INTEGRATING ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN RISK MANAGEMENT: IMPLICATIONS FOR REGIONAL TRADE IN SOUTHEAST NIGERIA

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Abstract
Global supply chains are increasingly exposed to complex risks arising from infrastructural fragility, regulatory inconsistencies, and market volatility, particularly in emerging economies. This study investigates the role of Artificial Intelligence (AI) in enhancing Supply Chain Risk Management (SCRM) and advancing regional trade competitiveness in Southeast Nigeria. Adopting a quantitative research design, data were collected from 400 supply chain practitioners, logistics managers, and SME operators across the five southeastern states. The study employed descriptive statistics, Pearson correlation, and multiple regression analysis using SPSS v26. The findings reveal a statistically significant positive relationship between AI adoption and supply chain performance outcomes: operational risk mitigation ($r = 0.979$), resilience improvement ($r = 0.985$), and trade efficiency ($r = 0.988$), all at $p < 0.001$. These results confirm that AI tools such as predictive analytics, real-time monitoring, and autonomous decision support act as dynamic capabilities that enhance responsiveness, resilience, and competitiveness in fragile trade environments. Theoretically, the study extends the Dynamic Capabilities Theory (DCT) by contextualizing AI as a resilience-enabling competence, while the Technology-Organization-Environment (TOE) framework explains adoption pathways under infrastructural and institutional constraints. Practically, the study provides managers with evidence-based insights for investing in AI-enabled solutions, while policymakers are urged to establish regulatory harmonization, digital skills development, and ethical AI frameworks to scale adoption.

Key words: *Artificial Intelligence, Supply Chain Risk Management, Resilience, Trade Efficiency, Competitiveness, Southeast Nigeria*

Introduction

The increasing complexity of global supply chains amplified by geopolitical instability, technological disruption, and environmental volatility has underscored the urgent need for resilient, adaptive, and intelligent risk management strategies. In this landscape, Artificial Intelligence (AI) has emerged as a transformative force, offering tools that

not only automate and optimize traditional logistics operations but also enhance predictive capabilities, real-time monitoring, and autonomous decision-making in supply chain environments (Adeoye et al., 2025; Belhadi et al., 2024; Bhargava et al., 2022; Dora et al., 2022). The case of Southeast Nigeria a regional trade hub comprising states such as Abia, Anambra, Enugu, Ebonyi, and Imo is particularly instructive. The region's economy is driven by small and medium-sized enterprises (SMEs), informal markets, and road-based logistics networks. Yet, these systems are deeply vulnerable to operational disruptions stemming from poor infrastructure, regulatory fragmentation, erratic power supply, and inadequate digital infrastructure (Akanbi et al., 2023; Oyeyemi et al., 2025a; Frimpong, 2025). These limitations not only constrain operational performance but also expose trade flows to significant risk, leading to inefficiencies and loss of competitiveness in regional commerce.

While AI technologies offer considerable potential to mitigate such risks by enabling intelligent forecasting, automated inventory control, and responsive routing mechanisms,the rate of adoption remains alarmingly low in the region. This is attributed to a combination of organizational inertia, digital skill shortages, fragmented governance, and ethical concerns regarding data bias and regulatory oversight (Ahmad et al., 2021; Božić, 2023; Mienye et al., 2024). Moreover, the lack of integrated data ecosystems and harmonized cross-border trade policies continues to undermine the scalability of AI innovations in the regional supply chain landscape (Ajibade et al., 2025; Oyeyemi et al., 2025b). Notwithstanding these challenges, empirical and theoretical research continues to demonstrate that context-sensitive integration of AI into SCRM can significantly enhance supply chain visibility, agility, and resilience, even in resource-constrained environments. Machine learning algorithms can support predictive maintenance and demand forecasting, digital twins can simulate disruption scenarios, and AI-powered dashboards can provide real-time insight into inventory levels, supplier performance, and logistics bottlenecks (Belhadi et al., 2024; Natuhwera & Onyango, 2024; Gaikwad, 2024).

Given these dynamics, this study is situated at the critical intersection of AI-enabled innovation and regional trade development, with specific attention to how AI tools influence risk governance, supply chain performance, and trade competitiveness in Southeast Nigeria. The research leverages a combination of theoretical insights from the Dynamic Capabilities Theory (DCT) and the Technology-Organization-Environment (TOE) framework to explore both the internal and contextual factors shaping AI adoption.

Objectives

This study seeks to examine the strategic role of artificial intelligence in mitigating operational risks, strengthening supply chain resilience, and enhancing trade performance in Southeast Nigeria. The specific objectives are to:

1. Examine the relationship between AI tools and operational risk control in supply chains within Southeast Nigeria.
2. Investigate the relationship between AI integration and the resilience of supply chains in Southeast Nigeria, focusing on disruption anticipation, response, and recovery.
3. Evaluate the relationship between AI adoption and trade performance in Southeast Nigeria with emphasis on order fulfillment, cost reduction, logistics optimization, and cross-border compliance.

Research Questions

1. What is the relationship between AI tools and operational risk control in supply chains within Southeast Nigeria?
2. What is the relationship between AI integration and the resilience of supply chains in Southeast Nigeria in terms of disruption anticipation, response, and recovery?
3. What is the relationship between AI adoption and trade performance in Southeast Nigeria with respect to order fulfillment, cost reduction, logistics optimization, and cross-border compliance?

Hypotheses

H_{01}: There is no significant relationship between AI tools and operational risk control in supply chains within Southeast Nigeria.

H_{02}: There is no significant relationship between AI integration and the resilience of supply chains in Southeast Nigeria in terms of disruption anticipation, response, and recovery.

H_{03}: There is no significant relationship between AI adoption and trade performance in Southeast Nigeria with respect to order fulfillment, cost reduction, logistics optimization, and cross-border compliance.

Literature Review

Conceptual Review

The conceptual foundation of this study is rooted in the transformative potential of Artificial Intelligence (AI) within modern Supply Chain Risk Management (SCRM) frameworks. In contemporary supply chain ecosystems, AI is no longer perceived merely as a support mechanism but as a strategic lever for enhancing agility, resilience, and end-to-end visibility across the value chain (Ahmad et al., 2021; Dora et al., 2022; Adeoye et al., 2025; Hassan, 2024). Artificial Intelligence, in this context, refers to the deployment of computational systems capable of mimicking cognitive human functions such as perception, reasoning, learning, and self-correction in order to facilitate autonomous, data-driven decision-making. Within supply chains, AI technologies are operationalized through various tools such as machine learning algorithms, neural networks, expert systems, digital twins, and robotic process automation (RPA), all of which provide predictive analytics, anomaly detection, dynamic simulation, and real-time optimization of logistical operations (Bhargava et al., 2022; Ajibade et al., 2025; Belhadi et al., 2024).

The relevance of AI to supply chain risk management is increasingly recognized, particularly in volatile trade regions such as Southeast Nigeria, where informal markets, infrastructure fragility, and policy inconsistencies prevail. Traditional SCRM practices in such contexts are typically reactive, fragmented, and data-poor. In contrast, AI-driven SCRM allows for continuous monitoring of disruption signals, early warning system activation, and the generation of prescriptive interventions. These capabilities represent a paradigm shift from reactive risk responses to anticipatory and proactive risk governance (Jia et al., 2024; Oyeyemi et al., 2025a; Dora et al., 2022; Gaikwad, 2024).

Central to this framework is the concept of operational risk, which refers to the possibility of loss resulting from inadequate or failed internal processes, systems, people, or from external events. In the Southeast Nigerian context, operational risks manifest through inconsistent inventory management, transportation bottlenecks, fluctuating demand, and unreliable regulatory systems (Balogun et al., 2023; Frimpong, 2025; Natuhwera & Onyango, 2024; Atwal et al., 2021). These challenges are exacerbated by infrastructural constraints and limited digital literacy, particularly among small and medium-sized enterprises (SMEs). AI technologies offer robust solutions through predictive demand forecasting, route optimization, and autonomous inventory control, thereby minimizing human error and reducing resource wastage (Ajibade et al., 2025; Belhadi et al., 2024; Dora et al., 2022; Oyeyemi et al., 2025b). Closely related to operational risk is the construct of supply chain resilience, defined as the capability of a system to prepare for, absorb, recover from, and adapt to unexpected disruptions. In unstable trade regions, the application of AI is particularly pivotal in

achieving resilient supply chains. For example, technologies such as digital twins and scenario-based modeling enable firms to virtually simulate disruptions and test alternative response strategies, enhancing their capacity for rapid reconfiguration and continuity planning (Božić, 2023; Dora et al., 2022; Belhadi et al., 2024; Gaikwad, 2024). These capabilities become critical during sudden events such as strikes, cross-border trade delays, or geopolitical shocks, which frequently affect regional supply chains in Southeast Nigeria (Hassan, 2024; Oyeyemi et al., 2025a; Frimpong, 2025; Ajibade et al., 2025). By enabling real-time adaptability, AI fosters adaptive capacity, thereby transforming vulnerable supply chains into robust and responsive systems.

Furthermore, AI exerts a significant impact on trade efficiency, which denotes the ability to conduct trade with minimal friction in terms of cost, time, and regulatory compliance. Fragmented documentation processes, slow customs procedures, and non-standardized regulatory frameworks continue to challenge efficient trade in Southeast Nigeria. AI technologies including real-time cargo tracking, blockchain-enabled smart contracts, and automated customs processing systems can substantially improve trade logistics and enhance transparency across nodes of the supply chain (Adeoye et al., 2025; Bhargava et al., 2022; Akanbi et al., 2023; Jia et al., 2024). These technologies reduce turnaround time, eliminate redundancies, and ensure timely delivery, ultimately contributing to faster throughput and enhanced customer satisfaction (Oyeyemi et al., 2025a; Belhadi et al., 2024; Ahmad et al., 2021; Natuhwera & Onyango, 2024). At the macroeconomic level, the integration of AI into SCRM translates into improved trade competitiveness, defined as a region's ability to produce and deliver goods more efficiently, reliably, and cost-effectively than its counterparts. In Southeast Nigeria, high logistics costs, erratic supply, and poor technology absorption significantly hinder competitive positioning. However, AI facilitates cost minimization, data-informed market access, and differentiated customer value propositions, positioning local firms for improved compliance with ECOWAS trade protocols and access to broader regional markets (Ajibade et al., 2025; Božić, 2023; Dora et al., 2022; Belhadi et al., 2024). Thus, AI becomes not only a technology enabler but also a strategic asset for elevating the region's stature in intra-African and global trade networks (Hassan, 2024; Frimpong, 2025; Oyeyemi et al., 2025b; Akanbi et al., 2023).

In summary, the conceptual synthesis of AI within SCRM provides a holistic understanding of how intelligent systems intersect with risk mitigation, operational agility, and competitive performance. The integration of AI into supply chain systems transforms the foundational d CTynamics of trade logistics by embedding intelligence, responsiveness, and resilience across the entire supply chain continuum.

Theoretical Framework

The theoretical underpinnings of this study rest on two complementary models: the Dynamic Capabilities Theory (DCT) and the Technology-Organization-Environment (TOE) framework. Together, these frameworks provide a robust interpretive lens for understanding how organizations in emerging economies adopt and operationalize Artificial Intelligence (AI) for managing supply chain risks and enhancing regional trade competitiveness.

Dynamic Capabilities Theory (DCT)

The Dynamic Capabilities Theory, first conceptualized by Teece, Pisano, and Shuen (1997), argues that a firm's long-term success in dynamic environments depends on its ability to integrate, build, and reconfigure both internal and external competences in response to rapidly changing conditions. Unlike traditional resource-based views, DCT emphasizes adaptability over static efficiency, aligning well with the evolving technological and infrastructural contexts of supply chains in regions like Southeast Nigeria. In the domain of Supply Chain Risk Management (SCRM), DCT provides a strategic explanation for how firms leverage AI as a dynamic capability to sense environmental disruptions, seize emergent opportunities, and transform internal processes to mitigate operational vulnerabilities. AI tools such as predictive analytics, machine learning, and autonomous systems embody dynamic capabilities that allow firms to preempt risks, accelerate decision-making, and reconfigure their supply networks with agility (Jia et al., 2024; Belhadi et al., 2024; Adeoye et al., 2025).

In Southeast Nigeria, where infrastructural deficits and regulatory inconsistencies prevail, AI integration allows firms to move beyond reactive risk management models to proactive, data-driven resilience strategies (Oyeyemi et al, 2025; Anyaeji et al., 2025). Predictive maintenance, intelligent routing, and simulation-based planning become strategic levers that reflect not only technological deployment but the organization's capability to learn, adapt, and reconfigure amid uncertainty (Ajibade et al., 2025; Hassan, 2024). Thus, DCT situates AI adoption within a broader context of organizational learning and capability evolution. In this way, the deployment of AI is not just a technological upgrade but a strategic reorientation that enhances the firm's capacity to survive and thrive in volatile regional markets.

Technology-Organization-Environment (TOE) Framework

To complement DCT's internal organizational focus, this study also applies the Technology-Organization-Environment (TOE) framework developed by Tornatzky and Fleischer (1990). TOE offers a contextualized model for technology adoption, positing that an organization's technological implementation is shaped by three interrelated domains: (i) the characteristics of the technology itself, (ii) the

organizational readiness for change, and (iii) the broader environmental context. In the case of AI adoption in supply chains, the technological dimension refers to the relative advantage, complexity, and compatibility of AI systems with existing operations. Tools such as real-time analytics, autonomous scheduling, and cognitive automation must be both technically feasible and strategically aligned with supply chain goals (Božić, 2023; Mienye et al., 2024).

The organizational dimension pertains to the firm's internal structures, leadership commitment, resource availability, and absorptive capacity. In many Southeast Nigerian firms particularly SMEs,AI integration is hampered by low digital literacy, limited capital, and weak IT infrastructure (Oyeyemi et al., 2025). These internal conditions critically influence the speed and depth of AI adoption. The environmental dimension accounts for external factors such as industry competition, customer pressure, government policies, and technological infrastructure. In Southeast Nigeria, challenges such as erratic electricity supply, weak internet penetration, and underdeveloped AI governance frameworks shape the viability of AI-based supply chain transformation (Ajibade et al., 2025; Oyeyemi et al., 2025a).

By synthesizing these three domains, TOE allows for a more nuanced understanding of why and how AI is adopted in constrained environments, providing insights into the systemic enablers and inhibitors that affect intelligent supply chain transformations in regional trade contexts.

Theoretical Integration and Relevance

The integration of DCT and TOE creates a comprehensive framework for analyzing the dual dimensions of AI adoption: strategic capability-building (DCT) and contextual readiness and constraints (TOE). While DCT highlights the why? emphasizing the strategic necessity of building adaptive capabilities.TOE explains the how? articulating the pathways and barriers to adoption within specific organizational and environmental contexts.

This theoretical synergy is particularly critical for emerging economies, where the gap between technological aspiration and infrastructural reality often persists. In such environments, AI implementation must be viewed not only as a function of technological availability but as a reflection of dynamic managerial intent and systemic readiness. Together, these frameworks offer a multidimensional lens to understand AI-driven supply chain innovation in Southeast Nigeria, enabling scholars and practitioners to better diagnose capability gaps, prioritize interventions, and design sustainable digital transformation strategies.

Empirical Review

The growing body of empirical literature underscores the strategic relevance of Artificial Intelligence (AI) in transforming supply chain systems, particularly in emerging economies where supply chain fragility, infrastructural deficits, and regulatory ambiguities are prevalent. This review critically synthesizes key empirical studies from Nigeria, Africa, and other developing economies, offering comparative insights into the transformative and contextual dynamics of AI in supply chain risk management (SCRM) and trade competitiveness.

Adeoye et al. (2025) conducted an extensive survey examining AI's contribution to operational agility in Nigerian logistics systems, with a sample of 180 firms across Lagos, Abuja, and Port Harcourt. Utilizing multiple regression analysis, the study found that AI tools especially predictive analytics and smart routing significantly enhanced responsiveness, minimized delays, and improved decision-making under uncertain conditions. The study concluded that AI fosters real-time visibility and operational dexterity, crucial for mitigating logistics-related risks in high-traffic trade corridors. These findings reinforce the proposition that AI-driven agility is central to supply chain resilience in urban African logistics hubs.

Bhargava, Ranjan, and Sharma (2022) employed a mixed-method approach to explore the adoption of autonomous AI tools such as drones and self-driving vehicles in 150 Indian transport companies. Structural Equation Modeling (SEM) results demonstrated that autonomous AI systems significantly reduced delivery turnaround time and in-transit risk exposure. The study affirmed the value of dynamic AI technologies in creating adaptive logistics systems capable of responding to infrastructure volatility, a characteristic shared with the Nigerian and broader African context. These findings offer strong comparative validation for AI's capacity to buffer external shocks in developing economies.

In a cross-border context, Natuhwera and Onyango (2024) assessed the role of AI in inventory optimization among 120 SMEs in Ugandan and Kenyan border towns. Employing ANOVA and regression analysis, the researchers found that AI-enabled demand forecasting and automated reordering improved inventory accuracy by over 40%. Importantly, the study observed that improved inventory control translated into enhanced customs compliance and faster border clearance, that reflects two critical enablers of regional trade facilitation. These results validate the proposition that AI can bridge operational efficiency and trade effectiveness in fragmented regulatory environments.

Oyeyemi, John, and Awodola (2025a) investigated AI-powered route optimization and logistics planning in South-West Nigeria. Drawing from a sample of 200 logistics workers, their study revealed that AI-driven real-time data analytics improved delivery timeliness by 35% and mitigated risks related to road infrastructure and weather. The

correlation and regression analysis confirmed a statistically significant relationship between AI adoption and reduction in transportation-related disruptions. These findings underscore the instrumental role of real-time analytics in enhancing last-mile delivery and operational continuity in high-risk environments.

Mienye, Sun, and Ileberi (2024) conducted a multicountry study involving 300 firms across Nigeria, Ghana, and South Africa to investigate how AI adoption influences inclusive economic growth and supply chain transparency. Their findings revealed a sharp disparity: while large firms leveraged AI for strategic advantage, small and medium-sized enterprises (SMEs) were constrained by limited technical skills and financial capacity. The study highlighted the need for democratizing access to AI technologies and investing in digital capacity-building to ensure equitable distribution of AI-driven supply chain benefits across firm sizes and regions.

Ajibade, Akintoye, and Ajah (2025) examined the intersection between regulatory readiness and AI adoption in trade logistics, focusing on Nigeria and Ghana. Through qualitative content analysis using NVivo, they found that fragmented data governance, inconsistent privacy legislation, and absence of cross-border AI frameworks inhibit the successful deployment of AI in supply chain contexts. The study concluded that institutional harmonization and coherent policy ecosystems are essential for scaling AI adoption across the region. Their findings strongly reinforce the Technology-Organization-Environment (TOE) framework's assertion that environmental and institutional factors significantly influence technological integration.

Methodology

In this research paper, the descriptive survey design was used to explore how business people are using artificial intelligence (AI) to address the risk management of supply chains and its effect on the regional trade in Southeast Nigeria. The target population consisted of supply chain practitioners, logistics managers, small and medium size businesses operators and policymakers in the States of Abia, Anambra, Ebonyi, Enugu and Imo. The unknown population size was used to calculate the sample size as Cochran (1977) suggests that with large or infinite populations, a sample size of at least 384 respondents is sufficient at 95 percent confidence and 5 percent margin of error. In order to be more representative and in order to address the potential non-responses, the number was rounded to 400 respondents. Proportional representation of all states and sectors was also achieved through stratified random sampling. A structured questionnaire was used to collect data which was reviewed by experts who pilot-tested and believed to be reliable with Cronbachs alpha of 0.87. To test the hypothesis of integrating AI, supply chain resiliency and efficiency of trade, SPSS 26 and descriptive statistics (mean, standard deviation) and inferential statistics (Pearson correlation, multiple regression) were applied to the data. Informed consent, confidentiality, and

voluntary participation were ethics followed during the study.

Results

Table 1: Demographics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	235	58.75
	Female	165	41.25
Age	18–30	120	30.00
	31–40	135	33.75
	41–50	90	22.50
	51 and above	55	13.75
Organization Type	Manufacturing	110	27.50
	Logistics	105	26.25
	Retail	90	22.50
	Government	85	21.25
	Other	10	2.50
Years of Experience	1–5 years	140	35.00
	6–10 years	130	32.50
	>10 years	130	32.50
State of Operation	Imo	85	21.25
	Enugu	75	18.75
	Ebonyi	60	15.00
	Anambra	90	22.50
	Abia	90	22.50

Source: *Field survey, 2025*

Table 1 provides the demographic data of 400 respondents that participated in the survey in relation to different sectors of the supply chain. The gender breakdown indicates that males prevail in workforce supply chain operations in the region of study (58.75%) than the females (41.25%). Regarding age, most respondents can be classified as the age group of 31 40 (33.75%), 18 that is followed by 30 (30.00%), which indicates that the labor market is not very old and will therefore be flexible enough to meet new technological developments such as artificial intelligence. The organizational distribution shows the industries best represented as manufacturing (27.50%) and logistics (26.25%), and second, the government (21.25%) and the retail (22.50) and last but not least, the denomination of the Others (only 2.50%). In the perspective of years of experience, the respondents were quite homogenized as 35.00 percent of the respondents had 1-5 years of experience, and the rest were divided into 6-10 years (32.50 percent) and more than 10 years (32.50 percent), representing a mixture between

new entrants and long time practitioners. The geographical population of the respondents was also fairly distributed within five southeastern states in Nigeria with Anambra and Abia sharing 22.50 percent respectively, Imo with 21.25 percent of respondents and Enugu and Ebonyi with 18.75 percent and 15.00 percent respectively showing proper representation of geographical locations vitalizing generalizability of the finding of the study.

Table 2: Artificial Intelligence Tools in Supply Chain Management

Statement	**SA**	**A**	**UN**	**D**	**SD**	**Total**
Our organization uses AI tools for real-time data analytics in supply chain operations.	140	160	20	45	35	400
AI systems help automate procurement and supply chain processes.	150	130	15	55	50	400
Predictive analytics powered by AI improves supply chain planning.	145	135	10	60	50	400
We use AI for monitoring supplier performance and risk analysis.	135	140	25	50	50	400
The integration of AI in our operations has led to smarter inventory control.	155	125	20	55	45	400
Total	**725**	**690**	**90**	**265**	**230**	**2,000**
Average	**145**	**138**	**18**	**53**	**46**	**400**
Percentage (%)	**36.25**	**34.50**	**4.50**	**13.25**	**11.50**	**100%**

Source: *Field survey, 2025*

Evidence in Table 2 shows that the use of artificial intelligence (AI) tools in supply chain management has been highly adopted in the various organizations. The total share of respondents either strongly agreeing or agreeing (72.75%) that their organizations employ AI systems to take the major responsibilities in the chain including real-time analytics, the automation of procurement, predictive planning, and inventory control. It is a great agreement, which entails a strategic approach to the use of AI to improve operations. Fewer in number (13.25%) disagreed with the listed statements and only 11.50 percent strongly disagreed with the statements mentioned whereas only 4.50 percent could not make a decision regarding their disagreement with the statements mentioned. Based on this distribution, we can suggest the level of confidence and overall positive responses to the questions related to AI tool use among the respondents, the importance of which is highlighted by the trend of artificial intelligence used positively in terms of increasing the performance of operational activities, but with certain reservations or gaps in implementation on the scale level.

Table 3: Operational Risks in the Supply Chain

Statement	**SA**	**A**	**UN**	**D**	**SD**	**Total**
Poor logistics coordination regularly disrupts our supply chain activities.	125	150	15	60	50	400
Regulatory inconsistencies affect the smooth flow of our supply operations.	135	145	10	55	55	400
Inadequate infrastructure increases operational risks.	140	135	20	60	45	400
Our organization faces frequent risks from demand and supply fluctuations.	130	140	15	65	50	400
Insufficient technical skills hinder the proper use of digital tools in managing risks.	120	155	25	50	50	400
Total	**650**	**725**	**85**	**290**	**250**	**2,000**
Average	**130**	**145**	**17**	**58**	**50**	**400**
Percentage (%)	**32.50**	**36.25**	**4.25**	**14.50**	**12.50**	**100%**

Source: *Field survey, 2025*

Table 3 gives a different emphasis whereby the respondents are asked about supply chain risks on operation where most (68.75%) of them (32.50%) SA and (36.25) A admitted to having experienced a number of risks such as bad coordination of logistics, inconsistency of regulations, inadequacy of infrastructure, and fluctuation of demand. Interestingly, about 14.50 percent and 12.50 percent either disagreed or strongly disagreed, which means that there are just a few organizations that have put effective risk mitigation plans or are in less risky operating environments. These undecided responses (4.25%) were the least showing that the respondents largely had some positive views when coming up with their responses founded on real life experiences. This shows the extent to which operational issues tend to prevail within the supply chain setting and the necessity to keep making technological and structural advancements to prevent emerging risks.

Table 4: Resilience and Reducing the Risks of Disruption

Statement	SA	A	UN	D	SD	Total
AI has helped improve the resilience of our supply chain during disruptions.	145	135	15	60	45	400
Our supply chain can quickly recover from unexpected challenges due to AI integration.	140	130	20	65	45	400
The use of AI has enabled us to foresee and prevent supply chain interruptions.	135	145	10	60	50	400
AI-based route optimization reduces delay risks caused by transportation issues.	130	140	15	65	50	400
AI has strengthened our capacity to handle supply disruptions across trade borders.	150	130	10	60	50	400
Total	**700**	**680**	**70**	**310**	**240**	**2,000**
Average	**140**	**136**	**14**	**62**	**48**	**400**
Percentage (%)	**35.00**	**34.00**	**3.50**	**15.50**	**12.00**	**100%**

Source: *Field survey, 2025*

Table 4 is a discussion on how AI can help in resilience and suppression of the supply chain shocks. A significant 69 percent of the respondents (35.00 percent SA and 34 percent A) confirmed that integration of AI had enhanced resilience, foreseeing, recovery, and responsiveness in the event of disruptions. According to the agreement, AI is effective in the facilitation of both proactive and reactive efforts within turbulent conditions of operations. Another aggregated 27.50 percent (15.50 percent D and 12.00 percent SD) held the contrary opinion, which can be explained by the low implementation rates or by the unsatisfactory technological base. The highest clarity of responses was evident as only 3.50 per cent of the respondents were not sure. These insights confirm the significance of AI to develop flexible and resilient supply chains, particularly in the areas prone to unstable shutdowns.

Table 5: Efficiency and Competitiveness of the Trade

Statement	SA	A	UN	D	SD	Total
AI has enhanced the speed of order fulfillment in our supply chain.	150	130	10	60	50	400
Our trade processes have become more competitive due to AI-driven innovations.	145	135	15	55	50	400
AI adoption has reduced operational costs and increased trade profitability.	140	140	20	50	50	400

Real-time visibility from AI tools improves our trade decision-making.	135	145	15	55	50	400
Regional trade operations have become more efficient due to AI-supported coordination.	130	150	10	60	50	400
Total	**700**	**700**	**70**	**280**	**250**	**2,000**
Average	**140**	**140**	**14**	**56**	**50**	**400**
Percentage (%)	**35.00**	**35.00**	**3.50**	**14.00**	**12.50**	**100%**

Source: *Field survey, 2025*

Table 5 shows how AI is expected to have an impact on the efficiency and competitiveness of trade. In this case, 70 percent (35.00 percent SA and 35.00 percent A) agreed on the positive changes in the speed of order fulfillment, competitiveness, cost reduction, decision making as well as regional coordination. Mere 17.50 percent (14.00 percent D and 12.50 percent SD) held opposite opinion and 3.50 percent of them were neutral. Such results are a very clear indication that AI adoption is linked to improved trade efficiency when used in central supply chain functions. The convergence in the level of agreement on various dimensions of the trade competitiveness also shows that AI is not merely a technology improvement but a strategic application in spurring sustainable distance in the trade and competitive advantage across trade sectors.

Test of Hypothesis

H_{01}: There is no significant relationship between AI tools and operational risk control in supply chains within Southeast Nigeria.

H_{02}: There is no significant relationship between AI integration and the resilience of supply chains in Southeast Nigeria in terms of disruption anticipation, response, and recovery.

H_{03}: There is no significant relationship between AI adoption and trade performance in Southeast Nigeria with respect to order fulfillment, cost reduction, logistics optimization, and cross-border compliance.

These hypotheses were tested using the Person's Correlation Coefficient in SPSS version 26. The SPSS Outputs are presented in Table 6 and 7; while the interpretation is presented in Table 8:

Table 6: Descriptive Statistics

	Mean	Std. Deviation	N
Artificial Intelligence Tools in Supply Chain Management	3.7075	1.37538	400
Operational Risks in the Supply Chain	3.6175	1.38961	400
Resilience and Reducing the Risks of Disruption	3.6450	1.40139	400
Efficiency and Competitiveness of the Trade	3.6600	1.39975	400

Table 7: Correlations

		Artificial Intelligence Tools in Supply Chain Management	Operational Risks in the Supply Chain	Resilience and Reducing the Risks of Disruption	Efficiency and Competitiveness of the Trade
Pearson Correlation	Artificial Intelligence Tools in Supply Chain Management	1.000	.979	.985	.988
	Operational Risks in the Supply Chain	.979	1.000	.991	.990
	Resilience and Reducing the Risks of Disruption	.985	.991	1.000	.994
	Efficiency and Competitiveness of the Trade	.988	.990	.994	1.000
Sig. (1-tailed)	Artificial Intelligence Tools in Supply Chain Management	.	.000	.000	.000
	Operational Risks in the Supply Chain	.000	.	.000	.000
	Resilience and Reducing the Risks of Disruption	.000	.000	.	.000
	Efficiency and Competitiveness of the Trade	.000	.000	.000	.

N	Artificial Intelligence Tools in Supply Chain Management	400	400	400	400
	Operational Risks in the Supply Chain	400	400	400	400
	Resilience and Reducing the Risks of Disruption	400	400	400	400
	Efficiency and Competitiveness of the Trade	400	400	400	400

Table 8: Summary of Hypotheses Test and Decisions

Hypotheses	**Variables Tested**	**Pearson Correlation (r)**	**Significance (p-value)**	**Decision Rule**	**Conclusion**
1. H_{01}: Artificial intelligence (AI) tools are not significantly applied to detect, manage, and mitigate operational risks within supply chains in Southeast Nigeria.	AI Tools & Operational Risks	0.979	0.000	Reject H_0 if $p < 0.05$	**Rejected** – AI tools are significantly applied to control operational risks
2. H_{02}: The integration of AI does not significantly contribute to enhancing the resilience of supply chains in Southeast Nigeria in terms of anticipating, responding to,	AI Tools & Resilience	0.985	0.000	Reject H_0 if $p < 0.05$	**Rejected** – AI significantly improves resilience and reduces disruption risks

and recovering from disruptions.					
3. H_{03}: AI adoption has no significant impact on trade efficiency and competitiveness in Southeast Nigeria with respect to order fulfillment, cost reduction, logistics optimization, and cross-border compliance.	AI Tools & Trade Efficiency	0.988	0.000	Reject H_0 if $p < 0.05$	**Rejected** – AI significantly impacts trade efficiency and competitiveness

Interpretation of Results

Table 7 indicates Pearson to demonstrate incredibly high positive correlations between artificial intelligence tools and each of the outcome variables: operational risk control ($r = 0.979$), resilience ($r = 0.985$), and trade efficiency ($r = 0.988$). The p of all the relationships is statistically significant (< 0.001). Therefore, none of the null hypotheses (H_{01}, H_{02}, and H_{03}) were accepted, the alternative hypotheses being accepted instead.

Summary of Findings

The analysis of the data collected is able to justify the acceptance of the following alternative hypotheses:

1. Artificial intelligence tools are significantly applied to control operational risks in the supply chain of Southeast Nigeria.
2. The application of artificial intelligence significantly improves the resilience of the supply chain and reduces the risks of disruption in Southeast Nigeria.
3. The use of artificial intelligence in supply chain activities significantly impacts the efficiency and competitiveness of trade in Southeast Nigeria.

Conclusion

This study concludes that the strategic deployment of AI technologies is pivotal to transforming supply chain risk management in Southeast Nigeria. The evidence reveals that AI-enabled capabilities particularly predictive analytics, automation, and real-time decision support are instrumental in: Reducing operational vulnerabilities arising from poor logistics coordination, infrastructural deficits, and regulatory inconsistencies; Strengthening resilience by enabling rapid recovery from disruptions and enhancing adaptive capacity; and Improving trade efficiency and competitiveness through faster order cycles, reduced transaction costs, and more informed decision-making. The research therefore positions AI as a cornerstone for modernizing regional supply chains in developing economies, bridging infrastructural and institutional gaps, and aligning local trade systems with global best practices.

Recommendations

In light of the findings, the following recommendations are advanced for policy-makers, industry stakeholders, and supply chain practitioners:

1. Companies ought to increase the use of AI-informed solutions to prevent disruptions in operations by building real-time risk monitoring solutions, analyzing the performance of their suppliers, and coordinating the logistics.
2. Companies need to invest in AI-related predictive analytics-based and simulation models that can improve the flexibility of supply chains and be quicker to overcome any abrupt impacts.
3. The stakeholders must incorporate AI into main trade activities like demand projection, inventory optimization, and cross-border logistics to improve overall efficiency and maintain a competitive edge.

By adopting these measures, Southeast Nigeria can unlock AI's transformative potential, creating a more resilient, efficient, and competitive regional trade ecosystem capable of thriving in an increasingly uncertain global supply chain environment.

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