

The Role of AI, IoT, and E-Marketing in Enhancing the Sustainability and Competitiveness of MSMEs

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Abstract - This research examined how the integration of Artificial Intelligence (AI), the Internet of Things (IoT), and e-marketing can enhance the sustainability and competitiveness of Micro, Small, and Medium Enterprises (MSMEs). It addresses the gap in existing literature regarding the synergistic effects of these technologies in overcoming resource constraints often faced by MSMEs during digital transformation. While previous research has focused on the individual benefits of AI or IoT, limited attention has been given to their combined impact on e-marketing and its influence on MSME sustainability. This research used a quantitative approach to survey 200 MSMEs in Denpasar City through a Likert-scale questionnaire and analyzed with PLS-SEM version 4.0. The findings reveal that AI improves access to e-marketing channels and operational efficiency, while IoT enhances data analytics and automates business processes. Their integrated adoption significantly boosts digital marketing performance, positively affecting MSME sustainability. The challenges identified include the high costs and expertise required for effective implementation. Nonetheless, with appropriate investment and technical support, AI, IoT, and e-marketing synergy can make MSMEs more sustainable. From a managerial perspective, the long-term integration of these technologies into business strategies is critical for sustaining growth in the digital era.

Keywords: Artificial Intelligence, Internet of Things, e-marketing, MSME sustainability, digital

transformation, business performance, automation, data analytics

I. INTRODUCTION

Globalization brings significant changes to the economic and business landscape. Entrepreneurs must adapt to rapid technological advancements, simultaneously presenting new opportunities and threats (Kolbjørnsrud, 2023; Tarigan & Dewi, 2015). Technology has become indispensable for industries and consumers in the digital era, deeply integrated into modern life (Sarker, 2023; Balahurovska, 2023).

Along with digital transformation and urbanization, smart cities represent a revolutionary approach to enhancing and experiencing urban environments. Denpasar, a strategic city in Indonesia, is advancing rapidly with technologies such as 4G and 5G (Priyadarshini, 2024; Darusalam et al., 2024). As the backbone of the Indonesian economy, MSMEs face immense pressure to survive amid intense market competition. Leveraging e-commerce platforms for sales, marketing, and customer engagement is essential to increasing market visibility (Cakranegara et al., 2022).

Emerging technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and e-marketing offer vast opportunities for MSMEs to thrive. These technologies enhance productivity, optimize resources, and support sustainability in competitive markets (Ardhiyansyah et al., 2024). Conversely, failure to adapt to these innovations could jeopardize the long-term survivability of MSMEs

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(Aziz, 2019).

Initially regarded as a technical concept among IT professionals, artificial intelligence has become a familiar term for consumers (Jo & Baek, 2023). AI has experienced rapid development, garnering increasing interest due to its growing influence in providing automatic recommendations and making critical decisions in various fields, including finance (Siderska et al., 2023; Putra et al., 2024). For MSMEs, AI can optimize business management by analyzing real-time operational data, identifying market trends, and improving customer relationship management (Ogata et al., 2024).

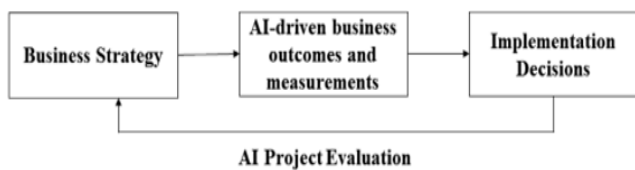


Figure 1 Framework for Making Strategic Decisions about Investments and Initiatives Related to AI

Figure 1 illustrates how AI-driven business outcomes are measured and evaluated to support effective implementation decisions. This framework outlines the key stages and metrics involved in the evaluation process, providing a comprehensive overview of how each element contributes to informed decision-making (Gudigantala et al., 2023).

For instance, AI can automatically monitor and analyze customer preferences to offer more relevant products, increasing customer satisfaction. Another significant application of AI lies in reducing operational costs. By automating routine tasks such as inventory management and order processing, productivity improves alongside competitiveness. The integration of AI into business processes is therefore crucial for MSMEs to develop strategies to face the increasingly fierce competition, such as in Denpasar city, Bali.

The Internet of Things (IoT) significantly enhances operational efficiency in MSMEs. IoT represents a new paradigm comprising networks of smart objects (Kristiyanto & Ernastuti, 2020) and serves as one of the main pillars of the Fourth Industrial Revolution (Gerakoudi et al., 2024). This concept evolved from the early idea of smart devices (Miladi et al., 2021). As IoT devices grow more intelligent, the value of the data they generate will also increase (Eckardt & Kerber, 2024). The implementation of IoT enables MSMEs to optimize inventory monitoring, streamline distribution, and manage supply chains more effectively. For instance, MSMEs in trade sectors in Denpasar can use IoT to automatically monitor product stock, minimizing stock shortages and expediting distribution processes.

Furthermore, the data collected, denoted as D_p , can be analyzed using AI models to predict consumer

preferences $P(t)$, $P(t) = f(D_p, t)$, with t representing time and f as the predictive function based on machine learning algorithms. Consequently, AI can optimize targeted marketing strategies based on data analysis and improve operational efficiency.

Digital marketing automation, denoted as $M(p)$, enables personalized campaigns where p represents the consumer profile generated from data analysis. This positively impacts the response rate RR , represented by the formula $RR = \sum M(p) \cdot C(p)$, where $C(p)$ indicates the conversion rate based on consumer preferences. Thus, this integration allows MSMEs to improve marketing effectiveness and overall business sustainability.

Social media marketing, a form of e-marketing, involves sharing content to strengthen users relationships (Haque et al., 2024). E-marketing satisfies customer demand for timely, up-to-date information and communication (Juniardi & So, 2012). MSMEs in Denpasar can leverage e-marketing, as more consumers use the internet to search for product information. Digital marketing approaches such as search engine optimization, social media engagement, and digital advertising offer broader coverage at lower costs than conventional marketing methods.

Adopting digital technologies like AI, IoT, and e-marketing forms a critical foundation for promoting the sustainability and growth of MSMEs in Denpasar. This aligns with the perspective of Kowalkowski et al. (2024), who argue that IoT facilitates the transformation of physical resources into configurable services. AI and IoT enhance operational efficiency, while e-marketing enables MSMEs to compete more effectively in global markets. The synergy of these three technologies empowers MSMEs to achieve their maximum business potential, improve productivity, operate more efficiently, and access broader markets.

Figure 2 illustrates how AI and IoT integrate to enhance e-marketing and support MSME sustainability by optimizing resources, improving customer engagement, and driving business growth. AI optimizes marketing strategies through data analysis, while IoT gathers real-time customer insights and streamlines operations. Together, they enhance e-marketing effectiveness, which supports the long-term sustainability of MSMEs by expanding market reach, improving customer engagement, and optimizing resource management. This interconnected system creates a feedback loop where efficient marketing and operations drive growth and sustainability.

Denpasar serves as a strategic regional economic hub for MSME development within Bali Province. Beyond being a business activity center, the city is the heart of culture and tourism, providing significant opportunities for MSMEs to thrive. This research examines how digital technologies—AI, IoT, and e-marketing—can be integrated to enable the sustainable performance of MSMEs in Denpasar.

The sustainability of MSMEs in Denpasar involves their ability to grow and innovate continuously. By leveraging the synergy of AI, IoT, and e-marketing,

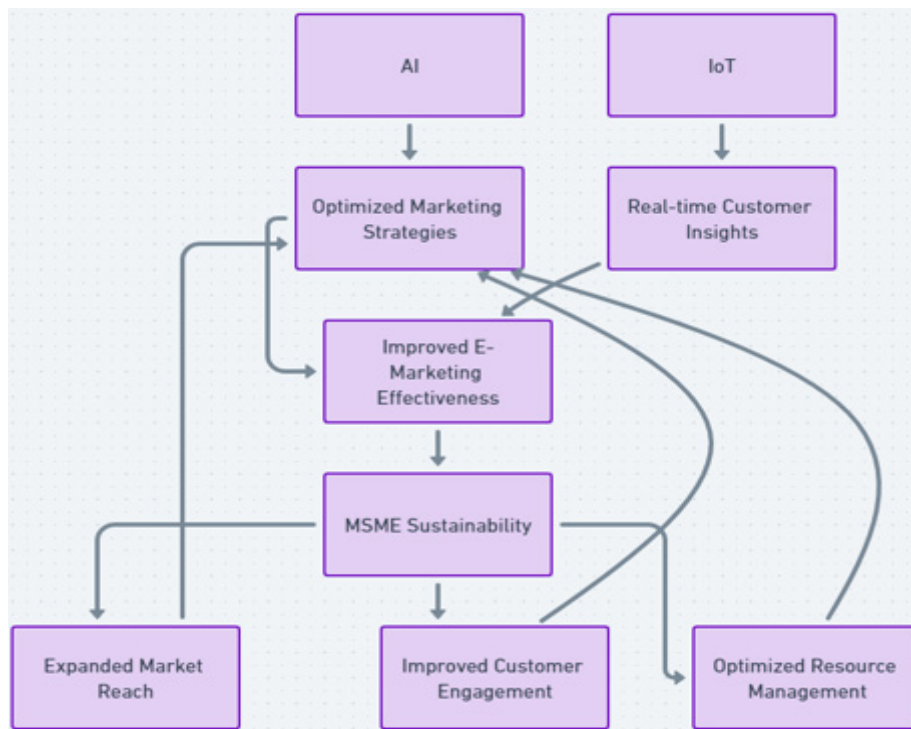


Figure 2 The Integration of AI and IoT in Enhancing E-Marketing and MSME Sustainability

MSMEs can strengthen their business structures and unlock technological potential to seize opportunities in increasingly competitive markets.

This research brings novelty by investigating the synergistic integration of AI, IoT, and e-marketing to enhance sustainability among MSMEs in Denpasar. Unlike most research that examines these technologies individually, this research explores their combined impact on optimizing operations, improving customer engagement, and expanding market reach. It offers a unique perspective on addressing sustainability challenges specific to MSMEs in a rapidly digitalizing economy. The study seeks to answer how the integration of AI, IoT, and e-marketing enhances MSME sustainability, identifies challenges and opportunities arising from their implementation, and assesses how their synergy improves business performance and competitiveness.

For instance, the research explores new strategies for MSMEs in Denpasar to leverage digital technologies as core elements for enhancing sustainability and competitiveness. It is expected to contribute meaningfully to adaptive and innovative MSME development in the digital era.

Two recent theories supporting research on MSMEs' sustainability in Denpasar, particularly the application of digital technology, are the uses and gratification theory and the Technology Acceptance Model (TAM). According to the uses and gratification theory, individuals actively select media and technology to fulfill their needs and wants (Moon et al., 2022). This theory highlights how MSME owners use digital technologies such as AI, IoT, and e-marketing to achieve business objectives and sustainability.

Most MSME owners are motivated by the need to enhance operational efficiency, expand market reach, and improve customer satisfaction. Consequently, they seek technologies that fulfill these expectations. The theory also suggests that satisfaction derived from using digital technology can influence decisions on continuance adoption and integration of innovations into business strategies. By understanding these motivations and gratifications, this research aims to provide deeper insights into how MSMEs in Denpasar can leverage digital technology to adapt and compete in increasingly complex markets.

The Technology Acceptance Model (TAM) explains how users accept and utilize technology. TAM emphasizes two key variables: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Scherer & Teo, 2019). Perceived Usefulness (PU) reflects the belief that a specific technology will enhance performance, while Perceived Ease of Use (PEOU) denotes how straightforward the technology is to operate. In the context of MSMEs in Denpasar, TAM elucidates the adoption of digital technologies like AI, IoT, and e-marketing. If MSME owners perceive that these technologies improve operational efficiency, reduce workloads, and are easy to learn and implement, they are more likely to adopt them.

Thus, TAM offers a framework for investigating the factors influencing MSMEs' acceptance of digital technologies and how this acceptance fosters sustainability and competitiveness in a dynamic marketplace. Building on the literature review of AI, IoT, and e-marketing synergy to support MSME sustainability in the digital era, this research proposes several hypothesis.

H1: AI facilitates access to e-marketing.

AI enhances access and efficiency in e-marketing by analyzing extensive datasets and automating marketing activities. According to Haleem et al. (2022), businesses can uncover hidden patterns within consumer data through machine learning algorithms, which aid in crafting effective targeting strategies. Similarly, Apriani et al. (2024) reveal that AI rapidly analyzes extensive customer behavioral data, enabling focused marketing campaigns.

H2: AI influences IoT.

The integration of AI into IoT creates an effective digital ecosystem, significantly enhancing IoT's capabilities. AI strengthens IoT security by enabling real-time detection of anomalies and threats, safeguarding device integrity (Giordano et al., 2022). Marengo (2024) further highlights that AI enhances the intelligence and autonomy of IoT devices, enabling them to operate with greater efficiency and adaptability.

H3: IoT influences E-Marketing.

IoT facilitates efficient data collection and direct communication with customers, enabling firms to deliver personalized content and products tailored to diverse consumer information. This facilitation improves the consumer shopping experience (Lo & Campos, 2018). Basaure et al. (2020) emphasize that IoT fosters interactive marketing through smart devices, such as sending targeted promotions or updates on new products directly to consumers.

H4: E-Marketing affects MSME sustainability.

Kilay et al. (2022) argue that MSMEs must integrate digital marketing techniques to adapt to evolving consumer behavior and technological advancements. This transformation allows businesses to expand their market reach and enhance operational efficiency, contributing to long-term sustainability. Similarly, Salah and Ayyash (2024) report that e-commerce adoption significantly improves marketing performance, market expansion, customer service, and overall sustainability for MSMEs.

H5: AI influences MSME sustainability through e-marketing.

AI enhances e-marketing strategies by analyzing consumer behavior and preferences, enabling MSMEs to execute focused and effective marketing campaigns. This drives customer engagement, retention, and loyalty, which contribute to sustainable business models (Di Vaio et al., 2020). Pan and Nishant (2023) note that AI adds personalization to marketing

interactions, improving customer experience and fostering satisfaction, loyalty, and business sustainability.

H6: IoT influences MSME sustainability through e-marketing.

IoT enables MSMEs to optimize operations using automation and real-time data analytics, reducing waste and improving energy efficiency, which is critical for environmental sustainability (Martínez-Peláez et al., 2023). Moreover, IoT enhances inventory and supply chain management, helping businesses better understand stock levels and demand forecasts. This enhancement reduces overproduction, minimizes waste, lowers costs, and supports sustainable resource management (Ding et al., 2023).

H7: AI affects MSME sustainability through IoT and E-Marketing.

AI enhances targeted advertising by leveraging consumer behavior data, allowing MSMEs to engage customers more effectively. However, excessive reliance on data analytics can lead to increased energy consumption and reduced environmental sustainability due to the demands of the supporting infrastructure (Marken et al., 2024). Despite these benefits, the adoption of AI and IoT in MSMEs faces challenges such as high initial costs, the need for technical expertise, and concerns over data privacy and security. Moreover, small businesses may struggle to compete with larger firms dominating the data economy, exacerbating market inequalities (Kulkarni et al., 2024).

H8: AI influences e-marketing through IoT.

AI leverages the vast data generated by IoT devices to gain deep insights into customer behaviors and preferences (Davenport et al., 2020). The integration of IoT and AI enables predictive analytics, allowing businesses to forecast consumer behavior based on historical data. This capability empowers companies to anticipate customer needs, adapt their marketing strategies proactively, and deliver personalized experiences, enhancing marketing effectiveness and customer satisfaction (Labib, 2024).

II. METHODS

The research is conducted in Denpasar, focusing on Micro, Small, and Medium Enterprises (MSMEs) listed in Denpasar Open Data. Moreover, data collection is a quantitative approach using questionnaires, with MSME owners serving as respondents. The research uses primary data, offering the most detailed and direct source of information. The population consists of all 28,224 SMEs listed

in Denpasar Open Data. Samples are drawn using purposive sampling, targeting SMEs that utilized AI services, engaged in e-marketing activities, and whose owners had a sufficient understanding of IoT access. A sample size of 200 SMEs is selected to ensure adequate representation of the key variables—AI, IoT, e-marketing, and sustainability. This sample size is deemed statistically sufficient for the requirements of Partial Least Squares Structural Equation Modeling (PLS-SEM) and suitable for the research's complexity and expected outcomes.

The questionnaire is designed to measure variables related to AI, IoT, e-marketing, and MSME sustainability. All variables are measured using Likert scale, following the approach described by Claveria (2021). The Likert scale format typically includes a series of statements for which respondents indicate their level of agreement or disagreement, ranging from "strongly agree" to "strongly disagree." The closed-ended nature of the questionnaire captured respondents' perceptions and attitudes regarding four identified key variables.

PLS-SEM is selected for hypothesis testing due to its suitability for exploring complex relationships among variables. This approach allows for simultaneous testing of both the measurement and structural models. It is particularly effective in analyzing the interrelations among AI, IoT, e-marketing, and MSME sustainability based on the eight hypotheses in the introduction. Additionally, PLS-SEM accommodates the independence of input data, as each variable is measured separately using distinct questionnaire statements.

Data analysis employs Partial Least Squares Structural Equation Modeling version 4.0 (PLS-SEM). It is a robust statistical method for examining complex interrelations in economic studies. Moreover, PLS-SEM enables the simultaneous evaluation of measurement and structural models, making it appropriate for testing the interdependencies among variables.

Complete Combined Model:

$$Y2 = \beta_0 + \beta_1 X1 + \beta_2 X2 + \beta_3 Y1 + \varepsilon_1 \quad (1)$$

$$Y1 = \beta_4 + \beta_5 X1 + \beta_6 X2 + \varepsilon_2 \quad (2)$$

$$X2 = \beta_7 + \beta_8 X1 + \varepsilon_3 \quad (3)$$

$$Y1 = \beta_9 + \beta_{10} X1 + \beta_{11} X2 + \varepsilon_4 \quad (4)$$

$$Y2 = \beta_{12} + \beta_{13} X1 + \beta_{14} X2 + \beta_{15} Y1 + \varepsilon_5 \quad (5)$$

$$Y2 = \beta_{16} + \beta_{17} X1 + \beta_{18} Y1 + \varepsilon_6 \quad (6)$$

$$Y2 = \beta_{19} + \beta_{20} X1 + \beta_{21} Y1 + \varepsilon_7 \quad (7)$$

$$Y2 = \beta_{22} + \beta_{23} X1 + \beta_{24} Y1 + \varepsilon_8 \quad (8)$$

Note:

- $Y1$: E-Marketing
- $Y2$: MSMEs sustainability
- $X1$: AI
- $X2$: IoT
- $\beta_0, \beta_1, \dots, \beta_{24}$: Regression Coefficients
- $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_8$: Error terms for each equation

III. RESULTS AND DISCUSSIONS

Table 1 presents a descriptive profile of the respondents. The research targets 200 MSMEs in Bali. By gender, males represented 56.0% of the respondents, while females are 44.0%. The age distribution of the respondents indicates that 54.5% are over 40 years old, suggesting a significant proportion of seasoned business owners with considerable experience. Meanwhile, 33.0% of respondents fall within the 30 to 40-year age range, and 12.5% are younger than 30.

Regarding company age, 65.0% of the MSMEs have been operational for over 10 years, indicating that they are established businesses. Additionally, 26.0% have been in operation for 5 to 10 years, and only 9.0% are in their first 5 years. Overall, the data reflects a comprehensive representation of respondents, encompassing both the business owners' demographics and the companies' age. These figures suggest strong representation in terms of experience and age, which is crucial for evaluating the impact of digital financial innovation, financial literacy, and access to finance on the growth and sustainability of MSMEs.

Table 1 Respondent Profiles

Characteristic	Total	Percentage (%)
Gender		
Male	112	56.00%
Female	88	44.00%
Age		
Under 30	25	12.50%
30 - 40	66	33.00%
Over 40	109	54.50%
Company Age		
Less than 5 years	18	9.00%
5 - 10 years	52	26.00%
More than 10 years	130	65.00%

Table 2 shows the construct reliability and validity. The AVE values for each variable in the output are greater than 0.5, indicating that all the indicators convergently represent their corresponding variables. Furthermore, Cronbach's Alpha and Composite Reliability (CR) values are greater than 0.6 for each variable. Variables and items of the research meet the requirements for the validity and reliability of the measurement. The results confirm that the measurement model is both reliable and valid, providing a robust foundation for further analysis.

Figure 3 illustrates the results of Structural

Equation Model (SEM) testing. It shows the relationships between the variables Internet of Things (IoT), Artificial Intelligence (AI), e-marketing, and micro, small, and medium enterprises (MSMEs) sustainability. The numerical values on the paths represent the path coefficients or significance levels, while the values on the indicators reflect the contribution of each indicator to the measured latent variables.

Table 3 presents the regression weights from the Structural Equation Model (SEM) analysis. The PLS-SEM results reveal several significant relationships

Table 2 Construct Reliability and Validity

Variable	Indicator	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Average Variance Extracted (AVE)
AI	AI helps automate routine marketing tasks in our business.	0.681	0.63	0.684	0.514
	AI tools enable analyzing customer behavior patterns more effectively.	0.681	0.63	0.684	0.514
	AI improves the accuracy of marketing campaigns by personalizing content.	0.681	0.63	0.684	0.514
	The use of AI in business reduces time spent on data analysis.	0.681	0.63	0.684	0.514
	AI assists in predicting market trends and customer preferences.	0.681	0.63	0.684	0.514
E-Marketing	Our business uses digital platforms to reach a broader customer base.	0.691	0.847	0.789	0.633
	E-marketing helps us target specific customer segments with personalized ads.	0.691	0.847	0.789	0.633
	Online marketing campaigns are a significant driver of our business growth.	0.691	0.847	0.789	0.633
	We regularly use social media and email marketing to engage with customers.	0.691	0.847	0.789	0.633
	The effectiveness of our marketing has improved through digital channels.	0.691	0.847	0.789	0.633
IoT	IoT allows us to collect real-time data from our customers.	0.628	0.762	0.638	0.525
	IoT devices help improve our product or service delivery process.	0.628	0.762	0.638	0.525
	The integration of IoT enables better management of our business resources.	0.628	0.762	0.638	0.525
	IoT technology enhances the accuracy of our marketing communications.	0.628	0.762	0.638	0.525
	IoT allows for more personalized interactions with our customers.	0.628	0.762	0.638	0.525
MSMEs Sustainability	Our business adopts environmentally friendly practices to reduce waste.	0.683	0.531	0.507	0.527
	We aim for long-term business growth through sustainable practices.	0.683	0.531	0.507	0.527
	Digital tools have helped us reduce operational costs and improve efficiency.	0.683	0.531	0.507	0.527
	Our business has seen growth due to the adoption of digital marketing.	0.683	0.531	0.507	0.527
	Online marketing efforts have increased our competitive advantage.	0.683	0.531	0.507	0.527

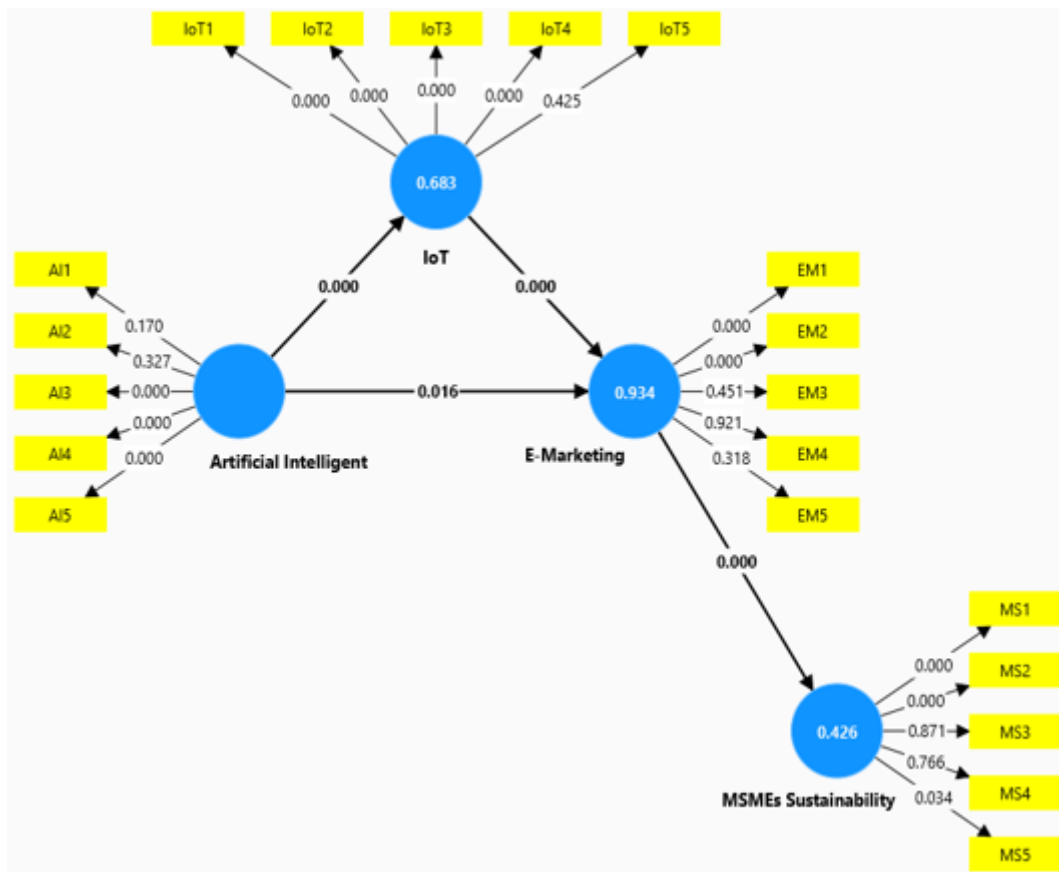


Figure 3 Structural Equation Model Testing

Table 3 Regression Weight Structural Equational Model

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
AI -> E-Marketing	0.147	0.148	0.061	2.406	0.016
AI -> IoT	0.594	0.624	0.060	9.919	0.000
IoT -> E-Marketing	0.847	0.840	0.047	18.207	0.000
E-Marketing -> MSMEs Sustainability	0.689	0.707	0.045	15.323	0.000

among the variables. First, the relationship between AI and e-marketing shows an original sample value of 0.147 and a P-value of 0.016, indicating a significantly positive influence at $p < 0.05$, supported by a T Statistics value of 2.406. The relationship between AI and IoT demonstrates an original sample value of 0.594 and a P-value of 0.000, signifying a very strong and highly significant effect at $p < 0.001$, with a T Statistics value of 9.919.

Furthermore, the connection between IoT and e-marketing has an original sample value of 0.847 and a P-value of 0.000, accompanied by a T Statistics value of 18.207, highlighting that IoT plays a crucial role in enhancing e-marketing strategies. The relationship between e-marketing and the sustainability of MSMEs shows an original sample value of 0.689, a P-value of 0.000, and a T Statistics value of 15.323, indicating that e-marketing significantly contributes to the sustainability of MSMEs. Collectively, these findings suggest that the integration of AI and IoT technologies,

along with e-marketing strategies, plays an essential role in the growth and sustainability of MSMEs in the digital age.

Table 4 highlights the Total Indirect Effect analysis, showcasing the relationships among the variables. One key finding is the effect of AI through e-marketing on MSME sustainability, which has an original sample value of 0.101 and a P-value of 0.024. This result indicates a significant positive impact at $p < 0.05$, supported by a T Statistics value of 2.259. This finding suggests that incorporating AI into E-Marketing strategies will positively influence MSME sustainability.

The relationship between IoT through e-marketing and MSME sustainability has an original sample value of 0.584 and a P-value of 0.000. It indicates a very strong and highly significant effect at $p < 0.001$, with a T Statistics value of 12.921. The result highlights that IoT integration in e-marketing significantly enhances the sustainability of MSMEs.

Table 4 Total Indirect Effect

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics ((O/STDEV))	P values
AI -> E-Marketing -> MSMEs Sustainability	0.101	0.105	0.045	2.259	0.024
IoT -> E-Marketing -> MSMEs Sustainability	0.584	0.593	0.045	12.921	0.000
AI -> IoT -> E-Marketing -> MSMEs Sustainability	0.347	0.371	0.047	7.455	0.000
AI -> IoT -> E-Marketing	0.503	0.524	0.053	9.431	0.000

The combined impact of AI through IoT and e-marketing on MSME sustainability shows an original sample value of 0.347, a P-value of 0.000, and a T Statistics value of 7.455. This indicates that AI, when combined with IoT and e-marketing, has a significant positive effect on MSME sustainability, underscoring that integrating these technologies into business strategies will foster long-term sustainability.

Lastly, the effect of AI through IoT on E-Marketing was found to have an Original Sample value of 0.503, a P-value of 0.000, and a T Statistics value of 9.431, demonstrating a significant influence at $p < 0.001$. This means that AI plays a direct role in e-marketing and enhances the effectiveness of digital marketing strategies through IoT. Overall, these findings indicate that the application of AI and IoT in E-Marketing strategies can significantly contribute to the sustainability of MSMEs.

The combined findings from Table 3 and the results in Table 4 highlight the key relationships within the model and demonstrate congruence with the hypotheses developed earlier.

H1: AI facilitates access to e-marketing.

The integration of AI algorithms in e-marketing increases accessibility and efficiency, as AI can process large data volumes and automate marketing tasks. This aligns with the study by Haleem et al. (2022), which states that AI can reveal hidden consumer trends, enhancing targeting precision. Apriani et al. (2024) support this statement, showing that AI can quickly analyze customer behavior data, enabling focused marketing campaigns. The findings illustrate that AI adoption in e-marketing gives SMEs a competitive edge.

H2: AI influences IoT.

AI's integration into IoT creates an effective digital ecosystem. Giordano et al. (2022) note that AI enhances IoT device security by enabling it to detect and respond to threats, thereby maintaining device integrity. Marengo (2024) adds that AI makes IoT devices more autonomous and more intelligent. This evidence aligns with recent advancements, highlighting how AI and IoT work together to build

secure and efficient systems.

H3: IoT influences e-marketing.

IoT facilitates effective data collection, enabling direct communication between businesses and customers. Lo and Campos (2018) observe that IoT's vast consumer data capabilities allow companies to provide personalized content and products, improving the shopping experience. Basaure et al. (2020) emphasize IoT's role in interactive marketing, where smart devices directly push promotions or product information directly to consumers. These findings affirm the contribution of IoT to enhancing e-marketing strategies.

H4: E-marketing affects MSMEs' sustainability.

Kilay et al. (2022) highlight that digital marketing helps SMEs adapt to rapid changes in consumer behavior and technology. Salah and Ayyash (2024) confirm that the adoption of e-marketing significantly improves SMEs' marketing performance. By leveraging online platforms, SMEs enhance market access and operational efficiency, leading to better business performance and sustainability. This underscores the critical role of e-marketing in the modern digital landscape for SMEs' survival and growth.

H5: AI influences MSME sustainability through e-marketing.

AI supports the development of sophisticated e-marketing strategies that analyze consumer behavior patterns and preferences. Di Vaio et al. (2020) indicate that evidence-based practices streamline marketing activities, fostering customer engagement and retention. Pan and Nishant (2023) also find that AI personalizes marketing, creating an integrated consumer experience. These findings suggest that AI can help SMEs develop sustainable business models through effective marketing.

H6: IoT influences MSME sustainability through e-marketing.

IoT enhances MSME operations by enabling automation and real-time data analysis, reducing waste and improving energy efficiency. Martínez-Peláez et al. (2023) demonstrate that IoT enhances inventory management and supply chain efficiency. Ding et al. (2023) support this, indicating that IoT reduces overproduction and waste. These results confirm that IoT significantly contributes to MSME sustainability.

H7: AI affects MSME sustainability through IoT and E-Marketing.

AI enables MSMEs to tailor marketing strategies based on consumer preferences. Marken et al. (2024) note that while AI and IoT offer significant benefits, challenges such as high initial costs, the need for technical expertise, and data privacy concerns must be overcome. These findings suggest that, despite the hurdles, AI and IoT integration into E-Marketing can support sustainable growth for SMEs.

H8: AI influences e-marketing through IoT.

AI leverages data generated by IoT devices to gain insights into consumer behavior and preferences, enhancing predictive analytics. Davenport et al. (2020) explain that this capability allows businesses to anticipate consumer needs and adjust marketing strategies accordingly. Labib (2024) highlights how strategic adjustments can be made using insights gained through AI-IoT integration. This symbiosis is essential for creating more effective e-marketing strategies.

IV. CONCLUSIONS

This research highlights the significant drivers of AI, IoT, and e-marketing in influencing the sustainability of MSMEs. The integration of these technologies has enhanced marketing accessibility and effectiveness by enabling better understanding and targeting of consumer behavior. Such advancements allow MSMEs to construct more focused, data-driven marketing strategies, improving their operational efficiency and competitive edge in a rapidly changing marketplace.

The research suggests that MSMEs should prioritize investments in digital technologies and employee training to maximize the benefits of AI and IoT. These investments support data-driven marketing strategies to enhance campaign efficiency and improve consumer engagement. Additionally, sustainability reports can be a powerful tool for MSMEs to showcase how these technologies contribute to operational efficiency and waste reduction, which is valuable for gaining trust among environmentally conscious consumers.

This research has several limitations that should be considered. First, the sample does not

represent of the greater MSME landscape, potentially limiting the generalizability of the findings. Second, potential external factors that could affect the results are not controlled, such as market trends or economic fluctuations. Third, the research focuses only on the positive side of digital technology, without mentioning any negative implications, such as ethical concerns, unfair competition, or crime. Fourth, the research does not address whether the financial investment required for adopting these technologies is feasible for smaller MSMEs. Lastly, critical infrastructure elements, such as internet access, transmission speeds, software compatibility, and language barriers were not addressed as elements that could be important in less developed areas where these technologies may still be helpful.

Despite these limitations, several gaps are identified that create opportunities for further research. A direction that could be taken is on cultural and social factors impeding the rate of technology adoption because this would avail broad insight into the regional differences in social dynamics to contextualize the problems and opportunities encountered by the MSMEs. In addition, future research should be devised to establish convergence between the theoretical insights garnered from the literature review and the empirics obtained from owners of MSMEs. This would further encourage the practical applicability of findings on nuanced roles of digital technology for MSME sustainability.

Addressing these gaps in future research can contribute to a more comprehensive understanding of how AI, IoT, and e-marketing can be leveraged for the sustainability of MSMEs. By considering both technological benefits and associated challenges, future studies can offer clearer guidance for MSMEs aiming to thrive in an increasingly digital economy.

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