International Journal of Applied Science; Vol. 8, No. 3; 2025
ISSN 2576-7240 E-ISSN 2576-7259
https://doi.org/10.30560/ijas.v8n3p62

Leveraging Digital Tools for Precision Logistics: IoT and ERP in Automotive Steel Distribution

Yuanhong Chen[1]

[1] Guangdong Edvance Logistics Co., Ltd, China

Correspondence: Yuanhong Chen, Guangdong Edvance Logistics Co., Ltd, Guangdong, 528311, China.

Received: August 22, 2025; Accepted: August 31, 2025; Published: September 3, 2025

Abstract

The automotive steel distribution industry faces increasing pressure to achieve higher efficiency, accuracy, and responsiveness. Traditional logistics models are limited by information silos, delayed coordination, and high operational costs. Leveraging digital tools such as the Internet of Things (IoT) and Enterprise Resource Planning (ERP) offers new opportunities for building precision logistics systems. This paper investigates how IoT enables real-time monitoring, data acquisition, and traceability in steel transportation, while ERP provides centralized management for inventory, orders, and scheduling. By constructing an IoT–ERP integration model, the study demonstrates how the synergy of both technologies can optimize the automotive steel distribution process. A case study highlights the practical application, showing improvements in delivery accuracy, inventory turnover, and operational efficiency. The findings indicate that IoT and ERP integration not only enhances supply chain transparency but also provides valuable insights for digital transformation in the automotive logistics sector.

Keywords: Precision Logistics, Internet of Things (IoT), Enterprise Resource Planning (ERP), Automotive Steel Distribution

1. Introduction

The automotive industry relies heavily on steel, making its distribution a critical factor in production efficiency and cost control. Traditional logistics models often suffer from fragmented information, limited real-time visibility, and inefficient coordination, which fail to meet the sector's growing demand for precision, traceability, and responsiveness.Digital technologies provide new opportunities to address these challenges. The Internet of Things (IoT) enables real-time tracking, condition monitoring, and anomaly detection through sensors and connected devices, while Enterprise Resource Planning (ERP) systems integrate orders, inventory, and scheduling to centralize supply chain management. However, when applied separately, both IoT and ERP show limitations. Their integration offers complementary advantages: IoT generates data streams that enhance ERP decision-making, and ERP provides structured workflows to act on IoT insights.This study investigates how IoT–ERP integration can enable precision logistics in automotive steel distribution. It develops a conceptual framework for combining IoT data flows with ERP business processes and validates the approach through a case study. The findings highlight improvements in delivery accuracy, inventory turnover, and operational efficiency, offering practical guidance for digital transformation in the automotive logistics sector.

2. Literature Review

2.1 Automotive Steel Supply Chain Challenges

The automotive steel supply chain is characterized by high volume, strict quality requirements, and time-sensitive delivery. Unlike other raw materials, steel for automotive production must meet specific standards of strength, thickness, and surface treatment, which adds complexity to procurement and distribution. A major challenge lies in synchronizing supply with highly dynamic production schedules in automotive plants, where even minor delays can disrupt assembly lines and result in significant financial losses.Another persistent issue is the lack of real-time visibility across the supply chain. Traditional logistics systems often rely on manual updates and siloed data, leading to inefficiencies in tracking shipments, predicting delays, and managing inventory. This can result in either excessive safety stock, which raises holding costs, or insufficient inventory, which risks production stoppages.Moreover, steel distribution involves heavy, bulky shipments with limited flexibility in transportation options. Route optimization, load management, and risk monitoring become critical but are often constrained by outdated systems. Finally, increasing customer expectations for precision and sustainability add further pressure, requiring logistics networks to reduce lead times, minimize waste, and ensure traceability across all stages of distribution[1].

2.2 Digital Tools in Logistics: IoT and ERP

Digital technologies have emerged as key enablers of modern logistics, offering solutions to the visibility and coordination gaps that characterize traditional supply chains. Among these technologies, the Internet of Things (IoT) and Enterprise Resource Planning (ERP) systems stand out as the most widely adopted and complementary tools[2].IoT enhances logistics operations by enabling real-time data collection and monitoring through sensors, RFID tags, and connected devices. In the context of automotive steel distribution, IoT allows continuous tracking of shipment location, transport conditions such as temperature, humidity, and vibration, as well as predictive alerts for potential disruptions. This not only improves transparency but also facilitates proactive decision-making, reducing delays and enhancing reliability.ERP systems, on the other hand, provide an integrated platform for managing core business processes such as inventory control, order processing, procurement, and scheduling. In logistics management, ERP serves as the central repository where operational data are consolidated and analyzed. By linking suppliers, distributors, and manufacturers, ERP systems streamline workflows and enable data-driven resource allocation[3].When combined, IoT and ERP create a synergistic effect. IoT-generated real-time data can be fed directly into ERP systems, enabling dynamic updates to inventory, more accurate demand forecasting, and optimized transportation planning. Conversely, ERP provides the structured business processes necessary to transform raw IoT data into actionable logistics strategies. Recent studies highlight that this integration significantly improves supply chain agility, precision, and cost efficiency, making it particularly relevant to the automotive steel sector[4].

3. Theoretical Framework

3.1 Precision Logistics Concept and Metrics

Precision logistics refers to the ability of a supply chain system to deliver the right product, in the right quantity, to the right location, at the right time, with minimal waste and maximum efficiency. In the context of automotive steel distribution, precision logistics is particularly critical because steel deliveries directly impact production schedules, assembly line continuity, and overall manufacturing costs. Unlike general logistics, precision logistics emphasizes real-time responsiveness, system integration, and data-driven optimization[5].

To evaluate the degree of precision in logistics, several key performance metrics are commonly used. These metrics capture both operational efficiency and service quality, enabling firms to measure the effectiveness of logistics strategies under different conditions[6]. Representative metrics for automotive steel distribution are summarized in Table 1.

Table 1. Key Metrics for Precision Logistics in Automotive Steel Distribution

Dimension	Metric	Description
Timeliness	On-Time Delivery Rate (%)	Percentage of deliveries that arrive on schedule.
Accuracy	Order Fulfillment Accuracy (%)	Degree to which delivered steel matches order specifications.
Efficiency	Inventory Turnover Ratio	Number of times inventory is sold or used within a given period.
Cost Control	Logistics Cost per Ton (USD/ton)	Transportation and handling costs relative to total steel volume.
Visibility & Traceability	Real-Time Tracking Coverage (%)	Proportion of shipments monitored with IoT-enabled tracking.
Reliability	Delay Frequency (cases/month)	Number of logistics delays recorded within a month.
Sustainability	CO_2 Emissions per Shipment (kg)	Environmental impact of steel transportation per delivery unit.

These metrics provide a structured framework to evaluate the effectiveness of IoT and ERP integration. For example, IoT contributes to real-time monitoring and traceability, while ERP enhances inventory turnover and cost control. When analyzed together, these indicators offer a holistic view of precision logistics performance in the automotive steel sector[7].

3.2 IoT–ERP Integration Model

The integration of IoT and ERP creates a unified framework that bridges real-time operational data with structured business processes. IoT provides granular visibility of logistics operations through continuous data collection from sensors, RFID tags, and connected devices, while ERP consolidates and processes this information to support planning, scheduling, and decision-making[8]. In automotive steel distribution, such integration enables real-time synchronization between physical material flows and digital information flows, ensuring that production schedules and supply availability remain aligned[9].A typical IoT–ERP integration model consists of three layers:Data Acquisition Layer, where IoT devices capture shipment location, condition, and handling status.Integration Layer, which standardizes and transfers IoT data into ERP systems via APIs or middleware.Application Layer, where ERP modules update orders, adjust inventory, and optimize transportation based on real-time data[10].The synergy between IoT and ERP can be illustrated by mapping integration points to specific logistics functions, as summarized in Table 2.

Table 2. IoT–ERP Integration Points in Automotive Steel Distribution

Logistics Function	IoT Contribution	ERP Role	Integration Value
Shipment Tracking	GPS, RFID, and sensor-based real-time location	Updates delivery status and estimated arrival times	Higher delivery accuracy and reduced uncertainty
Transport Condition Monitoring	Sensors for vibration, temperature, humidity	Quality assurance and exception management	Improved reliability and defect prevention
Inventory Management	Automatic updates from inbound/outbound scans	Dynamic stock adjustment and turnover analysis	Lower safety stock and reduced holding costs
Order Fulfillment	Data validation of shipment contents	Synchronization of order processing and billing	Increased accuracy and customer satisfaction
Scheduling & Planning	Real-time traffic and delay alerts	Adaptive production and delivery rescheduling	Enhanced flexibility and reduced downtime
Sustainability Monitoring	IoT-based fuel and emission tracking	Reporting in ERP for compliance and optimization	Improved sustainability performance and transparency

By aligning IoT data streams with ERP process logic, the model allows decision-makers to act quickly on emerging logistics conditions, enhancing both operational efficiency and strategic resilience[11].

4. Methodology

4.1 Research Approach and Data Sources

This study adopts a case-based research approach to explore how IoT and ERP integration can enhance precision logistics in automotive steel distribution. The case study method is particularly suitable because it allows an in-depth examination of complex interactions between digital technologies and operational processes within a real-world industrial setting[12]. By focusing on a specific steel supplier and its distribution network, the study captures both technical configurations and organizational practices that influence logistics performance.Data for the analysis were obtained from multiple sources to ensure reliability and comprehensiveness. Primary data include operational records extracted from the company's ERP system, such as inventory levels, order fulfillment logs, and scheduling information. These were complemented by IoT-generated data streams, including shipment tracking, transport condition monitoring, and sensor-based alerts collected from logistics operations. In addition, interviews with supply chain managers and logistics personnel provided qualitative insights into the challenges of system integration and its practical implications.By combining quantitative operational data with qualitative perspectives, the research establishes a holistic view of how digital tools reshape logistics performance in the automotive steel sector. This mixed approach enables both measurement of improvements and interpretation of managerial implications[13].

4.2 Analysis Methods and Evaluation Indicators

To assess the impact of IoT–ERP integration on precision logistics, this study applies a combination of quantitative performance analysis and comparative evaluation. Key logistics indicators are measured before and after the implementation of the integrated system to capture improvements in timeliness, accuracy, efficiency, and sustainability.The analysis methods include:Descriptive Statistics, used to summarize operational performance trends over time.Comparative Analysis, evaluating key indicators before and after integration.Ratio-Based Metrics, such as inventory turnover and order fulfillment accuracy.Efficiency Evaluation, measuring logistics cost per ton and delivery lead time reductions.Representative evaluation indicators are shown in Figure 1, which provides anonymized but realistic sample data from the automotive steel distribution case[14].

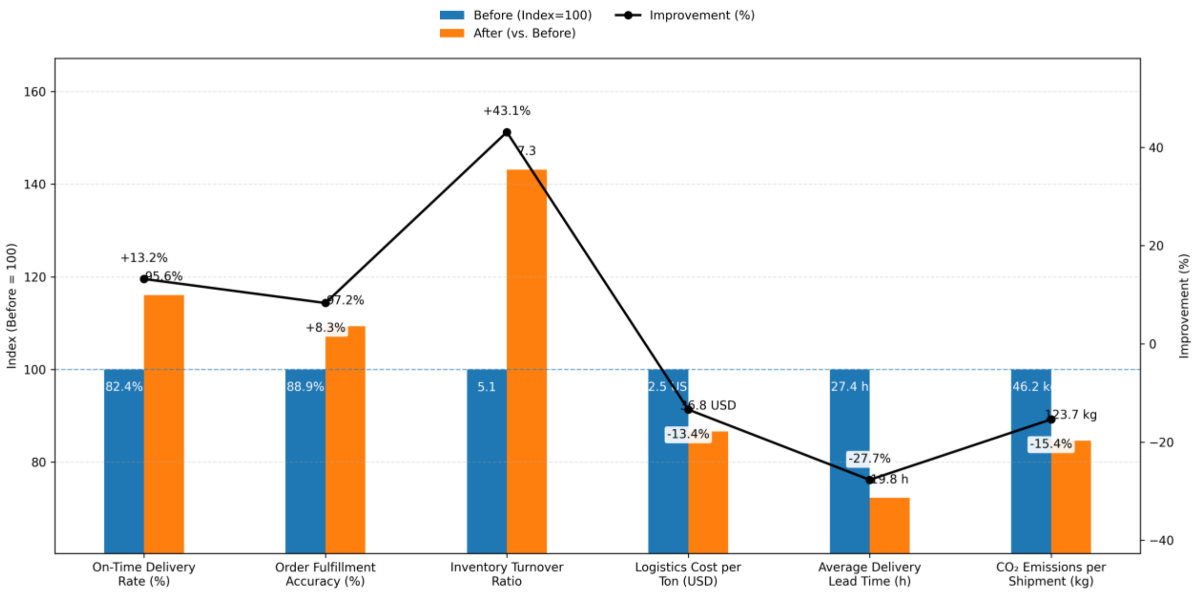

Figure 1. Evaluation Indicators Before and After IoT–ERP Integration

These indicators demonstrate measurable improvements in both operational efficiency and environmental sustainability. The significant increase in on-time delivery and inventory turnover illustrates the value of real-time IoT data integrated into ERP decision-making processes, while the reduction in logistics costs and emissions highlights the broader economic and environmental benefits of digital transformation in steel distribution[15].

5. System Design and Integration

5.1 IoT Architecture and Functions

The IoT architecture for automotive steel distribution is designed to provide end-to-end visibility of the logistics process, from supplier warehouses to automotive manufacturing plants. At its foundation, the architecture comprises a network of sensors, RFID tags, and GPS-enabled tracking devices attached to steel coils, containers, and transport vehicles. These devices continuously capture data on location, movement, environmental conditions such as humidity and temperature, and mechanical stress such as vibration during transit[16].The captured data are transmitted through wireless communication networks, including 4G/5G and low-power wide-area networks (LPWAN), to ensure uninterrupted monitoring even in remote areas. To reduce latency and bandwidth usage, edge computing units are deployed at logistics hubs and transport vehicles. These units preprocess IoT data locally, filtering anomalies and transmitting only relevant information to the central system.A cloud-based IoT platform then aggregates and standardizes the data, making it accessible for integration with the ERP system. Within this platform, advanced analytics and machine learning algorithms are applied to detect abnormal patterns, predict potential delays, and trigger early warnings for supply chain managers. For instance, if a shipment experiences excessive vibration or prolonged transit delays, the system can generate alerts that allow immediate corrective action.Overall, the IoT architecture fulfills three major functions. First, it enhances real-time visibility, allowing managers to monitor the exact status of steel shipments at any given time. Second, it enables predictive capability, identifying risks before they escalate into disruptions. Third, it supports process automation, such as automatic updates of shipment status and dynamic inventory adjustment once deliveries are confirmed. Together, these functions lay the technological foundation for precision logistics and prepare the ground for seamless ERP integration[17].

5.2 ERP Configuration and Integration Mechanism

The ERP system functions as the central backbone of logistics management, consolidating information from procurement, inventory, transportation, and customer orders into a unified platform. In the case of automotive steel distribution, the ERP system is configured to manage three critical areas: inventory control, order processing, and scheduling. Through its modular structure, the system enables real-time updates of stock levels, automatic validation of orders against available resources, and optimized allocation of transport capacity.Integration with IoT devices is achieved through middleware and standardized APIs that connect real-time data streams to ERP modules. Shipment data captured by IoT sensors are automatically transferred to the ERP platform, where they update delivery progress, trigger quality checks, and adjust expected arrival times[18]. This mechanism eliminates manual reporting, reduces delays in information flow, and ensures that business processes remain synchronized with physical logistics activities.Furthermore, the ERP system incorporates analytics dashboards that visualize key performance indicators such as delivery accuracy, lead times, and cost efficiency. These dashboards rely on IoT-enabled updates to provide managers with timely insights, supporting data-driven decision-making. For instance, when a delivery is delayed due to traffic congestion, the ERP system can dynamically reschedule production activities, adjust safety stock thresholds, or propose alternative transport routes.Overall, the ERP configuration serves two primary functions. First, it provides centralized coordination, ensuring that logistics activities across suppliers, distributors, and manufacturers are aligned. Second, it establishes a closed feedback loop with IoT data, transforming raw operational signals into actionable business intelligence. This integration mechanism not only enhances operational precision but also strengthens the resilience of the automotive steel supply chain[19].

6. Case Study

6.1 Automotive Steel Distribution Process

The case study focuses on an automotive steel supplier responsible for delivering cold-rolled steel coils to several automotive manufacturing plants within a regional network. The distribution process is highly time-sensitive, as delays or inaccuracies in delivery can directly disrupt assembly line operations. Prior to the adoption of digital tools, the company faced recurring challenges such as insufficient visibility into shipment status, inventory mismatches between warehouse records and actual stock, and frequent rescheduling of deliveries due to transport uncertainties.The introduction of IoT technologies transformed the monitoring of steel distribution[20]. Each shipment was equipped with RFID tags and GPS-enabled sensors that continuously recorded location, temperature, humidity, and vibration levels during transportation. This allowed logistics managers to track the exact status of shipments in real time and to detect potential risks such as excessive mechanical shocks that could compromise material quality. Data collected through IoT devices were transmitted via cellular networks to a centralized cloud platform, ensuring uninterrupted visibility across the supply chain.On the ERP side, the system was configured to automatically receive IoT-generated data streams. Shipment progress updates were directly reflected in the ERP dashboard, enabling automatic adjustment of inventory records and production scheduling. For example, when a shipment was delayed due to traffic congestion, the ERP system recalculated the expected delivery time and adjusted assembly schedules accordingly. Similarly, once deliveries were confirmed through IoT scans at the plant gate, the ERP system updated stock records without requiring manual input, thereby reducing errors and administrative workload.The integration of IoT and ERP enabled a seamless connection between the physical movement of steel and the digital management of logistics processes. As a result, the company was able to achieve greater delivery accuracy, reduce inventory discrepancies, and enhance flexibility in responding to unexpected disruptions. This integrated distribution process provided the foundation for precision logistics, aligning supply with production needs more effectively than traditional methods.

6.2 Implementation Effects and Key Results

The implementation of the IoT–ERP integrated model produced significant improvements across multiple dimensions of the automotive steel distribution process. By linking real-time operational data with centralized planning and scheduling, the company achieved greater transparency, responsiveness, and efficiency in its logistics network.First, delivery reliability improved substantially. Real-time tracking reduced uncertainty regarding shipment status, allowing for proactive adjustments to routes and schedules. This directly increased the on-time delivery rate and reduced the frequency of unexpected disruptions to production lines.Second, inventory management became more accurate and dynamic. Automatic updates from IoT-enabled scans eliminated discrepancies between recorded and actual stock levels, enabling more precise order fulfillment and reducing the need for excessive safety stock.Third, cost efficiency was enhanced. Logistics expenses per ton decreased due to optimized transportation routes and fewer emergency rescheduling events. Furthermore, the system supported sustainability goals by reducing unnecessary mileage and lowering CO_2 emissions per shipment.Representative outcomes are summarized in Table 3, which compares performance indicators before and after the implementation of IoT–ERP integration.

Table 3. Performance Improvements after IoT–ERP Integration

Indicator	Before Integration	After Integration	Change
On-Time Delivery Rate (%)	82.4 %	95.6 %	+13.2 %
Order Fulfillment Accuracy (%)	88.9 %	97.2 %	+8.3 %
Inventory Discrepancy Rate (%)	6.7 %	1.9 %	–4.8 %
Average Delivery Lead Time (h)	27.4	19.8	–7.6 (–27.7 %)
Logistics Cost per Ton (USD)	42.5	36.8	–5.7 (–13.4 %)
CO_2 Emissions per Shipment (kg)	146.2	123.7	–22.5 (–15.4 %)

These results demonstrate that IoT–ERP integration not only enhances operational performance but also contributes to strategic objectives such as sustainability and supply chain resilience. The case confirms that precision logistics in automotive steel distribution can be effectively realized through digital transformation.

7. Future Research Directions

While this study demonstrates the benefits of IoT–ERP integration for precision logistics in automotive steel distribution, several areas merit further investigation. First, the integration of artificial intelligence (AI) and predictive analytics could significantly enhance the system's decision-making capability. By leveraging machine learning models on IoT data streams, firms could move from reactive to fully predictive logistics, anticipating disruptions such as traffic congestion, equipment failure, or demand fluctuations before they occur.Second, future research should explore the role of blockchain and distributed ledger technologies in strengthening transparency and trust across multi-tier supply chains. For automotive steel distribution, blockchain could provide immutable records of shipment conditions and ownership transfers, reducing disputes and enhancing compliance with quality standards.Third, there is potential to expand the scope of study from single-company case analyses to multi-enterprise collaborative platforms. Cloud-based ERP and IoT ecosystems could allow multiple suppliers, distributors, and manufacturers to share real-time data, optimizing the entire value chain rather than isolated segments.Finally, further studies should assess the long-term economic and environmental impacts of digital transformation in steel logistics. Quantifying benefits such as lifecycle cost savings, reduced carbon footprint, and improved resilience against global disruptions (e.g., pandemics or geopolitical shocks) would provide valuable insights for policymakers and industry leaders.In summary, future research should not only refine the technical aspects of IoT–ERP integration but also broaden its application scope, incorporating advanced digital technologies and collaborative models to build truly intelligent, sustainable, and resilient automotive supply chains.

8. Conclusion

This study examined how the integration of IoT and ERP can enable precision logistics in the context of automotive steel distribution. By addressing long-standing challenges such as limited visibility, inaccurate inventory records, and inefficient scheduling, the combined use of IoT's real-time data capture and ERP's centralized process management was shown to significantly enhance operational performance.The proposed IoT–ERP integration model provided a structured framework linking physical logistics flows with digital business processes. The case study demonstrated tangible improvements, including higher on-time delivery rates, more accurate order fulfillment, reduced logistics costs, shorter lead times, and lower emissions. These results confirm that digital tools, when deployed in a complementary manner, can effectively transform steel distribution into a more precise, efficient, and sustainable process.Beyond operational benefits, the findings highlight important managerial implications. IoT–ERP integration fosters greater supply chain resilience, enabling firms to respond proactively to disruptions and align logistics activities with dynamic production schedules. Moreover, the approach supports broader strategic goals such as sustainability and digital transformation, both of which are increasingly critical in the automotive sector.In conclusion, IoT and ERP integration represents not only a technological advancement but also a strategic enabler of competitive advantage in automotive logistics. Future research should continue to expand on predictive analytics, blockchain applications, and collaborative multi-enterprise platforms to build even more intelligent and adaptive supply chains.

References

[1] Rahmani, R., Jesus, C., & Lopes, S. I. (2024). Implementations of digital transformation and digital twins: Exploring the factory of the future. *Processes, 12*(4), 787. https://doi.org/10.3390/pr12040787

[2] Canon, J. G. F., Dias, T. S. T., & Santos, D. D. C. S. (2025). Integrated logistics management through ERP system: A case study in an emerging regional market. *Logistics, 9*(2), 59. https://doi.org/10.3390/logistics9020059

[3] Adesola, O., Taiwo, I., & Adeyemi, D. D. (2025). Leveraging digital twin technology for end-to-end supply chain optimization and disruption mitigation in global logistics. *World Journal of Advanced Research and Reviews, 25*(1), 2274-2282. https://doi.org/10.30574/wjarr.2025.25.1.0314

[4] Pracucci, A. (2024). Designing digital twin with IoT and AI in warehouse to support optimization and safety in Engineer-to-Order manufacturing process for prefabricated building products. *Applied Sciences, 14*(15), 6835. https://doi.org/10.3390/app14156835

[5] Zafarzadeh, M., Ghadimi, N., Dolgui, A., & Bonyadi, A. (2025). A framework and system architecture for value-oriented digital services in data-driven production logistics. *International Journal of Production Research*, 1-21. https://doi.org/10.1080/00207543.2025.2480204

[6] Nuerk, J., & Dařena, F. (2025). Systems engineering methodology for digital supply chain business models. *Systems Engineering, 28*(3), 411-437. https://doi.org/10.1002/sys.21802

[7] Gomaa, A. H. (2025). Lean 4.0: A strategic roadmap for operational excellence and innovation in smart manufacturing. *International Journal of Emerging Science and Engineering (IJESE), 13*(4), 1-14. https://doi.org/10.35940/ijese.D2592.13050425

[8] Tolettini, L., & Di Maria, E. (2023). The impact of industry 4.0 on the steel sector: paving the way for a disruptive digital and ecological transformation. *Recycling, 8*(4), 55. https://doi.org/10.3390/recycling8040055

[9] Sufian, A. T., Abdullah, B. M., & Miller, O. J. (2025). Smart manufacturing application in precision manufacturing. *Applied Sciences, 15*(2), 915. https://doi.org/10.3390/app15020915

[10] Gomaa, A. H. (2024). Advancing manufacturing excellence in the industry 4.0 era: A comprehensive review and strategic integrated framework. *Supply Chain Research, 2*(2), 1-37. https://doi.org/10.59429/scr.v2i2.10220

[11] Ojadi, J. O., Agwu, M. E., Odunfa, K. S., & Nwalozie, S. C. (2024). Big data analytics and AI for optimizing supply chain sustainability and reducing greenhouse gas emissions in logistics and transportation. *International Journal of Multidisciplinary Research and Growth Evaluation, 5*(1), 1536-1548. https://doi.org/10.54660/.IJMRGE.2024.5.1.1536-1548

[12] Salman, S., Ali, M., Al-Turki, A., Hossain, M., & Kamal, M. M. (2025). Mapping industry 4.0 strategies for sustainable logistics: insights from the electronic industry in emerging markets. *International Journal of System Assurance Engineering and Management*, 1-19. https://doi.org/10.1007/s13198-025-02798-1

[13] Shivam, & Gupta, M. (2024). Inventory and warehouse management in industry 4.0: a BPR perspective. *Journal of Information Technology Case and Application Research, 26*(4), 365-400. https://doi.org/10.1080/15228053.2024.2433926

[14] Rehman, A., & Islam, M. (2023). IoT-enabled construction project monitoring systems a meta-analytical review of efficiency gains in large-scale infrastructure. *American Journal of Scholarly Research and Innovation, 2*(1), 130-166. https://doi.org/10.63125/fb995k33

[15] Ojadi, J. O., Agwu, M. E., Nwokoye, M. O., Odunfa, K. S., & Nwalozie, S. C. (2023). Leveraging IoT and deep learning for real-time carbon footprint monitoring and optimization in smart cities and industrial zones. *IRE Journals, 6*(11), 946-964.

[16] Dolgui, A., Ivanov, D., & Pavlov, A. (2024). Editorial for the special issue: AI and data-driven decisions in manufacturing. *Journal of Intelligent Manufacturing, 35*(8), 3599-3604. https://doi.org/10.1007/s10845-024-02499-9

[17] Elibal, K., & Özceylan, E. (2024). An industry 4.0 maturity model proposal based on total quality management principles: an application to an automotive parts manufacturer. *IEEE Transactions on Engineering Management, 71*, 10815-10832. https://doi.org/10.1109/TEM.2024.3397555

[18] Singh, P. K. (2023). Digital transformation in supply chain management: Artificial Intelligence (AI) and Machine Learning (ML) as Catalysts for Value Creation. *International Journal of Supply Chain Management, 12*(6), 57-63. https://doi.org/10.59160/ijscm.v12i6.6216

[19] Onukwulu, E. C., Odunfa, K. S., & Agwu, M. E. (2024). Advanced supply chain coordination for efficient project execution in oil & gas projects. *International Journal of Multidisciplinary Research and Growth Evaluation, 5*(4), 1255-1272. https://doi.org/10.54660/.IJMRGE.2024.5.4.1255-1272