Application of Artificial Intelligence in Automation of Supply Chain Efficiency in Oman

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ABSTRACT

Oman's supply chain sector is currently facing increasing pressure to improve efficiency due to rising demand, rapid digitalization, and growing expectations for faster and more reliable logistics services. However, many organizations continue to struggle with limited adoption of advanced technologies and varying levels of organizational readiness. In response to these challenges, this study investigates how Artificial Intelligence Technologies (AIT) and the Level of Automation (LOA) influence supply chain efficiency (SCE), and whether Organizational Readiness (OREAD) moderates these relationships. Data were collected via structured questionnaires distributed to 350 participants, including verified supply chain experts accessed through Oman's Ministry of Labour and employees in supply chain roles reached through social media platforms, ensuring both expertise and broad representation. Regression analysis was conducted using SPSS/AMOS to test the proposed hypotheses. The results show that both AIT and LOA have significant positive effects on SCE, and that OREAD strengthens these relationships by enhancing the effectiveness of technology adoption. These findings suggest that organizations in Oman's public and private sectors can improve supply chain performance by integrating AI and automation, particularly when supported by strong organizational readiness. This study contributes to the supply chain management literature by providing empirical evidence on the direct and moderated effects of AIT and LOA on SCE, emphasizing the crucial role of organizational readiness in maximizing technological benefits.

Keywords
Artificial Intelligence technologies; Level of automation; Supply chain efficiency

Introduction

The contemporary business landscape is changing faster than ever before due to the rapid development of technology, globalization, and rising competition (Amankwah-Amoah et al., 2021).One of the most important among these developments is Artificial Intelligence (AI), a technology that is transforming industries and changing the way companies have done business until now (Costa-Climent et al., 2024). AI has the potential to become one of a few key technologies that fundamentally change supply chain management, empowering the industries and companies that successfully deploy them (Danach et al., 2024). It's a well-established fact that organizations around the world are progressively using AI to outpace competitors, improve service delivery and meet increasing consumer demands (Wamba et al., 2023). AI in supply chain management (SCM) can offer significant benefits to organizations, particularly for Oman, which is trying to diversify its economic orientation following the Vision 2040 agenda and enter SCM to become a world logistics center (Abdelfattah et al., 2023).This study explores the role of AI through mechanisms based on their applications of supply chain processes and how they can help improve overall supply chain efficiency in the context of Oman.

AI technologies have revolutionized the supply chain efficiency across the globe (Belhadi et al., 2024; Modgil et al., 2022). AI has emerged as a foundation for smarter and more agile supply chain networks extending from demand forecasting, inventory management, logistics optimization, to process automation (Modgil et al., 2022). In fact, the

logistics industry is a key driver of the national economy in Oman, along with significant share of the GDP and labour force (Awain & Mohsin, 2022). With the understanding of the strategic significance of logistics, Oman has made significant investments in infrastructure development and policy reforms to establish a modern and efficient supply chain ecosystem (Jaboob et al., 2024).These initiatives demonstrate the country's commitment to developing AI, yet the application of AI-based solutions in Oman's supply chain industry is still at an early stage (Abdelfattah et al., 2023; Ba Awain et al., 2024; Khalifa et al., 2021). Such factors include organizational readiness, technology infrastructure, and workforce capability (AL-Shboul, 2024). In contrast, though global industries apply AI solutions to overcome supply chain complexities, Omani entities are still facing impediments such as expertise gaps, low automation levels, and resistance to change (Tan et al., 2022).

The purpose of this study is therefore to examine these challenges and to present evidence-based solutions, that facilitate the adoption of AI and subsequently enhance the efficiency of the supply chain process. These challenges are especially apparent in the implementation of AI in Oman's supply chain sector, as there is a growing need to understand how AI can be integrated in practice in Oman. While AI can increase efficiencies and reduce costs, Omani supply chains are far less automated than those in advanced economies. This is because of the technology adoption gaps, the low organizational readiness, and the absence of AI-driven measures and management frameworks. Additionally, the relationship between AI technologies, the level of automation, and organizational readiness in emerging economies such as Oman is yet to be thoroughly examined. This study aims to achieve several objectives to address these challenges. By examining how AI technologies can streamline processes, optimize network design, and facilitate better decision-making, the study aims to understand the potential effects of AI in improving supply chain efficiency in Oman. It further explores the critical role of automation levels with the supply chain and how organizational readiness moderates the impact of AI technologies on supply chain efficiency. The recommendations that will be gathered through the study will help these organizations to adopt AI in an efficient manner to compete in the global market.

Supply chain efficiency (SCE) strengthens supply chain resilience by bringing intrinsic quality vitality and high-quality development in filling the gap between globalization and market uncertainties. However, the lack of quality management efficiency among supply chain companies, the information asymmetry, inaccurate demand forecasting and mismatch between supply and demand of upstream and downstream companies have made supply chain financing performance deteriorate and inventory excessive, which hinders the SCE (Lu et al., 2023).

SCE in digital platforms is high because individual digitalization of an enterprise is less efficient for synergistic effects across a supply chain, making good information sharing mechanisms between enterprises important for effective SCE at a scale in the digital era (Nayal et al., 2022). In order to stay competitive and satisfy customer expectations, logistics companies across the globe are investing in innovative technologies and digitization programs. These technologies have improved visibility, operational efficiency, and data-driven decision-making through real-time tracking, predictive analytics, autonomous vehicles, and smart warehousing.

Omani logistics market is also going through a parallel transformation to comply with international best practices. Addressing the importance of a strong logistics sector for economic diversification and sustainable growth, Oman Global Logistics Group (OGL) had introduced the Sultanate of Oman Logistics Strategy 2040 (SOLS 2040)(Arnold, 2009). While the automatic identification system has been an integral part of real-time data in the shipping industry, many seaports have yet to adopt a more traditional approach. Around 80% of the seaports managed marine services even in Oman in the year 2021 (Komaromi et al., 2022)

This research is expected to make significant contributions to both academia and practice. From an academic perspective, it addresses a critical gap in the literature by exploring the role of organizational readiness as a moderating factor in the relationship between AI technologies and supply chain efficiency. This novel approach provides new insights into the conditions necessary for successful AI adoption and offers a framework that can be applied to other emerging economies facing similar challenges. Practically, the findings of this study serve as a valuable resource for policymakers, industry leaders, and supply chain practitioners in Oman. By identifying the enablers and barriers to AI adoption, the study offers strategic guidance for leveraging AI to drive operational excellence, foster innovation, and enhance economic growth. Moreover, the research contributes to Oman's broader efforts to establish itself as a global logistics hub, aligning with the nation's Vision 2040 goals and ensuring its long-term economic sustainability in a highly competitive global market.

Literature Review and Hypotheses Building

AI Technologies and Supply Chain Efficiency

New-generation digital technologies are increasingly shaping supply chain systems by improving data sharing, connectivity, and operational visibility (Yang et al., 2021; Colicchia et al., 2019). These advancements reduce response latency to market demand fluctuations, enabling more efficient supply chain processes.

Artificial Intelligence (AI) plays a critical role in transforming supply chain management (SCM) by enhancing efficiency, resilience, and sustainability. AI technologies, such as machine learning and predictive analytics, improve demand forecasting accuracy, optimize inventory management, and streamline logistics operations (Pan et al., 2024; Zhang et al., 2024). Empirical studies demonstrate that AI integration can lead to significant operational improvements, including cost savings and better forecasting performance (Borah et al., 2024). Additionally, AI supports sustainable supply chains by minimizing waste, reducing energy consumption, and lowering carbon emissions (Gupta & Sharma, 2023; Gupta et al., 2022).

Key applications of AI in SCM include intelligent supply chain planning, predictive maintenance, and blockchain integration, which enhance transparency and security (Vandana et al., 2024). While challenges such as data privacy and ethical considerations exist (Eyo-Udo et al., 2024), the overall impact of AI on supply chain performance is overwhelmingly positive, providing organizations with enhanced decision-making capabilities and adaptability to dynamic market conditions (Lin et al., 2024; Mohsen, 2023). Based on the literature, it is proposed that:
H1: AI technologies have a positive relationship with supply chain efficiency.

Level of Automation and Supply Chain Efficiency

Automation is a key driver of supply chain efficiency, enabling organizations to streamline operations, reduce errors, and enhance decision-making. While digitalization broadly refers to the adoption of digital technologies across business processes, automation specifically focuses on using technology to perform tasks with minimal human intervention. Increasing levels of automation have been shown to improve supply chain performance and overall economic outcomes (Kelly Weeks et al., 2022).

Intelligent automation, which integrates AI, machine learning (ML), and the Internet of Things (IoT), further optimizes processes and supports strategic decision-making (Gomes et al., 2024). Empirical studies indicate that automation reduces manufacturing costs, minimizes human errors, and accelerates time-consuming processes, thereby enhancing operational efficiency (Andiyappillai, 2021). In sectors such as telecommunications, automated spend analysis has been demonstrated to significantly improve supply chain efficiency. Moreover, frameworks identifying key application areas and antecedents for successful automation highlight the importance of structured implementation strategies (Nitsche et al., 2021).

Digital technologies such as AI and cloud computing complement automation by enabling better integration and coordination across supply chain functions. However, challenges in adoption, including technological readiness and workforce adaptation, necessitate the application of best practices to ensure successful implementation (Simchi-Levi & Timmermans, 2021; Srivastava et al., 2024). Based on these insights, the following hypothesis is proposed:
H2: Level of automation has a positive relationship with supply chain efficiency.

The Moderating Effect

Organizational Readiness as a Moderator Between AI Technologies and Supply Chain Efficiency

Recent research highlights the transformative potential of AI in enhancing supply chain management (SCM) efficiency and resilience. AI technologies, including machine learning, robotics, and predictive analytics, are increasingly leveraged to improve demand forecasting, inventory management, and logistics optimization (Eyo-Udo et al., 2024; Joel et al., 2024).

Organizational readiness, encompassing technological infrastructure, human resource capabilities, and strategic alignment, is identified as a critical factor for successful AI adoption in SCM (Balaji, 2023; Sharabati et al., 2024). Studies emphasize that organizations with strong digital competencies, structured processes, and supportive regulatory frameworks are better positioned to integrate AI effectively, thereby enhancing supply chain efficiency (Alhasawi et al., 2023; Hartley & Sawaya, 2019).

Organizational readiness moderates the relationship between AI technologies and supply chain efficiency by amplifying the positive effects of AI. For instance, even highly advanced AI systems may fail to deliver expected benefits without adequate training, supportive organizational culture, or strategic alignment. Conversely, firms with high readiness can leverage AI to improve decision-making, operational efficiency, and sustainability practices (Ali et al., 2024). Nevertheless, challenges such as data privacy concerns, ethical considerations, and change management issues must be addressed to realize the full potential of AI (Shahzadi et al., 2024). Based on these insights, the following hypothesis is proposed:
H3: Organizational readiness positively moderates the relationship between AI technologies and supply chain efficiency.

Organizational Readiness as a Moderator Between Level of Automation and Supply Chain Efficiency

The level of automation in supply chains significantly affects operational efficiency and overall performance, but its effectiveness often depends on the organization's readiness to adopt and utilize these technologies (Malik & Pasha, 2022). Organizational readiness can be conceptualized along three main dimensions: technological readiness (e.g., IT infrastructure, software systems), structural readiness (e.g., process alignment, organizational policies), and human resource readiness (e.g., employee training, management support) (Tiwari, 2022; Tiwari et al., 2023).

Empirical studies indicate that firms with higher technological and human resource readiness are more successful in implementing automation solutions such as robotic process automation, AI/machine learning, and blockchain in their supply chains (Glenn Richey Jr & Autry, 2009; Hartley & Sawaya, 2019; Nitsche et al., 2021). Such readiness enables organizations to optimize workflows, reduce errors, and improve decision-making, amplifying the positive effects of automation on supply chain efficiency. Additionally, external contingencies, including disruptions like the COVID-19 pandemic, highlight the importance of organizational flexibility and preparedness in technology adoption decisions.

Thus, organizational readiness not only facilitates the successful deployment of automation technologies but also strengthens their impact on supply chain efficiency by ensuring proper integration, training, and strategic alignment (Weeks et al., 2022). Based on these insights, the following hypothesis is proposed:
H4: Organizational readiness positively moderates the relationship between the level of automation and supply chain efficiency.
Figure I present the conceptual framework of the study, which depicts the various relationships studied.

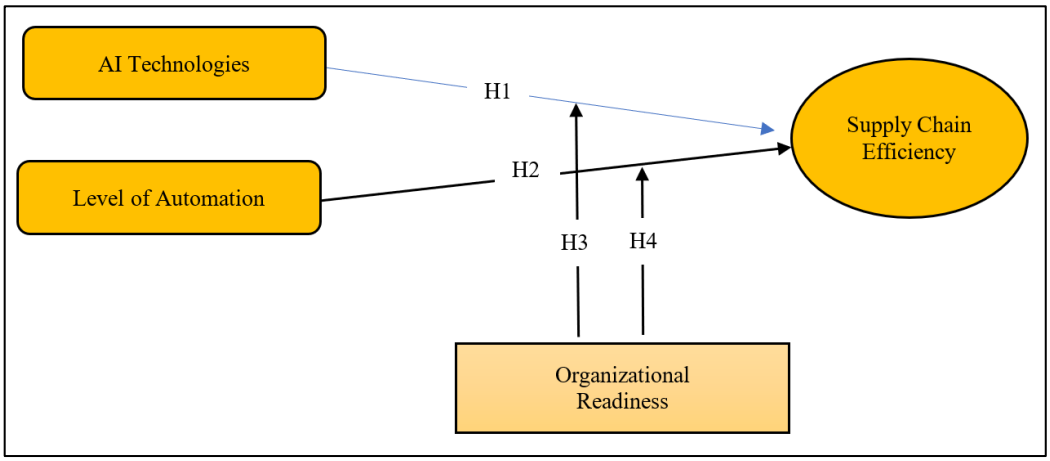

Figure 1. Conceptual Framework
(Source: Adapted from Pournader, et al, 2021

Methodology

Population and Sample

The study adopts a quantitative research approach to examine how the use of Artificial Intelligence (AI) in automating supply chain processes can enhance supply chain efficiency in Oman. The research framework investigates the relationships among AI technologies, automation, organizational readiness, and supply chain efficiency.

The population of the study comprises employees working in supply chain management roles across public and private sector organizations in Oman. Based on national employment records and industry estimates, this population is approximately 4,000 employees.

To obtain a representative and unbiased sample, the study used a simple random sampling approach. This technique was selected because it allows every individual in the population to have an equal probability of being chosen. As a result, it reduces selection bias and helps capture the full diversity of supply chain professionals, including differences in experience, job positions, and organizational backgrounds

The sample size of 350 respondents was determined using Cochran's sample size formula for large populations, with a 95% confidence level and a 5% margin of error. This sample size is considered sufficient to produce statistically significant findings while remaining practical in terms of time and resource constraints.

Data were collected through an online survey, distributed via official communication channels of the Ministry of Labour as well as professional social media platforms commonly used by supply chain employees in Oman (such as LinkedIn and specialized professional groups). The online mode was selected to maximize reach, improve accessibility for geographically dispersed respondents, and reduce administrative limitations. However, online data collection may introduce response bias, such as self-selection bias, where individuals with stronger interest in the topic may be more likely to participate. To mitigate this risk, reminders were distributed at regular intervals, participation was kept anonymous, and the survey was shared across multiple platforms to ensure broader representation.

Overall, the sampling strategy and data collection methods were designed to provide a diverse and representative dataset that captures the perspectives of supply chain professionals from different sectors within Oman.

Questionnaire Design

A structured questionnaire was developed to measure the key constructs of this study, including the introduction of AI technologies, degree of automation, organizational readiness, and supply chain performance. The questionnaire utilized a 5-point Likert scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree. A 5-point scale was selected because it is commonly used in organizational and supply chain research, reduces respondent cognitive load, and provides sufficient variability for statistical analysis.

All questionnaire items were adapted from validated instruments in previous studies, with modifications to fit the context of AI integration and supply chain operations in Oman. Items related to AI adoption and degree of automation were adapted from recent Industry 4.0 adoption literature, organizational readiness items were based on technology readiness and digital transformation studies, and supply chain performance items were adapted from prior logistics and operations management research. Any additional questions developed specifically for this study were constructed to align with established conceptual definitions.

To ensure content validity and clarity, the questionnaire underwent a two-step validation process: (1) Expert Review: The initial draft was reviewed by three experts in supply chain management and information systems to evaluate item relevance, wording, and construct alignment. (2) Pilot Testing: A pilot test with 20 respondents from Omani MSMEs was conducted to assess reliability and clarity. Necessary adjustments were made based on participant feedback and preliminary reliability analysis (Cronbach's α).

After data was collected, the responses were analysed using appropriate statistical techniques to evaluate the hypothesized relationships among the variables. The phrase "methods used to collect data are then analysed" has been

revised for clarity: the collected responses were systematically coded, cleaned, and processed using quantitative analysis procedures. All detailed item measurements for each construct are presented in Table 1.

Table 1 Items for Construct Measurement

Variable	Items	Measure	Reference
AI Technologies (AIT)	AIT-1	Our organization uses predictive analytics for demand forecasting.	Pournader et al., 2021
	AIT-2	Machine learning algorithms are implemented to optimize inventory management.	
	AIT-3	AI-powered tools help in supplier selection and evaluation	
	AIT-4	Robotics or automated systems are used in warehouse operations.	
	AIT-5	Chatbots or virtual assistants are used for customer interactions in the supply chain	
Level of Automation (LOA)	LOA-1	Most repetitive tasks in the supply chain are fully automated	Vagia et al., 2016)
	LOA-2	Automated tools are used to track and manage inventory levels	
	LOA-3	Order processing is handled efficiently using automated systems.	
	LOA-4	Supplier communication is managed through automated channels.	
	LOA-5	AI-driven automation has reduced the manual workload in supply chain operations.	
Organizationa l Readiness (OREAD)	OREAD-1	Our organization has invested significantly in AI-related IT infrastructure.	Weiner, 2020)
	OREAD-2	Employees have received sufficient training to use AI tools effectively.	
	OREAD-3	There is a strong organizational commitment to adopting AI technologies.	
	OREAD-4	The organization has a clear strategy for implementing AI in supply chain management	
	OREAD-5	There is a readiness to embrace change and innovate using AI in our supply chain	
Supply Chain Efficiency (SCE)	SCE-1	Our supply chain ensures timely delivery of products to customers.	Pournader et al., 2021)
	SCE-2	Automation has helped reduce overall operational costs	
	SCE-3	There has been a significant reduction in errors during supply chain operations	
	SCE-4	Our organization achieves high levels of order accuracy	
	SCE-5	Lead times have improved significantly due to automation and AI integration.	

Data Analysis Techniques and Software

The study employed both descriptive and inferential statistical analyses. Descriptive statistics (means, standard deviations, and frequency distributions) were used to summarize respondent demographics and key study variables. Inferential techniques, including correlation analysis, reliability testing (Cronbach's alpha), validity assessment (EFA/CFA as applicable), and regression or structural equation modelling, were used to test the proposed hypotheses. All analyses were conducted using SPSS Version 26 for data cleaning, descriptive analysis, and reliability testing, while SmartPLS Version 4 was employed to assess the measurement model and test the structural relationships among the study constructs.

Result

Respondent Profile

The respondents' genders are displayed in Table 2. Of the 350 responders, 266 were men (76%), and 84 were women (24%). The plurality of respondents (42.3%) is between the ages of 36 and 45, followed by those between the ages of 25 and 35 (35.4%), 46 and 55 (11.4%), and over 55 (10.9%). The findings indicate that there is an even age distribution of the respondents.

Additionally, Tables 2 show the education qualification of the respondents. Of the 350 respondents, 28 have a secondary education, 200 have a diploma, 102 have a bachelor's degree. The greatest level of education among the respondents is a Diploma degree.

Regarding to respondent's position within the organization or public sector organization, most of employees, 39.7 percent (139) were dominated by head of department, followed by assistant manager with total number was 130 (37.1 percent) and manager position was 23.1 percent (81).

Table 2 also showed that the years of respondent's experience. Out of 350 respondents, 30 (8.6%) have 1-5 year working experience, 88 (25.1%) 6 -10 years' experience, 124 (35.4%) 11- 15-year experience and 108 (30.9%) more than 15 year working experience.

Table 2 Profile respondent

		Frequency	Percent
Gender	Male	266	76.0
	Female	84	24.0
	Total	350	100.0
Age	25 – 35 years	124	35.4
	36 – 45 years	148	42.3
	46 – 55 years	40	11.4
	Above 55	38	10.9
	Total	350	100.0
Qualification	Secondary education	28	8,00
	Diploma	200	57,14
	Bachelor	102	29,14
	Total	350	100.0
Position	Head of Department	139	39.7
	Manager	81	23.1
	Assistant Manager	130	37.1
	Total	350	100.0
Experience	1 – 5 years	30	8.6
	6 – 10 years	88	25.1
	11 -15 year	124	35.4
	More than 15 years	108	30.9
	Total	350	100.0

Validity Result

The results of the questionnaire assessment are presented in Table 3. Reliability was evaluated using Cronbach's Alpha to determine the internal consistency of the measurement items for each construct. The analysis produced the following Cronbach's Alpha values: 0.932 for AIT, 0.936 for LOA, 0.923 for OREAD, and 0.933 for SCE. All values exceed the commonly accepted threshold of 0.70, indicating high internal reliability for each scale.

For validity assessment, the study examined item loadings, average variance extracted (AVE), and composite reliability (CR) (reported in subsequent tables). All constructs met the recommended criteria, demonstrating that the questionnaire items are both reliable and valid for measuring the intended variables.

Table 3 Cronbach's alpha coefficients

Construct	Items	Mean	Variance	Cronbach's alpha (α)	Valid
AIT	AIT-1	4.70	1.25	0.932	Yes
	AIT-2				
	AIT-3				
	AIT-4				
	AIT-5				
LOA	LOA-1	4.65	0.98	0.936	Yes
	LOA-2				
	LOA-3				
	LOA-4				
	LOA-5				
OREAD	OREAD-1	4.22	1.48	0.923	Yes
	OREAD-2				
	OREAD-3				
	OREAD-4				
	OREAD-5				
	SCE-1	4.12	0.89	0.933	Yes

SCE	SCE-2				
	SCE-3				
	SCE-4				
	SCE-5				

Hypotheses Testing

Using AMOS software, this study estimated the measurement model and the structural model using the SEM approach. The correlation between items and constructs as well as the correlation between latent variables can be examined using SEM, a latent variable analysis technique (Bollen and Long, 1993). As a result, SEM can concurrently Examine a number of relationships between latent factors (Hair et al., 2010). All of the statistical issues in this investigation were estimated using the Amos software and SPSS.

According to H_1, H_2, it was found that AIT, LOA, have significant impact on the SCE. For AIT, this was true (H1, β=0.36); for LOA, it was true (H2, β =0.29). As seen in Table 4, these findings support the theories that AIT, LOA, have a favourable impact on SCE. The different hypothesis' interactions were important.

According to Hypotheses H_3, H_4, the study aimed to investigate how OREAD moderates the relationship between AIT, LOA, and SCE. The results suggest that OREAD favourably moderated the link between AIT, LOA on SCE, as shown in Table 4. It is implied that SCE encounter improved when they use OREAD in their internal procedures to bring all departments under a single framework.

Table 4 Results of hierarchical regression test, dependent variable: SCE

	Model 1		Model 2	
	Sig.	β	Sig.	β
Constant	0.000***	4.803		
AIT	0.002**	0.36		
LOA	0.003**	0.29		
AIT X OREAD	0.000***	0.51		
LOADX READ			0.002**	0.31
R^2	0.764		0.792	
Adjusted R^2	0.761		0.710	

*p < 0.05, ** p < 0.01, *** p < 0.001

Discussions

The purpose of this study was to examine how Artificial Intelligence Technologies (AIT) and the Level of Automation (LOA) influence Supply Chain Efficiency (SCE) in Oman's logistics sector, as well as to determine whether Organizational Readiness (OREAD) strengthens these relationships. The findings provide several important insights for both theory and practice.

First, the results show that AIT has a positive and significant impact on SCE. This confirms that the integration of AI tools such as machine learning-based forecasting, predictive analytics, and intelligent planning can enhance decision-making, reduce operational delays, and improve resource utilization. While previous studies have broadly discussed how AI improves demand forecasting, inventory optimization, and logistics performance (e.g., Colicchia et al., 2019; Yang et al., 2021; Zhang et al., 2024; Borah et al., 2024), the current findings contribute more specifically by demonstrating how these technologies translate into measurable efficiency gains within the context of Omani modern logistics companies. Thus, the relationship detected in this study provides empirical support for the transformative role of AI in emerging logistics markets, not merely as a global trend but as an operational driver of efficiency at the firm level.

Second, the results indicate that LOA significantly enhances SCE, supporting the argument that automation facilitates standardized processes, reduces manual workload, and strengthens operational accuracy. Prior studies note that automation lowers costs, simplifies workflows, and boosts overall performance in supply chain operations (Kelly Weeks et al., 2022; Gomes et al., 2024). In this study, the positive linkage between LOA and SCE highlights that Omani logistics firms adopting higher automation through robotics, automated sorting systems, or automated data capture experience more streamlined operations. Importantly, this study extends earlier work by demonstrating that automation improves efficiency even in developing digital ecosystems, reinforcing its universal value across different national contexts.

A key contribution of this research is the inclusion of OREAD as a moderating variable, which was found to significantly strengthen the relationship between both AIT and LOA with SCE. This indicates that simply adopting advanced technologies is not sufficient; organizations must possess the internal readiness; skills, infrastructure, leadership support, and digital culture to effectively leverage these technologies. This aligns with the argument that the success of digital transformation depends on organizational capability rather than the technology alone. The moderation results suggest that firms with higher readiness extract greater efficiency benefits from AI and automation, whereas unprepared firms may struggle to translate investments into improved performance.

Overall, this study moves beyond general discussions of AI and automation by providing empirical evidence specific to Oman's logistics industry. It confirms that AIT and LOA are not merely technological trends but meaningful predictors of operational efficiency, and that OREAD plays a critical role in amplifying their effects. Compared to earlier research, the present study strengthens the understanding of how digital technologies interact with organizational conditions to shape supply chain outcomes in rapidly developing economies.

Implications

The study's findings that AIT and LOA significantly improve supply chain efficiency and that OREAD strengthens these effects offer important implications for modern logistics firms in Oman. However, translating these technological capabilities into measurable operational gains requires addressing several practical challenges that are particularly relevant to the Omani context. Rather than presenting a broad list of generic barriers, this section highlights the three most critical implications: data integration, talent readiness, and organizational change. These represent the most immediate constraints that may hinder firms from fully leveraging AI and automation.

Strengthening Data Integration Capabilities

One of the most pressing barriers to effective AI deployment in Oman's logistics sector is the integration of AI tools with existing legacy systems. Many firms still rely on fragmented platforms and non-standard data formats, making real-time data flow difficult. Poor interoperability limits the performance of AI applications such as predictive demand forecasting or automated routing systems.

Because the study shows that AIT significantly improves SCE, this implication emphasizes that firms must invest in unified data architectures, improved data governance, and standardized digital platforms. Without such foundations, AI-enhanced efficiency will remain unrealized despite the availability of advanced tools.

Addressing AI Talent Shortages and Workforce Readiness

The moderating role of OREAD underscores the importance of organizational capability, which includes the availability of skilled personnel. A major national challenge is the shortage of AI and automation talent in Oman, as demand for data engineers, AI developers, and analytics specialists far exceeds supply. This limits firms' ability to operate, customize, or maintain AI systems.

To fully benefit from the positive effects of AIT and LOA identified in this study, logistics firms must focus on: (1) Developing internal training and upskilling initiatives (2) Partnering with universities and training institutes (3) Retaining technical staff through competitive incentives. Without these efforts, firms risk underutilizing AI investments due to a lack of human capability to support the technology.

Navigating Organizational Change and Stakeholder Buy-In

The study demonstrates that OREAD enhances the impact of AI and automation, highlighting that technology adoption is not only a technical but also a behavioural and managerial challenge. Introducing AI reshapes workflows, reduces manual tasks, and shifts decision-making processes. This often leads to employee resistance, uncertainty about job roles, and hesitation among middle management.

Omani logistics companies must therefore prioritize structured change-management strategies, including transparent communication, stakeholder engagement, and incremental adoption phases. Improving readiness, as shown in this study ensures that investments in AIT and LOA translate into improved SCE through user acceptance and proper utilization.

Supporting Digital Infrastructure and Cost-Effective Investments

Although cost and infrastructure challenges are relevant, they act as secondary, but still important implications. High upfront costs for AI tools, limited cloud infrastructure maturity, and varying levels of internet reliability can slow AI adoption. Policymakers and industry leaders should therefore consider initiatives such as shared digital platforms, subsidized cloud solutions, and sector-wide funding mechanisms. This will help firms reduce cost burdens andenhance the digital environment needed for efficient AI adoption.

Future Research

This study offers valuable insights into how AIT, LOA, and OREAD shape supply chain efficiency in Oman; however, several avenues exist for expanding the depth and breadth of future research.

First, although the current cross-sectional design provides a snapshot of the present state of AI adoption, a longitudinal approach would offer stronger evidence on how the relationships evolve over time. Tracking firms across multiple time periods could help identify long-term trends, measure the sustained impact of AI and automation initiatives, and better assess whether improvements in supply chain efficiency are maintained, accelerated, or diminished as technologies mature.

Beyond longitudinal analyses, alternative methodological approaches could also deepen understanding. For instance, qualitative case studies of leading Omani logistics firms could reveal the nuanced organizational processes, cultural factors, and managerial decision-making that influence successful AI adoption issues not easily captured through surveys. Similarly, experimental or quasi-experimental designs could be used to evaluate the effectiveness of specific interventions, such as training programs, digital transformation initiatives, or policy incentives. These methods would allow researchers to isolate causal mechanisms and assess the conditions under which AI and automation generate the greatest efficiency benefits.

Additionally, future research could explore emerging themes that were beyond the scope of this study, such as the ethical implications of automation, changes in workforce dynamics, or sectoral differences in digital readiness across Oman. Investigating these topics would help build a more holistic understanding of the challenges and opportunities associated with AI integration in emerging economies.

Overall, expanding research through mixed methods and multi-period approaches will not only strengthen causal inferences but also provide richer insights into the evolving challenges of AI adoption in Oman's logistics sector and similar developing contexts.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper

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