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# AI and Machine Learning Impacts in Intelligent Supply Chain

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Digital transformation in supply chain management is a critical response to the evolving business landscape and the demands of modern customers. This transformation involves the adoption of advanced technologies, automation, and data-driven decision-making to streamline and enhance supply chain operations. This exploration outlines the definition of digital transformation in supply chain management, its pivotal importance in today's business landscape, and the pioneering role played by visionary leaders such as AI. The limitations of traditional supply chain management underscore the necessity of this shift. Manual processes, limited visibility, and inventory management issues highlighted the need for digital transformation.

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AI and machine learning affect intelligent supply chains, implementation challenges, and psychosocial factors affecting supply chain AI and ML acceptability. Behavioural operations management grows. It structures production and manufacturing processes utilising psychologically based behavioural and cognitive aspects, challenging the idea that “human being is rational” in decision-making. Supply chain management (SCM), a subset of operations management, studies social psychology and supply chains. A related research literature review follows. This report recommends improving supply networks, especially in competitive companies. Supply chain efficiency requires multilevel and employee interaction. Human behaviour impacts supply chain decisions and performance.

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The integration of machine learning in legal management and the development of intelligent supply chain governance represents transformative approaches to address the evolving complexities of the legal and supply chain domains. This chapter summarizes the key findings and insights drawn from the outlined sections. The problem statement underscores the growing need for data-driven strategies to navigate the intricate legal landscape and meet the challenges of modern supply chains. With a focus on transparency, accountability, and risk management, the significance of supply chain governance is highlighted, emphasizing its critical role in resilient and efficient supply chain operations. Legal management emerges as a pivotal player in this transformation, tasked with utilizing machine learning to navigate a data-rich and complex legal environment.

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In modern Nigerian supply chain management, the adjudication of intellectual property rights has gained paramount importance. With the rapid advancement of technology, the integration of AI-powered analytics has emerged as a promising resolution for settling disputes and safeguarding intellectual property rights. This chapter highlights the multifaceted role of AI-driven analytics in the adjudication process, exploring its impact on improving efficiency, precision, and impartiality in resolving disputes related to intellectual property within the Nigerian supply chain. The authors suggest that comprehensive ethical standards, data privacy regulations, and transparency protocols should be established by the government, stakeholders,

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All companies globally use supply chain management (SCM) in this complicated and ever-changing world. Deep learning in SCM is becoming prominent, needing a complete study review. AI could revolutionise many company operations. AI can anticipate demand, optimize logistics and transportation routes, and find supply chain bottlenecks. Better demand responsiveness, shorter lead times, and lower costs can ensue. This Scopus-based study covers supply chain management AI applications. Filling the study gap on AI's impact on SCM performance includes identifying AI methodologies that can increase performance, SCM subfields with high AI potential, AI application's impact on performance, and agile-leadership performance descriptions. Scopus identified countries/regions influencing SCM performance, subject area, and document type with AI.

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This study examines theoretical frameworks, methods, and key discoveries' practical, social, and theoretical impacts. Study envisions AI/ML SCM. Supply chain AI/ML is assessed by model optimisation, predictive analytics, and decision-making frameworks. Systematic literature reviews gather pertinent research. The authors read academic, conference, and industrial papers to learn. To uncover trends and insights, studies are critically assessed, classified, and synthesised. This study examines AI/ML supply chain

demand forecasting, inventory management, logistics optimisation, and risk management. The research suggests deep learning, neural networks, evolutionary algorithms, and SVMs for supply chain issues. The review highlights SCM AI/ML implementation issues and AI/ML supply chain management pros and drawbacks. Researchers, practitioners, and policymakers may discover how AI and ML improve supply chain efficiency, cost, and networks.

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The combination of AI and ML is driving supply chain digitalization. This chapter discusses supply chain management (SCM) in the digital age, including AI, ML, and classical techniques, SCM aspects and components, and supply chain network strategies. The chapter also covers AI and ML applications in supply chain optimisation, resilient supply chain network (SCN) methods, warehouse automation and robotics, transportation and route optimisation, and supply chain risk management. AI and ML enable supply chain stakeholders to use massive data streams for predictive analytics. AI-driven demand forecasting, inventory optimisation, and predictive maintenance reduce hazards and streamline resource allocation, improving cost-effectiveness. In a world of rapid change and innovation, organisations must use AI and ML as the supply chain ecosystem evolves.

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The COVID-19 pandemic has highlighted the critical need for supply chain resilience in the face of unforeseen disruptions. This research investigates the application of machine learning (ML) algorithms to enhance supply chain resilience during the COVID-19 crisis. The authors evaluated several ML

algorithms, including decision trees, random forests, naïve bayes, and LSTM. They explored using the SPIN COVID-19 RMRIO dataset to develop a proactive and data-driven approach to mitigate disruptions and improve supply chain performance. The ML model worked with and without feature selection. With chi-square feature selection, the long short-term memory (LSTM) performed well and achieved the highest accuracy, 96.74%, with an F1 score of 91.01%. Without feature selection, random forest outperformed, which provided an accuracy of 96.21% with an F1 score of 81.25%.

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In light of the COVID-19 pandemic, this research examines supply chain disruptions critically, highlighting their devastating effect on businesses like as drugs and perishable food. The report emphasizes the need of durable supply networks, encouraging firms to invest in strong risk mitigation measures and cutting-edge technology to maintain continuity and adaptation in an ever-changing business environment. Deep learning and machine learning approaches have emerged as critical tools for solving these supply chain difficulties. Decision trees, random forests, k-nearest neighbors, and support vector machines (SVM) have all been shown to be effective in mitigating supply chain issues, with SVM achieving an impressive accuracy rate of 96.6%. Furthermore, the random forest model has a respectable accuracy of 95.00%. Notably, the study discovers that the gated recurrent unit architecture outperforms the long short-term memory design, with an accuracy rate of 98.01%. This investigation provides useful insights for the difficulties confronting contemporary supply networks.

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This study employs predictive maintenance to enhance the Explainable XGBoost Model for predicting failures in industrial components. The research utilizes a model that employs the adaptive sliding window approach to extract features. The timeframe for this approach is set at 24 hours. This method leverages multi-device sensor data to extract the features. The BO-XGBoost model is assessed using accuracy, MCC, F1-Score, and G-mean. The measures achieved 99.87%, 0.988, 0.990, and 0.0989,

respectively. The SHAP analysis method also identifies the characteristics of target variable prediction. The variable “rotatemean\_24” is the most significant predictor. The model is easily understandable, aiding in comprehending relationships between features and outcomes. Therefore, it can assist in making decisions regarding predictive maintenance. Research has shown that implementing the optimized Explainable XGBoost Model can enhance factory maintenance efficiency and cost-effectiveness. The model’s predictive capabilities enable proactive maintenance by identifying machine faults in advance.

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This chapter discusses the use of an intelligent physarum solver (IPS) to optimize profit in oligopolistic supply chain networks. The IPS, inspired by the foraging behavior of the physarum polycephalum slime mold, addresses the challenges of resource allocation and profit distribution in oligopolistic markets. The chapter analyzes the IPS framework’s effectiveness in modeling and optimizing various aspects of oligopolistic supply chains, including pricing strategies, production allocation, and distribution logistics. This research uses case studies and simulations to demonstrate how IPS can improve decision-making, foster cooperation among oligopolistic firms, and increase profitability in supply chain networks. It uses nature-inspired intelligence to provide practical solutions for businesses in oligopolistic environments, contributing valuable insights to supply chain management.

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Supply chain management is essential to a company’s success in today’s fiercely competitive business environment, regardless of the industry. Businesses are increasingly turning to big data analytics as a

useful tool for supply chain improvement to meet the expanding needs of customers, save operational costs, and boost overall efficiency. In order to improve critical areas including demand forecasting, inventory management, logistics optimization, and risk reduction, research has been conducted on the collecting and use of big data in supply chain management. Big data analytics and supply chain management integration can result in more cost-effective operations, better customer service, and increased resilience to disturbances. Organisations that effectively use big data will gain a competitive advantage in the constantly changing supply chain landscape as technology and data capabilities continue to grow.

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The COVID-19 pandemic has imposed several challenges to mankind, among them one being biometric, for attendance of working community and the related demand and supply chain related to biometric companies, developers, investors and customers. Due to many medical constraints, people are now reluctant to use contact-based biometric systems. With the increase in personal and social hygiene to avoid transmission of pathogens via contact, people try to avoid usage of fingerprint, facial-, and voice-based biometrics. Further, if the system is not active then multiple times of access contacts may be necessary. This aspect has to be restricted for avoidance of future pandemic situations.

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Mixed Traffic Modelling: An Overview of Car Following and Lane Change Models ..... 209

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Traffic modelling has gained importance due to the adoption of intelligent transportation systems and software based on traffic models providing a platform to test and improve such systems. Modelling mixed traffic has proved to be a challenging task due to variations in vehicle dimensions and composition along with non-lane-based driving. Most of the simulation software is based on the car following models and lane change models which were originally developed for lane-based traffic. Several attempts have been made to adapt these models for mixed traffic by extending them to include new parameters. This study summarizes lane change models used along with car following for mixed traffic. It can be concluded from past studies that lateral manoeuvre varies with the longitudinal speed in a non-linear manner. Sub-models or specific parameters are needed to model the lateral behaviour of each class of vehicle. Trajectory data analysis and subsequent models have also pointed towards the need for vehicle pair-dependent parameters.

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An intelligent supply chain is essential in the continuously changing environment of the healthcare industry because it combines modern technology, data analytics, and artificial intelligence. Artificial intelligence-driven radiomics enables the extraction of intricate details from medical images, allowing for the early detection and diagnosis of cancer. These algorithms can identify subtle patterns and features in imaging data that might go unnoticed by human observers. Early detection is critical for improving survival rates and treatment outcomes. In this chapter, a review is done on convolutional neural networks (CNNs), transfer learning, ensemble models, radiomics features and machine learning, deep learning for histopathology, multi-modal integration, risk assessment models, and real-time image analysis. The review compresses work on parameters like cancer type, dataset size, accuracy, complexity, and applications of these AI techniques.

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This chapter describes a prototype of a system that automatically checks the surface of precision ground metallic surfaces. It specifically focuses on bearing rolls. The authors study and test how light bounces off the surface using optical experiments. The aim is to figure out how to make things look sharp and bright, so it's easy to see the contrast between surfaces that are damaged and those that aren't. A new method for choosing a value to separate different parts of an image is presented. In addition, the text explores various search methods that go through a list one by one and have been made available to the public. These algorithms are used to find the most suitable group of traits for organizing or categorizing something. The text also looks at how much computer power these algorithms need. Finally, the authors display the results of sorting 540 blemished pictures.

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# Chapter 14

## Mixed Traffic Modelling: An Overview of Car Following and Lane Change Models

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### **ABSTRACT**

*Traffic modelling has gained importance due to the adoption of intelligent transportation systems and software based on traffic models providing a platform to test and improve such systems. Modelling mixed traffic has proved to be a challenging task due to variations in vehicle dimensions and composition along with non-lane-based driving. Most of the simulation software is based on the car following models and lane change models which were originally developed for lane-based traffic. Several attempts have been made to adapt these models for mixed traffic by extending them to include new parameters. This study summarizes lane change models used along with car following for mixed traffic. It can be concluded from past studies that lateral manoeuvre varies with the longitudinal speed in a non-linear manner. Sub-models or specific parameters are needed to model the lateral behaviour of each class of vehicle. Trajectory data analysis and subsequent models have also pointed towards the need for vehicle pair-dependent parameters.*

### **1. INTRODUCTION**

Mobility is the most essential part of any civilization. From Roman Empire to Modern day countries roads have played an essential part in the economy, defence and tourism. With ever-expanding road networks and an exponential increase in road users traffic control became necessary. As per WHO road

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crashes can cost up to 3% of the gross domestic product of nations. An estimated 1.3 million people die each year as a result of road traffic crashes. Congested road networks have a negative impact in terms of environmental pollution, loss in productivity of a city and psychological. By 2030, five hundred million people will be living in cities as a result of rapid urbanization. Increasing income results in increased car ownership which necessitates the expansion of existing transportation infrastructure (Dargay, 2001). Expansion of road infrastructure can no more be the solution to the abovementioned problems. On the contrary, some cities have started claiming back the road infrastructure for better aesthetics (Pandey et al., 2022). In such a situation maximizing the efficiency of current road infrastructure seems the most logical approach. Intelligent Transportation Systems are being increasingly adopted to maximize road infrastructure efficiency (Iyyanar et al., 2023). These systems are developed and tested on simulated traffic by utilizing commercially available software packages (Sadat et al., 2018; Abuamer et al., 2017; Sadat & Celikoglu, 2017; Abuamer et al., 2018). The cost and risk of deploying any untested ITS technique, strategy or algorithm can lead to devastating results and can cause fatalities. Car following models and lane change models form the fundamentals of traffic simulation (Pramanik et al., 2023). The first car following model proposed was elementary. Since then it has come a long way. Macroscopic, Mesoscopic and Microscopic modelling approaches have been used to simulate traffic. Models have been developed primarily with homogenous traffic and more predictable lateral behaviour. Later models were extended to incorporate the behaviour of mixed traffic which generally has more erratic behaviour and poor lane discipline. In this paper, a review of lane change models for mixed traffic has been presented. The next section of the paper will discuss the brief background of traffic modelling, followed by a summary of car-following models. Later a review of lane change models will be presented. In the last section concluding remarks will be presented (Saxena et al., 2021).

## **2. TRAFFIC MODELLING**

Traffic is defined with help of three fundamental variables namely Speed, Density and Flow. Traffic was defined by first-order models which were based on continuity equations. These equations defined the rate of change of the density in terms of gradients or differences of flow (Trieber & Kesting 2013). As these models were closed by specifying flow or local speeds they failed to replicate the field traffic flows which usually had dispersed values of speed and flow. In other words, speed has its dynamic equation. This class of models, called Lighthill-Whithman-Richards (LWR) models, were known as models of first-class order (Lebacque et al., 1998). In such models, instant speed changes for different road conditions led to unlimited accelerations which in turn led to unrealistic traffic flows. Deficiencies of first-order models were addressed by second-order models as they have dynamic speed. Local speed has its dynamic acceleration equation. Speed is defined as a function of density. This gives the ability to model traffic flow instabilities, capacity drop, traffic waves and scattered flow density. Payne's Model, Kerner Konhäuser's (KK) Model, and Gas-kinetic Based Traffic Model (GKT) belong to this class of models (Trieber et al., 1999). In these models rate of change of local speed is equal to an acceleration function. They can define the dynamic nature of velocity wherein the speed detected by the detector as well as speed change due to movement to a new location is defined. These models however have a disadvantage in terms of anticipation of traffic conditions ahead of them. These shortcomings were addressed by adding anticipation terms in the modelling equations (Pandey et al., 2023).

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