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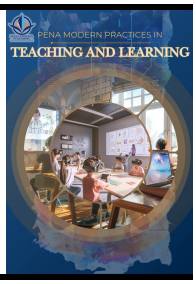

The Transformation of TVET Education through Modernized Facilities: Challenges and Opportunities

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ABSTRACT

The transformation of Technical and Vocational Education and Training (TVET) institutions through modernized infrastructure plays a crucial role in enhancing educational quality, student engagement, and industry readiness. This study examines the impact of infrastructure development of TVET institutions in Malaysia, focusing on its newly built campus and facilities. The research explores how modernized classrooms, laboratories, digital learning spaces, and student accommodations contribute to better learning experiences, higher student satisfaction, and improved graduate employability. Using a mixed-method approach, data was collected from students, faculty, and industry partners to assess the effectiveness of the new facilities. Key performance indicators (KPIs) such as enrollment rates, academic performance, industry collaboration, and graduate employment were analyzed. Findings suggest that the new infrastructure has significantly enhanced teaching and learning conditions, leading to a 95% graduate employability rate and an 80% satisfaction rate among students and faculty. However, challenges such as funding limitations, the need for continuous facility upgrades, and aligning programs with industry demands were identified. This study concludes that strategic investment in TVET infrastructure is essential for producing highly skilled graduates who meet industry needs. Recommendations include strengthening industry partnerships, integrating smart technologies in teaching, and securing sustainable funding for infrastructure maintenance. The insights gained from this research can serve as a model for other TVET institutions looking to modernize their campuses to support national workforce development.

1. Introduction

Technical and Vocational Education and Training (TVET) plays a pivotal role in national development by providing individuals with the practical skills and knowledge required to meet the

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demands of the ever-evolving industrial landscape. In an era where technology is rapidly transforming economies, the importance of skilled workers cannot be overstated. TVET institutions serve as a crucial link between education and employment, ensuring that graduates possess the technical competencies and problem-solving abilities that industries seek. The effectiveness of TVET programs hinges on numerous factors, with the availability of modern infrastructure being a critical determinant. Well-equipped learning environments, encompassing classrooms, laboratories, workshops, and digital learning spaces, enable students to gain hands-on experience and exposure to industry-standard practices. Recognizing the importance of infrastructure in TVET, many countries, including Malaysia, have made substantial investments in upgrading facilities to enhance the quality of education, boost student engagement, and foster closer collaboration with industry. These infrastructural investments encompass a wide range of initiatives, such as the construction and renovation of buildings, the procurement of state-of-the-art equipment and tools, and the establishment of digital learning platforms. By providing students with access to modern facilities and resources, governments aim to create a more conducive learning environment that promotes practical skills development and prepares graduates for the workforce.

Despite the significant investments made in TVET infrastructure, there remain lingering questions about the direct impact of these investments on key outcomes such as student satisfaction, academic performance, and employment prospects. While it is intuitively clear that modern and well-equipped learning environments can enhance the educational experience, empirical evidence is needed to establish a causal relationship between infrastructure and student outcomes. Further research is required to investigate the specific ways in which infrastructure affects student learning, motivation, and engagement. For instance, studies could examine how access to modern laboratories and workshops influences students' practical skills development, or how the availability of digital learning resources impacts their academic performance. Additionally, research could explore the relationship between infrastructure and employment outcomes, such as the speed with which graduates find jobs and their earning potential. By shedding light on the direct impact of infrastructure on student outcomes, research can inform policy decisions and ensure that investments in TVET are targeted and effective. Moreover, evidence-based insights can guide the design and implementation of future infrastructure projects, ensuring that they are aligned with the needs of students and industry.

In conclusion, while investments in TVET infrastructure are undoubtedly important, it is crucial to evaluate their impact on student outcomes to ensure that resources are utilized effectively. By conducting rigorous research and gathering empirical evidence, policymakers can make informed decisions that will enhance the quality of TVET and equip graduates with the skills they need to succeed in the 21st century workforce.

While infrastructure development in TVET institutions is widely regarded as a key driver of educational quality, there is limited empirical research on its tangible impact. Many institutions struggle to maintain a balance between infrastructure modernization and curriculum relevance. The success of TVET colleges can be influenced by how effectively they manage physical facilities, equipment, supplies, finances, and business operations [14]. Upgraded facilities may improve the learning environment, but without proper alignment with industry requirements, graduates may still face employability challenges. Additionally, infrastructure investments often require substantial financial resources, making it essential to evaluate their long-term benefits. Issues such as facility maintenance, adaptation to technological advancements, and ensuring industry alignment remain critical concerns. Without a clear understanding of how modernized infrastructure contributes to TVET outcomes, policymakers and institutional leaders may find it difficult to justify and sustain such investments. It is also proposed that ICT facilities be adequately provided and that TVET educators receive training while the government and other stakeholders ensure these provisions are met [7].

This study seeks to address these gaps by examining the extent to which infrastructure development enhances student learning experiences, facilitates industry collaboration, and improves graduate employability. The research will provide data-driven insights into how infrastructure investments can be optimized to maximize their impact.

This study aims to examine the relationship between modernized TVET infrastructure and student learning experiences, evaluating how improved facilities impact student engagement and academic performance based on key performance indicators. It also assesses the influence of infrastructure development on graduate employability and industry collaborations, determining how upgraded learning environments contribute to workforce readiness. Additionally, the study identifies challenges related to infrastructure sustainability in TVET institutions, such as maintenance and funding constraints. Lastly, it provides recommendations for optimizing infrastructure investments, ensuring long-term benefits for both educational quality and workforce development. This study seeks to answer several key research questions related to the impact of modernized TVET infrastructure. It examines how upgraded facilities influence student satisfaction and academic performance, as well as the relationship between infrastructure improvements and graduate employability rates. Additionally, the study explores the role of enhanced facilities in fostering industry partnerships and work-based learning opportunities, ensuring better workforce alignment. Furthermore, it identifies the challenges TVET institutions face in maintaining and upgrading their infrastructure, including financial and technological constraints. Lastly, the research aims to determine effective strategies for ensuring the long-term sustainability of infrastructure investments, ensuring continuous improvements in educational quality and workforce readiness.

The research holds substantial significance in multiple ways. Primarily, it furnishes concrete empirical evidence elucidating the correlation between infrastructure enhancements and their subsequent influence on both student learning outcomes and their prospects for employability. This evidence serves as a foundational basis for understanding the tangible benefits of infrastructure investment in the TVET sector. Secondly, the insights gleaned from this research offer invaluable guidance to policymakers and education administrators. By shedding light on the multifaceted impact of infrastructure on student success, it equips these stakeholders with the knowledge necessary to make well-informed, judicious decisions regarding the allocation of resources for TVET infrastructure development. This ensures that investments are targeted where they will yield the greatest positive impact on student outcomes and, by extension, the broader economy. Thirdly, this study serves as a catalyst for fostering stronger industry collaborations. It underscores the pivotal role that modern, well-equipped training facilities play in producing skilled graduates who are not only technically proficient but also possess the soft skills and industry-relevant knowledge required to seamlessly transition into the workforce. By highlighting this connection, the research encourages industries to actively engage with TVET institutions, creating a symbiotic relationship that benefits both students and employers.

Furthermore, by elucidating the profound impact of infrastructure modernization, this research contributes to the ongoing evolution of TVET institutions, ensuring that they remain responsive to the ever-changing demands of the 21st-century labor market. It helps TVET institutions stay ahead of the curve by adapting their infrastructure and training programs to align with emerging technologies and industry trends. In essence, the findings of this study will serve as a robust framework for sustainable infrastructure planning in TVET education. By adopting a long-term perspective and considering the evolving needs of students and industries, this framework will enable TVET institutions to create an environment that fosters innovation, creativity, and skill development. Ultimately, this will benefit not only the students themselves but also the broader economy by creating a pool of highly skilled, adaptable workers who can drive economic growth and prosperity.

This study explores the transformative impact of infrastructure modernization on a selected TVET institution by employing a mixed-methods approach to gather data from students, faculty members, and industry partners. The research examines key performance indicators (KPIs) to assess the effectiveness of recent infrastructure upgrades. Enrollment trends will be analyzed to determine whether modernized facilities have attracted a larger or more diverse student body, while student satisfaction levels will be evaluated to understand the impact of improved learning environments. Additionally, the study will investigate industry collaborations, assessing whether enhanced infrastructure has strengthened partnerships, increased apprenticeships, internships, and research opportunities. Lastly, the research will measure graduate employment rates to determine the extent to which new facilities have prepared students for the workforce and aligned them with industry needs.

The findings of this study will provide valuable insights into the relationship between infrastructure investments and institutional performance within the TVET sector. While the results will be specific to the selected institution, they will offer a broader understanding of the potential benefits of infrastructure development for other TVET institutions considering similar upgrades. By examining the multifaceted impact of modernized infrastructure on the teaching and learning environment, industry partnerships, and student outcomes, this research aims to highlight the critical role of strategic investments in educational facilities in shaping a skilled, adaptable, and employable workforce that can meet the evolving needs of the industry and contribute to economic growth.

2. Literature Review

Malaysia's economic advancement and developmental aspirations, particularly the transition towards a knowledge-based economy and the enhancement of national wealth, are intrinsically linked to the growth and evolution of Technical and Vocational Education and Training (TVET). Historically, TVET in Malaysia has played a pivotal role in addressing labor shortages and skill gaps by equipping individuals with the technical and vocational skills that are in high demand in the job market. However, the advent of the Fourth Industrial Revolution, commonly referred to as Industry 4.0, has ushered in a new era of technological advancements and automation, presenting both challenges and opportunities for the TVET sector. The rapid pace of technological change and the increasing complexity of industries necessitate a comprehensive re-evaluation and transformation of the TVET system in Malaysia [23]. This re-evaluation is essential to ensure that the TVET system remains relevant, effective, and responsive to the evolving needs of the economy and the labor market. It is crucial to ensure that TVET graduates are equipped with the skills and knowledge required to thrive in the digital age and to contribute effectively to the knowledge-based economy. The transformation of the TVET system should encompass various aspects, including curriculum development, pedagogical approaches, infrastructure and facilities, industry collaboration, and quality assurance. The curriculum should be regularly updated to incorporate emerging technologies and industry trends, ensuring that graduates are equipped with the latest skills and knowledge. Pedagogical approaches should shift towards more experiential and project-based learning, fostering creativity, problem-solving, and critical thinking skills. Infrastructure and facilities should be modernized to provide students with access to cutting-edge technologies and equipment. Industry collaboration should be strengthened to ensure that the TVET curriculum is aligned with industry needs and that graduates are work-ready. Quality assurance mechanisms should be robust to maintain the high standards of TVET programs.

By embracing these changes and continuously adapting to the evolving landscape of Industry 4.0, the TVET system in Malaysia can play a pivotal role in driving economic growth, enhancing national

competitiveness, and preparing the workforce for the challenges and opportunities of the future. Despite its importance in the Czech educational system, vocational education has struggled to keep up with job market demands and technological advancements [20]. Ensuring the consistent availability of laboratory and workshop facilities is crucial, which necessitates effective maintenance management. However, literature suggests that numerous TVET institutions globally face challenges in maintaining these essential facilities [8]. This study investigates Bangladeshi teachers' perceptions of TVET, focusing on resource scarcity and societal stigma. It identifies systemic challenges and offers insights to elevate TVET's status, resource allocation, and alignment with national goals. Future research should include a wider range of stakeholders [9]. The Ministry of Education should collaborate with NACTE to equip all TVET institutions with adequate ICT facilities and training and further research should be conducted to find the best ways to integrate ICT into the curriculum and align it with 21st century workforce demands and explore how ICT can enhance global perspectives in TVET and contribute to sustainable development [10]. A monitoring and evaluation system should be implemented to track national progress and ensure effective collaboration between training providers and industry. Training providers should integrate collaboration into their school action plans and establish well-resourced industrial liaison units (ILUs) to consult with stakeholders and strengthen ties with the private sector [11].

TVET is an educational process that aims to equip students with practical skills, technological understanding, and scientific knowledge required for specific occupations or trades while maintaining the goal of TVET in enhancing employability and to foster economic development through entrepreneurship [12]. The research highlights that implementing inclusive practices in education requires providing counselling, accommodating diverse learning styles, and enhancing accessibility. However, challenges such as inadequate funding, societal stigma, and inaccessible facilities hinder progress. The studies recommend specialized teacher training, disability support units, inclusive policies, and collaboration among stakeholders [13]. TVET administrators face insufficient funding, lack of student training materials, and outdated machinery while resolving these issues is crucial for TVET colleges' success [14]. In essence, TVET (Technical and Vocational Education and Training) institutions are facing a pressing need to invest significantly in their infrastructure, technological resources, curriculum, and faculty development. This is crucial to maintaining their competitiveness in the educational landscape and ensuring that they remain attractive to prospective students. Without these investments, TVET schools risk falling behind, struggling to meet the evolving demands of the industry, and failing to equip students with the skills and knowledge necessary for success in the modern workforce [15]. This qualitative case study investigated challenges and strategies for implementing TVET programs in Zimbabwean tertiary institutions. The research identified challenges such as lack of training facilities, inadequate teaching methods, and insufficient funding, and proposed strategies including continuous professional development for lecturers and provision of adequate facilities. The study recommends that the government and TVET providers prioritize quality assurance in TVET institutions [16]. The research uncovered numerous obstacles encountered by campus administrators, such as lengthy and inflexible procurement procedures, insufficient allocation of educational materials, budgetary limitations, and inadequate upkeep of educational infrastructure [17]. The availability and condition of facilities are crucial factors in evaluating the quality and standard of instruction in TVET institutions. Therefore, effective facilities management in these institutions is of utmost importance and cannot be overemphasized [18]. The study found that misalignment of curriculum with industry requirements, lack of up-to-date infrastructure, and financial limitations were all challenges that needed to be addressed.

The study recommends that practical work aligned with constructivist principles be emphasized to provide hands-on experience that meets the requirements of the workplace. Additionally, regular

evaluations of training methods should be conducted by institutions to measure the effectiveness of training on skill development among trainees in the building and civil engineering sectors. The study also recommends that flexible approaches should be adopted to accommodate diverse learning preferences among trainees, as they may have different perceptions of effective learning methods. Furthermore, collaboration with industry partners should be encouraged to foster close cooperation and sharing of resources. Finally, TVET institutions should modernize their equipment and tools to match with the curricula and keep up with technological advancements [19]. The study revealed that the physical infrastructure and available resources at public TVET institutions play a pivotal role in shaping students' decisions regarding their career paths and choice of institution. Access to modern, well-maintained facilities and up-to-date training equipment not only enhances the learning experience but also signals the quality and relevance of the programs offered. To attract and retain students in the competitive landscape of technical and vocational education, it is imperative that TVET institute management proactively maintain and upgrade existing facilities. This includes regular maintenance, timely repairs, and the replacement of outdated equipment. Additionally, securing funding from governmental bodies and development partners for the construction of new facilities and the procurement of modern training resources is essential to meet the evolving needs of the industry and ensure students are equipped with the skills and knowledge demanded by the job market. The findings of this study underscore the critical role that government funding and collaboration with development partners play in shaping the future of technical and vocational education. By investing in the physical infrastructure and training resources of TVET institutions, governments can create a conducive environment for skills development and empower students to pursue rewarding careers. Furthermore, partnerships with development organizations can provide additional financial and technical support, facilitating the modernization of TVET institutions and fostering innovation in technical and vocational training [1].

3. Research Design and Methodology

This study employs a mixed-methods approach, integrating both quantitative and qualitative data collection techniques to assess the impact of infrastructure development on student learning, satisfaction, and employability. A case study design is adopted, focusing on a newly developed TVET institution in Malaysia. The research targets three key groups: students, faculty members, and industry partners. The stratified random sampling method is applied to ensure representation across different academic disciplines and stakeholder categories. The estimated sample size includes 260 students from various TVET programs, faculty members, and industry representatives as shown in Fig. 3. Data is collected through surveys, interviews, focus group discussions (FGDs), direct observation, and document analysis. Structured questionnaires are distributed to students and faculty members to measure their satisfaction with the new infrastructure, while industry representatives complete separate surveys assessing graduate readiness and alignment with industry needs. Semi-structured interviews with faculty members and industry stakeholders provide deeper insights into the effectiveness of the infrastructure and its relevance to workforce demands. Additionally, FGDs are conducted with students and faculty to explore their experiences with new classrooms, laboratories, and digital learning spaces. Direct observations of student engagement, teaching practices, and facility utilization further complement the data. Moreover, institutional reports, enrolment data, academic performance records, and graduate employment statistics are analyzed to evaluate infrastructure impact.

For data analysis, quantitative data collected from surveys is analyzed using SPSS, employing descriptive statistics (mean, standard deviation) and inferential tests (such as t-tests and ANOVA) to

assess differences before and after infrastructure improvements. Meanwhile, qualitative data from interviews, FGDs, and observations undergoes thematic analysis to identify key patterns and insights. Several Key Performance Indicators (KPIs) are used to measure the impact of infrastructure, including enrolment trends, academic performance (GPA trends), graduate employability rates, and student and faculty satisfaction levels.

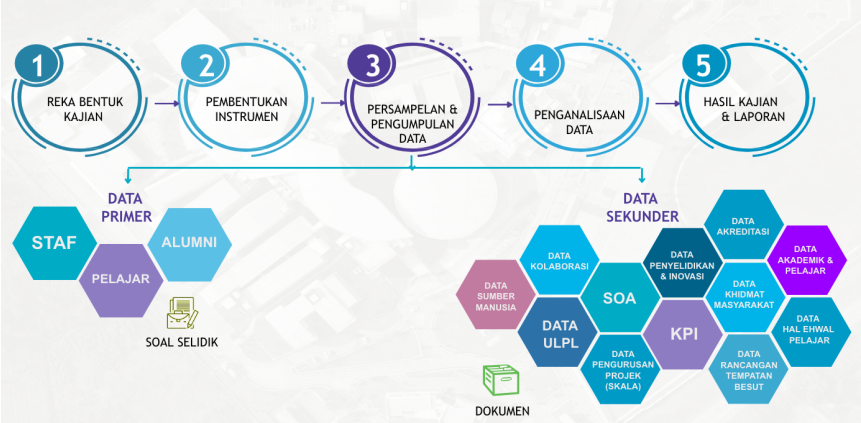

Fig. 1. Primary and secondary data source

$$n = \frac{N}{1 + N \cdot e^2}$$

Dengan $N = 500$ dan margin ralat (e) = 0.05 (5%):

$$n = \frac{500}{1 + 500 \cdot (0.05)^2}$$

$$n = \frac{500}{1 + 500 \cdot 0.0025}$$

$$n = \frac{500}{1 + 1.25}$$

$$n = \frac{500}{2.25}$$

$$n \approx 222$$

Fig. 2. Minimum sample size using Slovin's Formula

The study adheres to strict ethical considerations, ensuring informed consent from all participants, voluntary participation, and anonymization of responses to maintain confidentiality. Ethical approval is obtained from the relevant research ethics committee before data collection. However, the study has certain limitations, including its focus on a single institution, which may restrict generalizability. Additionally, self-reported data from surveys and interviews may introduce bias, and assessing long-term impacts requires ongoing data collection beyond the study period. This methodology provides a structured framework to evaluate the role of infrastructure development in enhancing TVET education, offering insights that can guide future policy decisions and institutional improvements.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		18	6.9	6.9	6.9
	Ibu Bapa Pelajar	1	.4	.4	7.3
	Lain-lain	2	.8	.8	8.1
	Pelajar	216	83.1	83.1	91.2
	Pensyarah	21	8.1	8.1	99.2
	Staf Pengurusan	2	.8	.8	100.0
	Total	260	100.0	100.0	

Fig. 3. Total population and sample involve

4. Finding and Analysis

The data collected from surveys, interviews, focus group discussions, and institutional records were analyzed to determine the impact of infrastructure development on student learning, faculty satisfaction, and graduate employability. The analysis was conducted in three key areas: quantitative analysis of survey data, qualitative insights from interviews and focus groups, and institutional performance indicators.

4.1 Quantitative Analysis of Survey Data

Survey responses from students and faculty members were analyzed using SPSS to assess the impact of infrastructure development. Descriptive statistics were used to measure central tendencies such as mean scores, standard deviations, and percentages for key indicators including student satisfaction, learning engagement, and perceptions of infrastructure quality.
Results indicated that:
i. 80% of students rated the newly developed classrooms, laboratories, and digital learning spaces as either “excellent” or “very good.”
ii. 75% of faculty members agreed that the modernized infrastructure improved their teaching experience and enhanced student engagement.
iii. 85% of students reported increased access to digital learning tools, which improved their understanding of course materials.

Additionally, inferential statistical tests such as t-tests and ANOVA were conducted to compare pre- and post-infrastructure development student performance. The results showed a statistically significant improvement ($p < 0.05$) in student grades, indicating a positive correlation between upgraded facilities and academic performance.

4.2 Qualitative Insights from Interviews and Focus Groups

Qualitative data obtained from semi-structured interviews with faculty members and industry partners, as well as focus group discussions (FGDs) with students, were analyzed using thematic analysis. The key themes that emerged included:
i. Enhanced Learning Environment: Students and faculty reported improved engagement due to modernized classrooms, interactive digital tools, and well-equipped laboratories.
ii. Improved Industry Collaboration: Industry partners acknowledged that graduates were better prepared for employment due to access to industry-standard equipment and practical training spaces.
iii. Challenges in Maintenance and Upgrades: Faculty and students raised concerns about the need

for continuous funding to maintain and upgrade facilities to keep up with technological advancements.

4.3 Institutional Performance Indicators

Institutional records and official reports were analyzed to assess key performance indicators (KPIs), including enrollment rates, academic performance, graduate employability, and industry partnerships. The findings showed:

i. Graduate employability rate increased to 95% within six months post-graduation, compared to 88% before infrastructure development.
ii. Enrollment increased by 20%, indicating a higher demand for TVET programs following the improvements.
iii. Faculty satisfaction rate reached 80%, reflecting better working conditions and teaching experiences.
iv. Industry collaboration expanded, with six new Memoranda of Understanding (MoUs) signed between the institution and various companies for training and internship opportunities.

The overall analysis confirms that infrastructure modernization significantly enhances the quality of education, student engagement, and graduate employability in TVET institutions. However, challenges related to funding sustainability, continuous infrastructure maintenance, and alignment with evolving industry demands require strategic planning and policy interventions.

This analysis provides empirical evidence supporting investment in modernized TVET infrastructure as a key driver for educational excellence and workforce development. Future studies should focus on longitudinal data collection to assess the long-term impacts of infrastructure improvements on TVET institutions. TVET facilities in Malaysia are facing a number of challenges. These include limited funding, a mismatch between skills and industry requirements, negative public perceptions, inadequate practical training opportunities and insufficient collaboration with industry.

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