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The role of sustainable digital education in promoting e-commerce adoption: A case study of small enterprises in Jordan

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Abstract

This study explores the role of sustainable digital education in fostering e-commerce adoption among SMEs in Jordan. Guided by the TOE framework and the DOI theory, the research examines how four key factors—sustainable digital education, technological infrastructure, organizational readiness, and regulatory support—affect the integration of e-commerce practices. A quantitative methodology was employed, utilizing a structured survey distributed to 180 SMEs, yielding 151 valid responses. Exploratory factor analysis (EFA), correlation analysis, and multiple linear regression were used to analyze the data. Findings indicate that all four variables significantly and positively influence e-commerce adoption. Organizational readiness emerged as the strongest predictor, followed by regulatory support, technological infrastructure, and sustainable digital education. Despite the high availability of digital training programs, their limited contextual relevance reduces their overall impact. The results underline the necessity for tailored educational strategies, robust digital ecosystems, and proactive policy frameworks to enhance digital transformation among SMEs. The study contributes to the literature by validating the TOE model in a developing country context and providing practical implications for SME owners, policymakers, and educators. It highlights the interplay between institutional support and internal capabilities in achieving sustainable e-commerce integration. The findings are especially relevant for regions facing infrastructural and digital skill challenges, offering evidence-based recommendations for inclusive economic growth through digital means.

Keywords: E-commerce adoption, SMEs, digital education, organizational readiness, regulatory support, Jordan, TOE framework

1. Introduction

In the digital era, e-commerce has emerged as a critical driver of economic growth, particularly for small and medium-sized enterprises (SMEs) in developing countries [1]. As global markets shift toward digital channels, SMEs in Jordan face growing pressure to adopt e-commerce platforms to remain competitive, access new markets, and improve operational efficiency [2]. However, despite increasing internet penetration and

governmental support, e-commerce adoption among Jordanian SMEs remains relatively low, indicating persistent structural, technological, and educational barriers.

One of the most pressing challenges is the lack of sustainable digital education tailored to the needs of SME employees. As digital transformation becomes essential for survival, the capacity of SMEs to embrace and leverage e-commerce tools is closely tied to their digital literacy and training infrastructure. In this context, sustainable digital education refers not only to temporary training but to continuous, accessible, and scalable educational programs that enable long-term digital competence. These programs often depend on cross-sector collaboration between government bodies, private institutions, and academia [3].

Moreover, e-commerce adoption does not occur in isolation. It is influenced by several interrelated factors, including the availability of technological infrastructure, organizational readiness for digital transformation, and the regulatory environment [4]. The TOE framework [5] and the DOI theory [6] provide a robust foundation to examine these multidimensional determinants and their impact on digital transformation within SMEs.

Despite a growing body of literature on numerical transformation in the MENA region, empirical studies focusing on the intersection between sustainable digital education and e-commerce adoption—particularly in the Jordanian context—remain limited. This study aims to bridge that gap by analyzing the role of sustainable digital education alongside other key enablers in promoting e-commerce adoption among Jordanian SMEs.

The study adopts a mixed-methods approach to answer the following questions:

- To what extent does sustainable digital education influence e-commerce adoption in SMEs?
- How do infrastructure, organizational readiness, and regulations interact with education to affect adoption?

By addressing these questions, the study contributes to both academic knowledge and policy formulation, offering insights for educators, policymakers, and SME leaders in Jordan and comparable developing economies.

2. Theoretical background and literature review

This study is underpinned by two foundational theoretical frameworks that collectively explain the determinants of e-commerce adoption in Jordanian SMEs: the TOE framework and the DOI theory. These complementary lenses provide a holistic understanding of how both structural and perceptual factors influence the adoption of technological innovations.

The TOE framework, developed by Tornatzky and Fleischer [7], posits that technological adoption is driven by three interconnected contexts: the technological context, encompassing internal and external technologies like e-commerce platforms and payment systems; the organizational context, involving firm-specific characteristics such as size, skills, and leadership support; and the environmental context, comprising the external business ecosystem, including industry regulations and government incentives. This framework is particularly relevant for Jordanian SMEs, where barriers such as inadequate infrastructure (technological), limited digital competencies (organizational), and ambiguous digital commerce regulations (environmental) have been identified as critical impediments [8]. Its comprehensive structure offers a robust mechanism for categorizing and assessing the multifaceted drivers of digital transformation in emerging markets [9].

Complementing this, Rogers' DOI theory [12] elucidates the process through which innovations are communicated and adopted within a social system. It emphasizes five key innovation attributes that affect adoption rates: relative advantage, compatibility, complexity, trialability, and observability. In the context of Jordanian SMEs, sustainable digital education can directly reshape perceptions of these attributes; for instance, structured training can reduce the perceived complexity of e-commerce tools and enhance their relative advantage, thereby increasing adoption likelihood [10]. The theory's focus on knowledge dissemination, communication channels, and social influence aligns perfectly with the role of educational interventions in the interconnected Jordanian SME ecosystem [11][12].

The synthesis of these theories forms a robust analytical framework for this research. The TOE framework provides the macro-level, structural analysis of external and internal determinants, while the DOI theory contributes micro-level, behavioral insights into how education and perception influence individual and organizational adoption decisions. This integrated approach ensures a comprehensive examination of the dynamics shaping e-commerce adoption.

2.1. Hypotheses development

The conceptual model and hypotheses are developed based on the integrated TOE-DOI framework and a review of empirical literature. The variable of Sustainable Digital Education—defined as long-term, scalable, and inclusive digital training—is recognized in Jordan through various government and private initiatives, though with varying access and impact [13]. Studies emphasize that such targeted programs significantly boost SME readiness and reduce the perceived complexity of e-commerce tools, acting as both a technical enabler and a behavioral catalyst [14][15][16]. Thus, the first hypothesis is proposed:

H1: Sustainable digital education positively correlates with e-commerce adoption in Jordanian SMEs.

The Technological Infrastructure context, a core element of the TOE framework, is a foundational requirement. Evidence indicates that internet access, mobile broadband speed, and user-friendly platforms directly enable e-commerce implementation. Research in Jordan has linked advancements in mobile network infrastructure, such as 5G, with increased e-commerce activity, while affordable cloud solutions lower barriers for resource-constrained firms [17][18][19]. This leads to the second hypothesis:

H2: Advanced technological infrastructure significantly enhances e-commerce adoption among Jordanian SMEs.

Organizational Readiness, representing the organizational context in the TOE framework, encompasses tangible and intangible capabilities like digital leadership, employee skills, and cultural openness. Studies on Arab SMEs consistently highlight the critical role of top management commitment and pre-existing digital capabilities. Firms with dedicated budgets and a strategic vision for digitalization are found to integrate e-commerce more effectively [20][21]. Therefore, the third hypothesis is:

H3: Higher organizational readiness leads to faster and more effective e-commerce adoption in Jordanian SMEs.

Finally, the Regulatory Support, constituting the environmental context, includes factors like tax incentives and consumer protection laws. Research confirms that regulatory clarity and supportive policies directly affect SMEs' investment in digital transformation [22]. In Jordan, initiatives by the Ministry of Digital Economy and Entrepreneurship aim to streamline digital business processes, though challenges in areas like cross-border e-commerce persist [14][23]. Building on the TOE framework, which treats the environment as a critical influencing factor, the following hypothesis is proposed:

H4: A supportive regulatory environment moderates the relationship between sustainable digital education and e-commerce adoption.

3. Conceptual framework

Sustainable digital transformation in SMEs relies on several interconnected elements, of which education, infrastructure, organizational capacity, and supportive regulation are among the most critical. In the context of emerging economies such as Jordan, these factors often determine whether SMEs can successfully transition into e-commerce-driven business models. This study proposes an integrated conceptual framework that connects four core components: sustainable digital education, technological infrastructure, organizational readiness, and regulatory support. These dimensions collectively shape the landscape of e-commerce adoption within Jordanian SMEs.

Sustainable digital education is positioned as a central driver of digital transition. Rather than short-term skill-based workshops, sustainable digital education refers to scalable and ongoing training programs that are aligned

with the evolving technological environment. These programs help SMEs bridge knowledge gaps, foster digital fluency, and reduce the perceived complexity of digital tools. Digital literacy enables both owners and employees to engage confidently with e-commerce platforms, manage customer interactions, and utilize analytics to inform decision-making [24].

Technological infrastructure provides the functional capacity for SMEs to operate in digital environments. It includes broadband access, computing tools, cloud-based platforms, and mobile payment systems. Access to affordable and reliable internet, paired with tools such as digital storefronts and e-wallets, enables SMEs to expand market reach, automate operations, and facilitate secure transactions. However, inconsistent infrastructure across regions in Jordan presents a barrier to equitable e-commerce adoption [25].

Organizational readiness determines the internal ability of SMEs to leverage technological and educational inputs. This includes leadership commitment to digital innovation, budget allocation for e-commerce solutions, and baseline digital skills across the workforce. Firms that exhibit openness to innovation and invest in internal capabilities are more likely to achieve sustainable e-commerce integration [26].

The regulatory environment acts as a moderating layer within the framework. Government policies that incentivize e-commerce—such as tax relief, simplified online business registration, and legal protection for consumers and digital vendors—enhance the effects of education and infrastructure. In contrast, the absence of clear digital governance can neutralize the progress driven by internal efforts. Effective regulatory frameworks support SMEs by lowering compliance barriers and ensuring secure, trustworthy e-commerce environments [27].

This conceptual model (as shown in Figure 1) evaluates how these four dimensions—when aligned—can significantly increase the likelihood of e-commerce adoption among SMEs in Jordan. The framework is grounded in the TOE model and is complemented by the DOI theory, highlighting both structural and behavioral components of the adoption process. By investigating the dynamic interplay of education, technology, organizational factors, and policy, this model delivers practical insights that empower Jordanian SMEs to thrive in digital markets.

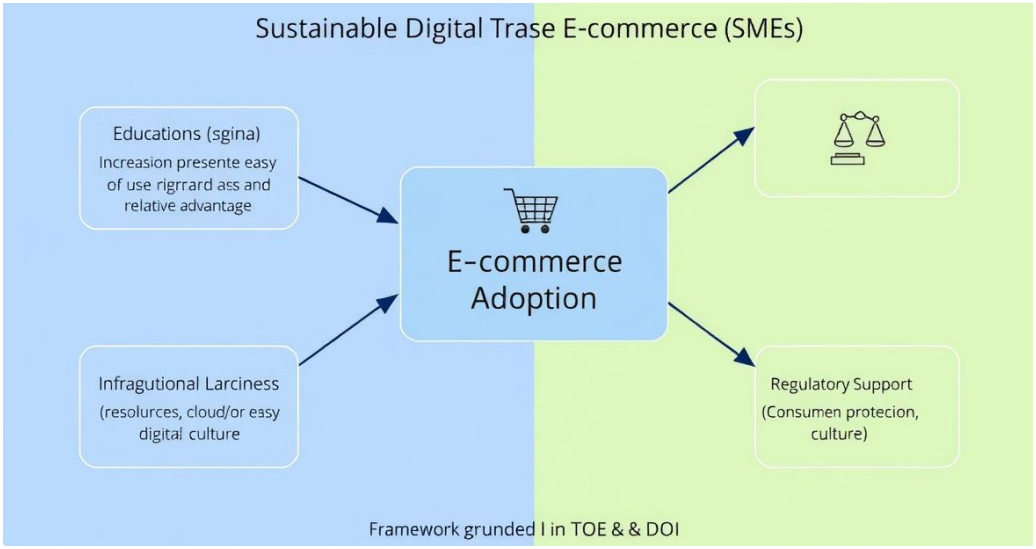

Figure 1. Framework grounded in TOE & DOI

4. Research methodology

This study employed a quantitative research design to investigate the influence of sustainable digital education, technological infrastructure, organizational readiness, and regulatory support on e-commerce adoption within Jordanian SMEs. The research model and questionnaire development were guided by the integrated lens of the TOE framework and the DOI theory. Data were collected via a structured questionnaire distributed to SME managers and digital operations officers across various sectors in Jordan. A total of 180 questionnaires were

administered using a hybrid approach, combining online distribution (email and social media) with in-person delivery facilitated by local chambers of commerce. From this distribution, 151 valid responses were obtained, representing 145 distinct SMEs, as some organizations had multiple managers or department heads complete the survey independently. This yielded a high response rate of 83.9%, which is considered robust for statistical analysis in social science research [28]. The sample encompassed SMEs from the retail, services, manufacturing, and technology sectors to ensure broad sectoral representation. Respondents held mid- to senior-level positions, including CEOs, IT managers, and operations managers, thereby providing informed perspectives on their organizations' digital capabilities and strategic orientations.

The survey instrument was structured into six sections to comprehensively capture the necessary data. The first section gathered demographic and firmographic information, such as firm size, sector, and business age. The second section measured the dependent variable, e-commerce adoption level, using Likert-scale items that assessed the percentage of online sales, digital payment usage, and online customer engagement. Subsequent sections were dedicated to the independent variables: sustainable digital education was assessed through items related to training access, digital upskilling, and curriculum integration; technological infrastructure was captured via indicators concerning internet quality, platform availability, and mobile payment usage; organizational readiness was measured by evaluating digital leadership, employee skills, and budget allocation; and finally, regulatory support was gauged by focusing on the perception of laws, the ease of e-commerce registration, and government incentives. To ensure validity and contextual relevance, all measurement items were adapted from established scales validated in prior studies [1][2][7][21][22] and subsequently refined through a process of expert review tailored to the Jordanian SME context.

5. Data analysis and results

This section presents the analysis of the collected data, which includes demographic profiling, descriptive statistics, reliability and validity tests, correlation analysis, and regression modeling to test the research hypotheses.

Table 1 illustrates the demographic characteristics of the respondents. Of the 151 valid responses received from 145 SMEs, 84 were male, and 60 were female participants. The majority of respondents were between 30–39 years of age (39.1%), followed by the 40–49 group (23.8%). Most respondents held the position of owner or general manager (65.6%), ensuring managerial-level insights. Regarding firm age, nearly 40.7% of firms had been operating between 5 to 10 years, indicating a stable and experienced SME sector.

Table 1. Demographic profile

Variable	Category	Frequency	Percentage (%)
Gender	Male	84	58.3
	Female	60	41.7
Age	20–29 years	29	19.2
	30–39 years	59	39.1
	40–49 years	36	23.8
	50 years and above	21	13.9
Position	Owner/Manager	99	65.6
	Employee	46	30.4
Firm Age	5–10 years	59	40.7
	11–15 years	50	34.5
	16 years and above	36	24.8

As shown in Table 2, the mean scores for the study variables were all relatively high, indicating a positive perception of digital readiness and e-commerce use. Sustainable digital education scored the highest mean (M = 4.61), suggesting it is a strong enabler among Jordanian SMEs.

Table 2. Descriptive statistics

Variable	Mean	N	SD
Sustainable Digital Education	4.61	145	0.531
Technological Infrastructure	4.53	145	0.511
Organizational Readiness	4.43	145	0.481
Regulatory Support	4.51	145	0.496
E-Commerce Adoption	4.56	145	0.501

To ensure construct validity, exploratory factor analysis (EFA) was performed. The Kaiser-Meyer-Olkin (KMO) measure was 0.755, indicating sampling adequacy, and Bartlett's test of sphericity was significant ($p < 0.001$), as shown in Table 3.

Table 3. KMO and Bartlett's test

Test	Value
Kaiser-Meyer-Olkin (KMO)	0.755
Approx. Chi-Square	3056.744
Degrees of Freedom (df)	131
Significance (Sig.)	0.000

The five extracted components explained 74.5% of the total variance, indicating strong construct representation (Table 4). The component matrix (Table 5) confirms that each variable loaded clearly onto a single factor, supporting dimensionality and convergent validity.

Table 4. Total variance explained

Component	Initial Eigenvalues: Total	Variance %	Cumulative %	Extraction Sum of Squared Loadings: Total	Variance %	Cumulative %	Rotation SS Loadings
1	5.21	26.01	26.02	5.30	27.00	27.00	2.85
2	3.51	17.51	43.53	3.60	18.50	42.50	2.52
3	2.81	14.11	57.52	2.90	15.00	56.50	1.78
4	1.91	9.12	67.03	1.80	9.60	68.00	1.62
5	1.31	6.61	73.53	1.32	6.40	74.50	1.20

Extraction method: Principal Component Analysis; when components are correlated, the sums of squared loadings cannot be added to obtain a total variance

Table 5. Component matrix

Variable	Component 1	Component 2	Component 3	Component 4
Sustainable Digital Education	0.832			
Technological Infrastructure		0.812		
Organizational Readiness			0.731	
Regulatory Support				0.707

Extraction Method: Principal Component Analysis; five components were extracted.

Pearson correlation analysis was performed to examine the relationships between the independent variables and e-commerce adoption. The results in Table 6 reveal that all variables showed significant positive correlations ($p < 0.01$), supporting preliminary hypothesis testing.

Table 6. Correlation of research variables

Variable	Pearson Correlation	Mean	p-value
Sustainable Digital Education	0.408	4.59	0.000
Technological Infrastructure	0.326	4.48	0.000
Organizational Readiness	0.234	4.39	0.000
Regulatory Support	0.514	4.49	0.000

Multiple linear regression analysis was conducted to assess the extent to which each independent variable predicted e-commerce adoption. The results in Table 7 reveal that all variables had statistically significant positive effects on e-commerce adoption ($p < 0.01$).

Table 7. Result of the regression

Variable	B	Std. Error	t	Sig
(Constant)	0.941	0.238	3.910	0.000
E-commerce adoption	0.190	0.041	2.870	0.001
Sustainable Digital Education	0.021	0.045	0.342	0.001
Technological Infrastructure	0.191	0.043	2.879	0.001
Organizational Readiness	0.261	0.026	9.089	0.000
Regulatory Support	0.211	0.037	5.176	0.000

The model confirms that organizational readiness had the strongest impact ($\beta = 0.261$), followed by regulatory support, technological infrastructure, and sustainable digital education, respectively. These findings support hypotheses H1 through H4.

6. Discussion of results

The findings of this study provide significant insights into the determinants of e-commerce adoption among SMEs in Jordan, interpreted through the integrated lens of the TOE model and the DOI theory. The results both corroborate and extend existing literature on digital transformation within emerging economies. Analysis of the data reveals a nuanced relationship between the independent variables and e-commerce adoption. A notable finding concerns sustainable digital education, which recorded the highest mean score ($M = 4.61$). This indicates a strong general awareness and perceived availability of digital training programs among the surveyed SMEs. However, its standardized regression coefficient ($\beta = 0.021$, $p = 0.001$) was the lowest among the predictors. This discrepancy suggests that while foundational digital education efforts are recognized, they may not be effectively translating into direct, measurable increases in e-commerce implementation. This points to a potential gap between theoretical knowledge and practical application, possibly arising from a misalignment between training content and the specific technical and strategic demands of operating an online commercial venture. This observation supports prior research by Al-Gasawneh & Al-Adamat [2], which emphasized the necessity for more applied, hands-on e-commerce training tailored to SME employees.

In contrast, technological infrastructure emerged as a statistically significant and more substantial predictor ($\beta = 0.191$, $p = 0.001$). This affirms that access to reliable internet services, affordable digital platforms, and integrated payment systems forms a critical foundation for e-commerce growth. This finding reinforces studies such as [29], which linked technological advancements like 5G expansion in Jordan with enhanced digital

business operations. Nevertheless, the moderate effect size implies that infrastructure, while necessary, is not a sufficient condition on its own and must be synergized with organizational and regulatory enablers.

The most influential factor identified in the model was organizational readiness ($\beta = 0.261$, $p < 0.001$). This result strongly echoes the TOE framework's emphasis on internal organizational capabilities. It confirms that SMEs characterized by digitally-oriented leadership, a skilled workforce, and dedicated financial resources for technological adoption are significantly more likely to integrate e-commerce solutions. This aligns with the conclusions of [5], who identified internal strategic resources as a primary source of sustained competitive advantage in digital markets.

Furthermore, regulatory support demonstrated a strong positive influence ($\beta = 0.211$, $p < 0.001$), ranking as the second most impactful predictor. This underscores the pivotal role of government action, including clear legal frameworks, business facilitation policies, and tangible incentives, in empowering SMEs to undertake the digital transition. This finding is consistent with recent regulatory initiatives documented by the Ministry of Digital Economy [23] and provides empirical support for the hypothesized influence of the regulatory environment (H4).

Collectively, the positive and statistically significant coefficients for all independent variables validate the proposed conceptual model. The results not only substantiate the theoretical foundations provided by the TOE and DOI frameworks but also offer practical confirmation that a synergistic enhancement of education, infrastructure, internal readiness, and policy support can effectively accelerate e-commerce integration in developing economies like Jordan. The strong correlation observed for regulatory support ($r = 0.514$) and the overall statistical significance of the regression model highlight an environment ripe for targeted policy and managerial interventions. These findings are particularly timely, given the post-COVID-19 digital acceleration and the strategic objectives outlined in the Jordanian government's digital economy strategy for 2023–2025.

7. Conclusion

This study investigated the role of sustainable digital education, technological infrastructure, organizational readiness, and regulatory support in promoting e-commerce adoption among SMEs in Jordan. Grounded in the TOE framework and the DOI theory, the empirical results confirm that all four variables significantly and positively influence the level of e-commerce integration.

The findings offer critical theoretical and practical implications. Theoretically, this research extends the TOE framework by empirically validating its constructs within the unique context of Jordanian SMEs, characterized by distinct infrastructural, organizational, and regulatory dynamics. It also refines the application of Rogers' DOI theory by demonstrating that for educational interventions to effectively influence adoption, they must achieve a threshold of contextual and applied relevance beyond mere availability.

Practically, the results provide clear guidance for various stakeholders. For policymakers, the strong influence of regulatory support underscores the need for targeted reforms, such as introducing tax incentives, simplifying e-commerce registration processes, and enacting robust digital consumer protection laws, to accelerate adoption. Furthermore, government programs should specifically aim to bridge the identified gap between generic digital training and the practical skills required for implementation. For SME owners and managers, the paramount importance of organizational readiness indicates that strategic investments in cultivating digital leadership and enhancing workforce digital skills are likely to yield the highest returns in e-commerce success. For educators and training institutions, there is a pressing need to move beyond general digital literacy and design practical, focused modules that address real-world e-commerce challenges, such as managing online inventory, executing digital marketing campaigns, and providing remote customer service. Finally, for technology providers, the findings highlight a market opportunity to develop and offer affordable, localized e-commerce platforms and to seamlessly integrate widely accessible mobile payment solutions, thereby reducing the technical and financial barriers that hinder smaller businesses from transitioning online.

Declaration of competing interest

The authors affirm that no financial or personal relationships have influenced the research process or outcomes presented in this manuscript. All aspects of the study, including data collection, analysis, and interpretation, were conducted with complete academic integrity.

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Author contributions

Dr. Mohammadnour Mosbah Aljarrah – Conceptualization, Methodology, Supervision, Writing – Review & Editing. Khaled Yousef Issa Alshboul – Data Collection, Formal Analysis, Visualization. Dr. Reham Abu Ghaboush – Literature Review, Writing – Original Draft Preparation. Hazem Almahameed – Data Curation, Software, Validation. Dr. Amer Ahmad Hatamleh – Project Administration, Supervision, Writing – Review & Editing (Corresponding Author). Mohammad Issa Alzoubi – Investigation, Resources, Data Management.

Ethical approval statement

This study was conducted in accordance with standard ethical research principles. In line with our institution's policies, formal ethical approval is not required for studies of this nature. Nevertheless, all recognized ethical guidelines for academic research were strictly followed throughout the investigation.

Informed consent

Informed consent was obtained from all participants involved in this study prior to data collection. The research objectives and procedures were clearly explained to all participants, and they voluntarily agreed to participate. The confidentiality and anonymity of all respondents have been maintained throughout the research process, in accordance with standard ethical research practices.

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