A Compherehive Study on Supply Chain Management Using Artificial Intelligence: An Indian Railway Perspective

Manoj Kumar, Vipin, and Ashish Agarwal

Abstract If this trend is not reversed, railroads' growth and existence will be in jeopardy because freight service is their main source of revenue. Railways are fast losing market share in the case of freight service. This essay examines how passengers and other stakeholders feel about the current state of IR. Using the example of the Indian Railway as a case study, this essay analyses the supply chain management framework in the context of public procurement. The article discusses supplier relationship management's impact on performance indicators. It manages public procurement. The study discusses Indian railway supply chain management. The findings could help policymakers incorporate commercial management into public administration.

Keywords Indian railway · Key performance indicator · Public procurement

1 Introduction

The Ministry of Railways oversees Indian Railways (IR). Material Management Department of the Indian Railway follows public procurement rules and procedures to ensure ongoing material supply for rolling stock manufacture and maintenance, repair, and overhaul of railway assets [1]. An efficient and effective supply chain management is vital to the Indian Railways for production and maintenance of railway assets, inventory management with budgetary constraints. Strict rules

M. Kumar (✉)
Research Scholar, Delhi Technological University, Delhi—110042, India
e-mail: manojkumar@abes.ac.in

Vipin
Department of Mechanical Engineering, Delhi Technological University, Delhi—110042, India

A. Agarwal
School of Engineering and Technology, IGNOU, New Delhi—110068, India

M. Kumar
Assistant Professor, ABES Engineering College, Ghaziabad, India

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and procedures and transaction-based approaches hinder Supply Chain Management (SCM). A tiny percentage of bill-of-materials savings translates to enormous financial benefits and improved Indian Railways efficiency [2]. This report examines Indian Railways' upstream procurement concerns (SCM). Indian Railways is one of the largest government organisations, employing 14 lakh people and spending 1.05 lakh crore rupees annually. Railways must maintain a significant number of assets to run trains efficiently and boost capacity by constructing 500 locomotives and 3000 carriages annually. Nearly 20% of the Railways' budget and assets are used for material purchase and administration [2]. Indian Railways formed a separate service, "Indian Railway Stores Services," to highlight the importance of purchase. UPSC recruits engineers to manage the procurement system and assure maintenance and production material availability. With decreasing budgetary support and rising fuel prices, and social obligations limiting fare increases, railways must think outside the box to make their systems more efficient, right-size their organisations, and critically examine procurement, manufacturing, and maintenance practises to eliminate redundant procedures [3]. Considering the volume and value of purchases, it's vital to relook at the Railways' supply chain system and employ the latest techniques in supply chain management to decrease wasteful spending. Supply chain management is an efficient technique to right-size a company. Supply chains can be redesigned scientifically to manage inventory, utilise backward integration, satisfy end-user needs, and maintain a tight balance between material availability and utilisation [4]. Unnecessary operations can be eliminated to free up labour for more productive uses.

2 Supply Chain Management

Supply chain is a network of organizations that link raw material supply to ultimate delivery. Raw materials are purchased, stored, loaded, and shipped to end users. Transportation networks are among the most critical building blocks in a country's economic development [5]. The performance of a country's transportation network affects travel and goods transfer. Freight transport uses rail, road, air, water, and pipelines. Material management has progressed greatly in the last 50–60 years. In 1940–50, material management was called Chief Storekeeper. His priorities were material, warehousing, and logistics. Stock outs were more costly than excess inventories. In 1970–1980, as competition increased, businesses realized the relevance of MM as a tool for boosting competitive advantage and profitability. Material Manager is added. The focus was on decreasing material costs, value engineering, vendor development, and inventory management. In the 1990s, inbound and outbound logistic functions were combined to use common resources and skills. Now Supply Chain management is a full-fledged operation [6]. It encompasses multiple disciplines and provides a framework for study. The service provider's downstream supply chain influences customers' goods purchases.

3 Relation, Supply Chain Management, and Indian Railways

Supply specifications, contract terms, and conditions govern supplier interactions in public procurement and IR. Product design and value engineering suffer from poor supplier incentives. Supplier R&D and value engineering are limited. Suppliers are hesitant to invest in process capabilities, productivity, and tools due to uncertain future orders. In lump sum competitive bidding, bidders give minimum quality. Bill of materials savings require supplier engagement [7]. Long-term contracts offer cheaper costs, supplier responsiveness, and smaller inventory, etc. Long-term contracts do fall under public procurement, despite popular belief. UNCITRAL allows framework agreements as a mechanism of public procurement. The last four years of Indian railways stock procurement statistics were reviewed. 95% of purchases are from approved suppliers. Indian railway contributes significantly to these vendors' operations. Even though the contracts are lump sum, IR procures from the same set of suppliers, which means the supplier has a long-term commercial relationship with IR. Railway business has been recession-free and offers development potential. Vendor acceptance without engineering cost estimates causes cartelization, mistrust, and corruption. Small improvements can boost Indian Railway's efficiency and effectiveness. Each thing needs a unique code in a codification system. IR assigns item codes based on end use [8]. If different types of equipment use the same spare parts, the rule that each item has its own unique item code could be broken. There are ongoing efforts to unify the item code, but they don't always work. From the point of view of procurement, it may be better to classify item codes by industry category. The end use of items is used to divide purchases into subgroups. This led to different subgroups buying the same type of item. So, from a procurement point of view, grouping by industry category is better. Purchases are made for each item separately and on a lump-sum basis every year [9]. This increases cycle times and repeats work during annual contract completion. System of lump sum procurement of all items year to year has certain demerits, such as high cycle time, poor responsiveness, high inventory and high stock out situation, repetition of contracting effort, high cost of procurement due to uncertainty of future business and fixed set up, cost, tooling cost, arm's length supplier relation management, poor incentive for innovation and value engineering, etc. Ongoing vendor approval [10]. Technical and financial supplier competency is considered when approving, although engineering cost estimation is not discussed or bargained. This often causes cartels. Development and source approval lack openness. Pre-shipment inspections ensure incoming raw material quality. This increases system inventory, cycle time, poor responsiveness, and costs. In Fig. 1, we have initialized the factors of supply chain management to Indian railway perspective.

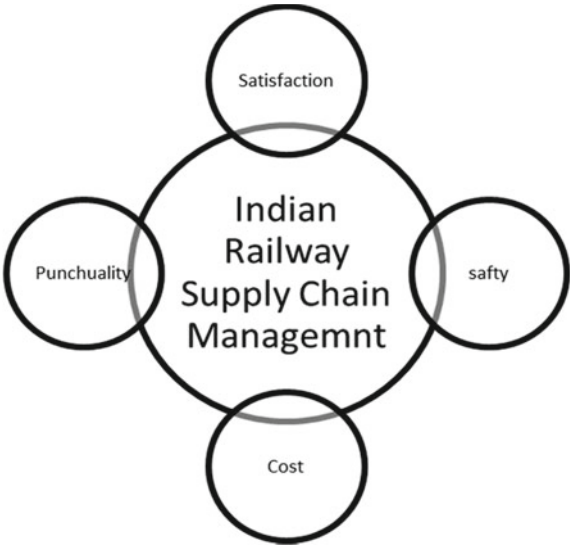

Fig. 1 Indian railway supply chain management factors

4 Machine Learning in Supply Chain Management

Retailers, wholesalers, shippers, manufacturers, and end users are all integral nodes in the supply chain. Because consumers are the driving force behind every supply chain, it's crucial to cater to their needs and preferences [11]. The availability chain facilities have learned to work together to meet demand. The entities collaborate to reduce supply chain costs. In the absence of such interactions, important and ideal supply Chain networks mismatch. Known and unknown factors cause the disparity. Alignment of company interests, long-term relationship management, unwillingness to share information, complexity of large-scale supply chain management, competency of supply chain management staff, performance management and incentive systems to assist supply chain management cause gaps [12]. With e-business and technology becoming more fluid and dynamic, corporations are reluctant to have long-term connections. Another factor could be not knowing buyer demand and creating more in advance. Machine Learning Models have replaced the traditional approach of knowing and forecasting demand. Supply chains are complicated and challenging, involving functions like purchasing, contracts, procurement, warehousing, production, packaging, shipping, and distribution. Each function is complex, thus combining them takes time, effort, and money. It's important to include quick-response tactics. Previously, basic decisions like product delivery to the client took a long time, but with AI and machine learning, this is now easier and the goods may be supplied within 24 h. This paper examines current and potential uses of Machine Learning in Supply Chain Management (Fig. 2).

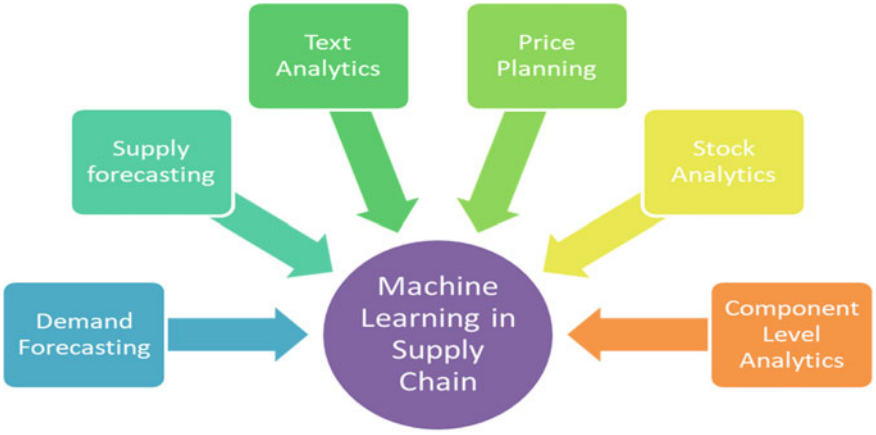

Fig. 2 Cases for machine learning in supply chain management

4.1 Predictions Approaches

ML has several types. Supervised, unsupervised, and reinforcement learning are well-known. Additional types [9].

4.1.1 Supervised Learning

Most people use Supervised Learning. Supervised Learning trains a computer program using example data. As the output is also known, this learning process seeks to uncover rules that relate input and output data and apply them to fresh data. The program is being trained.

4.1.2 Unsupervised Learning

Unsupervised learning is a knowledge-discovering mechanism. This method of learning lacks correct answers and pre-labeled target values [13]. "Learning without an instructor" describes this method. Unsupervised learning clustering is well-known. The approach categorizes inputs by common patterns by identifying similarities. Association Rules, Self-Organizing Maps, Multidimensional Scaling, Nonlinear Dimension Reduction.

Fig. 3 Process

4.1.3 Reinforcement Learning

Reinforcement learning requires iterative determination of the ideal solution, which is unknown at the start of the learning phase. This mechanism rewards logical approaches and punishes mistakes. This allows the system to respond to complicated external forces. Using rewards and punishments, the system seeks its own solutions. Machine Learning tasks can be categorized. Supervised learning includes classification and regression. Clustering and ARM are unsupervised learning problems. Reinforcement learning is another type. Figure 3 shows selected methods of ML, grouped by the task they commonly solve. This list of approaches is far from complete, and several can solve multiple tasks. Each technique has multiple algorithms. ML approaches and algorithms can provide complications. Error sources develop for two reasons. One problem is the data. Insufficiently representative training data and a lack of sufficient data for model training are still common issues. Bad data is another issue. First, patterns must be recognized in data sets. Identifying trends is difficult if the data contains errors or outliers. Unneeded features are another problem. Selecting suitable training characteristics is critical for ML performance.

4.2 Machine Learning Process

Real-world machine learning apps are frequently part of a larger project. Such initiatives have process model frameworks.

Figure 3's approach is used for ML projects and is a common standard. The six-phase method includes tasks. Starting with "Business Understanding" and finishing with "Deployment" The framework improves results while lowering project costs and time (Fig. 4).

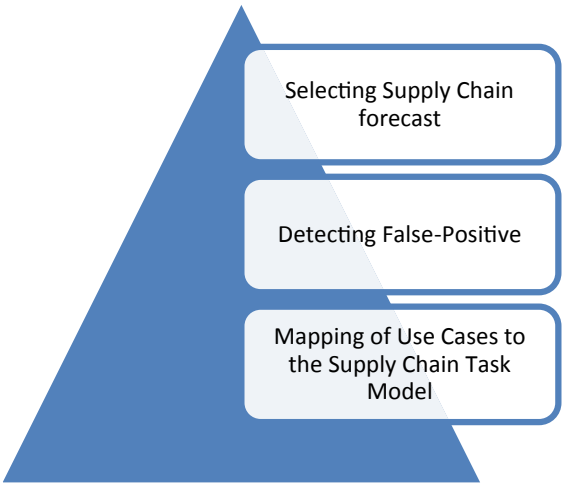

Fig. 4 Machine learning application areas in supply chain management

5 Outcomes and Key Findings

AI helps firms optimize processes, schedule production, manage supply risk, minimize supply chain interruption, decrease language barriers, improve customer service and quality control, and forecast demand. With these benefits, firms will confront several hurdles to maximize the new technology. Shortage of processing power, high cost, long implementation process, linguistic and social cue complexity, lack of data scientists and analysts, sharing data, legacy systems, and security concerns are the major difficulties today. As this technology advances, additional AI uses and difficulties will arise. AI and Machine Learning technologies allow computers to "learn" and mimic human activities in a continuous and autonomous process based on information and interactive processes. This lets AI generate more confident assumptions about new Indian Railway System supply chain management scenarios. AI has improved railway logistics efficiency and SCM parameters. Our research will focus on SCM and logistics outsourcing AI applications (3PL). Improved monitoring and visibility of supply chain processes allows dynamic decision making and optimization.

6 Conclusions and Implications

The paper explains how machine learning may improve supply chain management; especially lead time prediction and minimization. Lead time is vital for supply chain planning and customer satisfaction, thus it's been studied. Compared to standard programming, it rearranges tasks. Classical programming uses rules to calculate the desired result. In machine learning programming, known data and the desired output

are represented to find unknown rules. This unique approach to issue solving is useful in business, especially supply chain management. Due to the high number of hidden and unpredictable components in a complex ecosystem like the supply chain, modeling it using normal methodologies can be difficult or impossible. Responding to demand unpredictability and reducing prices is crucial for Indian customers, who have several low-cost options. Thus, customers are crucial to value delivery. The Indian railway system should integrate its supply chain with customers to build customer trust by meeting their needs. Supply-chain methods enhance manufacturing to make items more competitive. Collaborative planning, forecasting, and restocking can help retailers manage product assortment. This will also aid supply issues.

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