INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

Vol 15, Issue 4, (2025) E-ISSN: 2222-6990

# Examining Key Determinants of Ubiquitous Technology Adoption in TVET Higher Education: A UTAUT-Based Approach

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**To Link this Article:** http://dx.doi.org/10.6007/IJARBSS/v15-i4/25272 DOI:10.6007/IJARBSS/v15-i4/25272

***Published Date:*** 15 April 2025

**Abstract**

The Unified Theory of Acceptance and Use of Technology (UTAUT) identifies Performance Expectancy (PE), Effort Expectancy (EE), Behavioral Intention (BI), Facilitating Conditions (FC), and Social Status (SS) as key factors influencing technology adoption. This study investigates whether these factors contribute to the usage of ubiquitous technology (U-Tech), specifically laptops, smartphones, and tablets, among TVET students in higher education institutions in Malaysia. The research employs a quantitative approach, utilizing structural equation modeling (SEM) via AMOS. Findings indicate significant relationships: Technology Competency (TC) ($\beta = 0.35$, $p = 0.000$), Performance Expectancy ($\beta = 0.41$, $p = 0.000$), and Facilitating Conditions ($\beta = 0.23$, $p = 0.000$) influence U-Tech usage directly. Meanwhile, the influence of EE ($\beta = 0.26$, $p = 0.000$) and SS ($\beta = 0.52$, $p = 0.000$) on U-Tech usage is mediated by BI. These results suggest that 63% of the variance in U-Tech usage is explained by these factors, offering insights into technology adoption in academic settings, especially among TVET students.

**Keywords:** *UTAUT,* Structural Equation Modeling, Ubiquitous Technology, Higher Education, Technology Adoption

## Introduction

*Ubiquitous Technology (U-Tech) in Education*

In the 21st century, alongside rapid technological advancements, students have increasingly embraced mobility in their learning experiences. They expect to have access to technology wherever they go, seeking instant gratification and immediate feedback (Aguilos & Fuchs, 2022). Information and Communication Technology (ICT) can be described as the integration of technological devices into education and other society sectors (Mohd & Faaizah, 2021).

Additionally, students anticipate seamless connectivity, using technology for both academic and social interactions. Their vision of an ideal learning environment includes integrating the latest technological tools in classrooms, enabling real-time information retrieval from the internet (Kilbane & Milman, 2013). They aspire for their learning spaces to mirror the digitally connected world they live in, allowing them to utilize technology anytime and anywhere (Beetham & Sharpe, 2013). The nature of the new technology interweaves formal and informal learning such that students can participate actively in the use of ICT to learn (Mohd & Shahbodin, 2021). This growing demand has led to the incorporation of ubiquitous technology (U-Tech) in education. Currently, the most commonly used U-Tech devices among students include laptops (Awwad et al., 2013), smartphones (Backer, 2010), and tablets (Zain et al., 2013). Other U-Tech tools, such as Personal Digital Assistants (PDAs) (Shariffudin et al., 2012), MP3 players (Tan, 2013), and smart boards (Olugbade, Dare & Tolorunleke, 2023). Examining the impact of interactive smart board use on technical students' learning outcomes in Nigerian higher educational institutions. Journal of Education in Black Sea Region, 8(2), 30-40.), also contribute to enhancing the learning experience. This study focuses on laptops, smartphones, and tablets, as they are the primary technologies used by students for educational purposes.

U-Tech encompasses multifunctional and advanced mobile communication tools that support various activities, including making calls, browsing the internet for information, checking emails, navigating locations via Global Positioning System (GPS), and capturing photos or videos (Ying, Susilo, Mei & Rahardjanti, 2021). These features simplify students' daily tasks by consolidating multiple functions into a single device, ensuring accessibility and efficiency in learning (Passow, 2012). Moreover, U-Tech provides learners with rapid access to the latest information and knowledge, facilitated by internet connectivity, making learning faster and more convenient (Hwang et al., 2011). U-Tech is recognized as a highly versatile device, seamlessly integrating mobility and connectivity while incorporating powerful processors that allow users to manage multiple computing tasks simultaneously (Sedek et al., 2012). Its lightweight and portable nature enables users to carry it effortlessly, making technology accessible anytime and anywhere (Fareed & Kirkil, 2025). Additionally, U-Tech is designed to be interactive, featuring a visually engaging interface, high-speed performance, responsive touch controls, and instant feedback, enhancing user experience and engagement (Corona et al., 2013).

*Enhancing Ubiquitous Technology Utilization in Malaysian TVET Institutions: A Pathway to SDG 4*

In the era of digital transformation, Technical and Vocational Education and Training (TVET) institutions in Malaysia play a pivotal role in equipping students with the necessary skills for the workforce. In Malaysia, TVET institutions offer a wide range of courses and qualifications, from certificates and diplomas to bachelor's degrees and postgraduate education in various disciplines, such as engineering, information technology, automotive studies, and many others (Sedek & Mohd, 2025). The integration of ubiquitous technology (U-Tech) has become essential in supporting student learning, fostering digital competencies, and ensuring alignment with Sustainable Development Goal 4 (SDG 4): Quality Education. SDG 4 emphasizes the need for inclusive, equitable, and lifelong learning opportunities, which can be facilitated through seamless access to technology (Ra, Jagannathan & Maclean, 2021). U-Tech is regarded as a versatile tool that enhances mobility, connectivity, and interactivity,

enabling students to engage in learning anytime and anywhere. Its advanced computing capabilities allow for simultaneous task execution, making it a crucial asset in TVET education (Sedek et al., 2012). As Malaysia continues to push for a technology-driven workforce, integrating smartphones, laptops, and tablets into TVET institutions ensures that students develop relevant digital competencies essential for employment in Industry 4.0 and beyond. The sustainability of Malaysian technical universities is very important, and these universities carry a huge responsibility in producing competent skillful graduates (Sedek, Hussein, Husin, & Jalil, 2025). Lecturers play an important role in achieving the nation's objective. The lecturers have to be competent and efficient to carry out the task given to them by the university. An occupational framework can be an option for training and develop competent lecturers (Che Amran et al, 2020).

The advantages of ubiquitous technology (U-Tech) in TVET align with SDG 4: Quality Education, ensuring inclusive and equitable learning opportunities. U-Tech enhances learning access by allowing students to retrieve educational resources anytime and anywhere, fostering self-directed and lifelong learning. It also promotes skill development by strengthening digital literacy, problem-solving, and critical thinking through interactive and technology-driven environments. Additionally, U-Tech supports flexible learning models, including hybrid, blended, and online approaches, catering to diverse learning needs. Furthermore, it facilitates industry-relevant training by providing real-time access to technical simulations, virtual labs, and industry-based case studies, equipping students with job-ready skills essential for the modern workforce. By integrating U-Tech in TVET, education becomes more inclusive, accessible, and aligned with global competency standards, reinforcing the commitment to SDG 4 in advancing quality education for all.

**Statement of the Problem**

Numerous studies have been conducted to examine the factors influencing technology adoption among students in Malaysia (Amirnudin & Sulaiman, 2013; Tan, 2013; Russin et al., 2012; Yusof et al., 2012; Suki & Suki, 2013). While research on technology usage in education has expanded over the years, there remains a gap in understanding the specific factors influencing the adoption of ubiquitous technology (U-Tech), such as laptops, smartphones, and tablets. Most existing studies primarily focus on the adoption of learning management systems (LMS) and software-based educational tools, with limited attention given to the role of mobile and portable digital devices in student learning.

Khalid and Sulaiman (2012) highlighted that one of the key barriers to LMS adoption is its lack of engaging and interactive features, which has negatively impacted students' motivation to use it consistently. Similarly, Ayub et al. (2010) found that students perceived calculus learning software as complex and difficult to use, requiring substantial effort to understand and navigate. These findings suggest that the usability, engagement, and accessibility of technology play a critical role in determining its adoption. However, there is a lack of comprehensive studies investigating whether similar barriers exist in the adoption of U-Tech and what factors drive its successful integration into students' learning processes.

Given the increasing reliance on mobile learning and digital tools in education, it is essential to explore the determinants of U-Tech adoption among students in Malaysia. Understanding these factors will help institutions enhance digital learning environments, improve

accessibility, and ensure that U-Tech supports effective and sustainable education, aligning with the goals of Sustainable Development Goal 4 (SDG 4): Quality Education.

*Research Question*

How do Performance Expectancy (PE), Effort Expectancy (EE), Social Status (SS), Facilitating Conditions (FC), and Behavioral Intention (BI) influence the adoption of ubiquitous technology (U-Tech) in Malaysian TVET institutions?

*Objective*

To examine the influence of Performance Expectancy, Effort Expectancy, Social Status, Facilitating Conditions, and Behavioral Intention on the adoption of ubiquitous technology (U-Tech) among students in Malaysian TVET institutions.

**Significance of the Study**

The findings of this study will contribute to the digital transformation of Technical and Vocational Education and Training (TVET) institutions in Malaysia by identifying the key factors influencing ubiquitous technology (U-Tech) adoption. Technical universities demand their lecturers to be equipped with a different set of skills and knowledge compared to conventional universities. Conventional universities focus more on cognitive learning and do not emphasize hands-on or practical approaches. Their curriculum concentrates on lecturing and most assessments carried out are to examine students' cognitive achievement (Che Amran et al, 2020). For teachers in TVET, technological proficiency is vital, as they are preparing students for careers in technology-driven industries (Sedek & Mohd, 2025). As TVET institutions play a crucial role in preparing students for Industry 4.0, understanding the determinants of U-Tech utilization will help policymakers and educators develop effective strategies for technology integration. This study aligns with Sustainable Development Goal 4 (SDG 4): Quality Education, which emphasizes inclusive, equitable, and lifelong learning opportunities. By addressing challenges related to performance expectancy, effort expectancy, social influence, and infrastructure support, institutions can enhance digital learning environments and ensure students benefit from technology-driven education.

Additionally, this study will provide practical recommendations for improving institutional support, including technical assistance, digital competency training, and infrastructure upgrades to facilitate seamless technology adoption. It will also benefit students by ensuring that digital tools are accessible, engaging, and effective in enhancing learning outcomes. By bridging the gap between education and industry needs, the study will support the development of future-ready graduates equipped with essential digital skills, ultimately contributing to Malaysia's goal of becoming a technology-driven economy.

**Literature Review**

The Unified Theory of Acceptance and Use of Technology (UTAUT) framework identifies several key factors influencing the successful adoption of U-Tech in education.

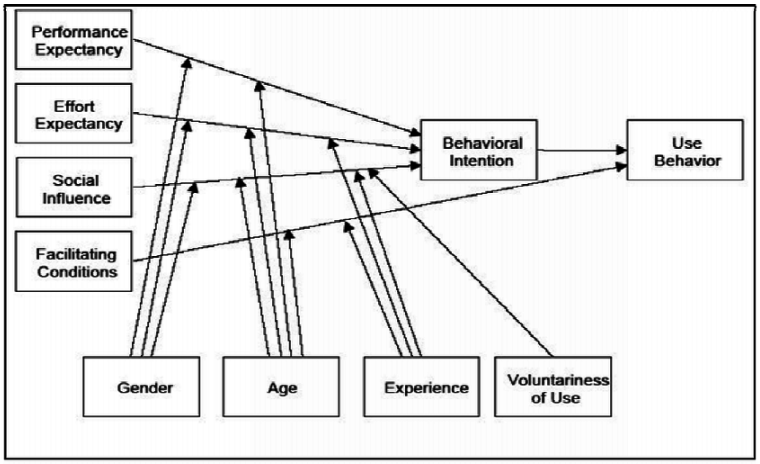


Figure 1: Unified Theory of Acceptance and Use of Technology (UTAUT)

Performance expectancy (PE) refers to students' perception of how U-Tech enhances their academic and technical training. In a TVET setting, where practical learning is fundamental, students are more likely to engage with technology if they believe it improves their skill acquisition and career readiness (Venkatesh et al., 2012). Research shows that the adoption of digital tools, such as computer-aided design (CAD) software and augmented reality (AR) training modules, is driven by students' expectations of efficiency, accuracy, and practical application in real-world industries (Wong et al., 2013). Meanwhile, another study conducted in Malaysia revealed that PE acted as one of the salient factors that influenced the students' usage of developed software in learning the computer graphics and image processing subjects as well as engineering subjects.

Effort Expectancy (EE) refers to an individual's perception that using a particular technology requires minimal physical and mental effort. A study by Loo and Choy (2013) found that engineering students perceived tablets as highly user-friendly and effective learning tools. The students reported that they encountered little difficulty in understanding and handling these devices. As a result, this ease of use encouraged them to integrate tablets not only into their engineering and technical coursework but also in broader academic applications such as research, data collection, and form completion for categorical data analysis.

In today's era of modernization and technological advancement, social status (SS) is defined as the extent to which individuals perceive that others consider it important for them to use a particular technology (Venkatesh et al., 2012). Within an educational context, Tapscott and Williams (2012) observed that modern technologies, such as smartphones, have become status symbols among students in higher education. Research indicates that students often select their technological devices based on a desire to emulate those they admire, such as lecturers, family members, and peers. The use of ubiquitous technology (U-Tech) serves as a means of aligning with specific social groups and projecting a sense of status. Additionally, students reported that showcasing their technology enhanced their confidence, making them feel both fashionable and respected. This sense of prestige and recognition from lecturers and peers further influenced their engagement with technology.

Facilitating Conditions (FC) refer to the extent to which individuals believe that an adequate organizational and technical infrastructure exists to support their use of technology as a learning tool. Research by Fareed and Kirkil (2025) highlights the importance of administrative support in ensuring the successful integration of technology in student learning. In addition, technical assistance plays a crucial role in sustaining technology adoption. According to Lee et al. (2013), technical support encompasses access to ICT service providers, internal helpdesks, and on-demand assistance to address any technological challenges. Institutions that provide strong technical infrastructure and readily available support staff significantly enhance students' ability to adopt and utilize U-Tech effectively.

Behavioral Intention (BI) serves as a mediating factor between Performance Expectancy (PE) and actual technology usage. A study conducted by Tan (2013) in Malaysia examined the key determinants influencing students' adoption of e-Placement tests and identified Social Status (SS) as a crucial factor shaping their BI. The study found that encouragement from lecturers, family members, and peers played a significant role in influencing students' intentions to use e-Placement technology consistently. This suggests that BI acts as a bridge, linking students' perceptions of social influence to their actual adoption of technology in learning environments.

**Statement of Problem**

Many researchers have explored the factors influencing students' use of technology for learning in Malaysia (Amirnudin & Sulairnan, 2013; Tan, 2013; Russin et al., 2012; Yusof et al., 2012; Suki & Suki, 2013). While numerous studies have examined technology adoption in education, there remains a lack of comprehensive research specifically addressing the factors affecting the use of ubiquitous technology (u-tech). Most existing studies have primarily focused on Learning Management Systems (LMS) and educational software rather than everyday devices like laptops, smartphones, and tablets. In Malaysia, Khalid and Sulaiman (2012) identified that the unappealing and monotonous nature of LMS discourages students from using it consistently. Similarly, Ayub et al. (2010) found that calculus learning software was perceived as challenging due to the considerable effort required to navigate and understand it, further hindering students' willingness to engage with the technology.

*Study Design*

This study employed a survey research design, with the accessible population comprising selected third-year undergraduates from four MTUN universities. To determine the minimum recommended sample size, Raosoft® software was utilized. The study adopted proportional stratified sampling, and questionnaires were randomly distributed to the identified sample within each faculty at the respective universities.

The questionnaire was structured into four sections: Section A collected demographic information, Section B focused on technology utilization, Section C assessed technology competency, and Section D examined factors influencing technology use. However, for this study, only Section B was analyzed. A five-point Likert scale was used to measure responses: Never (N), Rarely (R) – once a day per week, Sometimes (ST) – 2-3 days per week, Often (OFT) – 4-5 days per week, and Very Often (VO) – more than 5 days per week.

The questionnaire underwent validation by four experts specializing in educational technology and teaching and learning. A total of 493 questionnaires were distributed, and 420 responses were received. After screening for missing or incomplete data, 20 responses were found to contain errors and were removed, leaving 400 valid responses for analysis. The collected quantitative data were then analyzed using SPSS Version 20.0. A reliability test was conducted to determine the consistency of the instrument, with the reliability coefficients ranging from 0.819 to 0.901, indicating a high level of reliability.

*Structural Equation Modeling (SEM)*

According to Hair et al. (2010), Structural Equation Modeling (SEM) is an advanced multivariate analysis technique that integrates Confirmatory Factor Analysis (CFA), a measurement model, and a structural model. One of its key characteristics is the ability to simultaneously estimate multiple and interrelated dependent relationships, allowing for a more comprehensive analysis of complex data (Hair et al., 2010). Additionally, SEM enables the inclusion of individual items in the analysis, which helps define constructs while assessing convergent validity and construct reliability (Awang, 2013). Moreover, it facilitates the development of a structural model, providing researchers with a robust framework for testing theoretical relationships and validating measurement instruments (Awang, 2013).

*Model Analysis*

The primary objective of this study was to develop a predictive model for U-Tech usage. The $R^2$ values for each construct (variable) and the corresponding structural path values were analyzed in Table 1 below. A structural path was considered significant if its Critical Ratio (C.R) > ±1.96 and $p < 0.05$.

The analysis revealed that the structural path from Technology Competency (TC) to Behavioral Intention (BI) was insignificant ($\beta = 0.051$, $p = 0.337$). Similarly, the paths from Performance Expectancy (PE) to BI ($\beta = -0.037$, $p = 0.505$) and Facilitating Conditions (FC) to BI ($\beta = -0.110$, $p = 0.060$) were also found to be insignificant. However, the structural path from Effort Expectancy (EE) to BI was significant ($\beta = 0.267$, $p = 0.000$), indicating that effort expectancy plays a crucial role in influencing behavioral intention toward U-Tech usage.

Table 1
*Regression Weights Full Mediation*

| Estimate | SE | CR | p-values |
|---|---|---|---|
| BI<---TC 0.051 | 0.059 | 0.960 | 0.337 |
| BI<---PE -0.037 | 0.056 | -0.667 | 0.505 |
| BI<---EE 0.267 | 0.083 | 4.642 | 0.000 |
| BI<---FC -0.110 | 0.053 | -2.057 | 0.060 |
| BI<---SS 0.494 | 0.081 | 7.731 | 0.000 |
| TU<---TC 0.306 | 0.053 | 5.786 | 0.000 |
| TU<---BI 0.156 | 0.057 | 2.482 | 0.013 |
| TU<---PE 0.485 | 0.054 | 8.290 | 0.000 |
| TU<---EE -0.014 | 0.068 | -0.258 | 0.796 |
| TU<---FC 0.216 | 0.045 | 4.258 | 0.000 |
| TU<---SS -0.216 | 0.069 | -2.078 | 0.038 |

SE = Standard Error of regression weight; CR = Critical Ratio for regression weight;P = level of significance

The analysis of Structural Equation Modeling (SEM) reveals key factors influencing Behavioral Intention (BI) and Technology Utilization (TU) in the adoption of ubiquitous technology (U-Tech) in TVET. Social Status (SS) and Effort Expectancy (EE) significantly impact BI, with SS being the strongest predictor (β = 0.494, p = 0.000), indicating that students' perception of social standing influences their intention to use U-Tech. However, Technology Competency (TC), Performance Expectancy (PE), and Facilitating Conditions (FC) do not significantly affect BI, suggesting that ease of use and external support alone may not be enough to shape intention. In contrast, Performance Expectancy (PE) emerges as the strongest determinant of TU (β = 0.485, p = 0.000), followed by TC (β = 0.306, p = 0.000) and FC (β = 0.216, p = 0.000), highlighting that students are more likely to use U-Tech when they perceive it as beneficial, have the required competency, and receive adequate support. Additionally, BI significantly influences TU (β = 0.156, p = 0.013), confirming its mediating role. Interestingly, Social Status (SS) negatively affects TU (β = -0.126, p = 0.038), implying that students with higher perceived social status may be less reliant on technology for learning. Furthermore, Effort Expectancy (EE) does not significantly impact TU (β = -0.014, p = 0.796), indicating that ease of use alone does not drive actual utilization. These findings underscore the importance of perceived usefulness, competency, and supportive conditions in fostering effective U-Tech adoption, while also highlighting the complex relationship between social factors and technology usage in TVET education.

**Results and Discussion**

The Structural Equation Model (SEM) analysis highlights key factors influencing Technology Utilisation (TU) in TVET education, aligning with SDG 4: Quality Education, which promotes inclusive, equitable, and technology-driven learning environments. The model exhibits a good fit, with CFI = 0.916, IFI = 0.917, RMSEA = 0.062, and a relative chi-square ($\chi^2$/df) = 2.453, confirming its robustness. The results indicate that Behavioural Intention (BI) is the strongest predictor of TU (β = 0.48, p = 0.000), reinforcing its role as a mediator in technology adoption. Among the direct predictors of BI, Social Status (SS) (β = 0.53, p = 0.000) and Performance Expectancy (PE) (β = 0.49, p = 0.000) significantly influence students' intention to use technology, while Technology Competency (TC) (β = 0.38, p = 0.000) also plays an important role. However, Effort Expectancy (EE) (β = 0.04, p = 0.796) and Facilitating Conditions (FC) (β = -0.11, p = 0.060) show minimal or negative impact on BI, suggesting that ease of use and external support alone are insufficient motivators. Regarding TU, significant predictors include BI (β = 0.48, p = 0.000), TC (β = 0.31, p = 0.000), and PE (β = 0.22, p = 0.000), emphasising that students are more likely to engage with technology when they perceive it as beneficial and have the necessary skills. Interestingly, SS positively affects TU (β = 0.43, p = 0.000), while FC negatively influences TU (β = -0.13, p = 0.038), indicating that social influence encourages technology adoption, whereas infrastructure alone does not guarantee effective utilisation. These findings align with SDG 4's emphasis on technology-enhanced education, advocating for a student-centred approach where digital tools are integrated to improve access, engagement, and skill development. The results reinforce that to bridge the digital divide in TVET education, institutions must not only provide technological infrastructure but also promote digital literacy, increase awareness of technology's benefits, and foster a culture of self-directed learning.

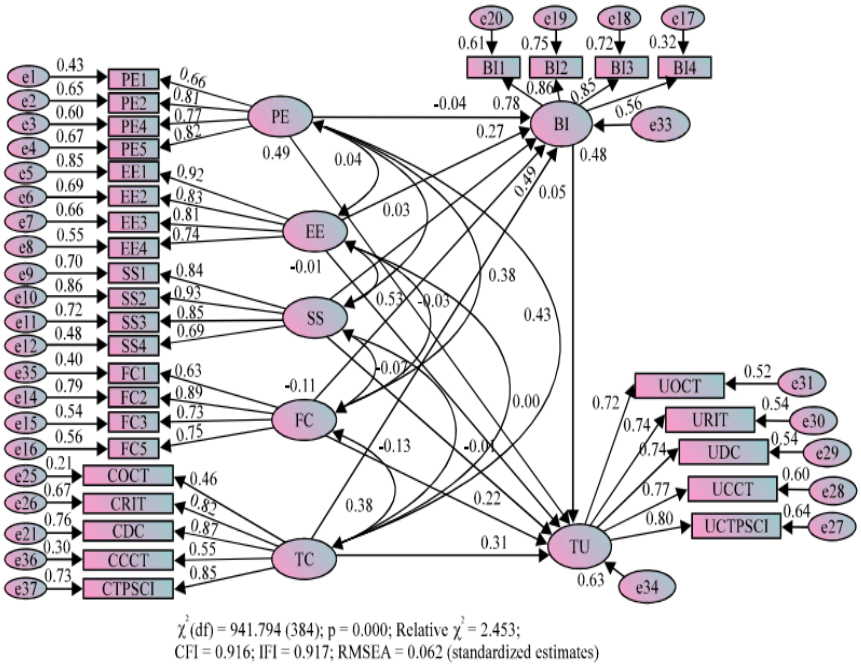


Figure 2: The Model

**Conclusion, Recommendation and Implications**

The findings of this study highlight the important role of Behavioral Intention (BI) as a bridge between Effort Expectancy (EE) and Social Status (SS) in shaping the use of ubiquitous technology (U-Tech) among TVET students. While Social Status (SS) was already recognized as a direct factor influencing technology adoption, the study reveals that when mediated through BI, its impact becomes even more significant. This suggests that a student's intention and motivation play a crucial role in whether they actively engage with technology for learning. Looking ahead, future research should explore how technology usage translates into real academic outcomes, such as grades and performance on standardized tests. A more rigorous experimental approach, such as a pre/post-test design, could provide clearer insights into the actual effectiveness of U-Tech in improving learning. Furthermore, curriculum flexibility and access to resources play vital roles in ensuring that educators can adapt their teaching to diverse student needs (Sedek & Mohd, 2025).

Since this study focused on TVET students using devices like laptops, smartphones, and tablets, it's important to recognize that technology adoption in education is not one-size-fits-all. Different academic disciplines may have unique technology needs, challenges, and learning environments. For example, engineering students may require simulation software, while business students might engage more with data analysis tools. Future studies should investigate these differences, identifying what makes technology most effective across various fields. By doing so, we can develop a more inclusive and adaptable approach to integrating technology in higher education, ensuring that all students—regardless of their field of study—can benefit from U-Tech in meaningful and impactful ways.

*Theoretical and Contextual Contributions*

At its core, this study aims to make meaningful contributions to both theory and practice. Theoretically, it adds value to the existing UTAUT framework by introducing Technology Competency (TC) as a key variable, offering a deeper understanding of what truly drives

students to adopt ubiquitous technologies in their learning. It also shows how students' intentions—shaped by factors like social influence and perceived ease of use—play a central role in whether they actually use technology meaningfully. From a contextual perspective, this study focuses on the lived realities of TVET students in Malaysia, where preparing for a technology-driven future is no longer optional, but essential. The insights gained here are not just numbers—they reflect the voices, behaviors, and aspirations of students navigating a rapidly evolving digital education landscape. Most importantly, this research supports Malaysia's efforts to meet the goals of SDG 4 by helping ensure that technology in education is not only available, but truly accessible, relevant, and empowering for all learners.

**Theoretical and Practical Implications**

The findings of this study offer valuable insights into the practical integration of ubiquitous technology (U-Tech) as a tool for teaching and learning. The study highlights that the factors influencing technology adoption manifest differently depending on individual users, their learning environments, and external support systems. These insights can serve as a guide for students, university administrators, curriculum planners, policymakers, and other relevant stakeholders to enhance and adapt both learning and teaching environments, ensuring they align with the needs of 21st-century learners.

By recognizing these factors, institutions can develop more inclusive and technology-driven education strategies that support student engagement, accessibility, and digital literacy. The study also emphasizes the need for a collaborative vision among stakeholders to deliberately and effectively implement U-Tech in higher education. Through strategic planning, investment in digital infrastructure, and policies that encourage active technology integration, this research can act as a catalyst for meaningful educational transformation, ensuring that students in Malaysia maximize the benefits of U-Tech in their learning journeys.

**Acknowlegement**

This research did not receive any grant from agencies in the public, commercial, or nonprofit sectors.

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