

LEVERAGING ARTIFICIAL INTELLIGENCE FOR SMES' SUSTAINABLE COMPETITIVE ADVANTAGE: THE MODERATING ROLE OF MANAGERS DIGITAL LITERACY

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ABSTRACT

In the modern digital era, SMEs have become one of the most important sectors within the economy, and they now face significant pressure to keep up with their competitors while incorporating sustainability into their operations, especially in Palestine. In this context, the role of digital literacy among managers in moderating SMEs' sustainable competitive advantage is paramount. This research investigates the possibility of adopting AI to enable SMEs in Palestine to achieve a sustainable competitive advantage. It explores how the AI-driven approach can optimize business processes, enhance decision-making, and fuel innovation under resource-constrained conditions. The study emphasizes the crucial role of digital literacy in ensuring the successful integration of AI technologies into the company's activities. This study will be critical in determining the drivers of AI adoption and the impact on Sustainable performance in Palestinian SMEs. A sample of 284 SMEs was drawn from the questionnaire using a simple random sampling technique. Data were analyzed using partial least squares-structural equation modeling to test the relationships among the exogenous, moderator, and endogenous variables. Empirical analysis shows that managers' digital literacy significantly enhances the effectiveness of AI adoption and is, therefore, instrumental in enabling SMEs to exploit AI for long-term sustainability and growth. These findings bring essential insights for policymakers and business leaders in developing targeted training programs to address the digital literacy gap and promote AI adoption in Palestinian SMEs.

Keywords: *Artificial Intelligence; SMEs; Sustainable Competitive Advantage; Managers Digital Literacy; Palestine.*

1. INTRODUCTION

SMEs have now emerged as a beacon of hope in the context of the Fourth Industrial Revolution. Their potential to maximize earnings and expand growth prospects, thereby contributing to a country's GDP, is a cause for optimism [1]. However, it is concerning that many SMEs in both developing and developed nations struggle due to resource management issues [2], [3]. This trend, while concerning, also presents an opportunity for academics, industry managers, and policymakers to make a significant impact [4].

For their stability and success, SMEs depend on continuously sustaining competitive advantage [5]. Many investigations have focused on organizational learning [6], inventive competence [7], entrepreneurial competency [8], and lean operations [9], and lean operations [9].

However, these studies ignore SMEs' distinctive dynamics because they primarily cater to large companies [2]. Given their advantages like extensive capital and high manufacturing capacities, the question is whether SMEs can compete with more prominent companies. Numerous academics are motivated to develop solutions to improve the competitiveness of SMEs as a result of this question [10], [11].

In this quest for competitive ability, data analytics emerges as a keystone. Information science has evolved into the core foundation of successful trajectories over time. Notably, current research [12], [13] supports AI as the apex of technological breakthroughs in digitalization.

AI is a key component in gaining a competitive advantage rather than just a technological variable [14][15][16]. AI promises to sculpt value propositions for business

excellence, especially for SMEs [17], and is positioned as the beating heart of organizational innovation [18]. The productivity of SMEs can be significantly increased by integrating AI [13]. However, difficulties do exist. A pronounced lack of digital literacy leads to mistrust, sluggish adoption rates, and hazy advantages of AI. Furthermore, SMEs struggle with incorporating AI effortlessly into their day-to-day operations, even though it has the undisputed potential to transform decision-making, customer service, operational processes, and data analytics [19], [20]. By skillfully tackling these issues, one can enhance one's sustainable competitive advantage, improving one's sustainable business performance [21], [22].

There has been a ton of research on SMEs against the backdrop of the Industrial Revolution 4.0, but there are still some obvious gaps. Most obviously, an overemphasis on larger companies has unintentionally ignored the complex patterns and challenges unique to SMEs [2]. Although it is widely understood that AI plays a crucial role in creating competitive advantages, little is known about how it can be used in the context of SME networks. The complex relationship between digital literacy and AI and how that relationship affects SMEs' competitive edge is yet largely unexplored. Even though they are rich, existing discourses frequently err on the side of genericity and ignore the unique way that digital literacy and AI interact in SME settings [23], [24], [25].

Our study departs from earlier studies in several ways. Its primary goal is to highlight SMEs' opportunities and problems in an AI-driven era while highlighting the Palestinian context. We explore the symbiotic relationship between AI and digital literacy in greater detail than in previous publications. The underlying tenor of our results points to the possibility that digital literacy surpasses its function as a supplemental aid and instead emerges as a catalyst, enhancing the revolutionary potential of AI. To give SMEs a sustained competitive advantage, our study offers an integrated approach that integrates technology, skills, and strategy into a single framework. By filling in these knowledge gaps, we hope to provide customized insights for SMEs and emphasize the importance of digital literacy in the current AI-centric business landscape. Our main goal is to investigate how AI may improve Palestinian

SMEs' sustained competitive advantage, with digital literacy as a crucial moderating factor.

2. LITERATURE REVIEW

2.1 Artificial Intelligence and SMEs' Sustainable Competitive Advantage

A key component of strategic management is achieving sustainable competitive advantage, particularly in light of the dynamism that AI has injected into the contemporary corporate environment. According to Hesterly and Barney (2014), a sustainable competitive advantage, which is rooted in the resource-based perspective, is the capacity of a company to provide economic value that surpasses that of its rivals consistently.

This multifaceted idea combines Sustainability—with its emphasis on enduring value generation [27],[28]—with competitiveness, offering a comparative standard to compare a firm's strength to its rivals. It's important to remember that although business performance acts as the aftermath, tracing a firm's realized accomplishments, sustainable competitive advantage forecasts a firm's trajectory of success [29].

Obtaining this competitive advantage in the age of AI requires a complex strategy. AI has become a transformational force in crucial industries, including e-business, human resource management, operations, market research, customer relationship management, accounting, finance, sales, and marketing. It is still its key goal to utilize its resources to obtain a competitive advantage [30]. Organizations use AI as a transformational tool in addition to using distinctive product strategies, developing core skills, and utilizing intellectual property [31].

In the digital age, leadership is instrumental in guiding efforts to integrate AI's capabilities with the firm's objectives [32]. Besides digital literacy, other vital factors that drive adoption include corporate culture, human resources, and leadership orientation; not surprisingly, this treads on a very high possibility of adopting AI [33]. Organizations, especially SMEs, must encourage innovations and a deep understanding of AI to compete with such an AI-driven market [34]. As such, our study attempts to understand the interaction by investigating how SMEs may leverage AI to attain a sustainable competitive advantage, with digital literacy as the most critical moderating component.

2.2 Manager Digital Literacy

The linking of SMEs' competitive advantage with the deployment of AI in the contemporary corporate arena is undisputedly complex. Therefore, it must be realized that although AI has promised to revolutionize industries, its potential to give firms a competitive advantage draws from several parameters, including prominently digital literacy features [35], [36]. After this interaction, we chose digital literacy as a moderator because it has played a vital role in influencing the efficient deployment and absorption of AI inside SMEs.

Digital literacy at the managerial level first determines organizational development in the identification, implementation, and optimization of AI-driven initiatives to ensure that the full extent of the technology is being utilized [25], [37]. [38] state that it secures competitive corporate performance. However, just adopting AI could be inadequate in producing a real and long-lasting competitive advantage without the crucial role of digital literacy [39]. This claim emphasizes how crucial it is to comprehend and integrate digital tools: possessing the technology is not enough; you also need to know how to use it effectively. The level of intrinsic digital literacy inside the firm significantly impacts the breadth and flexibility with which SMEs use AI. A higher level of digital literacy often transforms AI into a strategic partner from a simple operational tool. Digital solid literacy enables the intelligent use of AI to recognize and seize one-of-a-kind market possibilities, adapt to changing market dynamics, and promote ongoing innovation [40].

Furthermore, as the complexities of AI increase, managers with solid digital literacy can better handle possible pitfalls, ethical issues, and problems, ensuring that the adoption of AI is in line with the company's broader aims and values [41]. This alignment is essential to obtaining a true, lasting competitive advantage as opposed to a momentary increase in operational efficiency. In essence, we want to provide a deeper, more complex picture of how SMEs might best use AI by using digital literacy as a moderator. We contend that SMEs may acquire and retain a sustainable competitive advantage in a market that is becoming more digital and competitive via the synergistic convergence of AI and improved digital literacy.

3. RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

SMEs are threatened and have opportunities to be advantageous in a competitive business environment with rapid technical advancements. It is pertinent that contemporary studies are needed to relate AI integration to ethical business practices, as the advent of AI has changed traditional business models since their conception [20], [35]. This study will, therefore, attempt to explore the complex inter-relationship between SMEs' adoption of AI, the subsequent sustainable competitive advantage, and how such an advantage influences the performance of SMEs on a sustainable basis. By focusing on the less explored sector of SMEs, eclipsed by studies mainly focused on big firms, the study is expected to contribute to the existing literature.

In the proposed study model, AI integration is the independent variable of interest, moderated by four dimensions: decision-making, customer service, operational procedures, and data analysis. The sustainable competitive advantage of SMEs is measured through various measures associated with market share, customer retention, and sustainability indices. The last dependent variable is the sustainable performance of SMEs, operationalized through economic, social, and environmental measures. The variable in this study emanates from the sustainable competitive advantage. Managerial digital literacy is the complex layer of the model that tries to see how it affects the link between AI integration and sustainable competitive advantage. This overarching model sets out three assumptions to explore these interlinked variables and provides an excellent analytical framework for investigating the use of AI technologies in bringing about SMEs' sustained competitive advantage and performance. Figure 1 presents the research model.

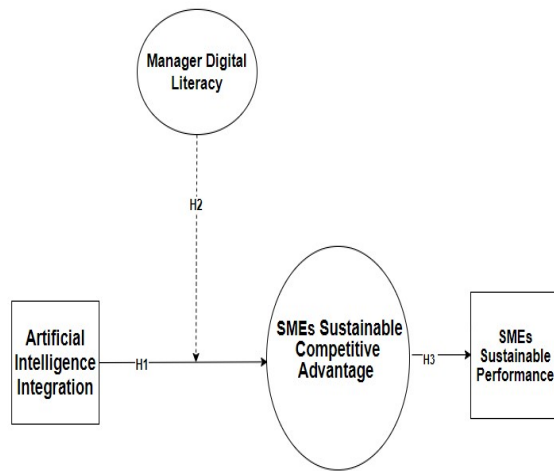


Figure 1. Research Model

3.1 Artificial Intelligence (AI) Integration and SMEs Sustainable Competitive Advantage

The integral role of AI in shifting the competitive climate has emerged both as an opportunity and a challenge for SMEs [42], [43]. AI finds clear articulation in transforming business models, logistics, risk management, and customer interaction in SMEs. Recent evidence has pointed out that AI possesses certain transformative powers related to operational performance and strategic decision-making, which will benefit SME industries [44], [45]. In this regard, [46], [47] have commented on how AI can revolutionize changes in operational effectiveness and strategic decision-making in many industries for SMEs. More importantly, [34] For AI's competitive advantages to be harnessed, there must be a change in management skills.

While there is an increasing number of studies investigating the impact of AI on the SME's sustainable competitive advantage [48], [49], [50], one can consider the clear presence of a research gap even though consent has grown regarding the transformational important role AI plays for multiple industries. Whereas the existing literature supports AI's operational and sectoral impacts, few studies investigate how AI directly enables sustainable competitive advantages among SMEs. Much of the current literature focuses on larger firms or takes on more general perspectives to ignore the unique opportunities and challenges SME contexts offer. This leaves an expansive room for investigating complex dynamics between AI integration and the sustainable competitiveness of SMEs. The

present research seeks to fill this gap by carefully analyzing the distinctive relationships between AI and sustainable competitive advantages in SMEs. To that end, we posit the following hypothesis:

H1: The integration of AI is positively related to the sustainable competitive advantage of SMEs.

3.2 Manager Digital Literacy

The integration of AI is increasingly acknowledged as a key component of gaining sustained competitive advantage in SMEs in today's dynamic competitive climate [51], [52], [53], [54]. Although the revolutionary potential of AI is widely known, the success of its integration into an organization depends greatly on its managers' level of digital literacy [25], [40].

In addition to technical proficiency, managerial digital literacy includes the capacity to critically assess and use digital technologies in ways that are both strategically beneficial and culturally suitable [55], [56]. As SMEs use AI more often, it is being used for a variety of operational improvements, including risk management and the development of new business models [56], [57], [58]. For instance, managers with high levels of digital literacy are better able to use AI-driven technologies to their advantage, increasing their chance of gaining a competitive edge [59]. On the other hand, a lack of digital literacy might make integration harder [60], [61]. Therefore, AI will not be used effectively; this also might pose a risk to the competitive position of the SME. Hence, a more nuanced hypothesis, considering previous research on AI for SMEs and the material role of management capabilities in technology adoption, could be the following:

H2: Higher digital literacy among managers moderates the relationship between AI Integration and SMEs' sustainable competitive advantage.

3.3 SMEs' Sustainable Competitive Advantage and SMEs' Sustainable Performance

The concept of sustained competitive advantage is one of the significant ideas regarding SMEs in strategic management; it has been confronted by a totally integrated global and highly competitive market [62], [63], [64]. Recent studies highlighted that having a sustainable competitive advantage affects SMEs

in their sustainability performances from economic, social, and environmental sides, as well as their immediate profitability and growth [65], [66], [67].

The existing research also shows that SMEs with a sustainable competitive advantage are better able to respond to stakeholder demands for Sustainability, better adapt to market changes, and allocate resources in a way that results in a comprehensive, multifaceted performance [2], [68], [69]. Increases in sustainable competitive advantage immediately enhance sustainable company performance, in keeping with the statements above. According to published research, businesses should concentrate on gaining a competitive edge in a market where competition is fierce while maintaining a stable level of financial performance. According to several research studies [70], [71], sustainable business performance correlates significantly with sustainable competitive advantage. Given these theoretical and empirical findings, we suggest the following hypothesis:

H3: SMEs' sustainable competitive advantage is positively related to their sustainable economic, social, and environmental performance.

4. METHODOLOGY

4.1 Data collection and participants

A cross-sectional design was adopted to test the hypotheses of this study. The sample would be drawn from SMEs affiliated with the Palestinian Information Technology Association of Companies, more commonly known as PITA. 350 SMEs were selected using simple random sampling. Before taking the survey of these businesses, its contents had to be checked for verification and validation. 320 responses were received from the SMEs selected within three months of data collection. Out of all these, 284 questionnaires were complete, usable, and thus included in the ensuing comprehensive analysis.

4.2 Measurement and survey instrument

Structured questionnaires were used to collect data for an instrument, a process that was informed by a literature review and email interviews. The questionnaire was designed with adaptability in mind and divided into two parts: the first focused on the demographics of the respondents, including gender, Year of Experience, Position in the organization, and age. The second part was dedicated to the selected variables, measured using a five-point Likert

scale rated as 1-Strongly disagree, 2-Disagree, 3-Slightly agree, 4-Agree, and 5-Strongly agree. The development of the measurement questions resulted from an extensive literature review, as detailed in Table 1 (see appendix 1). The items were carefully modified to ensure their relevance to the research context.

5. RESULTS AND DATA ANALYSIS

5.1 Measurement model

The study first examines the constructs' reliability, convergent validity, and discriminate validity using the procedure set by scholars [72], [73]. According to a study conducted by Hair et al. (2013), the reliability of a measurement model depends on its ability to distinguish between different variables (discriminant validity) and accurately measure the intended variables (convergent validity). The researchers evaluated the instrument's reliability using indicator loadings and Cronbach's Alpha (α). They assessed the indicators of the constructs to determine their effectiveness in measuring the research variables correctly. The researchers used two metrics to express the performance of the indicators: Average Variance Extracted (AVE) and Composite Reliability (CR). They found that the factor loadings of the elements included in the model were at least 0.6, as shown in Table 2 in Appendix 2.

The obtained α -values were found to be significantly higher than the cut-off point value, 0.70, reflecting that all variables had a good level of reliability. Besides, I would like to underline that the CR scores of the variables studied in this research have obtained a score above the cut-off point score of 0.7, indicating an internally reliable composition.

Also, the AVE values were well above 0.50, exceeding the threshold set by the pundits (Table 1). The present study's results further indicate that the construct used in the research instrument is reliable and consistent.

The researchers established the relationships among the study variables using correlation analysis. The AVE values and the factor loadings were examined to check for convergence validity. In this regard, all AVE values for the constructs had values above 0.50, indicating that at least 50 percent of the variation observed was explained by the underlying factors. The square root of AVE establishes discriminant validity. The results showed discriminant validity because the square root of AVE was higher than the

associations with other variables [74], as seen in Table 1.

Before continuing the process, the researchers applied the Fornell-Larcker criterion to the instrument to establish its discriminant validity. The criterion showed robust discriminant validity, thus proving that an instrument ultimately differentiates between the various variables. Table 3 represents the outcomes of the Fornell-Larcker criterion.

5.2 Assessment of Structure Model

In this study, bootstrapping was applied using 5000 resamples to verify the statistical significance of the concept model proposed for this study in determining the relationships among components of the structural model through one or more dependency relationships [75]. According to [73], the coefficient of determination R2, predictive relevance Q2, and effect size F2 should be documented together with path significance. These indicators give information about the dispersion of the endogenous variable. The importance of the correlation issue was also brought forth. The results of the analysis performed using the structural model and the threshold limit used for these evaluations in this study are given in Table 4.

Correspondingly, the R2 values of the endogenous latent constructs for SSCA-Adoption and SSP were 0.042 and 0.359, respectively, while their Q2 values were 0.018 and 0.224, respectively, considerable predictive capability and a significant portion of predictive relevance for the independent constructs. Effect size measures "the relative impact caused to the respective latent endogenous variable through variation in R2 by a particular exogenous latent variable ". This is based on the fact that the F2 value is determined by the contribution of the latent variable's path against unexpected variability of the latent variable itself [76]. Table 3 shows that all the effect size values were within the recommended range.

Table 3: Effect Size.

AII	SSCA
0.044	0.561

The magnitude of those direct effects was determined using 5,000 bootstrap subsamples

and one-tailed critical t-values greater than ±1.65. This analysis showed that all the hypotheses were supported and significant at p-value < 0.01 levels, as illustrated in Table 4 and Figure 2 in Appendix 3.

Table 4: Hypothesized Direct Effects of the Variables.

Hypotheses		Path Coefficient	t Statistics	p-Value	
H1	AII -> SSCA	0.205	3.347	0.001	Supported
H2	SSCA > SSP	0.599	14.892	0.000	Supported

5.3 Testing of the moderation effects of firm size

A moderator variable affects the relationship existing between both variables. That is to say, the impact of the independent variable on the dependent variable depends on the level of the moderator [77]. In that light, this present study assessed the moderation effects of SEM on Manager Digital Literacy about the influence that AII, as the independent variable, exerts upon Sustainable Competitive Advantage as the dependent variable.

As Table 5 reflects, the Manager Digital Literacy is statistically significant on AI Integration, with the p-values all below the conventional significance level of 0.05.

Table 5: Moderation effects of firm size.

Path	Path Coefficient (β)	t Statistics	p-Value	Hypothesis
H3	AII * MDL □ SSCA	0.109	18.534	0.000

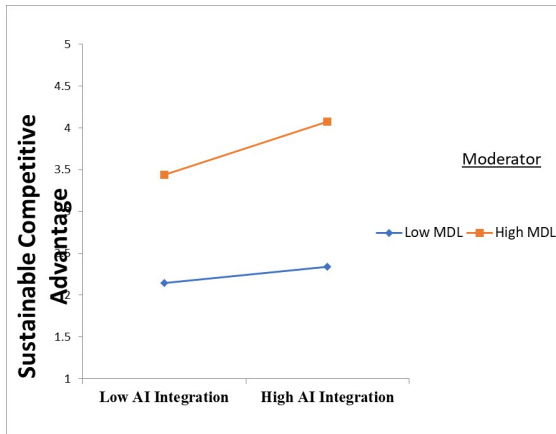


Figure 3: MDL strengthens the positive relationship between AI Integration and Sustainable Competitive Advantage

6. DISSCUSSION

A structured approach was followed to attain these objectives by developing a research framework by reviewing the literature and TOE: technological, organizational, and environmental. More importantly, the primary focus of this research would be highlighting opportunities and challenges SMEs face in this AI-driven era, focusing on the Palestinian context and discussing in much greater depth the symbiotic relationship between AI and digital literacy. Overall, the results provide valuable information from the relationships between the exogenous and endogenous variables in Table 4. Managerial digital literacy mediates and reinforces the relationship between AI integration and the SME's sustainable competitive advantage through more efficient decision-making and technological adaptability.

This finding supported H1, which is corroborated by the fact that there is a statistically significant relationship between these variables, as expressed by the path coefficient of 0.205 and the p-value of 0.001, as shown in Table 4. That is to say, integrating AI into SME activities improves SMEs' competitive advantages. This result has also been obtained in the literature, which, while integrating AI in organizations, would enable organizations to maintain business running while driving promotional operational efficiencies relevant to environmental improvement, reduce emissions, build a safe workplace, promote diversity, and encourage community effort [78]. This finding also aligns with previous literature that shows

how the usage of AI in small and medium-sized enterprises might bring opportunities for increased productivity and decrease the risks of SMEs when adopting e-commerce into their activities, as it provides them with a pretty good competitive advantage in the market [79].

Furthermore, this study supported H2, which is corroborated by the fact that there is a statistically significant correlation between these variables, as shown by the path coefficient of 0.599 and the p-value of 0.000, as shown in Table 4. This explores the role of managerial digital literacy in moderating the relationship between AI integration and SMEs' sustainable competitive advantage, which is found in previous studies [80]. Decision-making is one of the significant capabilities of SMEs. AI integration in decision-making can drive their sustainable competitive advantage, which is also considered one of the important core areas in which AI can make a significant difference in business results by enhancing the market share, customer hold, and environmental Sustainability. So, digital literacy amplifies the positive effects of AI, a hypothesis grounded in previous studies [24], [81].

Finally, H3 was also supported in this study; this is corroborated by the fact that there is a statistically significant correlation between these variables, as shown by the path coefficient of 0.109 and the p-value of 0.000, as shown in Table 5. This means a significant relationship exists between SMEs' sustainable competitive advantage and sustainable performance, which was endorsed in the literature, too. Some research indicates that competitive advantage can be crucial in SMEs' sustainable performance. By leveraging resources efficiently, SMEs can differentiate themselves in the marketplace, ensuring long-term success. This aligns with the resource-based view, suggesting that unique capabilities and strategic resource use can boost competitive advantage and Sustainability. Studies demonstrate that innovative strategies and dynamic capabilities can enhance a firm's long-term performance, even in highly competitive markets [82], [83]. [84] argued that integrating AI into SMEs significantly improves operational efficiency, cost thriftiness, and innovation. AI adoption helps SMEs compete by optimizing their decisiveness and better customer service, allowing them to develop a sustainable competitive advantage [85].

7. CONTRIBUTION AND NOVELTY IN COMPARISON WITH PRIOR WORK

Previous studies have focused - more or less - on the potential benefits brought about by AI in enhancing business operations and competitive advantage, mainly highlighting different aspects of those large enterprises genuinely endowed with resources [12], [13], [17], [18]. Indeed, these works have identified the following AI applications, which significantly enhance efficiency, better decision-making, and innovation in large organizations. For example, [12] and [13] examined the impact of AI on operational efficiency in multinational corporations, focusing on transformative potential in business models.

While AI applications in large companies have been the focus of many studies, their applications and adoption in small and medium enterprises still need to be explored at a time when these enterprises are significant in developing countries like Palestine. Previous chapters still need to address their particular challenges and opportunities because SMEs face considerable resource limitations, a lack of technological infrastructure, and lower levels of digital literacy among managers. Other works acknowledged the potentially positive role that AI could play for SMEs but did not investigate the role of digital literacy by managers as a moderator in this respect.

Our study is motivated and differs in its findings from previous research. Driven by the imperative need to enhance the competitiveness of Palestinian SMEs in the digital era, our study investigates how AI adoption under resource-constrained conditions leads to sustainable competitive advantage. We recognize that managers' digital literacy is a critical antecedent factor in derivating the successful integration of AI technologies in SMEs, positioning it as the moderating variable of our study.

Our findings add to the novelty of insights on how managers' digital literacy empirically significantly enhances the effectiveness of AI adoption in SMEs. While other studies may have treated digital literacy as a background factor or put forward purely technological aspects, we now emphasize its enabling role for SMEs to exploit AI for full long-term sustainability and growth. This emphasis on human capital adds a new dimension to the discourse of AI adoption in SMEs.

Second, we fill the gap in previous literature by focusing on the Palestinian context of SMEs. Our research provides customized insights relevant to developing economies, where SMEs form an essential part of the economic development process but face unique challenges regarding technology adoption. The integrated approach proposed here, combining technology, skills, and strategy, offers a comprehensive framework that other SMEs can adopt for similar contexts.

In the light of the results obtained, the relevance and novelty of our research lies in showing that:

- SMEs can adopt AI effectively to attain competitive advantage even under resource-constrained conditions.
- Managerial digital literacy lowers costs and acts to magnify this effect nonlinearly, far beyond what might be expected for such a supportive skill. The integration of AI thus relates synergistically with digital literacy in improving economic, social, and environmental sustainability performance.

Therefore, these insights advance our knowledge of AI's role in SMEs and underline the need for managers to develop the required digital competencies. This is an important contribution to policymakers' and business leaders' efforts to promote AI adoption and improve the competitiveness of SMEs in developing countries such as Palestine.

8. SPECIFIC APPLICATIONS OF THE WORK

Our findings have practical implications for SMEs who want to use AI as a basis for sustainable competitive advantage. The potential applications of our findings can be implemented in several key areas:

Firstly, AI technologies may also be used to enhance managerial decision-making activities by SMEs. Driven by the integration of AI with data analytics and predictive modeling, managers would obtain helpful insights from big datasets that would result in better-quality decisions and strategic choices. AI enhances forecasting, risk assessment, and market trend analysis.

Secondly, AI will revolutionize customer service by automating responses and offering personalized experiences. SMEs can use AI-

powered chatbots and virtual assistants to handle customer inquiries, thus reducing response time and boosting customer satisfaction. This will not only improve customer retention but also free human resources to deal with higher-order tasks.

Thirdly, AI technologies can smoothen this operational process by automating routine tasks, rationalizing supply chains, and managing inventory more efficiently. SMEs will be able to achieve greater efficiency and productivity, reduce operational costs, and quickly respond to market demand.

Fourthly, AI might be used by SMEs in a sophisticated data analysis, which would thereby convert raw data into decision-making material. This may involve the identification of consumer behavior patterns, market segmentation, and performance metrics that are considered important in strategic planning and competitive positioning.

Fifthly, AI can support the development of innovative products or services by SMEs in this industry by identifying market gaps, customer feedback, and emerging trends. Innovation is cherished, and it keeps the SME one step ahead of its competitors by meeting unfulfilled customer needs and adapting to changes in the market.

Lastly, AI can assist SMEs in monitoring and improving their environmental performance. By optimizing resource utilization, reducing waste, and enhancing energy efficiency with the aid of AI-powered solutions, SMEs can take their sustainability initiatives to the next level and stay in harmony with environmental legislation.

9. LIMITATIONS, OPEN RESEARCH ISSUES, AND COMPUTING RESEARCH CONTRIBUTION

Although our study provides an overview of the possible effects of AI integration and management's digital literacy on enhancing SMEs' sustainable competitive advantage, it is relevant to mention some limitations and open research issues from our work. A critical literature review also highlights several open areas that require future studies' attention.

Shortcomings of the current work one of the critical limitations of our study is its cross-sectional design; data are captured at one point in time. This design choice impacts our ability to establish any causality between AI integration, managers' digitally enabled literacy competence, and sustainable competitive advantage. Future studies should consider longitudinal studies to observe how these relationships may develop over time and achieve more robust causal inferences.

Another limitation is the sample used in our research. The SMEs surveyed herein were associated with the Palestinian Information Technology Association of Companies (PITA). This might easily indicate that these SMEs already had an inclination toward technology adoption and higher levels of digital literacy than the general population of SMEs. Our findings may only be generalized to some SMEs in Palestine or other developing economies. Therefore, future studies should be directed towards ensuring a sample with more heterogeneous natures of SMEs' activities and their location. Generalization of results would be made with more confidence.

Second, relying on self-reported data from questionnaires, we open our results to respondents' biases, such as social desirability bias or inaccuracies in self-assessments about their digital literacy level. This could be reduced by using objective measures of AI adoption and digital literacy or data triangulation for a more realistic or tangible representation of the examined constructs.

Several open research issues arise from this work for future exploration to better understand AI integration in SMEs.

The longitudinal impact constitutes another substantial area for further study. Future research may use longitudinal designs that capture and show how these relationships among AI integration, digital literacy, and sustainable competitive advantage unfold over time. Longitudinally investigating these variables would yield insights into the long-term effects of AI adoption in SMEs, capturing the dynamic nature of technological implementation and the long-term impact on business performance.

Exploring diverse contexts is essential in the second place. Consequently, there will be an extension of research to SMEs from different sectors, regions, and levels of technological

advancement that could allow for the comprehensive identification of contextual factors that may affect the level and outcomes of AI adoption. Beyond digital literacy barriers, financial constraints, cultural resistance, infrastructural limitations, and regulatory challenges, understanding obstacles to AI technology diffusion among SMEs would be particularly useful.

This would help develop strategies that address specific challenges offered to SMEs in different environments. This area of research is also open because effective AI technologies are to be found. Identifying what AI applications, such as machine learning, natural language processing, or robotics, apply best to SMEs across industries could bring the development of targeted adoption methodologies along. In such a manner, different AI technologies would also be contextualized regarding suitability for use and their impact in a specific sector, while helping SMEs make informed choices on strategic technology investments.

Last but not least, the role of external support will be investigated. It is essential to learn how supportive government policies, educational institutions, and industrial partnerships can enable the adoption of AI and improve the digital literacy necessary for managers and employees of SMEs. Support mechanisms from outside entities could supply resources, training, and incentives for reducing barriers to the acceptability of technology.

Our work's value to computing research creates an in-depth understanding of how technological innovations, especially AI, can be effectively embedded within an SME to strategically achieve certain objectives. We saw that the implementation of AI was not only a technical challenge but also highly interlinked with the human factor, especially the digital competencies of managers. Such insight underlines the need for an interdisciplinary approach interweaving computing with management and strategic planning.

Therefore, our study's outcome indicates that managers are more digitally literate, which significantly moderates the influence brought about by the integration of AI on the competitive advantage of SMEs. This infers, therefore, that computing research needs not only to move beyond the development of advanced technologies into strategies but also one that can

predispose and facilitate the adoption of technology across diverse organizational contexts. In recognizing a human element in technology adoption, computing research can contribute toward creating technically sound and practically implementable solutions within SMEs.

In short, this study has several implications for varied purposes, one of which is the design of AI solutions that are accessible and usable by persons with different levels of digital proficiency. Attention should be directed toward human-computer interaction, usability engineering, and training programs that can bridge the gap in digital literacy in SMEs.

Thus, computing research is positioned to make a significant difference in these areas, duly empowering SMEs so that these AI technologies can contribute positively to their performance through sustainable competitive advantage.

10. CONCLUSION

Today, implementing AI is a decisive challenge for moving towards sustainable competitive advantage and increasing the overall business effectiveness in SMEs. AI will enable SMEs to enhance productivity and improve their performance in support of automation, cost reduction, efficient operations, and better data-driven decisions in a fast-paced environment. AI allows SMEs to bring modernity into customer service, automate routine tasks, and catalyze innovation. It will help them create unique selling propositions to keep their businesses competitive for years. Besides, adopting AI performs sustainably, actively contributing to resource use optimization, shrinking the environmental footprint, and enabling strategic decision-making only when an organization grows resilient. According to the study, SMEs experience a competitive advantage and augment cost savings considering the integration of AI in strategic operations.

This research initiative tried to shed light on the opportunities and issues faced by SMEs in an AI-driven era and to emphasize the Palestinian context, exploring in greater detail how the symbiotic relationship between AI and digital literacy occurs. In addition, it was meant to test the role of digital literacy in enhancing the revolutionary potential of AI to provide SMEs with a sustained competitive advantage by integrating technology, skills, and strategy into one framework. Lastly, it was meant to test how

AI can enhance the sustained competitive advantage of Palestinian SMEs represented by digital literacy, which was to act as a moderator.

This study has answered the main questions raised in the introduction. We proved that integrating AI can enhance Palestinian SMEs' sustainable competitive advantage by optimizing business operations, making better decisions, and embracing innovation under resource-constraint conditions. Moreover, our findings confirm the manager's digital literacy as an essential moderator in such a relationship, which may amplify the positive effects of AI integration on sustainable competitive advantage. First, digital literacy by managers could enable SMEs to implement AI technologies better and thereby improve their sustainable performance in three dimensions: economic, social, and environmental. In other words, such a symbiotic relationship between AI and digital literacy empowers Palestinian SMEs to achieve long-term sustainability and growth.

This research used a straightforward random sample of 284 valid responses and applied PLS-SEM techniques to analyze these data to establish the validity and reliability of the study together with its structural model. Thus, evidence of the controlling statistical evidence indicated that artificial intelligence integration and SMEs' sustainable competitive advantage are associated. The manager's digital literacy positively impacts the interrelationship between the two constructs. Moreover, SMEs have a positive correlation between the sustainable competitive advantage factor and SMEs' performance in sustainability.

Various studies from different regions proved and confirmed these factors. The results also showed that AI adoption positively influenced the sustainable performance of SMEs in Palestine. It implicitly affirms that the adoption of AI and digital literacy by SME managers has played a vital role in moderating the relationship between artificial intelligence integration and SMEs' sustainable competitive advantage, directly influencing SMEs' sustainable performance.

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APPENDIX

Table 1: Scale items of the selected constructs

Constructs	References	Items
AI Integration (AII)	[86]	Consumers' behavior can be monitored with the help of AI integration.
		AI integration enables the rapid and comprehensive dissemination of product information, giving businesses a competitive edge.
		We firmly believe that AI integration has the potential to captivate consumers, leading to increased sales and revenue.
		It can also monitor and control an e-commerce business's inventory using AI.
		AI Integration is a powerful tool for predicting and preventing the patterns of fake customers, enhancing the security and trustworthiness of your e-commerce operations.
Manager Digital Literacy (MDL)	[87]	The manager effectively exploits digital devices within the organization's AI integrative framework.
		Periodic review of the practical uses of AI-driven and digital platforms within the organization's service delivery
		The capability of the manager to operate digital tools and AI technologies efficiently after acquiring proper training on the job
		The all-encompassing organizational capability, made possible by managerial digital literacy, to deploy AI technologies to achieve better operations and sustain competitive advantages.
Sustainable Competitive Advantage (SSCA)	[88]	My organization focuses on developing new ideas discovered in new services, processes, and procedures.
		My organization introduces services that are new to the market it serves.
		The preferred market positioning can confer competitive advantages in a marketplace.
		Access to better-limited resources may lead to certain competitive advantages in the marketplace.
		Resources can be exploited indefinitely to gain an upper hand in the marketplace.
Sustainable Performance (SSP)	[88]	Our organization's net profit margin has increased.
		Our organization noticed an improvement in the return on investment.
		Its profitability growth has been outstanding.
		We have outperformed our competitors in profitability.
		Overall, the financial performance has outperformed that of competitors.

Table 2: Factor loading and discriminant validity.

Variables	Item	Standard Loadings	Cronbach- α	CR	AVE
AI Integration	AII1	0.860	0.883	0.914	0.682
	AII2	0.804			
	AII3	0.887			
	AII4	0.828			
	AII5	0.742			
Sustainable Competitive Advantage (SSCA)	SSCA1	0.797	0.760	0.842	0.522
	SSCA2	0.845			
	SSCA3	0.735			
	SSCA4	0.668			
	SSCA5	0.622			
Sustainable Performance (SSP)	SSP1	0.747	0.859	0.899	0.640
	SSP2	0.822			
	SSP3	0.859			
	SSP4	0.810			
	SSP5	0.757			

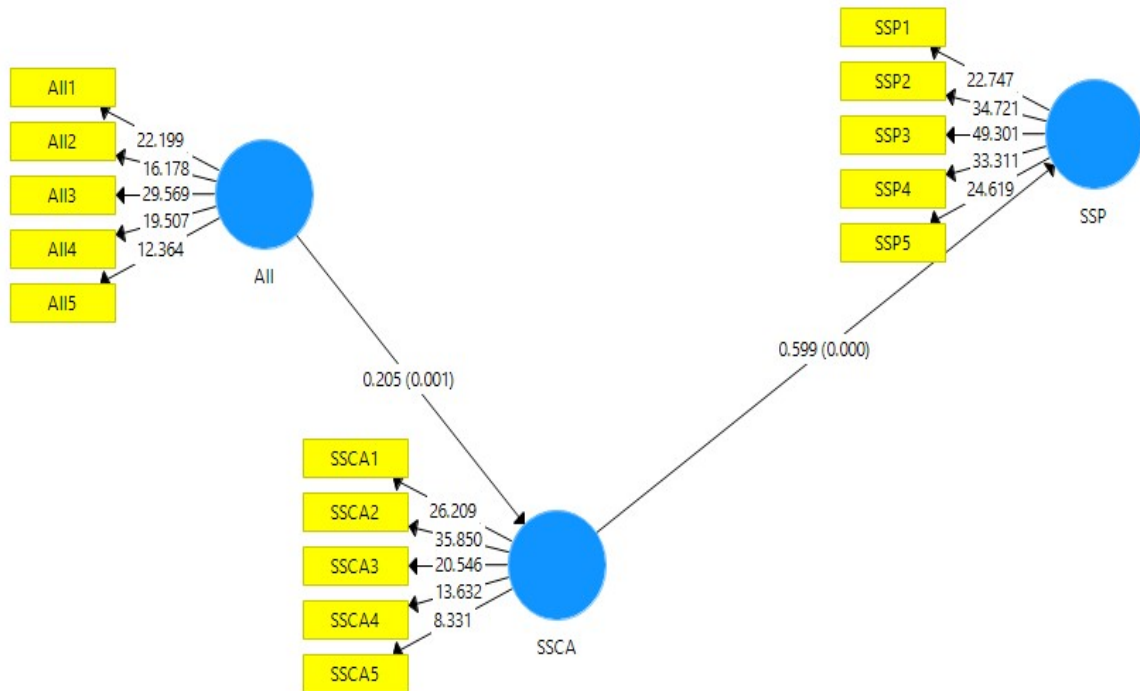


Figure 2: Structure Measurement.