Journal of Theoretical and Applied Information Technology
15th June 2025. Vol.103. No.11

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

ENABLING INFORMATION TECHNOLOGY IN DESIGNING THE TVET MODEL FOR TVET EDUCATION PROGRAM

ROSZIATI IBRAHIM[1], KHADIJAH MD ARIFFIN[2*], SANI INUSA MILALA[2#], MAZIDAH MAT REJAB[1*], SAPIEE JAMEL[1#], ABDUL RASID ABDUL RAZZAQ[3]

[1]Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia, Malaysia
[2]Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Malaysia
[3]Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, Malaysia

E-mail: [1]rosziati@uthm.edu.my, [2*]hadija@uthm.edu.my, [2#]saniinusmilala4@gmail.com , [1*]mazidah@uthm.edu.my, [1#]sapiee@uthm.edu.my, [3]rasid@uthm.edu.my

ABSTRACT

Technical and Vocational Education and Training (TVET) is essential for equipping students with industry-relevant skills and bridging the gap between vocational training and higher education. In Malaysia, the TVET matriculation program serves as a pathway for students transitioning into degree program. However, concerns persist regarding its effectiveness in preparing students for the academic and technical demands of higher degrees while meeting industry expectations. This study reviews previous research on TVET models, then the features of TVET models are extracted from different countries. The ideal TVET model is then proposed. The implementation plan of TVET model is executed to enhance the employability of students in TVET education program. Enabling the information technology in designing the TVET model, this paper discusses the effectiveness of executing the TVET model. Four main domains are discussed for effectiveness of TVET model. They are curriculum, implementation, feedback and review. This TVET model provides a structured framework for continuous curriculum improvement, ensuring better student preparedness and workforce alignment.

Keywords: *IT and Education, TVET Model, Workforce Alignment, Career Awareness, Industry Skills*

1. INTRODUCTION

Technical and Vocational Education and Training (TVET) refers to educational programs that equip individuals with industry-relevant skills, knowledge, and competencies essential for the labor market [1] TVET plays a crucial role in addressing skill shortages, enhancing employability, and fostering economic growth by aligning education with workforce demands [2]. As Malaysia advances toward a knowledge-based economy, strengthening TVET pathways into higher education has become a national priority to ensure a well-rounded and highly skilled workforce [3]. TVET plays a crucial role in equipping students with industry-relevant skills, preparing them for both the workforce and higher education [4].

TVET plays a pivotal role in producing a skilled workforce that aligns with Malaysia's industrial and economic needs [5]. The effectiveness of TVET education programs in equipping students with the necessary knowledge, skills, and competencies for higher education success is of paramount importance [6]. According to [7], competency development in TVET institutions relies on the integration of knowledge, skills, and attitudes, which are essential for academic and professional success. However, the extent to which these competencies translate into higher education preparedness remains uncertain. This study addresses this gap by providing a comprehensive assessment of TVET matriculation graduates' readiness for degree programs, offering insights into curriculum standardization, student support strategies, and policy recommendations to enhance academic preparedness.

This study presents an innovative Technical and Vocational Education and Training (TVET) model designed to address significant gaps in Malaysia's TVET matriculation program. Examining international TVET models and identifying key elements, the research develops a technology-driven TVET model customized for Malaysia,

emphasizing four core implementation areas: curriculum, application, feedback, and evaluation. This systematic approach enhances student preparedness for higher education while aligning workforce capabilities with industry requirements, thereby promoting employability and ongoing curriculum advancement.

The rest of this paper is outlined as follows. Section 2 discussed the related work and Section 3 proposed the new TVET model for Malaysia perspective. Section 4 discusses the implementation of the proposed TVET model. The effectiveness of TVET. framework is discussed in Section 5 and Section 6 draws the conclusion.

2. RELATED WORK

TVET has a rich historical background that dates to the pre-industrial era, where apprenticeships and craft-based learning were the primary means of acquiring skills [8]. During this period, skills were passed down through generations within families or through master-apprentice relationships, ensuring the continuity of trades and crafts [8]. The industrial revolution in the 18th and 19th centuries marked a significant shift in TVET, as the demand for skilled labor in factories and industries grew exponentially [9]. This period saw the formalization of vocational training, with the establishment of technical schools and institutions aimed at equipping workers with the necessary skills to operate machinery and manage industrial processes [10].

In the 20th century, TVET continued to evolve, particularly in response to the changing needs of the global economy [10]. The post-World War II era, for instance, witnessed a surge in the establishment of vocational training centers and polytechnics, especially in developing countries, as part of efforts to rebuild economies and reduce unemployment [10]. During this period, TVET was increasingly recognized as a critical component of national development strategies, with governments investing in vocational education to address skills shortages and promote economic growth [11].

In many countries, TVET has been shaped by colonial legacies and post-independence reforms [12]. For example, in Nigeria, the inferior positioning of TVET can be traced back to colonial policies that prioritized academic education over vocational training, a trend that persisted even after independence [12]. Similarly, in Malaysia, the development of TVET has been influenced by the country's industrialization policies, which sought to create a skilled workforce capable of supporting economic diversification and technological advancement [13].

The late 20th and early 21st centuries have seen a renewed emphasis on TVET as a means of addressing global challenges such as youth unemployment, technological advancement, and the need for sustainable development [14]. International organizations, including UNESCO and the World Bank, have played a pivotal role in promoting TVET as a tool for social and economic inclusion, particularly in developing countries [15]. This period has also witnessed the integration of TVET into broader education systems, with efforts to align vocational training with labor market needs and to enhance the quality and relevance of TVET programs [16].

In recent years, the focus on TVET has expanded to include the development of soft skills and the integration of technology into vocational training [17]. For instance, in Malaysia, there has been a concerted effort to enhance the professionalism and generic skills of TVET lecturers, recognizing the importance of these attributes in delivering high-quality vocational education [18].

Despite these advancements, challenges remain in the global TVET landscape [19]. These include the persistent stigma associated with vocational education, the mismatch between TVET programs and labor market needs, and the need for greater investment in TVET infrastructure and teacher training [20]. Addressing these challenges requires a concerted effort from governments, industry stakeholders, and educational institutions to reposition TVET as a viable and attractive pathway for skills development and career advancement [21]. Figure 1 illustrates the evolution of TVET, highlighting key transformations and trends over time.

Based on Figure 1, the historical evolution of TVET reflects its critical role in addressing the skills needs of societies across different eras. From its origins in apprenticeships to its status as a key component of national education systems, TVET has continually adapted to meet the changing demands of the global economy [22]; [23]; [24]. Table 1 presents a review of previous research on TVET models, summarizing key findings and methodologies.

Table 1: Review of previous research on TVET models

Author/	Title of Research	TVET Model	Description	Strengths	Weaknesses
[25]	Models in TVET	Institution-Based, Apprenticeship, Dual-System	Categorizes TVET models into three main approaches.	Provides flexibility in training approaches.	Lacks integration between industry and academia in some cases.
[26]	Tools and means to understand different TVET models in developing countries: An approach to the epistemological opening up of international TVET in development cooperation	Contextual TVET Model	Discusses TVET models in developing nations and their adaptability to economic conditions.	Contextual approach to TVET development.	Challenges in standardization across different countries.
[27]	The development of interactive case-based smart thinking and industrial problem-solving stimulator to enhance TVET students' thinking skills	Design Thinking TVET Model	Introduces design thinking as a framework for improving TVET learning experiences.	Enhances creativity and problem-solving skills.	Implementation requires trained educators.
[28]	Coe TVET Model Development in Economics and Creative Business	Coe TVET Model	Focuses on integrating business and economic education within TVET programs.	Bridges gap between business skills and technical training.	Requires strong industry collaboration.
[29]	Good Practice Models for Using TVET to Address Skill Shortages	Skills-Based TVET Model	Investigates TVET's role in addressing skill shortages in the health sector.	Aligns training with labor market needs.	Limited to specific industries.
[30]	ICT-Enabled TVET Education; a systematic literature review	ICT TVET Model	Examines the role of ICT in TVET education.	Enhances accessibility and digital competency.	Requires significant infrastructure investment.
[31]	Sustainable Curriculum in TVET	Sustainable TVET Model	Focuses on sustainable TVET curriculum development.	Promotes environmentally conscious skills.	Requires policy support for sustainability integration.
[32]	TVET teachers and instructors in Germany	TVET Teacher Education Model	Analyzes TVET teacher training models in Germany.	Strong teacher training framework.	May not be directly applicable to other contexts.
[33]	Technical vocational education and training (TVET) model in the disruptive technology era	Industry 4.0 TVET Model	Evaluates TVET adaptation to technological changes.	Prepares students for Industry 4.0.	Requires continuous curriculum updates.
[34]	Development of Competency Framework for Nigerian TVET Teachers	Nigerian TVET Competency Model	Proposes a competency framework for Nigerian TVET teachers.	Enhances teacher quality and professionalism.	Implementation challenges in underfunded institutions.
[35]	Development of TVET Leadership Model	TVET Leadership Model	Focuses on leadership models in TVET institutions.	Strengthens governance and institutional management.	Effectiveness depends on leadership quality.
[36]	Evaluation of Technical and Vocational Education and Training (TVET) Programmes in Nigeria	Kirkpatrick TVET Model	Assesses TVET programs using the Kirkpatrick Model.	Provides comprehensive evaluation framework.	Data collection and analysis may be complex.
[37]	*TVET in Malaysia: Vocational Education and Training in ASEAN Member States*	Dual Training System (DTS)	A model that integrates theoretical education in vocational institutions	- Strong industry linkages - Real-world experience - Enhances employability	- High dependency on industry collaboration - Limited availability of placements

[38]	*Knowledge, Skills, and Attitudes as Predictors in Determining Teachers' Competency in Malaysian TVET Institutions*	Competency-Based Training (CBT)	A learner-centered approach focusing on mastering specific competencies rather than time-based learning.	- Personalized learning pace - Focus on skill mastery - Industry-aligned competencies	- Requires highly trained instructors - Difficult assessment standardization - Limited focus on theoretical knowledge
[39]	*Factors Influencing Students' Attitudes Towards TVET*	School-Based TVET	TVET programs delivered entirely within educational institutions with limited industry exposure.	- Structured curriculum - Accessible to a larger student population - Standardized learning materials	- Lack of hands-on industry experience - Outdated training equipment - Limited industry partnerships
[40]	*Predicting Students' Inclination to TVET Enrolment Using Various Classifiers*	Work-Based Learning (WBL)	A model that places students directly in the workforce, where they learn through on-the-job training.	- Strong practical exposure - Immediate workforce integration - Builds professional networks	- Inconsistent training quality across workplaces - Employers may prioritize productivity over learning - Limited theoretical grounding
[41]	*Designing the Structural Model of TVET Lecturers' Professionalism and Generic Skills*	Blended Learning TVET	Combines online learning, classroom instruction, and hands-on training for flexibility.	- Flexible learning opportunities - Allows self-paced study - Expands in access to TVET education	- Digital divide issues - Requires strong ICT infrastructure - Less hands-on experience if not properly balanced

Based on Table 1, the current research on TVET highlights the diversity of approaches to vocational education and training, each with its own strengths and weaknesses. Figure 2 illustrates the summarization of the components needed for TVET model based on the reviews from Table 1.

Based on Figure 2, the summarization of components for TVET model consists of institution-based model, contextual model, design thinking model, skills-based model and ICT model. These components with enabling information technology are used to design the TVET model.

Several countries, such as [42] and [43], have implemented innovative and effective practices in TVET that can serve as benchmarks for others.

TVET plays a crucial role in addressing workforce demands by equipping students with practical skills and industry-relevant knowledge [44]. TVET models have proven effective in enhancing employability by bridging the gap between academic education and the actual requirements of industries. Work-Based Learning (WBL) is among the most impactful approaches, combining classroom instruction with hands-on industry experience. Studies highlight that WBL significantly improves job readiness by providing real-world exposure, as observed in Malaysia's TVET institutions [44]. Competency-Based Training (CBT) further ensures graduates are equipped with industry-specific competencies, aligning their skills closely with market standards.

Collaboration between TVET institutions and industries is another critical factor contributing to employability [43]. Industry partnerships facilitate curriculum development, internships, and job placements, resulting in higher employment rates for graduates [45]. Outcome-Based Education (OBE), focusing on measurable learning outcomes, ensures that students acquire the knowledge and skills directly demanded by employers [46]. Moreover, integrating technology into TVET programs, such as virtual simulations and e-learning platforms, has revolutionized skill training by offering innovative and competitive advantages [46].

While TVET demonstrates considerable success, challenges persist. Limited funding, outdated curricula, and a shortage of qualified instructors hinder its potential [47]. Addressing these issues

requires increased investment in modernizing infrastructure and training facilities, along with regular curriculum updates to align with evolving industry needs [48]. Capacity-building programs for instructors are vital to ensuring they stay abreast of the latest methodologies and technologies [49]. Strengthening industry linkages remains essential for aligning training programs with market demands [50]. Public awareness campaigns promoting TVET as a viable educational pathway can help improve perceptions and attract more students to these programs. These issues are highlighted in [51] and [52].

TVET models significantly enhance employability by providing students with the skills and knowledge required for industry success which is discussed in [53]. According to Paryono [54]. while challenges remain, innovative approaches and strengthened collaborations can further improve the effectiveness of TVET education programs. Addressing workforce demands and reducing unemployment rates, TVET continues to play a pivotal role in shaping the future of education and employment as discussed in [55].

3. METHODOLOGY

The methodology of this study adopts a systematic approach to develop an optimized TVET model tailored for Malaysia. Initially, previous research and international practices in TVET models were thoroughly reviewed to identify key features and innovative strategies. The study employs a comparative analysis of TVET frameworks from various countries, extracting critical components to inform the design of a robust, technology-driven TVET model. Subsequently, the proposed model focuses on enhancing employability through a practical implementation plan, targeting curriculum design, execution processes, feedback mechanisms, and iterative reviews. Information technology integration is leveraged throughout the methodology, enabling a data-informed approach to curriculum development and adaptation. The effectiveness of the model is assessed across four domains: curriculum alignment, implementation fidelity, stakeholder feedback, and continuous improvement, ensuring its relevance in bridging the academic-industry gap. The conceptual model of this study revolves around designing a robust TVET model tailored to Malaysia's context. It begins with analyzing global TVET models to extract their key features, which are then synthesized to create an ideal model. The core of the model focuses on four interconnected domains: curriculum design, implementation strategies, feedback mechanisms, and iterative review. Information technology acts as an enabler, integrating tools and systems that support these domains for effective execution. The outcome of this model aims to enhance student preparedness for higher education and workforce demands, while continuously improving the curriculum through stakeholder feedback and performance evaluation. This holistic approach ensures alignment with industry needs and fosters employability among students.

Some limitations exist that may impact the scope and applicability of the study. Firstly, the reliance on secondary data from previous research and international TVET models may introduce biases or limit the specificity of the findings to Malaysia's unique socioeconomic and industrial context. Additionally, the comparative analysis might overlook localized factors, such as cultural, institutional, and policy variations, which could influence the effectiveness of the proposed model. The implementation plan, while theoretically robust, may face practical challenges like resistance to change, resource constraints, or varying levels of technological readiness across institutions. Lastly, the evaluation of the model's effectiveness could benefit from longitudinal studies and real-world testing, as the short-term assessment may not fully capture long-term impacts on employability and workforce alignment.

4. THE PROPOSED TVET MODEL

Figure 3 shows the proposed TVET model. The model aims to evaluate and enhance the effectiveness of the TVET Education Program in preparing students for degree programs in higher institutions. The model incorporates key components such as curriculum design, teaching methods, assessment strategies, and industry partnerships, ensuring that students develop industry-relevant competencies and practical skills as in.

The foundation of the TVET model as illustrated in Figure 3 is curriculum enhancement. This will be achieved through modular training and competency-based learning. Modular training ensures that students' progress in stages, mastering fundamental skills before moving on to advanced technical competencies. Meanwhile, competency-based learning focuses on practical application, enabling students to develop job-ready skills that are directly relevant to their chosen fields. Through

integrating industry-specific certifications within the curriculum, students will gain additional qualifications that will improve their employability and career readiness.

TVET model provides a structured approach to evaluate the success of the TVET Education Program. The model integrates various components, including TVET program provisions, student outcomes, driver choices, industry needs, implementation strategies, and evaluation mechanisms to ensure the program's effectiveness.

Innovative teaching strategies are critical to engaging TVET students effectively. The TVET model will incorporate blended learning approaches, simulated work environments, and problem-based learning (PBL) to improve student engagement. Blended learning combines traditional face-to-face instruction with e-learning platforms, ensuring flexibility and accessibility. Simulated work environments, such as virtual reality (VR) labs, industry-relevant workshops, and digital twin simulations, allow students to practice technical skills in realistic settings before transitioning to on-the-job training. Additionally, problem-based. learning (PBL) encourages students to collaborate on real-world challenges, fostering critical thinking and problem-solving skills necessary for technical professions.

Based on Figure 3, a key feature of the TVET model is its strong industry integration, which ensures that students gain hands-on experience before entering the workforce. This is facilitated through on-the-job training, mentorship programs, and industrial placements. On-the-job training (OJT) provides students with exposure to real-world working environments, where they apply classroom knowledge to practical scenarios. Mentorship programs pair students with industry professionals, guiding them in career decision-making and professional development. Additionally, industrial placements and internships serve as a bridge between education and employment, increasing students' chances of securing jobs upon graduation.

5. EFFECTIVENESS OF TVET MODEL

Figure 4 presents the components to ensure TVET model is effective. The components consist of program effectiveness, industry partnerships, assessment strategies, teaching methods and curriculum design.

Based on Figure 4, the curriculum design of the TVET model is structured to include a balance of technical skills, problem-solving abilities, and soft skills development. The teaching methods integrate experiential learning, competency-based training, and project-based assignments, which are essential in a TVET-based curriculum. Additionally, the assessment strategies component incorporates continuous evaluation methods such as skill-based assessments, industry-driven projects, and performance-based grading, which align with the needs of the TVET sector. Furthermore, the industry partnership component is strengthened by internships, apprenticeship programs, and industry collaborations, ensuring that students gain exposure to real-world work environments before progressing to degree-level studies in universities. These components ensure the program effectiveness.

The foundation of the TVET model lies in the TVET Program Provisions as shown in Figure 5, which include essential elements such as curriculum content, knowledge relevancy, student support and practical hands-on learning. These elements ensure that students receive sufficient preparation for a TVET Bachelor's Degree, aligning their education with industry expectations. Moreover, the availability of student feedback platforms and multiple pathways for further studies allows for a flexible learning environment tailored to individual needs.

The overall assessment of the model's effectiveness is based on the interaction between TVET program provisions, student outcomes, and industry needs. By evaluating student satisfaction, employability rates, industry feedback, and curriculum relevance, the model provides a systematic framework for continuous improvement. Institutions can use these insights to modify teaching methodologies, upgrade infrastructure, and enhance student engagement to maximize program impact. This TVET Effectiveness Assessment Model offers a comprehensive and structured approach to evaluating and improving the quality of TVET education. By integrating student aspirations, industry demands, curriculum improvements, and continuous assessment mechanisms, the model ensures that TVET graduates are well-prepared to meet the challenges of the modern workforce.

Figure 6 illustrates the connection between student aspirations and industry demands in TVET Model.

The model acknowledges that students' choices to enroll in TVET program are influenced by various factors, including personal interest, career opportunities, parental choice, and peer influence as discussed in [20]. These factors shape the demand for TVET education to ensure the skills are developed. On the other hand, the model also considers industry needs, which emphasize employability rates, productivity, compatibility, and industry satisfaction. A well-designed TVET Model must bridge the gap between student aspirations and industry expectations by aligning curriculum design with real-world job requirements.

TVET model may follow a structured step-by-step implementation that ensures a seamless transition from matriculation to degree-level education. The process incorporates curriculum enhancement, innovative teaching methods, industry integration, student support systems, and a robust monitoring mechanism to optimize student learning and employability outcomes. Figure 7 illustrates the student support system in ensuring the success of implementing the effectiveness of TVET model.

Based on Figure 7, to ensure successful career progression, the TVET model emphasizes that a comprehensive student support system should be integrated. This includes career counseling, mentoring, and personalized guidance to help students choose TVET pathways aligned with their interests and abilities. Career counseling services help students identify career opportunities within various industries and advise them on education-to-employment pathways. Mentorship programs provide additional support by connecting students with alumni, industry experts, and faculty mentors who offer guidance on academic and career development. Additionally, personalized learning plans cater to individual student needs, ensuring that learners with different skill levels receive appropriate academic and professional support.

This continuous monitoring and feedback ensure that the TVET curriculum remains relevant and aligned with industry demands. Figure 8 shows the effectiveness of execution of the TVET model

Based on Figure 8, to ensure the effectiveness of execution of TVET model, 4 main domains need to be implemented. They are Curriculum, Implementation, Feedback and Review. The TVET model is assessed using quantitative evaluation methods to measure student success, employability, industry satisfaction, and long-term career growth. The curriculum must be designed first before it can be implemented. After the implementation of the curriculum, feedback needs to be gathered. Feedback can come from academic performance, technical proficiency, soft skills and enrollment rate of the program.

Student academic progress is evaluated through practical skill assessments, competency evaluations, and coursework performance. The competency-based approach ensures that students develop job-relevant technical skills, while continuous assessments track progress and learning outcomes.

Figure 9 highlights the components that need to be stressed to ensure the success of implementing the TVET model. The effectiveness of the TVET Education Program is measured through student satisfaction, industry feedback, graduate employability rate, student performance, and competency levels. The success of the program is reflected in how well students adapt to their future careers, their ability to meet industry demands, and their overall satisfaction with the education received. Industry feedback plays a crucial role in refining the curriculum and ensuring students acquire relevant skills that enhance their employability.

The success of the TVET model is reflected in employment placement rates, job retention, and career advancement. A study by Aziz et al. [17] highlights the importance of tracking graduates' employment status to determine whether TVET programs are producing workforce-ready professionals. Institutions use employment tracking systems to collect data on job placement trends and adjust curriculum and training accordingly.

Employers play a crucial role in evaluating the TVET model's effectiveness. Feedback from industry mentors, internship supervisors, and hiring managers provides insights into the technical and soft skills of graduates. Industry satisfaction surveys measure compatibility between TVET education and workforce needs, ensuring continuous curriculum enhancement.

Student satisfaction is another key indicator of the program's success. High satisfaction levels indicate that students feel supported and well-prepared for their careers, leading to higher retention rates and program completion rates.

To assess the long-term impact of the TVET model, longitudinal studies track graduates' career progression, job performance, and contributions to the industry. These studies will provide data-driven insights into how well the program prepares students for sustained career growth and whether adjustments are needed to align with future industry trends.

6. CONCLUSION

TVET model presents a structured and effective approach to bridge the gap between technical and vocational education and university-level degrees. By integrating curriculum enhancement, innovative teaching methods, industry partnerships, student support systems, and a robust evaluation framework, the model ensures that students acquire the technical skills, competencies, and employability attributes required for success in the modern workforce. The systematic monitoring and feedback mechanisms allow continuous improvement, ensuring that TVET education remains relevant, industry-driven, and adaptable to future economic demands.

Enabling the information technology in designing the TVET model gives the TVET graduates' benefit from industry exposure, competency-based learning, and structured career guidance, leading to higher employability rates and workforce readiness. Additionally, the incorporation of longitudinal tracking and industry feedback ensures that the TVET model remains aligned with evolving labor market needs. However, challenges such as limited access to resources, industry collaboration gaps, and student retention issues highlight areas requiring further improvement and policy adjustments. Ultimately, the TVET model provides a scalable and adaptable framework for transforming TVET education, promoting lifelong learning, and equipping students with the necessary skills to thrive in the Fourth Industrial Revolution (IR 4.0).

ACKNOWLEDGEMENTS

This research was supported by Universiti Tun Hussein Onn Malaysia (UTHM) through Contract Grant UTHM Q623. The authors would like to thank UTHM for supporting this research and polytechnics who participate the survey.

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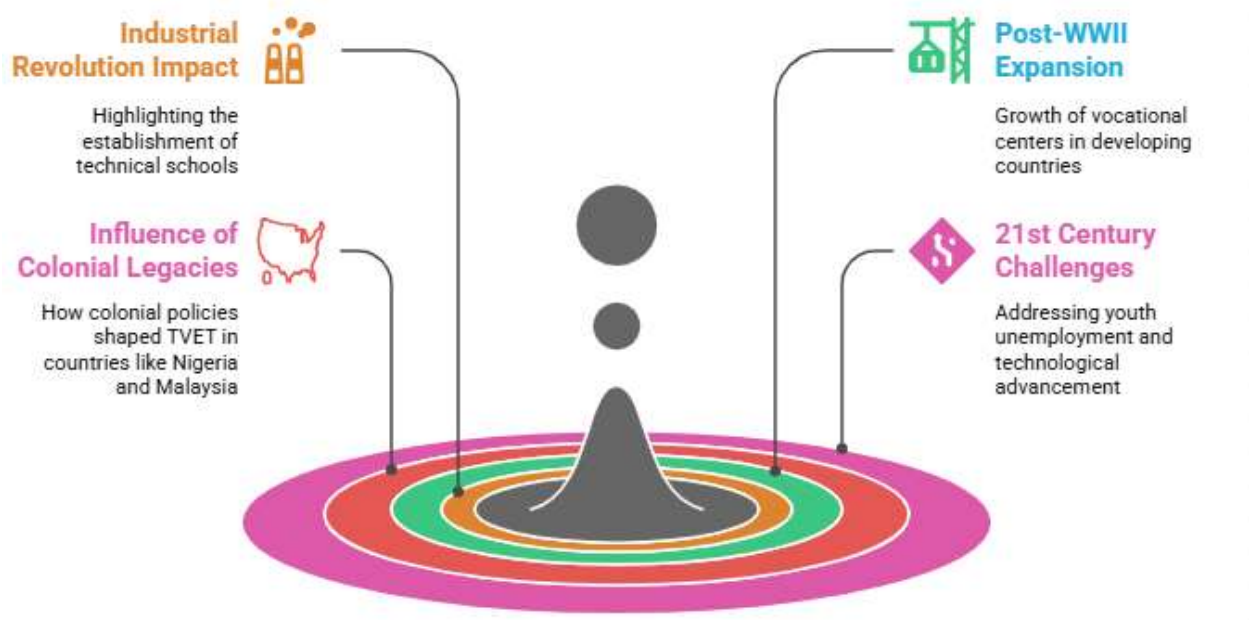

Figure 1: Evolution of TVET

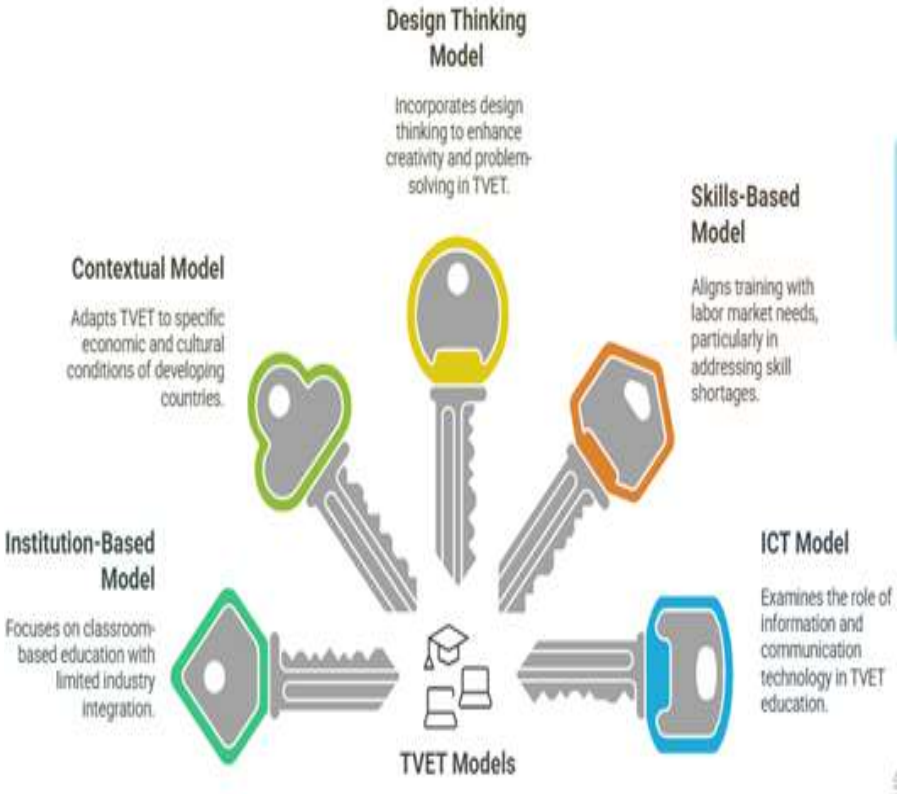

Figure 2: Summarization of components needed for TVET Model

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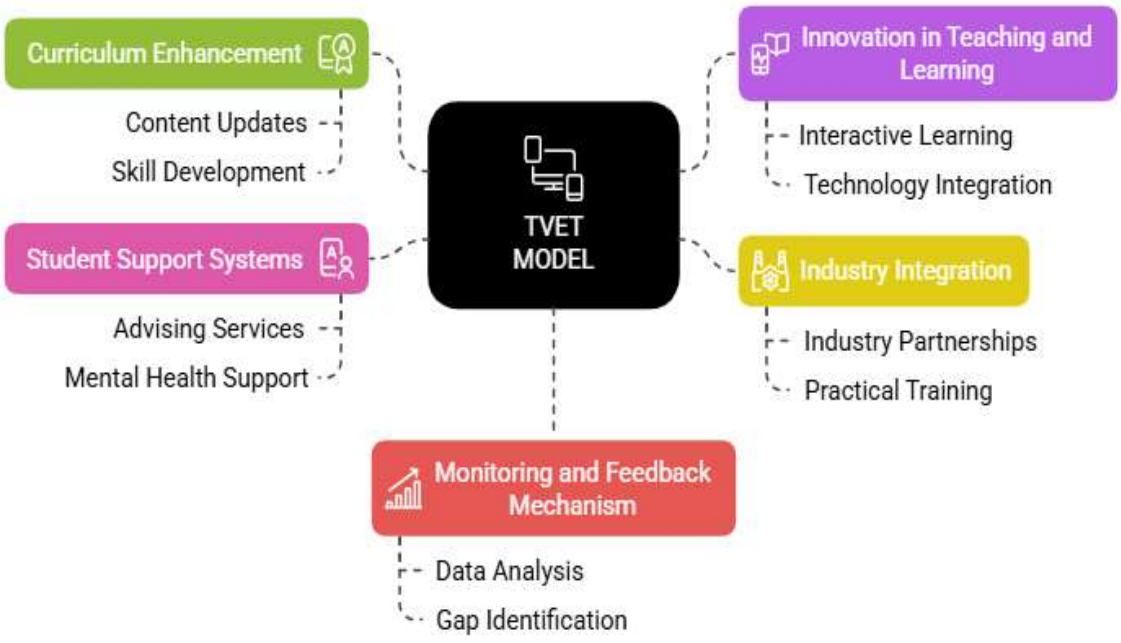

Figure 3: The Proposed TVET Model

***Figure 4**: Components to Ensure Effectiveness for TVET Model*

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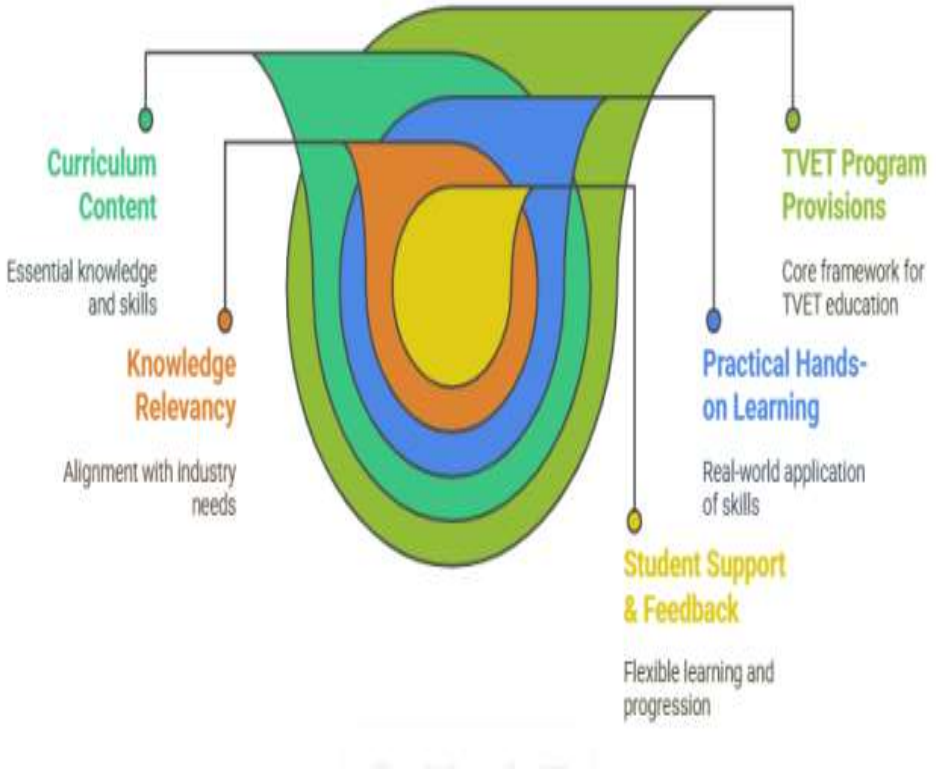

Figure 5: TVET Program Provisions

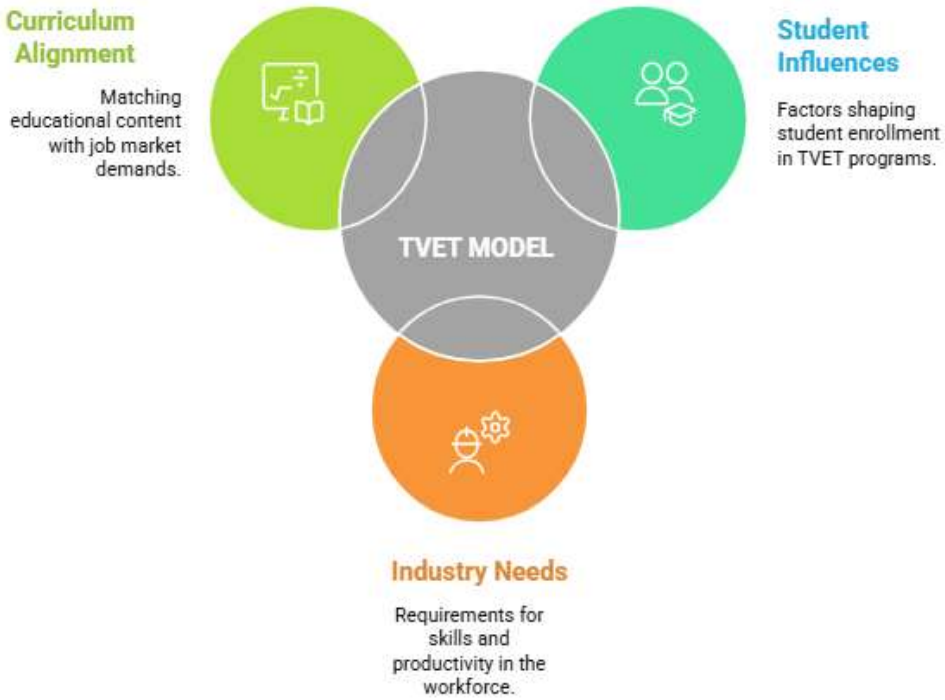

Figure 6: Bridging Student Aspirations with Industry Demands in TVET Model

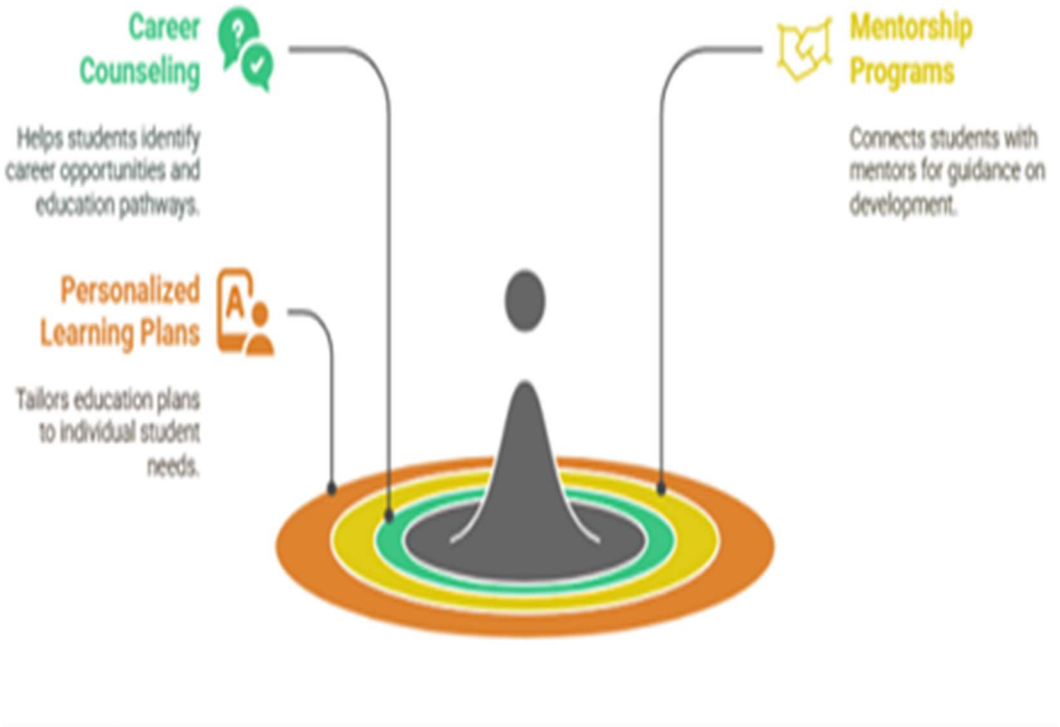

Figure 7: Student Support System to Ensure the Effectiveness of TVET Model

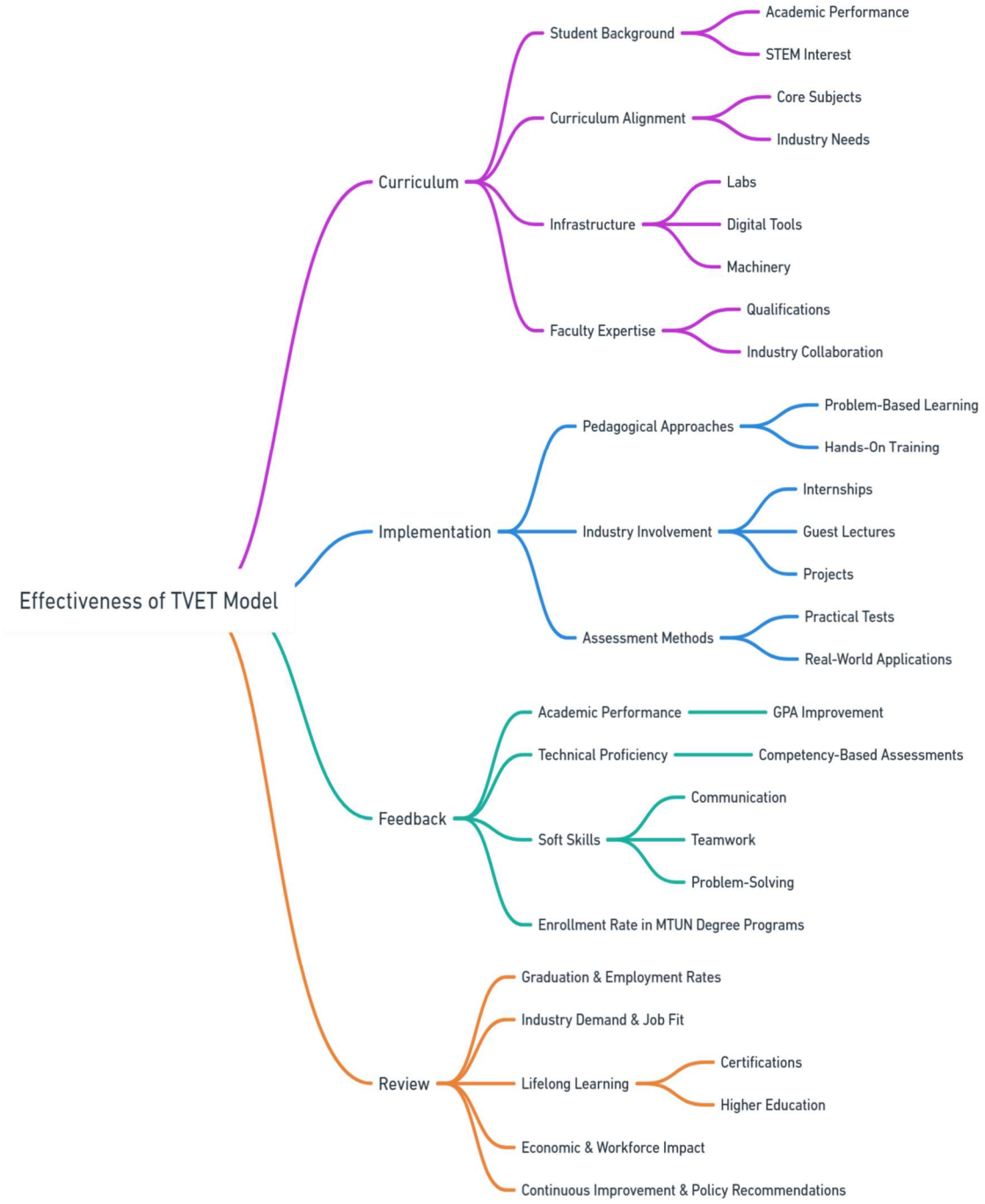

Figure 8: Effectiveness of TVET Model

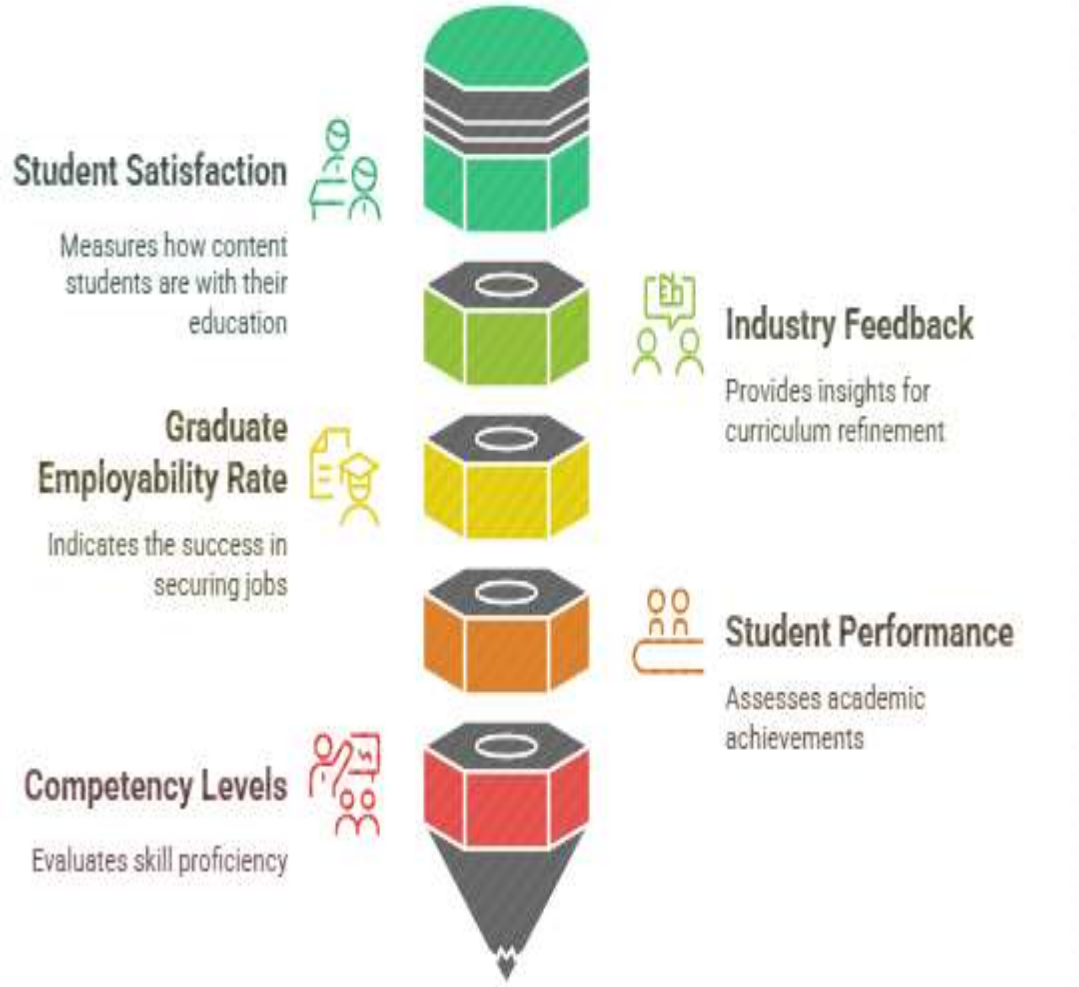

Figure 9: Components for TVET Program Success