Entrepreneurial Self-Efficacy as a Key Moderator in Academic Research Commercialization: Overcoming Environmental Barriers

Siti Aisah Binti Sahlan*, Farcadina Binti Ahmad

Faculty of Management, University Technology Malaysia

***Corresponding Author**

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ABSTRACT

The transition toward a knowledge-based economy has increased the emphasis on academic research commercialization in Malaysian universities. Despite substantial amount of investments in research and innovation activities, Malaysia's commercialization rates remain relatively low. This study aims to investigates the influence of personal and environmental factors on commercialization success, with entrepreneurial self-efficacy (ESE) as a moderating variable. Personal factors such as patent law knowledge, personal contact networks, and research involvement are examined alongside environmental factors, including resource availability, institutional support, and dynamic market conditions. The study utilize self-efficacy theory to understand how ESE enhances the ability of academicians to overcome the commercialization challenges. A quantitative research design is adopted, utilizing a structured survey distributed to academicians across engineering faculties in five Malaysian research universities. Data analysis is conducted using Structural Equation Modeling (SEM) to assess direct relationships and moderation effects. The findings indicate that personal attributes and environmental support significantly impact commercialization activities, with ESE strengthening these relationships. Academicians with high ESE exhibit greater resilience and problem-solving abilities, leading to improved commercialization success. The study contributes to self-efficacy and competency theories by demonstrating the critical role of ESE in academic entrepreneurship. Practical implications suggest that universities should implement targeted ESE training programs and enhance institutional support mechanisms to foster commercialization.

Keyword: Commercialization activity, Entrepreneurial Self-efficacy, Research University, Academicians, Environmental factors.

INTRODUCTION

Despite Malaysia's annual investment of over RM15 billion in research and development (R&D), the commercialization rate of academic research remains low compared to global benchmarks (MRANTI, 2022). Universities are expected not only to produce high-quality research but also to translate these innovations into commercially viable products that contribute to economic growth and societal well-being. However, despite their critical role in fostering innovation, Malaysian universities face significant commercialization challenges, with many research outputs failing to reach market implementation (Ismail, Mohd Nor, & Sidek, 2016). The barriers to commercialization include financial constraints, institutional rigidities, regulatory complexities, and limited entrepreneurial skills among researchers. These challenges underscore the need to explore personal and environmental factors that influence commercialization success, particularly within the Malaysian academic context.

One of the key personal factors that influence commercialization success is Entrepreneurial Self-Efficacy (ESE). ESE refers to an individual's belief in their ability to successfully execute entrepreneurial tasks, such as opportunity identification, resource acquisition, and venture creation. In the academic setting, researchers with higher levels of ESE are more likely to engage in commercialization efforts, persist through regulatory and funding challenges, and proactively seek collaborations with industry stakeholders. Previous studies suggest that

entrepreneurial training, mentorship, and exposure to successful academic entrepreneurs can significantly enhance ESE, increasing the likelihood of research commercialization. However, while ESE has been extensively linked to entrepreneurial intentions, there remains a gap in understanding how ESE moderates the relationship between environmental barriers and commercialization success in Malaysian universities. Despite significant investments in R&D and institutional reforms, Malaysian universities continue to struggle with low commercialization activities. Past studies have identified both personal limitations—such as lack of patent law knowledge, weak industry networks, and insufficient entrepreneurial capabilities—and environmental barriers such as limited financial support, rigid institutional structures, and weak university–industry linkages. However, most existing research treats these variables in isolation and fails to explain why some academicians succeed in commercialization despite these constraints. This gap highlights the need to explore moderating factors such as Entrepreneurial Self-Efficacy (ESE) that may enable individuals to overcome environmental challenges and achieve commercialization success. Therefore, this study investigates how ESE moderates the relationship between personal and environmental factors and commercialization activities among Malaysian academicians in research universities.

The commercialization environment is influenced by multiple external factors that either facilitate or hinder success. Financial constraints remain one of the most significant barriers, as many researchers struggle to secure funding for prototype development, product scaling, and patent registration. Institutional inefficiencies also play a critical role, as bureaucratic approval processes, restrictive university policies, and misaligned incentive structures often discourage commercialization efforts. Additionally, regulatory complexities related to intellectual property (IP) rights create additional challenges, particularly when navigating patent laws and licensing agreements. Despite these obstacles, global institutions such as the World Intellectual Property Organization (WIPO) emphasize that a well-structured IP framework and commercialization policy can significantly improve research-to-market translation.

Moreover, university–industry–government collaboration has been widely recognized as a key factor in improving commercialization activities. The Triple Helix Model highlights that strong partnerships between universities, industry players, and policymakers are essential in bridging the gap between research and commercial application. However, in Malaysia, such collaborations remain underdeveloped, with weak linkages between universities and the private sector, limiting the potential for commercialization. Studies have also shown that universities operating in rapidly evolving market landscapes must adopt flexible commercialization strategies. Similarly, fostering an entrepreneurial mindset within academic institutions is crucial for overcoming commercialization challenges.

While previous research has extensively examined the barriers to commercialization, limited studies have systematically explored how ESE moderates the impact of these environmental constraints on commercialization success. Researchers with high ESE may be more resourceful in seeking funding, adaptive in navigating institutional barriers, and strategic in forming industry partnerships, while those with lower ESE may experience greater commercialization setbacks. Given these considerations, this study aims to investigate the moderating role of Entrepreneurial Self-Efficacy in the relationship between environmental barriers and commercialization success among Malaysian academicians.

By examining this interaction, the study seeks to provide practical insights for developing targeted interventions, such as entrepreneurial training programs, policy reforms, and enhanced institutional support systems, to bolster research commercialization efforts in Malaysian universities. The findings of this research will contribute to academic literature and policy development, offering strategies to strengthen Malaysia's commercialization ecosystem and enhance the global competitiveness of its research institutions.

Research Questions

This study aims to investigate how Entrepreneurial Self-Efficacy (ESE) moderates the influence of personal and environmental factors on commercialization activities among academicians in Malaysian Research Universities. The specific objectives are:

1. To assess the level of commercialization activity among engineering academicians in Malaysian Research Universities.

2. To examine the influence of personal factors (e.g., patent law knowledge, personal contacts, involvement, experience, and capabilities) on commercialization activities.
3. To examine the influence of environmental factors (e.g., resources, financial support, institutional support, knowledge, role models, and market dynamics) on commercialization activities.
4. To evaluate the moderating effect of entrepreneurial self-efficacy on the relationship between personal factors and commercialization activities.
5. To evaluate the moderating effect of entrepreneurial self-efficacy on the relationship between environmental factors and commercialization activities.

The research is guided by the following questions:

1. What is the level of commercialization activity among engineering academicians in Malaysian Research Universities?
2. How do personal factors influence the commercialization activities of academicians?
3. How do environmental factors influence the commercialization activities of academicians?
4. Does entrepreneurial self-efficacy moderate the relationship between personal factors and commercialization activities?
5. Does entrepreneurial self-efficacy moderate the relationship between environmental factors and commercialization activities?

LITERATURE REVIEW

Personal Factors and Academic Involvement in Commercialization

Personal Involvement

Past studies have presented mixed findings regarding the role of academician involvement in commercialization activities. Jensen and Thursby (2001) reported that 71% of inventions required further involvement from researchers to be successfully commercialized. However, they also found that involvement in research does not necessarily translate to involvement in commercialization. This suggests a disconnect between scientific discovery and market implementation.

In contrast, Chrisman et al. (1995) and Doutriaux (1987) found that companies led by university researchers tend to develop more slowly than those developed independently from universities. These findings imply that academic affiliations might hinder rather than accelerate commercialization under certain conditions. Therefore, despite assumptions that academician involvement is beneficial, empirical evidence remains inconclusive.

H1: There is no relationship between academician involvement and commercialization activity.

Personal Contact

Prior research has consistently emphasized the importance of personal contacts as enablers of academic entrepreneurship and commercialization. Thursby and Thursby (2000, 2003) highlighted that the development of networks between universities and industry enhances mutual awareness of development activities and improves sensitivity to commercialization opportunities. Jansen and Dillon (1999) found a positive relationship between industry-researcher collaborations and technology licensing outcomes.

Similarly, Bourelos et al. (2010) demonstrated that academic networking with entrepreneurs and industry managers significantly contributes to outcomes such as patents, licenses, and spin-off activities. In the Malaysian context, Norain (2017) observed that academicians often engage with SME entrepreneurs to commercialize small-scale research products. Aniza et al. (2014) reported that academic researchers with influential personal contacts are better positioned to obtain financial support.

H2: There is a positive and significant relationship between personal contact and commercialization activity.

Past Experience

Past experience is a vital source of tacit knowledge, often acquired through a "learning by doing" approach. Researchers can identify weaknesses and improve their performance through direct involvement in commercialization processes.

Studies by Adkins (1995) and Floyd and Woolridge (1999) show that researchers with prior commercialization experience are more likely to succeed in future efforts. Ambos et al. (2008) found that researchers with industry experience have a positive relationship with commercialization activities. Shane (2010) emphasized that a lack of prior experience reduces entrepreneurial engagement. However, Ambos et al. (2008) noted that not all experiences contribute equally—specificity matters.

H3: There is no relationship between academician experience and commercialization activity.

Academician Capabilities

Researcher capabilities are believed to play a crucial role in encouraging commercialization activities. Vohora, Wright, and Lockett (2004) identify that commercialization involves multiple phases requiring specific competencies. Opportunity recognition, perseverance, and working under pressure are key (Roberts, 1991; Steffensen et al., 1999).

Kotter (1996) emphasized leadership and change management skills as vital for commercialization success. However, Baumeister et al. (1993) warned that overconfidence may result in poor decisions. These contradictory findings suggest no clear consensus.

H4: There is no relationship between academician capabilities and commercialization activity.

Patent Law Knowledge

Successful commercialization often requires a foundational understanding of patent law. Knowledge of patentability, ownership, and procedures protects innovations and enhances commercial potential (Moss, 1987; Yin Xin Dai, 2007).

Ardichvilli, Cardozo, and Ray (2000) showed that domain-specific knowledge facilitates entrepreneurship. Kamisah et al. (2011) and Standish Kuon (2007) found that knowledge of market needs and entrepreneurship roles supports commercialization. Yinxin Dai (2007) emphasized patent system literacy. However, Low Hock Heng (2011) found IP knowledge had minimal influence.

H5: There is no relationship between patent law knowledge and commercialization activity.

Entrepreneurial Self-Efficacy and Environmental Challenges in Academic Research Commercialization

The commercialization of academic research within Malaysian universities is vital for driving economic growth and technological advancement. However, the process faces numerous challenges, both personal and environmental. One of the most significant personal factors influencing commercialization success is Entrepreneurial Self-Efficacy (ESE), which refers to an individual’s belief in their capability to perform tasks necessary for entrepreneurial success (Bandura, 1997). This literature review examines the role of ESE in academic research commercialization and explores the environmental challenges that Malaysian academicians encounter in this endeavor.

Environmental Challenges in Research Commercialization

Despite the potential of entrepreneurial self-efficacy (ESE) in enhancing commercialization efforts, Malaysian academicians face several environmental challenges that hinder the translation of research into marketable products. These challenges—including financial constraints, institutional barriers, regulatory complexities, and

resource limitations—have been widely recognized in both global and local research as significant determinants of commercialization activities (O'Grady, 1996; Rahal, 2008; Low Hock Heng, 2011).

Financial constraints remain one of the most pressing issues, as many researchers struggle to obtain financial support for prototype development, market testing, and patent registration (Aziza & Ismail, 2007). The availability of venture capital is limited, and securing government grants remains highly competitive, leading to delays or the abandonment of commercialization efforts. Without sufficient funding, many innovative research projects fail to progress beyond the academic setting (Ismail et al., 2016).

Institutional barriers further impede commercialization efforts. Many universities in Malaysia have rigid administrative policies and bureaucratic procedures that slow down the process of securing patents, negotiating licensing agreements, and obtaining research commercialization approvals (Azley & Mohammed, 2007). There is often a greater emphasis on publishing academic research rather than translating findings into commercial products, discouraging entrepreneurial activities among faculty members (Owunna et al., 2024).

A lack of business knowledge and commercialization skills also presents a major challenge. Many researchers possess deep technical expertise but lack business acumen in areas such as market analysis, negotiation strategies, and commercial feasibility assessment (Geisler & Clements, 1995). This skills gap can result in poor commercialization decisions, misaligned product-market fit, and difficulties in securing investments (Ismail et al., 2016).

Regulatory and intellectual property (IP) complexities add another layer of difficulty. Many researchers are unfamiliar with patent laws, licensing agreements, and regulatory compliance requirements, leading to delays in securing intellectual property rights for their innovations (Malaysian Intellectual Property Organization, 2013). Without strong institutional support in navigating the legal landscape, academicians may struggle to protect their innovations from exploitation or patent disputes (Rahman & Pihie, 2014).

Resource limitations also impact research commercialization. Recent infrastructural developments, such as the establishment of data centers in regions like Johor, have intensified competition for essential resources, including electricity and water. These infrastructure projects, while beneficial to Malaysia's digital economy, may inadvertently affect the availability of resources needed for academic research (Associated Press, 2025). Researchers need to be increasingly adaptive in managing resource constraints to sustain their commercialization activities.

This section reviews the key theoretical and empirical findings on the influence of environmental factors on academic research commercialization. Based on past research, environmental factors have been widely recognized as significant determinants of commercialization activities. O'Grady (1996) emphasized that these factors play a crucial role in shaping technology transfer activities, while Rahal (2008) and Low Hock Heng (2011) demonstrated similar results in both international and Malaysian contexts.

Resources

Resources such as incubator programs, entrepreneurship courses, and university technology transfer offices (TTOs) serve as critical enablers of commercialization success. Studies by Hauksson (1998), Rothaermel et al. (2007), Swamidass and Vulasa (2008), and Jain, George, and Maltarich (2009) consistently found strong positive correlations between the availability of TTOs and commercialization activities. Additionally, infrastructure support was also highlighted by Gartner (1985) and Powers and McDougall (2005) as pivotal for researchers transitioning their work into marketable innovations.

H6a: There is a positive and significant relationship between resources and commercialization activity.

Finances

In both entrepreneurship and academic commercialization, financial capital remains one of the most essential determinants of success. Past studies such as Vesper (1990), Weinberg and Mazey (1988), and Geisler and Clements (1995) emphasized the importance of funding for R&D activities, laboratory development, and

commercialization. Financial support ensures continuity in product development and assists in overcoming early-stage barriers.

H6b: There is a positive and significant relationship between finances and commercialization activity.

Knowledge

Technical and managerial knowledge are equally vital for commercialization. Bruno and Tyebjee (1982), Gartner (1985), and Daniel and Hofer (1993) emphasized the need for technical skills, while Geisler and Clements (1995) and Ziedonis (2001) argued that management knowledge enables academics to navigate the commercialization pathway and evaluate the value of technologies. Muscio (2009) and Moroz et al. (2008) also reported positive relationships between knowledge levels and commercialization activities.

H6c: There is a positive and significant relationship between knowledge and commercialization activity.

Role Models

Role models, especially successful entrepreneurial researchers, provide motivation and practical guidance to other academicians. Studies by Bruno and Tyebjee (1982), Gartner (1985), and Geisler and Clements (1995) reveal that strong entrepreneurial cultures driven by visible role models can enhance commercialization engagement and performance. These figures serve as benchmarks and mentors for aspiring academic entrepreneurs.

H6d: There is a positive and significant relationship between role model and commercialization activity.

Dynamics

Market dynamics, technological changes, and competitive pressures create both opportunities and uncertainties for commercialization. Donckels and Courtmans (1990), Jarillo (1989), and Covin and Slevin (1991) highlighted that a dynamic market environment can act as a catalyst for spin-offs. However, Tushman and Anderson (1986) warned that technologies misaligned with market needs face novelty liabilities, reducing their commercial viability.

H6e: There is a positive and significant relationship between dynamics and commercialization activity.

Support

Institutional, organizational, and social support systems significantly influence researchers' motivation and capability to commercialize. Support mechanisms such as business environment networks, awards, and entrepreneurial communities provide encouragement and resources needed to bridge research and market. Bruno and Tyebjee (1982), Gartner (1985), and Covin and Slevin (1991) all support this claim.

H6f: There is a positive and significant relationship between support and commercialization activity.

Entrepreneurial Self-Efficacy (ESE) and Its Role in Commercialization

Entrepreneurial Self-Efficacy (ESE) is a significant predictor of entrepreneurial behavior (Bandura, 1997). Gartner (1985) and Bandura's social cognitive theory emphasize that individuals with high ESE are more confident in commercializing their research.

Rahman and Pihie (2014) found a correlation between ESE and entrepreneurial intent among students. Ismail et al. (2016) confirmed that academicians with strong ESE engage more actively in commercialization. Boyd and Vozikis (1994), Chandler (1994), Jung (2001), and Krueger and Brazeal (1994) also supported this relationship.

H7: There is no relationship between entrepreneurial self-efficacy and commercialization activity.

Moderating Role of ESE in Overcoming Environmental Challenges

ESE serves as a critical moderator in addressing environmental challenges associated with research commercialization. Academicians with high ESE are more likely to proactively seek funding through diverse avenues, including industry collaborations, consultancy projects, and international grants, reducing reliance on traditional government research funding (Schramm, 2004). Confident researchers also demonstrate better adaptability in navigating institutional barriers by leveraging networks and advocating for policy reforms within their universities (Etzkowitz et al., 2000).

Academicians with strong ESE also tend to engage in continuous learning, attending business-oriented workshops, seeking mentorship, and acquiring commercialization skills necessary for market success (Gartner, 1985). This proactive approach enhances their ability to align research with industry needs, increasing the likelihood of successful commercialization (Owunna et al., 2024). Researchers with high ESE are also more adept at managing intellectual property challenges by seeking legal assistance, educating themselves on patent regulations, and actively engaging with university technology transfer offices (Malaysian Intellectual Property Organization, 2013).

In addition, researchers with strong ESE exhibit resilience in responding to resource limitations. They are more likely to explore alternative solutions, such as forming cross-disciplinary partnerships, optimizing available resources, or pivoting their research focus to align with more accessible commercialization opportunities (Low Hock Heng, 2011). This adaptability allows them to maintain research momentum despite external constraints.

Previous studies showed that entrepreneurial self-efficacy differentiated entrepreneurs from non-entrepreneurs (Lucas, Cooper and Sarah, 2004; Makman, Balkin, and Baron, 2002; Chen, Greece and Crick, 1998 and Mitchell, 1992). Entrepreneurs who have entrepreneurial self-efficacy will be able to execute all the requirements to perform a new task successfully. Evidence also showed that entrepreneurs with self-efficacy tend to persevere until their task is completed. They tend to choose challenging tasks and have more ambitious goals (Bandura, 1997). According to Bandura (1997), entrepreneurial self-efficacy can help to explain why entrepreneurs implement certain behavior. Chandler (1994) validates the mediating role between entrepreneurial efficacy and entrepreneurial performance. Wang et al. (2005) also found that entrepreneurial efficacy as an intermediate variable affects entrepreneurial performance.

Several studies have used entrepreneurial self-efficacy as moderating variable. Hmieleski and Corbett (2008) found that entrepreneurial self-efficacy has positive moderating effect on relationship between entrepreneur's improvisational behavior and new venture performance. Another study conducted by Ballout (2009) also found that entrepreneurial self-efficacy had a moderating effect on the relationship between career commitment and career success.

Quite astonishingly, Cools (2008) found that self-efficacy is negatively related to proactive behavior, and achievement motivation has been found to have no impact on people's willingness to introduce new products, to be proactive towards environment and to take risks. These inconsistent findings need further investigation. Therefore, following hypotheses were developed.

H8a: There is no moderating effect of entrepreneurial self-efficacy on the relationship between personal factors and academician's commercialization activity.

H8b: There is no moderating effect of entrepreneurial self-efficacy on the relationship between environmental factors and academician's commercialization activity.

Implications for Policy and Practice

To improve commercialization success, universities and policymakers must actively support ESE development among academicians. Funding mechanisms should be enhanced to provide clearer commercialization pathways, and bureaucratic processes should be streamlined to reduce institutional barriers (Aziza & Ismail, 2007).

Entrepreneurial training programs and mentorship initiatives should be integrated into academic settings to address knowledge and skills gaps, equipping researchers with the necessary business competencies (Geisler & Clements, 1995). Universities must also strengthen their intellectual property support services to help academicians navigate legal complexities and secure patents effectively (Rahman & Pihie, 2014).

Addressing resource limitations is also crucial. Policymakers must ensure that infrastructure expansion does not impede academic research activities and that sustainability strategies are implemented to optimize resource allocation for research purposes (Low Hock Heng, 2011). Strengthening institutional policies to incentivize commercialization efforts will also encourage academicians to pursue entrepreneurial ventures rather than solely focusing on research publications (Owunna et al., 2024).

Although extensive research has examined the individual impacts of environmental factors and entrepreneurial self-efficacy on commercialization activities, few studies have systematically explored their interplay within the context of Malaysian academia. This review highlights that both environmental challenges and entrepreneurial self-efficacy play significant roles in shaping commercialization success, but their relationship remains underexplored. While financial constraints, institutional barriers, regulatory complexities, and knowledge gaps present substantial hurdles to commercialization, entrepreneurial self-efficacy has emerged as a crucial moderating factor that enables academicians to navigate these challenges effectively.

The literature underscores that academicians with higher self-efficacy are more likely to seek alternative funding sources, leverage institutional networks, and proactively acquire the necessary business skills to commercialize their research. However, there is limited empirical evidence on how self-efficacy directly moderates the relationship between environmental constraints and commercialization performance in Malaysian universities. This gap in the literature necessitates further exploration into how self-efficacy-driven interventions, such as entrepreneurial training, mentorship programs, and policy reforms, can strengthen commercialization efforts in resource-constrained environments.

Addressing this gap, the present study investigates the moderating role of entrepreneurial self-efficacy, offering insights that could inform strategies to bolster academic commercialization efforts in challenging environments. By systematically examining the interaction between environmental barriers and self-efficacy, this research aims to provide actionable recommendations for universities, policymakers, and academic entrepreneurs, ultimately contributing to a more supportive and resilient commercialization ecosystem in Malaysian higher education institutions.

CONCEPTUAL FRAMEWORK

The conceptual framework is developed based on Bandura's (1997) Social Cognitive Theory and integrates empirical findings from Malaysian academic settings. It posits that both personal and environmental factors directly affect commercialization activities, while entrepreneurial self-efficacy functions as a moderating variable that enhances or buffers these effects.

Independent Variables (IVs)

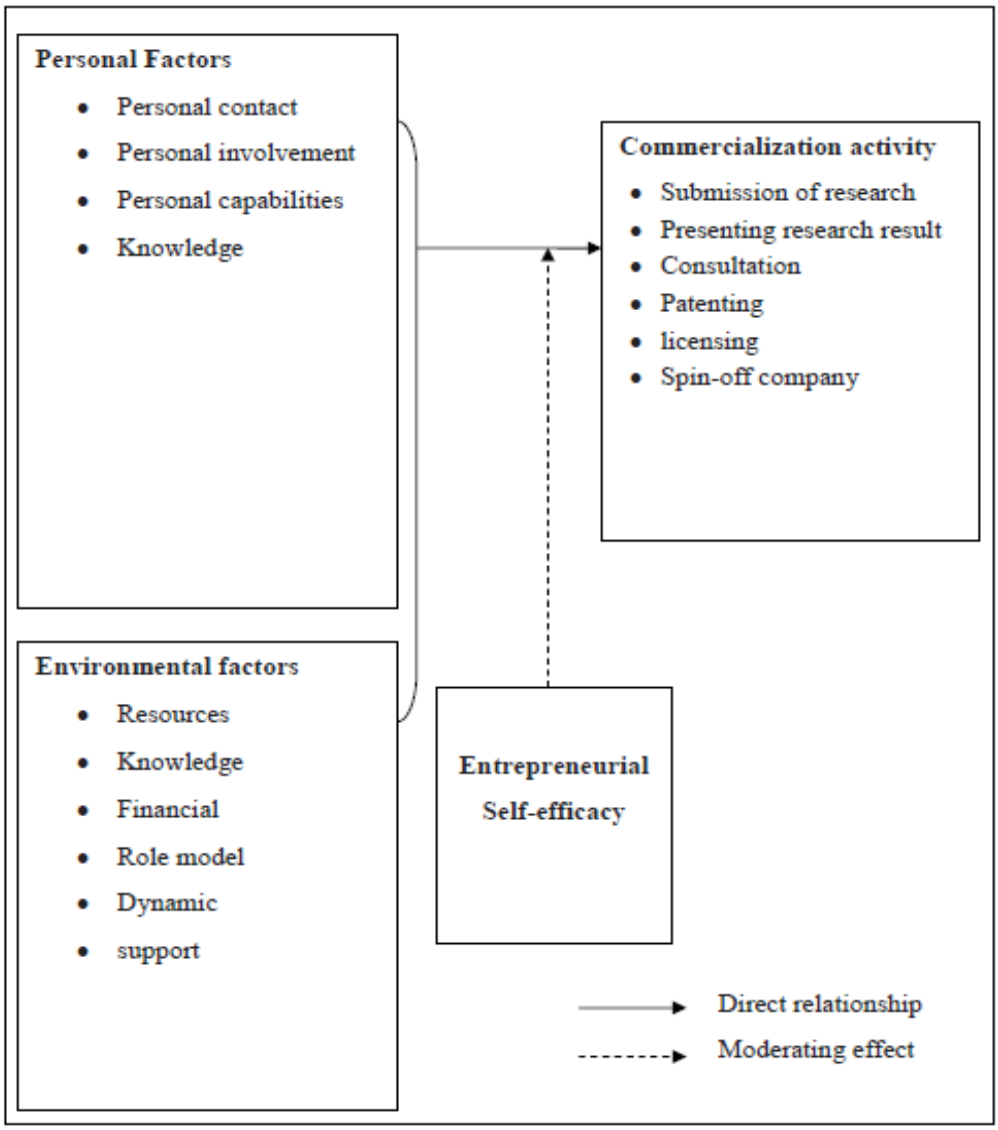
- Personal Factors: Patent law knowledge, personal contact, involvement, experience, capability
- Environmental Factors: Financial support, institutional support, knowledge availability, role models, market dynamics, resource availability

Moderator (M)

- Entrepreneurial Self-Efficacy (ESE)

Dependent Variable (DV)

- Commercialization activities (e.g., patents, licenses, spin-offs, consultancy, productization)



METHODOLOGY

This study employs a quantitative, cross-sectional survey design to examine how Entrepreneurial Self-Efficacy (ESE) moderates the relationship between environmental challenges and commercialization activities among Malaysian academicians. The theoretical foundation of this research is grounded in Bandura's Social Cognitive Theory, which highlights the importance of self-efficacy in shaping individuals' behaviours and responses to external challenges.

The target population comprises academicians from the engineering faculties of five Malaysian Research Universities: University Technology Malaysia (UTM), University Kembangan Malaysia (UKM), University Malaya (UM), University Sains Malaysia (USM), and University Putra Malaysia (UPM). A total of 311 responses were collected using a structured survey instrument.

The questionnaire was developed based on validated constructs and refined through expert evaluation. Three academic experts (two senior lecturers and one Associate Professor specializing in technology management and commercialization) reviewed the instrument for content validity. The final survey measured three main constructs: commercialization activities, entrepreneurial self-efficacy, and environmental factors (resources, finances, knowledge, role models, support, and dynamics), using a five-point Likert scale.

Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS. This method was chosen due to the model's complexity, the inclusion of a moderating variable, and the exploratory nature of the study. PLS-SEM is also robust for non-normal data and suitable for studies with medium sample sizes.

To ensure measurement quality, construct reliability was evaluated using Cronbach's Alpha and Composite Reliability (CR), with thresholds above 0.70. Convergent validity was assessed using Average Variance Extracted (AVE) (>0.50), and discriminant validity was confirmed using the Fornell-Larcker criterion and HTMT ratios (<0.85). Multicollinearity was examined using VIF values, which remained below the acceptable limit of 5.

Data Analysis

Data were analysed using SMART-PLS. Median scores were computed to gauge the levels of commercialization activity, entrepreneurial self-efficacy, and environmental factors. Spearman's Rank Correlation Coefficient was employed to determine the strength of the relationships between these variables. Finally, the moderating effect of entrepreneurial self-efficacy on the relationship between environmental factors and commercialization activities was examined using Structural Equation Modeling (SEM) via Partial Least Squares (PLS).

FINDINGS

This study's quantitative analysis offers clear This study aimed to examine the influence of personal and environmental factors on commercialization activity among Malaysian academicians, as well as the moderating role of entrepreneurial self-efficacy (ESE) in these relationships. The results are presented across three domains: personal factors, environmental factors, and the moderating effects of ESE.

Personal Factors and Commercialization Activity

The analysis revealed a significant positive relationship between patent law knowledge and commercialization activities ($\beta = 0.4954$, $t = 3.23$, $p < 0.05$), indicating that academicians who possess greater familiarity with patent regulations are more capable of navigating the complexities of innovation commercialization. Therefore, Hypothesis H4, which stated that "there is no relationship between patent law knowledge and commercialization activity," is rejected.

In addition, entrepreneurial self-efficacy demonstrated a significant positive association with commercialization activity ($\beta = 0.3389$, $t = 2.28$, $p < 0.05$). This suggests that academicians with higher levels of self-confidence in their entrepreneurial capabilities are more proactive in bringing research outputs to market. Accordingly, Hypothesis H7, which posited that "there is no relationship between entrepreneurial self-efficacy and commercialization activity," is also rejected.

Environmental Factors and Commercialization Activity

All six environmental dimensions tested showed statistically significant and positive relationships with commercialization activity:

- Dynamic environment ($\beta = 0.286$, $t = 3.79$, $p < 0.05$)
- Knowledge availability ($\beta = 0.254$, $t = 3.28$, $p < 0.05$)
- Financial support ($\beta = 0.291$, $t = 3.11$, $p < 0.05$)
- Resource access ($\beta = 0.236$, $t = 3.20$, $p < 0.05$)
- Role model presence ($\beta = 0.606$, $t = 5.22$, $p < 0.05$)
- Institutional support ($\beta = 0.267$, $t = 3.79$, $p < 0.05$)

These findings support all sub-hypotheses under Hypothesis 6 is accepted. The result shows that environmental factors have positive and significant relationship between environmental factors and commercialization activities.

Moderating Effects of Entrepreneurial Self-Efficacy

The moderating role of entrepreneurial self-efficacy was also tested to assess whether ESE amplifies the relationship between both personal and environmental factors with commercialization activities.

For personal factors, ESE significantly moderated the relationship between:

- Patent law knowledge and commercialization ($\beta = 0.5543$, $t = 5.04$, $p < 0.05$), and
- Personal contacts and commercialization ($\beta = 0.3748$, $t = 5.41$, $p < 0.05$).

These results suggest that academicians with high self-efficacy are more capable of leveraging their knowledge and networks to pursue commercialization, supporting the proposed moderation effects in the model.

Regarding environmental factors, entrepreneurial self-efficacy significantly moderated the effect of:

- Financial support,
- Role models, and
- Knowledge availability on commercialization activity.

However, the moderating effect of ESE was not statistically significant for resource access and institutional support, indicating that these two factors influence commercialization activities regardless of the academician's level of self-efficacy.

In summary, the findings confirm that both personal (patent law knowledge and self-efficacy) and environmental factors (resources, knowledge, financial support, role models, institutional support, and dynamics) significantly contribute to commercialization activities. Entrepreneurial self-efficacy plays a critical role both directly and as a moderator in enhancing the commercialization potential of Malaysian academicians.

DISCUSSION

The commercialization of academic research within Malaysian universities is influenced by both personal attributes of academicians and environmental factors. One of the most critical personal attributes in this process is Entrepreneurial Self-Efficacy (ESE), which significantly affects an academician's confidence and capability to undertake entrepreneurial activities. ESE encompasses an individual's belief in their ability to successfully execute tasks related to entrepreneurship, such as opportunity recognition, resource mobilization, and venture creation. Research has shown that higher levels of ESE correlate with increased entrepreneurial intentions and behaviors among university faculty members and students (Rahman & Pihie, 2014).

Environmental factors also play a crucial role in shaping commercialization success. Recent developments in Malaysia, such as the strategic push to position regions like Johor as data center hubs, have led to substantial investments from technology firms. However, these data centers are highly resource-intensive, consuming vast amounts of electricity and water. This surge in demand has raised concerns over potential resource shortages, which could inadvertently affect the availability of essential resources for academic research and its commercialization (Ismail, Mohd Nor, & Sidek, 2016). Additionally, the global emphasis on sustainability has prompted Malaysia to tighten its environmental policies, which now require industries, including those emerging from academic research, to comply with stricter regulations. This shift necessitates that academicians integrate sustainable practices into their commercialization strategies, potentially increasing operational complexities and costs (Owunna, Alias, & Ajobi, 2024).

Geopolitical changes have also influenced the research commercialization landscape. Trade tensions and policies such as "friendshoring" have repositioned Malaysia as a crucial player in the semiconductor industry. While this presents new opportunities for research commercialization, it also demands agility from academicians to align with rapidly evolving market needs and technological advancements (Ismail et al., 2016). Without the ability to quickly adapt to changing demands, commercialization efforts may face barriers that hinder research outputs from achieving market success.

In this complex interplay of personal and environmental factors, ESE serves as a critical moderating variable. Academicians possessing high ESE exhibit enhanced resilience and adaptability, enabling them to navigate resource constraints effectively (Rahman & Pihie, 2014). Confident in their entrepreneurial capabilities, these individuals proactively seek alternative solutions, such as forming industry partnerships or exploring diverse

funding avenues, to mitigate resource limitations (Owunna et al., 2024). Moreover, a strong sense of ESE empowers academicians to embrace and implement sustainable practices, ensuring compliance with environmental regulations and meeting the growing market demand for eco-friendly solutions (Ismail et al., 2016).

To enhance the commercialization success of academic research, universities and policymakers must recognize the dual impact of personal and environmental factors. This recognition should translate into comprehensive support systems that address both individual capacity-building and broader environmental challenges (Rahman & Pihie, 2014). Structured initiatives aimed at enhancing ESE can equip academicians with the necessary skills and confidence to overcome commercialization barriers. Such programs might include workshops, mentorship schemes, and real-world entrepreneurial engagements (Ismail et al., 2016). Given the emerging environmental challenges, it is imperative to integrate sustainability into the core of commercialization strategies. This approach not only ensures regulatory compliance but also aligns with global market trends favouring sustainable innovations (Owunna et al., 2024).

In conclusion, the successful commercialization of academic research in Malaysia requires a synergistic approach that enhances personal competencies, particularly ESE, while proactively addressing the evolving environmental landscape. This dual focus will position Malaysian academicians to effectively translate research innovations into impactful, market-ready solutions.

Theoretical and Practical Implications

Theoretically, this research advances the academic entrepreneurship literature by illustrating the interplay between internal capabilities and external supports. It moves beyond traditional models that examine these factors in isolation, offering a more integrated perspective that emphasizes the moderating role of entrepreneurial self-efficacy.

From a practical standpoint, our findings suggest that universities and policymakers should invest in initiatives aimed at enhancing entrepreneurial self-efficacy among academicians. Programs such as targeted training, mentorship schemes, and networking opportunities could not only build individual confidence but also maximize the benefits derived from available environmental resources. Strengthening these areas could lead to a more robust innovation ecosystem, ultimately helping Malaysian research universities close the commercialization gap with global leaders.

Limitations and Future Directions

While the study makes significant contributions, it is not without limitations. The focus on engineering academicians from a select group of research universities may limit the generalizability of the findings to other disciplines or institutional contexts. Additionally, the cross-sectional design restricts the ability to draw causal inferences. Future research should consider focussing on academicians in social science fields to capture the dynamic nature of commercialization processes and challenges they may faced to commercialize their research product.

CONCLUSION

In summary, this study demonstrates that entrepreneurial self-efficacy plays a critical role in enhancing research commercialization activities by both directly influencing entrepreneurial actions and moderating the impact of environmental supports. These insights not only enrich our theoretical understanding but also offer practical strategies for fostering a more supportive environment for academic entrepreneurship in Malaysia.

REFERENCES

1. Aniza, A., Noraini, R., & Fauziah, I. (2014). Challenges in the commercialization of research products in Malaysian universities. Asian Journal of Business and Management, 6(2), 123-130.
2. Aziza, Z., & Ismail, N. (2007). The impact of financial constraints on Malaysian academic entrepreneurship. Journal of Technology Innovation, 3(2), 88-100.

3. Azley, A., & Mohammed, S. (2007). Addressing resource constraints in university research commercialization: Insights from Malaysia. Journal of Malaysian Studies, 15(4), 45-56.
4. Bandura, A. (1997). Self-efficacy: The exercise of control. W.H. Freeman and Company.
5. Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. R. C. (2000). The future of the university and the university of the future: Evolution of ivory tower to entrepreneurial paradigm. Research Policy, 29(2), 313-330.
6. Gartner, W. B. (1985). A conceptual framework for describing the phenomenon of new venture creation. Academy of Management Review, 10(4), 696-706.
7. Geisler, E., & Clements, C. (1995). Managing technology transfer at universities: A study of the critical factors. Journal of Technology Transfer, 20(1-2), 56-60.
8. Ismail, N., Mohd Nor, M. J., & Sidek, S. (2016). Challenges for research product commercialization: A case of Malaysian academic researchers. Procedia - Social and Behavioral Sciences, 219, 461-468.
9. Low, H. H. (2011). The role of environmental factors in promoting research commercialization in Malaysian universities. Journal of Innovation Studies, 12(3), 89-101.
10. Malaysian Intellectual Property Organization. (2013). Intellectual property statistics. Retrieved from https://www.myipo.gov.my.
11. O'Grady, W. (1996). The role of dynamic environments in commercialization activities: A review of university-industry linkages. Technology Transfer Quarterly, 5(3), 45-67.
12. Owunna, R., Alias, S. N., & Ajobi, A. O. (2024). Influence of self-efficacy and social support on entrepreneurial behavior among Universiti Putra Malaysia undergraduate students. International Journal of Academic Research in Business and Social Sciences, 14(11).
13. Rahman, R. S. A. R. A., & Pihie, Z. A. L. (2014). Validation of a social entrepreneurial self-efficacy. IOSR Journal of Business and Management, 16(11), 133-141.
14. Schramm, C. J. (2004). Building entrepreneurial economies. Foreign Affairs, 83(4), 104-115.
15. Steinberg, H. (1990). Knowledge sharing as a resource: Implications for commercialization. Innovation Management Review, 2(3), 105-115.
16. The Star. (2016, June 14). Malaysia's commercialization challenges in research universities. The Star Online. Retrieved from https://www.thestar.com.my.