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When Small Businesses Go Digital: Exploring Innovation and Insecurity in Urban Micro MSMEs

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Abstract

Micro, Small, and Medium Enterprises (MSMEs) play a crucial role in Indonesia's economy but face major challenges in adopting technology. Despite its potential to improve competitiveness, especially in today's digital era, Indonesia's Information and Communication Technology (ICT) index remains relatively low. This study proposes a new model that combines Innovation, Insecurity, and the Technology Acceptance Model (TAM) to better understand the technology adoption process among micro-MSMEs. The research includes variables such as Perceived Usefulness, Perceived Ease of Use, Attitude, Behavioral Intention, Actual Use, Innovation, and Insecurity. Data were collected using a Likert-scale questionnaire, which underwent face validity, construct validity, and reliability testing. The analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) to examine relationships between variables. The findings indicate that the proposed model is well-supported and positively influences the adoption process. Most relationships among variables are strong and positive, except for Insecurity, which shows a negative relationship.

Keywords: Technology Adoption, SMEs, Innovation, Insecurity, Perceived Usefulness

1. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play a crucial role in economic growth in Indonesia's urban areas. As a dynamic nation, Indonesia has around 1.51 million MSMEs (BPS, 2023), contributing approximately 97% to job creation and 61% to local economic empowerment. However, despite their vital role, many MSMEs face significant challenges in accessing capital, developing marketing strategies, and adopting technology, which hampers their growth and sustainability (Nafisah et al. 2023).

Technology offers potential solutions to these challenges by improving MSME efficiency through automating business processes such as inventory management and financial reporting

(Dombrovskaya, 2019), as well as enhancing logistics management (Singh, 2019). Furthermore, technology facilitates MSMEs in managing data and analyzing customer behavior, enabling more accurate decision-making (Liu et al. 2020). In the realm of marketing, social media and online advertising provide effective and targeted promotional strategies for MSMEs (Dwivedi et al. 2021), while selling through marketplaces reduces operational costs without requiring a physical store (Yue & Guo, 2022).

While digital technology offers numerous advantages, Indonesia's Information and Communication Technology (ICT) index remains relatively low. In 2021, Indonesia's ICT index was only 5.76 out of 10, indicating that Indonesian businesses have tapped into only about 57.60% of the available technological potential (Untari et al. 2021). This suggests a gap in MSMEs' ability to leverage digital solutions for business growth.

As business units operating in the digital era, MSMEs need to increasingly master and adopt technology to remain competitive. One widely-used model for understanding the technology adoption process is the Technology Acceptance Model (TAM), initially designed for computer usage. However, with the rapid development of technology, especially in the MSME context, this model needs to be adapted.

Recent research applying TAM to MSMEs shows that promoting innovation is one strategy to boost technology adoption (Shaikh et al. 2021). Innovation can occur across various areas such as marketing (Suherlan & Okombo, 2023), human resources (Caselli et al. 2024), training (Gayan et al. 2019), and content marketing (Mansour & Barandas, 2017). Innovation in these areas can attract consumer interest, increase sales, and encourage MSMEs to continue evolving.

In addition, creating a sense of security in technology use is also essential. Some studies indicate that MSME actors still feel insecure about using technology due to data security risks (Arroyabe et al. 2024), limited technical skills (Domi & Domi, 2021), and uncertainties about the outcomes of technology adoption (Shaikh et al. 2021). These factors can hinder technology adoption, but they can be addressed through education, training, and clear evidence of the benefits of technology (Arroyabe et al. 2024; Shaikh et al. 2021).

While innovation and insecurity have become relevant issues for MSMEs, limited research specifically examines the adoption process in micro MSMEs, the most vulnerable category among all MSMEs (Mamun, 2019). Additionally, there is a scarcity of empirical evidence regarding the impact of innovation and insecurity on technology adoption in micro MSMEs.

Therefore, this study will observe and test the impact of a new model combining innovation, insecurity, and TAM on the technology adoption process in micro MSMEs. This research is crucial as it provides insights that can help MSMEs adapt and survive in an increasingly competitive market.

2. LITERATURE REVIEW

2.1. Micro SMEs

Micro-enterprises within MSMEs (Micro, Small, and Medium Enterprises) refer to businesses operating on a very small scale in terms of assets, turnover, and workforce size. In Indonesia, micro-enterprises are defined as businesses with assets of up to Rp50 million (excluding land and business premises) and an annual turnover of up to Rp300 million, as outlined in Law No. 20 of 2008 on MSMEs. Typically, micro-enterprises are managed by individuals or families, featuring simple structures and limited resources.

Micro-enterprises are considered the most vulnerable group within the MSME sector (Mamun, 2019). Their primary weaknesses, compared to other MSME classes, include limited capital

(Prijadi et al. 2020; Nafisah et al. 2023), a small-scale economy (Meressa, 2020), restricted market reach (Mukherjee, 2019), and limited managerial capabilities (Domi & Domi, 2021; Gure & Karugu, 2018).

In addition, micro-enterprises in Indonesia face challenges in utilizing technology for business development and marketing. One major factor is the limited digital knowledge and skills, which prevent many MSME operators from effectively using e-commerce platforms, social media, or other business applications (Xiong, 2016). Furthermore, access to technology remains an issue, especially in remote areas where internet infrastructure is still lacking (Salemink et al. 2017). The high cost of implementing technology also acts as a barrier, as the initial investment for hardware, software, or digital services often exceeds the financial capacity of MSMEs (Hendrawan et al. 2024; Rahman et al. 2024).

Data security is another serious concern for micro-enterprises. A lack of understanding of cybersecurity leaves MSMEs vulnerable to digital threats (Rahman et al. 2024). Lastly, limited awareness of the long-term benefits of digitalization leads some MSMEs to avoid investing in technology, with a conservative business culture that favors traditional methods (Hendrawan et al. 2024).

To address these challenges, technology needs to evolve to become more accessible for micro-enterprises. Research suggests that technology adoption by micro-enterprises becomes easier when the technology is user-friendly and affordable (Hendrawan et al. 2024), adaptable to specific needs and compatible with other systems (Marlyana et al. 2018), operable in remote regions (Salemink et al. 2017), protected against cyber threats (Rahman et al. 2024), and beneficial for product or service innovation in micro-enterprises (Rasool et al. 2023).

Overall, while these limitations make micro-enterprises more vulnerable and less competitive than small and medium-sized enterprises, embracing and innovating through technology across various business aspects can enhance the competitiveness of micro-enterprises in today’s digital era.

2.2. Technology acceptance model (TAM)

The TAM (Technology Acceptance Model) has become a popular framework for examining the influence of external factors on an individual's beliefs, attitudes, and intentions to accept technology (Chatterjee et al. 2021; Kayali & Alaaraj, 2020). The primary purpose of TAM is to provide a comprehensive understanding of how individuals perceive and respond to the acceptance or rejection of technology. This model explores cognitive factors, specifically Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), and offers a more detailed explanation of individual beliefs. PU refers to an individual’s personal assessment of how adopting a particular application within an organizational context will improve their job performance. Meanwhile, PEOU refers to the extent to which prospective users expect that the targeted system can be used with minimal effort. In addition to these factors, the TAM model also includes Behaviour Intention, Attitude, and Actual Use (Davis & Venkatesh, 1996).

Over time, TAM has been adapted and modified across various industries and organizational contexts, including MSMEs, to better understand technology adoption in enhancing competitiveness and productivity (Viet Tam et al. 2024; To & Trinh, 2021). Originally, this theory was developed to measure and evaluate the market potential for various PC-based applications (Davis & Venkatesh, 1996). In the context of technology adoption for MSMEs, it appears that adjustments to this model are also necessary. As we know, technology has evolved rapidly and now encompasses various forms such as mobile technology, social media applications, and e-commerce. Therefore, the TAM approach needs to be aligned with current conditions.

2.3. Research in SMEs for acceptance model

After reviewing previous studies, several have been found to apply the TAM framework across various sectors, such as banking (Viet et al. 2024), digital wallets (To & Trinh, 2021), manufacturing (Chatterjee et al. 2021), education (Kampa, 2023), and the F&B industry (Pangestu, 2022) in different countries. Some studies have also expanded the TAM model by adding variables, such as in the research by Viet et al. (2024), which incorporated Gamification and Perceived Value, and by To & Trinh (2021), which added Trust and Enjoyment.

In the context of MSMEs, TAM has also been used to understand the technology adoption process. Studies by Shetty & Panda (2023), Wei et al. (2021), and Rokhim et al. (2021) show that using TAM to analyze technology adoption in MSMEs yields positive and satisfactory results. This application of TAM could be valuable and engaging for MSME stakeholders, where the findings and practical implications can offer significant benefits.

2.4. Hypothesis Development

To achieve a more comprehensive research objective, this study integrates key elements from the original TAM model and expands it by including additional variables, namely innovation and insecurity. Previous studies have highlighted the importance of these variables in influencing technology acceptance, such as Suherlan & Okombo (2023) and Van Essen et al. (2023) for innovation, and Nemțeanu & Dabija (2023) and Lissitsa & Chachashvili-Bolotin (2016) for insecurity. To analyze the relationships among these proposed factors, this study employs structural equation modeling (SEM) and presents a path diagram. This approach allows for a visual representation of the connections between different variables, as well as an assessment of their impact on technology adoption (Figure 1).

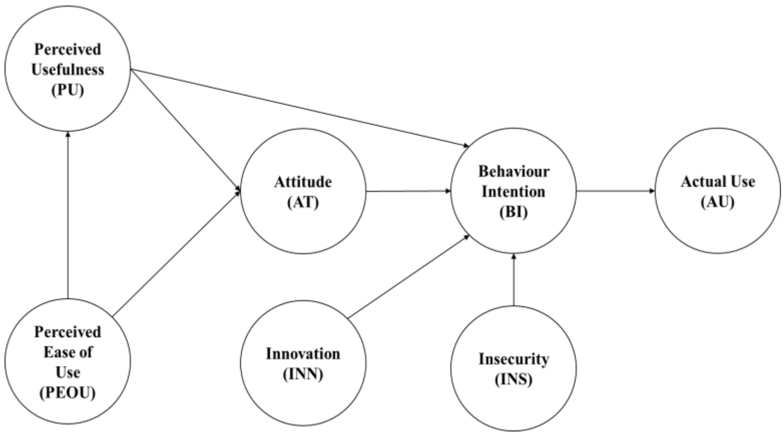

Figure 1. Model Hypothesis

2.5. Perceived Usefulness (PU)

PU (Perceived Usefulness) is defined as the extent to which an individual believes that using a particular technology will improve their performance or productivity (Davis & Venkatesh, 1996). In the context of MSMEs, PU plays a crucial role in influencing Behavioral Intention (BI) to drive technology adoption, as business owners are more likely to adopt technology when they see direct benefits to their operations, such as increased efficiency, cost savings, or market expansion (Sudirjo et al. 2023; Wijayanti & Sutarno, 2019; Taufik & Hanafiah, 2019). Furthermore, Liesa-Orus et al. (2023), Asmara & Ratmono (2021), and Lo & Stevenson (1991) also indicate that PU impacts Attitude (AT). Based on these references, the following hypothesis is proposed:

H1: Perceived Usefulness (PU) has a positive relationship with Behavioral Intention (BI) in MSME technology adoption.

H2: Perceived Usefulness (PU) has a positive relationship with Attitude (AT) in MSME technology adoption.

2.6. Perceived Ease of Use (PEOU)

Perceived Ease of Use (PEOU) refers to the belief that using a particular technology will be free from excessive effort (Davis & Venkatesh, 1996). In this regard, PEOU is crucial, especially for MSMEs, which often face resource limitations in terms of technical knowledge or technology training.

PEOU has a direct impact on PU, as technologies that are easier to use are generally perceived as more beneficial. Gefen et al. (2003) noted that technology perceived as easy to learn and use has a higher likelihood of being accepted by users, including MSME owners. Additionally, PEOU also influences Attitude (AT), as highlighted by Liesa-Orus et al. (2023) and Asmara & Ratmono (2021). If MSME owners feel that technology can be implemented without requiring significant investment in training or sacrificing considerable time, their intention to adopt the technology will be stronger. Based on these references, the following hypotheses can be proposed:

H3: Perceived Ease of Use (PEOU) has a positive relationship with Perceived Usefulness (PU) in MSME technology adoption.

H4: Perceived Ease of Use (PEOU) has a positive relationship with Attitude (AT) in MSME technology adoption.

2.7. Attitude (AT)

An attitude is defined as an organized and consistent way of thinking, feeling, and reacting regarding people, groups, social issues, or more generally any event in one's environment (Renato, 2023). In the context of technology adoption by MSMEs, attitude refers to the perceptions or views of MSME owners and managers towards new technology. According to Davis & Venkatesh (1996), Bechler et al. (2021), and Ajzen (2014), Attitude (AT) can significantly influence Behavioral Intention (BI). Based on these references, the following hypothesis can be proposed:

H5: Attitude (AT) has a positive relationship with Behavioral Intention (BI) in MSME technology adoption.

2.8. Behaviour Intention (BI)

Behavioral Intention (BI) is a function of attitudes toward behavior and subjective norms, and it predicts an individual's likelihood of engaging in a specific behavior based on their evaluation and social pressures (Pangestu, 2022). In the context of technology adoption, BI refers to a user's intention to use technology based on their perceptions of its usefulness and ease of use (Ajzen, 2014). BI is influenced by Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), and according to Venkatesh et al. (2000), PU has a stronger influence on BI compared to PEOU, particularly in the context of technology usage at the workplace. Additionally, research by Davis & Venkatesh (1996), Anthony et al. (2023), Zahrani (2021), and Hossain et al. (2017) shows that BI directly affects Actual Use (AU) in the technology adoption process. Based on these references, the following hypothesis can be proposed:

H6: Behavioral Intention (BI) has a positive relationship with Actual Use (AU) in the adoption of technology by MSMEs.

2.9. Actual Use (AU)

Actual use, in the context of technology adoption by MSMEs, is a key indicator of the success of the technology adoption itself. A technology that has been adopted will only bring benefits if it is used routinely, effectively, and tailored to the business needs. If a technology is easy to use, relevant to business processes, and supported by adequate training, it will be key to increasing actual use among MSMEs (Andarwati et al. 2020).

Actual use (AU) refers to the actual use of technology by the users. In the TAM model, AU is the result of Behavioral Intention (BI), meaning the higher an individual's intention to use the technology, the more likely they are to actually use it (Manda & Salim, 2021; Andarwati et al. 2020; Davis & Venkatesh, 1996).

2.10. Innovation (INN)

According to Baregheh (2009), innovation is a multi-stage process in which an organization transforms ideas into new or improved products, services, or processes to move forward and compete in the market. In the context of technology adoption in MSMEs, the innovation variable refers to a business's ability to introduce new or beneficial ideas, products, or processes. This variable strongly influences the Behavioral Intention (BI) (Suherlan & Okombo, 2023; Van Essen et al. 2022) of MSME owners or managers regarding their decision to adopt new technology. Based on these references, the following hypothesis can be formulated:

H7: Innovation (INN) has a positive relationship with Behavioral Intention (BI) in the adoption of technology by MSMEs.

2.11. Insecurity (INS)

In the context of capitalism, insecurity refers to a sense of unease arising from the ongoing disruption of traditional ways of life (Eriksen et al. 2010). In the context of technology adoption in MSMEs, the insecurity variable refers to feelings of uncertainty or concern about new technologies, such as doubts about outcomes, data security risks, or the ability to operate the technology. This variable can influence the Behavioral Intention (BI) of MSME owners or managers in deciding whether to adopt new technology (Nemțeanu & Dabija, 2023; Sudirjo et al. 2023; Lissitsa & Chachashvili-Bolotin, 2016).

Behavior towards new technology can be negative if MSME owners feel uncertain or fearful about the risks posed by technology, such as operational difficulties, cybersecurity threats, or an inability to keep up with changes (Sudirjo et al. 2023). Based on these references, the following hypothesis can be formulated:

H8: Insecurity (INS) has a negative relationship with Behavioral Intention (BI) in the adoption of technology by MSMEs

2.12. METHODOLOGY

The survey for this research was conducted from June to September 2024, targeting micro MSMEs with the following criteria: at least 3 years in operation, and monthly turnover not exceeding IDR 50 million. The research variables—Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude (AT), Behavioural Intention (BI), Actual Use (AU), Innovation (INN), and Insecurity (INS)—are latent variables developed based on Davis & Venkatesh (1996); Baregheh (2009); Ajzen (2014); Lissitsa & Chachashvili-Bolotin (2016); Taufik & Hanafiah (2019); Wijayanti & Sutarno (2019); Andarwati et al. (2020); Asmara & Ratmono (2021); Bechler et al. (2021); Gefen et al. (2003); Nemțeanu & Dabija (2023); Liesa-Orus et al. (2023); & Sudirjo et al. (2023).

To ensure that the micro MSMEs are familiar with and are using all these latent variables in their business activities, a Focus Group Discussion (FGD) was conducted. The FGD was held with 5 micro MSMEs, and the results are shown in Table 1. Table 1 indicates that all variables were found and used by the micro MSMEs.

Next, to obtain more valid and reliable data for statistical testing, the research instrument was developed based on the results of the FGD and previous studies. The research instrument can be seen in Table 2. The instrument was summarized in the form of a questionnaire, and before being distributed to 200 potential respondents, a face validity check was conducted. The instrument was measured using a Likert scale (1 = "strongly disagree"; 10 = "strongly agree"). Each variable is measured using 3-5 constructs.

Table 1. Results of FGD Formulation

Variable	Response
Perceived Usefulness	• Useful because it can be used as a marketing tool and medium. • Particularly useful for women because it can be done at home and generate income.
Perceived Ease of Use	• Easy, practical, with flexible timing. • However, it requires time and skills for editing. • The Canva app is easy to use.
Attitude	• Likes it because everything is already available and it helps in creating content with AI. • Likes it, but content needs to be created wisely.
Behaviour Intention	• Will continue to use it regularly, like TikTok, IG, FB Ads, and WhatsApp. • Must be wise in using digital technology.
Actual Use	• Already using apps like QRIS and Buku Warung. • E-commerce hasn't been used again due to the need for an admin. • Using WhatsApp status for selling, Instagram for branding, Facebook Business for selling, Google Business, and hashtags. • Have tried using paid ads. • Using a smartphone, tablet, and laptop.
Innovation	• Innovating by using the Canva app. • Creating videos of store activities.
Insecurity	• Concerned about data theft. • Privacy is compromised. • There are many scams. • Policies of some apps are not supportive, such as discount cuts or app shutdowns. • Price wars occur on marketplaces. • The least secure technology: Facebook.

The sample for this study was selected randomly via an online questionnaire created using Google Forms. The questionnaire was distributed through social media, and also by field enumerators. The questionnaire included information about the purpose and benefits of the research, as well as a consent statement for respondents to complete the questionnaire honestly and thoroughly.

After conducting the observation and validation of the questionnaire, valid data were obtained from 180 respondents. Before data processing, a test of the validity and reliability of the constructs was carried out. The items for each variable after the validity and reliability tests are presented in Table 4.

To examine the relationships between variables, Partial Least Squares Structural Equation Modeling (PLS-SEM) is used. PLS-SEM allows for testing relationships between latent variables, which are often abstract and cannot be directly measured, and can predict how these variables interact. Additionally, this method can handle complex structural models with multiple latent variables and indicators, moderator variables, mediator variables, and various causal relationships between these variables through a stepwise analysis. This approach is suitable for analysis with small sample sizes or data that do not follow a normal distribution (Hair et al. 2019). For descriptive data processing, Microsoft Excel is used, while PLS-SEM testing and analysis are conducted using Smart-PLS 4 software.

Table 2. Research Instrument

Variable	Research Instrument	References
Perceived Usefulness	• It improves the operational efficiency of my business. • It helps me complete tasks more quickly. • It increases the productivity of my business. • It allows me to serve customers better. • It helps me optimize product marketing.	FGD Davis (1989) Fortes & Rita (2016) Mudialba (2016)
Perceived Ease of Use	• It is easy to use in my daily business activities. • It simplifies business processes. • It's easy to learn how to use it. • The features are easily accessible and user-friendly. • It doesn't require much assistance to use.	FGD Davis (1989) Fortes & Rita (2016) Mudialba (2016)
Attitude	• I enjoy using technology in my business. • I have a positive attitude towards technology. • I feel motivated to use technology.	FGD Davis (1989) Fortes & Rita (2016)
Behavior Intention	• I intend to continue using technology. • I would recommend this technology to others. • I want to use technology for all aspects of my business operations. • I will continue to use digital technology even if there are other options.	FGD Davis (1989) Fortes & Rita (2016) Agag & El-Masry (2016)
Actual Use	• I use technology every day in my business. • I access technology from various devices. • I use technology to communicate with customers or business partners. • I use technology for marketing products or serving customers..	FGD Davis (1989) Andarwati et al. (2020) Yawised & Apasrawirote (2022)
Innovation	• I am always interested in and eager to try new technologies. • I am excited about new technologies that can improve the way I work. • I am always looking for information about the latest technologies on the market. • I believe that adopting new technology can provide a competitive advantage.	FGD Wang et al. (2008) Yu & Tao (2009) Van Essen et al. (2022) Mudialba (2016) Lányi et al. (2021)

Insecurity	• I am concerned about my personal data. • New technology often brings greater risks than benefits. • Some e-commerce platforms may suddenly shut down. • Usage fees are controlled by the app owners. • I have to rely entirely on technology to complete my work.	FGD Nemțeanu & Dabija (2023) Olsson & Bernhard (2021) Indrawati (2020) Tam et al. (2021)

3. RESULTS

3.1. Respondent Profile

The respondent profile for this study can be seen in Table 3. The table shows that the majority of the respondents have been in business for more than 3 years. This indicates that their businesses are well-established and accepted in the market, allowing them to continue and expand their operations.

Table 3. Respondent Profile

Description	Percentage
How many years has this MSME been in business?	
1 - 3 years	16,11
3 - 5 years	42,22
5 - 10 years	20,00
More than 10 years	21,67
What is the average monthly sales revenue?	
Rp.0 – Rp.10 million/month	62,78
Rp.10 – Rp.25 million/month	30,56
Rp.25 – Rp.50 million/month	6,67
Gender	
Male	58,33
Female	41,67
Education:	
High school or equivalent	86,11
Diploma (D1-3)	2,78
Bachelor's (S1)	10,56
Master's (S2)	0,56

Additionally, most respondents reported monthly sales of less than Rp.25 million. This aligns with the criteria for the respondents targeted in this study, which focuses on micro MSMEs as defined by the Indonesian Law No. 20 of 2008 on MSMEs. Furthermore, Table 3 also illustrates a relatively balanced ratio of male and female respondents, with most having a high school education.

4. Measurement Model

The first step in evaluating the measurement model is to assess the convergent validity of each item, which is determined based on the outer loading values. An item is considered reliable if the outer loading value is greater than 0.708 (Hair et al. 2019). In this case, all outer loading values exceed 0.708 (Table 4). The analysis continues by examining the convergent validity of each construct based on the Average Variance Extracted (AVE) values. An acceptable AVE value is 0.5 or higher, indicating that the construct explains at least 50% of the variance of its items (Fornell & Larcker, 1981). Based on Table 4, the AVE values for each construct range from 0.741 to 0.842.

The second step in evaluating the measurement model is to assess internal consistency, which is measured by the Composite Reliability (CR) and Cronbach's Alpha values (Hair et al. 2019). A construct is considered consistent if the CR value is greater than 0.7, as well as the Cronbach's Alpha value (Hair et al. 2019). In this case, the CR and Cronbach's Alpha values range from 0.865 to 0.955 (Table 4).

The next step is to evaluate discriminant validity, which indicates the extent to which a construct is empirically distinct from other constructs in the research model. One approach to assess this is the Fornell-Larcker criterion. Each construct demonstrates the highest quality when the correlation matrix shows that the first construct has a higher correlation coefficient with itself than with any other construct below it, and the second construct should show the same pattern (Fornell & Larcker, 1981). At this stage, one item from AU, INN, INS, PEOU, and PU had to be dropped to meet the Fornell-Larcker criterion requirements. Table 5 shows that the resulting matrix confirms that each construct is distinct from the others.

Table 4. Convergent Validity, Internal Consistency, and VIF

Construct/Items	Load' Factors	VIF	Cronbach'alpha	CR	AVE
Attitude			0,891	0,932	0,821
AT 1	0,898	2,458			
AT 2	0,915	2,790			
AT 3	0,905	2,665			
Actual Use			0,865	0,917	0,787
AU 1	0,904	2,385			
AU 3	0,910	2,747			
AU 4	0,847	1,954			
Behavior Intention			0,908	0,936	0,784
BI 1	0,861	2,339			
BI 2	0,899	3,044			
BI 3	0,913	3,327			
BI 4	0,868	2,539			
Innovation			0,905	0,933	0,778
INN 1	0,901	3,141			
INN 2	0,899	3,059			
INN 3	0,889	2,713			
INN 4	0,837	2,167			
Insecurity			0,860	0,915	0,782
INS 1	0,843	1,739			
INS 2	0,895	2,745			
INS 4	0,913	2,906			
Perceived Ease of Use			0,884	0,919	0,741
PEOU 1	0,895	3,515			
PEOU 2	0,889	3,404			
PEOU 4	0,825	2,379			
PEOU 5	0,831	2,379			
Perceived Usefulness			0,937	0,955	0,842
PU 1	0,930	4,568			
PU 2	0,916	3,522			
PU 4	0,923	4,343			
PU 5	0,902	3,174			

4.1. Structural Model

Before analyzing structural relationships, collinearity should be checked to ensure no bias in the regression results. Ideally, the variance inflation factor (VIF) value should be lower than 3, though values up to 5 are acceptable in some cases (Hair et al. 2019). In this model, all VIF values are below 5, ranging from 1.739 to 4.568 (Table 4).

The bootstrap process, using 10,000 subsamples, was applied to evaluate significant indicators and path coefficients. Model evaluation involved the coefficient of determination (R^2), cross-validated redundancy (Q^2), and path coefficient (Hair et al. 2019). In this study, an R^2 value of 0.809 (table 6) indicates the strength of the influence of AT, INN, INS, and PU on BI. An R^2 of 0.749 indicates the influence of PEOU and PU on AT, while an R^2 of 0.728 indicates the strength of PEOU's influence on PU. Meanwhile, an R^2 of 0.540 shows the influence of BI on AU.

Table 5. Discriminant Validity Test by Fornell-Larcker Criterion

	Actua l Use	Attit ude	Behaviour Intention	Innov ation	Insec urity	Perceived Ease of Use	Perceived Usefulness
Actual Use	0,887						
Attitude	0,677	0,906					
Behaviour Intention	0,737	0,863	0,885				
Innovation	0,683	0,811	0,833	0,882			
Insecurity	-0,171	- 0,223	-0,161	-0,039	0,884		
Perceived Ease of Use	0,697	0,830	0,815	0,784	-0,147	0,861	
Perceived Usefulness	0,722	0,839	0,817	0,744	-0,217	0,854	0,918

To assess the model's predictive accuracy based on empirical data, Q^2 values were calculated (Hair et al. 2019). The higher the Q^2 value (typically approaching or exceeding 0.5), the stronger the predictive relevance. Q^2 values for BI, AT, and PU are 0.628, 0.608, and 0.608, respectively, and the Q^2 for AU is 0.418 (table 6). These results indicate that BI, AT, and PU have strong predictive relevance based on the influencing variables, while the predictive relevance of AU based on BI is moderate.

Table 6. Structural Model

	Coefficient	P Values	Coefficient of determination (R^2)	Predictive Relevance (Q^2)
AT → BI	0,379	0,000	0,809	0,628
INN → BI	0,349	0,000		
INS → BI	-0,011	0,750		
PU → BI	0,238	0,001		
PEOU → AT	0,419	0,000	0,749	0,608
PU → AT	0,482	0,000		
PEOU → PU	0,854	0,000	0,728	0,608
BI → AU	0,737	0,000	0,540	0,418

5. DISCUSSION

Based on the proposed hypothesis model in Fig. 1, this model is considered adequate. This conclusion is supported by the coefficient values, R^2, and Q^2 shown in Table 6. With the addition of innovation and insecurity variables, the model becomes more responsive in the micro-MSME context, where these business entities face resource constraints and require innovation to remain competitive. Correlation test results indicate that Behavioral Intention is strongly influenced by its exogenous variables—Innovation, Insecurity, Attitude, and Perceived Usefulness—with an R^2 value of 80.90%. This finding aligns with Suherlan & Okombo (2023) and Van Essen et al. (2022), who noted that innovation positively impacts MSME behavior in technology adoption. This suggests that the technology adopted by micro-MSMEs is sufficiently designed with beneficial and user-friendly features. Moreover, the technology can boost efficiency through business process automation (Mudialba, 2016), reduce operational costs (McFarlane et al. 2020), facilitate customer relationship management and product customization (Marion & Fixson, 2021), expand market access via digital marketing and e-commerce platforms (Lányi et al. 2021), enable more accurate, real-time data-driven decisions (Duan et al. 2020), and respond to pressure from business partners who are already technology-enabled (Darby, 2020). MSMEs also need to adapt to increasingly digital consumer trends, as customers expect easily accessible online services.

Innovation assists in understanding the positive factors driving adoption, while insecurity sheds light on psychological barriers or risks faced by MSME owners. The test results for Insecurity on Behavioral Intention reveal that Behavioral Intention is negatively influenced by Insecurity (Nemțeanu & Dabija, 2023; Lissitsa & Chachashvili-Bolotin, 2016), although this effect is not significant (P-value: 0.750). Discomfort with technology in MSMEs can stem from a lack of digital knowledge and skills, leading to overwhelm (Olsson & Bernhard, 2021). Additionally, high costs of technology implementation and maintenance may raise concerns about the investment's return (Indrawati, 2020), and MSMEs also face cybersecurity risks that could jeopardize business and customer data (Tam et al. 2021).

Studies by Sudirjo et al. (2023), Wijayanti & Sutarno (2019), and Taufik & Hanafiah (2019) confirm that Perceived Usefulness also impacts Behavioral Intention. Furthermore, Olipas & Leona (2022) and Yusuf (2021) noted that Behavioral Intention is influenced by other variables such as Perceived Ease of Use in addition to Attitude (Bechler et al. 2021).

In general, this study’s results indicate that the proposed hypothesis model is acceptable and supports technology adoption processes among MSMEs. The relationships between variables in this model are positive and strong, except for Insecurity which negatively correlates with Behavioral Intention. Variables influenced through mediation by other variables also show positive outcomes. This finding is consistent with previous studies by Shetty & Panda (2023), Wei et al. (2021), and Rokhim et al. (2021), which used the TAM model to examine technology adoption.

5.1. Practical Implications for Asian Business

This study provides valuable insights for businesses across Asia, particularly for those working with micro, small, and medium enterprises (MSMEs). MSMEs form the backbone of many Asian economies, including Indonesia, where they significantly contribute to economic growth and employment. However, these enterprises face considerable challenges in adopting and integrating technology, which is increasingly necessary for business survival and competitiveness in the digital age. The model developed in this research offers a framework for understanding and addressing technology adoption challenges in micro-MSMEs, focusing on the variables of innovation, insecurity, perceived usefulness, perceived ease of use, attitude, behavioral intention, and actual use.

One of the key takeaways is the importance of promoting technological innovation among MSMEs. Asian countries, especially those with growing digital economies like Indonesia, can benefit from encouraging a culture of innovation within MSMEs. Governments and business associations should consider offering targeted training and incentives to foster innovation, helping businesses see technology not only as a tool for operational improvement but as an enabler of creative solutions and market differentiation. Countries like South Korea and Japan, where MSMEs have successfully integrated technology into their processes, provide models that other Asian nations can look to for structuring support and incentives around technological adoption and innovation.

Another practical implication is the need to address the insecurity associated with adopting new technologies. The study found that insecurity negatively influences behavioral intention towards technology adoption. This finding highlights that MSME owners may perceive technology as risky due to concerns over costs, data privacy, or lack of familiarity with digital tools. To mitigate this insecurity, policymakers and industry stakeholders in Asia should focus on building trust and reducing perceived risks associated with technology. This could include developing clear data protection laws, offering accessible support channels, and creating affordable technology solutions designed with MSMEs in mind.

In addition, support from local governments and industry organizations is crucial in building an ecosystem where MSMEs feel empowered to adopt and experiment with new technologies. By providing subsidies for technology purchases, creating co-working tech hubs, and offering digital literacy programs, these entities can foster an environment where MSMEs feel more confident in their ability to engage with technology. For instance, Japan's extensive support system for small businesses includes subsidies, technology transfer programs, and regional innovation hubs, which help alleviate barriers to technology adoption.

Finally, these findings can guide non-governmental organizations (NGOs), private companies, and CSR programs in designing programs that assist MSMEs in navigating digital transformation. By providing accessible digital solutions and training programs, these organizations can help MSMEs overcome perceived challenges and embrace technology for sustained growth. For example, large corporations could establish mentorship programs that guide smaller businesses through digital transformation, offering expertise and resources to bridge the technology gap.

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