

Research on the Synergistic Effect of Global Supply Chain Visualization and Data Technology

Zixing Wang^a

School of Economics, Qingdao University, Qingdao, China

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Abstract: With the deepening development of globalization, global supply chains play a crucial role in connecting production and consumption. However, the issue of transparency in the supply chain is becoming increasingly prominent, and phenomena such as information asymmetry, data silos, and difficult traceability seriously constrain the efficiency and security of the supply chain. This article focuses on the synergistic effects of global supply chain visualization and data technology, aiming to explore how to use advanced technologies such as the Internet of Things, blockchain, and augmented analytics to improve supply chain transparency, reduce risks, and enhance overall performance. Based on the differences in digital practices in different regions and their influence on supply chain performance, this study proposes a series of practical suggestions, including developing targeted digital transformation strategies based on regional characteristics and market demand, strengthening the application and promotion of advanced technologies in the supply chain, etc. These suggestions aim to help enterprises better cope with challenges and seize opportunities in the process of digital transformation, thereby enhancing the transparency and overall performance of the global supply chain.

1 INTRODUCTION

In the context of a globalized economy, the importance of the supply chain as a key link between production and consumption is becoming increasingly prominent. The transparency of the current global supply chain is facing many challenges. These challenges mainly stem from the complexity of the supply chain, the wide geographical distribution, and the diversity of participating entities. These factors work together to make information acquisition and transmission exceptionally difficult (Sun, 2025).

The complexity of the supply chain is one of the important reasons for the decrease in transparency. Global supply chains often involve multiple links and numerous participants, from raw material procurement to production, transportation, and distribution, each link may generate a large amount of data and information. The fragmentation and dispersion of this information make it very difficult to comprehensively and accurately grasp the overall situation of the supply chain. At the same time, different links in the supply chain may involve different industries, countries, and regions, and their

operating models and regulatory environments are also different, which further increases the difficulty of information integration.

Regional distribution is also an important factor affecting supply chain transparency. The various links in the global supply chain are often distributed in different countries and regions, even spanning multiple time zones. This geographical dispersion not only increases the cost of information communication and coordination but may also lead to delays and distortions in information. In addition, differences in regulations, culture, language, and other factors among different countries and regions may also pose obstacles to the transmission and understanding of information. By comparing and analyzing the differences in supply chain digitalization practices in different regions, enterprises can identify the gaps between themselves and advanced regions and thus learn from successful experiences in a targeted manner, formulate supply chain visualization and data technology application strategies that are more in line with their actual situation, and enhance their competitiveness in the global supply chain.

^a <https://orcid.org/0009-0004-1957-4618>

The diversity of participants is also an undeniable reason for the issue of supply chain transparency. Participants in the global supply chain include multiple roles such as suppliers, manufacturers, distributors, and retailers, each with their own interests and information needs. The existence of such diversity makes the flow of information in the supply chain more complex and difficult to control. Meanwhile, due to the potential for information asymmetry and conflicts of interest among participants in the supply chain, this also increases the likelihood of information fraud and risk.

This study aims to explore in depth the synergistic effects of global supply chain visualization and data technology to address the challenges of supply chain transparency. By leveraging advanced technologies such as the Internet of Things (IoT), blockchain, and augmented analytics, this study highlights the significant potential of these innovations in enhancing supply chain transparency, mitigating risks, and optimizing operational efficiency. This study will also compare and analyze the differences in supply chain digitalization practices in different regions, to provide more targeted practical suggestions for enterprises. By drawing on successful experiences from advanced regions and combining them with the actual situation of the enterprise, it can more effectively promote the application of supply chain visualization and data technology, thereby enhancing its competitiveness in the global supply chain.

2 GLOBAL SUPPLY CHAIN TRANSPARENCY CHALLENGES AND CORE PAIN POINTS

The challenges faced by global supply chain transparency are multifaceted, with information asymmetry and traceability difficulties being the core pain points. These pain points not only compromise the efficiency and flexibility of the supply chain but also escalate the operational risks and costs for enterprises.

Asymmetric information is due to the involvement of multiple links and numerous participants in the supply chain, which often hinders the acquisition and transmission of information. For example, in the procurement process, suppliers may provide incomplete or false information, which may prevent the purchaser from accurately assessing the supplier's capabilities and reputation, thereby affecting procurement quality and cost control; In the

sales process, distributors may exaggerate market demand to seek high profits, which in turn leads to overproduction and inventory accumulation by the production side, increasing the operating costs and risks of the enterprise; During the consumption process, consumers may choose low-quality and low-priced products based on limited information, which may affect the promotion of high-quality products.

Traceability difficulty is another important issue in the global supply chain. In the supply chain, the production and circulation of products involve multiple links and participants. Once a problem arises, it is often difficult to quickly identify the cause and the responsible person. This difficulty in tracing not only increases the quality risk and cost of the enterprise but also reduces consumers' trust in the product. Especially in the fields of food safety, drug quality, etc., traceability difficulties may lead to serious social problems and legal consequences.

3 PATH OF DATA-DRIVEN SUPPLY CHAIN VISUALIZATION TECHNOLOGY

3.1 Internet of Things and Edge Computing

The combination of the Internet of Things and edge computing has brought significant advantages to supply chain management. Firstly, this combination enables enterprises to monitor the status of their supply chain in real-time. Whether it is the inventory situation in the warehouse, the transportation progress of goods, or even the quality status of products, they can be tracked in real time through IoT devices. Secondly, through real-time analysis of the collected data through edge computing, enterprises can quickly find problems in the supply chain, such as inventory backlog, transportation delay, or abnormal product quality, to take timely measures to correct them. This real-time monitoring and instant response capability is crucial for improving the transparency and efficiency of the supply chain. The improvement of transparency means that enterprises can more accurately understand the actual situation of the supply chain and make wiser decisions. The improvement of efficiency is directly reflected in reducing unnecessary waste, speeding up the flow of goods, and ultimately improving the competitiveness of enterprises. The combination of the Internet of Things and edge computing has laid a solid

foundation for supply chain visualization, while blockchain and data sharing further promote the development of supply chain visualization from another angle (Lin,2025).

3.2 Blockchain and Data Sharing

In supply chain management, blockchain technology, with its decentralized nature, means that data no longer relies on a single central institution or server for storage and verification, thereby reducing the risk of data tampering or forgery. Every transaction and flow of information is permanently recorded on the blockchain, forming an immutable data chain that greatly enhances the authenticity and credibility of the data (Wang,2025).

The data sharing mechanism of blockchain technology enables various links in the supply chain to obtain and update information in real time. This not only includes basic information such as product production, transportation, and sales, but may also cover more dimensions of data such as quality inspection, certification, tariffs, etc. In this way, blockchain helps eliminate information silos, allowing all stakeholders to work collaboratively in a shared and transparent environment, with real-time updates and verification of information at each stage, thereby reducing unnecessary intermediate links and improving the operational efficiency and adaptability of the supply chain (Yin,2022).

For example, in the automotive supply chain, data sharing is achieved between different component suppliers, vehicle manufacturers, and dealers through blockchain technology, eliminating information silos, improving the collaborative efficiency of the supply chain, and reducing production delays and cost increases caused by information opacity.

Furthermore, the data traceability function of blockchain is also of great significance for addressing issues in the supply chain. Once problems arise, such as product quality issues or transportation delays, companies can quickly trace the source of the problem through blockchain and take timely measures to correct them. This ability not only helps companies improve the speed and accuracy of problem response but also prevents similar problems from happening again to a certain extent (Feng,2020).

3.3 Augmented Analytics

Augmented analytics play a crucial role in visualizing global supply chains. By utilizing advanced algorithms such as machine learning and natural language processing, this technology can deeply

explore the potential value in supply chain data, providing enterprises with more accurate and comprehensive operational insights (Alghamdi,2022; Prat,2019).

In supply chain management, data is the foundation of decision-making. Augmented analytics technology can automatically screen, integrate, and analyze large amounts of data, simplify the data, and present clear results. Users can get rid of subjective opinions and biases, gain true insights, and quickly and accurately act based on the data, providing powerful support for enterprise decision-making (Andriole, 2019).

More importantly, augmented analytics not only focus on historical data, but also reveals possible future market changes and supply chain risks through predictive analysis. By predicting key factors such as future demand changes and price fluctuations, companies can prepare in advance, adjust production and operational strategies to address potential market challenges.

In practical applications, augmented analytics has demonstrated its powerful potential. For example, in terms of inventory management, by analyzing historical sales data and combining it with market trends and consumer behavior predictions, companies can more accurately develop inventory plans to avoid inventory backlog or stockouts. In terms of risk management, enhancing analytical techniques can help companies detect abnormal situations in the supply chain promptly, such as supplier instability, transportation delays, etc., and take timely measures to respond.

3.4 Synergistic Effects of Technological Paths

When exploring the synergistic effects of technological paths such as the Internet of Things, blockchain, and augmented analytics in supply chain visualization, cannot help but mention how these technologies complement and promote each other to jointly promote the improvement of global supply chain transparency.

As a pioneer in supply chain data collection, IoT technology captures raw data from each link in real time, providing basic support for subsequent links. Blockchain technology ensures the openness, transparency, and immutability of data, greatly enhancing its credibility and establishing a foundation of trust for analysis and application. Augmented analytics technology utilizes AI to deeply mine data, predict demand, optimize operations, and warn of risks. Its insight value highly depends on the

quality and credibility of the data provided by the first two.

When the three are closely combined, the synergistic effect becomes apparent: the Internet of Things provides real-time data sources; Blockchain ensures its authenticity and security; Enhanced analysis involves deep processing and prediction based on trustworthy data, producing high-value insights. This closed-loop, trustworthy intelligent analysis system significantly improves the efficiency, visualization level, and risk response capability of supply chain management.

4 COMPARISONS OF THE IMPACT OF REGIONAL DIGITALIZATION LEVEL ON SUPPLY CHAIN PERFORMANCE

4.1 EU Compliance-Oriented Digital Practices

In the EU region, the digitalization of supply chains is heavily influenced by compliance orientation. While pursuing supply chain efficiency and cost optimization, enterprises must strictly comply with various regulatory standards, including environmental protection, safety, and data protection.

To satisfy various compliance requirements, enterprises are increasingly adopting IoT technology to enable real-time monitoring across the supply chain. Through the installation of sensors and RFID tags, organizations can continuously track the location, status, and transportation environment of goods. This capability ensures adherence to relevant regulatory standards throughout the supply chain process. Beyond ensuring compliance, real-time monitoring also enhances supply chain transparency and responsiveness, thus improving overall supply chain performance.

Chinese battery company Sunwoda is responding to the EU's battery regulations by collecting real-time data on the entire lifecycle of batteries (such as raw material traceability and carbon emissions) through IoT sensors and using blockchain technology to ensure that the data is tamper proof, meeting the EU's mandatory requirements for supply chain transparency. At the same time, integrate production, recycling, and other full chain data to generate automated compliance reports, avoiding market access risks; Analyze supply chain bottlenecks and

optimize production scheduling to increase partner inventory turnover by 15%. This transformation transforms the initial compliance investment into a competitive barrier, shortens the order response cycle by 20%, and supports the expansion of overseas markets. EU policies force companies to tilt their digital resources towards building auditable data trust chains (such as blockchain traceability), converting compliance costs into long-term market access advantages (Zhou,2025).

4.2 Efficiency-Oriented Digital Practices in China

In China, efficiency-oriented digital practices have become an important trend in supply chain management. By deeply mining and analyzing the massive data generated in the supply chain, enterprises can more accurately understand market demand, optimize inventory management, improve logistics paths, and predict future market changes. This not only helps companies make wiser decisions but also significantly improves the responsiveness and flexibility of the supply chain.

Intelligent management is another key to improving supply chain efficiency. With the help of IoT, big data, and AI, enterprises can achieve real-time monitoring and intelligent scheduling of various links in the supply chain. For example, by using IoT technology to track goods in real-time, companies can ensure the safe transportation of goods and respond promptly to emergencies; By optimizing warehouse management through artificial intelligence technology, enterprises can increase inventory turnover and reduce warehousing costs. At the same time, in digital practice, these enterprises also focus on introducing quality management systems and risk assessment tools to ensure the stability and sustainability of the supply chain.

Taking Guizhou Fengmao Chemical Logistics Enterprise as an example, its independently developed intelligent logistics system (RMS) embodies the logic of efficiency priority: by monitoring the transportation status of hazardous chemicals through on-board sensors, AI dynamically schedules thousands of vehicles, achieving a 40% increase in order matching efficiency and a 25% reduction in empty driving rate. Integrate warehouse and transportation data into the dashboard operation, automate financial processes with robots, and save 1.5 million yuan in labor costs annually; A 50% decrease in accident rate indirectly reduces insurance expenses. This system increases daily transportation volume by 30%, achieves a 98% order fulfillment rate,

and achieves a dual reduction in operating costs and risks (Wang,2025).

4.3 Comparative Analysis

To clearly present the essential differences in the impact of digital practices on supply chain performance under the EU compliance orientation

and China efficiency orientation, this study extracts key comparative dimensions based on the practices of Sunwoda (EU compliance case) and Guizhou Fengmao (China efficiency case), as shown in Table 1.

Table 1. A comparison of the impact of digital Practices on Supply Chain Performance under the EU Compliance Orientation and China Efficiency Orientation (Zhou,2025; Wang,2025).

Dimension	EU Compliance Orientation (Xinwangda Case)	China Efficiency Orientation (Case Study of Fengmao, Guizhou)
Core objective	Meet regulatory audits (such as battery passports)	Reduce transportation/warehousing costs
Technical weight	Blockchain>Internet of Things>Augmented analytics	Internet of Things=AI>Blockchain
Performance Focus	Avoid the risk of fines/bans	Vehicle/warehouse utilization rate
	Full chain traceability	Order response speed
Benefit cycle	Breaking through long-term market barriers	Significant decrease in short-term costs

5 CONCLUSIONS

This article systematically studies the collaborative mechanism between data technology and supply chain visualization through literature analysis, case studies, and comparative analysis. Research has found that global supply chains are facing core challenges of insufficient transparency: complexity and globalization lead to frequent information gaps, data silos, and traceability difficulties. The technology triangle, consisting of the Internet of Things, blockchain, and augmented analytics, is restructuring the supply chain management model - the Internet of Things enables real-time data collection throughout the entire chain, blockchain establishes a decentralized trust network, and augmented analytics optimizes inventory turnover through machine learning. The collaborative application of the three promotes the supply chain to enter an intelligent closed loop of "perception analysis decision-making". Based on research findings, enterprises implementing digital transformation need to follow three core paths:

Construction of technology integration architecture: Establish an integrated database of IoT and blockchain technology, realize real-time data collection and dynamic monitoring of the entire supply chain through IoT, and synchronously use

blockchain to build a decentralized and tamper-proof data sharing network. The architecture needs to be compatible with 5G, edge computing, and other new infrastructures, ensure the security and timeliness of the whole link of data from acquisition, storage transmission, and provide high-quality data input for intelligent decision-making.

Deployment of intelligent decision-making center: Build a data processing platform with enhanced analysis as the core, integrating technology modules such as machine learning and natural language processing. The system needs to have multi-dimensional data analysis, real-time risk warning, and adaptive optimization functions, and achieve intelligent demand forecasting, inventory optimization, and logistics scheduling through deep mining of data correlations, forming a closed-loop decision-making mechanism from data insight to execution feedback.

Regional adaptation strategy design: Develop differentiated technology application plans, deploy data traceability and transparency systems in compliance-oriented markets, build a digital governance framework that complies with ESG standards, strengthen the integration of IoT and intelligent algorithms in efficiency priority areas, and develop agile, responsive supply chain models. At the same time, establish a dynamic learning mechanism

and continuously absorb international advanced practices for localization transformation.

In future implementation, attention should be paid to the three core dimensions of technology aggregation, data liquidity, and organizational agility. Through systematic engineering such as building a technology platform, optimizing data governance, and reshaping business processes, the supply chain can be continuously upgraded from visualization to predictability and adjustability. Enterprises should establish a collaborative mechanism between technological iteration and organizational change to enhance supply chain resilience in dynamic balance.

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