Role of Disruptive Technology and Artificial Intelligence in Effective Logistics and Distribution Management: An Empirical Investigation

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Abstract

Real-time data can be collected and analysed with the assistance of artificial intelligence and digital technological that would enable faster and more accurate decision-making and enable ascertaining of patterns and trends of market. Involvement of such technological tools and with the disruption of technology in the system improves operational efficiency, helps in reduction of cost, improves customer satisfaction as technology and AI helps in identifying and resolving the issues and challenges rapidly and proficiently. The objective is to show the significance of disruptive technologies and artificial intelligence on logistics and distribution management and how it is beneficial for distribution and logistics operations. A significant impact is made by artificial intelligence on supply chain in this era of data analytics. It also anticipates to generate new opportunities for business firms all over the world. Implementation of new technological tools would improve complete system of supply chain by providing insights with regards to probable disruptions early and remove it. A sample of 233 respondents was collected from people working in logistic and supply chain management departments in different sectors. Four factors that determine the role of Disruptive Technology and Artificial Intelligence in Effective Logistics and Distribution Management are Optimizing of Logistics & SCM Operations, Warehouse Management, Customer Experience, and Risk Management.

Keywords: Disruptive Technologies, Artificial Intelligence, Logistic Management, Supply chain

Introduction

AI-powered logistics and supply chain management systems are continuously evolving and becoming more sophisticated. They offer businesses a competitive advantage by improving efficiency, reducing costs, enhancing customer satisfaction, and adapting to changing market conditions. As AI technology continues to advance, its role in logistics and supply chain management will likely become even more central to modern businesses. Artificial intelligence (AI) and blockchain technologies have been increasingly leveraged across various aspects of logistics, distribution and supply chain management. These innovations play crucial roles in improving efficiency, security, and transparency. However, despite their potential benefits, their widespread adoption still faces limitations mainly related to cost and complexity, and challenges regarding standardization of such technologies **(Rickardo & Gladson, 2023).** Implementation of AI into logistics and supply chain management transforms businesses operations and optimize its supply chains. Application of artificial intelligence provides many advantages, like enhanced capability of decision-making, improved productivity, and visibility and efficient tracking of supply chain. Moreover, AI enables real-time monitoring and tracking of goods as they navigate the supply chain, therefore increases its transparency and reduces the exposure to disruptions. This collaboration of Artificial intelligence and supply chain management has the potential to restyle the industry, providing businesses with the tools required to restructure business operations and beat competitors in complicated global market **(Ahmed et al., 2023).** The incorporation of AI enhances logistics and supply chain management from perspectives of Agile and Lean both. It has the potential to boost responsiveness, increase flexibility, minimize waste, foster collaboration, and enhance customer satisfaction. However, it's vital to recognize that executing AI in logistics and supply chain management need significant resources and proficiency and brings into view prominent concerns of ethics, mainly regarding privacy of data and security.

Therefore, it's important for companies to assess carefully the feasibility and risks before executing on AI integration in their SCM and logistic operation system **(Mohsen, 2023).** Digital disruption in logistics and supply chain management refers to the profound transformation brought about by digital technologies and innovations in the way goods and services are transported, tracked, and managed across the entire supply chain. This disruption has a significant impact on businesses, consumers, and the global economy. A remarkable evolution in AI has been seen in recent years, represented by the latest generation of "large language models (LLMs)" that show human-like capabilities across various areas. However, the field of supply chain management observed to be unprepared for the potential disturbance that technology tools can bring. Present viewpoints fail to apprehend the disruptive potential of AI, and it's worth observing that integration of technology into supply chain management is not just a technical endeavour but also a social endeavour **(Hendriksen, 2023).** Responding to significant disruptions of technology, optimization of supply chain has become more in agreement to the sensitive hopes of customers, unpredicted demand fluctuations, and the challenges of management of inventory costs. Through active procedures, understanding, and empowerment, optimization of supply chain has generated positive results like improved cooperation and operational flexibility. Artificial Intelligence has provided customization in the form of modifications and personalization, which is effectively modifying technology disruptions at the highest range within the logistic and supply chain operations **(Kashem et al., 2023).** The integral structure of supply chain management (SCM) and logistics based on network provides a natural framework for the application of artificial intelligence (AI). Within a network of suppliers, huge amounts of data are generated, demanding important decision-making. Thus, incorporating digital tools for wide-ranging big data analysis and decision support systems (DSSs) is highly suggested. Additionally, SCM firms depend on both physical and digital systems that must effortlessly work regardless of challenges like high volumes, resource allocations, profit margins, and strict deadlines. An important role is played by artificial intelligence in enhancing coordination of network efficiently, greater human capabilities **(Toorajipour et al., 2021).** In the outcome of current disruptions of technology in supply chains because to pandemics and crises, the importance of supply chain resilience (SCRes) and performance has grown significantly. Additionally, with regards to digitalization, incorporation, and globalization of supply chains, the awareness about advanced information processing techniques like Artificial Intelligence (AI) is improved in encouraging SCRes and enhancing supply chain performance (SCP) **(Belhadi et al., 2021).** Overall, digital disruption in logistics and supply chain management is reshaping the industry by making it more efficient, transparent, and customer-centric. Businesses that embrace these technologies can gain a competitive advantage, while those that resist risk falling behind in an increasingly interconnected and data-driven world. Artificial Intelligence (AI) and Big Data Analytics (BDA) possess the potential to bring about substantial enhancements in logistics and supply chain flexibility and enable efficient management of resources of supply chain. It is achieved by accelerating recovery times, assisting in selection of suppliers, and enhancing visibility of supply chain, transparency, and receptiveness **(Zamani et al., 2023).**

Literature Review

Thakur et al. (2023) revealed that application of AI and techniques of ML has recognized to be effective and efficient in enhancing various operations of logistics and supply chain like fulfilment of orders, planning of production, and management of logistics. The incorporation of AI-driven order fulfilment systems has resulted in enhanced order processing, increased accuracy of orders, and raised customer satisfaction. A vital role is played by ML algorithms in enhancing production planning processes, leading to better production schedules, reduced lead times, and reduced cost of production. Furthermore, the execution of AI-powered logistics management systems has made prominent developments in route optimization, load balancing, and real-time visibility, consequently streamlining operations and mitigating transportation delays.

Karabulut & Civelek (2020) emphasized that digital transformation has evolved from being an optional consideration to an absolute requirement. It has become domineering for every company operating within the logistics industry and international trade to assess the areas within their business that require transformation and to identify where they may be susceptible to disruptive technologies. It is essential to view these disruptive technologies as interrelated, mutually enhancing forces rather than isolating them from one another. While these technologies may not completely replace existing methods at present, they are commonly employed alongside traditional production and logistics activities in a hybrid model.

Chauhan et al. (2022) highlighted that sustainability integration is crucial in supply chain management to promote responsible consumption and production. The study identified several key areas where technology plays a pivotal role,

including real-time tracking, inventory optimization, digital trading, demand analysis, and operational management optimization. To enhance social sustainability in SCM, the study recommends the integration of technologies such as blockchain, and AI.

Rege (2023) stated that AI has the potential to improve SCM efficiency and significantly. Organizations who are empowered by artificial intelligence detects and address potential disruptions proactively, thus reducing their impact. Furthermore, AI enables the identification of new opportunities and the optimize the processes throughout the entire network of supply chain. The study emphasizes on the significant influence on stock management, efficiency of warehouse, safety enhancements, and cost reduction. It is clear that AI, in this age of data analytics, will play a transformative role in supply chain management, creating fresh prospects for companies across various industries. The adoption of AI is a strategic move to enhance supply chain efficiency and agility, providing early insights into potential disruptions and facilitating their mitigation while also identifying new optimization avenues throughout the supply chain network.

Mallieswari and Mishra (2023) highlighted the key functions of Locus, emphasizing its role in course and route planning, real-time tracking, statistical distance analysis, and determining optimal alternatives. These features significantly reduced costs in transportation and warehousing for businesses. Interestingly, the study revealed that the respondents exhibited a slight over-reliance on AI capabilities while lacking awareness of the associated establishment and maintenance costs. However, as reported by employees, it was evident that adopting AI technology was a more cost-effective and efficient choice compared to manual processes within their departments. It can be concluded that integrating new technologies, such as AI, into business operations offers numerous advantages and enhancements.

Borodavko, Illes, and Banyai (2021) highlighted the significance of digitizing the Supply Chain to align with evolving demands and expectations of customer. Effective inventory management emerged as a critical pillar of Supply Chain Management, directly impacting a company's cash flow and profit margins. Machine learning, particularly in the context of inventory management, was identified as a prominent application within Supply Chain Management. AI's ability to process, analyse, and interpret large real-time datasets is invaluable for accurately forecasting supply and demand, ultimately preventing overstocking or understocking issues. Notably, efficient inventory management plays a pivotal role in enhancing customer satisfaction, as poor stock management can lead to product shortages and extended delivery times, harming client relationships. AI offers a solution to optimize inventory management and ensure adequate response to customer demands.

Arivazhagan (2020) revealed how emerging technologies, driven by internet services, were making significant strides in various fields. Among these, supply chain management in India was seizing the most opportunities to bolster the nation's economy. The central element in this transformation was the movement of information, as a substantial portion of supply chain activities had migrated to web-based technologies. The seamless flow of information between suppliers and companies, as well as from companies to customers, became pivotal for the success of supply chain management. Moreover, these technological advancements facilitated global market access, opening up new horizons for the supply chain industry in India, which had been rapidly evolving over the past decade. However, certain challenges loomed on the horizon. Security and technology investments posed a significant threat. The sheer scale of India's population sometimes led marketers to overlook customer care, and concerns about online breaches and data theft were not receiving the attention they deserved. To address these issues, it was imperative to implement fully secure technologies for e-business operations. Additionally, there was a pressing need for a shift in attitudes within the communication sector to ensure uninterrupted service provision. Fortunately, in more recent times, Indian laws and regulations had started to take cybercrime and data theft more seriously. Solving these three major challenges would, at the very least, draw attention to and create opportunities for the development of online businesses.

Al-MSloum (2020) stated that a prominent domain where artificial intelligence has a profound impact is in the evolving philosophy of supply chain management. This field necessitates a deep comprehension of intricate and interconnected decision-making processes. It also requires the development of intelligent knowledge repositories to address common challenges, including the synchronization of various stages in demand planning, projecting within supply chain, and forecasting end customers' demands by fostering information exchange among multiple supply chain partners and leveraging past predictive insights. Artificial intelligence applications align perfectly with the core functions crucial for effective supply chain management. Furthermore, they accommodate the evolving demands of modern SCM and foster adoption of digital tools in enhancing logistics and distribution system and refining operational strategies. Notably, the

utilization of smart databases stands out as a particularly valuable AI application in enhancing the efficiency of logistic and distribution system."

Objective

To identify the Role of Disruptive Technology and Artificial Intelligence in Effective Logistics and Distribution Management.

Methodology

This study considered a sample of 233 people was collected from people working in working in logistic and supply chain management departments in different sectors. Data was collected through Random sampling method, and scrutinized by "Explanatory Factor Analysis" to get the results.

Findings

The table below shares respondents' general details in which it is found that 49.78% are male and 50.22% are female. Among them, 30.47% are between 28 to 33 years, 38.20% are between 33-38 years, and 31.33% are above 38 years. Regarding Domains of SCM, Healthcare is 25.32 %, Agriculture is 27.03%, FMCG is 25.75%, and Others are 21.90%. Looking at the Size of Firm, Small scale firms are 35.62%, Medium scale firms are 33.04%, and large-scale firms are 31.34%.

General Details

Variables	Respondents	Percentage
Gender		
Male	116	49.78
Female	117	50.22
Total	**233**	**100**
Age (years)		
28 to 33	71	30.47
33 to 38	89	38.20
Above 38	73	31.33
Total	**233**	**100**
Domains of SCM		
Healthcare	59	25.32
Agriculture	63	27.03
FMCG	60	25.75

Others	51	21.90
Total	**233**	**100**
Size of Firm		
Small scale firm	83	35.62
Medium scale firm	77	33.04
Large scale firm	73	31.34
Total	**233**	**100**

"Factor Analysis"

"KMO and Bartlett's Test"

| Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.807
Bartlett's Test of Sphericity	Approx. Chi-Square	3422.285
	df	91
	Sig.	.000

In table "KMO and Bartlett's Test" above, KMO value found is .807

"Total Variance Explained"

"Component"	"Initial Eigenvalues"			"Rotation Sums of Squared Loadings"		
	"Total"	"% Of Variance"	Cumulative %	"Total"	"% Of Variance"	Cumulative %
1	5.652	40.375	40.375	**3.702**	26.446	26.446
2	2.779	19.847	60.222	**3.599**	25.704	52.150
3	2.170	15.501	75.723	**2.418**	17.270	69.420
4	1.312	9.372	85.095	**2.194**	15.675	**85.095**
5	.550	3.927	89.022			
6	.364	2.599	91.621			
7	.316	2.255	93.875			
8	.268	1.917	95.792			
9	.188	1.341	97.133			

10	.124	.886	98.019			
11	.102	.725	98.745			
12	.092	.658	99.402			
13	.051	.367	99.769			
14	.032	.231	100.000			

All 4 factors contribute to explain total 85.095% of variance. The variance explained by Optimizing of Logistics & SCM Operations is 26.446%, Warehouse Management is 25.704%, Customer Experience is 17.270%, and Risk Management is 15.675%.
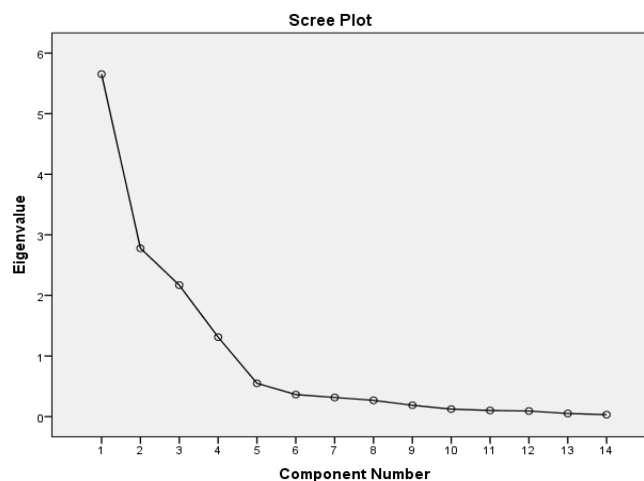
Screeplot

Rotated Component Matrix

S. No.	Statements	Factor Loading	Factor Reliability
	Optimizing of Logistics & SCM Operations		**.972**
1.	Enable better inventory management	.949	
2.	Reduce stockout or overstock situations	.945	
3.	GPS & AI driven system can plan efficient delivery routes	.938	
4.	Historical data and market trend is analyzed for accurate inventory planning	.932	

	Warehouse Management		**.960**
1.	Assist in warehouse work like picking, packing, and inventory management	.969	
2.	Improves speed and work accuracy	.943	
3.	Can monitor stock levels, and reorder supplies when required	.926	
4.	Optimize warehouse layout for better space utilization	.875	
	Customer Experience		**.887**
1.	Chatbots & virtual assistance provide real-time tracking and information	.894	
2.	Address customer's inquiry quickly enhancing customer satisfaction	.837	
3.	Analyze customer's data providing personalized products	.835	
	Risk Management		**.803**
1.	AI can predict maintenance of vehicles and machineries	.875	
2.	Reduce downtime and prevent costly breakdowns	.823	
3.	Provide real-time visibility and mitigate disruptions like natural disaster or supplier issue	.774	

Factors and associated variables

First factor in study is Optimizing of Logistics & SCM Operations, which includes variables like Enable better inventory management, reduce stockout or overstock situations, GPS & AI driven system can plan efficient delivery routes, and Historical data and market trend is analyzed for accurate inventory planning. Second factor is Warehouse Management the variables included in this factor are Assist in warehouse work like picking, packing, and inventory management, improves speed and work accuracy, can monitor stock levels, and reorder supplies when required, and Optimize warehouse layout for better space utilization. Third factor is Customer Experience it includes variable like Chatbots & virtual assistance provide real-time tracking and information, Address customer's inquiry quickly enhancing customer satisfaction, and Analyze customer's data providing personalized products. Fourth factor is Risk Management the variables included in this factor are AI can predict maintenance of vehicles and machineries, reduce downtime and prevent costly breakdowns, and provide real-time visibility and mitigate disruptions like natural disaster or supplier issue.

Reliability Statistics

Cronbach's Alpha	Number of Items
.881	14

Total reliability of 14 items including variables Role of Disruptive Technology and Artificial Intelligence in Effective Logistics and Distribution Management is 0.881.

Conclusion

Disruptive technology and artificial intelligence (AI) have played transformative roles in the field of logistics and distribution management. They have the potential to optimize operations, enhance efficiency, reduce costs, and improve customer satisfaction. Disruptive technology and AI are revolutionizing logistics and distribution management by optimizing processes, enhancing customer experiences, reducing costs, improving quality control, and providing valuable data insights. Companies that embrace these technologies can gain a competitive edge in the rapidly evolving logistics industry. AI-driven predictive analytics forecast demand, allowing companies to stock inventory strategically and ensure timely deliveries. Predictive maintenance helps prevent equipment breakdowns, reducing downtime. AI and IoT (Internet of Things) sensors provide end-to-end visibility into the supply chain. Companies can monitor goods' location, condition, and quality in real-time, allowing for better tracking and problem-solving. AI-driven chatbots and virtual assistants improve customer service by providing quick responses to inquiries, tracking shipment status, and resolving issues promptly. Personalized recommendations based on AI algorithms enhance the customer experience. AI can help reduce the carbon footprint of logistics operations by optimizing routes, reducing fuel consumption, and minimizing unnecessary emissions. Four factors that determine the role of Disruptive Technology and Artificial Intelligence in Effective Logistics and Distribution Management are Optimizing of Logistics & SCM Operations, Warehouse Management, Customer Experience, and Risk Management.

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