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TVET Education for Community Education 5.0 in Malaysia

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ABSTRACT

Introduction Technical and Vocational Education and Training (TVET) has evolved into a vital component of Malaysia's ambition to become a high-income, knowledge-driven economy. This study explores the evolution of TVET, MoHE-driven policies, and industry alignment within the Community Education 5.0 and Industry 4.0 frameworks. The findings highlight the critical role that MoHE institutions, such as Community Colleges and Polytechnics, play in advancing TVET's alignment with the broader goals of Industry 5.0. Using a mixed-method approach, this study combines qualitative case studies of initiatives such as the Penang Skills Development Centre (PSDC) and the National Dual Training System (NDTS), with quantitative enrolment and employment data analysis. The results reveal that although PSDC and NDTS exemplify successful industry partnerships and positive employment outcomes, persistent challenges include curriculum misalignment with industry needs, digital infrastructure disparities, and societal stigma towards vocational pathways. The recommendations emphasise the need for curriculum modernisation to include emerging technologies, expanding public-private collaborations, and strategic rebranding of televisionET to improve public perceptions, ensuring its alignment with broader development goals.

1. Introduction

Technical and vocational education and training (TVET) has evolved into a vital component of Malaysia's ambition to become a high-income, knowledge-driven economy [1,2]. From its colonial-era beginnings of providing skilled labour for public projects, TVET has transformed into a cornerstone to equip the workforce with skills aligned with the demands of Industry 4.0 and the visionary goals of Community Education 5.0 [3,4]. Guided predominantly by the Ministry of Higher Education (MoHE), the TVET system now encompasses critical sectors such as green technology, digital manufacturing, and aerospace, allowing Malaysia to pursue national and international economic goals [5]. However, while progress has been made through initiatives such as the Malaysia Technical University Network (MTUN) and Politeknik Malaysia, persistent challenges threaten the

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system's ability to adapt to the fast-evolving demands of the global economy [6,7]. The 12th Malaysian Plan (2021–2025) underscores TVET as a strategic driver of economic growth and the development of human capital [8]. Its Education 5.0 initiative emphasises future-ready graduates by integrating digital platforms, automation, and innovative pedagogies into the education system [9]. By 2023, Malaysia had established more than 1,000 TVET centres under the purview of multiple ministries, including the Ministry of Human Resources (MoHR) and the Ministry of Education (MoE) [6,7]. Despite significant investments, including RM6.8 billion allocated to ensure TVET quality and relevance, key challenges persist. These include misaligned curriculum with industry demands, uneven digital infrastructure, and societal stigmas that perceive vocational pathways as inferior to academic education [10]. These issues undermine TVET's potential to address critical labour market needs.

Recent strategies have increasingly focused on microcredentials to provide flexible and targeted training opportunities, shifting the emphasis from simply increasing the number of institutions to improving the relevance of training [9]. Notable initiatives, such as the German-inspired dual vocational training model, have strengthened industry partnerships in fields such as semiconductors, yet regional disparities remain, particularly in rural areas [8]. Moreover, while efforts such as collaborations with the Economic Planning Unit and the Malaysian Plastics Manufacturers Association showcase successful industry engagement, systemic challenges in policy coordination and public awareness campaigns hinder widespread adoption [6]. Despite these obstacles, Malaysia's TVET framework demonstrates its critical role in preparing a workforce capable of thriving in industries such as aerospace, green technology, and advanced manufacturing [11]. The integration of the principles of Community Education 5.0, namely focussing on personalised and human-centric learning, aligns with the focus of Industry 4.0 on technological advances [3,12]. By encouraging socially responsible and technologically proficient graduates, TVET can ensure a balanced approach to economic and social development [13].

This study addresses key gaps in the existing literature by examining barriers to policy implementation, regional inequalities, and societal perceptions of TVET. It also evaluates the effectiveness of initiatives such as the Penang Skills Development Centre (PSDC) and the National Dual Training System (NDTS) in bridging skill gaps and aligning educational outcomes with industry demands [12,14]. Through a comprehensive analysis, this research highlights actionable recommendations to modernise curricula, improve industry collaborations, and improve public perceptions of TVET, ensuring its alignment with Malaysia's broader development goals.

Following this introduction, the document explores the evolution of TVET, MoHE-driven policies, and industry alignment within the Community Education 5.0 and Industry 4.0 frameworks. The literature review, research design, and methodology provide context and approach, while curriculum, industry collaboration, and employability findings highlight examples such as PSDC and NDTS. Concluding with recommendations, the article addresses policy, curriculum, and perception challenges and suggests avenues for future research in digital infrastructure and green technology.

2. Review of the Literature

There is a close link between the growth of TVET in Malaysia and the country's larger economic and development goals, such as making the economy more knowledge-based and making people rich. TVET has a long history of helping solve labour shortages by providing people with the skills in demand. The Fourth Industrial Revolution, or Industry 4.0, has brought new problems and opportunities. This means that the TVET system needs to be reviewed again to see if it can still prepare workers for fields that are becoming more advanced. Community Education 5.0 adds to the

background of this change by trying to align educational institutions (including TVET) with long-term, welcoming, and people-centred goals. This will ensure that social and economic objectives are met [4]. Significant changes have been made to the way Malaysia's TVET system is run.

The National TVET Council is now the main body coordinating policies across many ministries and businesses. Because the government is committed to Industry 4.0, the national development plan and TVET programmes must work together in this coordinated way. Although the council tried hard, studies show that there were times when things did not go as planned. Although there are frameworks to encourage business cooperation and keep courses up to date, research has shown a gap between making policies and implementing them in practice [15]. TVET changes only work if the government is often broken up, and the Ministries of Higher Education, Ministries of Human Resources, and Industry Development must work better together. A big topic in the research is how to make technical and professional education and training programmes fit the needs of businesses, especially in places where Industry 4.0 technology is being used. There is a greater need for skilled workers due to progress in the digital industry, robots, and artificial intelligence. According to research, the current TVET programmes need to be changed to keep up with these technological changes. A study of Malaysian vocational schools found that many still use old programmes that do not teach students the skills that companies need now [15]. The difference in skill levels may be more noticeable in highly technical areas like aerospace and electronics, which is a big problem.

Graduates of TVET may need more training to run complicated machines or work in fully automated factories, even though they already know a lot about basic technical skills. Many businesses notice this. Even with these problems, programmes like the NDTS try to connect business and academia by letting students switch between official classroom learning and hands-on training on the job. Many people like the NDTS model, which is based on Germany's dual-vocational system, especially in fields such as manufacturing and construction, where practical skills are essential to get a job [16]. The plan needs a lot of money from the public and private sectors, so it can only be used on a small scale. Larger companies, especially those in rural areas, can sometimes only offer complete training programmes. Therefore, students from a wide range of backgrounds receive high-quality education. The way people think about technical education is another big problem that makes it challenging to update TVET programmes. TVET has lost students because it is seen as a "second choice" option for students who did not do well in more academic fields. As a result, vocational qualifications should be valued more in society. This deeply rooted stigma makes improving TVET's trustworthiness and reputation as a respectable way to get an education harder. Parents and society put a lot of pressure on children, who are brilliant ones, to not go to vocational programmes. This is true even though students who graduate from TVET programmes have a better chance of finding work and more options in some fields [10].

One way to change people's minds about TVET is to show off the accomplishments of graduates who have done well in technology, energy, and transportation. More and more attention is paid to adding sustainability and green technology to the TVET programme because Malaysia wants to align its educational policies more with global environmental goals. As businesses move towards more eco-friendly methods, training in green technologies like renewable energy, energy efficiency, and sustainable building methods is becoming more and more critical. TVET centres and schools such as Green-Tech Malaysia have teamed up to offer specialised classes that teach students how to work in the green economy. Although the field is still young [16], the long-term effects of incorporating green technology into vocational education must be clarified, especially in job results and industry participation. These programmes can only be used by some TVET institutions, especially those in areas that need to be better developed because they have to pay a lot for new infrastructure and tools.

A robust consensus has emerged, highlighting the indispensable need for a dynamic partnership between employers and TVET schools to bridge the yawning skills gap, thus ensuring graduates are thoroughly prepared for the workforce. However, the impact of these alliances fluctuates dramatically between different regions. This phenomenon is particularly pronounced in the automotive and semiconductor industries, where numerous large corporations boast robust collaborations with TVET schools. In stark contrast, smaller businesses urgently need more opportunities for sincere and practical cooperation. Consequently, students in specific locales and sectors benefit from markedly more advantageous training opportunities in the competitive job market than their peers elsewhere. The reports emphatically underscore that companies and TVET universities must forge closer and more consistent collaborations to keep courses relevant and equip students with the essential skills demanded by companies today [17]. Cultivating these partnerships is merely one facet of the challenge. Equally crucial is ensuring its longevity and adaptability in response to the rapidly evolving technological landscape [5]. Beyond business alliances, another critical issue frequently explored in scholarly discourse is the financial sustainability of TVET institutions and their enduring operational viability.

In recent times, the expansion of TVET government funding has been remarkable, driven by substantial investments to revitalise infrastructure with a keen focus on upskilling and reskilling the workforce. New machinery and various programmes are also strategically deployed to rejuvenate educational facilities. However, despite these advances, numerous institutions still need financial assistance to maintain their building's structural integrity and bolster the continuity of academic excellence by ensuring that educators can persist in their vital teaching roles. Performance-based funding models are instrumental in steering TVET programmes to stay meticulously aligned with the ever-evolving demands of the job market. These models offer tangible rewards to institutions that successfully achieve specific employment and industry participation benchmarks. However, there remains a persistent debate regarding the extent to which these funding streams contribute significantly to the long-term sustainability of the programme [3,7,18].

However, even amidst these challenges, the horizon for Malaysia's TVET system is generally promising. The trajectory of vocational education is poised for progressive growth, fuelled by government initiatives that explicitly aim to synchronise education with the sophisticated demands of Industry 4.0 and the dynamic paradigm of Community Education 5.0. However, ongoing studies underscore the need for increased efforts to ensure that educational content remains relevant, that business partnerships are solidly fortified, and that TVET is universally recognised as a vital and integral component of Malaysia's overarching educational framework [10,14,19].

3. Research Design and Methodology

This groundbreaking research embraces a robust mixed methods approach, meticulously incorporating both qualitative and quantitative data to evaluate the multifaceted effectiveness of Malaysia’s dynamic TVET system. The qualitative data from in-depth case studies showcase impressive examples like PSDC, vividly demonstrating how strategic industry collaboration can effectively bridge critical skill gaps. Compelling policy documents, such as the Polytechnic Transformation Plan 2023-2030 and influential Ministry of Human Resources reports, provide profound qualitative insights into governmental strategies designed for curriculum alignment and employment enhancement. Quantitative data from authoritative secondary sources within government reports provides rigorous evidence through metrics such as enrolment rates, employability outcomes, and pivotal industry participation figures. Data analysis employs thematic analysis for qualitative data, meticulously examining pivotal recurring themes like industry alignment

and cutting-edge technological adaptation. Descriptive statistics dynamically highlight trends in employment and enrolment for quantitative data, while sophisticated correlation analysis explores intricate potential relationships between industry participation and employment rates. These meticulously integrated methods offer an extensive and comprehensive view of the formidable progress of TVET and its strategic alignment with national objectives [15-17].

The quantitative element draws on secondary data from official and authoritative publications, including those of the crucial Department of Skills Development and the Ministry of Higher Education (MoHE), which encompass industry participation rates, graduate employability outcomes, and TVET enrolment figures. The quantitative study focusses on rigorously identifying trends in these critical fields and evaluating the overall performance of TVET programmes in satisfying the acute needs of the labour market [20]. For the meticulously chosen case studies, public and private TVET institutions in crucial sectors such as manufacturing, aerospace industry, and emerging green technologies form the critical focus of the study, using secondary data. The comprehensive literature review includes vital stakeholders, industry partners, educators, policymakers, and recent graduates. Data analysis will use a thematic study for the qualitative component, while quantitative data will employ robust descriptive statistics. Thematic analysis will illuminate recurring challenges and best practices in employability outcomes, industry collaboration, and curriculum design [22,23]. However, relying on secondary data can constrain the depth of analysis and the specific nature of particular case studies, particularly those within the aerospace and green technology sectors, may not fully represent the expansive TVET landscape, posing limitations to the broader scope of research.

4 Case Studies

4.1 Case Study 1: The Penang Skills Development Centre (PSDC)

The PSDC has been a model for successful TVET programmes in Malaysia, focussing on industry-led education since its inception in 1989. PSDC has pioneered expertise in fields such as manufacturing, automation, and electronics. A notable initiative is the Semiconductor Hands-On Industry Programme, developed in collaboration with multinational companies like Intel and Inari Amertron. This programme ensures that graduates possess cutting-edge skills aligned with Malaysia's booming semiconductor industry. Additionally, PSDC's partnership with Cleantech Solar has enabled the integration of renewable energy training, equipping students with proficiency in green technologies and demonstrating Penang's commitment to sustainability.

Although PSDC’s urban location offers ample access to advanced infrastructure and global partnerships, its approach highlights the disparities in access and opportunities for rural institutions. Expanding similar programmes to rural TVET centres can bridge the regional gaps in skills development and infrastructure. Furthermore, the adoption of Work-Based Learning (WBL) frameworks, inspired by PSDC’s success, in Polytechnics such as Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA), Politeknik Ibrahim Sultan (PIS), and Politeknik Merlimau (PMM) under MoHE could improve graduates' employability by aligning technical training with industry demands as described in the 12th Malaysian Plan (RMK-12).

4.2 Case Study 2: Polytechnic Malaysia under MoHE

Polytechnic Malaysia demonstrates the integration of theoretical knowledge with practical training to meet Industry 4.0 demands. These institutions have established strategic partnerships with local technology firms, enabling the inclusion of automation and digital fabrication courses.

Students are prepared for high-demand roles in fields such as robotics and precision engineering, addressing Malaysia's labour market needs while driving innovation in emerging industries.

Polytechnic Malaysia, under the MoHE, exemplifies how academic and practical training can be effectively integrated to address the demands of Industry 4.0. These institutions have formed strategic partnerships with various industries to develop programmes that emphasise theoretical knowledge and hands-on technical skills. For example, collaborations with local tech firms have enabled the implementation of automation and digital fabrication courses, preparing students for roles in high-demand fields such as robotics and precision engineering. These partnerships align with the broader efforts of MoHE, as described in the 12th Malaysian Plan (RMK-12), to ensure that TVET graduates are ready for work and capable of driving innovation in the evolving industrial landscape of Malaysia.

An example of success includes collaborations with rural industries, such as small and medium enterprises (SMEs) in sustainable manufacturing, highlighting the adaptability of Polytechnic Malaysia's programmes. However, challenges persist, particularly in aligning regional curriculum with local economic needs and accessing consistent industry collaboration in less developed areas. Community colleges under MoHE complement this approach by offering lifelong learning programmes that cater to local labour markets through flexible and accessible training. Expanding these efforts to underserved rural areas would significantly contribute to addressing regional disparities.

4.3 Case Study 3: TVET in the Aerospace Industry

The Malaysian Institute of Aviation Technology (MIAT) exemplifies Malaysia's ambition to establish itself as a global leader in aerospace education. Partnering with UniKL and MARA, MIAT offers Maintenance, Repair, and Overhaul (MRO) programmes in collaboration with industry leaders such as Airbus and Malaysia Airlines. These partnerships provide students with hands-on experience using cutting-edge technologies, ensuring their readiness for employment in high-demand aerospace manufacturing roles.

To replicate this success in rural contexts, institutions like Politeknik Banting (PBS) could adapt similar partnerships with regional aerospace suppliers. However, rural institutions often lack the infrastructure and industry access available to their urban counterparts, which presents a challenge to the development of a more equitable workforce. To address this, MoHE can facilitate funding and collaboration between rural polytechnics and key industry players to ensure a consistent standard of aerospace education across the country.

4.4 Case Study 4: Green Technology and Sustainability in TVET

As Malaysia aligns its education policies with global climate goals, green technology has emerged as a critical area within TVET. Institutions such as Politeknik Sultan Idris Shah (PSIS) and Politeknik Tuanku Sultanah Bahiyah (PTSB) have introduced the Solar Photovoltaic Installer Certification Programme, equipping students with skills to design and maintain solar energy systems. These programmes, developed in partnership with Green-Tech Malaysia, prepare graduates for careers in renewable energy and sustainable building practices, reflecting the growing demand for environmentally conscious labour.

However, the adoption of green technologies remains uneven, particularly in rural areas where infrastructure and funding are limited. Programmes such as Solar PV Installer Certification could be scaled to include rural TVET centres, addressing regional disparities while promoting sustainable

economic development. By designating rural institutions as green technology hubs, the MoHE could allow local economies to benefit from the global transition to renewable energy.

Although case studies highlight significant strides in aligning TVET with industry needs, the broader success of TVET systems hinges on effective policy implementation. However, persistent challenges in governance, inter-departmental coordination, and funding disparities continue to hinder the realisation of the full potential of TVET. The case studies underscore the critical role of industry collaboration in improving TVET outcomes. However, the broader success of Malaysia's TVET framework depends on addressing systemic governance and policy-related challenges.

5 Systemic Barriers in TVET

5.1 Challenges and Solutions to Policy Implementation

These challenges include interdepartmental coordination, funding disparities, and the need for more robust public-private partnerships. The following section delves into these issues and proposes actionable solutions to strengthen TVET governance and implementation. The successful implementation of TVET policies in Malaysia requires seamless inter-departmental coordination between MoHE, MoHR, and MoE. However, despite the establishment of the National TVET Council, key challenges persist. Fragmented governance structures, overlapping responsibilities, and inconsistent funding allocation often result in delays and inefficiencies. For example, while the RMK-12 outlines clear objectives to enhance the role of TVET in economic development, its implementation at the institutional level has faced hurdles, including limited monitoring and evaluation mechanisms [5-7].

One notable barrier is the lack of alignment between TVET curricula and evolving industry needs, particularly in sectors such as green technology and aerospace. Despite efforts to incorporate Industry 4.0 technologies, some institutions struggle to keep pace with technological advancements. This issue is exacerbated by insufficient involvement of industry stakeholders in designing and updating curricula [8,12].

To address these challenges, Malaysia could adopt a centralised policy monitoring framework. Such a framework would streamline collaboration between ministries and ensure that policy objectives are consistently aligned with industry needs. For example, the NDTS demonstrates the potential to integrate policy implementation with direct industry input, as it allows students to alternate between classroom learning and workplace training. Expanding this model across sectors, particularly in rural regions, could significantly improve the practical relevance of TVET programmes [6].

Furthermore, funding disparities between urban and rural institutions present another critical challenge. Urban centres often benefit from superior infrastructure and access to industry partnerships, while rural institutions struggle to maintain basic operational standards. Performance-based funding models, tied to employment outcomes and industry collaborations, could encourage institutions to align their programmes with labour market demands. Such models have been successfully tested in urban Polytechnics and could be adapted to address regional inequalities [9]. Another key area of improvement lies in PPPs. Although examples such as the PSDC highlight the value of industry collaboration, rural regions face significant barriers in attracting private sector investment. To mitigate this, the government could offer financial incentives and tax breaks to encourage industries to collaborate with rural TVET institutions. Additionally, the creation of regional industry clusters, focussing on high-demand sectors such as sustainable agriculture and green technology, could foster localised partnerships.

Finally, addressing the social stigma against TVET remains a cornerstone of effective policy implementation. Despite improvements, vocational education continues to be viewed as a less prestigious option compared to academic pathways. National awareness campaigns, featuring success stories from TVET alumni in prominent industries, could help shape public perceptions. Similarly, integrating TVET pathways into mainstream education systems - allowing seamless transitions between vocational and academic streams - would elevate its status and attract a more diverse student demographic [10,13].

By tackling these challenges, Malaysia's TVET system can achieve its dual objective of nurturing a technologically adept workforce while ensuring equitable access to quality education.

5.2 Societal Stigma and Strategies for Change

Societal stigma remains a significant barrier to the development of the Malaysian TVET system, with vocational education often perceived as a "second choice" option for students who underperform academically. This perception is deeply rooted in cultural and educational biases that prioritise academic pathways over vocational training. Parents, educators, and even students themselves often associate university degrees with prestige and greater career prospects, leading to the marginalisation of TVET as an inferior educational option. This stigma limits the pool of high-performing students who might otherwise benefit from vocational training and reinforces negative stereotypes about TVET programmes.

The lack of public awareness of the career opportunities available through TVET further contributes to this stigma. Although vocational education offers pathways to high-demand fields such as aerospace, digital manufacturing, and green technology, these opportunities are not widely publicised. Efforts have been started to showcase the success stories of TVET graduates, but they are not yet widespread or impactful enough to change social attitudes. The absence of a robust public narrative that supports TVET's potential perpetuates misconceptions, deterring students and parents from considering vocational education as a viable option.

To combat these challenges, a cultural change is required to reframe TVET as a future-ready education system that equips students with advanced skills for emerging industries. Large-scale national awareness campaigns should highlight the achievements of TVET graduates in high-tech fields and demonstrate the relevance of vocational training in meeting the demands of Industry 4.0. Integrating TVET pathways with academic education could further enhance its appeal. For example, allowing students to transition from vocational programmes to university degrees through credit transfer systems and dual-qualification programmes would elevate the status of TVET and make it an attractive option for students seeking flexible career trajectories. Collaboration with industry leaders could also play a key role in reshaping perceptions. Partnerships with prominent companies like Intel, Airbus, and Cleantech Solar would not only provide students with real-world exposure, but also position TVET as a gateway to high-demand careers. School outreach programmes, career fairs, and workshops involving successful TVET alumni could engage communities and expose students and parents to the opportunities that vocational education offers. Furthermore, government policies that encourage the enrolment of TVET through scholarships and subsidies would enhance its accessibility and appeal, encouraging more families to consider it a viable alternative to traditional academic routes.

By addressing social stigma through these strategies, Malaysia can create a more inclusive and dynamic education system. Reframe vocational training as a prestigious and future-focused pathway is essential to attract diverse talent and align public perceptions with national industrial and economic goals.

6 Finding and Analysis

The results of this study provide a comprehensive understanding of how effectively Malaysia's TVET system addresses the challenges posed by Industry 4.0 while aligning with the broader goals of Community Education 5.0. Through qualitative case studies and quantitative analysis, new insights have emerged regarding curriculum alignment, industry cooperation, and employment outcomes. The data show that while MoHR and MARA-led institutions like PSDC and MIAT have made substantial progress in integrating modern technologies and fostering industry partnerships, there remains a significant opportunity for institutions under the MoHE to adopt and scale these best practices. The analysis highlights the critical role that MoHE institutions, such as Community Colleges and Polytechnics, play in advancing TVET's alignment with Industry 4.0. Using strategic partnerships with industry leaders, these institutions have successfully integrated advanced technologies and hands-on training into their curricula. However, the study also underscores the need to further expand these efforts to address regional disparities in infrastructure and access. The strategic goals outlined in RMK-12 emphasise the importance of a cohesive TVET ecosystem that bridges academic and technical education, ensuring equitable opportunities for all students, and fostering a skilled and adaptable workforce.

The MoHE oversees 36 polytechnics and 105 community colleges in Malaysia. These institutions can improve their programmes in emerging fields such as automation and semiconductors by forming strategic partnerships similar to those between the PSDC, Intel, and Inari Amertron. For example, Politeknik Sultan Salahuddin Abdul Aziz Shah (PSA) and Politeknik Ibrahim Sultan (PIS) could collaborate with industry leaders to ensure that their graduates acquire industry-relevant skills. As TVET enrolment and employability rates increase, MoHE should implement comprehensive curriculum changes modelled after successful programmes to support this trend.

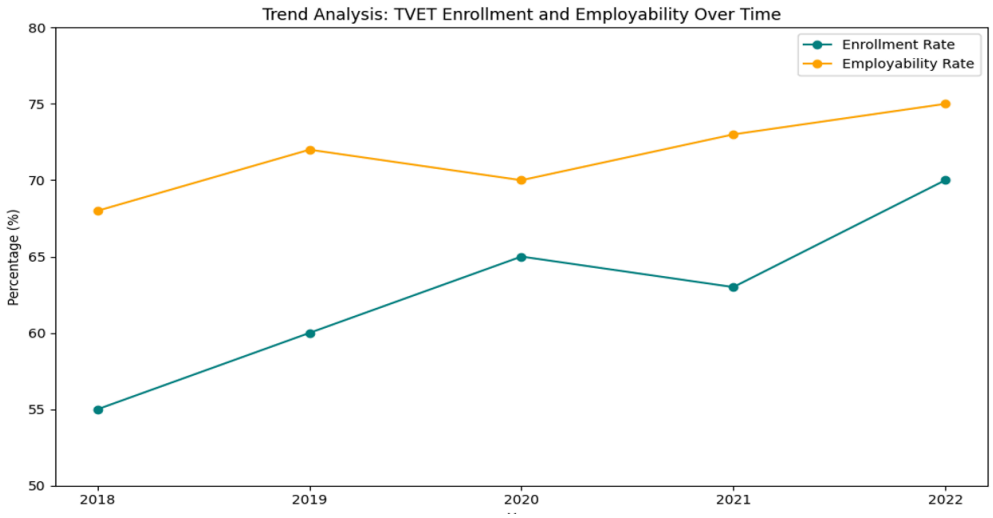

Fig. 1. Trend analysis of TVET enrolment and employability over time (2018-2022)

In particular, for those motivated by the technical developments of Industry 4.0, one of the most essential results relates to aligning TVET curricula with industry needs. The analysis of policy documents and case studies of the PSDC and NDTS shows the deliberate attempts of institutions to include new technologies in their operations. Although these colleges have made progress toward including robotics, digital manufacturing, and automation in their courses, the general rate of curriculum modernisation still needs to be revised. This has led to a continuous skill gap in which

graduates are often only partially qualified with the advanced capabilities required by contemporary companies. For example, while fundamental technical abilities are adequately addressed, more specialised instruction in emerging technologies sometimes needs to be improved. This difficulty is compounded in fields such as aerospace and digital technologies, where the speed of technical development demands ongoing curricular changes.

Quantitative data on graduate employability underscore the importance of industry partnerships, particularly in high-tech fields such as aerospace and digital technologies. Although NDTS has shown the effectiveness of dual training in sectors such as automotive manufacturing, MoHE institutions like Politeknik Sultan Azlan Shah (PSAS) can benefit from similar frameworks, ensuring graduates receive balanced academic and practical training. This approach would increase employability and enhance the competitiveness of MoHE graduates in the labour market. Figure 2 shows the difference in the employment rate between TVET graduates and non-TVET graduates in manufacturing, IT, and engineering, which underlines the practical benefits of TVET education in areas where specialised skills are vital (Department of Skills Development, 2023).

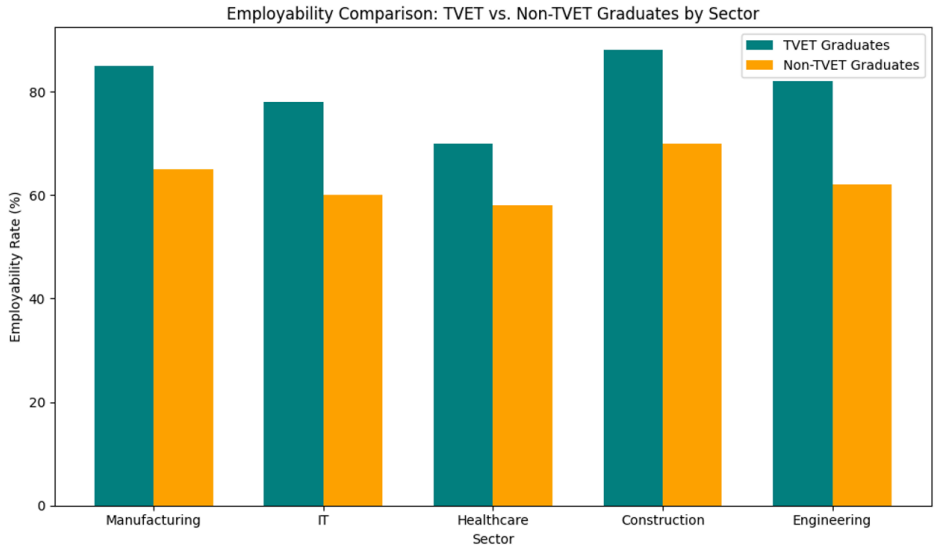

Fig. 2. Comparative analysis of employment rates by sector for TVET and non-TVET graduates

The study highlights the critical role of public-private cooperation in the success of TVET programmes. Substantial industry involvement enhances course relevance, exemplified by PSDC's ties with companies like Intel and AMD, providing students with practical tech experience and increasing job competitiveness. However, such partnerships are less common in rural areas, affecting training quality. Despite efforts by the National TVET Council to align with development goals, policy implementation needs to improve inter-departmental coordination issues, leading to ineffective sector synergies and slow legislative adaptation for green technologies. Although initiatives such as Green-Tech Malaysia introduce renewable energy training, their impact is limited due to insufficient support. Additionally, TVET faces societal stigma, which deters top-performing students despite rebranding efforts, exacerbated by cultural biases that favour academic education. Research emphasises the need for public awareness and policy changes to highlight TVET success stories, especially in high-demand tech fields.

Regarding sustainability and integration of green technologies, the results imply that green technology training is still in its infancy, even if its inclusion is a hopeful development. Only some universities have offered courses on renewable energy, energy efficiency, and sustainable building

techniques; lack of funding and institutional commitment now limits their availability. However, this field has significant room for development, particularly as Malaysia tries to match its educational policy to global environmental objectives. In addition to generating fresh employment prospects, green technology can guarantee that Malaysia's workforce is ready for the demands of a global economy. Figure 3 shows the TVET performance of Malaysia in essential spheres.

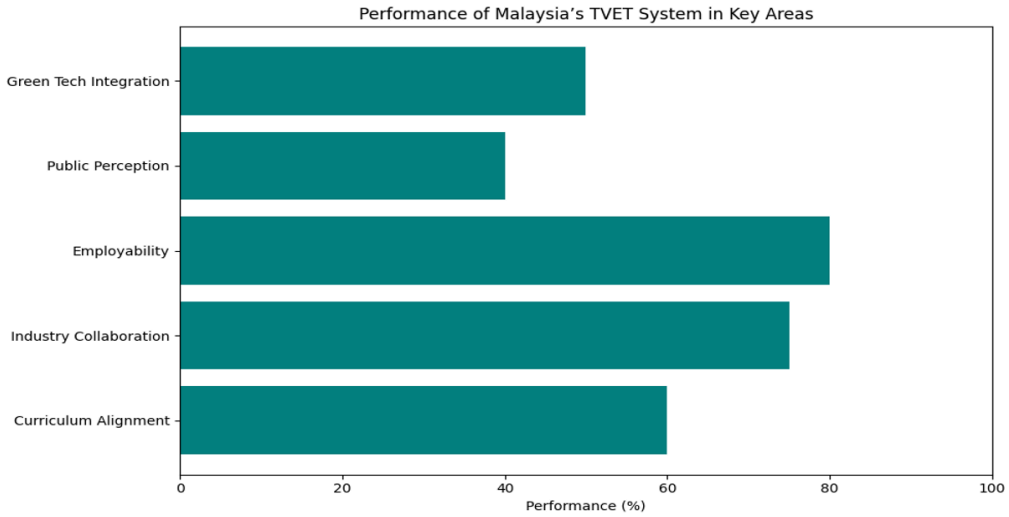

Fig. 3. Performance of Malaysia's TVET system in key areas

With much higher levels of robust industry participation in central and southern Malaysia, case studies clearly show severe geographical inequalities in industry collaboration (Figure 4). The key to confronting and mitigating these disparities lies in the MoHE. We can generate transformative change by dynamically fostering strategic connections between our esteemed institutions and essential industry leaders. Our focus will be on engaging under-represented regions. Inspiring models for collaboration with innovative groups like Green-Tech Malaysia can be found, for example, at Politeknik Merlimau (PMM) and Politeknik Tuanku Sultanah Bahiyah (PTSB). By working together, sustainable technology initiatives can be expanded and additional training opportunities distributed relatively and comprehensively. This would be in perfect harmony with the goals of Malaysia's RMK-12 framework.

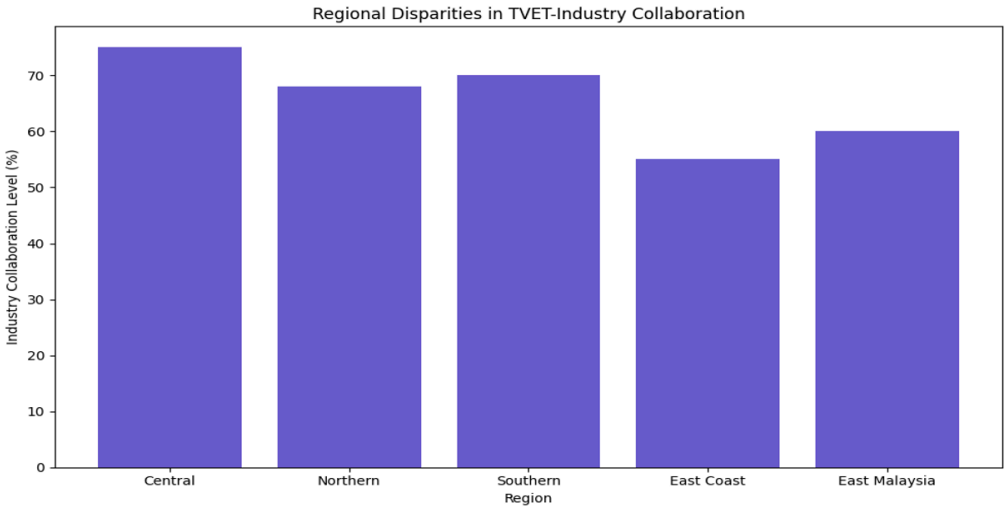

Fig. 4. Regional disparities in TVET-industry collaboration

Community Education 5.0 and Industry 4.0 are interconnected through their shared emphasis on innovation and humanisation. While Industry 4.0 focusses on technological advancement and automation, Community Education 5.0 emphasises personalised, human-centric, and socially inclusive education systems. This humanisation aspect is crucial to equipping students with adaptive skills to thrive in a rapidly evolving industrial environment. Integrating concepts from Education 5.0 ensures that TVET produces technically qualified graduates and fosters holistic development, preparing individuals to contribute positively to society.

Addressing policy alignment and governance remains a crucial challenge, with fragmented coordination between ministries often impeding the swift and effective execution of policies. The ambitious efforts of the National TVET Council to reform and streamline governance have not yet been fully realised at the institutional level, particularly within the MoHE. It is critical to significantly enhance interministerial collaboration and fine-tune MoHE policies to align closely with industry demands. Such measures are not only advantageous but essential for the successful evolution of TVET reforms.

Furthermore, removing negative perceptions surrounding vocational education requires robust public awareness campaigns enriched with compelling success narratives from MoHE-led programmes. These strategic initiatives would profoundly improve the perception and appeal of the TVET pathways, attracting a broader, more diverse and exceptionally talented student demographic. Although institutions such as the Penang Skills Development Centre (PSDC) offer invaluable blueprints for success, MoHE - which oversees 36 polytechnics and 105 community colleges - is in a unique position to lead the modernisation of TVET education. By meticulously crafting industry-aligned curricula and strengthening partnerships across its institutions, MoHE is well placed to equip Malaysia's workforce with the skills needed to meet the rigorous demands of an ever-evolving industrial landscape.

6. Conclusions

The findings of this insightful study emphatically highlight the pivotal role of Malaysia's TVET system in forging a workforce proficiently equipped to meet the evolving and intricate demands of Industry 4.0, while simultaneously championing the transformative principles of Community Education 5.0. Through a comprehensive analysis of impactful initiatives such as the PSDC and the NDTS, it becomes unequivocally clear that forging robust industry partnerships and implementing

laser-focused programmes can dramatically enhance graduate employability and deftly bridge existing skill gaps. Nevertheless, systemic challenges persistently loom large, obstructing the broader impact of TVET initiatives due to issues in policy implementation, societal stigma, and regional disparities. Key barriers have been identified, including the misalignment between educational curricula and industry needs, insufficient digital infrastructure in rural environments, and entrenched cultural biases that perceive vocational education as a less desirable path. Confronting these formidable challenges demands a nuanced, multifaceted approach. Policy reforms must prioritise interdepartmental coordination, bolster centralised monitoring frameworks, and introduce performance-based funding models to secure consistent and efficient implementation. Expanding public-private partnerships, particularly in regions that are currently under-represented, can effectively bridge infrastructure chasms and fine-tune industry alignment. Equally paramount is transforming the social perceptions of TVET. National awareness initiatives, seamless integration with academic pathways, and celebrating successful alumni can collectively reposition vocational education as both a prestigious and future-ready option. Moreover, it is imperative for future research to incorporate primary data to substantiate findings and uncover overlooked challenges, thus providing a more robust and comprehensive foundation for policy and programme development. By executing these strategic maneuvers, Malaysia's TVET system stands poised to achieve its dual aspirations: cultivating a workforce that is technologically adept and ensuring indiscriminate access to quality education. Harmonising TVET with Industry 4.0 and Community Education 5.0 will not only stimulate the nation's economic growth, but will also elevate its stature as a trailblazer in innovative and human-centric education for the future.

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