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RESEARCH ARTICLE

THE IMPACT OF ARTIFICIAL INTELLIGENCE, DIGITAL COMPETENCIES, AND ENTREPRENEURIAL COMPETENCIES ON B40 WOMEN'S SUSTAINABLE BUSINESS PERFORMANCE

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ABSTRACT - Artificial Intelligence (AI) has transformed the way businesses operate and the field of digital marketing. AI tools offer several benefits for digital marketers, making them a prevailing tool for businesses to achieve their marketing goals. This study aims to examine the impact of AI marketing on the performance of micro businesses. Second, it is to observe the mediating effect of digital and entrepreneurial competencies on the relationship between AI adoption and business performance. A cross-sectional quantitative design was employed, and questionnaires were distributed to 300 B40 women entrepreneurs. A final valid dataset of 235 respondents was analyzed using the Structural Equation Modeling (SEM) method. The study results display the direct effects of AI adoption, digital competencies, and sustainable business performance. Then, digital and entrepreneurial competencies mediate the relationship between AI adoption and sustainable business performance. The implications of these findings suggest that the systematic development of skills and knowledge, as well as the strategic deployment of AI and technologies, should be a priority for entrepreneurs seeking to improve performance and preserve a competitive edge in an ever-evolving market and industry.

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INTRODUCTION

To reduce extreme poverty, the government has executed a strategy that aligns with the Sustainable Development Goals (SDGs), specifically SDG 1, which aims to end poverty in all its forms. The Malaysian government offers the low-income (B40) group the opportunity to start or expand a business through capital assistance provided by the Department of Social Welfare. This assistance focuses on facilitating the official start of small businesses, increasing the income of low-income households, and promoting community economic development through entrepreneurship. This can help build the family's long-term economic foundation, reducing the poverty rate and improving the community's overall standard of living (Mohamad et al., 2021; Yakubi et al., 2022). Small and Medium Enterprises (SMEs) are the backbone of the Malaysian economic landscape since they create job opportunities for the local community (Al Mamun et al., 2021). Entrepreneurship activities contribute meaningfully to Malaysia's Gross Domestic Product (GDP). For instance, SMEs have contributed Ringgit Malaysia (RM) 652.4 billion to Malaysian GDP, up from RM616.6 billion in 2023 (The Star, 2025). SMEs operate in diverse market environments, including urban, rural, online, physical, local, regional, and international markets. Depending on their respective activities, SMEs may be formal or informal businesses with diverse skill levels (Al Mamun et al., 2021).

To further enhance our understanding, SMEs are categorized into micro, small, and medium enterprises, each with distinct financial and employee-based characteristics. In the manufacturing sector, micro businesses refer to firms with sales attainments of less than RM300,000 or fewer than five full-time employees. At the same time, small enterprises typically apply to firms with sales revenue between RM300,000 and RM15 million, or fewer than 75 full-time workers (Khalil et al., 2022). Then, the medium enterprise refers to a firm with a sales turnover of between RM15 million and a maximum of RM50 million, or employs between 75 and 200 full-time workers. For services and other sectors, the portions are slightly different. A micro enterprise is a business with a sales revenue of less than RM300,000 or fewer than five full-time employees. On the other hand, small enterprises refer to firms with a sales turnover of less than RM3 million or 5 to 30 full-time employees. Then, the medium enterprise comprises firms with sales revenue from RM3 million to no more than RM20 million or full-time employees from 30 to a maximum of 75 (Khalil et al., 2022).

SMEs are a significant part of the Malaysian economy. Known for their agility and growth potential, this type of business is important in fostering innovation, providing jobs, and contributing to the country's GDP (Hu & Kee, 2022). Although SMEs have great potential to contribute to the country's economic development, they often face various challenges, including a lack of capital, fierce competition, and rapid technological change (Kindström et al., 2024). Many

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Malaysian SMEs have not opened access to their products online. This displays that many SMEs still face fundamental issues in their digitization process (Reim et al., 2022). Low awareness levels lead SMEs in rural areas to be less attentive to development and global positioning (Hu & Kee, 2022). Studies have shown that low levels of knowledge about new technologies and expertise are due to inadequate income and training (Abdulaziz et al., 2023). From a social perspective, technophobia, or a fear of technology, negatively influences an individual's ability to use ICT (Shaikh et al., 2021). This situation causes entrepreneurs to overlook the benefits and advantages of ICT. Weak high-speed Internet networks and less effective telecommunications networks are also often cited as reasons why SMEs lag in implementing new technology (Shaikh et al., 2021). According to Abdulaziz et al. (2023), businesses that utilize e-marketing media are particularly concerned with providing complete, up-to-date, and structured product information to maintain customer trust and mitigate the issue of customer fraud, as these businesses often lack direct communication between sellers and consumers. This aligns with a study by Noor et al. (2024), which confirms that online traders must overcome the challenges of operating on social media and a limited budget.

The Industrial Revolution 4.0 has brought significant changes to the global economic landscape, introducing progressive technologies such as artificial intelligence (AI). As a key component of modern technology, AI can enhance business competitiveness through automation, efficient data analysis, and operational optimization (Haleem et al., 2022; Verma et al., 2021). Generally, AI is acquiring and applying skills and knowledge to solve problems using a machine or robot. AI can significantly improve digital marketing through task automation and customer personalization (Van Esch & Stewart Black, 2021). AI can forecast trends, tailor content, and enhance customer marketing by analyzing user data, thereby increasing engagement and conversion rates (Mikalef et al., 2023). AI-powered chatbots can handle 24/7 customer inquiries, respond quickly, and increase customer satisfaction. Additionally, AI-driven analytics can predict sales trends, enabling marketers to adjust their strategies proactively. Natural language processing (NLP) facilitates the comprehension of customer sentiment, enabling more personalized communications (Chintalapati & Pandey, 2022).

Technology continues to evolve, and entrepreneurs must keep up with this growth (Isac et al., 2025; Khoo et al., 2024). Entrepreneurs must be aware of the latest technological trends and understand how to leverage them for their business (Bartolomé et al., 2022). They must also understand SEO strategy, social media, email marketing, and digital advertising. Moreover, data is an important asset in the digital age (Schiuma et al., 2022). They must be able to analyze sales data, customer behavior, or other digital data to make informed business decisions (Drydakis, 2025). In the digital era, sales ability is not just a matter of face-to-face negotiations. Entrepreneurs must also be able to sell products or services online through e-commerce, social media, or other digital platforms (Noor, 2024). With the increasing use of technology, cybersecurity cannot be ignored. They must understand the basics of data security to protect the business from cyber-attacks. By mastering digital skills, they can become entrepreneurs ready to face challenges in the digital era (Schiuma et al., 2022). Entrepreneurs must understand how to use applications, software, and technologies related to their business (Khoo et al., 2024).

Entrepreneurial tasks require more complex skills, and entrepreneurs must possess knowledge, skills, abilities, and other characteristics that enable them to accomplish business-related tasks efficiently (Pennetta et al., 2024). Effective business management requires a diverse set of skills to navigate the complexities of a fast-paced and competitive environment (Noor et al., 2024a). Entrepreneurial success factors generally focus on two main factors: individual abilities (skills) and the business environment (nature) (Noor et al., 2025a). An individual's entrepreneurial nature includes lifestyle and daily social culture. This view aligns with Aulia et al. (2021), who state that business performance and entrepreneurial success are linked to business knowledge, attitude, motivation, capital, and business inputs. Ibidunni et al. (2022) also add innovative characteristics in creating new products and methods, and a proactive attitude in exploring new market segments and resources can help to achieve sustainable business performance. Therefore, the purposes of this study are as follows:

- RO1: To examine the influence of AI adoption on B40 women's sustainable business performance.
- RO2: To examine the mediation effect of digital competencies towards the relationship between AI adoption and B40 women's sustainable business performance.
- RO3: To examine the mediation effect of entrepreneurial competencies towards the relationship between AI adoption and B40 women's sustainable business performance.

The findings of this study are expected to support government authorities in articulating optimal strategies and action plans further to enhance the sustainable business performance of B40 women and plan appropriate measures to assist women entrepreneurs. Women's participation in the labor market plays a noteworthy role in a country's social development and economic growth (Noor et al., 2025a). The gradually active participation of women entrepreneurs in the country has directly driven a stronger momentum for economic sector growth. This study aims to close several research gaps in current studies. Most studies have examined the performance of women entrepreneurs in Western and developed nation settings (e.g., Botella-Carrubi et al., 2024; Drydakis, 2025). Moreover, although some studies have examined developing economies, the socio-cultural context of each country is diverse. Therefore, further empirical studies are necessary to investigate the context of the low-income group. Furthermore, some scholars have focused on only one dimension. For example, Haleem et al. (2022) examine technology adoption among small businesses, while Ibidunni et al. (2022) investigate the entrepreneurial knowledge and competencies of entrepreneurs. This study combines both contexts because technology and skills have become key to achieving entrepreneurial success. With advances in software,

online platforms, and data analytics, entrepreneurs can run their operations more efficiently and effectively. Therefore, entrepreneurs must continue to improve their digital skills to avoid being left behind (Isac et al., 2025; Khoo et al., 2024). A positive mental attitude and resilience are crucial for entrepreneurs. In the face of challenges and failures, a diligent and enthusiastic attitude can help to get back up and sustain (Aulia et al., 2021; Pennetta et al., 2024).

LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Resource-Based View (RBV)

The resource-based view (RBV) is a theory that originated in the field of strategic management. RBV has been utilized in management studies to deliberate or elucidate a firm's resources that can generate and sustain a sustainable competitive advantage, thereby directly improving the firm's performance (Barney et al., 2021). Penrose originated the RBV theory (Barney et al., 2021), who deliberated that a firm or business is a "pool of resources" that plays a role in competitive strategy. RBV is a strategic management concept that highlights the relationship between a firm's profits, the resources it owns, and how it manages its resources to overcome and win industry competition. Among the primary considerations of the RBV theory is how the resources a firm possesses can lead to the formation of its competitive advantage (Ferreira & Ferreira, 2025). RBV emphasizes firm resources that can distinguish the level of success or business performance among competing firms in the same industry (Barney et al., 2021). The central assumption of RBV is that resources have characteristics such as valuable, rare, inimitable, and complex or irreplaceable (Barney et al., 2021). In addition to tangible assets, strategic assets can also be intangible (Lubis, 2022). These include knowledge (know-how), reputation and legitimacy, and organizational skills. By identifying potential strategic resources and capabilities, a firm can be different from its competitors. Differences in capabilities and information sources can lead to the development of unique management capabilities and technical knowledge (Barney et al., 2021). In the 21st century, a time of rapid change and unexpected challenges, an entrepreneur's success depends on numerous complex factors. The key to this success lies in the ability to produce quality products or services, a deep understanding of the market, and the ability to adapt to the latest technologies and trends (Ferreira & Ferreira, 2025). Successful entrepreneurs must be able to leverage digital resources, build robust networks, and continually innovate to remain competitive and relevant.

Therefore, in this study, the researchers proposed the resources crucial for women entrepreneurs: business marketing strategy and competencies. In the 21st century, technology plays a vital role in an entrepreneur's success. Successful entrepreneurs must understand that the business world is constantly evolving rapidly. With technological advancements, they must constantly conduct research and development to ensure their products and services remain relevant. Additionally, utilizing digital platforms can help expand market reach and enhance operational efficiency. Entrepreneurs also need to be always ready to adapt to the changes that occur so as not to be left behind in the competition. An entrepreneur's success depends not only on business strategy but also on personal skills and knowledge (Aulia et al., 2021; Pennetta et al., 2024). Entrepreneurs need to invest in self-development to become effective leaders. This includes learning about management, communication, and decision-making strategies.

Artificial Intelligence and Sustainable Business Performance

AI is now a crucial element in the marketing world. With its ability to analyze data, understand consumer behavior, and personalize customer experience, AI helps businesses achieve marketing goals more effectively (Haleem et al., 2022). One of the primary advantages of AI is its ability to process large quantities of data quickly and accurately. Collecting and analyzing this information is essential in marketing, as it is filled with data (Verma et al., 2021). AI utilizes machine learning algorithms to identify patterns and trends in customer data, enabling marketers to gain a deeper understanding of user behavior (Van Esch & Stewart Black, 2021). For example, companies can utilize AI to analyze data from social media and other customer interactions, gaining insight into what their customers are seeking. This enables marketers to tailor their strategies to meet the specific needs of their customers. It enables businesses to offer a more personalized experience to their customers. The AI system can provide product or content suggestions tailored to an individual's interests by analyzing historical data and real-time behavior (Mikalef et al., 2023). For example, platforms like Netflix and Amazon utilize AI to create personalized content tailored to users' preferences. Personalization also includes email delivery tailored to specific segments of the audience. Using AI, companies can submit offers or information relevant to customers based on their purchase history or online behavior. Marketing processes often involve repetitive tasks that require a significant amount of time. AI facilitates automation of these various processes, including email delivery, ad management, and social media advocacy (Noor et al., 2025b). With tools like AI-powered chatbots, businesses can provide faster and more efficient customer service without increasing their workforce (Chintalapati & Pandey, 2022).

Chatbots can directly answer general customer questions, provide information on products or services, and even assist in the purchase process (Kopalle et al., 2022). This enables businesses to offer 24/7 service without requiring additional staff. AI can adjust strategies to improve ad performance by analyzing campaign data in real-time (Verma et al., 2021). This includes targeting accurate audiences with relevant ads based on consumer behavior and preferences. Through a programmatic advertising approach, AI helps businesses maximize their investment returns (ROI). Ads can be shown to the audience most likely to be interested in these products or services, reducing the waste of resources on irrelevant audiences (Kopalle et al., 2022). Although there are numerous benefits to using AI in digital marketing, businesses also encounter several challenges. One of the biggest challenges is the issue of data privacy. As the company collects more user data through AI-powered tools, concerns arise about how the data is used and protected. Excessive dependence on

AI technology can be problematic if the system fails or the algorithm malfunctions (Mikalef et al., 2023). Therefore, companies need a contingency plan if their automatic system is in trouble. Although AI excels in data analysis and automating specific tasks, it still cannot fully replace human creativity. Marketing is about creating emotional relationships with customers; Therefore, human creativity remains important in planning a successful marketing campaign (Mikalef et al., 2023). In this ever-changing world, adapting to innovations such as AI is crucial for long-term success in any organization or brand. Based on the above discussion, the following hypothesis is posited:

- H1: Adopting Artificial Intelligence (AI) significantly influences B40 women's sustainable business performance.

Digital Competencies and Sustainable Business Performance

Understanding, managing, and leveraging digital technologies is crucial for business success in today's technology-driven world (Van Esch & Stewart Black, 2021). Digital business skills encompass a range of competencies, from utilizing digital tools to integrating strategic digital initiatives within organizations (Bartolomé et al., 2022). Digital competencies refer to the capabilities required to effectively utilize digital technologies to achieve business objectives (Schiuma et al., 2022). These skills are essential for navigating the modern business landscape, including digital literacy, digital strategy, e-commerce management, data analytics, cybersecurity, agile project management, and UX/UI design (Drydakis, 2025). Mastering these skills enables businesses to streamline processes, enhance customer experiences, make data-driven decisions, and open new revenue streams. Digital transformation is reshaping nearly every industry, making digital competencies vital for staying competitive (Drydakis, 2025). Professionals with these skills can lead their organizations through technological changes and ensure they remain relevant in the market (Noor, 2024). Utilizing digital technologies can significantly streamline business processes, reducing time and costs (Drydakis, 2025). Automation tools, for instance, can handle repetitive tasks, allowing employees to focus on more strategic activities. Digital platforms offer innovative ways to connect with customers, providing personalized experiences that build loyalty and satisfaction (Schiuma et al., 2022). From chatbots to personalized marketing campaigns, digital tools can revolutionize customer interactions. The ability to analyze digital data allows businesses to make more informed decisions. Insights gained from data analytics can guide strategies, optimize operations, and improve overall business performance (Khoo et al., 2024).

Entrepreneurs must be able to plan and implement digital initiatives that align with business goals, which is crucial. This involves understanding market trends, setting digital objectives, and driving organizational innovation (Apasrawirote et al., 2022). Managing online sales channels and platforms is critical to digital business (Bartolomé et al., 2022). This includes setting up and optimizing e-commerce websites, handling online transactions, and ensuring a smooth customer experience. Moreover, they need to be able to analyse digital data to gain insights and guide decisions, which is a powerful skill (Apasrawirote et al., 2022). Proficiency in data analytics tools and techniques enables businesses to understand customer behavior, measure campaign effectiveness, and identify opportunities for growth (Isac et al., 2025). Hamid et al. (2020) realized that the intensity of technology implementation among low-income entrepreneurs is moderate. Most entrepreneurs only leverage modest digital tools, which involve minimal costs, require small technical skills, and offer simple training. Accordingly, the business is challenging to develop due to its lack of automation and digital marketing efforts. Faudzi et al. (2024) found that most B40 women entrepreneurs utilize social media platforms such as WhatsApp, Facebook, Instagram, TikTok, and Snapchat, as these channels are presumed to have a greater impact on their businesses. However, they need to work harder to establish unique advertising on each platform. Hence, they need to be innovative in selecting the best media channels and more productive when creating advertisements on their social media to ensure the value of the social media used. Malik et al.'s (2021) study demonstrates that social relationships have a positive and significant influence on the achievement of women entrepreneurs in adopting the Information and Communication Technology (ICT) support. However, a small entrepreneur accustomed to manual buying and selling will likely face difficulties in understanding the functions of software and computerized systems. The complex nature of its use can cause problems if it is operated without professional guidance. To ensure that the digital transformation runs smoothly, they should seek immediate assistance from those who are more knowledgeable in current technology matters. Based on the above discussion, the following hypotheses are posited:

- H2: Digital competencies have a significant influence on the sustainable business performance of B40 women.
- H3: Digital competencies mediate the relationship between AI adoption and the sustainable business performance of B40 women.

Entrepreneurial Competencies and Sustainable Business Performance

According to Pennetta et al. (2024), competency encompasses cognitive, affective, and motivational elements, as well as voluntary intentions and the will to act. It is also connected to psychomotor. Entrepreneurial competencies can be defined as fundamental characteristics, including general and specific knowledge, drive, talent, social role, and skills, that enable the creation of new businesses, sustainable business actions, and business growth (Aulia et al., 2021). Additionally, competency is a set of knowledge, attitudes, and skills that significantly influence a person's work, are closely tied to job performance, and can be enhanced through training and development (Ibidunni et al., 2022; Noor et al., 2024a). Competency is generally considered a central characteristic connected to effective or superior performance. This has been established since McClelland (1987) emphasized competency as a critical method for distinguishing ordinary and excellent performance. If applied in the context of entrepreneurship, it is associated with a business's birth, endurance, and development (Lingappa et al., 2023). Entrepreneurial competencies comprise 13 competencies, namely: 1) initiative,

2) opportunity, 3) perseverance, 4) information-seeking, 5) high quality work, 6) commitment to work, 7) efficiency, 8) systematic planning, 9) problem-solving, 10) self-confidence, 11) assertiveness, 12) persuasion, and 13) strategy use (Alagappar et al., 2023).

Entrepreneurs who take the initiative to do a task without being directed or forced have a proactive attitude and actively strive to develop and make their business successful (Khan et al., 2021). Entrepreneurs who can see and seize opportunities always look for and identify existing business opportunities (Botella-Carrubi et al., 2024). They can seize opportunities by expanding the market and pursuing the business's interests. This competence is a crucial factor in the success and resilience of the business (Noor et al., 2024c). Entrepreneurs are tenacious individuals who do not tire of finding ways to achieve their goals, do not give up easily, and always strive to overcome obstacles that can block their progress (Aftab et al., 2022). Entrepreneurs conduct research and market studies to gather information and feedback, providing goods or services that meet customer satisfaction (Noor et al., 2024b). They need the skills to obtain accurate and up-to-date information from reliable sources. The information and feedback obtained can be used to improve the experience, achievements, and performance of the business they lead (Li et al., 2023). Promising entrepreneurs emphasize the importance of high-quality work and tend to produce and sell high-quality goods (Kruger & Steyn, 2021). They always compare the quality of work produced with that of others, ensuring it is comparable or at a higher level. Entrepreneurs are leaders in their business and can influence employees and stakeholders to achieve their business goals (Abdullah Alshammari et al., 2023).

Even though entrepreneurial skills enable entrepreneurs to make informed decisions, adapt to challenges, and drive sustainable growth, Kamall et al. (2023) found that they do not influence the entrepreneurial readiness of B40 women. Rahman and Khan (2024) studied women entrepreneurs in Malaysia. They found that it is essential for entrepreneurs to have procedures, processes, operations, and internal systems in place to run a business effectively. Successful entrepreneurs should also have a vast network of professional contacts, knowledge, and business skills. Tanggamani et al. (2024) found in their study among B40 women entrepreneurs that the increasingly competitive business world demands that every entrepreneur master financial management knowledge, as it is a key element in ensuring business success. Based on the above discussion, the following hypotheses are posited:

- H4: Entrepreneurial competencies have a significant influence on the sustainable business performance of B40 women.
- H5: Entrepreneurial competencies mediate the relationship between AI adoption and the sustainable business performance of B40 women.

Figure 1 shows the research model of the study.

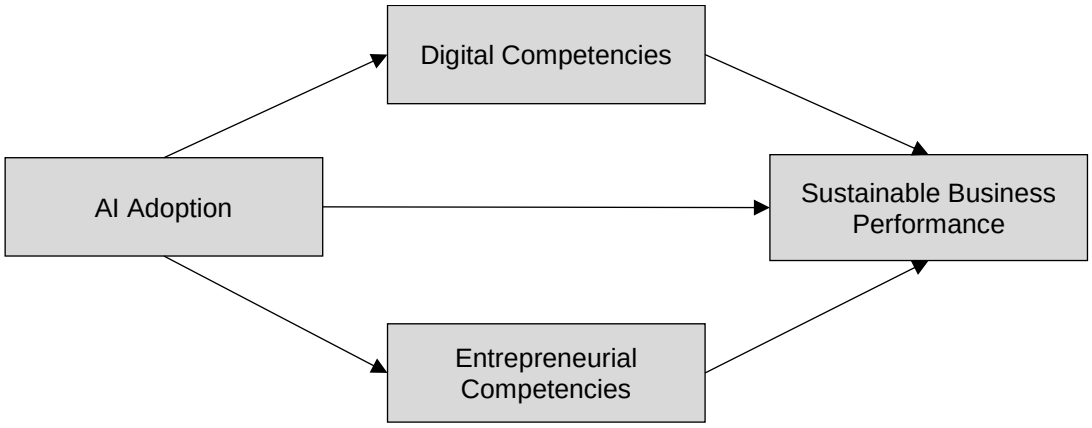

Figure 1. Research Model

RESEARCH METHODS

This study employed a quantitative research design, which involves collecting data in the form of numbers through measurements on a predetermined scale and then testing hypotheses using empirical statistics. The study population consists of B40 women micro entrepreneurs in Kuala Lumpur and Selangor, Malaysia. Malaysians are categorized into three groups: the T20 Group, the M40 Group, and the B40 Group. The T20 group has an income of more than RM10,960, while the M40 group has an income between RM4,850 and RM10,959. Finally, the group with an income of less than RM4,849 is the B40 group (Department of Statistics Malaysia, 2023). The number of respondents is determined based on the requirements of the research analysis method, which utilizes the Structural Equation Model (SEM). The basic assumption that must be met in SEM analysis is that the number of samples is sufficient to meet the analysis method's requirements. Hair et al. (2010) suggest a sample size between 100 and 200. Therefore, 300 B40 women entrepreneurs are selected as the study sample. This study employs purposive sampling, a method that involves the researchers' judgment in selecting respondents from a population that best suits the study's purpose. The sample identity selected comprised B40 women entrepreneurs who engaged in micro-scale entrepreneurial activities (i.e., sales turnover of less than RM300,000

or less than 5 full-time employees), resided in Selangor and Kuala Lumpur, and operated in both formal and informal sectors.

Artificial intelligence (AI) measures used five-item scales modified from Hoffman and Novak (2018) and Metcalf et al. (2019). Four items were adapted from the research of Rubach and Lazarides (2021) to measure digital competencies. Five measures of entrepreneurial competencies are adapted from Man et al.'s (2008) study. While items for measuring sustainable business performance were adapted from Lee and Roh (2023) and Agrawal et al. (2022). Data was collected through a 1-5 Likert-based questionnaire distributed online. A reliability test is an index test that shows how much a measuring instrument can be trusted or relied upon. Table 1 shows the measurement items used in this study. A measuring instrument is considered reliable if it consistently produces the same results when measured multiple times. A questionnaire is reliable if the answers obtained from it are consistent or stable over time. Reliability test can be measured by using the Cronbach's alpha (α), and the data is said to be reliable by using this technique when the value of Cronbach's alpha (α)>0.7 (Nunnally & Bernstein, 1994).

To evaluate the survey items, the researchers have selected and appointed a total of three expert panels to conduct the content validity evaluation. The appointed panels have evaluated the accuracy of language, phrases, and sentences. The characteristics that the experts possess include extensive experience related to women's entrepreneurship, with more than 10 years of experience. As shown in Table 1, the reliability assumptions in this study have been achieved. A pilot study was conducted with 30 respondents, and the analysis of the pilot study results showed that the developed instrument was reliable and suitable for use. The research model was empirically tested using a statistical approach, employing the Structural Equation Modeling (SEM) method. There are two fundamental reasons for using the SEM model in this research, namely: (1) SEM can test complex research models simultaneously, and (2) SEM can measure research variables that cannot be measured directly (unobserved variables) and can detect and calculate errors in measurement.

Table 1. Measurement of variables

Variables	Items	α
AI Adoption	1. AI helps my business accurately predict customer needs. 2. AI supports the marketing promotion of my business by eliminating human errors. 3. AI is important to the collaborative decision-making process in my business. 4. AI has increased my business's brand awareness in real time. 5. AI enables my business to personalize its marketing activities to individual customers.	0.870
Digital Competencies	1. I can communicate using different digital tools. 2. I can actively participate in society using digital media. 3. I am aware of the dangers and risks associated with digital environments and consider them. 4. I can independently use digital learning opportunities and appropriate tools.	0.840
Entrepreneurial Competencies	1. I can develop long-term trusting relationships with others. 2. I negotiate with others. 3. I apply ideas, issues, and observations to alternative contexts. 4. I determine long-term issues, problems, or opportunities. 5. I manage my business effectively.	0.820
Sustainable Business Performance	1. My customers are highly content. 2. I have a well-managed relationship with suppliers. 3. I tried to minimize energy consumption. 4. I tried to reduce the waste. 5. I tried to reduce the emission of air pollutants. 6. Sales are increasing. 7. Net profit is increasing.	0.850

RESEARCH FINDING

Demographic Profiles

A total of 235 questionnaires were returned out of 300 distributed to respondents, with a response rate of 78.3%. In the organizational and social research literature, a score of 60-70% is considered good, and more than 80% is considered excellent (Holtom et al., 2022). Table 2 shows the demographic distribution of respondents. The data collected showed that most respondents are between 40 and 49 years old, with 115 respondents (48.8%). This followed with 31–39 (n=100, 42.6%), 18–30 (n=10, 4.3%), and 50–60 (n=10, 4.3%). Next, most respondents are from the B4 category, with a household income of RM3,970 to RM4,849 (n = 226, 96.2%). The remaining 9 participants fall into the B3 category, with household incomes ranging from RM3,170 to RM3,969 (n = 9, 3.8%). Additionally, most respondents hold secondary-level academic qualifications, specifically the Sijil Pelajaran Malaysia (SPM), with 183 respondents (77.9%). In terms of marital status, most respondents are married (n = 121, 51.5%). This was followed by single (n = 94, 40.0%) and divorce/widow (n = 20, 8.5%).

Table 2. Demographic profiles (n=235)

	Profile	Frequency (n)	Percentage (%)
1.	Age		
	18–30	10	4.3
	31–39	100	42.6
	40–49	115	48.8
	50–60	10	4.3
2.	Household Monthly Income		
	Less than RM2,500	0	0
	RM2,500 – RM3,169	0	0
	RM3,170 – RM3,969	9	3.8
	RM3,970 – RM4,849	226	96.2
3.	Academic Qualifications		
	Peperiksaan Menengah Rendah (PMR)	0	0
	Sijil Pelajaran Malaysia (SPM)	183	77.9
	Sijil Tinggi Pelajaran Malaysia (STPM)	0	0
	Foundation	2	0.8
	Diploma	42	17.9
	Bachelor's degree	8	3.4
	Post-graduate	0	0
	Others	0	0
4.	Marital Status		
	Single	94	40.0
	Divorce/Widow	20	8.5
	Married	121	51.5

Confirmatory Factor Analysis

The fit of the measurement model to the study data can be assessed using various goodness-of-fit indices. For the fitness index, the Root Mean Square Error of Approximation (RMSEA) value should be ≤ 0.08 (Byrne, 2001), while the goodness fit index (GFI), the comparative fit index (CFI), and the Tucker–Lewis index (TLI) values should be ≥ 0.90 (Bentler, 1990). Relative/Normed Chi-Square (CMIN/df) values must be approximately ≤ 5.0 (Bentler, 1990). The output shown in Figure 2 indicates that the proposed measurement model has an RMSEA of 0.078, a GFI of 0.930, a CFI of 0.920, a TLI of 0.952, and a CMIN/df of 3.115. We can determine that our measurement model is suitable by examining the model parameters.

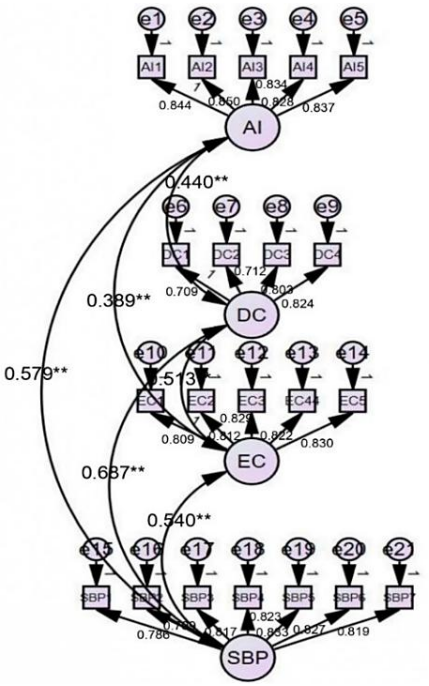

Figure 2. CFA Model

Validity and Reliability Assessment

The initial step of SEM analysis is to test the data's validity and reliability using causality tests. The validity test is determined by the Standardized Regression Weights value, which indicates the suitability of each indicator to its corresponding construct. An indicator of a reliable construct is that the value of Average Variance Extracted (AVE) ≥ 0.5 and the value of Composite Reliability (CR) ≥ 0.7 (Fornell & Larcker, 1981). Acceptable factor loading values are 0.50 and above for new items and 0.6 for developed items. With the results of outer loading that are all ≥ 0.70 and no indicators have been eliminated, it can be concluded that the measurement model has met the requirements of convergent validity statistically and substantially (Byrne, 2010).

Table 3. Composite reliability (CR) and average variance extracted (AVE) results

Variable	Items	Item Loadings	AVE	CR
AI Adoption	AI1	0.844***	0.703	0.922
	AI2	0.850***		
	AI3	0.834***		
	AI4	0.828***		
	AI5	0.837***		
Digital Competencies	DC1	0.709***	0.583	0.847
	DC2	0.712***		
	DC3	0.803***		
	DC4	0.824***		
Entrepreneurial Competencies	EC1	0.809***	0.673	0.911
	EC2	0.812***		
	EC3	0.829***		
	EC4	0.822***		
	EC5	0.830***		
Sustainable Business Performance	SBP1	0.786***	0.664	0.932
	SBP2	0.799***		
	SBP3	0.817***		
	SBP4	0.823***		
	SBP5	0.833***		
	SBP6	0.827***		
	SBP7	0.819***		

Discriminant Validity Assessment

Based on the results shown in Table 4, discriminant validity is considered to be met when the √AVE value exceeds the correlation value between the constructs (Fornell & Larcker, 1981). This result indicates that each construct in the model exhibits adequate discrimination, meaning the constructs can be distinguished clearly from one another. Therefore, this model can be used for further testing in AMOS's Structural Equation Modeling (SEM) analysis.

Table 4. Discriminant validity

No.	Variable	1	2	3	4
1.	AI Adoption	0.838			
2.	Digital Competencies	0.440**	0.763		
3.	Entrepreneurial Competencies	0.389**	0.513**	0.820	
4.	Sustainable Business Performance	0.579**	0.687**	0.540**	0.814

Note: Values in the diagonal show the square root of AVE

Hypothesis Testing

The results of the direct relationship analysis revealed that AI adoption (β = 0.530, p < 0.001), digital competencies (β = 0.450, p < 0.001), and entrepreneurial competencies (β = 0.390, p < 0.001) significantly predict sustainable business performance. Therefore, H1, H2, and H4 are supported. Bootstrapping is a sampling method with replacement, in which researchers instruct the algorithm to draw new samples from the existing dataset, allowing for the inclusion of previously sampled elements. Meanwhile, according to Hair et al. (2019), bootstrapping is a resampling procedure that aims to estimate the statistical distribution based on independent observations to confirm the model's mediator testing results. Table 6 shows that there is a significant indirect effect (β = 0.143, p < 0.001) of AI adoption on sustainable business performance after digital competencies are included in the study model. Moreover, the study model includes a significant indirect effect (β = 0.159, p < 0.001) of AI adoption on sustainable business performance, mediated by entrepreneurial competencies. Thus, H3 and H5 are accepted as the CI did not contain zero. Figure 3 shows the final research model.

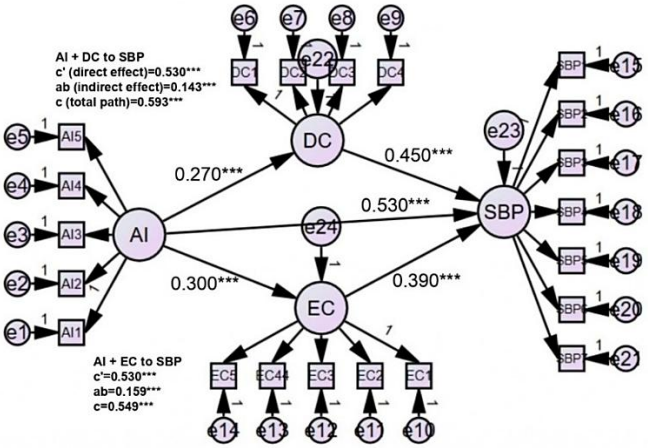

Figure 3. Final Model

Table 6. Result of mediation analysis

Path	β	S.E	t
AI Adoption → Sustainable Business Performance	0.530***	0.059	4.220
Digital Competencies → Sustainable Business Performance	0.450***	0.048	5.110
Entrepreneurial Competencies → Sustainable Business Performance	0.390***	0.062	2.409
AI Adoption → Digital Competencies	0.270***	0.035	6.205
AI Adoption → Entrepreneurial Competencies	0.300***	0.070	2.124
Mediating Effect via Digital Competencies	***β***	**S.E**	**95% CI**
AI Adoption → Sustainable Business Performance	0.143***	0.064	[0.022, 0.189]
Mediating Effect via Entrepreneurial Competencies			
AI Adoption → Sustainable Business Performance	0.159***	0.030	[0.034, 0.270]
Total Path			
AI Adoption + Digital Competencies → Sustainable Business Performance	0.593***	0.044	[0.110, 0.350]
AI Adoption + Entrepreneurial Competencies → Sustainable Business Performance	0.549***	0.092	[0.070, 0.150]

*Note: Significance level: ***p < 0.001; *p <0 .01; *p <0 .05*
Source: *Authors' calculations*

DISCUSSION

B40 households are vulnerable due to their overly reliance on a single source of income, the rising cost of living, and limited access to other assets (Noor et al., 2025a). This problem is compounded by their low level of education, which affects the ability of B40 households to secure employment. In addition, the storm of the fourth industrial revolution (IR 4.0) has challenged the persistence of B40 women, as most jobs require information and communication technology (ICT) skills. Most B40 women are reportedly using social media platforms to launch businesses and market their products (Al Mamun et al., 2021). The study's results first demonstrate that AI has a substantial direct impact on the business performance of women entrepreneurs. This finding is supported by studies conducted by Kopalle et al. (2022) and Mikalef et al. (2023), which found that AI improves the way organizations operate and deliver value. It is used to streamline workflows, analyze data, personalize customer experiences, and support more informed decisions.

Additionally, AI enhances efficiency by automating time-consuming, repetitive tasks. It can generate reports, schedule messages, manage workflows, and trigger follow-ups without manual effort (Kopalle et al., 2022; Van Esch & Stewart-Black, 2021; Verma et al., 2021). AI tools can detect data patterns that may be difficult to identify, allowing entrepreneurs to gain valuable insights into customer behavior, choices, and needs (Chintalapati & Pandey, 2022). This allows marketers to create more personalized and targeted customer campaigns, increasing engagement and conversion rates. This can lead to higher customer satisfaction and loyalty rates, ultimately increasing sales and profitability for the business (Haleem et al., 2022).

The study also found that digital competencies have a direct impact on micro business performance. In a similar vein to the findings of Apasrawirote et al. (2022) and Bartolomé et al. (2022), digital competencies are among the most sought-after abilities in today's technological landscape. Entrepreneurs who master at least one type of digital skill have great opportunities to advance their businesses (Isac et al., 2025). Technology plays a key role in improving the efficiency of business operations. Automated processes introduced through digital technology can save time, costs, and increase productivity (Faudzi et al., 2024; Hamid et al., 2020). Aligning with studies such as Alagappar et al. (2023) and Khan et al. (2021), the third finding also indicates that entrepreneurial competencies have a significant influence on sustainable business performance. Strong skills are invaluable assets in the ever-changing business world (Aftab et al., 2022). Successful entrepreneurs must be able to quickly identify problems, analyze situations from multiple angles, and devise innovative solutions (Lingappa et al., 2023). This involves critical thinking, creativity, and the ability to see opportunities in challenges. These skills will enable entrepreneurs to face challenges, seize opportunities, and achieve their business objectives (Aftab et al., 2022). By continuously developing these skills and adapting to the latest business trends, they will be well-positioned to succeed in an ever-changing business landscape (Abdullah Alshammari et al., 2023). Thus, both digital and entrepreneurial competencies, as well as AI adoption, have enabled them to become more resilient and expand their businesses further (Aulia et al., 2021; Pennetta et al., 2024; Verma et al., 2021; Van Esch & Stewart Black, 2021).

Next, the findings have found that both digital and entrepreneurial competencies mediate the relationship between AI adoption and sustainable business performance. Competencies encompass the knowledge, skills, and specific characteristics that an individual must possess to perform a task effectively (Aulia et al., 2021; Pennetta et al., 2024). Ibidunni et al. (2022), Botella-Carrubi et al. (2024), and Alagappar et al. (2023) have elucidated that among the entrepreneurial competencies that need to be formed through entrepreneurship education are the need for achievement, leadership, creativity, confidence, networking, initiative, risk-taking, imagination, and analytical ability. Mastery of digital skills is also important. Entrepreneurs need to understand how to utilize application software relevant to their business, such as accounting software, stock management systems, and e-commerce platforms (Bartolomé et al., 2022). These skills facilitate daily business management and enable entrepreneurs to make more informed decisions (Schiuma et al., 2022). Many online courses enable entrepreneurs to acquire new skills without leaving their businesses. This can help entrepreneurs advance their knowledge and skills in business-related technology (Drydakis, 2025).

The results of this study provide a solid foundation for stakeholders to formulate more effective strategies and programs that increase the role and contribution of women in economic development, ensuring the sustainability and continuity of the business. The government must continue formulating more effective strategies to empower them and ensure they play a greater role in the country's economic development. This is important not only for the well-being of families and communities but also for achieving the goal of sustainable and inclusive development. As implications, digital technologies and the business environment constantly evolve; thus, continuous learning is essential. Entrepreneurship training plays a crucial role in enhancing the economic empowerment of entrepreneurs. Entrepreneurship training can help entrepreneurs enhance their entrepreneurial knowledge and skills and build confidence to start and grow a business (Aulia et al., 2021). Entrepreneurship training can equip entrepreneurs with the skills they need to manage their businesses more effectively and efficiently. Important skill components include financial management, marketing, and business operations (Ibidunni et al., 2022; Noor et al., 2024a).

Staying updated with the latest trends, tools, and best practices helps entrepreneurs to maintain their competitive edge (Isac et al., 2025). The government and entrepreneurial agencies need to focus more on executing digital talent development and increasing technological literacy to ensure that more businesses can adapt to the data-driven economy, thus taking full advantage of the opportunities in the AI era (Mohamad et al., 2021). Real-world application of digital skills builds confidence and expertise. The training delivered should be tailored to the current needs and interests of

women entrepreneurs. Ongoing mentoring programs should also be held to provide moral and technical support to women entrepreneurs (Kindström et al., 2024). Experienced mentors can help them face challenges and overcome problems that arise in the business. Additionally, support in market management is also crucial. This includes assistance in marketing and entrepreneurial products through a wider marketing network and digital technology. Organizing business exhibitions and expos can deliver opportunities for women entrepreneurs to showcase and sell their products to potential buyers. This helps increase the visibility of their products and opens up wider marketing opportunities (Mohamad et al., 2021). The development of a support network is considered important because it serves as the basis for any opportunity, where the combined effects of efforts and resources facilitate the process. The network will play a role in supporting and giving encouragement and ideas to the entrepreneurs (Al Mamun et al., 2021). Establishing partnerships with government agencies, NGOs, and the private sector can also support women entrepreneurs, ensuring they receive the necessary assistance to succeed (Noor et al., 2025b). By implementing these suggestions, it is anticipated that B40 women entrepreneurs can continue to improve their economic position.

CONCLUSION

The government, through various policies and support programs, provides skills training, access to financing, and business development platforms to enhance the economic position of women. Through this opportunity, women can not only improve their living standards and become financially independent, but also play a significant role in contributing to the country's economic growth and inspiring the community. Additionally, women comprise a significant portion of the Malaysian population, making substantial contributions to the national economy. It cannot be denied that women today need to have a job, and the business sector is seen as an excellent opportunity for them. This study examines the impact of AI marketing on business performance. Second, we aim to examine the mediating effect of digital and entrepreneurial competencies on the relationship between AI adoption and business performance. The study's findings reveal the direct impact of AI adoption, digital competencies, and sustainable business performance. Then, digital and entrepreneurial competencies mediate the relationship between AI adoption and sustainable business performance. Thus, wider access to funding, educational resources, mentoring, and advocacy focused on women's development is essential to building a new generation of successful women entrepreneurs. This study has several limitations that need to be considered. Regarding methodology, the cross-sectional approach cannot detect changes in the relationship between variables over time. The study sample, limited to B40 women entrepreneurs in Kuala Lumpur and Selangor, also limits the generalizability of the findings. The study instrument also relies on self-reports, which may be affected by social bias. Based on these limitations, several further research suggestions can be considered. First, future studies should expand the study sample to include other states, and longitudinal studies are necessary to understand the development of the relationship between the variables. Future research can also consider additional variables such as personality, orientation, national culture, and resources as alternative mediators. Using mixed methodologies that combine quantitative and qualitative data can provide a deeper understanding of the dynamics between the proposed relationships.

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CONFLICT OF INTEREST

The authors declare that they have no affiliations with or involvement in any organization or entity with any financial interest in the subject matter or materials discussed in this manuscript.

AUTHOR CONTRIBUTIONS

Nurul Hidayana Mohd Noor contributed to the conceptualization and design of the research, performed the data analysis, and participated in the writing and revision of the manuscript

Azizan Zainuddin conceived the original and supervised the project.

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