

Online Commerce Adoption and Smart Supply Chain Modernization: Empirical Evidence from Saudi Arabia's Retail Sector

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Abstract

The retail sector in Saudi Arabia is experiencing swift digital transformation in accordance with the national Vision 2030 initiative. This study examines the influence of online commerce adoption on the modernization of smart supply chains in retail and distribution industry. A quantitative methodology utilizing SPSS and Partial Least Squares Structural Equation Modeling (PLS-SEM) was employed to gather data from 50 managerial participants. The empirical results indicate that the introduction of online commerce substantially boosts technical integration, hence improving the performance of smart supply chains. Furthermore, organizational readiness was identified as a moderating factor in the association between technological integration and supply chain results. The findings indicate that managerial commitment and cultural alignment are critical facilitators of digital supply-chain success.

Keywords: E-commerce, Smart Supply Chain, Digital Marketing, Technological Integration.

1. Introduction

The swift advancement of e-commerce has significantly transformed global supply chain dynamics, promoting a transition from conventional, linear systems to digitally interconnected, data-driven, and adaptable networks. As companies increasingly depend on digital platforms for procurement, logistical coordination, and customer engagement, supply chain activities are becoming more interconnected and technologically advanced (Ivanov & Dolgui, 2020; Christopher, 2016). The integration of e-commerce and supply-chain technologies has expedited the implementation of automation, real-time analytics, and cloud-based solutions that improve transparency and responsiveness (Dubey et al., 2021). This change is a critical catalyst for economic diversification and digital competitiveness in emerging economies. E-commerce and logistics are acknowledged as fundamental components of this agenda, facilitating sustainable growth and enhanced service delivery (Al-Khalid, 2022; Alshahrani & Hung, 2023).

Notwithstanding this advancement, some firms persist in encountering integration difficulties between e-commerce technologies and traditional supply chain processes. These challenges frequently arise from disjointed technology frameworks, inadequate data analytics proficiency, and a lack of managerial preparedness to successfully execute digital transformation (Li et al., 2020; Dubey et al., 2022). Consequently, companies jeopardize the optimal exploitation of e-commerce's strategic capabilities, particularly with logistics coordination and decision-making

responsiveness. This study investigates the impact of online commerce adoption on the modernization of smart supply chains, emphasizing the mediating effect of technical integration and the moderating function of organizational readiness. Intelligent supply chains are defined by automation, connection, and cognitive capabilities, allowing organizations to utilize real-time data for anticipatory decision-making (Ivanov et al., 2019; Wamba et al., 2020). Moreover, e-commerce produces ongoing streams of transactional and behavioral data that when adeptly integrated—can transform forecasting, inventory management, and logistics coordination (Nguyen & Kim, 2020). Nonetheless, the mere acceptance of technology is inadequate. Effective digital transformation necessitates managerial commitment, leadership involvement, and an organizational culture that fosters learning and innovation (Tornatzky & Fleischer, 1990; Yu et al., 2023). Organizations demonstrating elevated readiness are more equipped to synchronize personnel, processes, and technologies to attain enduring operational excellence.

This study intends to:

- Analyze the influence of online commerce implementation on the efficacy of smart supply chains.
- Examine the intermediary function of technological integration.
- Evaluate the extent to which organizational preparation influences the relationship between technological integration and supply chain performance.

This research enhances both scholarly discourse and management application in significant ways. Initially, it amalgamates the Technology–Organization–Environment (TOE) paradigm with the Resource-Based View (RBV) to elucidate how the adoption of online commerce propels the modernization of intelligent supply chains. This study integrates many theoretical approaches to provide thorough knowledge of the interplay between technological, organizational, and strategic resources in promoting supply-chain innovation. Secondly, it offers empirical evidence from the retail sector, where internet business models are nascent yet rapidly proliferating. This context provides critical insights into how companies in growing digital marketplaces convert e-commerce adoption into measurable performance results.

The paper presents a moderation-based conceptual model that illustrates the dynamic interaction among technological integration, organizational readiness, and performance enhancement. This paradigm emphasizes that mere technology adoption does not ensure success; rather, it is the congruence of preparedness and resources that dictates the extent of transformational advantages. The report provides actionable insights for executives leading digital transformation efforts in the logistics and retail industries. It emphasizes the necessity for leadership dedication, interdisciplinary collaboration, and ongoing investment in technology competencies to attain quantifiable outcomes.

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73 2. Literature Review

74 2.1 Online Commerce and Supply Chain Modernization

75 E-commerce has fundamentally transformed the dynamics of global supply networks. It
76 promotes an uninterrupted exchange of information between companies and clients, fostering
77 more agile, transparent, and data-informed operations. Christopher (2016) asserts that internet
78 commerce improves coordination and reduces inefficiencies by digitizing procurement and
79 order fulfillment procedures. Ivanov et al. (2019) assert that the integration of e-commerce with
80 logistical operations enhances supply chain agility and responsiveness, especially in the context
81 of market instability.

82 2.2 Integration of Technology

83 Technological integration is the degree to which diverse digital systems such as Enterprise
84 Resource Planning (ERP), Customer Relationship Management (CRM), Warehouse Management
85 Systems (WMS), and Internet of Things (IoT) platforms are networked to facilitate real-time
86 decision-making. Lee (2017) contends that effective integration improves coordination,
87 diminishes lead times, and fosters automation throughout the supply chain.

88 This study suggests that technological integration serves as a mediating factor, converting online
89 commerce acceptance into quantifiable enhancements in supply-chain performance.

90 2.3 Organizational Preparedness

91 Organizational readiness refers to the extent to which a firm's internal resources, leadership
92 commitment, and cultural orientation enable it to adopt, implement, and sustain technological
93 innovation effectively. Tornatzky and Fleischer (1990) conceptualize readiness as the
94 convergence of strategic intent, resource availability, and technological awareness, emphasizing
95 that successful digital transformation depends not only on technological capacity but also on
96 the organization's ability to align people and processes with innovation objectives.

97 2.4 Intelligent Supply Chain Efficacy

98 An intelligent supply chain utilizes new technologies such as automation, data analytics, and
99 artificial intelligence to attain enhanced flexibility, accuracy, and resilience. Ivanov et al. (2019)
100 characterize it as an adaptable network that can dynamically react to market fluctuations and
101 potential disruptions. Critical metrics of intelligent supply-chain efficacy encompass cost

efficiency, order precision, delivery velocity, and comprehensive reaction to demand variations. Saudi Arabia stands at the forefront of logistics and digital commerce transformation in the Middle East, demonstrating exceptional performance and technological maturity. The continuous enhancement of supply-chain intelligence aligns with Vision 2030's ambition to consolidate the Kingdom's position as a global hub for innovation, efficiency, and digital trade excellence.

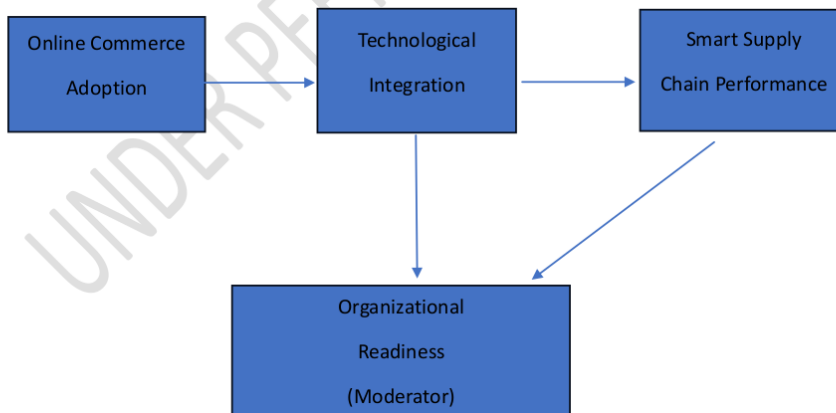
3. Conceptual Model and Hypotheses Development

Drawing upon the **Technology–Organization–Environment (TOE) framework** and the **Resource-Based View (RBV)**, this study proposes a conceptual model linking online commerce adoption, technological integration, organizational readiness, and smart supply-chain performance.

Hypotheses:

- **H1:** Online commerce adoption positively influences technological integration.
- **H2:** Technological integration positively influences smart supply-chain performance.
- **H3:** Organizational readiness moderates the relationship between technological integration and smart supply-chain performance.
- **H4:** Online commerce adoption positively influences organizational readiness.

Figure 1. Conceptual Model Of Online Commerce Adoption and Smart Supply Chain Modernization



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This study adopts a quantitative, cross-sectional research design to examine the relationships among online commerce adoption, technological integration, organizational readiness, and smart supply-chain performance. The research follows a deductive approach, whereby hypotheses are developed from established theoretical frameworks and empirically tested through statistical modeling. Data analysis was conducted using a combination of descriptive statistics (via SPSS Version 27) and Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4. This dual-analytic approach enables both preliminary assessment of data characteristics and rigorous testing of causal relationships among multiple latent constructs. Such a design is particularly well suited for capturing managerial perceptions of digital transformation and for exploring the complex interdependencies that exist between technological, organizational, and performance variables in supply-chain contexts.

4.2 Sampling and Data Collection

The target population included managers working in a Saudi retail and distribution company.

A purposive sampling technique was used to select respondents directly involved in digital operations, supply chain, IT, logistics, and marketing. Out of 60 distributed questionnaires, 50 complete responses were received (83% response rate).

4.3 Research Instrument

The structured questionnaire consisted of five sections:

1. **Online Commerce Adoption (OCA)** – measured with 5 items adapted from **Zhu & Kraemer (2005)** (e.g., “Our company uses online platforms to manage transactions and customer data”).
2. **Technological Integration (TI)** – measured with 6 items from **Lee (2017)** (e.g., “Our systems integrate sales and logistics data in real time”).
3. **Organizational Readiness (OR)** – measured with 4 items based on **Tornatzky & Fleischer (1990)** (e.g., “Top management supports digital transformation initiatives”).
4. **Smart Supply Chain Performance (SSCP)** – measured with 5 items adapted from **Ivanov et al. (2019)** (e.g., “Our supply chain responds rapidly to demand fluctuations”).

All items used a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

4.4 Reliability and Validity

A pilot test involving ten managers was conducted to verify the clarity, comprehensibility, and reliability of the survey instrument. Based on the feedback received, minor adjustments were made to the phrasing of several items to enhance accuracy and contextual relevance.

17

All constructs demonstrated adequate internal consistency, with Cronbach's alpha coefficients exceeding the 0.70 threshold, confirming satisfactory reliability. Moreover, content validity was established through expert evaluation by two scholars in supply-chain management and one senior industry professional in logistics operations. Their feedback confirmed that the measurement items effectively captured the intended constructs and were contextually appropriate for the retail environment.

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Table 1. Reliability and Validity Statistics

Construct	Cronbach's α	Composite Reliability	Average Variance Extracted (AVE)
Online Commerce Adoption (OCA)	0.87	0.9	0.65
Technological Integration (TI)	0.89	0.91	0.63
Organizational Readiness (OR)	0.84	0.88	0.61
Smart Supply Chain Performance (SSCP)	0.86	0.89	0.67

All Average Variance Extracted(AVE) values exceeded 0.50, confirming convergent validity across the constructs. As shown in Table 1, the Cronbach's alpha coefficients surpass the conventional 0.70 benchmark, while the composite reliability (CR) values exceed 0.85, indicating strong internal consistency and coherence. The AVE values, ranging from 0.61 to 0.67, further support the convergent validity of the measurement model. Collectively, these results confirm that the instrument is both reliable and valid, providing a robust foundation for subsequent structural analysis.

4.5 Data Analysis Procedures

The data analysis was conducted in two sequential stages to ensure both the robustness and interpretability of results. In the first stage, descriptive and preliminary analyses were performed using SPSS (Version 27). This stage involved generating demographic statistics (means and

frequency distributions) to summarize the characteristics of the sample, followed by correlation analysis to explore initial relationships among the study constructs. The reliability of each construct was further assessed through Cronbach's alpha coefficients to confirm internal consistency.

In the second stage, Partial Least Squares Structural Equation Modeling (PLS-SEM) was conducted using SmartPLS 4 to examine hypothesized relationships. The analysis began with an assessment of the measurement model, including evaluations of factor loadings, Average Variance Extracted (AVE), and Composite Reliability (CR), to establish construct validity. Subsequently, the structural model was evaluated to test the proposed hypotheses by examining path coefficients, t-values, and R² values. The moderating effect of Organizational Readiness was tested using an interaction term to determine whether readiness influences the strength of the relationship between technological integration and smart supply-chain performance. Model fit was assessed using the Standardized Root Mean Square Residual (SRMR), with values below 0.08 indicating acceptable fit. The statistical significance of the hypothesized paths was established through bootstrapping with 5,000 resamples.

5. Results and Analysis

5.1 Descriptive Statistics

The descriptive statistics were computed to provide an overview of the respondents' perceptions of online commerce adoption, technological integration, organizational readiness, and smart supply-chain performance. As presented in Table 2, the mean scores and standard deviations reflect generally positive managerial attitudes toward digital transformation and its impact on supply-chain modernization.

Table 2. Descriptive Statistics of Constructs

Construct	Mean	Standard Deviation (SD)
Online Commerce Adoption (OCA)	4.12	0.51
Technological Integration (TI)	4.06	0.57
Organizational Readiness (OR)	3.98	0.6
Smart Supply Chain Performance (SSCP)	4.21	0.49

Overall, the results suggest that managers perceive online commerce adoption as a key enabler of enhanced supply-chain visibility and responsiveness, consistent with the growing role of digital platforms in optimizing operations and customer service.

5.3 Correlation Analysis

Correlation analysis was conducted to examine the preliminary relationships among the key constructs. The results, summarized in Table 3, reveal significant positive associations across all variables at the $p < 0.01$ level.

Table 3. Correlation Matrix

Variable	OCA	TI	OR	SSCP
OCA	1	—	—	—
TI	0.68**	1	—	—
OR	0.59**	0.62**	1	—
SSCP	0.55**	0.72**	0.66**	1

($p < 0.01$)

The strongest correlation was observed between Technological Integration (TI) and Smart Supply Chain Performance (SSCP) ($r = 0.72$), underscoring the pivotal role of technological connectivity in driving superior operational outcomes and digital performance improvements.

5.4 PLS-SEM Measurement Model

The measurement model was evaluated to ensure construct validity and reliability. All factor loadings exceeded 0.70, while Average Variance Extracted (AVE) values were above 0.50 and Composite Reliability (CR) scores surpassed 0.80 for all constructs. Discriminant validity was assessed using the Fornell–Larcker criterion, which confirmed that the square root of each construct's AVE was greater than its correlations with other constructs, demonstrating conceptual distinctiveness.

The model fit indices indicated satisfactory goodness of fit, with $SPMR = 0.061$ and $NFI = 0.91$, both within the recommended thresholds. These findings confirm that the measurement model exhibits strong reliability and validity.

5.5 Structural Model Results

The structural model was analyzed to test the hypothesized relationships among the study variables. The path coefficients, along with their associated t -values and p -values, are presented in Table 4.

236

237 **Table 4. PLS Path Coefficients**

Hypothesis	Path	β	t-value	p-value	Result
H1	OCA $\rightarrow$ TI	0.68	9.42	<0.001	Supported
H2	TI $\rightarrow$ SSCP	0.47	6.35	<0.001	Supported
H3	OR $\times$ TI $\rightarrow$ SSCP	0.19	2.74	0.007	Supported
H4	OCA $\rightarrow$ OR	0.55	7.83	<0.001	Supported

238 **R² Values:**

- 239 • Technological Integration (TI) = 0.46
 240 • Smart Supply Chain Performance (SSCP) = 0.59

241 The findings demonstrate that the adoption of online commerce and organizational readiness
 242 collectively account for 59% of the variance in smart supply chain performance. This significant
 243 explanatory capacity underscores the critical role of both technological and organizational
 244 elements in realizing effective digital transformation in the retail industry.

245

246 **6. Discussion**

247 This study's findings offer robust empirical evidence for the notion that the adoption of online
 248 commerce facilitates technology integration, hence substantially enhancing smart supply-chain
 249 performance. This link highlights the pivotal function of digital platforms in facilitating the
 250 alignment of sales, logistics, and customer service operations. The moderating effect of
 251 organizational readiness was statistically significant, indicating that the performance advantages
 252 of technological integration are largely contingent upon internal organizational
 253 capabilities—specifically managerial commitment, employee competence, and an innovative
 254 culture. Companies demonstrating elevated degrees of preparedness are more adept at
 255 deriving enhanced value from their digital investments. These findings strongly correspond with
 256 the Technology–Organization–Environment (TOE) framework and the Resource-Based View
 257 (RBV) paradigm, both of which underscore that technology alone is inadequate for attaining
 258 sustainable change without supplementary organizational resources.

259

260

261 6.1 Theoretical Implications

262 This research enhances current thinking in two significant manners. It empirically illustrates that
263 internet commerce serves as a technical facilitator for the modernization of smart supply
264 chains, especially in emerging economies. Secondly, by integrating organizational readiness as a
265 moderating variable, the research enhances the conceptual framework of the TOE model,
266 demonstrating that technology adoption outcomes depend on the unique preparation levels of
267 firms rather than being consistent across all businesses. The findings confirm that the successful
268 application of technology requires managerial commitment, cultural alignment, and efficient
269 resource allocation to achieve significant performance results. The findings align with the
270 assertions of Tornatzky and Fleischer (1990) and Al-Khalid (2022), highlighting that effective
271 digital transformation relies equally on organizational context and technology capacity.

272 6.2 Practical Implications

273 From a managerial perspective, the results indicate that effective digital transformation
274 necessitates both technological investments and significant organizational readiness. Managers
275 ought to prioritize the subsequent actions:

- 276 • Facilitate interdepartmental collaboration among marketing, logistics, and IT to achieve
277 cohesive digital operations.
- 278 • Establish ongoing training initiatives to improve staff expertise in e-commerce platforms,
279 data analytics, and automation technologies.
- 280 • Synchronize digital initiatives with strategic goals and implement quantifiable key
281 performance indicators (KPIs) to monitor advancement.
- 282 • Promote leadership involvement to cultivate an innovation-driven culture and maintain
283 digital transformation initiatives.

285 6.3 Managerial Implications

286 Online commerce should be viewed not merely as a sales tool but as a strategic catalyst for
287 organizational change and supply chain optimization. Integrating digital platforms with
288 fundamental operational systems—such as inventory management, enterprise resource
289 planning (ERP), and logistics management—allows organizations to achieve real-time data
290 visibility, predictive analytics, and expedited decision-making. This integration mitigates
291 inefficiencies, enhances forecast precision, and establishes agile, customer-focused supply
292 chains that can swiftly adapt to market changes. Organizational readiness fundamentally
293 originates with individuals. Managers must foster an environment of innovation and learning

that promotes experimentation and interdisciplinary collaboration. Employees must be enabled to cultivate digital competencies, adopt technology advancements, and participate in ongoing enhancement. Transformational leadership, defined by inspiration, trust, and empowerment, is essential for motivating employees and improving their preparedness for change. Ultimately, effective digital transformation relies on the congruence of technology, personnel, and strategy. Organizations that integrate investment in modern technologies with robust leadership and a proficient, adaptive staff are more likely to attain sustainable competitive advantage and enduring supply-chain resilience.

7. Conclusion

²¹ This study examined the role of online commerce adoption in the modernization of smart supply chains, highlighting the moderating effect of organizational readiness. Survey data from management respondents indicate that the implementation of online commerce greatly promotes technology integration, hence improving supply-chain performance. The findings underscore three interconnected insights: technology adoption alone improves coordination and visibility; integration acts as the crucial link that converts digital investments into measurable performance improvements; and organizational readiness manifested through leadership commitment, employee development, and resource alignment ultimately dictates the success of digital transformation efforts.

²⁹ The study enhances the Technology Organization–Environment (TOE) and Resource-Based View (RBV) frameworks by illustrating that firm-specific skills enhance the advantages of technological innovation. The findings provide explicit direction for firms on structuring digital transformation initiatives to attain sustainable operational excellence from a managerial perspective. Subsequent study ought to broaden these findings by integrating environmental and regulatory factors, analyzing many industries to improve generalizability, and utilizing longitudinal or mixed-method approaches to document the changing dynamics of readiness and change management across time. The report emphasizes that the transition to intelligent, technology-driven supply chains relies not only on the use of digital tools but also on the organizational ability to integrate, adapt, and innovate essential for companies aiming for resilience and competitiveness in the digital age.

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