



Determinants of Artificial Intelligence Adoption among MSMEs in Medan City: The Role of Digital Literacy and Human Resource Readiness

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ARTICLE INFO

Article history:

Received: 4 July 2026

Revised: 7 August 2026

Accepted: 29 September 2026

Available online: 30 September 2026

E-ISSN: 2776-6276

P-ISSN: -

How to cite:

Ramadani., Tinaria, L., Siregar, D.A., Sari, M.R., Wati, L., "Determinants of Artificial Intelligence Adoption among MSMEs in Medan City: The Role of Digital Literacy and Human Resource Readiness", Journal of Management Analytical and Solution (JoMAS), Vol. 6, No. 3, September. 2026, doi: doi.org/10.32734/jomas.v6i3.26738

ABSTRACT

The rapid advancement of Artificial Intelligence (AI) has accelerated digital transformation across various sectors, including Micro, Small, and Medium Enterprises (MSMEs). Nevertheless, AI adoption among MSMEs remains influenced by several factors, particularly digital literacy and human resource readiness. This study aims to examine the effects of digital literacy and human resource readiness on AI adoption among MSMEs in Medan City, Indonesia. A quantitative approach with an explanatory research design was employed. The study involved 80 MSMEs owners selected through purposive sampling. Data were collected using a structured questionnaire and analyzed using multiple linear regression with IBM SPSS Statistics 30. The results show that digital literacy has a positive and statistically significant effect on AI adoption ($\beta = 0.202$; $p = 0.042$), while human resource readiness has a stronger positive and statistically significant effect ($\beta = 0.638$; $p < 0.001$). Simultaneously, both variables significantly affect AI adoption ($F = 65.140$; $p < 0.001$), with an R^2 of 0.629, indicating that 62.9% of the variance in AI adoption is explained by the model. These findings highlight the importance of strengthening digital literacy and human resource readiness to support AI adoption among MSMEs. The study contributes empirical evidence for policymakers and MSMEs support institutions in developing targeted capacity-building programs to accelerate sustainable digital transformation.

Keyword: *artificial intelligence adoption, digital literacy, digital transformation, human resource readiness, MSMEs.*



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<http://doi.org/10.32734/jomas.v6i3.26738>

1. Introduction

The rapid advancement of digital technology has fundamentally transformed the way businesses operate. This transformation has become increasingly evident with the emergence of Artificial Intelligence (AI), which is no longer exclusively utilized by large corporations. AI has been increasingly integrated into a wide range of business activities, including marketing content creation, consumer behavior analysis, financial management, chatbot-based customer service, and business decision-making. For Micro, Small, and Medium Enterprises (MSMEs), AI offers significant opportunities to improve operational efficiency, gain deeper market insights, and strengthen competitive advantage in the era of accelerating digital transformation [1]–[3].

Despite its considerable potential, AI adoption among MSMEs remains challenging. The technological capabilities of business owners vary considerably, resulting in limited AI utilization compared with the

widespread use of basic digital technologies, such as social media platforms and messaging applications. This condition suggests that successful AI adoption depends not only on the availability of technological infrastructure but also on business owners' ability to understand and effectively utilize AI according to their business needs [4]–[6]. Previous research on MSMEs in Medan City has shown that entrepreneurial competency, market orientation, and entrepreneurial orientation are positively associated with business performance, highlighting the importance of internal capabilities in strengthening MSMEs outcomes [7].

One of the key factors influencing AI adoption is digital literacy. Digital literacy extends beyond the ability to operate digital devices; it also encompasses the capacity to access, evaluate, manage, and effectively utilize digital information. Business owners with higher levels of digital literacy are more likely to recognize the benefits of emerging technologies and integrate them into their business operations. Conversely, limited digital literacy may hinder digital transformation because business owners often encounter difficulties in understanding both the functionality and potential benefits of AI [8], [9]. Likewise, Susanto and Kamil [10] emphasized that digital competence serves as a fundamental prerequisite for the effective utilization of AI.

In addition to digital literacy, human resource readiness plays a crucial role in the successful implementation of AI. This readiness encompasses adaptability, willingness to learn, openness to change, and continuous competency development. These aspects are particularly important for MSMEs, where business owners are often directly involved in almost every aspect of business operations. Without adequate human resource readiness, even readily available technologies may not be effectively utilized. Sengkey et al. [11] identified human resource readiness as a critical factor in responding to AI advancement, while Mayasari [6] argued that digital transformation must be accompanied by continuous human capacity development.

Previous studies have consistently highlighted the importance of these two factors. Aprilia et al. [12] demonstrated that digital literacy enhances individuals' readiness to cope with digital transformation. Similarly, AI integration requires continuous competency development through reskilling and upskilling to enable organizations to adapt to technological change [4], [5], [13], [14]. Within the MSMEs context, Sánchez et al. [15] further argued that successful AI adoption is influenced by both technological readiness and organizational readiness. Nevertheless, empirical findings regarding the determinants of AI adoption remain inconclusive. Technological readiness and organizational capabilities do not always translate into actual AI adoption, as implementation decisions are often influenced by implementation costs, perceived risks, data security concerns, technological complexity, and environmental pressures. These findings suggest that AI adoption is a complex organizational decision shaped by both internal capabilities and external business environments.

Existing studies have also been conducted primarily within educational institutions, government organizations, and large enterprises. Astri [16] examined the convergence of AI and digital human resource management, while Rahmadi and Rusmiati [17] investigated digital transformation in public-sector human resource management. Meanwhile, Andika and Nasution [18] developed an AI adoption model for higher education management information systems using the Technology Acceptance Model (TAM) and the Technology–Organization–Environment (TOE) framework. In contrast, studies focusing on MSMEs have largely emphasized the role of AI in supporting business decision-making and digital business transformation [3], [2]. Consequently, empirical evidence regarding the factors driving AI adoption among MSMEs remains relatively limited.

Previous studies have examined the relationship between digital and AI-related literacy and responses to Artificial Intelligence (AI), but their findings should be interpreted in relation to the specific constructs and outcomes examined. Digital literacy refers broadly to the ability to access, understand, evaluate, and effectively use digital technologies, whereas AI literacy specifically concerns knowledge and understanding of AI technologies and their capabilities. Meanwhile, AI receptivity reflects an individual's openness or willingness to accept AI, while AI adoption refers to the actual use or implementation of AI technologies. Moravec et al. [19] found that digital literacy was associated with several forms of ChatGPT use, although the relationship was not significant for work or educational purposes. In contrast, Tully et al. [20] found that lower AI literacy was associated with greater AI receptivity. These findings should not be regarded as direct contradictions because the studies examined different forms of literacy, behavioral outcomes, and research contexts.

This distinction highlights an important gap in the existing literature. While previous studies have provided evidence concerning digital literacy, AI literacy, and receptivity to AI, relatively limited empirical evidence has examined how digital literacy is associated with actual AI adoption among MSMEs, particularly in emerging-market and local business contexts. Moreover, studies conducted in other organizational settings cannot necessarily be generalized to MSMEs, which often face different technological, organizational, and human resource conditions. Therefore, this study focuses specifically on MSMEs in Medan City, Indonesia, and examines the role of digital literacy and human resource readiness in explaining AI adoption. By focusing

on actual AI adoption within the MSMEs context, this study seeks to provide more context-specific empirical evidence regarding the factors associated with AI implementation in small-business environments.

Similar inconsistencies have also been observed regarding the relationship between human resource readiness and AI adoption. Organizational and human resource readiness are generally recognized as essential drivers of AI implementation; however, they do not necessarily guarantee higher adoption rates, particularly among MSMEs that often face limited resources, inadequate digital infrastructure, and resistance to organizational change. Therefore, this study aims to examine the effects of digital literacy and human resource readiness, both individually and simultaneously, on Artificial Intelligence adoption among MSMEs in Medan City.

1.1. Technology–Organization–Environment (TOE) Framework

The Technology–Organization–Environment (TOE) Framework, proposed by Tornatzky and Fleischer [21], posits that organizational technology adoption is influenced by three interrelated dimensions: technology, organization, and environment. This framework has been widely applied to explain the adoption of various technological innovations, including Artificial Intelligence (AI), because it captures the interaction between technological readiness, organizational capabilities, and environmental conditions in shaping technology implementation outcomes [21], [15]. In this study, the TOE framework serves as the underlying theoretical foundation, as AI adoption among MSMEs is influenced not only by the availability of technological resources but also by the organization's ability to effectively manage its human resources. Digital literacy represents technological readiness at the individual level, reflecting business owners' ability to understand and utilize digital technologies effectively. Meanwhile, human resource readiness reflects organizational capability in adapting to technological change and developing the competencies required to implement AI successfully. Therefore, the TOE framework provides an appropriate theoretical lens for explaining the relationships among digital literacy, human resource readiness, and AI adoption within the MSMEs context [18], [15].

1.2. Artificial Intelligence Adoption

Artificial Intelligence (AI) refers to technologies that enable computer systems to learn from data, perform analytical tasks, and make decisions in ways that resemble human cognitive processes. Within the context of Micro, Small, and Medium Enterprises (MSMEs), AI has been increasingly utilized to improve operational efficiency, enhance customer service, support digital marketing activities, and facilitate business decision-making. Al Ghazali [3] argued that AI provides MSMEs with opportunities to enhance productivity and improve decision-making quality. Similarly, Yahya [2] emphasized that AI can optimize business processes through the automation of various operational activities. Accordingly, AI adoption in this study is defined as the extent to which MSMEs owners utilize AI technologies to support their business operations and decision-making processes.

1.3. Digital Literacy

Digital literacy refers to an individual's ability to access, understand, evaluate, and effectively utilize digital technologies to support both daily activities and business operations. Pandapotan et al. [8] identified digital literacy as a critical competency for navigating digital transformation, enabling individuals to use digital technologies productively and responsibly. Likewise, Kawengian et al. [9] described digital literacy as a twenty-first-century competency that strengthens individuals' capacity to adapt to technological advancements. Furthermore, Susanto and Kamil [10] emphasized that digital literacy serves as a fundamental prerequisite for the effective utilization of Artificial Intelligence. Therefore, higher levels of digital literacy are expected to increase the likelihood of AI adoption among MSMEs.

1.4. Human Resource Readiness

Human resource readiness refers to the ability, willingness, and preparedness of individuals and organizations to embrace and effectively utilize emerging technologies. Sengkey et al. [11] highlighted human resource readiness as a crucial factor in responding to AI advancement, arguing that successful technology implementation largely depends on users' competencies. Similarly, Anshori [4] asserted that AI integration requires continuous improvement in digital competencies, learning capabilities, and adaptability to technological change. Moreover, Mayasari [6] emphasized that human resource development in the digital era should prioritize continuous learning and adaptive capabilities to enable organizations to maximize the benefits of technological innovation.

1.5. Empirical Review and Hypothesis Development

Drawing upon the theoretical framework and previous empirical studies, digital literacy is expected to enhance MSMEs owners' ability to understand, utilize, and integrate Artificial Intelligence applications into their business activities. Likewise, human resource readiness, reflected in digital competence, adaptability, willingness to learn, and openness to change, is expected to facilitate AI implementation within business operations. These two factors are anticipated to influence AI adoption not only individually but also collectively. Based on these theoretical and empirical considerations, the following hypotheses are proposed:

H₁: Digital literacy has a positive and significant partial effect on Artificial Intelligence adoption among MSMEs in Medan City.

H₂: Human resource readiness has a positive and significant partial effect on Artificial Intelligence adoption among MSMEs in Medan City.

H₃: Digital literacy and human resource readiness jointly have a significant effect on Artificial Intelligence adoption among MSMEs in Medan City.

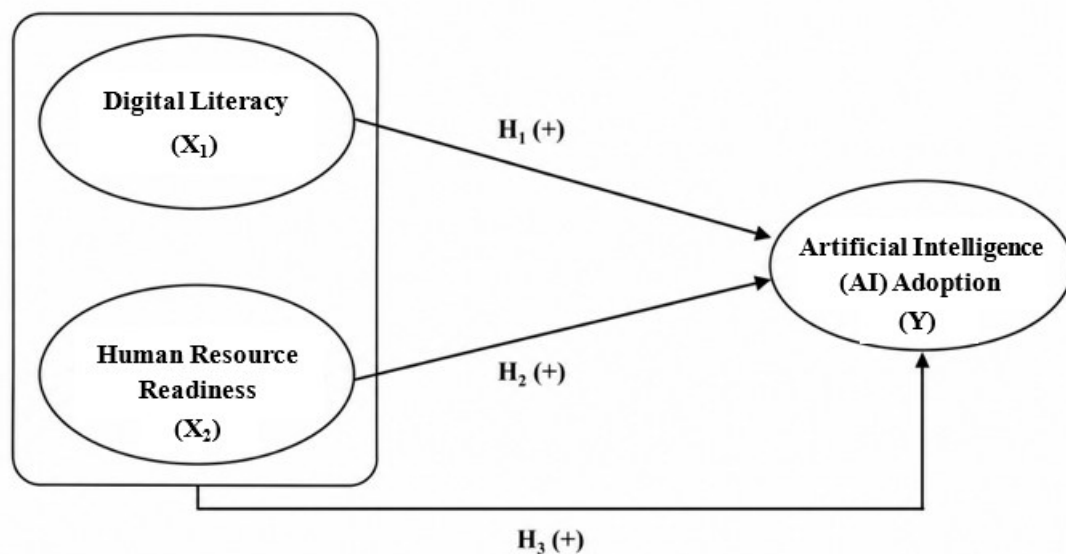


Figure 1. Conceptual Framework of the Study

2. Method

This study employed a quantitative explanatory research design to examine the relationships among digital literacy, human resource readiness, and Artificial Intelligence (AI) adoption among Micro, Small, and Medium Enterprises (MSMEs) in Medan City, North Sumatra, Indonesia. The target population consisted of MSMEs owners who used digital technologies in their business activities. Because no official database specifically identified MSMEs according to their use of digital technologies and AI, the size of the target population could not be determined precisely. The research instrument was developed on April 28, 2026, finalized on May 5, 2026, and subjected to validity testing on May 12, 2026. Data collection was conducted from May 14 to June 20, 2026, through both offline and online questionnaire distribution. Offline questionnaires were distributed during MSMEs meetings, while online questionnaires were disseminated through relevant MSMEs networks and communities. Respondents were purposively selected based on the predetermined eligibility criteria. A total of 110 questionnaires were distributed, with the initial target determined using Hair's recommendation of five observations per measurement item, resulting in 110 observations for the 22 measurement items. Of the 110 questionnaires distributed, 80 were returned and met the requirements for analysis, while 30 were not returned, resulting in a response rate of 72.73%. Respondents were purposively selected based on the following criteria: (1) owning or managing a business operating in Medan City; (2) actively conducting business activities during the data-collection period; (3) using digital technologies in their business activities; and (4) having knowledge of or prior experience with AI applications.

The MSMEs owner or individual directly responsible for managing and operating the business served as the unit of analysis, rather than the business organization as an abstract entity. For the 25 owner-managed businesses without employees, human resource readiness was assessed at the individual level, with the business owner regarded as the primary human resource responsible for managing the business and making technology-related decisions. Before completing the questionnaire, respondents were informed that participation was voluntary, their responses would be kept confidential, their names would not be published, and the information

collected would be used solely for research purposes. Primary data were collected using a structured questionnaire with a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire comprised 22 measurement items, consisting of seven items for digital literacy, seven items for human resource readiness, and eight items for AI adoption. The measurement items were developed and adapted from relevant literature and contextualized to the MSMEs setting. Digital literacy was measured through respondents' knowledge, skills, and utilization of digital technologies; human resource readiness was assessed in terms of digital competence, willingness to learn and adapt, openness to technological change, and confidence in using AI; and AI adoption was operationalized as the actual use of AI applications in business activities, rather than intention to use or perceived readiness. The AI adoption items covered the use of AI for business tasks, marketing, routine business activities, content development, decision-making, operational activities, and the development of business ideas and solutions. The measurement instrument was tested prior to the main data collection, and item-level validity was assessed using corrected item–total correlations, while internal consistency was evaluated using Cronbach's alpha. The complete measurement items, dimensions, indicators, sources, and scoring procedures are presented in Table 1.

Table 1. Sources of Measurement

Construct	No. of Items	References / Basis for Item Development
Digital Literacy (DL)	7	Pandapotan et al. [8]; Kawengian et al. [9]
Human Resource Readiness (HRR)	7	Sengkey et al. [11]
Artificial Intelligence Adoption (AIA)	8	Al Ghazali [3]
Total	22	

Source: Adapted and contextualized from previous studies

Data analysis was performed using IBM SPSS Statistics version 30. The analysis began with descriptive statistical analysis, followed by validity and reliability testing of the research instrument. Prior to estimating the regression model, the data were assessed using classical assumption tests, including tests of normality, multicollinearity, and heteroscedasticity. The relationships among the study variables were subsequently examined using multiple linear regression analysis. The partial relationships of digital literacy and human resource readiness with AI adoption were evaluated using the t-test, whereas their joint statistical significance was examined using the F-test. The coefficient of determination (R^2) was used to assess the proportion of variance in AI adoption explained by the regression model. The multiple linear regression model employed in this study is presented in Equation (1).

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \quad (1)$$

where Y represents Artificial Intelligence adoption, X_1 denotes digital literacy, X_2 represents human resource readiness, α is the regression constant, β_1 and β_2 are the regression coefficients, and ε is the error term.

3. Result and Discussion

3.1. Respondent Characteristics

Table 2. Demographic Characteristics of Respondents

Characteristic	Category	Frequency	Percentage (%)
Age	20–30 years	13	16.25
	31–40 years	20	25
	41–50 years	15	18.75
	Over 50 years	32	40
Highest Educational Attainment	Junior High School or Equivalent	2	2.5
	Senior High School/Vocational High School or Equivalent	32	40
	Diploma (D1–D3)	15	18.75
	Bachelor's Degree	27	33.75
	Postgraduate Degree (Master's/Doctoral)	4	5

Source: Authors' Data Processing Results (2026)

As presented in Table 2, the largest proportion of respondents were over 50 years of age (40%), followed by those aged 31–40 years (25%). This finding indicates that most MSMEs owners participating in the study were

within the productive age group and had accumulated substantial business experience. Regarding educational attainment, the largest group of respondents had completed senior high school or vocational high school (40%), followed by those holding a bachelor's degree (33.75%). These findings suggest that most respondents possessed an educational background sufficient to support their understanding and utilization of digital technologies in business operations.

Table 3. Business Characteristics of Respondents

Characteristic	Category	Frequency	Percentage (%)
Business Sector	Culinary	54	67.5
	Handicrafts	13	16.25
	Trade	13	16.25
Years in Business	Less than 1 year	5	6.25
	1–3 years	21	26.25
	4–6 years	25	31.25
	7–10 years	13	16.25
	More than 10 years	16	20
Number of Employees	No employees	25	31.25
	1–3 employees	50	62.5
	4–6 employees	4	5
	More than 10 employees	1	1.25

Source: Authors' Data Processing Results (2026)

As shown in Table 3, the majority of respondents operated businesses in the culinary sector (67.50%), while the remainder were engaged in handicrafts and trade. In terms of business experience, the largest group of respondents had been operating their businesses for 4–6 years (31.25%), indicating that many had progressed beyond the start-up stage and gained sufficient experience in managing their enterprises. Furthermore, the majority employed between one and three workers (62.50%), reflecting the typical characteristics of micro and small enterprises. Overall, these findings suggest that the respondents possessed adequate business experience and organizational capacity to begin adopting digital technologies, including Artificial Intelligence (AI), to support their business operations.

3.2. Descriptive Statistics of the Research Variables

Table 4. Descriptive Statistics of the Research Variables

Variable	N	Minimum	Maximum	Mean	Standard Deviation	Category
Digital Literacy (X_1)	80	2.00	5.00	4.06	0.687	High
Human Resource Readiness (X_2)	80	2.57	5.00	4.20	0.557	High
Artificial Intelligence Adoption (Y)	80	2.88	5.00	4.11	0.535	High

Source: Authors' Analysis Using IBM SPSS Statistics 30 (2026)

As presented in Table 4, all research variables recorded mean scores above 4.00, indicating that respondents expressed positive perceptions of digital literacy, human resource readiness, and Artificial Intelligence (AI) adoption. Among the three variables, human resource readiness achieved the highest mean score ($M = 4.20$), followed by AI adoption ($M = 4.11$) and digital literacy ($M = 4.06$). Overall, these findings suggest that MSMEs owners in Medan City demonstrate a high level of readiness for digital transformation and have begun integrating AI technologies into their business activities.

3.3. Instrument Testing

Table 5. Results of the Instrument Validity Test

Variable	Number of Items	Range of Item–Total Correlation (r)	Critical r -value	Interpretation
Digital Literacy (X_1)	7	0.684–0.871	0.220	All items are valid
Human Resource Readiness (X_2)	7	0.674–0.846	0.220	All items are valid
Artificial Intelligence Adoption (Y)	8	0.656–0.829	0.220	All items are valid

Source: Authors' Analysis Using IBM SPSS Statistics 30 (2026)

As shown in Table 5, all questionnaire items measuring Digital Literacy, Human Resource Readiness, and Artificial Intelligence Adoption produced corrected item–total correlation coefficients exceeding the critical r-value of 0.220. The corrected item–total correlations ranged from 0.684 to 0.871 for Digital Literacy, 0.674 to 0.846 for Human Resource Readiness, and 0.656 to 0.829 for Artificial Intelligence Adoption. These results indicate adequate item-level validity, and all items were retained for subsequent statistical analyses. The reliability analysis showed Cronbach's alpha values of 0.940 for Digital Literacy, 0.931 for Human Resource Readiness, and 0.932 for Artificial Intelligence Adoption, indicating high internal consistency. However, these findings provide evidence of item-level validity and internal consistency rather than comprehensive construct validity.

Table 6. Results of the Reliability Test

Variable	Cronbach's Alpha	Criterion	Interpretation
Digital Literacy (X ₁)	0.940	> 0.70	Reliable
Human Resource Readiness (X ₂)	0.931	> 0.70	Reliable
Artificial Intelligence Adoption (Y)	0.932	> 0.70	Reliable

Source: Authors' Analysis Using IBM SPSS Statistics 30 (2026)

As presented in Table 6, all research variables achieved Cronbach's Alpha coefficients exceeding the recommended threshold of 0.70, indicating satisfactory internal consistency. These findings confirm that the measurement instrument is highly reliable and suitable for subsequent data analysis.

3.4. Classical Assumption Tests

Table 7. Results of the Classical Assumption Tests

Test	Variable/Indicator	Result	Criterion	Conclusion
Shapiro–Wilk Normality Test	Regression residuals	Sig. 0.108	> 0.05	Normally distributed
Multicollinearity Test	Digital Literacy (X ₁)	Tolerance 0.508 VIF 1.969	Tolerance > 0.10 VIF < 10	No multicollinearity
	Human Resource Readiness (X ₂)	Tolerance 0.508 VIF 1.969	Tolerance > 0.10 VIF < 10	No multicollinearity
Glejser Heteroscedasticity Test	Digital Literacy (X ₁)	Sig. 0.656	> 0.05	No heteroscedasticity
	Human Resource Readiness (X ₂)	Sig. 0.057	> 0.05	No heteroscedasticity

Source: Authors' Analysis Using IBM SPSS Statistics 30 (2026)

As presented in Table 7, the Shapiro–Wilk normality test produced a significance value of 0.108, which is greater than 0.05, indicating no statistical evidence against residual normality at the 5% significance level. The multicollinearity test showed Tolerance values of 0.508 and VIF values of 1.969 for both independent variables. These values remain within commonly used screening thresholds, indicating that multicollinearity was not considered problematic in the regression model. The Glejser test produced significance values of 0.656 for Digital Literacy and 0.057 for Human Resource Readiness. Thus, there was no statistical evidence of heteroscedasticity at the 5% significance level, although the result for Human Resource Readiness was relatively close to the threshold and should therefore be interpreted cautiously.

The results of the Glejser heteroscedasticity test reveal significance values of 0.656 for digital literacy and 0.057 for human resource readiness, both of which are greater than 0.05. Therefore, the Glejser test did not detect heteroscedasticity at the 0.05 significance level. Overall, the findings demonstrate that the proposed regression model satisfies all classical regression assumptions and is therefore appropriate for multiple linear regression analysis and subsequent hypothesis testing.

3.6. Multiple Linear Regression Analysis and Hypothesis Testing

Table 8. Results of Multiple Linear Regression Analysis

Variable	B	Std. Error	β	t	p-value	Decision
Constant	0.894	0.284	—	3.142	0.002	—
Digital Literacy (X ₁)	0.157	0.076	0.202	2.069	0.042	H ₁ Supported

Variable	B	Std. Error	β	t	p-value	Decision
Human Resource Readiness (X ₂)	0.613	0.094	0.638	6.548	<0.001	H ₂ Supported

Source: Authors' Analysis Using IBM SPSS Statistics 30 (2026)

Multiple linear regression analysis was conducted to examine the effects of digital literacy and human resource readiness on Artificial Intelligence (AI) adoption among MSMEs in Medan City. The regression model obtained is expressed as follows:

$$Y = 0,894 + 0,157X_1 + 0,613X_2 + \varepsilon$$

The regression equation indicates that the constant value of 0.894 represents the estimated level of AI adoption when both predictor scores equal zero, which is outside the reported score ranges. The regression coefficient for digital literacy ($B = 0.157, p = 0.042$) indicates that a one-unit increase in digital literacy is associated with an increase of 0.157 units in AI adoption, assuming other variables remain constant. Likewise, the regression coefficient for human resource readiness ($B = 0.613, p < 0.001$) suggests that a one-unit increase in human resource readiness is associated with an increase of 0.613 units in AI adoption, holding other variables constant. Since both regression coefficients are positive and statistically significant, the findings support H₁ and H₂, indicating that improvements in digital literacy and human resource readiness contribute positively to AI adoption among MSMEs.

Furthermore, the standardized regression coefficients indicate that Human Resource Readiness ($\beta = 0.638$) has a stronger statistical association with AI adoption than Digital Literacy ($\beta = 0.202$). This finding suggests that MSMEs owners with greater human resource readiness tend to report higher levels of AI adoption. However, given the observational design, these results should be interpreted as statistical associations rather than causal effects. The findings also suggest that AI adoption is associated not only with digital competencies but also with readiness to learn, adapt, and integrate AI into business activities. Nevertheless, the study only partially operationalizes the TOE framework because environmental factors and potential interactions among TOE dimensions were not examined. These limitations should be considered when interpreting the findings.

Table 9. Simultaneous Test and Coefficient of Determination

R	R ²	Adjusted R ²	F	p-value
0.793	0.629	0.619	65.140	< 0.001

Source: Authors' Analysis Using IBM SPSS Statistics 30 (2026)

As shown in Table 9, the multiple correlation coefficient ($R = 0.793$) indicates a strong relationship between the independent variables (digital literacy and human resource readiness) and Artificial Intelligence adoption. The coefficient of determination ($R^2 = 0.629$) indicates that 62.9% of the variance in AI adoption among MSMEs in Medan City is explained by digital literacy and human resource readiness, while unexplained variation may reflect omitted factors, measurement error, and model misspecification. The Adjusted R² value of 0.619 further confirms that the model retains substantial explanatory power after adjusting for the number of predictors included in the regression model. The results of the F-test reveal an F-statistic of 65.140 with a significance level of $p < 0.001$, indicating that digital literacy and human resource readiness jointly exert a statistically significant effect on AI adoption. Accordingly, Hypothesis 3 (H₃) is supported, confirming that the two independent variables collectively explain a significant proportion of the variation in AI adoption among MSMEs in Medan City.

3.7. Discussion

The findings of this study indicate that digital literacy has a positive and statistically significant effect on Artificial Intelligence (AI) adoption among MSMEs in Medan City, thereby supporting Hypothesis 1. This result suggests that MSMEs owners with stronger capabilities in accessing, understanding, and utilizing digital technologies are more likely to adopt AI to support their business activities. This finding is consistent with the Technology–Organization–Environment (TOE) Framework, which posits that successful technology adoption is influenced by an organization's technological readiness [21]. In the present study, digital literacy represents technological readiness at the individual level, enabling business owners to recognize, accept, and effectively utilize AI-based innovations. The findings are also consistent with those of Pandapotan et al. [8], Kawengian et al. [9], and Susanto and Kamil [10], who emphasized that digital literacy is a critical competency for digital transformation and the effective utilization of AI. Furthermore, Sánchez et al. [15] argued that digital literacy, as a key component of the technological dimension within the TOE framework, plays a pivotal role in

facilitating AI adoption among MSMEs. Therefore, strengthening digital literacy should be considered a strategic priority for accelerating digital transformation in the MSMEs sector.

The results further demonstrate that human resource readiness has a positive and statistically significant association with AI adoption, thereby supporting Hypothesis 2. This finding indicates that adaptability, willingness to learn new technologies, and preparedness for organizational change are important factors associated with AI adoption among MSMEs. These results are also consistent with the TOE framework, which identifies organizational readiness as a critical determinant of technology adoption [21]. The findings corroborate previous studies by Sengkey et al. [11], Anshori [4], and Mayasari [6], who emphasized the importance of strengthening human resource competencies to support digital transformation. The findings are also consistent with Sembiring [22], who highlighted the importance of employee readiness for change and organizational support in facilitating organizational transformation. Similarly, Angelica et al. [23] emphasized the importance of competency development and digital technology utilization in strengthening human resource capabilities in the digital era. Accordingly, continuous investment in human resource development represents a strategic approach to enhancing AI adoption among MSMEs.

In addition to the individual effects of each independent variable, the findings reveal that digital literacy and human resource readiness jointly exert a significant influence on AI adoption, thereby supporting Hypothesis 3. The coefficient of determination indicates that these two variables explain a substantial proportion of the variation in AI adoption among MSMEs. This result suggests that successful AI implementation depends not only on technological competence but also on the readiness of human resources to embrace and manage technological change. These findings further reinforce the Technology–Organization–Environment (TOE) Framework, which explains that technology adoption results from the interaction between technological readiness and organizational readiness [21]. The results are also in line with previous studies by Al Ghazali [3], Yahya [2], and Andika and Nasution [18], which concluded that AI adoption among MSMEs is influenced by technological readiness, organizational capability, and human resource competence. Therefore, initiatives aimed at accelerating digital transformation in MSMEs should adopt a comprehensive approach that combines digital literacy enhancement, continuous human resource capacity development, and sustained assistance in the implementation of AI technologies.

4. Conclusion

This study demonstrates that digital literacy and human resource readiness each have a positive and statistically significant effect on Artificial Intelligence (AI) adoption among Micro, Small, and Medium Enterprises (MSMEs) in Medan City. The findings indicate that MSMEs with higher levels of digital literacy and better-prepared human resources are more likely to adopt AI to support their business operations. Furthermore, digital literacy and human resource readiness jointly exert a significant influence on AI adoption, suggesting that successful AI implementation depends not only on technological competence but also on the readiness of human resources to embrace and implement technological innovation. These findings highlight the importance of strengthening digital literacy and continuously developing human resource capabilities as strategic priorities for accelerating digital transformation and enhancing the competitiveness of MSMEs. Future studies are encouraged to incorporate additional determinants of AI adoption, such as organizational support, technological infrastructure, innovation capability, and environmental factors, in order to provide a more comprehensive understanding of AI adoption among MSMEs.

5. Acknowledgements

The authors would like to express their sincere gratitude to all Micro, Small, and Medium Enterprise (MSMEs) owners in Medan City who generously participated as respondents in this study. The authors also extend their appreciation to all individuals and institutions who provided valuable support, assistance, and constructive feedback throughout the data collection process and the completion of this research. Their contributions were invaluable to the successful completion of this study.

6. Declaration

The authors declare that they have no conflict of interest. This research received no specific funding from any public, commercial, or non-profit organization. The data supporting the findings of this study are available

from the corresponding author upon reasonable request, subject to applicable ethical and confidentiality considerations.

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