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Factors Influencing E-Commerce Adoption in Indonesian Micro-Enterprises: An Integrated TOE–TAM Framework Analysis in Central Java

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Abstract

Background: The Indonesian government's 30 Million MSMEs Go Digital by 2024 initiative aims to foster digitalisation and enhance the performance of micro, small, and medium enterprises. Despite these efforts, adoption rates remain inconsistent, as many micro-enterprises continue to face barriers in transitioning to digital technology.

Objective: This study explores the factors influencing e-commerce adoption among micro-enterprises in Central Java, Indonesia. It employs an integrated theoretical framework combining the Technology–Organisation–Environment (TOE) theory and the Technology Acceptance Model (TAM).

Methodology: A quantitative survey was conducted among 150 respondents from five regencies in Central Java with high concentrations of micro-enterprise internet users: Jepara, Pemalang, Semarang City, Klaten, and Tegal. Partial Least Squares (PLS) path modelling was utilised to test

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the relationships between environmental factors, technological readiness, organisational readiness, and adoption intentions.

Results: The findings indicate that external environmental factors significantly and positively influence perceived ease of use and perceived usefulness. Technological readiness was found to influence perceived ease of use, whereas organisational readiness showed no significant effect due to the limited resources and simple structural characteristics inherent in micro-enterprises. The results confirm that TAM remains highly relevant in explaining adoption intentions, with perceived ease of use and usefulness acting as critical mediators.

Conclusion: The study validates the continued relevance of TAM in the context of modern digital adoption. It demonstrates that micro-enterprises' attitudes and intentions towards e-commerce are primarily shaped by their initial perceptions of technological utility and simplicity, which are further influenced by environmental factors.

Unique Contribution: This research strengthens empirical evidence for the combined TOE–TAM model in an emerging economy. It specifically highlights how the unique limitations of micro-enterprises—such as minimal organisational complexity—alter the traditional drivers of technology adoption compared to larger firms.

Key Recommendation: To improve e-commerce adoption rates, the study underscores the need for targeted external support, including digital literacy training and robust technological infrastructure. Policymakers should focus on initiatives that enhance the perceived ease of use of digital tools for small-scale entrepreneurs.

Keywords: attitude, digitalisation, intention, organisational readiness, technology readiness, TOE–TAM framework, Indonesia.

Introduction

Digitalisation has transformed economies worldwide, including how Micro, Small, and Medium Enterprises (MSMEs) develop and market goods and services. According to data from the Ministry of Cooperatives and MSMEs in 2023, the number of MSMEs is estimated at 65.5 million, comprising 97% micro, 2% small, and 1% medium enterprises. MSMEs contributes 61%, or IDR 9,580 trillion, to GDP. This figure is a 2.3% increase compared to the previous year. In addition, MSMEs absorb 97% of the national workforce.

The Indonesian government has designed the “30 Million MSMEs Go Digital by 2024” program to foster digitalisation, supported by the inclusion of e-payment and e-commerce services into the supply chain, aiming to improve MSME performance in Indonesia. However, this program has not been fully successful, as many MSMEs have not yet adopted digital technology. One form of technology applicable to MSMEs is e-commerce, which enables efficient market expansion (Sanchez-Torres & Juarez-Acosta, 2018). Based on accessibility and usability, e-commerce, particularly social media, has become the most widely used platform and a crucial component of digital marketing strategies (Wijaya et al., 2025). E-commerce is not only a type of business

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technology but also a spectrum of activities, accelerated by various technologies, including advertising and marketing, online sales, and customer service.

The intention to use e-commerce among MSMEs is affected by organisational readiness, technology readiness, external factors, perceived usefulness, perceived ease of use, and user attitude. However, the strength of each variable effect can vary. This study adopted a combination of the TOE and TAM because both focus on the determinants of technology adoption from internal and external perspectives. TOE emphasises organisational readiness, technology readiness, and the influence of environmental factors, while TAM focuses on perceived usefulness, ease of use, and user attitude. This shared focus makes the integration of the two models relevant to explaining e-commerce adoption intention among MSMEs .

E-commerce adoption among MSMEs in Indonesia faces several barriers. These barriers include employees' technological knowledge, telecommunications, connectivity costs, technical expertise, technology costs, internet security, and legal obstacles (Irianto et al.). Customer data leaks with potential legal implications.

This study aims to examine factors influencing e-commerce adoption among MSMEs to inform the formulation of supporting policies and programs. The novelty lies in the combined adoption of TOE and TAM to explain MSMEs' e-commerce adoption intention, resulting in a more comprehensive perspective than either approach alone.

Literature Review

TOE Framework

The TOE framework is a basis for analysing factors influencing the decision to adopt an innovation and the effectiveness of implementation (Wang & Chiou, 2020). An organisation or corporation's adoption of an innovation is affected by technology, the organisation, and the environment. The technology context refers to the functions and benefits that can be created by adopting e-commerce. The technological factor comprises all technologies relevant to the company, including those already implemented and those available on the market. Therefore, technological infrastructure and IT skills are necessary elements for implementing e-commerce for MSMEs (Hussain et al., 2022).

The organisational context includes size, human resources, the availability of specific resources, and the innovative attitude of senior management (Salmizi et al., 2022). The environmental context refers to the external environment in which the organisation operates, including factors such as industry, characteristics, competition, laws and regulations, the number of service providers, and government (Wang & Chiou, 2020). The TOE model can identify various aspects that affect technology adoption within an organisation (Himawan et al., 2024).

TAM Framework

The TAM model consists of three variables, namely attitude toward using a technology or system, perceived usefulness, and perceived ease of use. This model is used to investigate technology adoption (Himawan et al., 2024). TAM comprises two key factors that influence individuals' intention to adopt new technology: perceived ease of use and usefulness (Kumar et al., 2024). Perceived usefulness is the extent to which individuals believe using a particular technology will

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improve job performance. Meanwhile, perceived ease of use reflects the degree to which individuals believe the technology can be used with minimal effort (Buabeng-Andoh, 2018).

According to TAM, individual perceptions of the benefits of technology directly affect attitude, which then shapes usage intention and ultimately determines actual behaviour. Technology capable of improving work performance or efficiency will be used even when others have negative perceptions (Masa'deh et al., 2024).

Method

Sampling Method

This research was conducted in Central Java, where data from the Micro and Small Industry Profile, released by the Central Statistics Agency in 2024, show that Central Java Province has one of the highest numbers of internet-using MSMEs in Indonesia. According to data from the Central Statistics Agency, there are 887,561 MSMEs in Central Java, but only 410,795 (47.29%) use the internet, making this a particularly interesting study. A total of 35 regencies/cities in Central Java were selected purposively, including Semarang City, Klaten, Jepara, Tegal, and Pemalang Regency (Riptanti et al., 2024). In terms of infrastructure, these five regencies have internet access speeds that vary only slightly. According to data from https://urgent.id for 2025, Klaten, Pemalang, and Tegal, served by Telkomsel, have internet speeds ranging from 4 to 22 Mbps; Jepara has speeds of 3–19 Mbps; and Semarang has speeds ranging from 4 to 31 Mbps.

Respondents were purposively selected from a total of 150 MSMEs, with a sampling quota of 30 respondents per selected regency. The number of respondents was 150, based on multiplying the minimum number of latent variables by 20 (Hair et al., 2022). MSME respondents were selected because they had used e-commerce and were active on social media platforms such as Instagram, TikTok, and Google Ads, as shown in Table 1. The data collection period is from April to June 2025.

Table 1: Respondent Characteristics

Characteristics	Category	Percentage
Age (year)	Baby Boomer (>60)	2.00
	Gen X (45-60)	31.33
	Milenial (22-44)	63.33
	Gen Z (<22)	3.33
	Amount	100.00
Business Sector	Food	50.00
	Beverage	7.33
	Manufacture	2.67
	Services	2.67
	Creative Industry	37.33
	Amount	100.00
Length of Business (year)	< 10	75.33
	10 - 20	16.00
	21 - 30	7.33

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> 30	1.33
Amount	100.00

This study used two types of data: primary and secondary. Primary data were obtained using a questionnaire developed for the study. Data were collected through in-depth interviews, observations and notes were taken at the respondents' locations. Secondary data, sourced from literature studies and other credible publications, served as supporting guidelines.

Data Analysis and Hypothesis

Data analysis used the Simultaneous Equation Modelling (SEM) method. Exogenous variables included organisational readiness, technology readiness, perceived usefulness, perceived ease of use, and attitude toward use. Meanwhile, the endogenous variable was behavioural intention to use. This study used reflective measurement, and data analysis was conducted based on evaluating the outer and inner models (Hair et al., 2022). The outer model included convergent validity, discriminant validity, and reliability. Meanwhile, the inner model included evaluation of the inner VIF, F-squared, R-squared, and hypothesis test. The study model is shown in Figure 1.

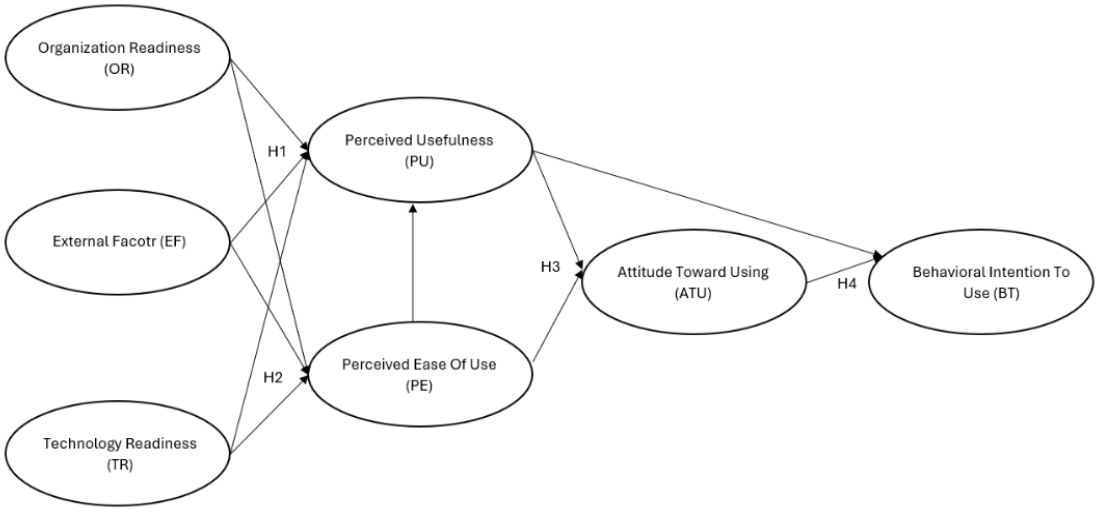

Fig. 1: Research Model

Figure 1 shows the developed model, integrating TAM and TOE to explain technology adoption intention. Based on previous studies, the variables organisational readiness, external factor, and technology readiness have a positive and significant effect on Perceived Usefulness (Kamble et al., 2021). Therefore, the mathematical equation and hypothesis proposed are as follows:

$$PU = \beta 1OR + \beta 2EF + \beta 3TR + \beta 4PE$$

Hypothesis 1 (H1): Organisational readiness, external factor, technology readiness, and perceived ease of use have a positive effect on perceived usefulness

Testing: $H_0 : \beta i = 0$

$H_a : \beta i \neq 0$

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The hypothesis test is significant when the p-value is <0.10.

The TOE framework in Figure 1 can also affect perceived ease of use. Found that the variables organisational readiness, external factor, and technology readiness had a positive and significant effect on Perceived Ease of Use. Furthermore, Setiawan et al. (2024) found that organisational factors are positively related to Perceived Ease of Use, indicating that organisational characteristics, including policies, procedures, and work culture, can influence how easily individuals or organisations can use a technology. Therefore, the mathematical equation and hypothesis proposed are:

$$PE = \gamma 1OR + \gamma 2EF + \gamma 3TR$$

Hypothesis 2 (H2): Organisational readiness, external factor, and technology readiness have a positive effect on perceived ease of use

Testing: $H_0 : \gamma i = 0$

$H_a : \gamma i \neq 0$

The hypothesis test is significant when the p-value is <0.10.

TAM was used to determine individual behaviour in technology adoption. Previous studies have shown that perceived usefulness and perceived ease of use positively affect attitude toward use (Indarsin & Ali, 2017). Furthermore, attitude toward use also positively affects behavioural intention to use (Na et al., 2022).

$$ATU = \delta 1PU + \delta 2PE$$

Hypothesis 3 (H3): Perceived usefulness and perceived ease of use have a positive effect on attitude toward use.

Testing: $H_0 : \delta i = 0$

$H_a : \delta i \neq 0$

The hypothesis test is significant when the p-value is <0.10.

$$BT = \theta 1ATU + E$$

Hypothesis 4 (H4): Attitude toward use has a positive effect on behavioural intention to use.

Testing: $H_0 : \theta i = 0$

$H_a : \theta i \neq 0$

The hypothesis test is significant when the p-value is <0.10.

Result

Measurement Model Results

The measurement model was evaluated by examining convergent validity, reliability, and discriminant validity. Convergent validity was assessed based on the loading factor and Average Variance Extracted (AVE) values, while reliability was evaluated using rho_C, rho_A, and Cronbach's alpha values. According to Hair et al. (2022), the convergent validity test criteria

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require a loading greater than 0.7 and an AVE greater than 0.5 to demonstrate good discriminant validity. The reliability test used criteria such as Cronbach's alpha, rho_A, and composite reliability (rho_C) values greater than 0.7. From the results of validity and reliability tests, five measurement items were eliminated because the loading factor was <0.7: supplier incentives and demands for e-commerce adoption, government incentives for businesses to market, the use of e-commerce, the use of e-commerce reduces the cost of advertising/promoting stores/products, and the use of e-commerce helps extend customer service time. The outer-model evaluation results indicate that this study has passed the reliability and convergent validity tests.

Structural Model Results

In the next stage, the structural model was evaluated to test the inner model, see Table 2. The inner model is used to estimate the relationships between the constituent variables. The structural model was evaluated using the Variance Inflated Factor (VIF) value to detect multicollinearity. A VIF score below 3 indicates no multicollinearity. This study used the bootstrapping method to test the inner model, particularly the Bias-Corrected and Accelerated (BCA) Bootstrap confidence interval method. The results were then derived based on the p-value of the hypothesis test. The magnitude of the effect between variables can also be determined using the effect size (f^2) value. A value of 0.02 indicates a small effect, while 0.15 and 0.35 indicate moderate and large effects, respectively (Hair et al., 2022).

Table 2: Structural Model-Direct Effect

Hypothesis	Path	p-*value*	f^2	Inner VIF
(ATU) -> (BT)	0.533	0.000***	0.314	2.429
(EF) -> (PE)	0.225	0.023**	0.052	1.859
(EF) -> (PU)	0.393	0.000***	0.183	1.955
(OR) -> (PE)	0.134	0.198 ns	0.013	2.570
(OR) -> (PU)	0.146	0.111 ns	0.019	2.604
(PE) -> (ATU)	0.309	0.000***	0.173	1.569
(PE) -> (PU)	0.203	0.019**	0.050	1.902
(PU) -> (ATU)	0.581	0.000***	0.614	1.569
(PU) -> (BT)	0.306	0.000***	0.103	2.429
(TR) -> (PE)	0.410	0.000***	0.127	2.516
(TR) -> (PU)	0.138	0.133 ns	0.016	2.836

Notes: $p < 0.1$; *: $p < 0.05$; **: $p < 0.01$; ***; ns: not significant

$p < 0.1$ was used in this study to avoid missing potentially important findings

The analysis continued by evaluating the mediation effects formed in the model. Mediation evaluation is important to understand how factors in the TOE can indirectly affect adoption intention through the psychological mechanisms described in the TAM. The mediation results are shown in Table 3.

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Table 3: Structural Model-Indirect Effect

Mediation	Path	p-value	The Role of Mediation
OR – PE – PU	0.027	0.248^{ns}	No Effect (No Mediation)
EF – PE – PU	0.046	0.158^{ns}	Direct Only (No Mediation)
TR – PE – PU	0.083	0.043**	Full Mediation
PE – PU – ATU	0.118	0.030**	Complementary (Partial Mediation)
PU – ATU – BT	0.310	0.000***	Complementary (Partial Mediation)

Notes: $p < 0.1$; *: $p < 0.05$; **: $p < 0.01$; ***; ns: not significant

According to Table 3, a mediation effect is present in the model. Perceived usefulness and attitude toward use act as partial mediators. Perceived ease of use fully mediates the relationship between technology readiness and perceived usefulness.

Discussion

The Hypothesis 1 test shows that organisational readiness has no effect on perceived usefulness and perceived ease of use. This research found that, despite limited resources, the majority of respondents shared similar perceptions of organisational readiness, as measured by capital readiness, risk tolerance, leadership commitment, employees' readiness to adopt e-commerce, and readiness to embrace developments in information technology. This uniformity of perception regarding organisational readiness indicates that respondents view e-commerce as easy and useful because of the technology itself, rather than the organisation's readiness. From a TOE perspective, organisational readiness influences adoption and implementation decisions at the organisational level more than individual users' perceptions. Perceived usefulness and perceived ease of use are largely shaped by technological characteristics, including system usability, functionality, and task-technology fit. These results reinforce the conceptual distinction between organisational readiness as a structural driver and individual-level technology perceptions. From a TAM perspective, these perceptions remain the primary predictors of individual intentions and behaviours, while organisational readiness is more relevant at the structural level for system adoption and implementation (Schorr, 2023).

Hypothesis 1 indicates that the external factor positively affects perceived usefulness. External environmental factors can strengthen perceived usefulness, a key belief that drives the intention to adopt e-commerce. This finding aligns with integrating both theories, in which the environmental context within the TOE can moderate how individuals assess the benefits of adopting technology, particularly e-commerce. These environmental factors signal the strategic advantages and relevance of technology within the business ecosystem, thereby strengthening perceived usefulness (Setiawan et al., 2024). The belief that technology will improve performance is a key predictor of usage intention in the TAM.

Hypothesis 2 test shows that the external factor has a positive effect on perceived ease of use. External factors have been shown to positively contribute to the perceived ease of use of e-commerce platforms. The research findings indicate that the pressures and demands arising from the growing online business landscape are the primary external factors driving SMEs to adopt e-commerce. This is evident from the fact that the majority of SMEs (41.3%) strongly agreed with this statement. Within the TOE framework, the technological and environmental contexts

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encourage e-commerce adoption by improving external conditions that facilitate user interaction with digital systems. Research integrating TAM shows that perceived ease of use is strongly influenced by external factors, which in turn increase the intention to use and adopt e-commerce technology. The integration of TOE and TAM (Setiawan et al., 2024) illustrates that external factors not only facilitate adoption but also strengthen users' confidence in the ease of use of e-commerce systems. The results showed that external environmental support, specifically government-facilitated training, can assist MSMEs in operating e-commerce. Therefore, perceived ease of use is not solely shaped by individual experience or internal organisational readiness, but is also strengthened by external factors.

Technology Readiness has no effect on Perceived Usefulness. This variable, which comprises internet availability, speed, and quality, does not affect the perceived usefulness of MSMEs. A data search on https://urgent.id for 2025 revealed that Klaten, Pemalang and Tegal, served by Telkomsel, have internet speeds that do not differ significantly, ranging from 4 to 22 Mbps; Jepara has speeds of 3–19 Mbps; and Semarang has higher speeds than the other four regencies, ranging from 4 to 31 Mbps. Furthermore, the results of the technological readiness measurement indicate that 116 respondents (77.3%) agreed or strongly agreed that they already possess the necessary devices (mobile phones, tablets, or laptops) and internet connectivity (Wi-Fi or data plans) to manage e-commerce. MSMEs can be “ready”, but still not adopt due to fear of risks or costs. From a TOE perspective, technological readiness serves as an infrastructure prerequisite that enables technology use, but does not directly shape users' perceived benefits.

The results show that technology readiness positively affects perceived ease of use. When MSMEs have technology readiness, including access to gadgets and an adequate internet connection, it increases the ease of adoption (Rahardja et al., 2023). Technology readiness not only allows MSMEs to adapt quickly but also increases confidence in using e-commerce. Respondents in this study generally reported having relatively fast internet connections and gadgets for operating e-commerce.

The analysis shows that perceived ease of use has a positive effect on attitude toward use. This result is consistent with previous studies, in which perceived ease of use significantly affects attitude toward use in the context of digital technology. Field results found that the easier the use of e-commerce, the more positive the attitude of MSMEs. The respondents in this study reported experiencing no difficulties in learning e-commerce, thereby increasing confidence in adoption. An easy-to-use system will strengthen positive attitudes and technology adoption intentions.

Based on the analysis, perceived ease of use positively affects perceived usefulness. These results are consistent with previous studies, in which perceived ease of use affects perceived usefulness within the technology usage intention framework (Yao & Wang, 2024). When MSMEs perceive e-commerce technology as easy to use, perceived benefits become more practical, aligning with the basic assumptions of the TAM. The ease of using digital technology in e-commerce, including digital payments and integrated delivery services, fosters the belief that e-commerce is truly beneficial.

Hypothesis 3 test shows that perceived usefulness has a positive effect on attitude toward use. When MSMEs perceive e-commerce as providing tangible benefits, including improved operational efficiency, expanded market access, and increased sales, their attitude toward use

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becomes more positive. Perceived usefulness is a key determinant of technology acceptance, explaining a significant proportion of the variance in behavioural intention to use technological innovations (Hubert et al., 2019).

Based on the analysis results, perceived usefulness has a positive effect on behavioural intention to use. For MSMEs, the decision to adopt e-commerce is strongly influenced by benefits such as increased sales, expanded market reach, and more accurate cost calculations. Therefore, the greater the perceived benefits, the stronger the intention to use e-commerce. This is true for MSMEs in Klaten, where pottery is mostly sold through e-commerce rather than through direct sales. In addition to SMEs in Klaten, further evidence can be found in other regencies, such as Semarang, where food and fashion SMEs are prevalent; Jepara, where e-commerce is dominated by woodcraft businesses; and Pemalang and Tegal, where the food sector predominates.

Hypothesis 4 test shows that attitude toward use has a positive effect on behavioural intention to use. The respondents believe e-commerce enhances business excellence and supports business; hence, their attitude toward its use can affect their behavioural intention to use it. This is in accordance with the TAM theory, which emphasises that attitude toward use is a direct predictor.

Table 3 shows that the TOE theory is less relevant in explaining the role of mediating variables in perceived usefulness. Organisational readiness does not affect perceived usefulness through perceived ease of use, as most MSMEs operate in traditional businesses and have limited resources. It also has no direct effect on perceived usefulness; hence, it does not mediate. The external factor has no effect on perceived usefulness through perceived ease of use, but it has a direct effect on perceived usefulness. This can occur because external influences, including market opportunities, competitive pressures, and government support, provide a perception of direct usefulness to MSMEs. Meanwhile, perceived ease of use is more affected by personal and technical e-commerce experience. This implies that technology readiness increases perceived usefulness when MSMEs perceive e-commerce as easy to use. Technology readiness does not directly instil confidence in e-commerce's benefits. When a system is perceived as simple, practical, and consistent with digital capabilities, MSMEs perceive e-commerce as beneficial.

Based on the mediation test results in Table 3, the TAM theory remains relevant in explaining technology adoption intention. This framework emphasises that perceived ease of use not only directly shapes attitude but also affects it through perceived usefulness. Perceived usefulness further strengthens a positive attitude, ultimately increasing behavioural intention to adopt the technology. This suggests that when business owners perceive e-commerce as easy to use, they consider the technology useful. The perceived usefulness then shapes a positive attitude, which ultimately drives intention to adopt. Therefore, both perceived usefulness and attitude toward use play important mediating roles, bridging initial perceptions of technology and adoption decisions.

This study examined the influence of external factors on ease-of-use and perceived usefulness, as well as the influence of technological readiness on ease of use, among respondents who actively use e-commerce and social media platforms such as Instagram and TikTok. However, no further research has been conducted on the usage patterns of these platforms specifically, whether they are limited to marketplaces or also function as social commerce platforms that combine social media and e-commerce by utilising all social media features, such as uploading photos and videos and livestreaming for promotional purposes and sales transactions. It is therefore crucial to conduct

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further research on whether adoption patterns differ between marketplace-only platforms and social-commerce platforms.

Although legal obstacles were identified as a potential barrier in the introduction, they were not explicitly modeled in the analysis. However, these obstacles may be reflected indirectly through constructs such as perceived risk and external factors. In the context of MSMEs, regulatory uncertainty, taxation concerns, and lack of legal clarity may increase perceived risk and hinder e-commerce adoption. Future research should explicitly incorporate legal dimensions to better capture their role.

Conclusion

In conclusion, external factors had a positive effect on perceived ease of use and usefulness, while technology readiness influenced only ease of use. This relationship shapes attitude and behavioural intention to adopt technology. Furthermore, organisational readiness did not significantly affect perceived usefulness. The ineffectiveness of these variables can be attributed to limited resources and simple organisational characteristics. The result confirms the relevance of TAM in explaining technology adoption, where perceived ease of use and perceived usefulness act as mediators that bridge initial perceptions of the technology with attitude and intention to use. Practically, this study shows the importance of external support, training, and technology readiness for MSMEs to increase their intention to adopt e-commerce. Theoretically, it strengthens empirical evidence that TAM remains relevant in the context of modern technology adoption while also confirming the mediating role of perceived ease of use and perceived usefulness in shaping attitude and intention to use.

Declarations

AI Use Statement: The authors declare that no Artificial Intelligence tools were used in the writing or production of this manuscript.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, Emi Widiyanti, upon reasonable request.

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Conflict of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical Approval: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Universitas Sebelas Maret.

Authors' Contributions: EW conceived and designed the study; HI performed the data collection; EWR analysed the data; EW, HI and EWR wrote the paper. All authors have read and agreed to the published version

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