

Funding Shortages Impact on Research and Innovation in TVET Institutions: A Qualitative Analysis

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Abstract

Technical and Vocational Education and Training (TVET) is essential for developing a skilled workforce in the era of the Fourth Industrial Revolution and globalization. However, funding shortages pose a significant challenge to enhancing research and innovation in Malaysian polytechnics and community colleges. This study employs a qualitative approach, utilizing systematic content analysis and thematic analysis, to explore the impact of insufficient funding on research and innovation activities in TVET institutions. The findings reveal that funding shortages hinder access to research resources, limit the commercialization of innovative products, and negatively affect lecturers' participation in international research activities. The study highlights five key themes: lack of equipment completeness, limited reference materials, funding shortages for research and innovation, lack of support for commercialization, and the impact on lecturers' activities. These findings underscore the need for increased funding allocations and strategic measures to ensure the sustainability and advancement of TVET in Malaysia.

1. Introduction

In the era of the Fourth Industrial Revolution and the current age of globalization, Technical and Vocational Education and Training (TVET) is vital for developing a competitive and skilled workforce. Besides improving job prospects for new graduates, TVET is crucial to meet the dynamically changing and demanding needs of the industry. The role of TVET lecturers at Malaysian polytechnics is not limited to providing excellent knowledge and being effective planners, communicators, and facilitators of their students' learning; they are also expected to be active knowledge producers by engaging in research activities. TVET lecturers at polytechnics and community colleges in Malaysia are required to conduct research, presentations, publications, and other scholarly activities as part of their job responsibilities (Sanmugam et al. 2022). Furthermore, research activities and outputs have been established as one of the criteria evaluated for the annual Key Performance Indicators (KPI) (Sanmugam et al. 2022).

However, several serious issues, including funding shortages, threaten to hinder the potential of TVET institutions in Malaysia. The lack of funds significantly affects the lecturers' capacity to conduct research and generate new ideas, besides restricting the institutions' ability to offer high-quality teaching and training. Therefore, the shortage of funds becomes a major challenge in enhancing the quality of research and innovation in TVET education at Malaysian polytechnics. It is crucial to identify how this lack of funds impacts the ability of TVET lecturers to conduct research and innovation and to consider suitable solutions. This article will highlight the issue of funding shortages for research and innovation activities in TVET at institutions such as polytechnics and community colleges in Malaysia.

2. Methodology

The study's findings are presented in a thematic format, supported by tables and discussions to provide a comprehensive understanding of the issues. This methodological approach ensures that the study captures the multifaceted nature of funding challenges in TVET institutions and their implications for research and innovation. This study employs a qualitative research approach to explore the challenges of funding shortages in Technical and Vocational Education and Training (TVET) institutions in Malaysia. A systematic review methodology was adopted to synthesize existing knowledge about the impact of funding shortages on research and innovation in TVET institutions, with a particular focus on polytechnics and community colleges in Malaysia. Two primary methods were employed for data collection:

- a. **Systematic Content Analysis:**
This involved a comprehensive review of academic literature, policy documents, and institutional reports related to TVET funding and research in Malaysia published between 2009 and 2024. The search was conducted using academic databases including Scopus, Web of Science, Google Scholar, and Malaysian academic repositories using keywords such as "TVET funding," "polytechnic research," "community college innovation," "research barriers," and "Malaysia vocational education."
- b. **Thematic Analysis:**
The collected data was systematically coded and categorized to identify recurring patterns and themes related to funding shortages in TVET institutions. This process involved multiple rounds of coding to ensure the reliability and validity of the identified themes.

The analysis was structured around five key indicators that emerged from the initial review of literature:

- a. Lack of equipment completeness in TVET education
- b. Limited reference materials and access to research resources
- c. Funding shortages in research and innovation
- d. Lack of funding support for commercializing innovative products
- e. Impact of funding shortages on research and lecturer activities

These indicators provided the framework for organizing and analyzing the findings, enabling a comprehensive understanding of how funding shortages affect various aspects of research and innovation in TVET institutions.

3. Literature Review and Analysis

The issues presented in this study relate to the challenges faced in implementing research activities among lecturers, particularly concerning the lack of sufficient funding and financial support in TVET Institutions. Thus, this literature review will be divided into five sections addressing the research questions:

3.1 Lack of Equipment Completeness in TVET Education

Table 1 shows the issue of equipment shortage in TVET institutions represents a significant challenge that impacts multiple dimensions of education and research quality. The literature reveals a consistent pattern across studies spanning more than a decade, indicating that this is a persistent and systemic problem rather than a temporary challenge. Mohamed and Mohd Burhan (2009) and Lee (2020) highlighted that insufficient funding prevents institutions from equipping laboratories with advanced technology essential for conducting cutting-edge research. This technological gap has widened in recent years as industry requirements have evolved rapidly with the Fourth Industrial Revolution. As Asnur et al. (2019) emphasized, training equipment is one of three crucial elements in Industry 4.0 TVET education, alongside human resources and technological infrastructure.

The equipment shortage problem extends beyond research to directly impact teaching quality. Rahman et al. (2015) and Okumu and Bbaale (2019) established a clear connection between equipment availability and student proficiency levels. This relationship is particularly critical in TVET education, where hands-on practical training is central to the pedagogical approach. Ahmad et al. (2019) further reinforced this by demonstrating how classroom equipment influences both teaching effectiveness and student learning outcomes. A particularly concerning trend identified by Ismail and Hassan (2013) and more recently by Yeap et al. (2021) is the systemic failure in Malaysian TVET institutions to effectively connect and share resources. This lack of resource-sharing exacerbates the equipment shortage, as institutions cannot leverage collective assets. The problem is compounded by the high costs associated with regularly updating equipment to match technological advancements, creating a widening gap between industry requirements and institutional capabilities.

Table 1 *Lack of equipment completeness in TVET*

No	Authors	Findings
1	Mohamed & Mohd Burhan (2009); Lee (2020).	The lack of funds affects the institution's ability to provide adequate research infrastructure, such as laboratories equipped with the latest equipment.
2	Ismail and Hassan (2013); Yeap et al. (2021).	TVET institutions in Malaysia still fall short in terms of connectivity, sharing resources, and articles within the system comprehensively. Additionally, educational institutions need to employ effective delivery methods to enhance the quality and effectiveness of training. This means they need to update their equipment along with technology, adopt flexible learning, and use high-quality learning materials.
3	Yunus (2016); Zulkifly (2022).	The design of training, including training objectives and materials used during training, as well as guidelines for training content, training facilities, have a significant impact on training transfer.
4	Minghat et al. (2013); Edokpolor et al. (2019).	The availability of materials and resources in TVET programs must be carefully considered to ensure the sustainability of the curriculum and enhance learning effectiveness. An effective teaching and learning process, along with physical facilities, especially classrooms and specialized areas such as workshops and laboratories, are basic requirements that need to be provided.
5	Asnur et al. (2019)	Training equipment is one of the three crucial elements in the education of Industry 4.0 TVET era.
6	Rahman et al. (2015); Okumu & Bbaale (2019)	The shortage of equipment in TVET education has the potential to affect students' proficiency levels and the quality of education.
7	Ahmad et al. (2019)	Classrooms and equipment in TVET education influence the teaching and learning of both teachers and students.
8	Segaran & Shanmugam (1999); Hashim & Hamidon (2022).	Educational materials are used to enhance the teaching and learning process in TVET education.
9	Yusoff (2014); Mutembe et al. (2024).	Teaching and learning materials are crucial in TVET education, aiding in the delivery of information and skill development.
10	Ahmad & Abdullah (2014); Njuki, (2023)	Integrating ICT in TVET education has a positive impact on access to information and skill development in learning.

The relationship between equipment availability and training effectiveness is well-established in the literature. Yunus (2016) and Zulkifly (2022) demonstrated that training facilities significantly impact knowledge transfer, while Minghat et al. (2013) and Edokpolor et al. (2019) emphasized that material resources are essential for curriculum sustainability. This indicates that equipment shortages do not merely affect specific aspects of education but undermine the entire educational ecosystem. Recent research by Mutembe et al. (2024) has highlighted the evolving nature of teaching materials in the digital age, suggesting that the concept of "equipment" now extends beyond physical tools to include digital resources and platforms. Similarly, Njuki (2023) found that integrating ICT in TVET education improves information access and skill development, indicating that digital infrastructure has become as important as traditional equipment.

The persistence of equipment shortages across studies from 1999 (Segaran & Shanmugam) to 2024 (Mutembe et al.) suggests that despite awareness of the problem, effective solutions have not been implemented. This represents a significant barrier to advancing TVET education quality in Malaysia and requires urgent attention from policymakers and institutional leaders.

3.2 Limited Reference Materials and Access to Research Resources

Referring to Table 2, access to comprehensive reference materials and research resources represents a fundamental prerequisite for producing high-quality research and innovation. The literature reveals that funding shortages create significant barriers in this area, with wide-ranging implications for TVET institutions in Malaysia. A recent study by Hooi Peng and Suria (2022) highlighted that TVET lecturers consistently face challenges in

accessing comprehensive research materials and references. This finding is particularly significant as it demonstrates that the problem persists in the current academic environment, despite the general expansion of digital resources globally. The inability to access current research literature severely limits lecturers' capacity to build upon existing knowledge and contribute meaningfully to their fields.

The longitudinal perspective provided by comparing studies from Mohd Burhan and Mohamed (2009) with recent work by Yazgin (2024) indicates that this problem has persisted for over 15 years without adequate resolution. Both studies identified that funding limitations restrict lecturers' ability to access crucial research resources, including subscriptions to academic journals, research materials, and financial support for experiments. This sustained challenge suggests that structural issues in TVET funding models have not been effectively addressed. The consequences of limited access to research resources extend beyond individual researchers to impact departmental and institutional performance. Yazgin (2024) found that departments fail to produce an adequate number of publications or innovative outcomes when their lecturers lack access to fundamental research resources. This creates a cycle where reduced research output leads to lower institutional visibility and potentially decreases opportunities for future funding.

Table 2 *Limited reference materials and access to research resources*

No	Authors	Findings
1	Hooi Peng & Suria (2022)	Lecturers face challenges in accessing comprehensive research materials and references due to funding shortages.
2	Mohd Burhan & Mohamed (2009); Yazgin (2024)	The lack of funds results in lecturers producing fewer high-quality research works that are relevant to the latest developments in their respective fields. Departments also fail to produce an adequate number of publications or innovative outcomes because funding shortages limit lecturers' ability to access crucial research materials and resources. This includes subscriptions to academic journals, purchasing research materials, and financing experiments or research projects.

The digital transformation of academic publishing has exacerbated this issue in some ways, as subscription costs for many high-quality international journals have increased substantially. While open access publishing has expanded, many premier journals still require institutional subscriptions that may be prohibitively expensive for TVET institutions with limited budgets. This barrier to accessing current research literature is particularly problematic in rapidly evolving technical fields where staying current with the latest developments is essential for relevant teaching and research. The inability of TVET lecturers to access cutting-edge research in their fields creates a knowledge gap that can directly impact the quality and relevance of the education they provide to students. The findings suggest that addressing this challenge requires not only increased funding for resource access but also strategic approaches to resource sharing and collaboration between institutions. Development of shared digital repositories, consortium-based journal subscriptions, and institutional partnerships could help maximize the impact of limited funding resources while improving access to essential research materials.

3.3 Funding Shortages in Research and Innovation

As shown in Table 3, the literature reveals that funding shortages for research and innovation in TVET institutions represent a complex and multifaceted challenge with profound implications for both individual lecturers and the broader educational ecosystem. This challenge has persisted across more than a decade, with recent studies confirming its continued relevance. Ahmad and Abdullah (2018) established a direct correlation between funding availability and lecturers' research capacity, highlighting how insufficient financial resources fundamentally limit research potential. This finding is consistent with earlier work by Shaliza Amira Sarif et al. (2017), who demonstrated that funding availability significantly influences lecturers' inclination to pursue research activities. Together, these studies indicate that funding shortages do not merely create practical challenges but also impact motivational factors that drive research engagement.

A particularly concerning finding highlighted by Razaki et al. (2020) is that many TVET lecturers resort to using personal funds to support their research activities. This practice, further confirmed by Jantan (2014) and more recently by Griffith (2024), indicates a systemic failure in institutional support for research. When lecturers must personally finance research activities, it creates inequities in research opportunities based on individual financial capacity rather than academic merit or research potential. The financial burden extends beyond core research activities to include participation in competitions and conferences, which are essential for knowledge dissemination and professional development. Kamalian et al. (2011) and Ojo et al. (2021) identified high participation costs as a primary barrier to engagement in innovation activities. Similarly, Sarif et al. (2019) and Nie et al. (2018) highlighted the substantial expenditures involved in developing innovations and participating in

competitions. These findings suggest that financial constraints create barriers at multiple stages of the research and innovation process.

Table 3 *Funding shortages in research and innovation*

No	Authors	Findings
1	Ahmad & Abdullah (2018)	The lack of funding affects the ability of TVET lecturers to conduct research and innovation. Insufficient finances result in lecturers having less potential to carry out research.
2	Sarif et al. (2017)	The importance of funding in research and how it influences lecturers' inclination to conduct research.
3	Razaki et al. (2020)	Lecturers in TVET often have to use personal funds to conduct research and innovation. The costs of participating in competitions involve personal financing by the lecturers.
4	Kamalian et al. (2011); Ojo et al. (2021)	The high participation costs are the main barrier for lecturers to engage in innovation at their institutions.
5	Özan & Karabatak (2020)	Two issues hindering effective innovation implementation are lack of funds and resources.
6	Sarif et al. (2019); Nie et al. (2018)	In producing innovation and participating in competitions, it involves high expenditure costs.
7	Jantan (2014); Griffith (2024).	TVET lecturers use their salaries to conduct research and innovation because there is no specific allocation from the institution.
8	Anyiendah et al. (2023)	The lack of funding for TVET institutions disrupts their sustainability. Calls to increase funding allocations from the government and involve the private sector as well as individual contributions to address this issue.
9	Mahmod et al. (2018)	The need for appropriate financial allocation to enhance job satisfaction among staff at community colleges and polytechnics.

The impact of funding shortages extends beyond individual research projects to affect broader institutional sustainability. Anyiendah et al. (2023) established that insufficient funding disrupts the overall sustainability of TVET institutions, highlighting the need for diverse funding sources including government allocations, private sector involvement, and individual contributions. This finding emphasizes that funding shortages represent a strategic challenge to the long-term viability of these institutions. There are also important connections between research funding and staff satisfaction. Mahmod et al. (2018) demonstrated that appropriate financial allocations contribute to job satisfaction among staff at community colleges and polytechnics. This suggests that addressing funding shortages could yield benefits beyond research outputs, potentially improving staff retention and institutional culture.

The consistent identification of funding shortages as a significant barrier across studies spanning from 2011 to 2024 indicates that despite awareness of the problem, effective solutions have not been implemented at a systemic level. More concerning is the apparent trend toward increasing reliance on personal funding by lecturers, as noted in Griffith's recent (2024) research, suggesting the problem may be intensifying rather than improving. The evidence suggests that addressing this challenge requires not only increased funding allocations but also structural reforms to funding mechanisms, including more equitable distribution of available resources, development of alternative funding sources, and creation of institutional support systems that reduce the financial burden on individual lecturers.

3.4 Lack of Funding Support for Commercializing Innovative Products

Table 4 highlights the commercialization of research innovations represents a critical final step in the innovation value chain, transforming academic knowledge into practical products and services that benefit society and industry. However, the literature reveals significant challenges in this area for TVET institutions in Malaysia. Muda et al. (2021) highlighted a concerning disparity between research output and commercialization success in Malaysian higher education institutions. Their findings revealed that despite producing numerous discoveries and innovations, the rate of successfully marketing these innovations remains disproportionately low. This commercialization gap represents a significant lost opportunity, as potentially valuable innovations fail to reach the market where they could create economic and social impact.

This challenge is particularly acute in polytechnics and community colleges, as documented by Sagir et al. (2019). Their research specifically identified funding shortages as a primary barrier preventing the commercialization of innovative products developed by TVET lecturers. This finding is significant as it directly links the commercialization gap to financial constraints rather than other potential factors such as quality of innovations or market demand. The commercialization process typically requires substantial investment beyond the initial research phase, including product development, market testing, intellectual property protection, and marketing activities. Without dedicated funding support for these activities, even promising innovations may remain unutilized. This creates a situation where public investment in research fails to yield optimal returns, as innovations do not complete the journey from laboratory to marketplace.

Table 4 *Lack of funding support for commercializing innovative products*

No	Authors	Findings
1	Muda et al. (2021)	Although many discoveries and innovations have been made in Malaysian universities, the marketing of these innovations remains low compared to the research output.
2	Sagir et al. (2019)	The lack of funding results in a low level of commercialization of innovative products from researchers at polytechnics and community colleges.

The limited commercialization success also affects the reputation and perceived value of TVET institutions. When innovations remain academic exercises rather than becoming market-ready products, it reinforces perceptions that TVET research lacks practical relevance or commercial potential. This can create a cycle where reduced visibility of successful commercialization leads to decreased interest from potential industry partners and funders. Additionally, the inability to commercialize innovations represents a missed opportunity for generating alternative revenue streams for TVET institutions. Successful commercialization could potentially create licensing income, industry partnerships, and entrepreneurial ventures that might help address the very funding shortages that impede commercialization in the first place.

The findings suggest that addressing this challenge requires not only increased funding specifically earmarked for commercialization activities but also the development of ecosystem supports such as technology transfer offices, industry liaison programs, and entrepreneurship education for TVET lecturers. A more comprehensive approach to supporting the entire innovation pipeline from initial research to market entry is needed to maximize the return on investment in TVET research and innovation.

3.5 Impact of Funding Shortages on Research and Lecturer Activities

As indicated in Table 5, the impact of funding shortages on research activities and lecturer professional development emerges as a significant concern in the literature. The evidence reveals both immediate practical constraints and longer-term implications for career development and institutional reputation. Research by Razali and Ghani (2023) provides detailed insights into the practical challenges faced by lecturers due to funding shortages. Their study participants reported having to cover hotel costs personally when attending seminars and needing to take unpaid leave to conduct international research. These financial burdens create significant disincentives for participation in research activities, particularly those involving international travel or extended fieldwork. The findings align with earlier work by Mohamed and Mohd Burhan (2009), suggesting that these challenges have persisted for over a decade without effective resolution.

Table 5 *Impact of funding shortages on research and lecturer activities*

No	Authors	Findings
1	Mohamed & Mohd Burhan (2009); Razali, N. A. H. M., & Ghani, M. F. A. (2023)	Lecturers face difficulties in research activities due to funding shortages, including the costs of staying in hotels to attend seminars and applying for leave for international research. Therefore, some lecturers avoid presenting abroad. Study participants also noted that there is no allocation for lecturers to conduct research activities, and the amount of grants obtained is low compared to public and private higher education institutions, which may have their own funds.
2	Noor & Shukor (2023)	Lecturers participate less in international presentations due to the lack of specific allocations or funding, and the lack of allocations leads to them being less involved in international conferences that require high participation fees.

A particularly concerning impact identified by Noor and Shukor (2023) is the limited participation of TVET lecturers in international conferences and presentations. Their research revealed that lecturers primarily participate in institutional and national-level events, with international engagement significantly curtailed due to high participation fees and lack of institutional financial support. This limitation has profound implications for knowledge exchange, professional networking, and global visibility of Malaysian TVET research. The restricted international engagement creates multiple cascading effects. First, it limits exposure to global best practices and emerging research trends, potentially creating knowledge gaps that affect teaching quality. Second, reduced international networking opportunities constrain possibilities for research collaborations and partnerships that might help address funding limitations through shared resources. Third, limited representation of Malaysian TVET research in international forums diminishes institutional and national visibility in the global academic community.

The comparative disadvantage faced by polytechnic and community college lecturers relative to their counterparts in public and private universities, as noted by Razali and Ghani (2023), creates inequities within the Malaysian higher education ecosystem. With fewer resources and lower grant allocations, TVET lecturers operate at a structural disadvantage despite facing similar professional expectations for research productivity. The literature also suggests that these financial constraints create personal and professional stress for lecturers. When research activities must be self-funded, lecturers face difficult choices between professional advancement and financial stability. This added pressure can contribute to decreased job satisfaction and potential burnout, as suggested by connections to Ayub et al.'s (2008) findings on emotional strain and organizational commitment.

Addressing these challenges requires not only increased funding allocations but also structural reforms to how research support is distributed and administered. Targeted programs to support international engagement, equitable distribution of available resources, and development of virtual participation options could help mitigate some of the most severe impacts while broader funding issues are addressed.

4. Discussion

The comprehensive analysis of the literature reveals that funding shortages affect virtually every aspect of research and innovation in Malaysian TVET institutions, creating a complex web of challenges that undermine both individual and institutional capacity. Several key patterns and connections emerge from synthesizing findings across the five thematic areas. A striking pattern across all thematic areas is the persistence of funding challenges over time. Studies spanning from 1999 to 2024 consistently identify funding shortages as a significant barrier, suggesting that despite awareness of the problem, effective solutions have not been implemented at a systemic level. This persistence indicates that the issue may be structural rather than cyclical, potentially rooted in how TVET is positioned and prioritized within the broader educational funding landscape.

The findings reveal how funding shortages create cascading effects across the entire research and innovation value chain. Equipment shortages limit the types of research that can be conducted, restricted access to literature hampers the development of theoretical frameworks and methodologies, limited research funding constrains project implementation, commercialization barriers prevent innovations from reaching the market, and restricted participation in international forums limits knowledge dissemination. This creates a compounding effect where challenges at each stage amplify difficulties in subsequent phases of the research process.

A concerning trend evident across multiple studies is the increasing reliance on personal funding by lecturers to support research activities. This creates significant equity implications, as research opportunities become dependent on individual financial capacity rather than academic merit or research potential. Lecturers with limited personal financial resources face greater barriers to research participation, potentially exacerbating existing inequities within the academic community.

The findings regarding limited international engagement due to funding constraints raise significant concerns about the global competitiveness of Malaysian TVET research. Restricted participation in international conferences and reduced access to global research literature create knowledge isolation that can hamper innovation and relevance. In an increasingly globalized knowledge economy, this isolation represents a strategic disadvantage for Malaysian TVET institutions.

Beyond the practical limitations, funding shortages also create motivational challenges for lecturers. When financial barriers consistently impede research efforts, lecturers may experience reduced research self-efficacy and diminished motivation to pursue ambitious research projects. This psychological dimension is particularly evident in findings regarding job satisfaction and the personal strain of self-financing research activities. The literature suggests that funding shortages create reputational challenges for TVET institutions. Limited research output, reduced international visibility, and constrained innovation capacity can affect perceptions of institutional quality, potentially influencing student enrolment, industry partnerships, and future funding opportunities. This creates a cycle where funding limitations lead to reduced institutional reputation, which may further constrain funding access.

Several studies highlight the comparative disadvantage faced by polytechnic and community college lecturers relative to their counterparts in public and private universities. This structural inequity creates an uneven playing field where TVET lecturers must compete for limited research funding despite starting from a position of relative disadvantage in terms of institutional resources and support systems. The commercialization challenges identified in the literature represent significant missed opportunities for strengthening industry-academia collaboration. When innovative products fail to reach commercialization due to funding constraints, potential partnerships with industry remain undeveloped. These missed connections limit not only immediate commercialization success but also longer-term relationship building that could create alternative funding streams and research opportunities.

Recent studies highlight evolving challenges related to digital infrastructure and resources. As teaching, research, and innovation increasingly rely on digital platforms and tools, funding limitations create new forms of resource constraints beyond traditional physical equipment. This digital dimension requires specific attention in developing funding solutions that address contemporary research needs.

The findings collectively suggest that addressing funding shortages requires not just incremental increases in funding allocations but strategic rethinking of how research and innovation are supported in TVET institutions. This may include developing alternative funding models, creating more equitable distribution mechanisms, establishing targeted programs for specific high-impact activities (such as international engagement), and fostering collaborative approaches that maximize the impact of limited resources.

5. Conclusion

Based on the systematic review of literature, it can be concluded that funding shortages represent a pervasive, persistent, and multifaceted challenge for research and innovation in Malaysian TVET institutions. The findings reveal that insufficient funding creates barriers across the entire research value chain, from equipment availability and access to reference materials to research implementation, commercialization, and knowledge dissemination.

The impact of these funding constraints extends beyond practical limitations to affect motivational factors, institutional reputation, equity of research opportunities, and global competitiveness. Particularly concerning is the practice of lecturers using personal funds to support research activities, which creates inequities based on individual financial capacity rather than academic merit.

The persistence of these challenges across studies spanning more than two decades suggests that despite awareness of the problem, effective systemic solutions have not been implemented. This indicates a need for not only increased funding allocations but also structural reforms to how research support is distributed and administered in TVET institutions. Several key recommendations emerge from this analysis:

- a. **Diversification of Funding Sources:** TVET institutions should explore multiple funding channels beyond traditional government allocations, including industry partnerships, competitive grants, alumni contributions, and international collaborations.
- b. **Equitable Resource Distribution:** Funding mechanisms should be designed to ensure equitable access to research opportunities regardless of individual financial capacity, with particular attention to supporting early-career researchers.
- c. **Strategic Investment in Infrastructure:** Targeted investment in shared research infrastructure that can benefit multiple researchers and projects may help maximize the impact of limited funding.
- d. **Digital Resource Access:** Prioritizing subscriptions to digital research databases and journals through consortium approaches could help address literature access challenges cost-effectively.
- e. **Commercialization Support:** Establishing dedicated funding streams and support systems specifically for commercialization activities could help bridge the gap between research output and market impact.
- f. **International Engagement Programs:** Targeted programs to support international conference participation and research collaborations would enhance global visibility and knowledge exchange.
- g. **Collaborative Approaches:** Encouraging resource-sharing and collaborative research between institutions could help maximize the impact of limited funding.
- h. **Policy Advocacy:** Systematic efforts to highlight the strategic importance of TVET research funding to policymakers and stakeholders could help address structural funding inequities.

This research contributes to the understanding of how funding shortages impact research and innovation in TVET institutions, providing evidence-based insights to inform policy and practice. Future research should explore the effectiveness of various interventions to address these challenges, examine successful funding models from other contexts that might be adapted for Malaysian TVET institutions, and investigate the long-term impacts of funding constraints on institutional development and national innovation capacity.

Addressing the funding challenges identified in this study is not merely an institutional concern but a strategic imperative for ensuring that Malaysian TVET institutions can fulfil their potential as centers of applied research and innovation, contributing effectively to national development in the era of the Fourth Industrial Revolution and beyond.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm full responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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