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Enhancing Technology Commercialization Capabilities in Non-Profit TTOS Using Market Orientation, Funding and Strategic Alliances and Entrepreneurial Orientation of Project Manager

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Abstract

Technology Transfer Offices (TTOs) in Malaysian public universities play a pivotal role in bridging academic research and market application. However, these non-profit entities face persistent challenges in translating research outputs into commercially viable innovations. This conceptual paper proposes a theoretically grounded framework to enhance technology commercialization capabilities (TCC) within these institutions. Guided by Open Innovation Theory and Dynamic Capabilities Theory, the framework identifies Market Orientation, Funding, and Strategic Alliances as core organizational enablers, while introducing the Entrepreneurial Orientation (EO) of project managers as a moderating variable. By integrating structural and behavioral dimensions, this study addresses significant gaps in the literature on university -industry collaboration, especially within emerging economies. The proposed model contributes to theory development and offers actionable insights for policymakers and academic leaders aiming to strengthen the commercialization ecosystem. The paper concludes with directions for future empirical research to validate the proposed relationships and to assess their practical relevance in diverse institutional contexts.

Keywords: Technology Commercialization, Market Orientation, Funding, Strategic Alliances, Entrepreneurial Orientation, Open Innovation, Dynamic Capabilities

Introduction

In Malaysia, fewer than 3% of academic research innovations are successfully commercialized, despite sustained public investment in university research (Yusof & Jain, 2020; Jamil et al., 2024). This highlights a persistent gap between research outputs and market application. Technology Transfer Offices (TTOs) in public universities are mandated to address this gap by facilitating the commercialization of academic innovations and supporting national innovation agendas.

Despite the government's long-term commitment to fostering innovation, Malaysia continues to lag behind regional peers such as Singapore and South Korea in translating academic research into market impact. Strengthening technology commercialization in public universities is therefore a strategic national priority, essential for achieving Malaysia's high-income, innovation-driven agenda (RMK12, 2021). Non-profit TTOs serve as critical intermediaries linking research with industry application, yet their potential remains underutilized due to structural and behavioral limitations. Understanding how market orientation, funding mechanisms, and strategic alliances interact moderated by the entrepreneurial behavior of project managers offers valuable insights for policymakers, university administrators, and industry collaborators seeking to optimize innovation performance.

Although Malaysia has introduced policies and built institutional infrastructure to strengthen university–industry linkages, non-profit TTOs in public universities continue to face significant hurdles. These include policy-level inefficiencies, regulatory rigidity, and institutional constraints such as resource scarcity, rigid governance models, and weak external engagement (Sharif & Baark, 2018; Rodriguez-Gonzalez et al., 2021). Many innovations fail to progress beyond the proof-of-concept stage, underscoring the need for more adaptive and entrepreneurial approaches within TTO operations.

Prior research has identified market orientation, funding access, and strategic alliances as key enablers of technology commercialization (Behfar et al., 2024; Rondeau et al., 2022). However, the role of individual project managers and particularly their entrepreneurial orientation remains underexplored. This study proposes a conceptual framework that positions Entrepreneurial Orientation as a moderating factor in the relationship between organizational enablers and Technology Commercialization Capability (TCC) within non-profit TTOs in Malaysian public universities.

Problem Statement

Despite sustained policy efforts to transform Malaysian public universities into engines of innovation, the commercialization performance of non-profit Technology Transfer Offices (TTOs) remains critically underwhelming. Only 8% of research innovations from public universities are successfully commercialized, and fewer than 3% achieve tangible market success (Yusof & Jain, 2020; Jamil et al., 2024). These figures underscore a persistent gap between academic research outputs and market uptake, revealing systemic weaknesses in university-industry technology transfer.

TTOs, as key intermediaries bridging academia and industry, face structural and strategic constraints that limit their effectiveness. These include insufficient market orientation, fragmented internal processes, limited early-stage commercialization funding, and underdeveloped strategic alliances. While some institutions have adopted promising practices such as early-stage grooming and market validation, these remain isolated cases rather than system-wide strategies (Zaki et al., 2023).

Market orientation, though widely recognized as essential for aligning innovations with market needs, is often deprioritized in public university settings. Academic environments tend to favor publication outputs over commercial relevance, leading to a misalignment between

research and industry demands (Delgado, 2017; Fransisca & Soelaiman, 2023). Without customer-driven strategies, many innovations fail to meet real-world application needs.

Compounding this issue is the lack of sustained commercialization funding at critical development phases including proof-of-concept, prototyping, and market testing. Funding discontinuity frequently results in the premature termination of potentially viable technologies (Ramachandran, 2022; Jamil et al., 2024).

Strategic alliances, a core component of open innovation, remain underutilized due to bureaucratic hurdles, weak trust among stakeholders, and poorly defined collaboration frameworks (Findik, 2018; Kimiagari et al., 2015). Most university–industry partnerships in Malaysia fail to scale beyond pilot collaborations, thereby limiting access to commercial channels and external capabilities.

Beyond structural issues, the behavioral dimension particularly the Entrepreneurial Orientation (EO) of project managers has received limited attention. EO, defined by innovativeness, proactiveness, and risk-taking, plays a crucial role in enabling adaptive, market-responsive strategies. While scholars like Nakos et al. (2019) and Martinez-Climent et al. (2019) highlight EO's moderating effect in translating organizational resources into commercialization outcomes, empirical insights from Malaysian non-profit TTOs remain scarce.

Moreover, intangible but critical enablers such as trust-building, experiential learning, and cross-sector alignment are often overlooked, reducing long-term commercialization capacity and strategic resilience.

These gaps signal the urgent need for a context-specific, theoretically grounded conceptual framework tailored to non-profit TTOs in Malaysia. Such a framework must explore how project managers interpret and enact market orientation, navigate resource constraints, build strategic partnerships, and apply entrepreneurial behavior within institutional limitations. By addressing these multi-level gaps, this study aims to enrich the academic discourse on university-based commercialization and inform national innovation policy aligned with Malaysia's ambition to become a high-income, innovation-led economy.

Research Objectives (RO)

This conceptual paper aims to explore and propose a framework for enhancing technology commercialization capabilities in non-profit Technology Transfer Offices (TTOs) in Malaysia. The specific research objectives are as follows:

RO1: To examine how Market Orientation influences technology commercialization capabilities in non-profit TTOs.

RO2: To explore the role of Funding in supporting the commercialization process.

RO3: To investigate how Strategic Alliances contribute to technology commercialization outcomes.

RO4: To assess how Entrepreneurial Orientation of project managers moderates the relationship between these organizational factors and commercialization capabilities.

Research Questions (RQ)

Based on the above objectives, the following research questions are proposed:

RQ1: How does Market Orientation affect technology commercialization capabilities in non-profit TTOs?

RQ2: What is the role of Funding in influencing the success of commercialization?

RQ3: How do Strategic Alliances enhance the commercialization process in public university TTOs?

RQ4: In what ways does Entrepreneurial Orientation of project managers moderate the effect of these factors on commercialization outcomes?

Literature Review

Overview of Technology Commercialization in Public University TTOs

Technology commercialization refers to the process of transforming research-based innovations into marketable products, services, or processes. In the context of public university TTOs, commercialization involves identifying viable research outputs, protecting intellectual property, attracting industrial interest, and facilitating technology transfer. TTOs in Malaysia operate as non-profit entities, often situated within larger bureaucratic and academic systems. Their performance is influenced by both institutional capabilities and environmental factors, including funding policies, industry collaboration structures, and national innovation agendas (Abdul Hamid & Mazlan, 2016; Ramachandran, 2022).

However, commercialization efforts within Malaysian public universities remain relatively underdeveloped. As Jamil et al. (2024) note, fewer than 3% of research outputs achieve tangible market success. This indicates systemic inefficiencies in the commercialization pipeline and a need for a more strategic alignment between organizational practices and commercialization goals. The remainder of this literature review will examine four key constructs that influence commercialization outcomes: market orientation, funding, strategic alliances, and entrepreneurial orientation.

Market Orientation and Technology Commercialization

Market orientation refers to an organization's capability to gather, interpret, and act upon market intelligence (Narver & Slater, 1990). Within university TTOs, this means understanding industry needs, emerging technology trends, and customer pain points to align research and development (R&D) outputs with market demand. A market-oriented TTO is more likely to anticipate industry requirements, engage in customer-centric product development, and tailor its licensing or spin-off strategies accordingly (Rodriguez-Gonzalez et al., 2021; Pujianto & Tannady, 2023).

In the Malaysian context, market orientation remains largely under-implemented in practice, despite being acknowledged in policy discourse. Most TTOs operate within academic cultures that prioritize scholarly outputs over marketable innovations (Delgado, 2017). This often leads to a mismatch between available technologies and industry expectations. Studies have emphasized that market orientation is a dynamic capability that can enhance the alignment between research outputs and commercialization pathways, thus increasing the success rate of technology transfer (Teece et al., 1997; Sharan et al., 2023).

Funding and Commercialization Viability

Funding is a critical enabler of successful technology commercialization, particularly during early-stage development. The availability of grants for proof-of-concept testing, prototyping, and market validation often determines whether research outputs can progress toward commercialization (Rondeau et al., 2022; Behfar et al., 2024).

Malaysian TTOs, however, face a fragmented funding landscape. According to Ramachandran (2022), many research outputs fail to progress due to a lack of sustained and targeted funding. Public funding is often insufficient or overly competitive, and many TTOs lack access to private investment or industry co-funding. Moreover, institutional mechanisms for managing and deploying funds tend to be rigid, further slowing the commercialization process. Funding, therefore, not only enables development but also signals institutional commitment and credibility to potential industry partners.

Strategic Alliances in Technology Transfer

Strategic alliances are partnerships between TTOs and external stakeholders, including industry players, government agencies, and research institutes, aimed at resource sharing, joint development, and market expansion. These alliances help TTOs overcome internal capability gaps and gain access to complementary resources (Findik, 2018).

In the Malaysian higher education ecosystem, strategic alliances are frequently cited but inconsistently practiced. Kimiagari et al. (2015) and Jamil et al. (2024) observe that while some partnerships are established during technology showcases or innovation grant cycles, many fail to advance beyond the initial stage due to unclear expectations, lack of mutual trust, and weak institutional support. A well-executed alliance can offer market intelligence, testing environments, or even commercialization pathways yet this potential is often unrealized in practice due to bureaucratic constraints and siloed communication.

Entrepreneurial Orientation of Project Managers as a Moderator

Entrepreneurial Orientation (EO) is recognized as a strategic disposition that empowers organizations to proactively identify opportunities, take calculated risks, and pursue innovation to navigate uncertain environments and drive performance (Khan et al., 2021; Zighan et al., 2022; Eidlisz et al., 2024). In the context of public TTOs, EO among project managers may significantly enhance the organization's ability to adapt commercialization strategies in response to external shifts.

In the context of public TTOs, the EO of project managers can significantly affect how commercialization strategies are implemented. Project managers with high EO are more likely to seek innovative solutions, act swiftly in response to opportunities, and engage confidently with external stakeholders (Martinez-Climent et al., 2019; Nakos et al., 2019).

Despite its theoretical importance, EO remains underexplored in TTO settings, especially within Southeast Asia. Existing studies tend to focus on structural or policy-level factors, ignoring the leadership styles and personal dispositions of those responsible for commercialization. Given the resource-constrained environment of Malaysian public universities, project managers with strong EO may be more capable of leveraging limited resources, navigating institutional hurdles, and forming meaningful alliances.

This study conceptualizes EO as a moderating variable that can strengthen the relationship between market orientation, funding, and strategic alliances with technology commercialization capability. Integrating EO into the framework responds to calls for more nuanced, behaviorally grounded models of university technology transfer.

Underpinning Theories: Open Innovation and Dynamic Capabilities Theories

This section introduces the theoretical foundations of the study: Open Innovation Theory (OIT) and Dynamic Capabilities Theory (DCT). These theories provide a comprehensive lens to understand the mechanisms through which Market Orientation, Funding, and Strategic Alliances influence Technology Commercialization Capability (TCC) in non-profit Technology Transfer Offices (TTOs), with Entrepreneurial Orientation (EO) acting as a moderating variable.

Open Innovation Theory

Open Innovation Theory (Chesbrough, 2003) advocates that organizations should combine both internal and external sources of knowledge to foster innovation. In the context of non-profit TTOs, which often face resource constraints and operate in less market-driven environments, open innovation offers a strategic framework to access complementary expertise, networks, and commercialization pathways.

TTOs situated within public universities can benefit from outside-in processes by integrating knowledge from industry partners, customers, and government bodies, while inside-out processes allow them to license or spin off underutilized innovations. The coupled process further enables collaborative development and commercialization of technologies (Lee & Mwebaza, 2020; Almeida, 2021).

Moreover, the open innovation ecosystem involves TTOs acting as intermediaries among universities, industries, and policymakers. This creates shared value and strengthens national innovation systems (Cavallo et al., 2018; Roszkowska-Menkes, 2018). As such, open innovation enhances the ability of TTOs to scout emerging technologies, secure industry collaboration, and facilitate commercialization even with limited internal resources (Wang, 2022; Neumann et al., 2019).

Open innovation also complements Market Orientation by encouraging responsiveness to market needs. It aligns with Funding strategies that include partnerships and external grants, and it is reinforced by Strategic Alliances, which are central to knowledge exchange (Huggins et al., 2019; Radziwon & Bogers, 2019).

In Malaysia's public research universities, TTOs face structural challenges including insufficient funding and weak industry linkages (Sharif & Baark, 2018; Ramachandran, 2022). Open Innovation Theory is adopted to explain how these organizations overcome internal limitations by leveraging external knowledge flows and collaborations. This study extends OIT by showing how state policy, institutional culture, and behavioral traits such as EO shape open innovation effectiveness in a developing-country context (Fu et al., 2024; Abdul Hamid & Mazlan, 2016).

EO is proposed as a moderator in this framework, emphasizing the role of project managers' innovativeness, risk-taking, and proactiveness in executing open innovation strategies. This micro-foundational perspective adds a behavioral dimension to OIT, addressing its previously underexplored human agency component.

Complementarity of Open Innovation and Dynamic Capabilities Theories

Open Innovation Theory (OIT) emphasizes leveraging both internal and external knowledge flows to facilitate innovation (Chesbrough, 2003). In contrast, Dynamic Capabilities Theory (DCT) focuses on how institutions adapt by sensing opportunities, seizing them through strategic actions, and transforming resources (Teece et al., 1997). Together, they offer a complementary lens: OIT frames the external collaborative landscape while DCT explains the internal agility and reconfiguration needed to act on those collaborations. This dual-theory approach provides a holistic view of how TTOs navigate external partnerships and internal constraints to achieve commercialization success.

Entrepreneurial Orientation: Operationalizing Behavioral Constructs

Entrepreneurial Orientation (EO), as conceptualized by Khan et al., 2021; Zighan et al., 2022; Eidlisz et al., 2024, includes five dimensions: innovativeness, proactiveness, risk-taking, autonomy, and competitive aggressiveness. In the context of non-profit TTOs, these dimensions manifest through project managers' behaviors such as initiating industry partnerships without guaranteed funding (risk-taking), advocating for unconventional licensing paths (innovativeness), or preemptively aligning technologies with industry needs (proactiveness). These behavioral traits serve as micro-foundations for dynamic capabilities and directly influence how Market Orientation, Funding, and Strategic Alliances translate into Technology Commercialization Capability.

Critical Reflection on Market Orientation in Academic Settings

Although Market Orientation is critical for aligning research outputs with market needs, its institutionalization within public universities is fraught with tension. Academic cultures typically prioritize publications and citations over market relevance. This misalignment hampers efforts to embed market-driven logics within TTOs, which often lack access to real-time market intelligence or customer feedback loops. Therefore, this study argues that Entrepreneurial Orientation is essential to overcome these tensions by enabling project managers to champion market engagement despite institutional inertia.

Dynamic Capabilities Theory

Dynamic Capabilities Theory (Teece et al., 1997) highlights how organizations sustain competitive advantage through sensing, seizing, and transforming capabilities. In the context of TTOs, these capabilities explain how internal routines and resources are configured to adapt to a changing commercialization landscape (Bogers et al., 2019; Heaton et al., 2019).

- Sensing: Project managers gather intelligence on industry needs, policy changes, and technological trends.
- Seizing: TTOs mobilize internal and external resources through partnerships and funding acquisition.
- Transforming: TTOs restructure procedures, reallocate roles, and align their missions to commercialization goals (Ma et al., 2023).

This framework is particularly relevant for non-profit TTOs in Malaysia that must operate under institutional rigidity and policy-driven constraints. Dynamic Capabilities allow them to remain responsive and strategically flexible in pursuing commercialization objectives (Cevallos & Sanchez, 2024; Phalswal et al., 2024).

DCT is suitable for analyzing the internal adaptive mechanisms that enable Malaysian TTOs to commercialize technologies amid uncertainty. The theory supports this study's goal to explore how entrepreneurial project managers utilize market orientation, funding strategies, and alliance networks to enhance TCC. Prior studies show that universities with strong dynamic capabilities are better positioned to navigate industry linkages and resource constraints (Fernandes & Machado, 2019; Szalavetz, 2020). By integrating DCT with OIT, this study presents a holistic view of commercialization addressing both the external collaborative environment and the internal strategic flexibility required. The role of EO as a moderating force is again central, as it catalyzes dynamic capabilities in resource-constrained environments.

Table 2.1
Summary of Key Constructs, Theoretical Gaps, and Their Relevance to Non-Profit TTOs

Construct	Key Authors	Gaps Addressed	Relevance to TTOs
Market Orientation (MO)	Narver & Slater (1990); Rodriguez-Gonzalez et al. (2021); Pujianto & Tannady (2023)	Limited integration in non-profit TTOs; weak alignment with market signals	Helps TTOs identify industry needs and design market-relevant tech solutions
Commercialization Funding	Rondeau et al. (2022); Behfar et al. (2024); Ramachandran (2022)	Underexplored in early-stage phases; lack of sustainable funding mechanisms	Enables transition from proof-of-concept to viable product within university settings
Strategic Alliances	Findik (2018); Kimiagari et al. (2015); Tengku Shahdan et al. (2023)	Scarcity of models for long-term academic–industry collaboration	Bridges internal capability gaps and expands commercialization networks
Entrepreneurial Orientation (EO)	Nakos et al. (2019); Martinez-Climent et al. (2019)	EO rarely applied in non-profit public institutions; limited TTO behavioral studies	Enhances proactive behaviors in TTO project managers and facilitates commercialization
Technology Commercialization Capability (TCC)	Teece et al. (1997); Jaakkola (2020)	TCC often treated as outcome; limited studies on enablers and moderators	Provides an integrated performance measure for evaluating TTO effectiveness

To synthesize the theoretical foundations and empirical insights guiding this study, Table 2.1 presents a summary of the core constructs, key contributing authors, identified gaps, and their specific relevance to non-profit Technology Transfer Offices (TTOs). This table highlights how the selected variables which are Market Orientation, Commercialization Funding, Strategic Alliances, and Entrepreneurial Orientation address critical limitations in existing

literature while reinforcing their practical significance for enhancing Technology Commercialization Capability (TCC) in public university settings. By integrating behavioral and organizational enablers within a unified framework, this study contributes to a more contextually grounded understanding of commercialization dynamics in emerging economies.

Conceptual Research Framework and List of Proposition

This study aims to examine the key organizational and behavioral factors that enhance the Technology Commercialization Capabilities (TCC) of non-profit Technology Transfer Offices (TTOs) in Malaysian public universities. The proposed framework, depicted in Figure 2.1, is theoretically grounded in Open Innovation Theory (Chesbrough, 2003) and Dynamic Capabilities Theory (Teece et al., 1997). It conceptualizes Market Orientation (MO), Commercialization Funding (CF), and Strategic Alliances (SA) as independent variables influencing the dependent variable, TCC, with Entrepreneurial Orientation (EO) of project managers as a moderator that may amplify or shape these relationships.

Market Orientation reflects the TTO's capability to gather market intelligence, anticipate industry needs, and align research outputs with real-world demands. This construct aligns with the *sensing* function in Dynamic Capabilities Theory, enabling institutions to detect opportunities and threats in the innovation ecosystem (Heaton et al., 2019). Concurrently, Open Innovation Theory emphasizes an *outside-in* process where external market cues and stakeholder inputs drive innovation (Chesbrough, 2003; Lee & Mwebaza, 2020).

Commercialization Funding plays a crucial role in enabling key processes such as IP protection, prototyping, and early-stage market entry. From an open innovation perspective, funding acts as an enabler for collaborative licensing and joint ventures, while Dynamic Capabilities Theory associates it with the *seizing* capability mobilizing resources to capture value (Teece, 2014; Cevallos & Sanchez, 2024). Funding shortfalls are repeatedly identified in the literature as a core barrier to effective TTO operations (Polasko et al., 2021).

Strategic Alliances support knowledge co-creation, risk-sharing, and resource pooling between academia, industry, and government. These alliances embody the *coupled* mode of Open Innovation, blending internal and external innovation flows through structured collaboration (Radziwon & Bogers, 2019; Onetti, 2019). Dynamic Capabilities Theory links alliances to the *transforming* capability, wherein institutions reconfigure assets and processes to sustain competitiveness (Teece et al., 1997; Ma et al., 2023).

Technology Commercialization Capability (TCC) represents the TTO's ability to translate academic knowledge into viable products or services typically through licensing, start-ups, or spin-offs. It is the culmination of strategic, behavioral, and collaborative efforts informed by both theoretical lenses (Semenya, 2020; Rodriguez-Gonzalez et al., 2021).

Entrepreneurial Orientation (EO) encompassing innovativeness, proactiveness, and risk-taking serves as a moderating variable that influences how organizational capabilities are mobilized. From a Dynamic Capabilities perspective, EO explains how project managers activate and adapt routines under institutional complexity. Meanwhile, Open Innovation Theory, which traditionally lacks a behavioral focus, is complemented by EO's emphasis on

boundary-spanning and entrepreneurial initiative (Fu et al., 2024). Thus, EO enhances both internal dynamism and external engagement.

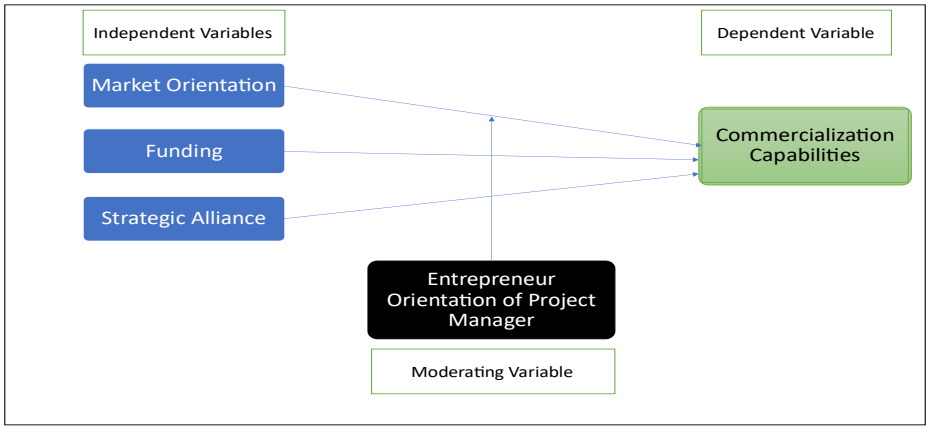

Figure 2.1 Conceptual Framework

Figure 2.1 illustrates the proposed conceptual framework, integrating Open Innovation Theory and Dynamic Capabilities Theory to explain the determinants of Technology Commercialization Capability (TCC) in non-profit university-based TTOs. The framework positions Market Orientation (MO), Funding, and Strategic Alliances (SA) as key organizational enablers, with Entrepreneurial Orientation (EO) of project managers moderating the strength and direction of their influence on TCC. This dual-theoretical approach provides a holistic view of how TTOs navigate both external collaboration and internal adaptability to achieve commercialization success.

Although conceptual in nature, this framework lays the foundation for future empirical research. Each construct is measurable through established instruments and observable indicators. EO can be assessed using the multidimensional scale by Khan et al., 2021; Zighan et al., 2022; Eidlisz et al., 2024 capturing traits such as innovativeness, proactiveness, and risk-taking through project manager surveys. MO may be operationalized via co-engagement metrics with industry, responsiveness to market signals, and alignment between technologies and end-user needs. Funding can be evaluated based on the accessibility, stage-specific adequacy, and continuity of funding particularly for early commercialization phases like proof-of-concept and prototyping. SA may be measured by the number, strength, and strategic outcomes of inter-organizational collaborations. Finally, TCC can be quantified through performance indicators such as the number of technologies licensed, spin-offs formed, or commercialization revenues generated.

Methodology

This chapter outlines the methodological approach used to develop the conceptual framework of this study, which aims to examine the key factors influencing the technology commercialization capabilities of non-profit Technology Transfer Offices (TTOs) in Malaysia. The research is conceptual in nature and is primarily grounded in extensive literature analysis, integrating Open Innovation Theory and Dynamic Capabilities Theory as the underpinning theoretical lenses.

Research Design

This study adopts a conceptual qualitative approach, focusing on theory building through an extensive review and synthesis of existing literature. It is not empirical, meaning no primary data is collected. Instead, secondary data from past academic publications, industry reports, and policy documents form the basis of analysis. Conceptual papers play a crucial role in advancing scholarly understanding by proposing new relationships between constructs and laying the groundwork for future empirical testing (Jaakkola, 2020).

Methodological Paradigm

The research aligns with the interpretivist paradigm, emphasizing the importance of understanding context and meaning behind organizational practices (Creswell & Poth, 2021). This perspective is suitable for conceptual research in innovation management, where the phenomenon of interest technology commercialization in TTOs requires a nuanced and context-sensitive exploration.

Variable Identification and Conceptual Development

The conceptual framework was developed based on a theory-informed thematic synthesis of literature. The constructs Market Orientation, Funding, Strategic Alliances, and Technology Commercialization Capabilities were identified through recurring themes in past studies (Rodriguez-Gonzalez et al., 2021; Ferreira & Franco, 2019; Sharan et al., 2023). The role of Entrepreneurial Orientation as a moderating variable was introduced based on recent calls to incorporate behavioral dimensions into innovation theories (Fu et al., 2024; Bamel et al., 2021).

Theoretical Justification

The conceptual framework is underpinned by Open Innovation Theory (Chesbrough, 2003) and Dynamic Capabilities Theory (Teece, 1997). Open Innovation Theory supports the integration of internal and external knowledge flows in the commercialization process, especially for resource-constrained TTOs. Dynamic Capabilities Theory complements this by focusing on how TTOs adapt through sensing, seizing, and transforming capabilities (Bogers et al., 2019; Ma et al., 2023).

Future Research Suggestions

This paper proposes that future studies empirically test the propositions using qualitative case studies or mixed-methods approaches within Malaysian public research universities. A multiple-case study design could be employed to explore how different TTOs implement open innovation practices and develop dynamic capabilities. Interviews with project managers, licensing officers, and university administrators would yield valuable insights into real-world practices.

Ethical Considerations

While no human subjects were involved in this conceptual paper, any future empirical study must comply with ethical standards, including obtaining informed consent, ensuring confidentiality, and securing institutional review board (IRB) approval.

Contribution of the Methodological Approach
By synthesizing literature across innovation management, entrepreneurship, and higher education policy, this conceptual study contributes a context-specific framework tailored to the realities of non-profit TTOs in developing countries. It enriches the theoretical understanding of how behavioral and structural factors interact to influence commercialization capabilities.

Discussion of Propositions and Theoretical Implications
This chapter discusses the theoretical propositions derived from the conceptual framework introduced in Chapter 2. Each proposition reflects hypothesised relationships between organizational enablers Market Orientation, Funding, and Strategic Alliances—and Technology Commercialization Capabilities (TCC) in the context of Malaysian non-profit public university TTOs. The Entrepreneurial Orientation (EO) of project managers is positioned as a moderating variable that potentially strengthens these relationships. Drawing on Open Innovation Theory (Chesbrough, 2003) and Dynamic Capabilities Theory (Teece et al., 1997), this chapter aims to provide theoretical justification for each proposition, offering insights relevant to both scholars and practitioners in the field of technology commercialization.

Proposition 1: Market Orientation and Technology Commercialization Capabilities
P1: *Market orientation enhances the technology commercialization capabilities of non-profit TTOs by aligning research outputs with market needs, fostering strategic stakeholder engagement, and enabling more effective resource allocation.*

In the context of non-profit TTOs, market orientation involves the ability to gather, disseminate, and respond to market intelligence effectively (Kohli & Jaworski, 1990). This capability allows TTOs to align research priorities with real-world demands, particularly in Malaysia's constrained innovation ecosystem (Rodriguez-Gonzalez et al., 2021). According to Dynamic Capabilities Theory, such alignment enables TTOs to "sense" and "seize" emerging opportunities, reconfiguring internal resources to meet external changes (Teece, 1997).
Market orientation also supports the Open Innovation paradigm, encouraging TTOs to interact beyond institutional boundaries and co-create value with industry partners (Chesbrough, 2003). Studies by Pujianto and Tannady (2023) and Fegada (2024) affirm that a strong market-oriented culture leads to greater relevance, adaptability, and ultimately, higher commercialization performance.

Proposition 2: Funding and Technology Commercialization Capabilities
P2: *Adequate funding positively influences commercialization capabilities by facilitating prototype development, IP protection, and market entry, especially in resource-constrained non-profit environments.*

Funding is foundational to successful commercialization. It underwrites essential activities such as proof-of-concept development, regulatory testing, IP filings, and marketing. As highlighted by Clayton et al. (2018) and Fini et al. (2018), the lack of early-stage funding often results in a "valley of death," where innovations stall before reaching the market.

In the Malaysian context, funding is typically fragmented and difficult to secure (Ramachandran, 2022; Jamil et al., 2024). According to Dynamic Capabilities Theory, the

ability to reconfigure and deploy financial assets under uncertainty is crucial for innovation. Open Innovation Theory also points to diversified and collaborative funding as a way to share commercialization risk and build co-ownership (Almeida, 2021). Strategic funding partnerships public-private co-investment or joint IP development can enhance institutional readiness and innovation agility.

Proposition 3: Strategic Alliances and Technology Commercialization Capabilities
P3: *Strategic alliances enhance commercialization outcomes by enabling knowledge sharing, reducing risks, and providing access to complementary assets and networks.*

Strategic alliances allow non-profit TTOs to overcome internal limitations by accessing external capabilities. These alliances are especially important for non-profit TTOs in Malaysia, which often lack the infrastructure, human capital, or industry linkages required to drive commercialization independently (Calcagnini et al., 2018; Emami et al., 2022).
Dynamic Capabilities Theory underscores the importance of forming and reconfiguring alliances to improve responsiveness and reduce operational risks (Teece, 2007). In line with Open Innovation principles, alliances serve as vehicles for inbound and outbound flows of knowledge and IP (Chesbrough & Bogers, 2014). When managed strategically, these alliances facilitate co-evolution and improve TTO positioning in national and regional innovation systems (Galera-Zarco et al., 2020).

Proposition 4: Moderating Role of Entrepreneurial Orientation on Market Orientation and TCC
P4: *Entrepreneurial orientation strengthens the impact of market orientation on commercialization capabilities by encouraging proactive decision-making and opportunity exploitation.*

EO includes proactiveness, innovativeness, and risk-taking (Khan et al., 2021; Zighan et al., 2022; Eidlisz et al., 2024), which can enhance how TTO managers interpret and apply market intelligence. As suggested by Fernandez-Alles et al. (2019), project managers with high EO are better equipped to initiate market-aligned strategies, reduce delays in execution, and creatively adjust approaches based on market feedback.

This is consistent with Teece's (2007) assertion that dynamic capabilities are not only organizational but also behavioural. Entrepreneurial managers are more likely to act on sensed opportunities and drive institutional change. This is especially crucial in Malaysia's bureaucratic academic settings, where rigid systems can hamper innovation diffusion.

Proposition 5: Moderating Role of Entrepreneurial Orientation on Funding and TCC
P5: *Entrepreneurial orientation amplifies the effect of funding on commercialization success by enabling innovative resource utilization and risk-taking strategies.*

In resource-constrained environments, entrepreneurial project managers are likely to stretch limited funds, pursue alternative funding models (e.g., spin-offs, licensing deals), and take calculated risks that yield long-term value (Nkurunziza et al., 2022; Almarri, 2024). These behaviours align well with Open Innovation thinking, where funding is not simply a transactional input but a catalyst for partnership, experimentation, and co-creation (Chesbrough, 2003).

EO also facilitates agility in budget reallocation, often necessary when market dynamics change or when new commercialization paths emerge midstream. Thus, EO serves as an enabler that bridges rigid funding policies and the need for dynamic innovation pathways.

Proposition 6: Moderating Role of Entrepreneurial Orientation on Strategic Alliances and TCC
P6: *Entrepreneurial orientation enhances the value of strategic alliances by facilitating trust-building, adaptive collaboration, and goal alignment with external partners.*

EO fosters behaviours such as autonomy, initiative, and creative problem-solving, all of which are essential for effective collaboration. Entrepreneurial project managers are more adept at navigating alliance complexities, managing stakeholder expectations, and establishing long-term, trust-based partnerships (Pitsakis & Giachetti, 2019; Mulda, 2020).
This proposition is supported by Open Innovation Theory, where the success of collaborative partnerships depends heavily on interpersonal trust, mutual benefit, and aligned goals (Almeida, 2021). Entrepreneurial leadership ensures that alliances evolve from one-off interactions to dynamic, knowledge-sharing networks critical for sustained commercialization success in Malaysian public universities.

Conclusion and Future Research Directions
This conceptual paper set out to develop a theoretically grounded framework to enhance the technology commercialization capabilities (TCC) of non-profit Technology Transfer Offices (TTOs) within Malaysian public universities. Drawing from Open Innovation Theory and Dynamic Capabilities Theory, and informed by an extensive review of relevant literature, the study integrates three core organizational enablers;Market Orientation, Funding, and Strategic Alliances as key determinants of successful commercialization. The Entrepreneurial Orientation (EO) of project managers is introduced as a moderating variable, reflecting the behavioral and cognitive dimensions that influence how these capabilities are enacted and leveraged in real-world contexts.

The proposed model contributes to the growing body of research that emphasizes the importance of adaptive, collaborative, and behaviorally driven strategies in public sector innovation systems. Unlike many existing frameworks that treat institutional capabilities in isolation, this study presents a more holistic, multi-level approach that aligns organizational structures with individual agency. The emphasis on project managers' EO fills an important gap in the technology transfer literature, especially in the Southeast Asian context, where bureaucratic constraints and limited entrepreneurial culture can hamper commercialization efforts.

From a theoretical perspective, the framework advances current thinking by:
- Demonstrating how Open Innovation processes can be supported through strategic alliances and stakeholder engagement;
- Operationalizing Dynamic Capabilities in the public university context, particularly through responsiveness to market needs and funding mobilization;
- Highlighting the behavioral influence of EO in translating institutional intent into commercialization outcomes.

From a practical standpoint, the model has implications for university administrators, policymakers, and TTO leadership. It suggests that investing in capacity-building for project managers, developing clearer market intelligence processes, and facilitating cross-sector alliances are essential steps toward improving commercialization outcomes. Furthermore, it underscores the importance of aligning individual entrepreneurial mindsets with institutional goals to create an enabling environment for innovation.

This conceptual study contributes theoretically by integrating Open Innovation Theory and Dynamic Capabilities Theory to explain technology commercialization in non-profit academic environments, extending both frameworks to public-sector innovation. Contextually, it enriches the limited body of literature on Malaysian Technology Transfer Offices (TTOs) by highlighting how behavioral factors such as the Entrepreneurial Orientation of project managers interact with organizational enablers to influence commercialization success. This integration of behavioral and structural perspectives provides a fresh lens for future empirical testing and policy development in emerging economies.

Future Research Directions

Given the conceptual nature of this study, several avenues for future empirical investigation are recommended:

1. *Empirical Validation of the Model*
   Future studies can operationalize this framework using qualitative case studies or mixed-method designs to validate the relationships proposed. Malaysian public universities offer a rich context for this, given their strategic importance in national innovation policy.
2. *Measurement of Entrepreneurial Orientation in TTO Contexts*
   While EO is well-established in entrepreneurship literature, its application within non-profit TTOs requires customized metrics. Future research should develop or adapt instruments to measure EO among project managers within academic institutions.
3. *Comparative Studies Across Institutions or Countries*
   Cross-institutional or regional comparisons (e.g., ASEAN countries) could shed light on how institutional design, funding regimes, and cultural factors influence the efficacy of commercialization enablers.
4. *Longitudinal Research on TTO Development*
   Given the evolutionary nature of capabilities and orientation, longitudinal studies can explore how changes in leadership, policy, or funding structures affect commercialization performance over time.
5. *Policy Impact Assessment*
   Researchers may also evaluate how government programs such as grant schemes or industry matching initiatives interact with internal TTO dynamics to produce commercialization outcomes.

As Malaysia aspires to transition toward a high-income, innovation-driven economy, the role of public universities in driving applied research and commercialization becomes increasingly critical. This paper offers a theoretically informed lens through which to understand and enhance the commercialization efforts of non-profit TTOs. By integrating organizational resources and behavioral factors, the framework provides a valuable foundation for both academic inquiry and strategic policymaking. It is hoped that this study will inspire further

research and practice aimed at strengthening the knowledge economy through more effective university-industry collaboration.

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