GAP iNTERDISCIPLINARITIES
A Global Journal of Interdisciplinary Studies
(ISSN – 2581-5628)
Impact Factor: SJIF - 5.363, IIFS - 4.875
Globally peer-reviewed and open access journal.

APPLICATIONS OF ARTIFICIAL INTELLIGENCE (AI) IN SUPPLY CHAIN OPTIMIZATION AND LOGISTICS (WITH HYPOTHETICAL EXAMPLE OF AI IN GSRTC)

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Abstract

India's logistic costs as a percentage of GDP is 8.35 on an average, the NCAER (National Council of Applied Economic Research) had concluded in a 2019 report. That study, "Analysis of India's Logistics Costs", based on surveys, had also calculated the logistics costs for different commodities and sectors. The Economic Survey 2022-23 pointed out that logistics costs in India have been in the range of 14-18 per cent of GDP against the global benchmark of 8 per cent. Logistics and supply chain expenses encompasses all costs concerning to moving goods and services, from sourcing raw materials to delivering finished products, including transportation costs (i.e moving goods via various modes like air, sea, rail or road including freight charges, carrier fees and fuel), warehousing means related to storing goods in warehouses and distribution centres and inventory carrying costs like holding, storage and obsolesce), inventory and related administrative expenses i.e expenses related to supply chain including software, personnel and communication. Artificial Intelligence (AI) is revolutionizing business by automating tasks, improving efficiency, driving innovation and enhancing customer experiences, but businesses need to adapt and embrace AI to stay competitive. AI is transforming supply chain optimization and logistics by enhancing efficiency, reducing costs and improving decision making through technologies like predictive analytics, machine learning, and real time tracking. The profit margin in transport business in India is 10% - 25% on average. But, you will have to work wisely and keep monitoring your employees regularly to get the actual profits. Moreover, application of AI in supply chain management and logistics can largely help to increase the profit margin.

Keywords: *AI, Supply Chain Optimization, Machine Learning, Game Theory, Reinforcement learning.*

INTRODUCTION

Due to technological advancement and continuous up gradation in various aspects of organization, the global market become increasingly interconnected and dynamic so it's imperative to optimize supply chain processes has become paramount for organizations to maintain competitive advantage. Supply chain management has evolved from production and distribution to highly intricate networks spanning the globe. The advent of AI technologies has catalysed this revolution, enabling organizations to leverage data driven insights, predictive analytics and advanced optimization algorithms to streamline operations, minimize costs and mitigate risks (Aldoseri et al;2023). AI holds the promise of revolutionizing every facet of the supply chain ecosystem. Mathematical modeling and algorithms frameworks provides the theoretical base for AI –driven solutions. Such concept enable the formulation of optimization problems, the development of efficient algorithms and the implementation of decision support systems tailored to the unique requirement of diverse supply chain. Machine learning, has emerged as a powerful tool for demand forecasting, inventory optimization and risk management in supply chains (Younis et.al; 2022). By analysing historical data and identifying patterns, machine learning algorithms can generate accurate forecasts, optimize inventory levels. In addition to machine learning, other theoretical approaches such as game theory, swarm intelligence and reinforcement learning offer innovative solutions for strategic decision making and adaptive optimization in supply chain operations.

The AI market is set to grow at a Compound Annual Growth Rate (CAGR) of 36.6% from 2024 to 2030 , with estimates suggesting it could reach a value of $243.70 billion by 2025, as noted by Grand View Research and Statista Market Insights. The United States stand out with the most advanced AI ecosystem surpassing all other nations in several areas, according to Stanford's Global Vibrancy Ranking 2023.

Global AI Leaders (Data as of 2023): Assessing the AI outlook in countries across various essential criteria – such as Research and Development, Responsible AI, Economy, Education, Diversity, Policy and Governance, Public Opinion, economic activity and infrastructure. The indicators are normalized to a (0,100) scale using min-max normalization. Following are top ten countries leading in AI, based on Stanford's Report Global Vibrancy Ranking, with data collected up to 2023.

Rank	Country	Total Score

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1	United States	70.06
2	China	40.17
3	United Kingdom	27.21
4	India	25.54
5	United Arab Emirates	22.72
6	France	22.54
7	South Korea	20.48
8	Germany	18.49
9	Japan	18.47
10	Singapore	18.15

(**Source:** Global AI Vibrancy Ranking 2023, developed by Stanford University's Institute of Human Centered AI)

- AI is revolutionizing supply chain management, with early adopters seeing significant improvements in logistics costs, inventory levels, and service levels, and the AI in supply chain market is projected to grow rapidly. Following breakdown of key statistics and trends:

Market Growth:

- The global AI in supply chain market is projected to grow from USD 9.15 billion in 2024 to USD 40.53 billion by 2030, with a CAGR of 28.2%.
- The global integrated automated supply chain market is projected to reach USD 25.6 billion by 2033, growing from USD 13.4 billion in 2023, with a CAGR of 6.7%.

			CAGR (Compound Annual Growth Rate)
Global AI in Supply Chain Market	USD 9.15 Billion in 2024	USD 40.53 Billion by 2023	28.2%
Global Integrated Automated Supply Chain Market	USD 13.4 Billion in 2023	USD 25.6 Billion by 2033	6.7%

OBJECTIVE

The general objective of the study was to investigate the impact of Artificial Intelligence on supply chain optimization.

To analyse the impact of AI applications on various important and critical components of logistics management like Optimized Inventory Management, Route Optimization, Warehouse Automation, Demand forecasting and Decision Making etc.

METHODOLOGY

The study adopted desktop research methodology. Desktop research refers to secondary data or that which can be collected without fieldwork. Desk research is basically involved in collecting data from existing resources. The study depends on already published studies, reports and statistics.

Preliminary review revealed that AI significantly improved various aspects of Supply Chain Management, including forecasting, inventory management, logistics and risk management. It was found that AI technologies enhanced operational efficiency by providing more accurate demand predictions, optimizing logistics operations and improving risk management capabilities.

The study recommended that future research should focus on developing theoretical models that integrate AI with traditional supply chain theories and that companies should adopt AI driven tools for improved supply chain performance. It suggest that policymakers create guidelines for ethical AI use and data management to ensure responsible implementation. Additionally, it was suggested that collaboration between academia, industry and technology providers be fostered to share best practices and address real problems.

GSRTC: Gujarat State Road Transport Corporation: GSRTC is a passenger transport organization providing bus services both within Gujarat and neighbouring.

As per author opinion Hypothetical Model of Implementing AI in GSRTC,

Infrastructure of GSRTC and areas where AI can be implemented	
Sr.No	**Particulars**
1.	16 Divisions
2.	125 Depots
3.	226 Bus Stations
4.	1554 Pick up Stands

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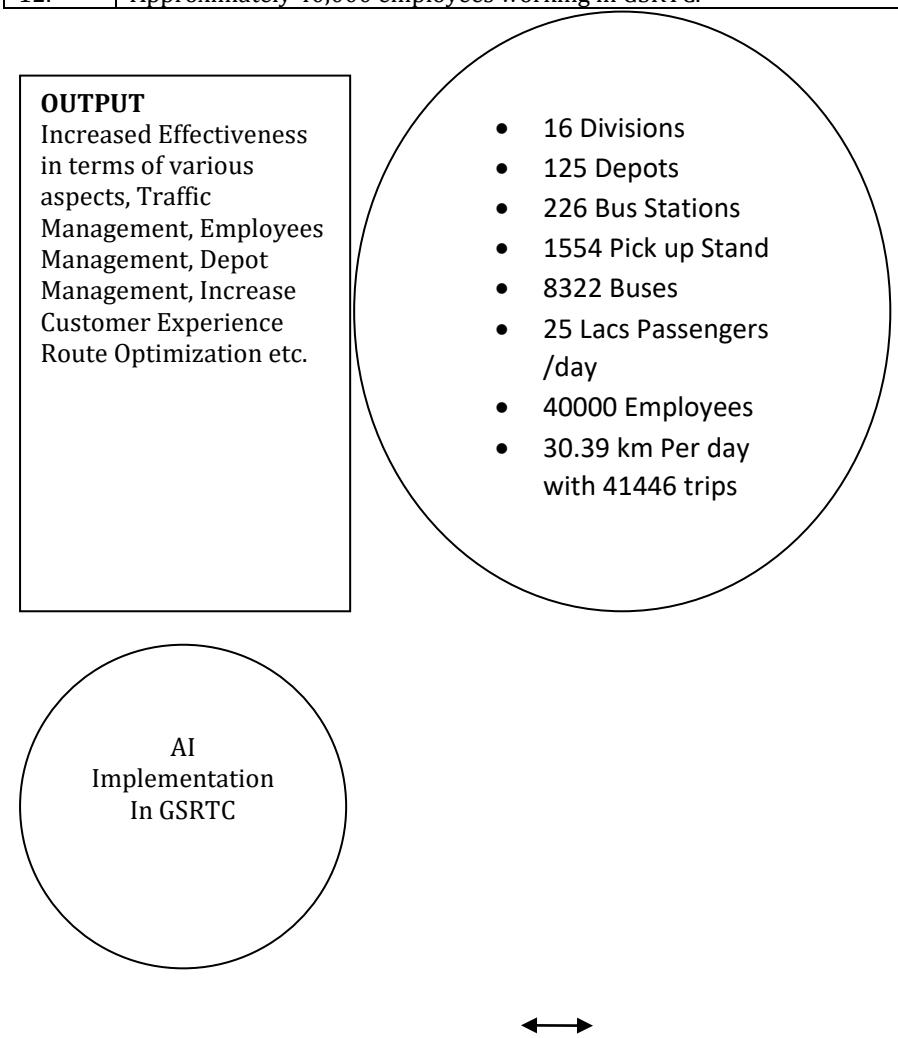
5.	8322 Buses
6.	Bus Body Building Plant (1000 bus bodies/year)
7.	14000 Electronics Ticketing Machines have been scheduled in all 7496 schedules.
8.	Video Conference Between Central Office and All 16 Divisions
9.	The GSRTC caters to approximately 25 lakh passengers daily.
10.	Facilities provided to Passengers
11.	Daily Operations: They operate 30.39 lakh Kilometres daily with 41446 trips.
12.	Approximately 40,000 employees working in GSRTC.



Following is a detailed look at how AI is imparting Supply Chain Optimization and logistics:
Optimized Inventory Management: AI algorithms can analyse data to predict demand, optimize stock levels, and identify potential shortage or excess inventory, leading to reduced holding costs and improved inventory turnover.
Route Optimization: AI-powered systems can analyse real time traffic, weather conditions and other factors to optimize transportation routes, reducing fuel consumption, delivery times and transportation costs.
Warehouse Automation: AI can automate tasks like sorting, loading and unloading, improving warehouse efficiency and reducing labour costs.
Demand Forecasting: AI can analyse historical data and market trends to forecast demand more accurately, enabling businesses to plan production and inventory levels more accurately.
Predictive Maintenance: AI can monitor equipment performance and predict potential maintenance needs, reducing downtime and maintenance costs.
Improved Decision Making: Real time Visibility: AI can provide real time visibility into the entire supply chain, from raw materials to finished goods, enabling businesses to identify and address potential problems.
Innovation and Technological Advancements: Adaptability and Change: Entrepreneurs must be adaptable and embrace change, as traditional methods are often disrupted technological advancements. **Digital Marketing:** Effective digital marketing strategies are crucial for reaching target audiences and building brand awareness.

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AI and Automation: Artificial Intelligence and Automation are transforming industries and entrepreneurs need to understand and leverage these technologies.

Companies using AI Application:

Several logistics companies in India are leveraging artificial intelligence (AI) for various applications like

Indian AI-Driven Logistics Companies:

Locus: An AI- powered logistics start up that optimize supply chain operations and provides real time tracking and visibility.

Arya.ai: An IT company that simplifies AI-enhanced deployment for bankers, insurers and other entities across the financial sector.

Gatik: Specializes in logistics, using AI and Computer vision to optimize the transportation of goods.

Haptik: An AI platform for Indian enterprise, developing technology for organizations to create chatbots and smart assistants.

Global Players with AI in Indian Logistics:

Bosch: A global leader in automation and AI-integrated manufacturing leveraging AI for various applications.

IBM: A significant player in the IOT-powered logistics space, bringing cutting edge technologies like AI and block chain into solutions.

Infosys: Uses technologies such as machine learning, big data and analytics to map the learning ability of employees and suggest training programs.

Top Five AI start-ups for logistics Management in India:

[1] **LogiNext:** Founded in 2014 by Dhruvil Sanghavi, LogiNext provides AI-enabled solutions for logistics and on field workforce planning and tracking and optimization. The platform allows enterprise to have complete visibility over delivery drivers (be it third party or their own fleet). Through features like auto-order allocation and route optimization, the platforms efficiently manage drivers to reduce delivery, increase customer experience and help brands navigate through the problem of driver shortage in a better fashion.

[2] **Pickrr:** Founded in 2015 by Rhitiman Majamdar, Gaurav Mangla and Ronak Agrawal. With tech driven value added services and efficient fulfilment facilities, Pickrr addresses the issues. Some of the products offered by Pickrr include Pickrr Connect, Pickrr Predict, Pickrr fulfilment and Pickrr Advantage. Pickrr's Warehouse Management System (WMS) also allows sellers to track their inventory in real time across all of their fulfilment centres, giving them information on Stock Keeping Unit (SKU) performance.

[3] **GoBOLT:** GoBOLT provides technology and solutions in supply chain management. The company specialises in B2B surface transportation and provides full truckload services as well as intends to expand into the part load market.

[4] **Locus:** Started in 2015 by Nishith Rastogi and Geet Garg, Locus provides Smart Logistics Solutions, including route optimization, real time tracking, truck allocation, utilization using technology and patented algorithms e.g Locus Dispatch Management Platform (DMP). Its various modules are powered by in-house artificial intelligence that may help fleets achieve better efficiency, which can lead to increased sales.

[5] **Shipsy:** Shipsy is a logistics SaaS platform that empowers organizations to optimize their trade and logistics operations, offering an AI-powered for end-to-end global logistics management, automating processes and enhancing customer experiences. Shipsy caters to various industries, including process manufacturing, retail and e-commerce. AI benefits are Cost Optimization i.e helps businesses reduce transportation costs. Enhanced customer experiences in terms of improve delivery times and transparency. Scability: designed to handle the needs of both small and large businesses.

What are the barriers tackled by companies when implementing AI to support supply chain and operations management?

From the analysis of the barriers that can hinder or slow down the process of implementing AI solutions within companies, three distinct sets emerge: barriers that concern the more technical aspects of the implementation processes, barriers related to the more strategic-organisational aspects, and barriers related to financial aspects.

In case of technical dimensions, the sample of companies investigated highlighted the complexity inherent in the process of collecting the data necessary to feed the algorithms underlying the implemented AI solutions. The necessary condition for maximising the learning process of ML and DL systems is the availability of large quantities of high-quality data. The more the data available, the more frequently they are updated, and the more differentiated forms they come in, the better the ability of the algorithm to learn and produce accurate outputs. Five companies substantially confirm what emerges from the analysis of the main contributions that have appeared in the literature, highlighting the issue of data quality as the main barrier to implementation due to a low ability to govern the data acquisition processes and the subsequent archiving and processing phases.

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They underlined the difficulty of building a sufficiently consistent and reliable database to feed the learning process of AI algorithms, and the criticality of the data acquisition process correlated with the constraints posed by the machines currently in use.
Concerning the strategic-organisational dimension, five companies involved in the research reported a lack of adequate technical skills to support the development and implementation of AI solutions as another significant problem.

FINDINGS

Implementing AI in logistics can significantly reduce costs, with early adopters reporting improvements of up to 15% in logistics costs, 35% in inventory levels, and 65% in service levels, compared to competitors.
The Economic Survey 2022-23 pointed out that logistics costs in India have been in the range of 14-18 per cent of GDP against the global benchmark of 8 per cent. India's logistics cost will come down to single digits within the next two years, as per the Union Road Transport and Highways Minister, Nitin Gadkari.
Future of AI in Supply Chain Management: By leveraging AI-powered technologies, supply chain managers can more accurately forecast needs, manage inventory, optimize transportation and plan according to demand. These AI-driven systems help companies cut down on costs, improve agility and enhance customer satisfaction.

CONCLUSION

So from the above study it can be concluded that systematic implementation of AI in supply chain management and logistic can benefit to the organization in a large extent in various areas.

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