

# Surmounting Commercialization Barriers in Malaysian Research Universities: Paving the Way for Unprecedented Innovation Impact

Azlin Abd Jamil<sup>1</sup>, Logaiswari Indiran<sup>1</sup>, Samsilah Roslan<sup>2</sup>, Sofia Adrianna Ridhwan Lim<sup>2</sup>, Salina Muhamad<sup>1</sup>, Kamarulafizam Ismail<sup>1</sup>

<sup>1</sup>Universiti Teknologi Malaysia

<sup>2</sup>Universiti Putra Malaysia

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## ABSTRACT

The process of commercialising research findings remains a crucial element in fostering innovation and stimulating economic growth within academic environments. This study explores the obstacles encountered by Malaysian research universities in transforming their research findings into tangible products or services with commercial viability. Leveraging empirical data and case studies from multiple Malaysian research universities, expert inventors participated in two rounds of interviews using the Delphi method and Semi-Structured Interviews (SSI) survey. They were selected based on their expertise and involvement in product development, and assessed the market alignment of their innovations. The study meticulously analysed the gathered insights to develop a comprehensive framework aimed at enhancing technology commercialization in Malaysia. It specifically focused on addressing challenges related to Intellectual Property (IP) management and exploitation that impact both universities and industries. The final output of the study comprises a detailed outline of current commercialization barriers in Malaysian research universities, accompanied by actionable recommendations for dissemination to relevant stakeholders.

**Keywords:** Commercialization, Intellectual Property Management and Exploitation.

## INTRODUCTION

### Background and context of commercialization in research universities

According to [21], RUs play a crucial role in fostering innovation and stimulating economic growth through the process of commercialising research findings. Nevertheless, RUs face considerable obstacles in this pursuit [1], which hinder the potential influence of innovation and its transformation into tangible products or services. The challenges include financial limitations, insufficient infrastructure, intricate regulations, limited cooperation among industries, a lack of entrepreneurial spirit, limited market knowledge, inadequate allocation of resources, bureaucratic inefficiencies, and complexities in managing IP.

In order to address these challenges, the objective of this research is to provide significant perspectives and efficient approaches [21], utilising empirical evidence and case studies from various RUs in Malaysia. The study aims to enhance knowledge transfer and promote a culture of commercialization by identifying and addressing specific barriers. By doing so, it seeks to maximise the impact of research findings and contribute to the economic development of Malaysia. The results will be shared with policymakers, industry stakeholders, and academia to establish a favourable setting for effective commercialization, acting as a guide to improve Malaysia's research environment. Ultimately, the goal is to create a thriving ecosystem where research outputs can be successfully commercialised, leading to economic growth, job creation, and societal impact.

## **Importance of commercialization for innovation and economic growth**

Commercialization plays a vital role in driving innovation and catalysing economic growth [21]; [26]; [8]. By effectively converting research outcomes into tangible commercial products or services, RUs contribute to the advancement of technology, improvement of living standards, and the overall growth of the economy. Successful commercialization not only benefits the universities and researchers but also creates opportunities for industry collaboration, job creation, and societal advancement [3]; [15]. However, the path to commercialization is often hindered by various challenges. Funding constraints, inadequate infrastructure, regulatory complexities, limited industry collaboration, weak entrepreneurial culture within academia, lack of market awareness and validation, inadequate resource allocation, bureaucratic hurdles, administrative inefficiencies, and IP exploitation management complexities are some of the barriers that need to be addressed to fully harness the potential of commercialization [14]; [27]; [24].

In particular, IP exploitation management complexities present a crucial aspect of commercialization [9]; [6]; [4]. The management and protection of IP are essential for both universities and industries to facilitate successful knowledge transfer and commercialization [13]; [7]. Proper management of IP ensures that the rights and ownership of innovative technologies are secured, encouraging collaboration and investment in research initiatives [17]; [16]. This, in turn, fosters a conducive environment for innovation and economic growth.

Addressing these challenges and effectively managing IP will pave the way for enhanced commercialization, leading to the development of a robust innovation ecosystem and sustainable economic growth, and thus, the importance of efficiency.

Technology Transfer Officers (TTOs) cannot be overstated in ensuring the success of IP exploitation endeavours. Through the dissemination of actionable recommendations and the implementation of efficient strategies, RUs can establish a favourable environment for commercialization [11]; [1]; [19], thus maximising the impact of their research outcomes and positively contributing to the nation's economic development.

### **The importance the Technology Transfer Officers (TTOs) in IP exploitation**

TTOs serve as linchpins, leveraging their expertise in IP, market analysis, and legal frameworks to navigate the complexities of technology transfer. By acting as intermediaries between academia and industry, TTOs bridge the gap between research innovation and commercial application, facilitating the seamless transition of technologies from universities to industries [3]. Their proactive approach to addressing challenges such as IP complexity, industry understanding, legal hurdles, resource limitations, risk management, and cultural differences is paramount in unlocking the full potential of IP assets [22]; [1]. Efficient TTOs play a pivotal role in driving innovation, fostering collaborations, and maximising the impact of research efforts, ultimately contributing to the successful exploitation of IP and the realisation of tangible societal and economic benefits [25]; [3].

## **UNCOVERING RESEARCH GAPS THROUGH DEFINING KEY OBJECTIVES**

### **Uncovering Research Gaps through Defining Key Objectives**

The conventional hurdles in research commercialization were being exacerbated by the intricate challenges of IPs exploitation management, which were often complicating the transfer of knowledge from academic institutions to industry. This study was addressing these complexities by shedding light on the specific obstacles being faced by RUs. The first objective of the research was identifying the specific challenges inherent in IP exploitation management within Malaysian RUs, providing a clearer understanding of the critical issues obstructing commercialization efforts. The study was also aiming to analyze the impacts of these challenges on the commercialization process of IPs, uncovering how they were hindering progress in turning research into commercial products.

The third objective was to develop a detailed outline of these challenges, offering actionable recommendations to help universities overcome barriers, improve knowledge transfer, and enhance commercialization efforts.

Properly addressing these intricacies was crucial, as it was ensuring the safeguarding of innovative technologies and fostering stronger collaborations with industries. In turn, this collaboration was expected to be attracting more investments, catalyzing innovation, and driving economic growth [28]; [3].

Furthermore, the study was aiming to pinpoint critical factors necessary for successful technology commercialization in Malaysia, including market awareness, effective IP rights management, and enhanced university-industry collaborations [19]; [1]. It was also assessing how commercialization was being incorporated into engineering curricula within Malaysian RUs, identifying any gaps and offering recommendations to foster a culture of entrepreneurship among students [19]. By addressing these gaps, the study was contributing to creating a more entrepreneurial mindset within academia, which was vital for ensuring long-term commercial success.

The outcomes of this research were anticipated to be providing substantial benefits not only for RUs and industries in Malaysia but also advancing the broader understanding of effective IP management, university-industry collaboration, and commercialization strategies [11]. These insights were instrumental in equipping Malaysian RUs and industries with the tools they needed to navigate the inherent challenges in commercialization processes, ultimately fostering more efficient knowledge transfer and bolstering commercialization efforts. This strategic approach was aligned with the goal of creating a robust ecosystem for innovation, economic growth, and societal impact through academic research commercialization.

## LITERATURE REVIEW

### Theoretical frameworks and models of technology transfer and commercialization

In 2016, global patent filings reached over three million, up 8.5% from the previous year [29]. China led with 98% of filings, approximately 236,600 patents, while the rest of the world contributed just 2% [29]. The US followed with 16,200 patents, a 7.7% increase from the previous year [29] (see Fig. 1).

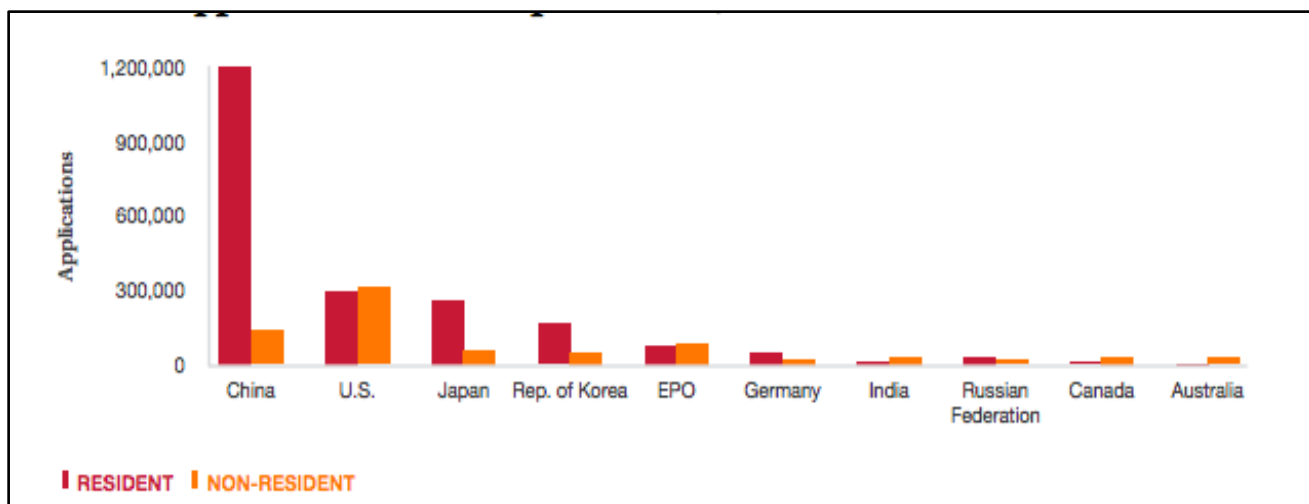


Fig. 1. Patent Applications of the Top Ten IP Offices in the World, 2016 [30].

Technology commercialization is crucial for developed nations to sustain productivity and competitiveness (Low et al., 2012; Jones et al., 2011; Berggren, 2009). This shift is influenced by the entrepreneurial university model adopted by many higher-income countries like the US, Canada, the UK, and Australia (Etzkowitz et al., 2000; Etzkowitz, 2002, 2003). Governments reducing funding have prompted universities to engage in entrepreneurial activities to secure alternative sources of income (Elfenbien, 2005). Consequently, universities in these countries have revamped their R&D strategies to leverage IP rights for innovation and commercialization (Etzkowitz et al., 2000).

Eventually local universities have transitioned to become centres for high-impact technologies and innovations, with the goal of improving the well-being of the community, necessitates cooperation with industries to cultivate economic expansion via research-driven technologies. This study assessed universities in innovation and

commercialization, serving as examples for enhancing revenue and supporting the government's high-tech innovation agenda.

### **Previous studies on commercialization barriers in RUs globally and in Malaysia**

A significant body of scholarly research has been devoted to investigating the impediments encountered in the process of commercialization within RUs, both on a global scale and with a specific focus on the Malaysian context. These studies aim to comprehensively understand the multifaceted challenges and complexities associated with the translation of academic research outcomes into commercially viable products or services. By systematically analysing various factors influencing commercialization endeavours, such as IP management, technology transfer mechanisms, industry collaboration dynamics, funding constraints, regulatory frameworks, and institutional policies, researchers seek to identify critical barriers and formulate strategic interventions to overcome them. Through empirical inquiries, theoretical frameworks, and comparative analyses, these studies contribute to the advancement of knowledge in the field of technology transfer, innovation management, and economic development, ultimately informing policymakers, university administrators, industry stakeholders, and researchers about the strategies required to foster a conducive ecosystem for successful commercialization initiatives within RUs, thereby enhancing societal welfare and economic growth.

### **Factors influencing successful commercialization efforts**

The process of converting novel concepts and technologies into prosperous commercial products is an intricate and multifaceted undertaking. Several factors have been identified as essential for the successful commercialization of new inventions. An essential factor is the capacity to recognise and assess market opportunities. According to Thursby and Berbari (2016), for an invention to have commercial significance, it must generate value in one or more markets by addressing an existing problem or fulfilling unmet customer needs. Unfulfilled demands signify potential market prospects, and the objective is to precisely evaluate the profitability and feasibility of these prospects (Natarajathinam & Nepal, 2012).

Effective IP protection is a crucial factor that contributes to successful commercialization efforts (Commercialising Technology, 2023; Tolk off & Anders, n.d.; Chandra & Liaqat, 2019). Obtaining patents, trademarks, and copyrights can protect the inventive elements of a product or technology, giving it a competitive edge and minimising the possibility of imitation by rivals (Thomä & Bizer, 2013; Chandra & Liaqat, 2019). Furthermore, possessing a robust go-to-market strategy is imperative for achieving successful commercialization. This entails evaluating the most optimal strategy to reach the desired customer base, establish efficient distribution channels, and effectively advertise the product to the intended target audience (Vincent, 2016).

Moreover, the involvement of industry experts, investors, and potential customers through partnerships and collaborations can significantly impact the success of commercialization endeavours (Liew et al., 2012; Huang et al., 2018). These partnerships can offer valuable knowledge, resources, and financial support to facilitate the advancement and commercialization of novel innovations. To summarise, achieving successful commercialization of new inventions necessitates a blend of market acumen, safeguarding IP, strategic foresight, and forging collaborative alliances to navigate the intricate journey from innovation to commercial triumph.

### **Intellectual property management and exploitation complexities**

IP management and exploitation are complex and pose significant challenges to organisations trying to protect and leverage their innovative assets. (Jahanian & Salehi, 2013; Nikzad, 2014) . The complex IP rights laws in different jurisdictions make compliance and protection difficult. Technology and innovation often outpace regulation, making IP rights scope and enforceability unclear.

Strategic IP management requires balancing protection and exploitation. Patents, trademarks, and copyrights protect innovative ideas, but organisations must also find ways to monetize and value their IP portfolios. (Jain, 1996; Nikzad, 2014) To find licensing, partnership, and commercialization opportunities, one must understand market dynamics, competitive landscapes, and emerging trends.

Market globalisation and the digital economy have complicated IP management and exploitation (Dong, 2011). Cross-border transactions, international collaborations, and online platforms present jurisdictional, enforcement, and infringement challenges. The rise of digital technologies and information dissemination have increased IP theft, counterfeiting, and unauthorised use, necessitating strong security and proactive enforcement [31].

In conclusion, legal, strategic, and technological factors complicate IP management and exploitation. In an ever-changing landscape of innovation and competition, organisations must use legal expertise, market insights, and technological solutions to protect and monetize their intellectual assets.

## **METHODOLOGY**

### **Research approach**

This study adopts a qualitative research approach, drawing upon empirical data and case studies collected from various Malaysian research universities. Expert inventors, chosen for their extensive experience and involvement in product development, participated in two rounds of consultations utilising the Delphi method and Semi-Structured Interviews (SSI) survey. The Delphi method, a structured communication technique, facilitated the aggregation of diverse expert opinions to achieve consensus on complex issues. In contrast, the SSI survey allowed for in-depth exploration of participants' perspectives and insights. By combining these methodologies, the study aimed to comprehensively assess the market alignment of innovations developed within Malaysian research universities.

The qualitative data gathered from these consultations underwent meticulous analysis to derive meaningful insights and develop a comprehensive framework. This framework aimed at addressing the challenges surrounding technology commercialization in Malaysia, particularly focusing on issues related to IP management and exploitation. Through a systematic examination of the qualitative data, the study identified key barriers hindering the successful commercialization of innovations within Malaysian research universities and proposed actionable recommendations to overcome these challenges.

The final output of the study consists of a detailed outline of current commercialization barriers, supported by empirical evidence and case studies. These findings are accompanied by practical recommendations aimed at informing and guiding relevant stakeholders, including policymakers, university administrators, industry partners, and researchers. By disseminating these recommendations, the study seeks to facilitate collaboration, foster innovation, and enhance technology commercialization efforts in Malaysia, ultimately contributing to the country's economic growth and development.

### **Data collection methods**

**Interviews:** Expert inventors from Malaysian research universities participated in two rounds of consultations using the Delphi method and Semi-Structured Interviews (SSI) survey. These interviews provided an opportunity for in-depth exploration of participants' perspectives, experiences, and insights regarding technology commercialization and IP management. Through structured and open-ended questions, the interviews elicited rich qualitative data, allowing researchers to gain a nuanced understanding of the challenges and opportunities associated with commercialising innovations.

**Surveys:** The Semi-Structured Interviews (SSI) survey complemented the interview process by capturing quantitative data on market alignment and other relevant variables. The survey format allowed for the systematic collection of responses from a larger sample of expert inventors, providing insights into trends, preferences, and perceptions across the research community. By combining qualitative insights from interviews with quantitative data from surveys, researchers were able to triangulate findings and develop a comprehensive understanding of the research landscape.

**Case Studies:** Additionally, the study incorporated case studies from multiple Malaysian research universities to provide real-world examples and context to the findings. These case studies offered detailed narratives of specific commercialization initiatives, highlighting successes, challenges, and lessons learned. By analysing these case



studies, researchers were able to identify common patterns, themes, and best practices that informed the development of recommendations for enhancing technology commercialization efforts in Malaysia.

### Sampling techniques and participant selection criteria

The sampling techniques and participant selection criteria employed in this study were designed to ensure the inclusion of relevant stakeholders and experts in the field of technology commercialization within Malaysian research universities.

**Sampling Techniques.** Purposive Sampling: Participants were selected purposively based on their expertise and involvement in product development, innovation, and technology commercialization within Malaysian research universities. This sampling technique ensured that participants possessed relevant knowledge and experiences to provide valuable insights into the subject matter.

**Participant Selection Criteria.** Participant selection criteria are essential to ensure that the study engages individuals with the relevant expertise and experience necessary to provide valuable insights. By selecting participants who are directly involved in areas like IP management, technology transfer, or university-industry collaboration, researchers can gather accurate, applicable data that addresses the specific challenges being studied. This process enhances the credibility and relevance of the findings, leading to more reliable conclusions and actionable recommendations. Additionally, well-defined criteria help maintain the study's focus, avoiding irrelevant data and ensuring that the research outcomes effectively address the core objectives.

**Expertise and Experience.** Participants were required to have demonstrated expertise and experience in technology commercialization, IP management, and innovation within the context of Malaysian research universities. This criterion ensured that participants could contribute meaningful insights and perspectives to the study.

**Involvement in Product Development.** Participants were selected based on their active involvement in product development processes, including research, invention, prototyping, and commercialization activities. This criterion ensured that participants had firsthand experience with the challenges and opportunities associated with bringing innovations to market.

**Diversity.** Efforts were made to ensure diversity among participants in terms of academic disciplines, institutional affiliations, and roles within the research community. This criterion aimed to capture a broad range of perspectives and experiences, enhancing the richness and depth of the data collected.

**Availability and Willingness to Participate.** Participants were selected based on their availability and willingness to participate in the study, ensuring that data collection could proceed smoothly and efficiently.

Table 1. Respondents List

RU TTO	Inventor	Spin Off Company CEO	Funder
RUTTO1	INV1	CEO1	Funder1
RUTTO2	INV2	CEO2	Funder2
RUTTO3	INV3	CEO3	Funder3
RUTTO4	INV4	CEO4	Funder4
RUTTO5	INV5	CEO5	Funder5
RUTTO6	INV6	-	-

RUTTO7	INV7	-	-
RUTTO8	INV8	-	-
RUTTO9	INV9	-	-
RUTTO10	INV10	-	-

By employing purposive sampling and applying stringent participant selection criteria, the study aimed to gather insights from a diverse group of experts with relevant expertise and experiences in technology commercialization within Malaysian research universities. This approach ensured the collection of robust and comprehensive data, enabling researchers to develop meaningful recommendations for enhancing technology commercialization efforts in the context of Malaysian research universities (see Fig. 2).

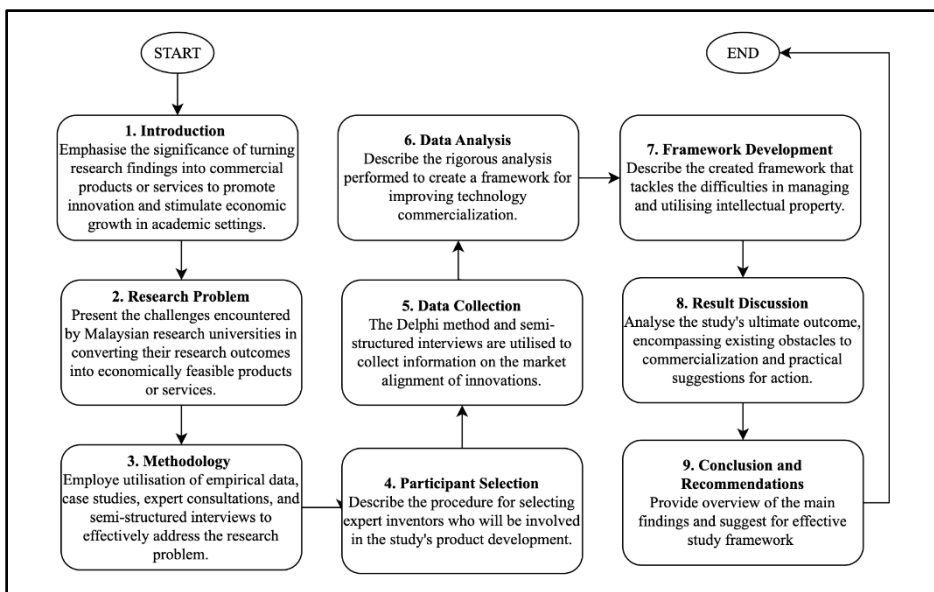



Fig. 2. The Flow Process of the Study

## RESULTS AND FINDINGS

### Overview of common challenges faced by Malaysian RUs

The study found significant differences in technology commercialization strategies among Malaysian RUs like UTM, USM, UKM, UM, and UPM, despite their shared research-oriented focus and recognition as RUs under MyRA. These differences impact revenue generation and outcomes. While MyRA streamlines RU assessment, it only addresses one aspect of similarity among RUs. The ecological system's other elements rely on each university's innovation and capacity for growth, shaping strategies based on their capabilities and objectives. Table 7.1 highlights MyRA's impact on RU achievements and its Glossary's Breakdown Section.

Table 2. Overlap Point of Strategies Influenced by MyRA

	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
	SECTION H	Support Facilities

In contrast to the majority, dissenting respondents emphasised the perceived simplicity of managing service-based businesses. They argued that such businesses involve a brief exchange of knowledge among specialists, unlike tangible products requiring extensive documentation and bureaucratic approval for transfer. RUs have tailored strategies for their consultancy activities in line with MyRA requirements. These activities are decentralised, allowing all centres of excellence to engage in consultancy projects rather than focusing on a single unit. Income from consultancy projects is strategically allocated to benefit four primary stakeholders: universities, project research groups, responsibility centres overseeing projects, and the original faculty associated with staff members. This approach ensures diverse execution of consultancy activities and prevents monopolisation by any university subsidiary. For instance, income distribution at one RU is as follows: 5% to the university, 83% to project research groups, 10% to the consultancy project management centre, and 2% to the faculty of the lead staff member, excluding government service tax.

Prior to MyRA implementation, the university mandated all consultancy activities through its subsidiary entity. Over time, vulnerabilities emerged, including revenue projection data leakage. Interviews with university researchers revealed a lack of viable alternatives to the subsidiary, which monopolised consultancy remuneration. It was the sole platform managing university projects, imposing a 10% service fee without additional support. To address this, the university adopted a policy of income distribution equality, allowing employees to choose platforms offering more appealing services. Consequently, staff members increasingly declare their consultancy services to the university and register projects on non-subsiary platforms.

Additionally, interviews with representatives from the university's spin-off companies and experienced licensees revealed that 80% believed the products and services offered by universities lacked novelty and quality. Industry stakeholders have proposed alternative approaches to tackle market challenges, offering cost-effective and streamlined solutions. High technology transfer fees and lengthy processes have deterred companies from acquiring licences from academic institutions. The study confirmed previous research indicating deficiencies in university commercialization systems, including inadequately skilled personnel in technology transfer offices, leading to negative perceptions among industry stakeholders and hindering technology licensing efforts.

Moreover, Malaysian research universities, despite resource constraints, must uphold their competitiveness as premier institutions. The study identified shortcomings in the technology commercialization process within universities, particularly in stakeholder collaboration across value chains. These gaps hinder efficient value creation transfer between locations, compromising commercialization initiatives aligned with national agendas and local research methods.

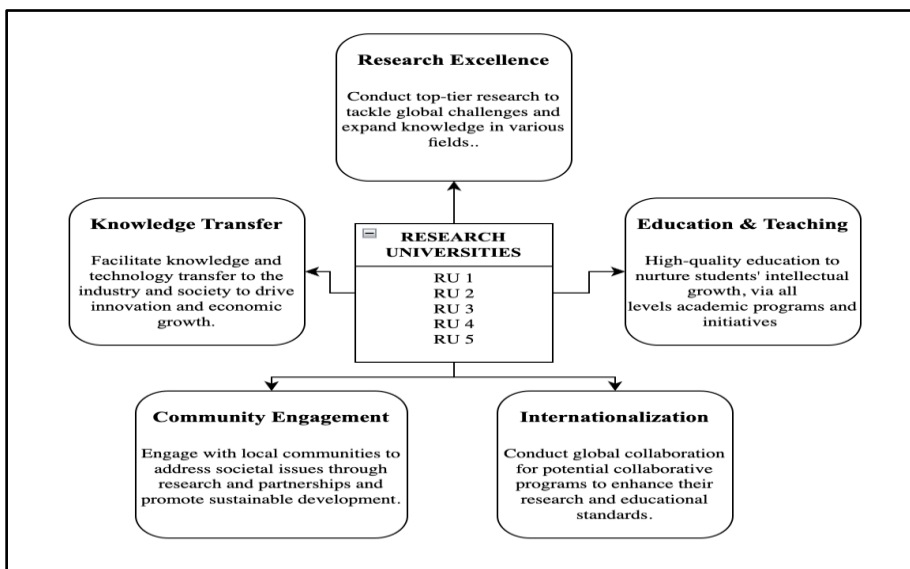


Fig. 3. Malaysian Research University (RUs) Core Business



**Funding Constraints and Resource Allocation Issues.** RUs seem to encounter substantial challenges in the domain of funding constraints and resource allocation issues, which has become common. To begin with, there is a widespread and intense competition for limited funding for commercialization, which directly affects innovation initiatives. The limited availability of financial resources fosters a competitive atmosphere in which only a limited number of projects are granted financial backing, potentially impeding the progress of promising innovations.

Furthermore, the inadequacies in grant management worsen the situation, resulting in less than optimal utilisation of the funds that are currently available. Insufficient coordination and oversight in the management of grants lead to the misallocation or underutilization of resources, thereby impeding the overall efficacy of research endeavours. Moreover, the problem is worsened by the excessive dependence on government funding, as universities become overly reliant on external sources of finance. The reliance on government funding or alterations in funding priorities can give rise to vulnerabilities, as they have the potential to disrupt ongoing research projects and hinder long-term planning. In order to enhance their capacity for innovation and research excellence, it is imperative for RUs to address funding constraints and improve resource allocation mechanisms.

**Inadequate Infrastructure and Administrative Inefficiencies.** RUs face significant challenges due to insufficient infrastructure and administrative inefficiencies. The insufficient allocation of resources towards research infrastructure and facilities poses a significant challenge to the ability of institutions to engage in advanced research and foster innovation. The scarcity of resources poses a hindrance to the progress and execution of projects, thereby constraining the extent and influence of research endeavours. Furthermore, the lack of adequate coordination among various departments and units further worsens the situation, hindering the successful execution of projects. The fragmented endeavours and absence of cooperation impede advancement and effectiveness, resulting in delays and inefficiencies in attaining research goals.

Additionally, the constrained availability of incubator facilities and technical proficiency for startups plays a significant role in impeding innovation and entrepreneurship. The absence of sufficient support structures poses challenges for emerging entrepreneurs in their efforts to transform their ideas into marketable products or services, thereby impeding the expansion of the innovation landscape. Moreover, the challenges are further intensified by inadequate communication and collaboration between researchers and administrative personnel. This lack of connection results in misinterpretations, setbacks in making decisions, and inefficiencies in distributing resources, which undermines the overall efficacy of research endeavours. In order to cultivate an environment that promotes innovation and research excellence, it is crucial for RUs to prioritise the resolution of infrastructure deficiencies and administrative inefficiencies.

**Regulatory Complexities and Bureaucratic Hurdles.** RUs face considerable challenges when it comes to navigating the intricate regulatory frameworks and bureaucratic obstacles. The timely initiation and execution of research projects are impeded by the intricate and time-consuming approval processes. These procedures frequently entail a series of evaluations and administrative obstacles, resulting in project initiation delays and hindering the advancement of research. Furthermore, the absence of specificity and uniformity in policies and guidelines intensifies the circumstances, resulting in perplexity and uncertainty among researchers and administrative personnel.

The lack of consistency in research governance undermines its effectiveness and worsens compliance challenges. Moreover, the challenge of navigating legal and regulatory obligations for the transfer and commercialization of technology adds further complexity to the situation. The complex legal environment and regulatory structure pertaining to IP rights and licensing agreements present substantial obstacles to the effective progress of commercialization endeavours. Universities face challenges in effectively managing the intricacies associated with compliance and maximising the potential of their research innovations in the absence of sufficient support. Moreover, the challenges are further exacerbated by inconsistencies in data collection and reporting resulting from regulatory changes.

The need for regular modifications to data collection practices arises from the dynamic nature of regulatory requirements, resulting in inconsistencies and inaccuracies in reporting. It is imperative to tackle the intricate

regulatory intricacies and bureaucratic obstacles in order to optimise research procedures, improve adherence to regulations, and facilitate the effective transfer and commercialization of technology.

Moreover, the challenges are further intensified by inadequate communication and collaboration between researchers and administrative personnel. This lack of connection results in misinterpretations, setbacks in making decisions, and inefficiencies in distributing resources, which undermines the overall efficacy of research endeavours. In order to cultivate an environment that promotes innovation and research excellence, it is crucial for RUs to prioritise the resolution of infrastructure deficiencies and administrative inefficiencies.

**Limited Industry Collaboration and Weak Entrepreneurial Culture.** RUs face significant challenges due to a lack of industry collaboration and a deficient entrepreneurial culture. The absence of incentives for engagement in industry partnerships and collaborations poses a significant obstacle to the endeavour of fostering connections between academia and industry. The absence of concrete advantages or incentives for collaboration may lead industry stakeholders to exhibit hesitancy in participating in research and development endeavours with universities. Furthermore, the limited involvement of industry stakeholders exacerbates the situation, thereby restricting opportunities for the exchange of knowledge and transfer of technology. Furthermore, insufficient assistance provided by universities to startups and spin-off companies hampers entrepreneurial pursuits.

Aspiring entrepreneurs encounter significant challenges in transforming their ideas into viable businesses due to the absence of crucial resources, guidance, and funding. In addition, the presence of cultural barriers within academic institutions poses obstacles to the advancement of entrepreneurship and innovation. The dominant scholarly culture may place greater emphasis on conventional research rather than entrepreneurial pursuits, thereby generating a lack of motivation for faculty members and researchers to participate in commercialization activities.

Finally, the constrained accessibility of mentorship and support initiatives for individuals aspiring to become entrepreneurs exacerbates the difficulties they face. The absence of mentorship, training, and networking opportunities poses substantial obstacles for aspiring entrepreneurs seeking to enter the startup environment. To tackle these challenges, it is necessary to make focused endeavours to cultivate an entrepreneurial culture, encourage collaboration among industries, and offer extensive assistance to startups and aspiring entrepreneurs.

**Lack of Market Awareness and Validation.** RUs face significant challenges due to a lack of market awareness and validation. The identification of viable commercial opportunities is often hindered by a lack of sufficient market research and validation conducted for research outputs. The absence of validation enhances the difficulties associated with converting research findings into commercially feasible products or services, as the market demand and feasibility of these innovations remain uncertain. Moreover, the lack of marketing proficiency and resources exacerbates the problem, as universities encounter difficulties in efficiently promoting their innovations to prospective stakeholders. Furthermore, the challenge of recognising and resolving market demands and patterns restricts the significance and influence of university research outcomes in the commercial sphere.

In addition, the limited availability of success stories and instances of university-industry collaborations acts as a disincentive, as stakeholders confront a lack of concrete illustrations to motivate and direct their own endeavours. To tackle these challenges, it is imperative to make focused endeavours in improving market research capabilities, developing marketing expertise, and promoting collaborative partnerships between academia and industry. These measures are crucial for ensuring the effective commercialization of research innovations.

## DISCUSSION

In order to achieve significant innovation impact in the global market for strategic imperatives at Malaysian RUs, it is crucial for these institutions to cultivate exceptional innovation impacts. This is necessary not only to ensure their survival but also to thrive in the competitive environment. At the core of this undertaking is the necessity to utilise innovative technologies, stimulate industry upheaval, and advocate for sustainable development solutions. Furthermore, it encompasses the promotion of strong systems for sharing and selling knowledge, cultivating international networks for collaboration, allocating resources to develop skilled

individuals, and guaranteeing efficient management of IP, initiatives for social innovation, and influential thought leadership in policy-making to ensure long-term significance and influence in the ever-changing global innovation landscape.

### **Breakthrough Technologies vs. Incremental Innovation**

Within the domain of technological progress, there exist two divergent methodologies that compete for visibility: Breakthrough Technologies and Incremental Innovation. Breakthrough Technologies places a high emphasis on the pursuit of groundbreaking innovations that have the potential to fundamentally transform industries or create entirely novel markets. Supporters argue that these disruptive advancements have the capacity to propel RUs to a leading position in global innovation, attracting investment and attracting a significant influx of talented individuals. On the other hand, proponents of Incremental Innovation advocate for a strategic approach that focuses on making incremental improvements to current technologies or processes. They argue that this approach, characterised by its practicality and decreased risk, promotes consistent advancement and enduring long-term achievement.

### **Industry Disruption vs. Economic Stability**

In navigating the landscape of innovation, two competing perspectives emerge: Industry Disruption and Economic Stability. Industry Disruption advocates for RUs to prioritise disruptive innovations capable of reshaping traditional industries and catalysing the emergence of new economic sectors. Proponents assert that embracing disruption is imperative for maintaining a competitive edge in the swiftly evolving global economy. Conversely, Economic Stability proponents argue for the preservation of stability within existing industries to safeguard economic security and continuity. They caution against hasty changes that could potentially destabilise the economy, resulting in job losses or societal unrest.

### **Sustainable Development Solutions vs. Short-term Economic Gain**

Two contrasting perspectives arise in the conversation about innovation: Sustainable Development Solutions and Short-term Economic Gain. Proponents of Sustainable Development Solutions argue in favour of giving priority to innovations that address urgent societal and environmental challenges, in accordance with global sustainability goals. The authors contend that prioritising long-term sustainability should take precedence over immediate economic benefits, underscoring the significance of ensuring a prosperous future for future generations. On the other hand, proponents of Short-term Economic Gain advocate for prioritising innovations that have immediate commercial viability and can generate rapid returns on investment. The aforementioned statement highlights the importance of short-term economic growth and competitiveness in guaranteeing current financial stability and prosperity.

### **Knowledge Transfer and Commercialization vs. Academic Freedom**

Within the academic sphere, there are two divergent viewpoints that influence the conversation: Knowledge Transfer and Commercialization versus Academic Freedom. Proponents of Knowledge Transfer and Commercialization advocate for the prioritisation of initiatives that promote the transmission of knowledge between academic institutions and industry, as well as the conversion of research findings into commercial enterprises. They emphasise the importance of tangible outcomes and financial gains in supporting the research efforts of universities. On the other hand, advocates of Academic Freedom stress the utmost significance of safeguarding academic independence and the quest for knowledge for its inherent worth. The authors advise against placing commercial interests above intellectual integrity, thereby protecting the independence of academic research endeavours.

### **Global Collaboration Networks vs. National Autonomy**

Strategic decisions in the field of research and innovation are influenced by two distinct approaches: Global Collaboration Networks and National Autonomy. Supporters of Global Collaboration Networks argue in favour of forming strong alliances with international organisations in order to capitalise on their knowledge, assets, and markets. The authors contend that these collaborations have the potential to improve the quality of research,

strengthen the capacity for innovation, and enhance competitiveness at a global level. On the other hand, proponents of National Autonomy place emphasis on the advancement of domestic expertise and the fostering of self-reliance in research and innovation pursuits. The importance of maintaining national sovereignty and avoiding dependence on foreign partners or technologies is emphasised, with a focus on safeguarding autonomy in strategic decision-making processes.

### **Talent Development Programs vs. Resource Allocation**

Two contrasting perspectives arise in the conversation regarding research and innovation strategy: Talent Development Programmes and Resource Allocation. Proponents of Talent Development Programmes argue for the imperative of allocating resources towards endeavours that foster the cultivation of prospective innovators and research leaders. The significance of human capital in driving innovation and maintaining long-term competitiveness is emphasised. On the other hand, advocates of Resource Allocation support the idea of allocating resources towards immediate research priorities and efforts to bring products to market. Their primary focus is on optimising resource allocation in order to attain immediate outcomes and effectively respond to prevailing market needs.

### **Intellectual Property Management vs. Open Innovation**

Within the domain of innovation strategy, there exist two divergent viewpoints that significantly influence the conversation: Intellectual Property Management and Open Innovation. Supporters of Intellectual Property Management advocate for a proactive strategy in protecting and generating revenue from IP assets generated by universities. The argument posits that the proficient administration of IP plays a pivotal role in stimulating innovation and enticing investment, thereby propelling the advancement of society. On the other hand, advocates of Open Innovation advocate for a collaborative approach that emphasises openness, wherein ideas and technologies are openly exchanged to foster cooperation and accelerate progress. The authors contend that open innovation not only expedites the process of resolving problems, but also yields wider societal advantages through the democratisation of knowledge accessibility and the promotion of collective advancement.

### **Social Innovation Initiatives vs. Market Demands**

There are two distinct paradigms that govern decision-making in the field of innovation strategy: Social Innovation Initiatives and Market Demands. Proponents of Social Innovation Initiatives strive to address urgent societal challenges by employing inventive approaches, even if they deviate from immediate market requirements. The argument posits that placing emphasis on social innovation has the potential to generate enduring societal advantages and augment the overall standard of living. On the other hand, advocates of Market Demands advocate for a concentration on innovations that are in line with prevailing market requirements and demonstrate potential for commercial success. Our primary focus is on satisfying customer needs and generating income in order to support our research and innovation initiatives, with the goal of ensuring long-term viability and competitiveness in the market.

### **Thought Leadership vs. Regulatory Compliance**

Two distinct perspectives arise when determining the direction for innovation and research: Thought Leadership and Regulatory Compliance. Proponents of Thought Leadership advocate for RUs to adopt a central position in directing national innovation agendas and influencing policy deliberations. The authors contend that thought leadership plays a crucial role in stimulating policy reforms related to innovation and creating a favourable environment for the growth of research and innovation. On the other hand, advocates of Regulatory Compliance emphasise the utmost significance of conforming to national regulatory frameworks and academic standards. In order to uphold accountability and integrity in research endeavours, it is imperative to prioritise compliance with regulations and guidelines. This is essential for preserving public trust and credibility within the academic community.



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## Long-term Impact vs. Short-term Gain

Two contrasting viewpoints arise in the conversation regarding innovation strategy: Long-term Impact and Short-term Gain. Proponents of Long-term Impact argue in favour of giving priority to innovations that offer reliable and lasting advantages for society, the environment, and the economy. The importance of sustainable development and legacy-building is emphasised, with a focus on prioritising the establishment of enduring positive effects rather than short-term benefits. On the other hand, advocates of Short-term Gain support a concentration on innovations that can quickly generate profits and meet immediate market needs. Research universities place a high emphasis on financial stability and competitiveness in the short term, acknowledging their crucial role in guaranteeing the ongoing sustainability and prosperity of these institutions.

## RECOMMENDATIONS

### On funding constraints and resource allocation issues:

To address funding constraints and resource allocation challenges in RUs, several actionable steps can be taken. Firstly, RUs should diversify funding sources beyond government grants, including industry partnerships and philanthropic donations. Implementing robust grant management systems and procedures is crucial to ensure optimal fund allocation and utilisation. Collaboration and coordination among RUs, government agencies, and industry stakeholders should be fostered to streamline resource allocation and avoid duplication. Promoting innovation and commercialization through technology transfer offices and incubation support can drive research impact. Building researchers' capacity in fundraising and proposal writing is essential, along with advocating for stable funding policies at both national and institutional levels. Cultivating an entrepreneurial culture within RUs and recognizing entrepreneurial achievements can further stimulate innovation. These measures collectively enhance RUs' capacity for innovation and research excellence amidst funding constraints.

### On inadequate infrastructure and administrative inefficiencies

Regarding insufficient infrastructure and administrative inefficiencies, several actionable recommendations can be implemented. Firstly, RUs should prioritize the allocation of resources towards upgrading research infrastructure and facilities to facilitate advanced research and innovation. This includes investing in state-of-the-art equipment, laboratory spaces, and technology infrastructure. Secondly, efforts should be made to improve coordination among departments and units within RUs to streamline project execution and avoid delays.

Implementing centralised project management systems and fostering a culture of collaboration can enhance effectiveness and efficiency. Thirdly, addressing the shortage of incubator facilities and technical support for startups is crucial for promoting innovation and entrepreneurship. RUs should establish or expand incubation programs and provide mentorship and training to aspiring entrepreneurs. Additionally, enhancing communication and collaboration between researchers and administrative personnel is essential to ensure smooth operations and resource distribution. Implementing regular communication channels, cross-departmental meetings, and training programs can bridge the gap and improve efficiency. By prioritising these actions, RUs can cultivate an environment conducive to innovation and research excellence despite infrastructure deficiencies and administrative challenges.

### On regulatory complexities and bureaucratic hurdles

To overcome the challenges posed by regulatory complexities and bureaucratic hurdles faced by RUs in Malaysia, several actionable recommendations can be implemented. Firstly, streamlining and simplifying approval processes for research projects is essential to minimise delays. This can be achieved by establishing clear and standardised procedures, reducing redundant evaluations, and providing training to administrative staff on efficient protocol navigation. Secondly, enhancing the specificity and uniformity of policies and guidelines can reduce confusion and uncertainty among researchers and administrative personnel.

Developing comprehensive, accessible guidelines and providing regular updates can help ensure compliance and consistency in research governance. Thirdly, addressing legal and regulatory complexities related to technology



transfer and commercialization requires collaboration between RUs, government agencies, and industry stakeholders. Establishing support mechanisms such as technology transfer offices and providing legal assistance and guidance can facilitate smooth navigation of IP rights and licensing agreements. Additionally, improving data collection and reporting practices through regular updates and training can mitigate inconsistencies arising from regulatory changes. By implementing these recommendations, RUs can optimise research procedures, ensure adherence to regulations, and facilitate the effective transfer and commercialization of technology, thus fostering a conducive environment for innovation and research excellence.

### **On limited industry collaboration and weak entrepreneurial culture**

To address the challenges of limited industry collaboration and a weak entrepreneurial culture faced by RUs in Malaysia, several actionable recommendations can be implemented. Firstly, incentivizing industry engagement by offering tangible benefits such as tax incentives, research grants, and access to university resources can encourage industry stakeholders to participate in research and development collaborations with RUs. Establishing industry liaison offices within RUs can also facilitate communication and collaboration with industry partners.

Secondly, RUs should actively promote and support entrepreneurship by providing comprehensive assistance to startups and spin-off companies. This includes offering incubation programs, access to funding opportunities, mentorship, and guidance on business development. Creating a supportive ecosystem for entrepreneurship within RUs can help aspiring entrepreneurs overcome challenges and transform their ideas into viable businesses.

Thirdly, addressing cultural barriers within academic institutions requires fostering an entrepreneurial mindset among faculty members and researchers. This can be achieved through awareness campaigns, training programs, and incentives for faculty members to engage in entrepreneurial activities. Encouraging interdisciplinary collaboration and recognizing entrepreneurial achievements can also help shift the culture towards a greater emphasis on commercialization and innovation.

Finally, enhancing accessibility to mentorship and support initiatives for aspiring entrepreneurs is crucial. RUs can establish mentorship programs, networking events, and entrepreneurship centres to provide guidance and support to individuals seeking to enter the startup environment. Collaborating with industry mentors and experienced entrepreneurs can offer valuable insights and connections to aspiring entrepreneurs. By implementing these recommendations, RUs can foster a stronger entrepreneurial culture, promote collaboration with industry partners, and provide valuable support to startups and aspiring entrepreneurs, ultimately driving innovation and economic growth.

### **On lack of market awareness and validation**

To address the challenges of lack of market awareness and validation faced by RUs in Malaysia, several actionable recommendations can be implemented. Firstly, RUs should prioritise enhancing their market research capabilities by investing in resources and expertise dedicated to market analysis and validation. This includes conducting thorough market surveys, competitor analysis, and feasibility studies to assess the demand and potential viability of research outputs.

Secondly, developing marketing expertise within RUs is essential for effectively promoting research innovations to prospective stakeholders. Offering training programs, workshops, and mentorship opportunities in marketing and business development can equip researchers and administrative staff with the skills needed to market innovations successfully. Thirdly, fostering collaborative partnerships between academia and industry is crucial for validating research outputs and aligning them with market needs. RUs should actively seek out industry partners for collaboration, joint research projects, and technology transfer initiatives. Establishing industry advisory boards and engagement platforms can facilitate dialogue and collaboration between academia and industry stakeholders.

Furthermore, showcasing success stories and examples of university-industry collaborations can serve as powerful incentives for stakeholders to engage in similar endeavours. RUs should highlight and publicise successful commercialization projects, spin-off companies, and technology transfer initiatives to inspire and guide others in their commercialization efforts. By implementing these recommendations, RUs can improve market awareness, validate research outputs, and enhance the commercialization of innovations, thereby maximising the impact and relevance of university research in the commercial sphere.

### **On challenges in IP Exploitation Management by TTOs**

TTOs play a critical role in addressing the challenges associated with IP exploitation by providing expertise, guidance, and support throughout the technology transfer process. By leveraging their knowledge of IP law, industry trends, and business development strategies, TTOs help universities effectively commercialise their IP assets and maximise the impact of their research efforts.

## **CONCLUSION**

This research thoroughly explores the various aspects of technology commercialization within RUs, identifying both the opportunities and challenges present across several dimensions. However, the study's focus on Malaysian RUs raises concerns about the generalizability of its findings to other contexts. Due to the unique organizational, cultural, and geographical factors at play in different regions, applying the results beyond Malaysia should be approached with caution. It is important to acknowledge these limitations when extrapolating the research insights to broader settings [5]; [18].

Additionally, the research recognizes potential limitations stemming from sample bias and representation issues. The selection of expert inventors, though essential for gaining in-depth perspectives, could limit the diversity of insights. To mitigate this, the study emphasizes the importance of ensuring diverse representation across academic disciplines, career stages, and institutional backgrounds. Such diversity is crucial for enriching the research outcomes and minimizing bias [10]; [2]. The study also highlights the need to combine qualitative insights from expert inventors with supplementary quantitative methodologies, thereby enhancing the robustness of the findings [20].

Finally, the study underscores the need for broader exploration of factors influencing technology commercialization, such as institutional, regulatory, socio-cultural, and economic aspects. These dimensions are integral to understanding the full scope of commercialization challenges. It also stresses the importance of rigorously validating case studies and empirical data to ensure the credibility of its findings. Despite practical challenges, such as stakeholder engagement and resource constraints, the research offers pragmatic strategies like early engagement and feasibility studies to overcome these barriers [23]; [12]. The long-term sustainability and adaptability of the research's recommendations must be monitored to maintain relevance amid evolving market dynamics.

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