

THE IMPACT OF ARTIFICIAL INTELLIGENCE LITERACY ON BUSINESS PERFORMANCE TOWARD SMES SERVICES SECTOR IN UPPER-UPPER-NORTHERN THAILAND: THE MEDIATING ROLE OF COMPETITIVENESS*

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Abstract

This study examines the indirect influence of artificial intelligence (AI) literacy on business performance of SMEs in the service sector in Upper Northern Thailand, with competitiveness as a mediator variable. The population is SMEs in eight provinces, and the unit of analysis is the business owner or manager. The sample size is 400 firms. The study uses proportionate stratified random sampling by province and simple random sampling within each province. Data are collected by a structured questionnaire in both online and paper formats. All items use a five-point Likert scale. A pilot test with 30 cases shows acceptable reliability, with internal consistency values between 0.731 and 0.796. Data analysis uses descriptive statistics, correlation, and hierarchical multiple

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regression to test direct and indirect effects. The mediation test shows that competitiveness has a significant mediating role between AI literacy and business performance. The Sobel test is 1.116 with $p = 0.032$, which supports the mediation hypothesis. Path results also show that AI literacy positively affects competitiveness ($\beta = 0.379$), and competitiveness positively affects business performance ($\beta = 0.446$). The direct effect of AI literacy on business performance decreases from $\beta = 0.408$ to $\beta = 0.239$ when competitiveness is included, which indicates partial mediation. This means AI literacy improves business performance both directly and through higher competitiveness. The study recommends that SME support programs and firms should develop practical AI literacy skills and apply them in daily work to strengthen competitiveness and improve performance outcomes.

Keywords: artificial intelligence literacy, competitiveness, business performance, SMEs, service sector

Introduction

Small and medium-sized enterprises (SMEs) play an important role in the Thai economy. They create jobs, support income generation, and contribute to national production. According to the Situation Report of SMEs in 2025 by the Office of Small and Medium Enterprises Promotion (OSMEP), SMEs accounted for 34.9% of total GDP in 2024, with medium enterprises contributing 17.8%, small enterprises 14.5%, and micro enterprises 2.6% (Office of Small and Medium Enterprises Promotion, 2025). However, SME GDP has not fully returned to the pre-COVID-19 level. This situation shows that SMEs still face many challenges in a changing economic environment. In Upper-Northern Thailand, where the service sector such as tourism, hospitality, and retail is important, SMEs must improve their capabilities to survive and grow.

Artificial intelligence (AI) has become a key technology in the digital era (Kamkankaew et.al, 2025). AI can help firms improve decision-making, customer service, and operational efficiency. However, the successful use of AI depends on the level of AI literacy among business owners and employees. AI literacy refers to the competencies that enable individuals to understand, evaluate, and use AI technologies effectively (Long & Magerko, 2020). Recent studies also show that AI literacy includes awareness, usage, evaluation, and ethics (Wang et al., 2022). Many SMEs still have limited knowledge about AI, especially in developing countries. Without AI literacy, SMEs may not use AI effectively or responsibly. Therefore, AI literacy may become an important intangible resource for SMEs.

From the perspective of competitiveness, firms must develop unique capabilities to gain competitive advantage. Competitiveness at the SME level is related to the ability of a firm to create and sustain competitive advantage in its market (Ceptureanu, 2015). Innovation and differentiation are also important drivers of competitiveness and performance (Inegbedion et al., 2024). In addition, innovation has a positive effect on SME performance, especially when firms improve their existing products and services (Le et al., 2023). In the service sector of Upper-Northern Thailand, competitiveness can be improved by using AI tools for marketing, customer analysis, and service personalization. Thus, AI literacy may not directly increase business performance, but it may improve competitiveness, which then leads to better performance.

Business performance is an important outcome for SMEs. It reflects the firm's ability to generate revenue, profit, and growth. Many studies confirm that innovation capability and strategic orientation influence SME performance (Yahaya & Nadarajah, 2023). In the context of AI adoption, responsible AI literacy can support better technological readiness and sustainable performance (Rahman et al., 2025). However, there is still limited research that examines the indirect effect of AI literacy on business performance through competitiveness,

especially in the SME service sector in Upper-Northern Thailand. Therefore, this study aims to examine the indirect influence of artificial intelligence literacy on business performance, with competitiveness as a mediator variable. This research will contribute to the literature by integrating AI literacy, competitiveness, and performance in one conceptual model and by providing practical implications for SME development in Upper-Upper-Northern Thailand.

Objective

To examine the indirect influence of artificial intelligence literacy on business performance toward SMEs services sector in Upper-Upper-Northern Thailand, with competitiveness as a mediator variable.

Literature review

Business performance

Business performance refers to the ability of a firm to achieve its goals and create value in both financial and non-financial aspects. For SMEs, performance is often measured by sales growth, profit, productivity, and market share. Yahaya and Nadarajah (2023) explain that firm performance is closely related to strategic orientation and the ability of the firm to use its resources effectively. This view is consistent with the idea that SMEs must align their internal capabilities with market needs in order to survive in a competitive environment. In addition, Le et al. (2023) show that innovation has a positive effect on SMEs' performance, especially in improving revenue and value added. Therefore, business performance in SMEs can be seen as the outcome of effective strategy, innovation, and resource management.

Business performance is not only about financial results but also about customer satisfaction, operational efficiency, and long-term growth. Chong (2008) suggests that SMEs should use both financial and non-financial indicators to

measure performance, such as profit, turnover, customer satisfaction, and delivery time. This balanced approach helps SMEs understand their real position in the market. Furthermore, supply chain practices and innovation can also influence SME performance, especially in uncertain environments (Sukati et al., 2023). In the context of artificial intelligence literacy, SMEs that can use digital knowledge and data effectively are more likely to improve decision making, increase efficiency, and strengthen competitiveness. As a result, business performance becomes a reflection of how well SMEs adapt, innovate, and respond to market changes.

Artificial intelligence literacy

Artificial intelligence literacy (AI literacy) refers to the ability of individuals to understand, use, and evaluate AI technologies in daily and business activities. It does not mean that a person must become an AI expert. Instead, it means that a person can properly identify AI systems, use them correctly, and judge their results in a responsible way. Wang, Rau, and Yuan (2022) explain that AI literacy includes four main parts, which are awareness, use, evaluation, and ethics. Awareness means knowing what AI is and where it is used. Use means the ability to operate AI tools. Evaluation means judging whether AI outputs are correct and useful. Ethics means understanding issues such as bias and fairness. AI literacy is also related to digital literacy and daily use of AI tools. In the SME service sector, this literacy helps managers and employees apply AI in marketing, customer service, and decision-making.

AI literacy is important because AI has become a key tool for business competitiveness. In the digital era, AI can support data analysis, customer personalization, and process improvement. However, without enough literacy, firms may not use AI effectively. Rachmatulloh et al. (2025) state that AI literacy supports innovation capability and business sustainability. When SME owners understand how AI works, they can make better decisions and reduce risks in

digital operations. AI literacy also helps firms connect technology with strategy. This ability is very important for SMEs in Upper-Northern Thailand, where many firms are still developing their digital skills.

In addition, AI literacy supports business growth through better customer engagement and marketing performance. Kamkankaew et al. (2024) explain that AI tools such as chatbots, predictive analytics, and personalized recommendations can improve customer experience and increase sales in digital markets. However, to gain these benefits, business owners must understand how to manage AI systems and interpret data correctly. Therefore, AI literacy is not only a technical skill but also a strategic capability. In this study, AI literacy is viewed as a key resource that can indirectly improve business performance through competitiveness. SMEs with higher AI literacy are more prepared to adapt, innovate, and compete in the service sector of Upper-Northern Thailand.

Competitiveness

Competitiveness refers to the ability of a firm to perform better than other firms in the same market. It means that a company can produce goods or services more efficiently and deliver higher value to customers. Chavez et al. (2022) explain that competitiveness is related to a firm's ability to supply products and services more effectively than competitors. Labor productivity and export performance are often used as key indicators to measure competitiveness (Cragg et al., 2020). In manufacturing and service sectors, productivity shows how well a firm uses its resources. As discussed in the literature, productivity has long been linked with competitiveness since the time of Adam Smith, who emphasized the importance of efficiency in production (Dallasega et al., 2018). In the context of SMEs, competitiveness also reflects the firm's ability to survive and grow in global and digital markets.

In addition, competitiveness is strongly connected with digital transformation and technology adoption. Digital technologies help firms improve efficiency, quality, and customer response. Da Silva et al. (2025) show that higher

digital maturity leads to higher productivity and better export results in SMEs. This means that firms with better digital systems can compete more effectively in global supply chains. Porter (1998) also states that competitiveness depends on productivity and the ability to create value. For SMEs in the service sector in Upper-Northern Thailand, competitiveness is important for maintaining customers, improving service quality, and increasing market share. In this study, competitiveness is viewed as a key mechanism that links artificial intelligence literacy with business performance. SMEs that improve their competitiveness through technology and innovation are more likely to achieve better performance outcomes.

Conceptual Framework

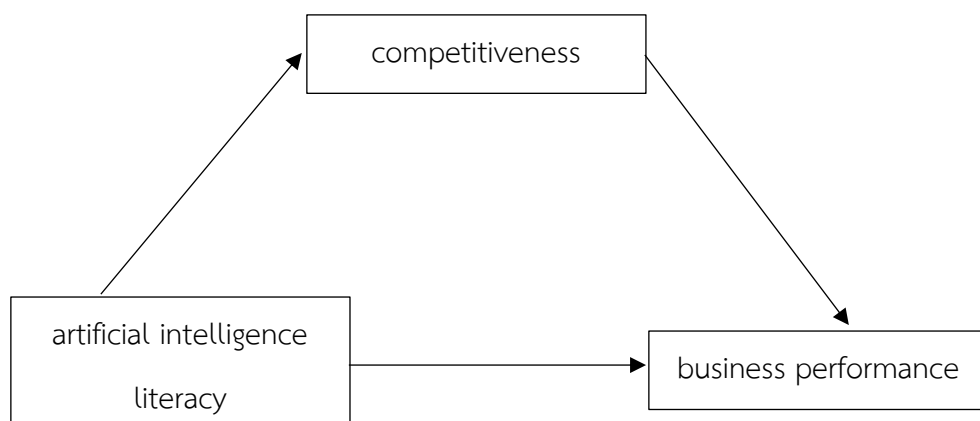


Figure 1 Conceptual Framework

H1 artificial intelligence literacy have an influence on business performance toward SMEs services sector in Upper-Northern Thailand

H2 artificial intelligence literacy have an influence on competitiveness toward SMEs services sector in Upper-Northern Thailand

H3 competitiveness have an influence on business performance toward SMEs services sector in Upper-Northern Thailand

H4 artificial intelligence literacy have an influence on business performance toward SMEs services sector in Upper-Northern Thailand, with competitiveness as a mediator variable.

Methodology

Population and sample size

The population of this study is small and medium enterprises in the service sector in Upper Upper-Northern Thailand. The service sector includes food and beverage services, other personal service activities, wholesale, retail, repair of motor vehicles and motorcycles, and real estate activities. The total number of SMEs in this area is 267,869 firms (Office of Small and Medium Enterprises Promotion, 2025). Chiang Mai has 80,641 firms, Chiang Rai has 54,777 firms, Lampang has 29,241 firms, Phrae has 28,218 firms, Lamphun has 24,998 firms, Nan has 24,409 firms, Phayao has 17,555 firms, and Mae Hong Son has 8,030 firms. The unit of analysis is the business owner or manager because they have knowledge about artificial intelligence literacy, competitiveness, and business performance. The definition of population follows the concept of target population in survey research as explained by Creswell (2014).

The sample size was calculated by using the formula of Yamane (1967) with a 95 percent confidence level and 5 percent error. The calculation from 267,869 firms gives a sample size of 400 firms. The study used proportionate stratified random sampling to ensure that each province was represented based on its number of SMEs. This method helps to reduce sampling bias and increase representativeness as suggested by Cochran (1977). After that, simple random sampling was used in each province to select the SMEs. This sampling method is suitable for quantitative research and supports generalization to the population.

Research instrument

The research instrument in this study was developed based on established scales from previous studies to ensure content validity and theoretical consistency. Artificial intelligence literacy was measured using the concept of awareness, use, evaluation, and ethics adapted from Wang et al. (2022), who developed and validated an AI literacy scale. Competitiveness was measured by adapting indicators related to productivity and competitive advantage from SME competitiveness studies (Wang et al., 2024). Business performance was measured using subjective performance indicators such as operational efficiency, revenue growth, and overall performance, which are commonly used in SME research (Kgakatsi et al., 2024). All items were measured using a five-point Likert scale from 1 = strongly disagree to 5 = strongly agree. Before data collection, the questionnaire was reviewed by three experts in SME research and digital business to ensure clarity and relevance. A pilot test was conducted with 30 SME owners in the service sector in Upper-Northern Thailand. Reliability was tested using Cronbach's alpha, and all constructs showed acceptable values between 0.731 to 0.796, which indicates good internal consistency (Hair et al., 2019). Composite reliability values were also above 0.70, which confirms that the instrument is reliable and suitable for further analysis.

Data collecting

Data were collected by using a structured questionnaire survey. The population of this study was small and medium enterprises in the service sector in Upper Northern Thailand. The service sector included food and beverage services, other personal service activities, wholesale, retail, repair of motor vehicles and motorcycles, and real estate activities. The unit of analysis was the business owner or manager because they had knowledge about artificial intelligence literacy, competitiveness, and business performance. The definition of population followed the concept of target population in survey research as

explained by Creswell (2014). The sample size was 400 firms. The study used proportionate stratified random sampling to ensure that each province was represented based on its number of SMEs. The questionnaires were distributed to the selected firms by both online and paper formats. The researcher contacted the owners or managers directly and asked for their voluntary participation. This sampling method was suitable for quantitative research and supported generalization to the population.

Data analysis

Data analysis in this study is conducted using hierarchical multiple regression analysis. This method is suitable for testing both direct and indirect relationships among variables in line with the research objectives. First, descriptive statistics are used to explain the basic characteristics of the data, such as mean and standard deviation. Then, correlation analysis is applied to examine the relationship among artificial intelligence literacy, competitiveness, and business performance. After that, hierarchical multiple regression analysis is used in step-by-step order. In the first step, control variables are entered into the model. In the second step, artificial intelligence literacy is added to test its direct effect on business performance. In the third step, competitiveness is added to test the mediation effect. The change in R-square and beta coefficients are considered to explain the influence of each variable in the model.

Result

Results of the normality test of the data.

Table 1 Results of the normality test of the data

Variable	Mean	S.D.	SK	KU
artificial intelligence literacy (AIL)	3.43	0.761	-0.949	0.421
Competitiveness (CMN)	3.53	0.792	-1.379	2.715
business performance (BUP)	3.42	0.742	-1.046	2.548

Table 1 shows the results of the normality test of the data. The mean of artificial intelligence literacy (AIL) is 3.43 with S.D. = 0.761. The skewness (SK) is -0.949 and the kurtosis (KU) is 0.421. The mean of competitiveness (CMN) is 3.53 with S.D. = 0.792. The SK is -1.379 and the KU is 2.715. The mean of business performance (BUP) is 3.42 with S.D. = 0.742. The SK is -1.046 and the KU is 2.548. The values of skewness are between -2 and +2. The values of kurtosis are between -3 and +3. This result shows that the data are normally distributed. The data meet the basic assumption for further analysis such as structural equation modeling. According to Hair et al. (2019), if skewness and kurtosis are within the acceptable range, the data can be considered normal.

Results of the linear relationship test among variables

Table 2 Results of the linear relationship test among variables

	BUP	AIL	CMN	Tolerance	VFI
BUP	1.000				
AIL	0.616**	1.000		0.686	1.540
CMN	0.623**	0.776**	1.000	0.766	1.463

Note: ** indicates statistical significance at the 0.01 level.

Table 2 shows the results of the linear relationship test among variables. Artificial intelligence literacy (AIL) has a positive relationship with business performance (BUP) ($r = 0.616$, $p < 0.01$). Competitiveness (CMN) also has a positive relationship with business performance ($r = 0.623$, $p < 0.01$). In addition, artificial intelligence literacy has a strong positive relationship with competitiveness ($r = 0.776$, $p < 0.01$). All relationships are significant at the 0.01 level. The tolerance values are 0.686 and 0.766. The VIF values are 1.540 and 1.463. The VIF values are lower than 5. This result shows that there is no multicollinearity problem.

The variables have linear relationships and are suitable for further analysis. According to Hair et al. (2019), correlation values should not be too high and VIF should be less than 5 to confirm that multicollinearity is not a serious problem.

Hypothesis testing results

Based on the research objectives, this study aims to the indirect influence of artificial intelligence literacy on business performance toward SMEs services sector in Upper-Upper-Northern Thailand, with competitiveness as a mediator variable. The results of this research are presented below.

The first step of the analysis

The results of the first step analysis support Hypothesis 1, which proposes that artificial intelligence literacy has an influence on business performance toward SMEs in the service sector in Upper Northern Thailand. The analysis shows that artificial intelligence literacy has a positive and significant effect on business performance. The regression coefficient is $b = 0.202$ and the standardized coefficient is $\beta = 0.408$. The t-value is 8.684 and the significance level is $p < 0.05$. This result shows that the relationship is statistically significant. The model shows a strong correlation value ($R = 0.677$). The R-square is 0.459. This means that artificial intelligence literacy can explain 45.9 percent of the variance in business performance. Therefore, Hypothesis 1 is supported.

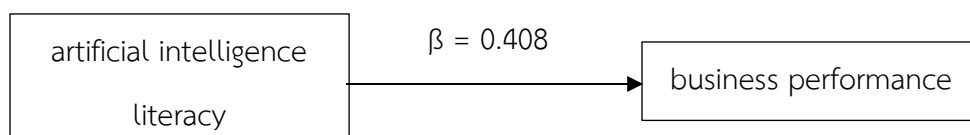


Figure 2 The first step of the analysis

The second step of the analysis

The results of the second step of the regression analysis support Hypothesis 2, which states that artificial intelligence literacy has an influence on

competitiveness toward SMEs in the service sector in Upper Northern Thailand. The findings show that artificial intelligence literacy has a positive and significant effect on competitiveness. The regression coefficient is $b = 0.195$ and the standardized coefficient is $\beta = 0.379$. The t-value is 8.435 and the significance level is $p < 0.05$. This result confirms that the relationship is statistically significant. The model shows a correlation value of $R = 0.666$. The R-square is 0.444 and the adjusted R-square is 0.438. This means that artificial intelligence literacy can explain 44.4 percent of the variance in competitiveness. Therefore, Hypothesis 2 is supported by the empirical results.

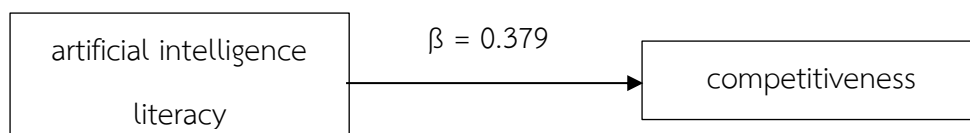


Figure 3 The second step of the analysis

The third step of the analysis

The results of the third step of the regression analysis support Hypothesis 3, which states that competitiveness has an influence on business performance toward SMEs in the service sector in Upper Northern Thailand. The findings show that competitiveness has a positive and significant effect on business performance. The regression coefficient is $b = 0.327$ and the standardized coefficient is $\beta = 0.446$. The t-value is 4.067 and the significance level is $p < 0.05$. This result shows that the relationship is statistically significant. The model shows a correlation value of $R = 0.395$. The R-square is 0.156 and the adjusted R-square is 0.147. This means that competitiveness explains 15.6 percent of the variance in business performance. Therefore, Hypothesis 3 is supported by the empirical results.

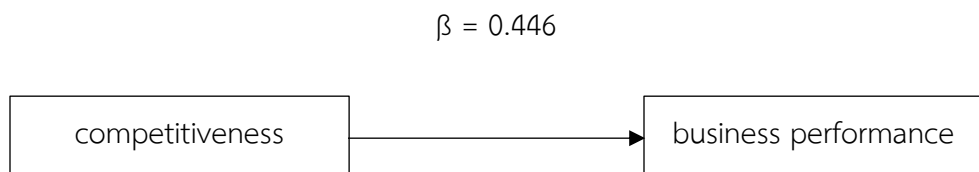


Figure 4 The second step of the analysis

The fourth step of the analysis

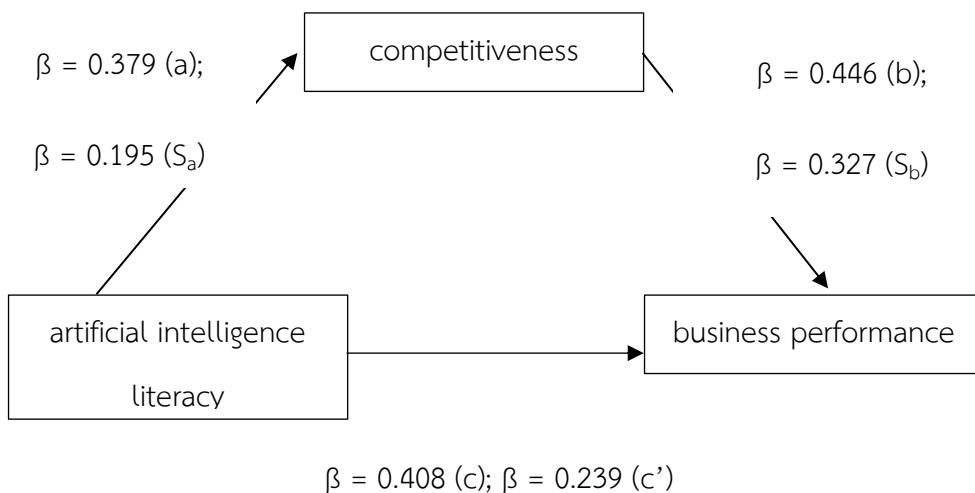


Figure 5 The fourth step of the analysis

The results of the mediator variable test show that competitiveness plays a significant mediating role in the relationship between artificial intelligence literacy and business performance. The Sobel test value is 1.116, and the p-value is 0.032. The p-value is lower than the 0.05 level. This result shows that the indirect effect is statistically significant. Therefore, Hypothesis 4 is supported. Artificial intelligence literacy has an indirect influence on business performance through competitiveness in SMEs in the service sector in Upper Northern Thailand. This finding is consistent with the concept of mediation analysis

proposed by Baron and Kenny (1986), which explains that a mediator variable can transmit the effect of an independent variable to a dependent variable.

In addition, the path analysis results show that artificial intelligence literacy has a positive effect on competitiveness ($\beta = 0.379$). Competitiveness also has a positive effect on business performance ($\beta = 0.446$). The direct effect of artificial intelligence literacy on business performance decreases from $\beta = 0.408$ to $\beta = 0.239$ when competitiveness is included in the model. This result indicates partial mediation. It means that artificial intelligence literacy influences business performance both directly and indirectly through competitiveness. This finding is in line with mediation testing principles explained by Preacher and Hayes (2008), who state that a significant indirect effect supports the mediating role of the variable.

Table 3 Results of Hypothesis Testing

Hypothesis	Hypothesis Testing
H1 artificial intelligence literacy have an influence on business performance toward SMEs services sector in Upper-Northern Thailand	Accepted
H2 artificial intelligence literacy have an influence on competitiveness toward SMEs services sector in Upper-Northern Thailand	Accepted
H3 competitiveness have an influence on business performance toward SMEs services sector in Upper-Northern Thailand	Accepted
H4 artificial intelligence literacy have an influence on business performance toward SMEs services sector in Upper-Northern Thailand, with competitiveness as a mediator variable.	Accepted

Discussion

The results of this study show that competitiveness plays a significant mediating role between artificial intelligence literacy and business performance. The Sobel test shows a value of 1.116 with a p-value of 0.032, which is lower than 0.05. This means that the indirect effect is statistically significant. Therefore, Hypothesis 4 is supported. Artificial intelligence literacy has an indirect influence on business performance through competitiveness in SMEs in the service sector in Upper Northern Thailand. This finding follows the concept of mediation by Baron and Kenny (1986), who explain that a mediator can transmit the effect of an independent variable to a dependent variable. In addition, the direct effect of artificial intelligence literacy on business performance decreases when competitiveness is added to the model. This result shows partial mediation. It supports the idea of Preacher and Hayes (2008) that a significant indirect effect confirms the mediating role of a variable.

The path analysis also shows that artificial intelligence literacy has a positive effect on competitiveness ($\beta = 0.379$). Competitiveness also has a positive effect on business performance ($\beta = 0.446$). These results mean that SMEs with higher AI literacy are more competitive. When SMEs are more competitive, they can improve sales, profit, and market share. This result is consistent with the idea that firm performance depends on effective use of internal resources and strategy (Yahaya & Nadarajah, 2023). It also supports the view that innovation improves SME performance (Le et al., 2023). AI literacy helps SME owners understand and use AI tools such as data analysis and customer systems. This ability improves service quality and efficiency. As Porter (1998) explains, competitiveness depends on productivity and value creation. Therefore, AI literacy becomes an important capability that supports competitiveness and performance.

In the context of Upper Northern Thailand, many SMEs are still developing their digital skills. AI literacy can help them adapt to digital change and improve their strategic decisions. Wang et al. (2022) explain that AI literacy includes awareness, use, evaluation, and ethics. When SME owners understand these elements, they can use AI more effectively. This result also supports Rachmatulloh et al. (2025), who state that AI literacy supports innovation and sustainability. In addition, Kamkankaew et al. (2024) show that AI tools can improve marketing and customer experience. Therefore, this study confirms that AI literacy is not only a technical skill but also a strategic resource. It helps SMEs build competitiveness, and competitiveness leads to better business performance in the service sector.

Recommendation

Recommendation for SMEs services sector in Upper-Northern Thailand

The results show that competitiveness is an important mediator between artificial intelligence literacy and business performance in SMEs in the service sector in Upper Northern Thailand. Therefore, SME owners should focus on improving their AI literacy as a strategic priority. They should learn how to use AI tools for data analysis, customer management, and online marketing. Training programs and workshops should be organized by local government and business associations to support this learning. When SME owners increase their AI literacy, they can improve their competitiveness. Higher competitiveness will help them increase sales, profit, and market share in a competitive service market.

SMEs should also integrate AI literacy into their business strategy. AI should not be used only for daily tasks, but also for planning and decision making. Owners should use AI to study customer behavior, forecast demand, and improve service quality. This action will increase productivity and create more

value for customers. When SMEs can create higher value, they can build stronger competitive advantage. This step follows the finding that competitiveness has a strong positive effect on business performance. Therefore, developing AI literacy together with strategic planning is very important for sustainable growth.

In the context of Upper Northern Thailand, many SMEs still have limited digital skills. Public and private sectors should cooperate to provide continuous support. Universities, training centers, and government agencies can offer simple and practical AI courses for SME owners. Financial support and digital infrastructure should also be improved. SME owners should also consider ethical use of AI and data protection. When AI literacy is developed in a responsible way, SMEs can improve innovation and long-term sustainability. As a result, SMEs in the service sector can strengthen their competitiveness and achieve better business performance in the future.

Recommendation for academia and future research

This study gives important recommendations for academia and future research. First, academic institutions should include artificial intelligence literacy in business and management programs, especially for SME development. Universities can design short courses and training programs that focus on AI awareness, use, evaluation, and ethics. This can help future entrepreneurs build competitiveness through digital skills. Second, future research should test this model in other regions of Thailand and in other sectors to compare the results. Researchers can also use longitudinal data to study long-term effects of AI literacy on competitiveness and performance. In addition, future studies may examine other mediator or moderator variables such as innovation capability, digital strategy, or organizational culture. This can help develop a deeper understanding of how AI literacy improves business performance. Finally, researchers should apply advanced methods such as SEM with larger samples to confirm the mediation effect in different contexts. These directions can extend academic knowledge and support SME development in the digital era.

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