ARTIFICIAL INTELLIGENCE BASED DATA TRACKING METHODS FOR SUPPLY CHAIN PERFORMANCES OPTIMIZATION

Matayo V. A.[1], Jibrin H. S.[2], Isah M. A.[3], & Aminu A. A.[4*]

[1, 4] Department of Information and Communication Technology, Federal Polytechnic Kaltungo, Nigeria*
[4]Department of Management Information Technology, Abubakar Tafawa Balewa University, Bauchi, Nig.*
[2] Department of Computer Science, Abubakar Tafawa Balewa University, Bauchi, Nigeria,
[2] Department of Computer Science, Federal Polytechnic Kaltungo, Gombe, Nigeria,
[3] Department of Computer Science, Khadijah University Majia, Jigawa State, Nigeria,

v.a.matayo@gmail.com[1], habibsjibril@gmail.com[2], iamuhammad@kum.edu.ng[3], aaahmed.pg@atbu.edu.ng[4]*

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ABSTRACT

This study explores the integration of artificial intelligence (AI) in data tracking and supply chain management. It examines the methods, performance, and limitations of these processes, and identifies the contributions of AI to improve performance. The research focuses on real-time data tracking in supply chains, aiming to optimize performance metrics. IoT devices like sensors and RFID tags monitor and collect data at various stages of the supply chain, enabling critical information collection. The collected data is then transmitted to a centralized platform where ML algorithms analyze the information in real-time. Machine Learning models can predict bottlenecks, identify inefficiencies, and optimize routing and inventory management. Real-time analytics provide valuable insights for supply chain managers, enabling proactive decision-making and responses to unexpected events. The study also highlights the potential impact of emerging technologies and provides recommendations for successful implementation and potential challenges to be addressed.

***Keywords*:** Data tracking methods, supply chain, operational performance, Internet of Things, Machine learning

1 INTRODUCTION

This study offers a thorough analysis of data tracking and its importance, especially for supply chain management systems. It talks about how tracking and analysing data has become more crucial for strategic planning and decision-making. Readers will have a better knowledge of the value of data tracking and the necessity of investigating cutting-edge technologies like AI in this field. In supply chain management, the tracking of data via AI technologies has gained importance. It is possible to forecast when maintenance is necessary and avoid expensive downtime by utilising sensors to track individual units of components and finished goods inventory and evaluating this data using ML algorithms (Böck et al., 2022; Maxwell & Couper, 2023). By expediting information synchronisation and distribution as well as commodities monitoring and tracking in manufacturing and transportation, the Internet of Things has a promising future in intelligent supply chain logistics management (Wang et al., 2022). By using these steps, the firm can give real-time commodity information on supply chain logistics management for market analysis and monitoring. Supply chain management has been thoroughly studied by researchers using cutting-edge IoT tracking devices. They focus on using machine learning rather than big data, blockchain, or other technologies (Duan, 2022; W. Jiang, 2022; Nguyen et al., 2017). In order to ensure continued growth, modern supply chain management built on machine learning can achieve self-optimization and continuous improvement (Duan, 2022; Y. Wei, 2022). While ML entails applying algorithms to analyse data and make predictions or judgements based on patterns and trends, IoT refers to a network of networked devices that can communicate and exchange data with one another.

The systematic organisational structure known as SCM includes interior resources (both human and non-human), techniques, processes, suppliers, adversarial partners and markets, clients including consumers, and the externally placed organisational environment (outdoor) relevant to this research. Supply chain management (SCM) is the term for the efficient business collaboration between suppliers, producers, consumers, and rival business partners (Fritz, 2022; Wu et al., 2021). However, if there is no cooperation between the indoor and outdoor, situational (communities around the organization's operations), and/or operational (internal surroundings, i.e., within the organisation) environments, the goals of SCM (SC interoperability and sustainability) may not be achieved.

Real-time tracking and optimisation are two of the most important ongoing problems with the supply chain management (SCM) system, which this study refers to as supply chain operational performance (SCOP) problems. It serves as the foundation for all organisational systems as well. Real-time tracking is vital (optimisation) because it can simultaneously identify the problem in the system process cycle and ask for an urgent correction (Bolhasani et al., 2021; Sun & Gu, 2021; L. Zhu, 2020). According to Al et al. (2021; Sharma & Singh, 2020), the Internet of Things (IoT) is a network of connected devices that includes industrial machinery, physical objects with radio frequency identification (RFID), wireless sensors, and/or human-to-human or human-to-machine communication. The "Internet of Things" is made up of the following two words: The Internet is one example. According to Yadav and Garg (2020), the Internet is a collection of interconnected networks that may connect billions of individuals utilising particular internet protocol standards. The Internet connects many departments and industry sectors while utilising a variety of technologies. Many different devices, including those connected to desktop and mobile computers as well as those connected to corporate organisations and other organisations, can access the Internet (Sharma & Singh, 2020).

In this study, the state-of-the-art in data tracking processes, supply chain management, IoT, and ML technologies, as well as the approaches, performance, and limitations of these data tracking processes, are investigated. Additionally, it highlights the roles that IoT and machine learning technologies play in the performance-improving data tracking process. Additionally, it emphasises the possible effects of incorporating IoT and machine learning technologies in supply chain management and offers suggestions for successful implementation as well as potential issues to be resolved.

2 LITERATURE REVIEW

Several studies Bolhasani et al. (2021); Hurley (2015); and Yao et al. (2020) make an effort to establish data tracking utilising IoT and machine learning to increase equipment reliability, decrease downtime, and improve overall supply chain performance. Another study sought to create a machine learning-based supply chain tracking system to increase visibility and operational effectiveness. Predictive analytics for demand forecasting, real-time monitoring of commodities, and inventory management optimisation were the main areas of focus (M. Jiang et al., 2019; Munasinghe & Halgamuge, 2023; Sadeghian et al., 2021). Other studies Marbouh et al. (2020); Munasinghe & Halgamuge (2023); and Seifermann et al. (2023) aimed to develop sensor-based inventory management systems that use IoT technology and machine learning algorithms to optimise inventory levels and improve supply chain performance; an integrated quality control system that uses IoT and big data analytics to improve manufacturing quality and supply chain performance; a real-time health monitoring system (Dabbas & Friedrich, 2022).

By providing real-time data collecting, boosting visibility, aiding proactive decision-making, enabling predictive analytics, streamlining transportation and logistics, and driving continuous improvement, the IoT adds to the data monitoring process in supply chain performance optimisation. These contributions ultimately result in increased customer satisfaction, cost savings, and supply chain efficiency. (Hu et al., 2023; Dabbas & Friedrich, 2022). Kuwornu and others (2023) In addition, the IoT is generating a flood of structured and unstructured data thanks to a burgeoning army of sensors that can track position, voice, face, audio, temperature, sentiment, health, and other things (Operations et al., 2020; Tan & Sidhu, 2022). For instance, numerous studies have evaluated the integration of IoT-ML for screening patients with different medical problems as a measure of data security in healthcare systems. For quicker, automatic reactions and better decision-making, IoT provides insights that might otherwise be concealed in data. By consuming photos, videos, and audio, IoT can be used to predict future trends, identify abnormalities, and improve intelligence.

By offering advanced data analysis, predictive analytics, routing and logistics optimisation, inventory management, anomaly detection, and continuous improvement capabilities, ML adds to data tracking for supply chain performance optimisation. These contributions improve resource allocation, lower costs, increase customer satisfaction, and optimise supply chain operations (Dabbas & Friedrich, 2022).

ML has advanced to the point that it can deduce interesting trends and conclusions from these streams of real-time data. With the aid of sensors and devices, the combination of machine learning and IoT swiftly lowers possible security and safety risks. In order to control and forecast risk variables, including financial, cyber, and many others, the combination creates a safe ecosystem (Hu et al., 2023; Lei, 2022; Li et al., 2022). By examining vast amounts of data with powerful algorithms, machine learning can assist in demystifying the hidden patterns in IoT data. In crucial operations, automated systems applying statistically derived actions can augment or completely replace manual processes.

3 METHODOLOGY

Data collection procedures, sample and sampling techniques, sample and sample selections and method of data analysis are the four subsections that make up this section. The purpose of this study is to examine and synthesise the state-of-the-art of the current data tracking process, certain discovered limitations, and its performance in terms of metrics for performance evaluation, as was previously indicated. To examine the data, a systematic literature review (SLR) was used. Boolean search operators like AND and OR were employed.

3.1 Method of data collection

Google Scholar, Hindawi, Science Direct, Research Gate, and Emerald Insight are the three major databases (see Fig. 3) that the researcher used to find the various papers (see Fig. 1). The procedure for gathering data was modified in accordance with a method known as the that begins with search, identification, filtration, exclusion (if necessary), reliability and validity, inclusion, and analysis.

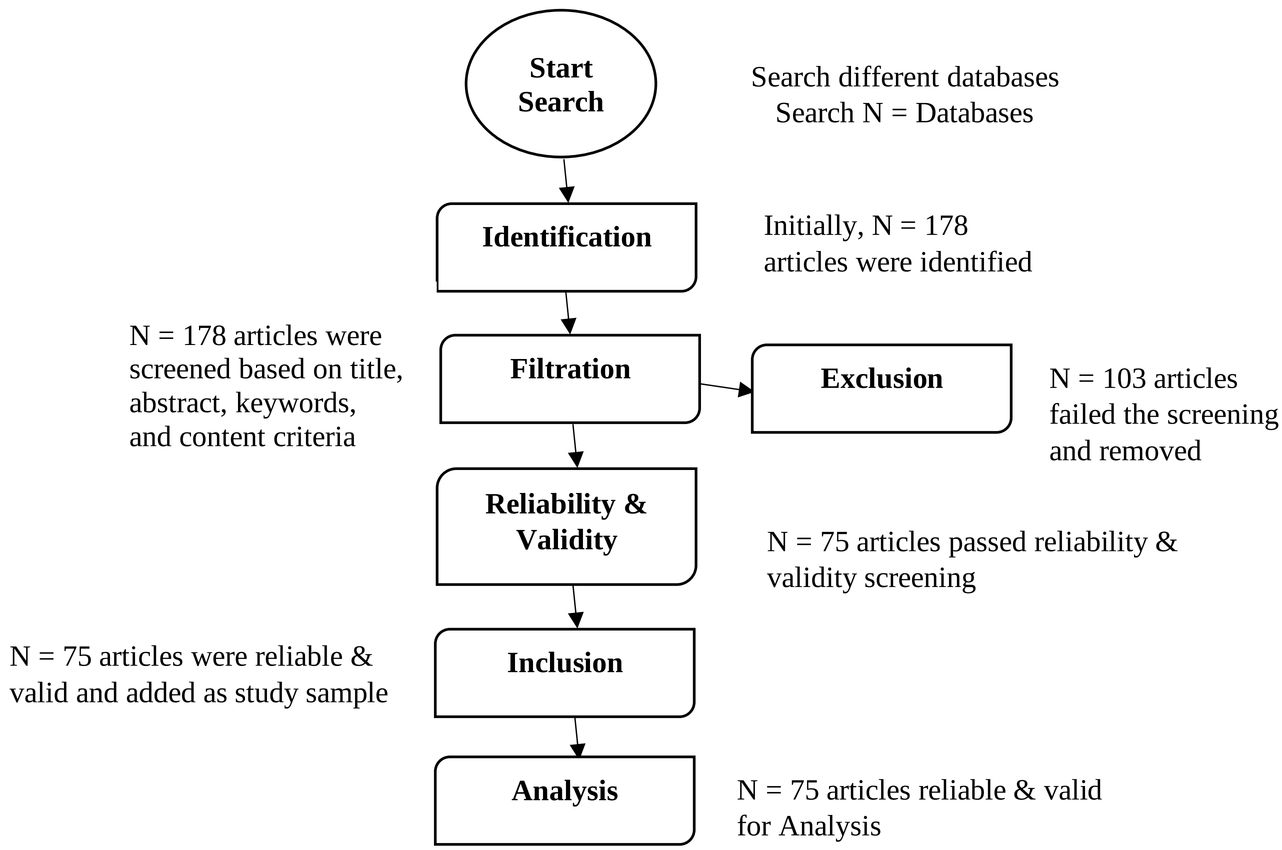
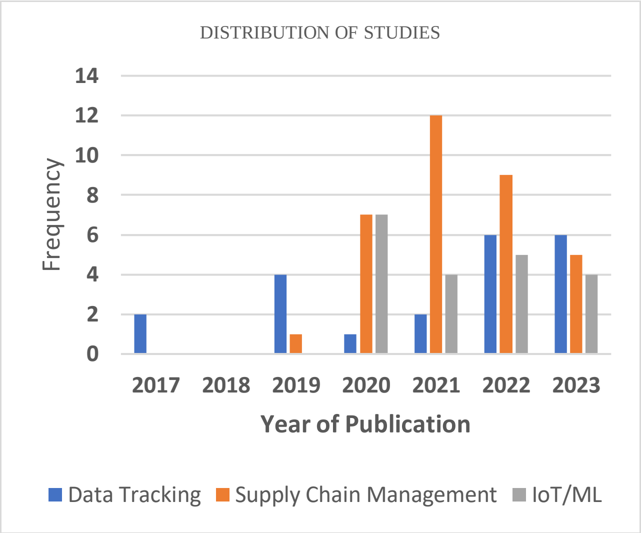


Figure 1. SIFRIA flowchart shows sample and sampling techniques

3.2 Sample and sample selections

From a total of 178 papers downloaded, 75 papers were chosen as the study sample size based on data gathering methods. The chosen samples span the years 2017 through June 2023 (see Fig. 2).



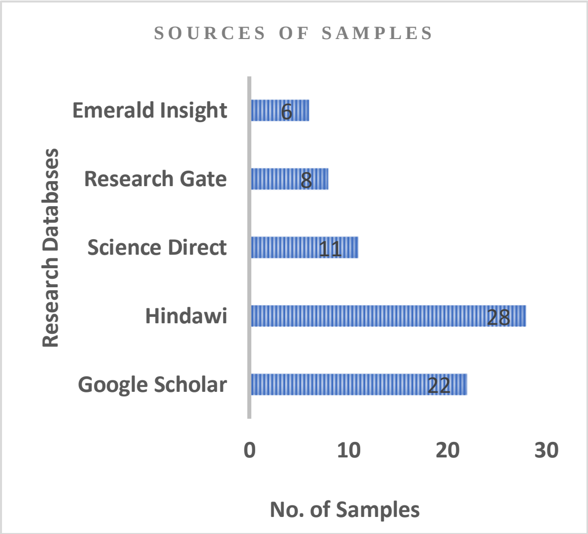


Fig. 2. Distribution of studies over time; *Fig. 3. Sources of samples based on research databases*

3.3 Literature searching techniques

The Boolean search operators have been used as follows: (data tracking process OR method) and (data tracking using the internet of things OR IoT (AND machine learning OR ML)). Based on the SIFRIA flowchart (Fig. 1), the abstracts, keywords, and contents of the materials were taken into consideration.

3.4 Method of data analysis

In order to obtain accurate and trustworthy results by utilising SLR, the findings of this review were assessed and reported using title and keyword reading (scanning) and content reading skills (skimming).

3.5 Ethical and privacy considerations

AI technology integration in data tracking presents significant ethical and privacy issues. For instance, there are issues with how these technologies collect and exploit personal data (Lin, 2022). The possibility of these technologies being exploited for surveillance raises additional concerns. Organisations must be open and honest about how they acquire and utilise data if they want to allay these worries (Munasinghe & Halgamuge, 2023). To safeguard against online risks, they should also put in place robust security measures. To ensure the proper use of these technologies, they should collaborate with regulators and other stakeholders to set policies and guidelines (Kishore et al., 2023).

4 DISCUSSION OF FINDINGS

4.1 State-of-art on data tracking process, supply chain management using AI

As illustrated in Table 1 and Fig. 2, the state-of-the-art in data tracking operations today entails the effective gathering, managing, and processing of massive volumes of data. The most recent developments in supply chain management are geared on improving collaboration, transparency, and traceability. There are numerous studies on data tracking techniques, such as intelligent monitoring systems for smart agriculture based on AI, as shown in Table 1. Object tracking sensor networks in smart cities: taxonomy, architecture, applications, research challenges, and future directions (Adam et al., 2017); Using a cutting-edge blockchain-based Vacledger system, supply chain tracking and counterfeit detection of COVID-19 vaccinations were possible (Munasinghe & Halgamuge, 2023); Table 1 also lists the numerous research that have been done on supply chain management, IoT, and ML technologies, as well as data tracking procedures. Fig. 2 depicts the study areas used to construct this report, which include data tracking studies, supply chain studies, and IoT and/or ML investigations. The graph demonstrates that, with a score of 34 out of a possible 75, the supply chain management area has the most existing studies. This is followed by the data tracking methods area, which received a score of 21 out of a possible 75, and the IoT and/or ML area, which received a score of 20 out of a possible 75. In summary, the current state-of-the-art in data tracking processes places an emphasis on effective data management; supply chain management places an emphasis on openness and cooperation; and AI technologies are advancing real-time monitoring, predictive analytics, and automation across a range of industries.

Table 1. Distribution of studies on data tracking, supply chain management, and IoT and/or ML

Study	No. of Studies	Source
Data Tracking Studies	21	(Adam et al., 2017; Aljuaid et al., 2023; Böck et al., 2022; Campanile et al., 2021; Dabbas & Friedrich, 2022; Dhungana et al., 2021; Gessinger-befurt et al., 2023; Guo, 2022; Jeong et al., 2022; M. Jiang et al., 2019; Lee & Lee, 2019; C. Li, 2022; Marbouh et al., 2020; Maxwell & Couper, 2023; Munasinghe & Halgamuge, 2023; Rodrigues et al., 2017; Sadeghian et al., 2021; Seifermann et al., 2023; Wei Xiong, 2023; L. Y. Wu & Swartz, 2023; Yan & Wu, 2019; Yazdizadeh et al., 2019)
Supply Chain	34	(H. Hu et al., 2023; Rad & Rana, 2017; Souprayen & Ayyanar, 2021; Sun & Gu, 2021; L. Wang, 2022; Y. Wang & Gong, 2021; L. Wei, 2021; W. Wu et al., 2023); Alshammari et al., 2022; Bai et al., 2022; Cui, 2021; Fang & Su, 2021; Han, 2022; Hong, 2021; Hu et al., 2021; Kishore et al., 2023; Lei, 2022; Li,

Management		2021; Li et al., 2022; Li et al., 2021; Lin et al., 2022; Pal & Yasar, 2023; Sharma et al., 2022; Souprayen & Ayyanar, 2021; Tan & Sidhu, 2022; Wang et al., 2022; Wei, 2021; Wei, 2022; Wu, 2021; Wu et al., 2023; Zhang, 2021; Zhang et al., 2022; Zhang, 2021; Zhou & Li, 2021; Zhu & Cai, 2021)
IoT and/or Machine Learning	20	Hu et al., 2023; Rad & Rana, 2017; Souprayen & Ayyanar, 2021; Sun & Gu, 2021; Wang, 2022; Wang & Gong, 2021; Wei, 2021; Wu e t al., 2023; Nguyen et al., 2017; Sharma et al., 2022; Wu et al., 2023; (Bai et al., 2022; Cui, 2021; Li, 2022; Lin, 2022; Pal & Yasar, 2020; Sharma et al., 2022; Wu, 2021; Zhu et al., 2022; Zhuang, 2021)

4.2 Data tracking methods, performance and limitations of data tracking process

Table 2 (see Appendix: A Taxonomy of Data Tracking) lists and describes the various data tracking techniques, along with how well they work and any drawbacks they may have. Using sensor networks as a strategy, Adam et al. (2017) studied the use of object tracking sensor networks in smart cities. They emphasise energy conservation, object identification, object speed, tracking precision, sensor node collaboration, data aggregation, and calculation of object recovery position. Only the OTSN algorithms utilised in the smart city are pinned. Additionally, they listed the following limitations: In the course of object tracking and communication, sensor node energy is depleted. The authors recommended that during object tracking and communication, the energy of the sensor nodes be depleted; they then proposed a hybrid OTSN as a solution to these problems. Another study into the use of a blockchain-based vecledger system for COVID-19 vaccine supply chain tracking and counterfeit detection. False vaccination enterprises shut down patient and manufacturer dialogue to boost profits. To stop the production of fake vaccinations using Blockchain, a tracking system is necessary. Numerous bogus vaccinations are being created and distributed undercover. Vaccines that are counterfeit are those whose identity and origin are concealed or purposefully misrepresented. They are unregulated and have erroneous labels. False labelling and insufficient or wrong components are just two examples of these immunisations' shortcomings. According to Munasinghe and Halgamuge (Munasinghe & Halgamuge, 2023), the strategy might be used in a variety of supply chain industries, such as the food, energy, and commodity trade.

Additionally, an IoT Data Streams Scalable and Distributed Analytics Platform, Machine learning is used in conjunction with IoT networks, sensors, and machine learning. The study is primarily concerned with IoT data stream analytics and does not offer a thorough comparison with other comparable platforms. Instead of concentrating solely on IoT devices, provide thorough comparisons with various approaches (Yilmaz, Simsek, & Durmusoglu, 2021). There are numerous additional studies that provide evidence regarding data tracking techniques, including their effectiveness and limits (see Table 2 in the appendix).

Last but not least, our study supported the notion that AI technologies are driving innovation across numerous industries. In order to provide real-time monitoring of assets, processes, and surroundings, IoT devices are utilised to gather and transmit enormous volumes of data from linked sensors and devices. Then, ML algorithms analyse this data to derive useful insights, automate decision-making, and spot abnormalities or patterns that perhaps aren't immediately apparent to people. Applications for predictive maintenance are increasingly using ML methods and IoT. ML algorithms can identify patterns signalling probable breakdowns and initiate preventative action by continuously monitoring the equipment. With this strategy, downtime and maintenance costs are greatly decreased, and the processes' overall dependability and productivity are increased.

4.3 Challenges and strategies for integrating AI technologies

AI technology integration is not without its difficulties. The huge amount of data produced by IoT devices is one of the major obstacles (Lin et al., 2022). For this data to be meaningful, real-time processing and analysis are required (N. Sharma & Singh, 2020). The requirement for more complex algorithms to analyse this data presents another difficulty. The issue of security is the last one (Bolhasani et al., 2021). Moreover, Alshammari et al., 2022; X. Lin, 2022; Pal & Yasar, 2020) explain that IoT devices are frequently vulnerable to hacking and other security risks. Organisations must invest in the appropriate infrastructure and technologies if they are to successfully address these issues. This includes making investments in cloud computing systems that have the processing power needed for ML algorithms and can handle enormous amounts of data. Additionally, it entails spending money on security measures like firewalls and encryption to guard against online dangers.

As an alternative to transferring all of the data to a central point for processing, edge computing includes processing the data closer to the source. In doing so, latency may be decreased and real-time processing capabilities may be enhanced (Aslanpour et al., 2020; Huang et al., 2022; T. Wang et al., 2022). Finally, businesses must spend money on educating staff members to use these technologies efficiently. This involves training data scientists on how to create and apply ML algorithms as well as instructing other staff members on how to exploit the insights these algorithms produce.

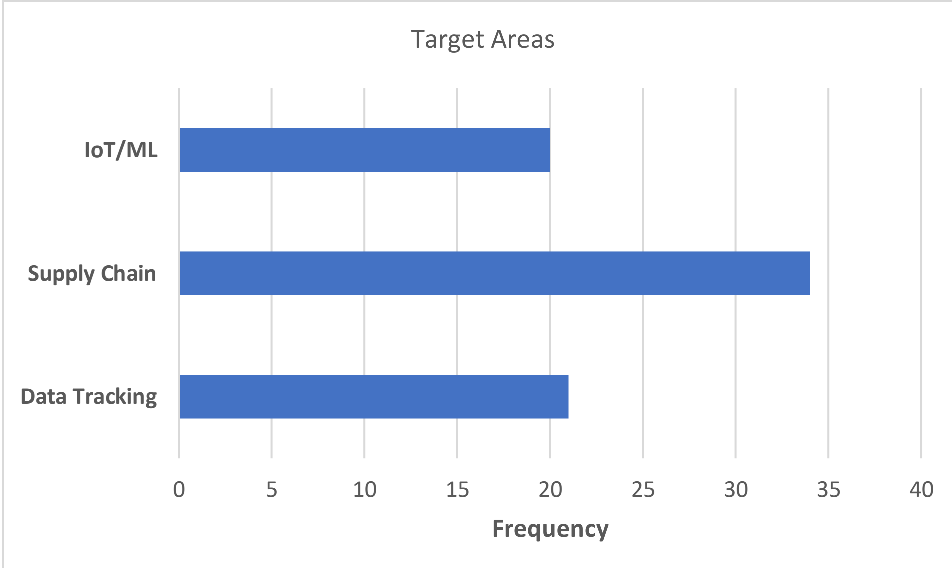


Figure 2. Target areas of study

4.4 Contributions of AI in the data tracking process to improve SC performance

Several studies (Gessinger-Befurt et al., 2023; Rodrigues et al., 2017; L. Y. Wu & Swartz, 2023) successfully established an IoT platform that incorporated sensors and RFID technologies to track items at every level of the supply chain. increased visibility, fewer stockouts, and increased operational performance were the results of the application of machine learning algorithms to assess the data that had been collected and give real-time insights for decision-making (Dabbas & Friedrich, 2022; W. Jiang, 2022; J. Li et al., 2022). According to a different study's methodology (Tan & Sidhu, 2022; Q. Zhu & Cai, 2021), IoT devices were utilised to track production operations and gather data, which was then examined using big data analytics techniques. The technology enabled proactive quality control interventions by identifying potential quality issues in real-time (Tan & Sidhu, 2022). The study showed greater supply chain performance, decreased defect rates, and improved product quality as a result. For example, Adam et al. (2017), Sadeghian et al. (2021), and Campanile et al. (2021) incorporated IoT devices on delivery vans to collect real-time data on traffic conditions, fuel consumption, and vehicle performance. To examine the gathered data and provide optimised routing and scheduling plans, machine learning techniques were used (Ko et al., 2017; Lei, 2022). The study showed how prompt and effective deliveries increased customer satisfaction while also reducing fuel use and delivery times, (see Table 3 for more details).

Table 3. State-of-Art on existing literature based on data tracking methods,

Data Tracking Methods	Area of Applications	Enabling Technologies	Sources

Object tracking sensor networks	Smart cities	IoT	(Adam et al., 2017)
Botnet tracking data	General data protection and regulation	Artificial intelligent (AI)	(Böck et al., 2022)
Supply chain traceability & counterfeit detection	Covid-19 vaccines distributions	Vecledger system using Blockchain	(Munasinghe & Halgamuge, 2023)
GPS Trace, tracking data	Transportation	RFID	(Sadeghian et al., 2021; Yazdizadeh et al., 2019)
Tracking & tracing	Manufacturing supply chain	Blockchain	(Seifermann et al., 2023)
Benchmarking machine learning algorithms GPS	Transportation	ML Algorithms	(Dabbas & Friedrich, 2022)
Researching activity tracking	Support learning	Video tracking, wearable sensor	(Lee & Lee, 2019)
Construction tracking	Construction logistics	GPS, RFID, Bluetooth	(Maxwell & Couper, 2023)
Postures anomaly tracking & prediction model	Crowd data analytics	Data analytics	(Aljuaid et al., 2023)
Tracking of player speed	Sport	Sensors, RFID	(L. Y. Wu & Swartz, 2023)
Tracking & data association	Learning	Reinforcement learning	(Wei Xiong, 2023)
The open data detector tracking system	Track reconstruction	Sensors, RFID	(Gessinger-befurt et al., 2023)
Trusted tracking system	Covid-19 vaccines distributions	Blockchain	(Marbouh et al., 2020)
Fusion data tracking system	Multi-object tracking accuracy/precision	Sensors, GPS	(Rodrigues et al., 2017)
Internet of vehicles distributed information tracking system	General Data Protection Regulation	Blockchain	(Campanile et al., 2021)

Multisource target data fusion tracking method	Heterogeneous network	Data mining	(Guo, 2022)
Visual object tracking	Generic feature learning	Generic Algorithm	(M. Jiang et al., 2019)
Front-tracking method	Indicator functions	Direc delta function	(Jeong et al., 2022)
Tracking method	Big data acquisitions algorithm	Data mining in hetrogenous network	(Li, 2022)
Identity tracking	Integrity audit	Shared cloud data	(Yan & Wu, 2019)

The prototype systems developed by Aljuaid et al. (2023), Habibzadeh et al. (2020), Sheng et al. (2020), and Nguyen et al. (2017) successfully tracked and monitored supply chain operations in real-time utilising IoT sensors and data analytics. Delivery delays and inventory costs were decreased as a result of the use of machine learning algorithms, which also increased visibility, accuracy, and decision-making abilities (Duan, 2022; W. Jiang, 2022; J. Li et al., 2022). The study showed how IoT and machine learning have the potential to enhance supply chain operational effectiveness. Additionally, the researchers (Dabbas & Friedrich, 2022; Ko et al., 2017; Odeh, 2020) suggested a system that used IoT devices to gather real-time data on energy use from various appliances. The data was analysed using machine learning algorithms, which produced recommendations for consumers on how to use energy effectively. The study showed that energy efficiency in smart houses may be successfully achieved, resulting in lower energy costs and a less environmental effect.

In order to continuously monitor equipment performance and gather pertinent data, the researchers suggested an architecture that made use of IoT sensors. In order to examine the data and forecast probable failures or maintenance requirements, machine learning techniques were used. In industrial settings, the study showed increased operating efficiency, decreased maintenance costs, and improved equipment uptime (Hwang et al., 2016; Lippert, 2006; Nord et al., 2019). Here, the researchers presented a system with wearable IoT devices to continually gather data including heart rate, blood pressure, and body temperature (Debauche et al., 2019; Habibzadeh et al., 2020; Li et al., 2021; Prokofieva et al., 2019; Qian et al., 2020). In order to assess the data and find anomalies or potential health problems, machine learning algorithms were used (Aljuaid et al., 2023; Dabbas & Friedrich, 2022). The study showed the possibility for improved real-time patient monitoring and early diagnosis of health issues. The researchers (Gessinger-Befurt et al., 2023; Lee & Lee, 2019; Rodrigues et al., 2017) developed a system that employed IoT sensors and cameras deployed at various locations to collect real-time traffic data. To examine the data and forecast traffic flow patterns, machine learning models were used (Duan, 2022; Lin et al., 2022). The study showed enhanced traffic flow prediction accuracy, which helped smart cities manage traffic better and experience less congestion.

The researchers assessed a range of data tracking techniques, including distributed, centralised, and hybrid strategies. They looked at things like resource usage, scalability, and the effectiveness of data transfer. According to the study, hybrid systems that combine centralised and distributed methodologies provided a well-balanced answer to various IoT application requirements. Each of these studies offers helpful suggestions and insights for enhancing data tracking techniques using AI technology. While others offer more comprehensive surveys or recommendations, some concentrate on particular applications or difficulties. They all contribute to our understanding of the challenges and opportunities presented by data monitoring techniques in the IoT era, despite the fact that their individual strengths and contributions range greatly.

5 CONCLUSION AND RESEARCH IMPLICATIONS

In conclusion, modern data tracking techniques use cutting-edge technologies like AI to effectively manage and analyse data. ML, IoT, and blockchain technologies have all contributed to the evolution of supply chain management. These technologies improve stakeholder collaboration, traceability, and transparency while streamlining supply chain operations. Real-time asset monitoring, real-time analytics, and predictive maintenance applications are made possible by AI technology. They open doors for further automation, optimisation, and decision-making across numerous industries. The potential for data tracking, supply chain management, IoT, and ML technologies is only projected to increase as technology develops, making applications ever more complex and significant. The study on supply chain management, IoT, and ML technologies highlights the research suggestions and business ramifications. Businesses can gain productivity, visibility, predictive maintenance, and increased security by implementing advanced data monitoring methods and leveraging AI technology. Future studies should concentrate on creating solid frameworks for data governance, examining cutting-edge AI methods, addressing related problems with supply chain operational performance, and looking into solutions tailored to certain industries. For these sectors to grow in the future, interdisciplinary cooperation must be prioritised, and the social and economic implications must be examined.

The study on the state-of-the-art in IoT, ML, supply chain management, and data tracking systems has a number of consequences for both enterprises and researchers.

5.1 The implications for business

- Improved Efficiency: Organisations can handle and analyse massive amounts of data with more efficiency by implementing advanced data tracking techniques like AI. As a result, decisions are made better, operations are run more efficiently, and customers are more satisfied.
- Enhanced Transparency and Traceability in the Supply Chain: IoT, ML, and blockchain technologies have improved supply chain visibility. This enables businesses to locate bottlenecks, lower risks, and streamline procedures, improving stakeholder participation.
- Predictive and proactive maintenance: By combining ML algorithms with IoT devices, enterprises are given the ability to use predictive maintenance techniques. This reduces downtime and maintenance costs by detecting potential equipment faults early on. Additionally, it guarantees the best possible asset utilisation and raises overall production.
- Improved risk management and cybersecurity are made possible by AI technology. Organisations can quickly discover and address possible security breaches because to ML algorithms' ability to analyse patterns and spot abnormalities. This contributes to improving data protection and preserving the reliability of crucial systems.

5.2 Research Consequences

- Data Governance and Standards: To guarantee the quality, integrity, and security of tracked data, future research should concentrate on creating strong data governance frameworks and standards. This will help businesses manage privacy and regulatory compliance issues.
- Integration and Interoperability: Studies on the smooth integration and interoperability of different data tracking systems, supply chain platforms, and IoT devices are required. Organisations can improve collaboration and connectivity by creating standardised protocols and frameworks.
- Automation and artificial intelligence: The use of machine learning (ML) algorithms in data tracking and supply chain management will grow. To further improve automation and decision-making in these areas, future research should investigate cutting-edge AI approaches like deep learning and neural networks.
- Ethical and Legal Implications: With data monitoring becoming more and more important, it is important to address the ethical and legal issues related to data collecting, storage, and use. Research ought to look into ways to handle data responsibly, preserve personal information, and adhere to rules.
- Sustainability and Environmental Impact: Future research can concentrate on using AI technology to enhance supply chain management sustainability practises. This entails streamlining waste

management efforts, minimising operational environmental effect, and improving transportation routing.

6 LIMITATIONS AND FUTURE STUDIES

The following suggestions for the limitations can direct future research in the areas of data tracking, supply chain management, and AI technologies based on the consequences of the study:

- Develop solutions that are industry-specific: Industry-specific AI technology, supply chain management strategies, and data monitoring procedures can all be tailored to handle unique difficulties and optimise benefits. Future research should concentrate on creating solutions tailored to individual industries and requirements.
- Research edge computing Edge computing can improve real-time decision-making and lower latency by processing data closer to where it is created. For increased effectiveness and responsiveness, future research should look into the integration of edge computing with AI technologies.
- ML algorithms are essential to decision-making processes, hence research should concentrate on creating ML models that are easy to understand. This would promote transparency and accountability by assisting stakeholders in comprehending and having faith in the judgements made by these models.
- Address Privacy and Security Issues: More investigation is required to address privacy and security issues relating to data tracking procedures, supply chain management, and IoT technology. This entails creating mechanisms for privacy protection, encryption standards, and secure data sharing.
- Place an Emphasis on Interdisciplinary Collaboration: Future research should place an emphasis on interdisciplinary collaboration because these areas involve several disciplines. Experts from data science, supply chain management, IoT, and ML coming together will result in creative solutions and a thorough understanding of the problems at hand.
- Research should also look into the social and economic effects of data tracking procedures, improvements in supply chain management, and the use of AI technology. Organisations and governsments may better prepare for the changes these innovations will bring about by understanding the implications for job positions, skill sets, and market dynamics.

AUTHOR DECLARATIONS

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Alhassan and A. A. Ahmed; Data Curation, V. A. Matayo, H. S. Jibrin, I. M. Alhassan and A. A. Ahmed; writing—original draft preparation, V. A. Matayo, H. S. Jibrin, I. M. Alhassan and A. A. Ahmed; writing—review and editing, V. A. Matayo, H. S. Jibrin, I. M. Alhassan and A. A. Ahmed; funding acquisition, All authors have read and agreed to the published version of the manuscript.

Data Availability Statement: The data utilized for this study will be made available upon reasonable request.

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