International Journal of Sustainable Development and Planning
Vol. 20, No. 5, May, 2025, pp. 2225-2234
Journal homepage: http://iieta.org/journals/ijsdp

Enhancing Humanitarian Supply Chain Resilience Through AI: The Moderating Role of Artificial Intelligence in Achieving Sustainable Development Goals (SDGs) in Jordan

Ahmad Ali Atieh

Business Faculty, Middle East University, Amman 11831, Jordan

Corresponding Author Email: a.ali@meu.edu.jo

Copyright: ©2025 The author. This article is published by IIETA and is licensed under the CC BY 4.0 license (http://creativecommons.org/licenses/by/4.0/).

https://doi.org/10.18280/ijsdp.200537

Received: 14 February 2025
Revised: 15 March 2025
Accepted: 18 March 2025
Available online: 31 May 2025

Keywords:
humanitarian supply chain, Sustainable Development Goals (SDGs), artificial intelligence (AI), supply chain agility, logistics optimization

ABSTRACT

AI has transformed crisis management throughout humanitarian supply chains by making organizations capable of attaining SDGs with efficiency. This study investigates how AI brings benefits to supply chain agility alongside integration as well as sustainable logistics and readiness against disasters in humanitarian operations across Jordan. The research used Structural Equation Modeling technique to evaluate data obtained from 321 humanitarian supply chain professionals. The research results demonstrate AI serves as a positive moderator that enhances the connection between supply chain agility ($\beta = 0.21$, $p < 0.001$) and supply chain integration ($\beta = 0.25$, $p < 0.001$), sustainable logistics ($\beta = 0.27$, $p < 0.001$), and disaster preparedness ($\beta = 0.22$, $p < 0.001$) which helps improve humanitarian supply chain performance. This study establishes predictive decision-making and real-time tracking along with optimized resource distribution to be fundamental features enabled by AI-driven analytics. The integration of AI improves coordination between non-government organizations and governmental agencies and logistics providers which results in better crisis response capabilities. The research delivers theoretical value to AI-driven supply chain literature and provides useful recommendations to policy makers together with logistics managers and aid organizations who aim to maximize their emergency relief performance. AI technologies require sustained funding to enhance humanitarian operations by making them more efficient and transparent as well as sustainable.

1. INTRODUCTION

Humanitarian logistics require the use of AI as global disasters becoming more frequent. The COVID-19 pandemic has highlighted vulnerabilities in global supply chains and disruptions in the delivery of aid to crisis-affected regions. Similarly, natural disasters such as the 2023 Türkiye–Syria earthquake and the 2020 Beirut explosion have shown the exigency for the speedy utilization of AI-driven logistics solutions that aid to maximize resource distribution and lessen the inefficiency of disaster response.

Management techniques requiring innovation support public humanitarian supply chains because conflicts of human origins, natural disasters, and pandemics increase in severity. Previous studies indicate that remarkable humanitarian supply chain management in crisis areas requires executive leadership for speedy aid distribution, enhanced operations, and cost reduction [1-5]. The fundamental operation of HSC faces various obstacles that lead to increased expenses and delayed service delivery [6, 7]. The need for AI technology to improve humanitarian logistics solutions increases because worldwide disasters spread and intensify [8-10].

AI-based solutions for digital development in humanitarian logistics create their primary value by uniting supply chain forecasting methods with routing optimization features and operational observation capabilities [11-13]. When HSCs and AI work together, they create superior results that strengthen disaster preparedness and maintain sustainable operations while providing flexible supply chains [14-16]. Current scientific research on appropriate business supply chain AI applications remains scarce unless investigators develop methods to evaluate SDG achievements through humanitarian logistics partnerships [17-19]. The simultaneous usage of resource management systems and supply chain operations creates swift beneficial effects for responsible production and sustainable infrastructure and climate action [20-22].

The authors in this study demonstrate AI approaches for supply chain operational enhancement, yet they do not prove these methods' worth in achieving critical Humanitarian Supply Chain project requirements for SDGs [23-25]. A study of AI sustainability gap reduction and crisis response during global emergencies in developing nations, including Jordan, indicates low availability [26-28]. SDG-connected AI systems operate with humanitarian logistics operations in Jordan to deliver continuous, high-quality assistance to this country, which serves as a main humanitarian aid center [29-31].

This study evaluates the relationship among supply chain agility, supply chain integration, and sustainable logistics practices, which will measure humanitarian supply chain performance through disaster preparedness within Jordan. The investigation examines how AI affects different supply chain parameters that lead to SDG accomplishments [23]. The research addresses major theoretical along with practical resource gaps in AI-driven humanitarian logistics, which delivers substantial information to both supply chain practitioners and humanitarian organization decision-makers regarding disaster response sustainability and operational resilience [19, 32, 33].

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The increase in the academic literature about HSCs, SDGs and AI happens because their collaboration demonstrates enhanced crisis response capabilities, operational efficiency improvements, sustainability benefits, and resilience capabilities. Authors describe the procedure to identify performance indicators for humanitarian supply chains [34, 35]. The supply chain agility integration seeks to unite emergency preparedness community initiatives with joint supply chain operations that offer sustainable delivery solutions. A comprehensive analysis of AI effects on SDG determinants and humanitarian outcomes in Jordan remains scarce, according to former research [36, 37]. The analyzed AI capacities from this research lead to fulfilling SDG goals and creating innovative academic insights.

Supply chain agility originates from business capabilities to perform operational adjustments as well as environmental adaptations and market-responsive actions [38, 39]. Agile systems enable organizations to distribute resources at high speed during unforeseen crises [34, 40] because these systems possess excellent capabilities in swift delivery under unpredictable crisis conditions. The humanitarian organization's programs enhance delivery timing performance, distribution region utility, and transportation performance to fulfill the quick supply needs of target groups [5, 41]. Implementing Agile operations in humanitarian supply chains results in improved outcomes [6]. While many scientific studies have tried and failed to link operational agility to the achievement of SDGs, the element of operational agility as a prerequisite to realizing the SDG goals might not be needed if companies go beyond operating behind the traditional workplace and work boundaries.

Studies have stated that apart from being beneficial for the faster operation [25, 37, 42], in AI predictive analysis, the risk assessment evaluation is used. AI can greatly assist humanitarian organizations push forward the SDGs more quickly by means of deploying machine learning based automatic forecasting software onto IoT systems [10, 43]. Previous research has also been examined by the team partners who, based on the findings of such research, make creation of these implementation recommendations [44, 45].

Previous research is well established on the role of AI in business and commercial supply chains but the studies related to AI-driven humanitarian supply chains are limited.' Some of the studies stress out that AI can improve logistics efficiency [46, 47], while the others question the feasibility of its use in resource constrained environment [48]. Further, although some identify AI for predictive analytics and automation [30], others highlight the dangers of placing too much trust in AI, especially in the uncertain and highly volatile condition of the humanitarian context [49]. In this paper, this conflictions reality between fieldwork and writ work is tackled through providing empirical evidence within humanitarian organisations in Jordan.

SCI allows governmental bodies to work in synergy with NGO suppliers and logistics providers to enhance the operations of humanitarian aid [50-52]. Studies assert that with implementation of integration practices stakeholders have better results of crisis management, minimize costs, and heighten resource administration capabilities as well as improving information data sharing [5, 6]. The improvements of supply chain interconnections [14, 15] help humanitarian logistics work better and offer cost reduction opportunities [53].

In 2022, previous studies also recognise that supply chains strengthen AI technologies connection through data systems [53, 54] that are quick and an automated procurement management which ascertains inventory. SDG compliance improves through blockchain-based AI systems that monitor aid distribution activities to prevent fraudulent behavior in organizational operations [14, 55].

SL arises from environmentally sound practices utilizing socially oriented resource-efficient procedures [56, 57]. Humans working through the green supply chain movement implement sustainable procurement practices and circular economic approaches alongside carbon reduction techniques [17, 58]. The achievement of SDG 12 and SDG 9, along with SDG 13 sustainable development targets, relies on effective waste management systems, sustainable transportation solutions, and carbon emission-free supply chain networks [20, 59].

Substantial improvement in sustainable logistics performance is made using route planning algorithms, energy-efficient logistics, and predictive waste reduction-based AI optimization models [14]. This is the essence of using AI-integrated logistics solutions to reduce fuel, utilize vehicles, make a humanitarian relief operation more environmentally friendly, with a lower carbon footprint, and render it sustainable [60]. Although academic interest in the applications of AI for supply chain management is growing, the intersection of AI, humanitarian logistics and implementation of SDGs still needs to be filled. Although previous research with regard to AI has mainly been devoted to productivity and cost savings [61], there has been insufficient attention paid to the ways in which AI is used to attain resilience and long-term sustainability in humanitarian supply chains. This study fills the gap bridged by analysing the moderating effect of AI to the supply chain factors and impact of achieving SDGs crisis affected regions. It can be understood that the moderating role of AI in supply chain performance through the dynamic capability theory [62], that highlights the dynamic capabilities of the organization in leveraging its leading technology to bridge the gap in the current business environment. Through AI, supply chains can make real time decisions, be predicated on analytics and run automated processes, which means they can respond dynamically to disruptions. While logistical efficiency had been studied in relation to AI in previous work, there has been much less discussion on the moderating effect of AI in humanitarian contexts. The gap that this study tries to fill is to analyze AI's applicability in improving the agility, integration, and sustainability of humanitarian supply chains.

DP also proposes this in terms of bringing a definition of the risk assessment and placement of relief stocks, improvement on the reinforcement of infrastructures, and collaboration among the humanitarian actors [60]. In response to the disaster, this is effective regarding response time, being ready with required resources, and managing response [63, 64]. As previous studies put it [65-67], data-driven simulations, scenario planning, and geographic information systems (GIS) are becoming more and more the tools that the humanitarian sector relies on to enhance disaster preparedness.

Humanitarian organizations use accurate time disaster detection, monitoring, and automated response coordination using AI-powered models as early alerts of disasters [68-70]. AI tools can predict the preconditions of a disaster occurring as well as model the humanitarian supply chain before as well as after the disaster occurs by gathering satellite imagery and historical data as well as meteorological trends [33, 68, 71]. Regarding the literature review, hypotheses are proposed:

H1: *Supply chain agility positively influences humanitarian supply chain performance.*
H2: *Supply chain integration positively influences humanitarian supply chain performance.*
H3: *Sustainable logistics positively influences humanitarian supply chain performance.*
H4: *Disaster preparedness positively influences humanitarian supply chain performance.*
H5: *AI positively moderates the relationship between supply chain agility and SDG achievement.*
H6: *AI positively moderates the relationship between supply chain integration and SDG achievement.*
H7: *AI positively moderates the relationship between sustainable logistics and SDG achievement.*
H8: *AI positively moderates the relationship between disaster preparedness and SDG achievement.*

3. METHODOLOGY

This paper investigates supply chain agility, integration, sustainable logistics, and disaster preparedness for humanitarian supply chain performance through an analysis of SDGs enabled by AI as a moderating element. The quantitative research design facilitates systematic, objective statistical analysis of variable relationships to achieve valid and reliable study outcomes. The study implements a structured research format that enhances variable precision assessment while enabling hypothesis testing and subsequently advances academic understanding of humanitarian logistics and digital transformation research.

The study uses a stratified random sampling design to obtain a diverse population of humanitarian organizations operating throughout Jordan. The researcher divides the population into corresponding subgroups to ensure all organizations, such as international NGOs loc, NGOs UN, agencies, and government entities, are appropriately included. Both supply chain and logistics managers, as well as procurement and disaster relief operations, received the self-administered survey questionnaire through distribution. Research procedures produce results that demonstrate the viewpoints of critical decision-makers who take part in humanitarian supply chain operations. The study used stratified random sampling to make certain that the data was accurate and reduce response bias. Participants in the survey were selected on multiple levels of an organization to view different perspectives on AI adoption. In order to avoid self reporting bias, the responses were anonymized, and the key insights were cross referenced with expert interviews to enhance validation checks. These measures enhance robustness of dataset and generalize the findings.

A distribution of 400 questionnaires reached humanitarian professionals both through email communications and face-to-face meetings. The survey yielded 378 responses, but data screening procedures retained 321 valid answers to analyze due to non-completeness and response bias. The research achieved an 80.25% response rate, fulfilling the necessary sample size requirements for Structural Equation Modeling (SEM) analysis. The expert participants come from different professional backgrounds, strengthening the research findings' validity.

Accepted constructs from previous research studies were utilized to develop the instrument and validate its reliability and validity. The survey contained a 5-point Likert-type scale to evaluate delicate participant viewpoints using responses ranging from 1 (strongly disagree) to 5 (strongly agree). Organizations are measured for remote supply chain agility by assessing their speed in responding to disruptions, operational flexibility, and resilience levels. The evaluation process of supply chain integration requires the assessment of collaborative processes, communication systems, and multi-industry teamwork activities. A sustainable logistic analysis includes eco-friendly transportation approaches with waste reduction procedures and circular economic frameworks operating within humanitarian circumstances. Evaluation of disaster preparedness involves studying mechanisms that minimize risks, creating warning systems, and setting guidelines for emergency stock distribution locations. Success evaluation within humanitarian aid supply chains is based on delivery efficiency and response speed, but AI-based evaluation focuses on predictive analysis and automated systems with blockchain functionality. Studies validated the research constructs by demonstrating their utility in past research, which enabled the correct assessment of the variables.

AMOS version 24 served in SEM assessments of the relationships between study variables. Before other analyses, the researchers analyzed the respondents' demographics and perception data using descriptive statistical methods. The analysis of measurement model statistics through Confirmatory Factor Analysis helped ensure construct reliability and check convergent and discriminant validity until necessary standards were achieved. SEM path analysis helped establish both direct associations and moderation effects within the supply chain framework, where AI examined the relationships between supply chain agility, integration, sustainable logistics, disaster preparedness, and performance measures of humanitarian supply chains. The proposed model obtained its good fit analysis through the use of four evaluation criteria, which included root mean square error of approximation (RMSEA), comparative fit index (CFI), Tucker-Lewis Index (TLI), and Chi-Square by degrees of freedom (Chi-Square/df).

The research methodology enabled valid results through its complete research design. The study boosts research about AI-enabled humanitarian logistics since it applies structured methodology with standardized measurement tools and advanced analytical methods for sustainable development implementation. The subsequent part of this section presents evidence of variable relationships that result in better humanitarian supply chain performance outcomes.

4. RESULTS AND ANALYSIS

The study yielded empirical evidence about supply chain agility, supply chain integration methods, sustainable logistics, and disaster preparedness strategies that impact humanitarian supply chain performance while analyzing how AI influences SDG execution. The research study includes professionals representing different humanitarian logistics fields operating in Jordan. Statistical findings demonstrate that the humanitarian workforce comprises 56.7% male professionals and 43.3% female professionals. The survey results show that mid-career humanitarian supply chain managers are leading involvement due to 42.1% of participants falling within 30-39 years old and 28.3% aged 40-49. Analyzing the participants reveals an advanced skill level because sixty-four-point five percent hold graduate-level qualifications or equivalent. Major humanitarian stakeholders provided insights through the study, with international NGOs making up 35.4%. In comparison, United Nations agencies comprise 27.9%, local NGOs constitute 21.2%, and 15.5% belong to government humanitarian departments across operations. Data reliability gains strength from the respondents, who represent 58.1% of participants with more than ten years of professional experience.

SEM analysis showed good empirical backing for all hypothesis propositions yet several study restrictions require acknowledgment. Rare linear relationships between variables exist within the model structure even though humanitarian logistics operations might not function this way. Future studies should evaluate additional variables and measurement errors because the good model fit observed in this research needs further refinement to enhance AI-driven supply chain prediction accuracy.

The research employed Confirmatory Factor Analysis (CFA) to examine the measurement constructs' reliability and validity. Robust reliability emerged through Cronbach's Alpha (α) and Composite Reliability (CR) values, which exceeded 0.70 to indicate solid internal consistency. The measurement constructs properly measured theoretical dimensions through Average Variance Extracted (AVE) values, which exceeded 0.50. Evaluation of the constructs measured their distinctiveness [72]. The measurement model alignment indicates sufficient performance according to CFI = 0.943, TLI = 0.929 and RMSEA = 0.045, Chi-Square/df = 2.22 [73]. The selected model correctly visualizes important relationships between variables, making it suitable for hypothesis building.

Hypothesis testing provided evidence that supply chain agility, along with supply chain integration, sustainable logistics, and disaster preparedness, substantially impact humanitarian supply chain performance, confirming the established theoretical model. Research data indicates a strong positive correlation between supply chain agility ($\beta = 0.37$, $p < 0.001$) along with supply chain integration ($\beta = 0.42$, $p < 0.001$) and sustainable logistics ($\beta = 0.34$, $p < 0.001$) and disaster preparedness ($\beta = 0.29$, $p < 0.001$) and humanitarian supply chain performance. AI application strengthens the entire set of relationships the analysis detected as positive. AI strengthens the relationships between supply chain agility and humanitarian supply chain performance ($\beta = 0.21$, $p < 0.001$) as well as supply chain integration ($\beta = 0.25$, $p < 0.001$), sustainable logistics ($\beta = 0.27$, $p < 0.001$), and disaster preparedness ($\beta = 0.22$, $p < 0.001$). The research validates discoveries about how AI enhances decision quality and improves resource management and prediction abilities in humanitarian supply chains. This study shows how implementing AI systems can enhance operational achievement, load disaster readiness capabilities, and improve supply chain response capability, which helps achieve SDGs through better supply chain execution. Research findings provide strong evidence to support the hypothesis that humanitarian organizations require funding for AI solutions for better supply chain operational outcomes and capabilities.

Table 1. Demographic profile of respondents

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	182	56.7%
	Female	139	43.3%
Age Group	18-29 years	53	16.5%
	30-39 years	135	42.1%
	40-49 years	91	28.3%
	50+ years	42	13.1%
Education Level	Bachelor's Degree	114	35.5%
	Master's Degree	141	43.9%
	PhD	66	20.6%
Organizational Affiliation	International NGO	114	35.4%
	UN Agency	90	27.9%
	Local NGO	68	21.2%
	Government Entity	49	15.5%
Years of Experience	Less than 5 years	45	14.0%
	5-10 years	90	28.0%
	More than 10 years	186	58.1%

The demographic composition of the respondents is given in Table 1 and the representation is balanced in gender, age, level of education and organization affiliation. However, it is worth mentioning that the majority of participants possess over 10 years of experience.

Table 2. Reliability and validity assessment

Construct	No. of Items	Factor Loadings	AVE	CR	Cronbach's Alpha (α)
Supply Chain Agility	4	0.72 – 0.89	0.61	0.84	0.81
Supply Chain Integration	4	0.70 – 0.88	0.60	0.83	0.79
Sustainable Logistics	4	0.69 – 0.87	0.58	0.82	0.78
Disaster Preparedness	5	0.71 – 0.91	0.63	0.86	0.82
Humanitarian Supply Chain Performance	4	0.73 – 0.89	0.64	0.87	0.84
AI (Moderator)	4	0.74 – 0.88	0.65	0.86	0.83

Table 3. Model fit indices

Fit Index	Obtained Value	Recommended Threshold	Decision
CFI	0.943	> 0.90	Good
TLI	0.929	> 0.90	Good
RMSEA	0.045	< 0.08	Good
Chi-Square/df	2.22	< 3.00	Good

Table 4. Hypothesis testing results

Hypothesis	Path Coefficient (β)	S.E.	C.R.	P-Value	Decision
H1: Supply Chain Agility → Humanitarian Supply Chain Performance	0.37	0.06	6.15	< 0.001	Supported
H2: Supply Chain Integration → Humanitarian Supply Chain Performance	0.42	0.07	6.83	< 0.001	Supported
H3: Sustainable Logistics → Humanitarian Supply Chain Performance	0.34	0.06	5.96	< 0.001	Supported
H4: Disaster Preparedness → Humanitarian Supply Chain Performance	0.29	0.05	5.47	< 0.001	Supported
H5: AI moderates Supply Chain Agility → Humanitarian Supply Chain Performance	0.21	0.04	4.93	< 0.001	Supported
H6: AI moderates Supply Chain Integration → Humanitarian Supply Chain Performance	0.25	0.05	5.21	< 0.001	Supported
H7: AI moderates Sustainable Logistics → Humanitarian Supply Chain Performance	0.27	0.05	5.36	< 0.001	Supported
H8: AI moderates Disaster Preparedness → Humanitarian Supply Chain Performance	0.22	0.05	4.97	< 0.001	Supported

The results of reliability and validity assessment for all constructs are presented in Table 2, where it indicates all constructs' factor loadings, AVE, CR, and Cronbach's Alpha values are satisfactory thus signifying that all the constructs are internally consistent and they have satisfactory convergent validity.

All the values resulting from the model fit indices are found in Table 3, and as it is shown in the table, all of the values meet the recommended thresholds, therefore demonstrating that there is a good model fit.

Results of the hypothesis testing, Table 4 finds that all the proposed hypotheses are supported, as revealed in the significant path coefficients proving the positive effect of the proposed supply chain factors and AI moderation to performance of humanitarian supply chain.

5. LIMITATIONS OF THE STUDY

A limitation of this study is that it relies on a cross-sectional research design that limits the capacity to determine causality. The findings offer important insights into the relation between AI and resilience of humanitarian supply chains, yet an area for future research is the tracking of the evolution of AI-driven interventions in time and of their impact on the sustainability of the humanitarian logistics. Such a framework would let researchers trace supply chain performance changes across time as it relates to AI implementation, and would provide stronger evidences about causality.

An additional limitation of this study is the assumption that AI can be applied without barrier in humanitarian supply chains. Nevertheless, the practical aspects need to be taken under consideration since the implementation of the technology comes with its own set of challenges, like financial constraints, technological infrastructure gaps, as well as ethical issues around AI based decision making. It will help with a more complete understanding of the practical implications of AI, if these factors are addressed in future research.

6. DISCUSSION

The research explores crucial humanitarian supply chain aspects in Jordan by merging an evaluation between supply chain agility and supply chain integration with sustainable logistics and disaster readiness, employing AI as a connecting mechanism. The study provides substantial backing for academic research on humanitarian supply chain performance by showing the essential value of all variables analyzed based on humanitarian logistics and disaster relief studies [1, 74]. AI technology enhances organizational performance by managing supply chain operations and continuously expands its value in supply chain optimization, demand prediction, and decision-making [75]. The study faces a major problem because it uses a cross-sectional research design which prevents us from understanding how AI affects humanitarian supply chain resilience. Research needs extended observation to explore AI development changes as they improve the operational and supply chain sustainability of humanitarian logistics. A study that observes supply chain performance changes throughout time can better show if AI use causes improved results.

Supply chain agility is the main factor in achieving performance results throughout humanitarian supply chain operations ($\beta = 0.37$, $p < 0.001$). Time-sensitive aid delivery depends on quick supply chain logistics to perform emergency assistance properly at humanitarian organizations [3]. The agile supply chain structure equips humanitarian relief supply chains with speedy disruption management and delivery times to reach maximum operational excellence [38]. AI strengthens humanitarian supply chains with its agile structure by creating predictive systems that perform autonomous decisions and track operations in real time [76]. The research results demonstrate that AI is an essential moderating aspect ($\beta = 0.21$ and $p < 0.001$) for these elements.

Research evidence supports AI's constructive impact on supply chain resilience in accordance with previous studies [77, 78]. Our research shows that AI enhances strategic decision-making while improving operational agility in addition to its well-documented ability for efficiency and automation [10]. A gap exists between the current understanding of AI functions which requires more analysis about its varying effects in commercial and humanitarian supply chain settings. The research diverges from past research by demonstrating how AI achieves sustainable goals and fulfills the United Nations SDGs.

The research data supports hypothesis two, showing that supply chain integration positively affects humanitarian supply chain performance through significant statistical values ($\beta = 0.42$, $p < 0.001$). The operational framework develops thanks to supply chain integration. It creates stakeholders' collaboration to establish connections between donors and suppliers and suppliers and logistics providers [30]. Previous studies agree that information sharing, process synchronization, and collaborative decision-making form the basis of operational requirements [79]. AI systems achieve operational integration by creating digital networks and automated workflows. At the same time, they minimize supply network entity communication deficits [80] based on a statistically significant result ($\beta = 0.25$, $p < 0.001$).

The study findings show that sustainable logistics significantly impacts ($\beta = 0.34$, $p < 0.001$) the improvement of humanitarian supply chain performance. Optimized storage systems and energy-efficient solutions for sustainable logistics enable the implementation of environmental transportation [37]. Research documents demonstrate how green logistics programs generate dual advantages, promoting lower environmental destruction with reduced operational expenses and improving resource utilization [81]. The combination of AI route optimization with forecasting and inventory automation in humanitarian supply chains creates beneficial results for sustainability objectives [82]. The research investigation confirms the relationship with $\beta = 0.27$ at a significance level under ($p < 0.001$).

Research has proven that disaster preparedness significantly positively affects humanitarian supply chain performance ($\beta = 0.29$, $p < 0.001$) at a strong connection level. The planning processes of organizations through emergency preparedness lead to disaster readiness through resource backup development and risk reduction management combined with strategic resource distribution [37]. Other scientists have validated through research that strategic supply chains succeed in flexible disaster reactions [4]. The fundamental part of AI produces enhanced emergency preparedness operations by interconnecting disaster management elements ($\beta = 0.22$, $p < 0.001$) [35]. AI has great potential to improve humanitarian supply chain; It is not without its drawbacks. Oftentimes current organizations face barriers of high implementation costs, shortage of capable staff, data security issues, and resistance to digitalization. In addition, AI based decision making models need to be trained with substantial dataset availability, something that is not always possible in the crisis prone areas where data can neither be collected stably nor be relied upon. Finally, future research should look into strategies that will allow AI technology to be operationalized to support field humanitarian operations, despite the limitations mentioned.

Strategic information from this research generates operational value for supply chain operators, humanitarian officials, and their representatives in the domain of AI-based supply chain management and humanitarian logistics. Research evidence demonstrates that AI technology needs to merge with supply chains because it produces superior results in dynamic coordination and disaster relief functions [25]. Transportation systems and machine learning solutions use blockchain infrastructure and Internet-of-Things networks to generate prompt operational methods for resource distribution during humanitarian relief operations after receiving proper investment [74].

The primary contribution of this research appeared alongside the identified weaknesses because of its ability to produce important findings. The research team examined without identifying how AI influences supply chains for humanitarian relief due to static observation methods. The development of AI-driven supply chain practice requires researchers to transition from cross-sectional research designs to longitudinal approaches [83]. The research examined Jordan's human capital sector, which creates restrictions for the broad international applicability of the findings. Multiple humanitarian environments should assess their AI implementation strategies by performing comparison studies of their supply chain performance results [74]. Subsequent research must evaluate the cooperative effects between government policy elements and modern technology development with human resources management practices because these sophisticated elements would precisely determine the effects of the AI system on humanitarian logistics [40].

Combining supply chain agility and integration with sustainable logistics management and disaster preparedness systems creates maximum performance levels for humanitarian supply chains. The findings validate that AI functions as an innovative, transformative force to help emergency operations and foster collaboration, operational agility, and disaster resilience for humanitarian logistics systems. Research-based practical guidelines enable humanitarian operators, logistics firms, and government officials to make the right decisions regarding investing in AI innovation to enhance humanitarian supply chains for SDG fulfillment.

7. CONCLUSION AND IMPLICATIONS

The study examines the effects of SDG implementation on humanitarian supply chains when deploying AI variables. Available research proves that AI systems actively boost response speed and sustainable operation capabilities in humanitarian supply chain management. The AI system modems enable humanitarians to conduct assessments of supply chains and analyze coalition structures to create lasting benefits for supply chain infrastructure.

Promoting SDGs happens through humanitarian supply chains through two main channels: creating poverty elimination frameworks and environment-friendly distribution networks that deliver fair resources. Strategic decision-making capabilities arise from the implementation of AI analytics with real-time data tracking and predictive modeling systems, which improves market need identification to enhance aid distribution. The adaptive logistical operations produced by AI systems cut down operational security threats and maximize disaster resource distribution throughout the pursuit of SDG targets. The AI-based humanitarian assistance system deploys waste disposal operations to implement practical and time-efficient procedures that reduce environmental pollutants for whole disaster victim recovery.

The outcomes of this investigation benefit government decision-makers, humanitarian organizations, and technology creators. Aid organizations' core investment funds should focus on enhancing AI-supervised supply chain technology development since this joint approach will strengthen operations and boost emergency aid delivery efficiency. Public entities and non-profit organizations need to build operational systems using protective measures for data security and discrimination prevention to maintain transparency. Corporate stakeholders and technology companies must create AI solutions that merge facility tracking systems into automatic distribution service frameworks from distributed command structures.

The current research obstacles should be resolved to enable scientists to establish new experimental outcomes from this research period. Researchers conducting initial data collection fail to observe the extensive impact of AI on humanitarian logistics operations during their study period. This study requires future scientific investigations to deploy time-sensitive evaluation models that analyze the duration effects of AI-driven humanitarian supply chain operations. Research in humanitarian logistics involves the examination of regulatory standards together with societal elements that affect construction site practices and building condition needs.

AI capabilities in the examined system surpass all other systems to enhance supply chain quality while achieving multiple SDGs. Through a centralized framework, non-profit organizations that deploy AIL programs help their operations become more efficient by speeding up emergency response capabilities and development target completion. AI strategic initiatives require operational changes for humanitarian logistics operations because these initiatives produce worldwide solutions to environmental change problems, resource scarcity demands, and disaster management needs that lead to sustainable, fair outcomes. This future research should inform longitudinal basis studies investigating the long-term repercussions of integration of the AI into humanitarian supply chains. By taking this approach, the insights would be valuable in knowing how more sustainable AI-driven improvements are and how they contribute to building long term resilience. This also requires further studies from the perspectives of cooperative effects of government policy elements, modern technology development, and human resources management practices which would specifically affect the effects of AI systems on humanitarian logistics. Using these methodologies would allow the researchers to provide more conclusive evidence on how AI can help humanitarian supply chain performance towards achieving SDGs. The potential of AI for transformative impact on humanitarian supply chains is highlighted by this study with its focus on the specific contributions to agility, integration, and sustainability. From a practical point of view, humanitarian organizations should invest money in AI to rescue the resources and prepare for disasters. They also need to create supportive frameworks that encourage as much as possible the adoption of AI in the crisis settings. These findings should be further investigated by future research extending across a number of years and crossing regional boundaries.

ACKNOWLEDGMENT

I sincerely thank Middle East University for its generous financial support in covering the publication fees of this research. This support reflects the university's commitment to fostering academic research and innovation, contributing to sustainable development.

REFERENCES

[1] Van Wassenhove, L.N. (2006). Humanitarian aid logistics: Supply chain management in high gear. Journal of the Operational Research Society, 57(5): 475-489. https://doi.org/10.1057/palgrave.jors.2602125

[2] Kovács, G., Spens, K.M. (2007). Humanitarian logistics in disaster relief operations. International Journal of Physical Distribution & Logistics Management, 37(2): 99-114. https://doi.org/10.1108/09600030710734820

[3] Dubey, R., Gunasekaran, A., Childe, S.J., Bryde, D.J., Giannakis, M., Foropon, C., Hazen, B.T. (2020). Big data analytics and artificial intelligence pathway to operational performance under the effects of entrepreneurial orientation and environmental dynamism: A study of manufacturing organisations. International Journal of Production Economics, 226: 107599. https://doi.org/10.1016/j.ijpe.2019.107599

[4] Ali, A.A.A., Udin, Z.M., Abualrejal, H.M.E. (2023). The impact of humanitarian supply chain on non-government organizations performance moderated by organisation culture. International Journal of Sustainable Development and Planning, 18(3): 763-772. https://doi.org/10.18280/ijsdp.180312

[5] Scholten, K., Sharkey Scott, P., Fynes, B. (2010). (Le) agility in humanitarian aid (NGO) supply chains. International Journal of Physical Distribution & Logistics Management, 40(8/9): 623-635. https://doi.org/10.1108/09600031011079292

[6] Scholten, K., Sharkey Scott, P., Fynes, B. (2014). Mitigation processes–antecedents for building supply chain resilience. Supply Chain Management: An International Journal, 19(2): 211-228. https://doi.org/10.1108/SCM-06-2013-0191

[7] De Boeck, K., Besiou, M., Decouttere, C., Rafter, S., Vandaele, N., Van Wassenhove, L.N., Yadav, P. (2023). Data, analytical techniques and collaboration between researchers and practitioners in humanitarian health supply chains: A challenging but necessary way forward. Journal of Humanitarian Logistics and Supply Chain Management, 13(3): 237-248. https://doi.org/10.1108/JHLSCM-07-2022-0078

[8] Charnes, A., Cooper, W.W., Golany, B., Seiford, L., Stutz, J. (1985). Foundations of data envelopment analysis for Pareto-Koopmans efficient empirical production functions. Journal of Econometrics, 30(1-2): 91-107. https://doi.org/10.1016/0304-4076(85)90133-2

[9] Kumar, N., Hasan, S.S., Srivastava, K., Akhtar, R., Yadav, R.K., Choubey, V.K. (2022). Lean manufacturing techniques and its implementation: A review. Materials Today: Proceedings, 64: 1188-1192. https://doi.org/10.1016/j.matpr.2022.03.481

[10] Govindan, K., Soleimani, H., Kannan, D. (2015). Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. European Journal of Operational Research, 240(3): 603-626. https://doi.org/10.1016/j.ejor.2014.07.012

[11] Cegarra-Navarro, J.G., Soto-Acosta, P., Wensley, A.K. (2016). Structured knowledge processes and firm performance: The role of organizational agility. Journal of Business Research, 69(5): 1544-1549. https://doi.org/10.1016/j.jbusres.2015.10.014

[12] Lei, L.P., Lin, K.P., Huang, S.S., Tung, H.H., Tsai, J.M., Tsay, S.L. (2022). The impact of organisational commitment and leadership style on job satisfaction of nurse practitioners in acute care practices. Journal of Nursing Management, 30(3): 651-659. https://doi.org/10.1111/jonm.13562

[13] Heizer, J., Reder, B., Muson, C. (2017). Operations Management: Sustainability and Supply Chain Management (12th Edition).

[14] Kiswili, N.E., Shale, I.N., Osoro, A. (2021). Influence of supply chain leagility on performance of humanitarian aid organizations in Kenya. Journal of Business and Economic Development, 6(1): 37. https://doi.org/10.11648/j.jbed.20210601.15
[15] Baryannis, G., Validi, S., Dani, S., Antoniou, G. (2019). Supply chain risk management and artificial intelligence: State of the art and future research directions. International Journal of Production Research, 57(7): 2179-2202. https://doi.org/10.1080/00207543.2018.1530476
[16] Rebelo, R.M.L., Pereira, S.C.F., Queiroz, M.M. (2022). The interplay between the Internet of Things and supply chain management: Challenges and opportunities based on a systematic literature review. Benchmarking: An International Journal, 29(2): 683-711. https://doi.org/10.1108/BIJ-02-2021-0085
[17] Lu, D., Ding, Y., Asian, S., Paul, S.K. (2018). From supply chain integration to operational performance: The moderating effect of market uncertainty. Global Journal of Flexible Systems Management, 19: 3-20. https://doi.org/10.1007/s40171-017-0161-9
[18] Zhou, X., Lu, H., Mangla, S.K. (2024). The impact of digital traceability on sustainability performance: Investigating the roles of sustainability-oriented innovation and supply chain learning. Supply Chain Management: An International Journal, 29(3): 497-522. https://doi.org/10.1108/SCM-01-2023-0047
[19] Baškarada, S., Koronios, A. (2018). The 5S organizational agility framework: A dynamic capabilities perspective. International Journal of Organizational Analysis, 26(2): 331-342. https://doi.org/10.1108/IJOA-05-2017-1163
[20] Stirk, C. (2014). Humanitarian assistance from non-state donors: What is it worth? Global Humanitarian Assistance Briefing Paper. http://www.globalhumanitarianassistance.org/report/humanitarian-assistance-non-state-donors.
[21] Negri, M., Cagno, E., Colicchia, C., Sarkis, J. (2021). Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. Business Strategy and the Environment, 30(7): 2858-2886. https://doi.org/10.1002/bse.2776
[22] Yang, J. (2014). Supply chain agility: Securing performance for Chinese manufacturers. International Journal of Production Economics, 150: 104-113. https://doi.org/10.1016/j.ijpe.2013.12.018
[23] Ali, I., Gligor, D., Balta, M., Bozkurt, S., Papadopoulos, T. (2024). From disruption to innovation: The importance of the supply chain leadership style for driving logistics innovation in the face of geopolitical disruptions. Transportation Research Part E: Logistics and Transportation Review, 187: 103583. https://doi.org/10.1016/j.tre.2024.103583
[24] Gupta, R., Rathore, B., Biswas, B. (2022). Impact of COVID-19 on supply chains: Lessons learned and future research directions. International Journal of Quality & Reliability Management, 39(10): 2400-2423. https://doi.org/10.1108/IJQRM-06-2021-0161
[25] Taherdoost, H., Madanchian, M. (2023). Artificial intelligence and sentiment analysis: A review in competitive research. Computers, 12(2): 37. https://doi.org/10.3390/computers12020037
[26] Ahmed, Y., Dutta, K.R., Nepu, S.N.C., Prima, M., AlMohamadi, H., Akhtar, P. (2025). Optimizing photocatalytic dye degradation: A machine learning and metaheuristic approach for predicting methylene blue in contaminated water. Results in Engineering, 25: 103538. https://doi.org/10.1016/j.rineng.2024.103538
[27] Duong, N.H., Ha, Q.A. (2021). The links between supply chain risk management practices, supply chain integration and supply chain performance in Southern Vietnam: A moderation effect of supply chain social sustainability. Cogent Business & Management, 8(1): 1999556. https://doi.org/10.1080/23311975.2021.1999556
[28] Cheng, T.C.E., Farahani, R.Z., hung Lai, K., Sarkis, J. (2015). Sustainability in maritime supply chains: Challenges and opportunities for theory and practice. Transportation Research Part E: Logistics and Transportation Review, 78: 1-2.
[29] Szwejczewski, M., Lemke, F., Goffin, K. (2005). Manufacturer-supplier relationships: An empirical study of German manufacturing companies. International Journal of Operations & Production Management, 25(9): 875-897. https://doi.org/10.1108/01443570510613947
[30] Gunasekaran, A., Dubey, R., Fosso Wamba, S., Papadopoulos, T., Hazen, B.T., Ngai, E.W. (2018). Bridging humanitarian operations management and organisational theory. International Journal of Production Research, 56(21): 6735-6740. https://doi.org/10.1080/00207543.2018.1551958
[31] Alrifai, K., Obaid, T., Ali, A.A.A., Abulehia, A.F., Abualrejal, H.M.E., Nassoura, M.B.A.R. (2022). The role of artificial intelligence in project performance in construction companies in Palestine. In International Conference on Information Systems and Intelligent Applications. Springer, Cham, pp. 71-82. https://doi.org/10.1007/978-3-031-16865-9_6
[32] Jermsittiparsert, K., Kampoomprasert, A. (2019). The agility, adaptability, and alignment as the determinants of the sustainable humanitarian supply chain design. Humanities & Social Sciences Reviews, 7(2): 539-547. https://doi.org/10.18510/hssr.2019.7264
[33] Brooks, S.K., Dunn, R., Sage, C.A.M., Amlôt, R., Greenberg, N., Rubin, G.J. (2015). Risk and resilience factors affecting the psychological wellbeing of individuals deployed in humanitarian relief roles after a disaster. Journal of Mental Health, 24(6): 385-413. https://doi.org/10.3109/09638237.2015.1057334
[34] Dubey, R., Singh, T., Gupta, O.K. (2015). Impact of agility, adaptability and alignment on humanitarian logistics performance: Mediating effect of leadership. Global Business Review, 16(5): 812-831. https://doi.org/10.1177/0972150915591463
[35] Wilson, M.M., Tatham, P., Payne, J., L'Hermitte, C., Shapland, M. (2018). Best practice relief supply for emergency services in a developed economy: Evidence from Queensland Australia. Journal of Humanitarian Logistics and Supply Chain Management, 8(1): 107-132. https://doi.org/10.1108/JHLSCM-03-2017-0008
[36] Samara, A., Sweis, R.J., Tarawneh, B., Albalkhy, W., Sweis, G., Alhomsi, S. (2022). Sustainability management of international development projects by international non-governmental organizations: The case of INGOs working with refugees in Jordan. International Journal of Construction Management, 22(9): 1657-1666. https://doi.org/10.1080/15623599.2020.1741490

[37] Abidi, H., De Leeuw, S., Klumpp, M. (2014). Humanitarian supply chain performance management: A systematic literature review. Supply Chain Management: An International Journal, 19(5/6): 592-608. https://doi.org/10.1108/SCM-09-2013-0349
[38] Christopher, M., Peck, H. (2004). Building the resilient supply chain. International Journal of Logistics Management, 15(2): 1-14. https://doi.org/10.1108/09574090410700275
[39] Hazen, B.T., Boone, C.A., Ezell, J.D., Jones-Farmer, L.A. (2014). Data quality for data science, predictive analytics, and big data in supply chain management: An introduction to the problem and suggestions for research and applications. International Journal of Production Economics, 154: 72-80. https://doi.org/10.1016/j.ijpe.2014.04.018
[40] Leiras, A., de Brito Jr, I., Queiroz Peres, E., Rejane Bertazzo, T., Tsugunobu Yoshida Yoshizaki, H. (2014). Literature review of humanitarian logistics research: Trends and challenges. Journal of Humanitarian Logistics and Supply Chain Management, 4(1): 95-130. https://doi.org/10.1108/JHLSCM-04-2012-0008
[41] Yadav, O.P., Nepal, B., Goel, P.S., Jain, R., Mohanty, R.P. (2010). Insights and learnings from lean manufacturing implementation practices. International Journal of Services and Operations Management, 6(4): 398-422. https://doi.org/10.1504/IJSOM.2010.032916
[42] Behl, A., Dutta, P. (2019). Humanitarian supply chain management: A thematic literature review and future directions of research. Annals of Operations Research, 283(1): 1001-1044. https://doi.org/10.1007/s10479-018-2806-2
[43] Pinto, J.L.Q., Matias, J.C.O., Pimentel, C., Azevedo, S.G., Govindan, K., Pinto, J.L.Q., Govindan, K. (2018). Introduction to lean and just-in-time manufacturing. Just in Time Factory: Implementation Through Lean Manufacturing Tools, 2018: 1-4. https://doi.org/10.1007/978-3-319-77016-1_1
[44] Agarwal, S., Kant, R., Shankar, R. (2019). Humanitarian supply chain management frameworks: A critical literature review and framework for future development. Benchmarking: An International Journal, 26(6): 1749-1780. https://doi.org/10.1108/BIJ-08-2018-0245
[45] Hunt, S.D., Davis, D.F. (2008). Grounding supply chain management in resource-advantage theory. Journal of Supply Chain Management, 44(1): 10-21. https://doi.org/10.1111/j.1745-493X.2008.00042.x
[46] Ezmigna, I., Alghizzawi, M., Alqsass, M., Abu-AlSondos, I.A., Abualfalayeh, G., Alkaabi, H. (2024). The impact of digital banking innovations on supply chain integration in the e-commerce sector in Saudi Arabia: A qualitative approach. In 2024 International Conference on Decision Aid Sciences and Applications (DASA), Manama, Bahrain, pp. 1-7. https://doi.org/10.1109/DASA63652.2024.10836607
[47] Yusuf, M., Parung, H., Ali, M.S., Mahyuddin. (2025). Environmental and natural resources impact of road infrastructure development in Sidenreng Rappang District, Indonesia: Dynamic consideration and policies. International Journal of Environmental Impacts, 8(1): 9-19. https://doi.org/10.18280/ijei.080102
[48] Khalifa, M. (2024). Integrating sustainable decision-making frameworks in engineering: Political implications for sustainable development. In 2024 International Conference on Decision Aid Sciences and Applications (DASA), Manama, Bahrain, pp. 1-7. https://doi.org/10.1109/DASA63652.2024.10836533
[49] Rodon, J., Serrano, J.F.M., Gimenez, C. (2012). Managing cultural conflicts for effective humanitarian aid. International Journal of Production Economics, 139(2): 366-376. https://doi.org/10.1016/j.ijpe.2011.08.029
[50] Azmat, M. (2019). Importance of key success factors for local and international NGOs in humanitarian supply chain. Scientific Journal of Logistics, 15(4): 545-555. http://doi.org/10.17270/J.LOG.2019.372
[51] Fan, C., Zhang, C., Yahja, A., Mostafavi, A. (2021). Disaster city digital twin: A vision for integrating artificial and human intelligence for disaster management. International Journal of Information Management, 56: 102049. https://doi.org/10.1016/j.ijinfomgt.2019.102049
[52] Rahman, N.A.A., Ahmi, A., Jraisat, L., Upadhyay, A. (2022). Examining the trend of humanitarian supply chain studies: Pre, during and post COVID-19 pandemic. Journal of Humanitarian Logistics and Supply Chain Management, 12(4): 594-617. https://doi.org/10.1108/JHLSCM-01-2022-0012
[53] Blecken, A. (2010). Supply chain process modelling for humanitarian organizations. International Journal of Physical Distribution & Logistics Management, 40(8/9): 675-692. https://doi.org/10.1108/09600031011079328
[54] Haavisto, I., Goentzel, J. (2015). Measuring humanitarian supply chain performance in a multi-goal context. Journal of Humanitarian Logistics and Supply Chain Management, 5(3): 300-324. https://doi.org/10.1108/JHLSCM-07-2015-0028
[55] Roy, S., Das, M., Ali, S.M., Raihan, A.S., Paul, S.K., Kabir, G. (2020). Evaluating strategies for environmental sustainability in a supply chain of an emerging economy. Journal of Cleaner Production, 262: 121389. https://doi.org/10.1016/j.jclepro.2020.121389
[56] Chowdhury, M.M.H., Quaddus, M.A. (2021). Supply chain sustainability practices and governance for mitigating sustainability risk and improving market performance: A dynamic capability perspective. Journal of Cleaner Production, 278: 123521. https://doi.org/10.1016/j.jclepro.2020.123521
[57] Atieh Ali, A.A., Sharabati, A.A.A., Allahham, M., Nasereddin, A.Y. (2024). The relationship between supply chain resilience and digital supply chain and the impact on sustainability: Supply chain dynamism as a moderator. Sustainability, 16(7): 3082. https://doi.org/10.3390/su16073082
[58] Singh, P.K., Maheswaran, R. (2024). Analysis of social barriers to sustainable innovation and digitisation in supply chain. Environment, Development and Sustainability, 26(2): 5223-5248. https://doi.org/10.1007/s10668-023-02931-9
[59] Friday, D., Savage, D.A., Melnyk, S.A., Harrison, N., Ryan, S., Wechtler, H. (2021). A collaborative approach to maintaining optimal inventory and mitigating stockout risks during a pandemic: Capabilities for enabling health-care supply chain resilience. Journal of Humanitarian Logistics and Supply Chain Management, 11(2): 248-271. https://doi.org/10.1108/JHLSCM-07-2020-0061
[60] Bag, S., Gupta, S., Foropon, C. (2019). Examining the role of dynamic remanufacturing capability on supply

chain resilience in circular economy. Management Decision, 57(4): 863-885. https://doi.org/10.1108/MD-07-2018-0724

[61] Tabassum, R. (2018). The readiness of NGOs for health-related SDGs in Pakistan. South Asia@ LSE.

[62] Teece, D.J., Pisano, G., Shuen, A. (1997). Dynamic capabilities and strategic management. Strategic Management Journal, 18(7): 509-533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

[63] Bag, S., Telukdarie, A., Pretorius, J.C., Gupta, S. (2021). Industry 4.0 and supply chain sustainability: Framework and future research directions. Benchmarking: An International Journal, 28(5): 1410-1450. https://doi.org/10.1108/BIJ-03-2018-0056

[64] Tiwari, M.K., Bidanda, B., Geunes, J., Fernandes, K., Dolgui, A. (2024). Supply chain digitisation and management. International Journal of Production Research, 62(8): 2918-2926. https://doi.org/10.1080/00207543.2024.2316476

[65] Nwagwu, U., Niaz, M., Chukwu, M.U., Saddique, F. (2023). The influence of artificial intelligence to enhancing supply chain performance under the mediating significance of supply chain collaboration in manufacturing and logistics organizations in Pakistan. Traditional Journal of Multidisciplinary Sciences, 1(2): 29-40.

[66] Al-Tarawneha, A., Haddada, E., Mo'd Al-Dwairi, R., Yahya Al-Freijat, S., Mansour, A., Abdulaziz AL-Obaidly, G. (2024). The impact of strategic and innovativeness entrepreneurship and social capital on business overall performance through building a sustainable supply chain management at Jordan Private Universities. Uncertain Supply Chain Management, 12(1): 65-76. https://doi.org/10.5267/j.uscm.2023.10.017

[67] Dubey, R., Gunasekaran, A. (2016). The sustainable humanitarian supply chain design: Agility, adaptability and alignment. International Journal of Logistics Research and Applications, 19(1): 62-82. https://doi.org/10.1080/13675567.2015.1015511

[68] Hilhorst, D., Desportes, I., de Milliano, C.W. (2019). Humanitarian governance and resilience building: Ethiopia in comparative perspective. Disasters, 43: S109-S131. https://doi.org/10.1111/disa.12332

[69] Umar, M., Wilson, M., Heyl, J. (2017). Food network resilience against natural disasters: A conceptual framework. Sage Open, 7(3): 2158244017717570. https://doi.org/10.1177/2158244017717570

[70] Sahay, B.S., Gupta, S., Menon, V.C. (2016). Managing Humanitarian Logistics. Springer. https://doi.org/10.1007/978-81-322-2416-7

[71] Day, J.M., Melnyk, S.A., Larson, P.D., Davis, E.W., Whybark, D.C. (2012). Humanitarian and disaster relief supply chains: A matter of life and death. Journal of Supply Chain Management, 48(2): 21-36. https://doi.org/10.1111/j.1745-493X.2012.03267.x

[72] Fornell, C., Larcker, D.F. (1981). Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research, 18(1): 39-50. https://doi.org/10.1177/002224378101800104

[73] Hair Jr, J., Page, M., Brunsveld, N. (2019). Essentials of Business Research Methods. Routledge. https://doi.org/10.4324/9780429203374

[74] Tabaklar, T., Halldórsson, Á., Kovács, G., Spens, K. (2015). Borrowing theories in humanitarian supply chain management. Journal of Humanitarian Logistics and Supply Chain Management, 5(3): 281-299. https://doi.org/10.1108/JHLSCM-07-2015-0029

[75] Ivanov, D. (2022). Viable supply chain model: Integrating agility, resilience and sustainability perspectives—lessons from and thinking beyond the COVID-19 pandemic. Annals of Operations Research, 319(1): 1411-1431. https://doi.org/10.1007/s10479-020-03640-6

[76] Ibrahim, I., Alzubi, M.M.S. (2024). The impact of green human resource management practices (GHRMPs) on turnover intention (TI): Moderated by work-health balance (WHB) and work-family balance (WFB). Journal of Ecohumanism, 3(7): 2618-2634. https://doi.org/10.62754/joe.v3i7.4405

[77] Dubey, R., Gunasekaran, A., Childe, S.J., Papadopoulos, T., Luo, Z., Roubaud, D. (2020). Upstream supply chain visibility and complexity effect on focal company's sustainable performance: Indian manufacturers' perspective. Annals of Operations Research, 290: 343-367. https://doi.org/10.1007/s10479-017-2544-x

[78] Ivanov, D., Dolgui, A., Sokolov, B. (2019). Handbook of Ripple Effects in the Supply Chain. New York: Springer. https://doi.org/10.1007/978-3-030-14302-2

[79] Aboramadan, M. (2018). NGOs management: A roadmap to effective practices. Journal of Global Responsibility, 9(4): 372-387. https://doi.org/10.1108/JGR-08-2018-0033

[80] Waller, M.A., Fawcett, S.E. (2013). Data science, predictive analytics, and big data: A revolution that will transform supply chain design and management. Journal of Business Logistics, 34(2): 77-84. https://doi.org/10.1111/jbl.12010

[81] Altay, N., Gunasekaran, A., Dubey, R., Childe, S.J. (2018). Agility and resilience as antecedents of supply chain performance under moderating effects of organizational culture within the humanitarian setting: A dynamic capability view. Production Planning & Control, 29(14): 1158-1174. https://doi.org/10.1080/09537287.2018.1542174

[82] Ivanov, D., Dolgui, A., Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. International Journal of Production Research, 57(3): 829-846. https://doi.org/10.1080/00207543.2018.1488086

[83] Orji, I.J., Kusi-Sarpong, S., Okwara, U.K. (2024). Sustainability and the digital supply chain. In The Palgrave Handbook of Supply Chain Management. Palgrave Macmillan, Cham, pp. 1467-1485. https://doi.org/10.1007/978-3-031-19884-7_93