university holding any equity stake. Conversely, certain universities opt for equity ownership in the startup while also imposing licensing fees for startups to obtain legal rights for commercializing the IPR. The lack of

consistency in policies related to IPR commercialization across universities complicates the possibility of coordinated national-level efforts.

Industry

This section highlights two issues and challenges in the commercialization of university-generated IPR from the perspective of the industry: (1) the expectation mismatch, where university-developed technologies are often obsolete or misaligned with industrial needs, and (2) the inability of local SMEs to innovate and adopt new technologies, limiting their capacity to leverage academic advancements for competitive advantage.

Expectation mismatch: technology from universities is obsolete and mismatched with industrial needs

The lack of interest among the industry players in adopting technological IPR from the universities is due to a variety of reasons, such as R & D misalignment with industry needs, inadequate communication and networking, insufficient financial resources, and limited infrastructures possessed by industry players (Chandran et al., 2014; Ali et al., 2017, RMK12, 2021). Ali et al. (2017) state that several factors prevent industry players from collaborating with academic institutions and using locally developed technologies. These include outdated university technologies and complex products similar to what is already available in the market. In addition, the university and industry may have a different understanding of the technology readiness level (TRL). The TRL of the IPR may be perceived differently between academic researchers and industry players. For example, from the industry perspective, as Mr. Adam stated:

> "Many lecturers or university representatives might assert that the level is TRL7, TRL8, or something similar. However, this isn't always accurate, as in the market, the payer holds the ultimate decision-making power."

Furthermore, as efforts are being made to strengthen the Triple Helix network, the government venture capitalist plays a role as the intermediary that connects industry and the university. While attempting to bridge the gap between the university and the industry, Ms. Susana received unpleasant feedback from the industry regarding collaboration with academic researchers. This is due to the researchers' strong technical orientation and their protective stance toward their R&D work. According to her:

> "When I speak to the industry, they often express that they are not interested in working with academic researchers because of their technical nature, which leads to defensiveness. When the industry provides comments, they [i.e., the academic researchers] often say, "What do you know? I'm the expert." Somehow, they need to receive feedback more positively."

Local SMEs' inability to innovate and adopt new technologies

Small and medium-sized enterprises (SMEs) are significant to Malaysia's national economy because they account for 97.2% of all business establishments, 38.2% of the GDP, and 48% of the country's workforce in 2020 (OECD, 2022). Another issue and challenge affecting the local SMEs from adopting university-generated technologies is that SMEs in Malaysia do not focus on innovation and have low innovative capabilities despite various supports from the government (Chian Tam et al., 2019). While the Malaysian government has launched a number of initiatives to encourage the adoption of home-grown technologies, such as tax breaks and pioneer status through the Malaysia Investment Development Authority (MIDA), a funding scheme such as High Impact Programme 2 (HIP2) (Adilah, 2017), as well as various trainings and support (SMECorp, 2023), local SMEs embracing innovative culture are still scarce (Singh & Hanafi, 2020). As a result of

Malaysia relying on foreign technologies for its economic growth, Malaysia lacks highly skilled human resources with strong fundamental knowledge and innovation-driven.

> "Can you imagine being a user nation and then wanting to shift to becoming a manufacturer nation? It's a huge paradigm shift. For example, we once hired a highly experienced engineer from a multinational electrical and electronic factory. Surprisingly, he lacked the necessary know-how, despite having worked for around 15 to 17 years. (…) in Malaysia, we have very poor resources of the people with complete competency skills set". (Mr Adam, CEO of BetaMedical).

Summary of Findings

Figure 1 presents a summary of the issues and challenges concerning IPR commercialization in Malaysia, viewed from the Triple Helix perspective. This perspective pertains specifically to the interactions between University-Industry, University-Government, and Government-Industry.

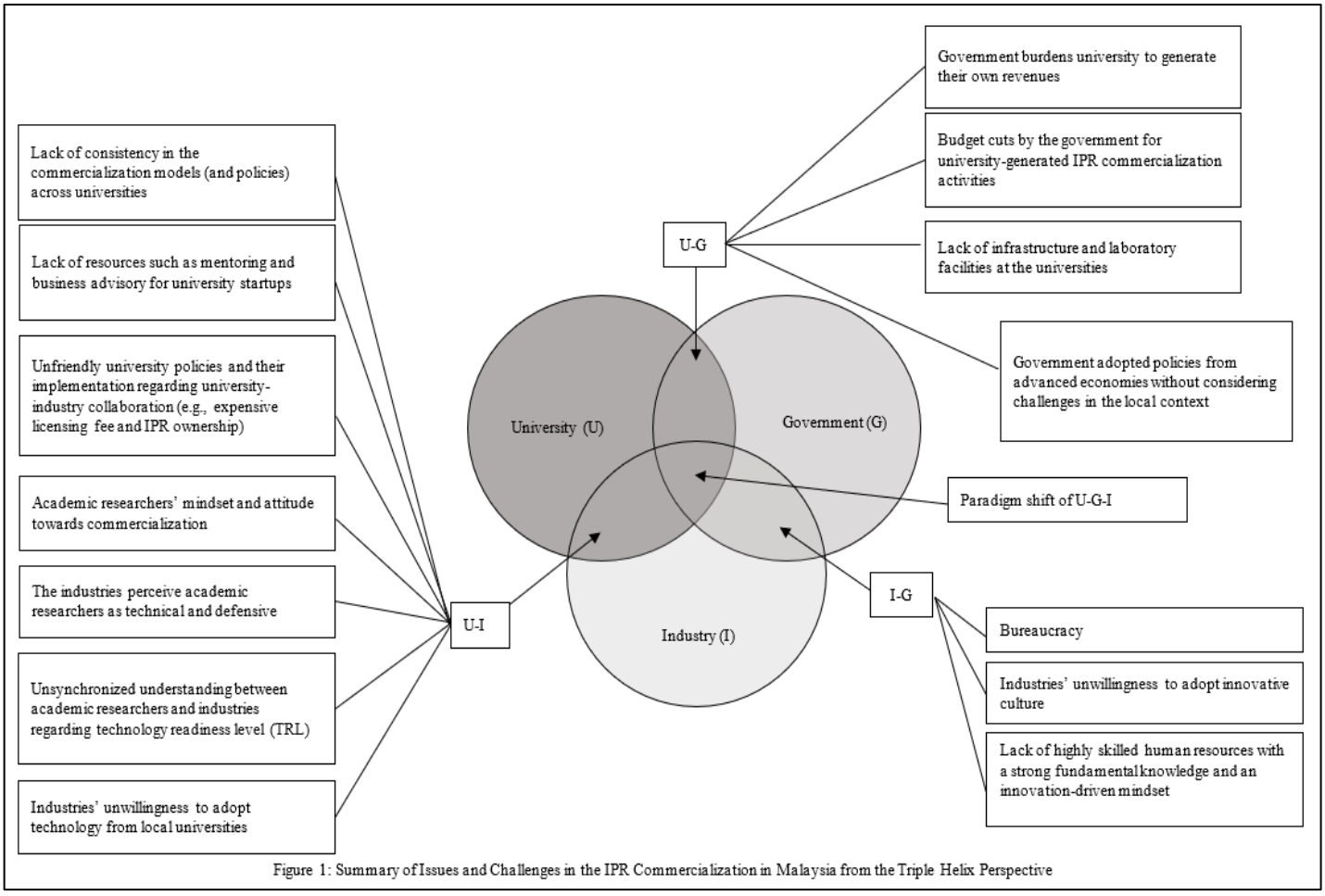

Figure 1: Summary of Issues and Challenges in the IPR Commercialization in Malaysia from the Triple Helix Perspective

MOVING FORWARD: RECOMMENDATION AND POTENTIAL SOLUTIONS

The findings of this study shed light on critical issues and challenges within the Malaysian innovation ecosystem, particularly the low success rate of IPR commercialization. Addressing the issues and challenges in IPR commercialization and strengthening the Malaysian innovation ecosystem requires concerted and tremendous efforts in the long run, along with a significant paradigm shift among the three Triple Helix stakeholders – the Government of Malaysia, universities, and industries. In this section, we delve into the implications of our conceptualized findings and provide recommendations as well as potential solutions that each of the Triple Helix stakeholders within the Malaysian innovation ecosystem could consider. Based on the summary of issues and challenges presented in Figure 1, we outline

how the targeted focus on awareness, policies, and resources by the stakeholders can significantly improve the IPR commercialization rate.

Raising Awareness

Effective communication among the Triple Helix stakeholders is crucial for collaboration in disseminating awareness about the benefits and processes related to IPR commercialization. Issues such as academic researchers' attitudes and mindsets towards commercialization, industry perceiving academic researchers as "technical and defensive," and industries' unwillingness to adopt an innovative culture and local technology are some consequences of the lack of awareness on the long-term impacts of commercialization. Furthermore, increasing the number of workshops and seminars that facilitate interactions between academic researchers and industry professionals can foster a mutual understanding of market demands and technological capabilities.

The TTOs at public universities are strongly encouraged to regularly organize seminars related to commercialization, thus equipping academic researchers with the skills needed to navigate the commercialization landscape. Academic researchers should proactively take steps to develop an entrepreneurial mindset and tailor their academic careers toward producing R&D outputs that are commercially viable. The key lies not in remaining content with solely conducting R&D, supervising postgraduate students, and teaching. Instead, academic researchers need to embrace a culture of collaboration with industries. Concurrently, industries should strive to cooperate closely with academic researchers by offering insights into industrially driven challenges. The primary objective of awareness-raising efforts aims to shift the mindset paradigm of each stakeholder within the Triple Helix, particularly within universities and industries. Currently, the Malaysian Research Accelerator for Technology & Innovation (MRANTI), which operates as the nation's primary agency for advancing commercialization, has the capacity to lead public awareness campaigns aimed at showcasing successful cases of IPR commercialization. These campaigns, in turn, can motivate researchers and industries to actively participate in commercialization activities.

Resource Allocation

Our findings reveal resource constraints, including inadequate laboratory facilities and R&D infrastructure at universities, insufficient funding for R&D and commercialization due to government budget cuts, and a lack of entrepreneurial support systems to provide business advisory and mentoring to university startups. The Government of Malaysia needs to reconsider its strategy and allocate sufficient funding to enhance university laboratory equipment and facilities. Additionally, specific funds dedicated to commercializing university-generated IPR, such as CRDF, need to be reintroduced.

To maximize the utilization of available resources, industries need to engage with universities, leveraging resources such as laboratory equipment, technical expertise, and potentially accessible funding. This engagement enhances their innovative capability and organizational competence. Conversely, industries can provide insights, entrepreneurial support, and potential R&D ideas to address industrial problems. Table 1 outlines selected government agencies related to IPR commercialization that provide funding, mentoring, support, incubation centers, and certifications. Universities and industries should proactively reach out to these agencies to explore the available resources that can assist their commercialization activities.

Table 1: Summary of Selected Government Agencies in the Malaysian Innovation Ecosystem

No	Name of Agency	Functions	Website
1	Malaysian Technology Development Corporation (MTDC)	Providing funds to startups and SMEs, mentoring & support, rental of incubator space	www.mtdc.com.my
2	SME Corporation Malaysia	Providing funds to startups and SMEs, mentoring & support	https://www.smecorp.gov.my/
3	Nano Malaysia Sdn Bhd	Providing facilitation funds to SMEs to develop Technology-Based Applications, Nano Verify Certification for products containing nanomaterials	www.nanomalaysia.com.my
4	Malaysian Research Accelerator for Technology & Innovation (MRANTI)	Startup mentoring, training, business networking, rental of incubator space	https://mranti.my/
5	Cradle Fund Sdn Bhd	Providing funds to startups and SMEs, mentoring & support	https://www.cradle.com.my/
6	Malaysian Debt Ventures (MDV)	Venture and project financing for high-growth technology startups in the form of hybrid solution of equity and/or debt financing	https://www.mdv.com.my/v3/
7	Kumpulan Modal Perdana (KMP)	Equity funding	https://www.kmp.vc/porter/
8	Jelawang Capital	Equity funding	https://www.jelawangcapital.com/
9	Venture TECH Sdn Bhd	Equity funding	https://www.venturetech.my
10	Malaysia Digital Economy Corporation (MDEC)	Provision of grants for purpose of co-creation, problem-solving and commercialization of digital-based solution	https://mdec.my/

Source: Authors'own work

Developing Effective Policy Frameworks

Our findings reveal the presence of issues and challenges stemming from inadequate policies and regulatory frameworks. These policies differ in their approaches to address specific relationships between university-industry, government-university, and government-industry.

At the university level, it is necessary to establish IPR policies that clearly address ownership, royalty distribution, licensing terms, and mechanisms for dispute resolution. Additionally, the TTO should refrain from imposing a burdensome licensing fee on industries for IPR that have not yet demonstrated commercial viability. Moreover, a supportive policy framework must be in place to encourage academic researchers' participation in commercialization activities. This involves ensuring flexibility in their Key Performance Indicators (KPIs) to strike a balance with other responsibilities, including teaching, publishing, research, and student supervision. Universities should also formulate industry-friendly policies that foster a comfortable environment for collaboration between academic researchers and industries. Lastly, collaborative efforts should be initiated among all public universities to establish a standardized commercialization policy and model. This collective approach will facilitate streamlined processes and ensure a consistent approach to fostering innovation and IPR commercialization across the academic landscape.

At the government level, it is imperative to minimize bureaucracy at all costs. While eliminating all bureaucratic processes might not be ideal for the sake of auditing purposes, the most favourable options involve reducing bureaucracy and streamlining operational procedures. Additionally, the government's policy of

encouraging universities to generate their own revenue requires reassessment. Lastly, the government should thoroughly examine all the issues and challenges, drafting policies that are based on local needs and available resources rather than merely adopting policies from advanced economies. In summary, by collectively addressing the challenges of awareness, policy frameworks, and resource allocation, Triple Helix stakeholders can navigate the complexities of IPR commercialization and foster a thriving innovation landscape.

LIMITATION AND FUTURE DIRECTION

Building on previous research and drawing upon the Triple Helix framework, this paper focuses on three key stakeholders within the Malaysian innovation ecosystem: universities, industry, and government. It specifically examines issues and challenges related to the commercialization of university-generated IPR. While we used qualitative interviews to complement our literature analysis, it is important to note that these interviews were part of a pilot study with a limited number of informants. Consequently, we did not achieve data saturation, which is essential for a comprehensive qualitative analysis. This pilot study primarily served as an exploratory phase, laying the groundwork for our forthcoming comprehensive study. Hence, we might have inadvertently overlooked other significant factors beyond awareness, policies, and resources that contribute to accelerating the paradigm shift among Triple Helix stakeholders within the Malaysian innovation ecosystem. Therefore, an in-depth qualitative case study is required to collect empirical data that can further support our conceptualization of the issues and challenges associated with IPR commercialization in the Malaysian context. Additionally, future studies that individually explore the relationships and links between University-Government, University-Industry, and Government-Industry are also necessary.

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