

The Adoption of Text-to-Speech Technology in Malaysia's E-Banking

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Abstract

This study investigates the adoption dynamics of Text-to-Speech (TTS) technology within the e-banking domain among Malaysian banking customers. Grounded in the Technology Acceptance Model (TAM), the research examines key constructs including Perceived Usefulness (PU), Perceived Ease of Use (PEU), Attitude Towards Technology (ATT), and Behavioral Intention to Use (BI). In addition, this study attempts to investigate the impact of age towards BI. Utilizing a cross-sectional survey design, data was collected from a representative sample of Malaysian working adults who actively use e-banking services. The sample size was determined using G*Power analysis, ensuring statistical robustness with a minimum of 100 participants. Structural Equation Modeling (SEM) was used to test the hypothesized relationships between the constructs. This study revealed that PU and ATT have a significant relationship towards the BI. In contrast, PEU found to be insignificant towards BI but found to be significant towards ATT. However, age found to be insignificant towards the relationship between PU and PEU on BI respectively. The study's implications extend to e-banking service providers, suggesting targeted strategies to enhance user adoption of TTS features. By addressing the identified factors, financial institutions can improve user experience and increase the uptake of innovative technologies in digital banking. This research contributes to the broader understanding of technology acceptance in the financial sector, offering a framework for future studies on emerging technologies in e-banking.

Keywords: Behavioral intention to Use, E-banking, Malaysia, Technology Acceptance Model, Text-to-Speech (TTS) technology

Introduction

While financial services are progressing at high speeds, the banking operations and its experience is also modified through the introduction of technological techniques especially in Malaysia. Malaysia is one of the most progressive countries in the region thanks to its booming economy and young populace that uses technology in their daily lives. Therefore, e-banking is an essential foundation of Malaysia's financial system (Alsmadi et al., 2023).

Technological advancement in internet usage and the popularity of smartphones have seen the uptake of e-banking services take root in Malaysia (Saif et al., 2022). Thus, the integration of TTS technology can be significant in e-banking during the transition to the digital format. Malaysia being a culturally diverse country, it is important to ensure its population has equal opportunity in accessing financial services regardless of their category in the society. TTS technology is in demand among visually impaired people and other citizens who use audio information which is in line with Malaysia's commitment to financial inclusion and diversity. Thus, TTS technology avails, improves, and personalizes banking services beyond simple accessibility benefits for disabled individuals, thereby increasing the overall satisfaction and engagement of the Malaysian banking customers (Hassan et al., 2020). With Malaysia's vision for the country to be a prevaizing digital nation in Southeast Asia, the TTS technology is instrumental in steering forward the development of the nation's digital economy. Malaysia becomes ready to strengthen its progress towards a more permissive and innovative financial environment, with the help of implementing advanced solutions for the population's variety (Urus & Mohamed, 2021).

While TTS technology has been regarded as highly effective in the e banking system, its usability, satisfaction and acceptance among Malaysian banking customers has not been researched yet. While there are studies on the general acceptance of e-banking services, specific research focusing on TTS technology within this context is limited. It is therefore important for financial institutions that seek to improve the TTS technology to appreciate the factors that may affect the implementation of this technology (Yaseen et al, 2024). Without such understanding, the actual implementation of TTS features and promoting usage of those might become a problem which potentially miss out on the opportunity to better serve a diverse customer base. (Morton et al., 2011). TTS technology has been effectively implemented in e-banking to improve the look and feel of the e-banking system but poses unique problems. Gupta and Thakur (2022) stated that despite advancements in digital banking, visually impaired and elderly users still face barriers due to traditional visual interfaces

Research has shown that the Technology Acceptance Model (TAM) is a robust framework for predicting and explaining user behavior towards new technologies. Originally proposed by Davis (1989), TAM posits that perceived ease of use and perceived usefulness are the primary determinants of technology adoption. In the context of TTS in e-banking, these determinants must be validated to understand how users perceive and interact with auditory feedback systems. Factors such as user trust and perceived security are critical in the banking sector, where concerns about privacy and data protection are extremely important (Venkatesh & Bala, 2008).

Despite the theoretical foundations provided by TAM, empirical validation specifically for TTS technology in e-banking is limited. It is essential to conduct comprehensive studies that assess user attitudes and behavioral intentions towards TTS in various demographic groups. Such studies will not only validate the applicability of TAM in this context but also provide actionable insights for banks to design more user-friendly and accessible e-banking platforms. Addressing these issues can significantly enhance the adoption rates of e-banking services among underserved populations, thereby promoting financial inclusion and digital accessibility (Gupta & Thakur, 2022). This research is significant for several reasons. Firstly, it

contributes to the existing literature on technology acceptance by focusing on a novel application within the e-banking sector. Secondly, it provides empirical insights specific to the Malaysian context, addressing a gap in the current understanding of TTS technology adoption in this region. Thirdly, the findings of this study can inform banking institutions about customer preferences and barriers related to TTS technology, enabling them to tailor their strategies to enhance user experience and increase adoption rates. Ultimately, this study aims to support the broader objective of financial inclusion and technological innovation in the banking industry. Therefore, the primary aim of this study is to investigate the relationship between perceived usefulness (PU) and perceived ease of use (PEU) as independent variables, mediated by attitude towards technology (ATT), and moderated by age with the dependent variable being behavioral intention to use (BI).

The remaining details of this paper are as follows. The literature review of the study is presented in Section 2. Thereafter, the methodology consisting of research design, data collection methods, and analysis techniques are presented. It is followed by the results and discussion of the analysis. Finally, the paper is concluded with the conclusion and future studies of this research.

Literature Review

Research on technology acceptance has significantly evolved, initially focusing on identifying core determinants of technology usage and validating the TAM across various contexts. Recent studies have extended TAM to include variables relevant to contemporary technologies, such as mobile apps, e-learning platforms, and healthcare systems, underscoring its adaptability (Marangunić & Granić, 2015). Kalayou et al. (2020) examined the sustainable use of eHealth systems when implemented in low resource environments where technological improvement are a challenge by using a modified TAM. AlQudah et al. (2021) synthesized research works on the application of TAM in the health sector with a view of determining essential usability and adoption factors that shape the use of health technologies.

Nadri et al. (2018) have discussed the integrations of TAM in the health informatics field by providing a systematic review for understanding the effectiveness of TAM for minimizing the challenges associated with the implementation of health care systems. Similarly, using the TAM, Balaman and Baş (2023) proposed a quantitative questionnaire for the evaluation of perceived barriers as well as behavioral belief of e-learning consumers towards the adoption of online learning systems. Ukaegbu and Mingyue (2024) studied the influence of eHealth personal literacy in the use of mobile health application with the help of an extended TAM that embraced behavioral patterns. Employing TAM in the context of blended e-learning systems, Tsai et al. (2018) integrated other models to analyze the nursing staff's continued usage intentions of these systems, especially the unique predictiveness of the model for continued usage. AlQudah et al. (2021) also described that, during the COVID-19 pandemic, the extensions of TAM contributed to reducing challenges by enhancing the acceptance of technology assets in healthcare organizations.

Building on the existing literature, Rajak and Shaw (2021) included extra dimensions in TAM, which provoked discussion over the utilization of factors, affecting the adoption of mobile health applications and emphasizing on the applicability of the model in the subject

area of mHealth advancements. Alkhwaldi and Abdulmuhsin (2022) adopted the IoT-environment factors to the TAM model to examine the health technology acceptance particularly to IoT interface healthcare solutions. Lew et al., (2019) extended the TAM to cloud e-learning systems which revealed the predictors of continued usage intention of these systems in learning environment.

TAM is chosen for this research because of the scalability, reliability, and empirical verification of TAM in numerous technological domains. This model has been shown to effectively estimate the intention to adopt new technologies in other contexts such as e-banking (King et al., 2019). Furthermore, the nature of TAM is uncomplicated without disregarding real life, and as a result the model anticipates applying empirical studies that seek to investigate user attitudes and their behavioral intentions. Subsequent research has also equally extended and validated the applicability of TAM within more current forms of advanced digital technology adoption (Venkatesh, 2022).

Perceived Usefulness (PU) and Behavioral Intention to Use (BI)

PU is a core concept in the TAM, which communicates users' confidence in increased effectiveness, or the advantages accrued from use of a certain technology. In the case of e-banking with TTS, it includes users' impression on the way TTS provides features that make banking easy for them. In previous studies, PU has always been cited as one of the most important factors that influence technology adoption. Thus, positive attitude towards the TTS technology is only possible when the users perceive that the designed technology will help in improving their banking efficiency and aids in tasks such as understanding and managing the financial information or transactions (Al-Jabri & Sohail, 2019). PU contributes significantly to molding the users' BI technology especially in the e-banking and TTS technology. TTS features are viewed by the users as valuable in the improvement of their banking experience by bringing convenience and availability, users are likely to state the preparedness to adopt this technology in their banking. The study shows that perceived usefulness affects the behavioral intention of the user with strong evidence to support the fact that perceived benefits or advantages of TTS technology in e-banking should positively influence the attitude of users towards the technology (Al-Jabri & Sohail, 2019). In order to encourage users to adopt TTS technology as well as complementing the e-banking services, it is important to develop and advance user's perceived usefulness on TTS technology which will lead to increased customer satisfaction in the digital banking sector. As to the dependence of internet use intentions on demographic variables, hypothesis 1 is derived based on a number of assumptions adopted from previous research.

Hypothesis 1 (H1): PU has a positive effect on BI TTS technology in e-banking.

Perceived Ease of Use (PEU) and Behavioral Intention to Use (BI)

PEU assesses the perceptions of the user concerning ease of interacting with technology. Specifically in the TTS context it evaluates the comprehensibility of TTS features of e-banking applications. Studies state the fact that users are ready to embrace technology that is easy to use. This suggests that positive attitudes towards TTS technology and considering the use of TTS an easy task relate well with increased use of TTS technology in banking hence the increased adoption rate, increased user satisfaction (Dwivedi et al., 2019). PEU captures users' self-estimate about how easily they can use TTS features for banking activities such as balance inquiry or fund transfer. The link between PEU and BI indicates

that, if users perceive TTS technology as easy to use and involving low resources, they are likely to plan to use the technology from their e-banking transactions. This means, the perceived ease of using TTS technology is directly related to the users' behavioural intention regarding adoption of TTS technology as a regular part of their e-banking operations. The improvement of the usability of TTS features can have positive effects on the behavioral intention to engage and use this technology in self-service banking. From this, PEU impacts users' behavioral intention through the effort associated with the use of the technology. The result showed that perceived usefulness had a significant relationship with perceived ease of use as well as an effect on the users' intention to use TTS technology. The hypothesis 2 is given the following construct:

Hypothesis 2 (H2): PEU has a positive effect on BI TTS technology in e-banking.

Attitude Towards Technology (ATT) and Behavioral Intention to Use (BI)

In this study, ATT operates as a moderator, representing users' general attitudinal process regarding TTS technology in e-banking based on perceived usefulness and ease of use. ATT captures the totality of perceived attitude users have about the acceptance and usage of a particular technology (Davis, 1989; Venkatesh and Davis, 2000). As applied to the field of e-banking and TTS technology, ATT evaluates/estimates user's perceived benefits, credibility, and positivity concerning employment of TTS aspects within banking processes (Alalwan et al., 2017). Self-efficacy is expected to moderate relationships between perceived usefulness (PU) and perceived ease of use (PEU) and intention to use TTS technology (Chen, 2022). Studies underscore the main role of attitude as a determinant of technology use. This study recognizes that users' perceptions of TTS technology will depend on their previous experience with such technology, their understanding of the benefits of adopting TTS technology, and the level and kind of confidence they have deposited on the reliability of the technology (Nyugen et al., 2023). However, perceived beliefs which are perceived negative towards TTS, like perceived risk or perceived threat of TTS may influence users' intention to adopt and integrate TTS into their e-banking behavior positively. Hence, there is a need to promote a positive attitude towards TTS technology that would help increase usage by e-banking clients (Nyugen et al., 2023). The hypothesis 3 is developed as follows.

Hypothesis 3 (H3): ATT has a positive effect on BI TTS technology in e-banking.

Perceived Usefulness (PU) and Attitude Towards Technology (ATT)

PEU measures the ease with which bank customers are able to use and engage with TTS in the environment of e-banking. This simple interaction between PEU and ATT suggests that the overall attitude towards TTS technology is likely to improve whenever users seem to find the technology easy to use (Davis, 1989; Venkatesh & Davis, 2000; Chen, 2022; Alalwan et al., 2017; Nguyen et al., 2023). This positive attitude has been as a result of a belief that the technology is easy to use and operate. TTS technology is generally perceived favorably by users when its use is perceived as convenient and easy. That is, the more the user has a positive attitude towards TTS technology, the higher the chances of embracing and employing it in e-banking exercises. The examination of PEU and AT is important to grasp users' perception and attitudes as to the proposition and adoption of TTS technology amongst the e-banking firms. The hypothesis 4 is developed as follows.

Hypothesis 4 (H4): PU has a positive effect on ATT.

Perceived Ease of Use (PEU) and Attitude Towards Technology (ATT)

A usability study for TTS in e-banking and applications examines how PEU quantifies the relative difficulty of users' engagement with TTS options within banking applications. The pattern between PEU and ATT explication highlights that as users' perceived usefulness of TTS technology enhances their view of the difficulty of operating the TTS technology as easy and smooth, their global attitude towards the technology becomes more positive (Zheng & Li, 2020; Alalwan et al., 2017; Nguyen et al., 2023). This can be attributed to the positive sentiment that comes with the perception that technology is easy to use and effortless to manipulate. As a result, users are predisposed to developing better attitudes toward as well as elevated perceived USE of TTS technology, thus enhancing their readiness to adopt and use TTS technology to accomplish their e-banking tasks. Knowledge of this relationship between PEU and ATT is crucial in understanding the general users' perception and attitude towards the utilization of TTS technology for enhancing e-banking services. Thus, hypothesis 5 is generalized as follows.

Hypothesis 5 (H5): PEU has a positive effect on ATT.

Moderation effect of Age

Age can in fact act as a buffer and influence the correlation between independent variables (PU and PEU) and dependent variables (BI). The innovative nature of PEU might make it easier for the younger users to adopt them thus reducing the effects of PEU on BI (Kikawa et al., 2022). In addition, demographic differences impact on the view that users have about the applicability, relevance and the easiness of TTS which they shall adopt the technology (Alalwan et al., 2018). Moderation effects of PU on BI indicate that there exist other factors, which affect the existing connection between PU and BI. For example, users who are younger and more familiar with new developments such as TTS technology are more likely to find it more useful and therefore have a higher intention towards the use of the technology compared to older users (Venkatesh et al., 2012; Morris and Venkatesh, 2000; Zheng and Li, 2020; Charness and Boot 2009; Alalwan et al., 2017). The same applies to cases where users with different levels of education or income are likely to have different perceptions on the usefulness of TTS and therefore different tendency to engage in intended behaviors. It is important to establish these moderation effects for e-banking service and TTS technology features to address the acceptance and adoption aspect with regard to different users. Thus, by explaining these moderating variables, organizations can create a set of specification regarding usage of the TTS technology within the banking environment.

Moderation by PEU and BI includes the role of the following demographics variables on the model between these constructs: In this study, demographic factors such as age, gender, level of education, and income regulate the extent to which PEU influences BI (Venkatesh et al., 2012; Morris & Venkatesh, 2000; Zheng & Li, 2020; Charness & Boot, 2009; Alalwan et al., 2017). This suggests that the effect of PEU on the behavioral intention to use and subsequent behavioral consequences may be moderated by demographic factors among the population. It is important to comprehend these moderation effects for purposes of designing intervention and strategy aimed at improving technology acceptance to different subgroups of the users. Therefore, the hypotheses 6 and 7 are developed as follows.

Hypothesis 6 (H6): The relationship between PU and BI TTS technology in e-banking is moderated by age.

Hypothesis 7 (H7): The relationship between PEU and BI TTS technology in e-banking is moderated by age.

Conceptual Framework of the Study

The conceptual framework proposed in the TAM aims to elucidate the factors influencing users' behavioral intention to adopt a particular technology. As shown in Table 1, there are two independent variables: PU and PEU. PU refers to the user's perception of the extent to which a technology will enhance their performance or provide benefits, while PEU pertains to the user's perception of how easy it is to use the technology. These independent variables are theorized to influence users' attitude towards the ATT, which serves as a mediating variable. ATT reflects the users' overall evaluative judgment about using the technology, shaped by their perceptions of its usefulness and ease of use. Additionally, the model incorporates moderating variables, specifically age, which is a demographic variable. Age is expected to moderate the relationships between the independent variables (PU and PEU) and the dependent variable BI. Finally, BI represents the dependent variable, indicating the user's intention to use the technology. It is influenced by PU, PEU, and ATT. Figure 1 shows the conceptual framework in this study.

Table 1
Interpretation of the variables in a conceptual framework.

Variables	Indicators
Independent Variables	Perceived Usefulness (PU) Perceived Ease of Use (PEU)
Mediating Variables	Attitude Towards Technology (ATT)
Moderating Variables	Demographic Variables (Age)
Dependent Variables	Behavioral Intention to Use (BI)

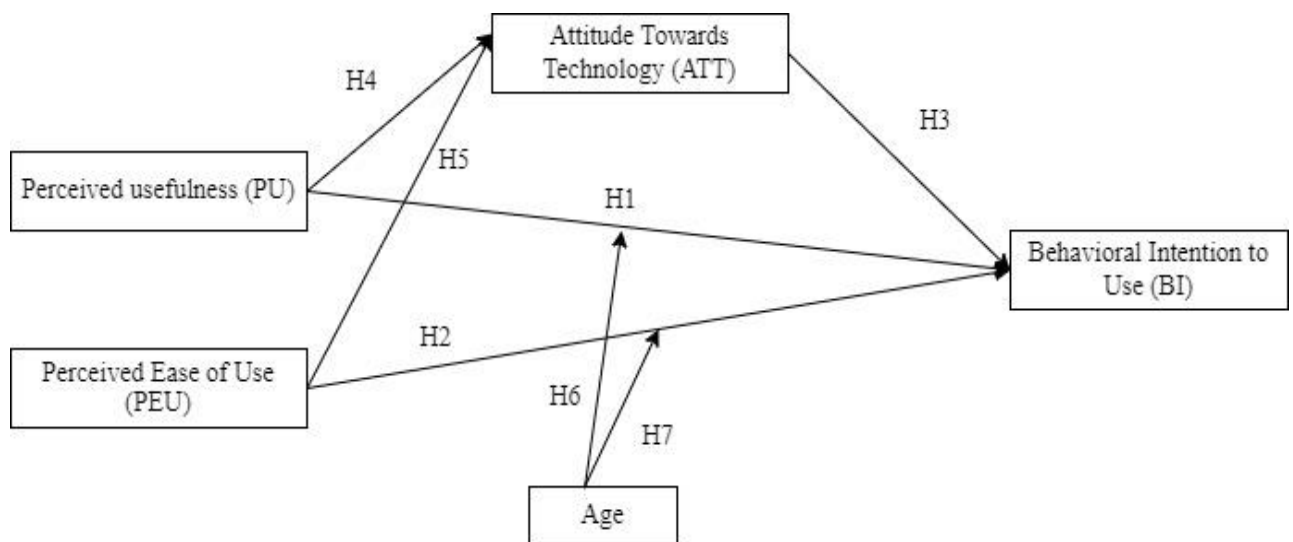


Figure 1 Conceptual Framework

Methodology

This study examines the perceptions, attitudes, and behavioral intentions of Malaysian working adults toward adopting TTS technology in e-banking. A cross-sectional survey design is employed, utilizing structured electronic questionnaires distributed through online platforms. The questionnaire assesses key constructs of the TAM, including PU, PEU, ATT, and BI, alongside demographic variables such as age, gender, education, and income. The sample, selected using random sampling techniques, targets Malaysian e-banking users across diverse socio-economic backgrounds. The survey instrument, developed to capture numerical data, will undergo pre-testing to ensure clarity and reliability. G*Power analysis determined a minimum sample size of 77 participants for detecting medium effects, though data will be collected from at least 100 respondents to account for non-responses. Statistical analyses, including regression and structural equation modeling (SEM), will be conducted to test hypothesized relationships between PU, PEU, ATT, and BI. These methods align with a predominantly quantitative research paradigm grounded in positivist principles, enabling the identification of objective factors influencing TTS adoption in e-banking.

Questionnaire Design

The questionnaire design follows the best practices in survey methodology to ensure clarity, ease of understanding, and reliability of responses. It consists of multiple-choice questions, Likert scale items, and open-ended questions where applicable. The questionnaire has been pre-tested to identify and correct any potential issues with wording or formatting. The questionnaire is divided into two main sections: Demographics and Technology Acceptance. The first section collects demographic data and general information about the respondents' use of technology and financial literacy as shown in Figure 2. PU, PEU, ATT, and BI which are the technology acceptance constructs are measured on a 5-point Likert scale.

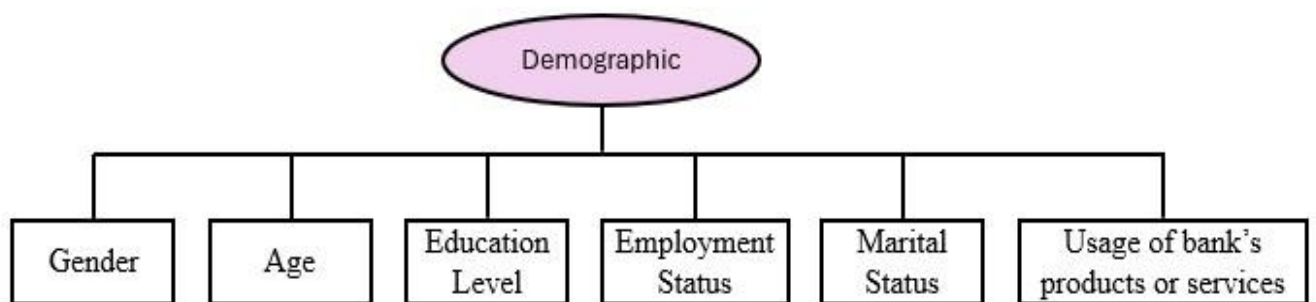


Figure 2 Demographics Questions in the Questionnaire.

Table 1
Scale Items

Variable	Denoted As	Question	Source
Perceived Usefulness (PU)	PU1	The text-to-speech technology will help you grasp the risks associated with credit card usage.	Kim et al. (2010)
	PU2	The text-to-speech technology will make it easier for you to manage your financial productivity.	
	PU3	The text-to-speech technology will assist you to understand complex terms and conditions.	
	PU4	The text-to-speech technology will enhance the effectiveness of making informed decisions.	
	PU5	I find the text-to-speech technology useful.	
Perceived Ease of Use (PEU)	PEU1	I find the text-to-speech technology is easy to use.	Kim et al. (2010)
	PEU2	Learning how to use the features of text-to-speech technology is easy for me.	
	PEU3	It is easy to become skillful in using the text-to-speech technology.	
	PEU4	My interaction with text-to-speech technology is clear.	
	PEU5	My interaction with text-to-speech technology is understandable.	
	PEU6	It will be easy for me to find information through text-to-speech technology.	
Attitude Towards Technology (ATT)	ATT1	Studying using the text-to-speech technology is a good idea.	Schierz et al. (2010)
	ATT2	I feel positive towards the use of the text-to-speech technology.	
	ATT3	I believe that the text-to-speech technology helps to be more engaged in purchasing financial products.	
	ATT4	I generally favor the use of text-to-speech technology for purchasing financial products.	
	ATT5	I believe that it is a good idea for me to use this text-to-speech technology for my future financial needs.	
Behavioral Intention to use (BI)	BI1	I intend to frequently use the text-to-speech technology to understand risk disclosure of financial products.	Lin (2011)
	BI2	I intend to use text-to-speech technology heavily.	
	BI3	I intend to use text-to-speech technology throughout my purchase of financial products.	
	BI4	I intend to repetitively use the text-to-speech technology as often as possible.	

Results and Discussion

The survey instrument was distributed to a total of 200 potential respondents through various channels, including online platforms and physical distribution at selected locations. Out of the 200 distributed questionnaires, 137 completed responses were received, resulting in a response rate of 68.5%. This response rate is deemed satisfactory for conducting statistical analyses and drawing generalizable conclusions about the population. The high response rate can be attributed to the relevance of the topic and the accessibility of the survey to the target demographic.

The study's respondents' demographic profiles are shown in Table 2. The demographic profile of the respondents provides valuable insights into the diversity of the sample. The gender distribution shows that 55.5% of the respondents were female, while 44.5% were male. Regarding age, the largest age group was 18 to 24 years old, comprising 32.8% of the sample, followed by 25 to 34 years old (23.4%), 35 to 44 years old (17.5%), 45 to 54 years old (12.4%), and below 18 years old (13.9%). In terms of education level, a significant majority (66.4%) of respondents held a Bachelor's degree or equivalent, 22.6% had a Master's degree or equivalent, 7.3% had a diploma or equivalent, and 3.6% had lower than a diploma. Employment status varied, with 48.9% employed, 45.3% self-employed, 5.1% unemployed, and 0.7% students. Marital status was nearly evenly split, with 49.6% married and 50.4% single. Additionally, 93.4% of respondents had previously purchased products or services from a bank, indicating a high level of banking experience within the sample.

Validity and Reliability

The first step in SEM is to assess the measurement model such as evaluating construct reliability, indicator reliability, convergent validity, and discriminant validity of the outlined constructs. Construct reliability can be determined using composite reliability (CR), Cronbach's alpha (CA) and Average Variance Extracted (AVE). According to Hair et al. (2017), the criterion for adequate reliability is that the CR value should exceed 0.70, which aligns with the CR values in this study, confirming adequate construct reliability. Meantime CA is used to assess the indicator reliability, where the CA values must be higher than 0.60. The results showed that the CA values for all factors in this study were acceptable.

Furthermore, a latent variable can explain over 50 percent of the variation of its indicators on average if it has an AVE value of at least 0.5 (Fornell & Larcker, 1981; Henseler et al., 2015; Ali et al., 2018). In case of AVE is less than 0.5 but composite reliability is higher than 0.6, the convergent validity of the construct is still adequate (Fornell & Larcker, 1981). The convergent validity of the constructs for this study was confirmed by the results, which showed that each construct had a significant AVE. In the meantime, the degree of collinearity is evaluated by examining the variance inflation factor (VIF). A possible collinearity problem is indicated if the VIF is 10 or above (O'Brien, 2007; Akinwande et al., 2015). There is no collinearity issue in this investigation, as indicated by all the VIF values being less than 10. The CA, CR, AVE, and VIF values are shown in Table 3.

Table 2

Demographic characteristics.

Content	N	%
Gender		
Female	76	55.5
Male	61	44.5
Total	137	100
Age		
Below 18	19	13.9
18 to 24	45	32.8
25 to 34	32	23.4
35 to 44	24	17.5
45 to 54	17	12.4
Total	137	100
Highest level of Education		
Lower than Diploma	5	3.6
Diploma or equivalent	10	7.3
Bachelor's degree or equivalent	91	66.4
Master's degree or equivalent	31	22.6
Total	137	100
Current employment status		
Employed	67	48.9%
Self-employee	62	45.3%
Student	1	0.7%
Unemployed	7	5.1%
Total	137	100
Current marital status		
Married	68	49.6%
Single	69	50.4%
Total	137	100
Have you ever purchased any products or services from a bank?		
No	9	6.6%
Yes	128	93.4%
Total	137	100

Table 3

Reliability and validity

Variables	No. Items	Mean	Standard Deviation	CA (>0.6)	CR (>0.7)	AVE (>0.5)	VIF (<10)
PU	5	4.612	0.550	0.832	0.884	0.603	5.083
PEU	6	4.627	0.500	0.915	0.872	0.532	5.908
ATT	5	4.610	0.502	0.794	0.816	0.470	4.142
BI	4	4.624	0.516	0.770	0.715	0.385	

Table 4

Path coefficients

	Path coefficients	T statistics	P values	Decision
H1: PU → BI	0.208	2.293	0.023	Supported
H2: PEU → BI	0.188	1.748	0.083	Rejected
H3: ATT → BI	0.519	0.505	<0.001	Supported
H4: PU → ATT	0.367	3.812	<0.001	Supported
H5: PEU → ATT	0.479	4.518	<0.001	Supported

The analysis of the path coefficients provides evidence to evaluate the hypotheses concerning the adoption of TTS technology in e-banking. H1, which proposed that PU positively affects BI is supported with a path coefficient of 0.208 ($p = 0.023$). This result shows that PU of TTS technology has a positive influence on BI. This study supports the TAM that indicates that PU has an overriding influence on the acceptance of technologies. H2 proposed that PEU has an influence on BI in a positive way. But heteroscedasticity imposed on the model results in a non-significant path coefficient of 0.188, $p = 0.083$ thereby rejecting this hypothesis. This implies that, although PEU has an impact on BI through other factors like attitude, its direct impact on BI remains insignificant. This has highlighted the need of understanding the indirect ways that PEU affects users' intention in technology adoptions (Sánchez-Prieto & Olmos-Migueláñez, 2017; Mailizar & Maulina, 2021; Ursavas & Yalçın, 2019). H3 that suggests a positive relationship between ATT and BI receives strong support since the above path estimate equals 0.519 ($p < 0.001$). Such a result provides a rich support for attitude as a mediator that lies between users' perception about the technology and their behavioral intention to use the technology. The analysis also supports the TAM hypothesis that ATT can well describe the adoption behavior in so far as users with more favorable predisposition toward TTS technology will engage in the e-banking activities, incorporating the TTS technology as well. The analysis also confirms H4, which postulated that PU has a positive impact on ATT, with a path coefficient of 0.367 ($p < 0.001$). This finding demonstrates that users who perceive TTS technology as beneficial develop more positive attitudes toward its adoption. Similarly, H5 is supported, with a strong path coefficient of 0.479 ($p < 0.001$), indicating that PEU significantly enhances ATT. This suggests that the user-friendliness of TTS technology is critical in fostering favorable attitudes, further driving adoption intentions.

Table 5

The Moderating Effect of Age

	Path coefficient	T statistics	P values	Decision
H6: PU → BI	-0.099	-0.570	0.570	No moderation
H7: PEU → BI	0.111	0.641	0.523	No moderation

The analysis of the moderating effect of age on the relationships between PU, PEU, and BI indicates that age does not significantly influence these relationships, leading to the rejection of H6 and H7 as shown in Table 5. For H6, which suggested that age moderates the relationship between PU and BI, the path coefficient is -0.099, with a non-significant p-value of 0.570 (T = -0.570). This result suggests that regardless of age, the perception of usefulness has a consistent impact on users' intentions to adopt TTS technology in e-banking. Similarly, H7, which proposed that age moderates the relationship between PEU and BI, is also unsupported. The path coefficient for this relationship is 0.111, with a non-significant p-value of 0.523 (T = 0.641). This means that the PEU of TTS technology impacts behavioural intention with similar intensity across all age groups and does not depend on age. These analyses suggest that age as a demographic characteristic does not moderate the relationship between PU or PEU on BI for the purposes of TTS technology use.

Conclusion

The understanding of TTS technology adoption is very important in the e-banking sector as it helps in driving Malaysia to be the banking powerhouse in the future. Therefore, this study aims to understand the adoption of TTS among the Malaysians' e-banking users through TAM. This study contributes to the theoretical understanding of the TAM by examining the relationships between PU, PEU, and BI to adopt TTS technology in e-banking. The findings reveal that PU has a significant positive effect on BI, aligning with previous research suggesting that when users perceive technology as useful, they are more inclined to adopt it. While PEU showed a positive effect on BI, it was not statistically significant, suggesting that ease of use alone may not strongly influence behavioral intentions but may work indirectly through other factors like attitude. ATT emerged as a critical mediator in the model, significantly influencing BI while being positively impacted by both PU and PEU. The mediating role of ATT in the relationships between PU, PEU, and BI highlights the importance of integrating attitudinal factors into TAM frameworks. This study demonstrates that ATT partially mediates the effect of PU and PEU on BI, emphasizing the need to foster positive user attitudes to enhance technology adoption. While age was hypothesized to moderate the relationships between PU, PEU, and BI, the results indicate that age does not play a significant moderating role. It is for this reason that the present study advocates for the inclusion of more moderating variables or interaction terms that may highlight the fact that age and other demographic characteristics have a more complex influence on technology acceptance, depending on a range of other factors.

From the practical contribution, the research presents implications for service delivery in the e-banking sector as well as the technology creating agencies. Increasing the PU of TTS technology due to marketing campaigns, first-hand experience and educating the community, might lead to usage. Making PEU more user friendly along with having easy instructions and easily approachable support teams are just as crucial for success. On this account, increasing the positive attitudes of the employees towards the TTS technology by offering interesting

on-boarding programs as well as healthy incentives and constant encouragement are likely to impact positively on the level of acceptance. Age was not found to moderate any of the investigated relationships, however, it is crucial for service providers to consider demographic factors in their marketing mix, to ensure appropriate targeting and appropriateness of the services they deliver for their consumer base.

The following limitations are recognized in this study: the use of self-administrated questionnaires may raise confounding factors; cross-sectional data does not allow making conclusions about causality; the use of Age as the only moderating demographic variable. In future studies, data collection methods can be diversified by including mixed methods such as qualitative interviews alongside questionnaires to reduce potential bias and provide richer insights. Instead of just collecting cross-sectional data, a mixture of longitudinal research design can also be adopted to understand the dynamic relationship between the variables changed over time. Also in future studies, other demographic variables such as gender, education level and income level can be investigated instead of age to ensure that the findings are generalized across different settings and demographics.

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