

Exploratory Study of Sustainable Automotive Supply Chain Logistics Process Based on Blockchain Technology

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Abstract. Given the intricate nature of the automotive supply chain, it is essential to effectively oversee and guarantee the traceability and sustainability of cars and their components. Numerous automotive manufacturers have undertaken an examination of the integration of blockchain technology into their supply chain operations, with some entities having already started its implementation. This study explores the implementation of blockchain technology in the logistics operations using H Automobile Manufacturing Company as a case study. Blockchain technology is used within the automobile manufacturing logistics process to facilitate the comprehensive tracking of vehicles and their constituent components, for sharing information among the relevant stakeholders. The objective is to provide organizations a reference point and a solution for using blockchain technology for the evolution of the automobile industry supply chain. In conclusion, this study acknowledges and articulates the limitations in the study, while also presenting the research findings and suggesting potential avenues for further research.

Keywords: Blockchain Technology, Supply Chain, Logistics Process, Automotive industry.

1 Introduction

Against the backdrop of an evolving and increasingly competitive global automotive industry, supply chain efficiency and sustainability have become critical. The management of the automotive supply chain is a multifaceted procedure that spans from the acquisition of raw materials to the ultimate distribution of the finished product. This process necessitates the harmonization of many suppliers, manufacturers, and logistics partners.

As supply chains continue to expand and become more complex, managing and ensuring their traceability and sustainability is becoming increasingly challenging. Against this backdrop, blockchain technology has attracted widespread attention as it is recognised as having the potential to transform the way supply chains are managed, improving efficiency and enhancing security, while helping to drive supply chain sustainability.

The emergence of the automobile sector has led to a shift in competitive dynamics among firms, transitioning towards a focus on supply chain rivalry. Supply chain management (SCM)

is of utmost importance in the automobile sector. In the German there is a focus on sustainable supply chain management(SSCM) in automotive industry[1].Multiple businesses have done their best to maintain their strategic advantage by launching efficient, globally expansive supply networks[2].

Automotive vehicle manufacturers, parts suppliers and logistics companies are beginning to explore how to leverage the application of blockchain technology is making significant progress in the automotive supply chain. With blockchain, participants can share and validate transaction data in real time without intermediaries, thus enhancing the transparency of information in the supply chain. Blockchain technology can be used to create transparent, traceable and highly secure transaction records that can be shared and verified by supply chain participants This enables supply chain managers to better track logistics, inventory and deliveries, respond quickly to problems, and blockchain reduces the risk of data tampering and fraud. This is critical to ensure the integrity and trustworthiness of supply chain data.

However, despite the huge potential of blockchain technology, its practical application faces a number of challenges, including technical standards, compliance and partner acceptance. Therefore, it is crucial to study the application of blockchain technology in the automotive supply chain and its impact on sustainability.

The aim of this study is to explore the application of blockchain technology in SCM from the perspective of logistics management, using Company H as an example, and to study its impact on the sustainability of the supply chain and provide insights into future developments.

2 Literature Review

Automotive SCM is a complex area that requires effective coordination and tracking of logistics and information flows from raw materials to final products.A large number of automobile manufacturers and other players in the supply chain are starting to investigate the use of new technologies in order to enhance the industry's efficiency, visibility, and sustainability. One of them is the technology known as blockchain, which is considered as a potentially useful option for improving the management of the automotive supply chain in all of its elements.

2.1 Automotive SCM and sustainability

The automotive supply chain is a comprehensive network that includes upstream and downstream suppliers, logistics service providers, vehicle manufacturers, service providers, and various after-sales auto repair services. At the center of this network is the automobile manufacturing industry. It encompasses all of the pertinent activities, beginning with the acquisition of raw materials and ending with sales, consumer usage, and logistical operations at intermediate stages[3].

Mougayar, W. (2016) stated that blockchain can reduce product recalls and wastage by ensuring product origin and quality, thus improving sustainability[4].Jansiti and Lakhani (2017) argued that blockchain technology can improve trust relationships between supply chain partners and increase supply chain efficiency[5].Tapscott and Tapscott (2016)

highlighted the potential of blockchain technology in the automotive supply chain, emphasising its potential to change business models[6].

2.2 Current status of blockchain technology applications

Although there are still many constraints on blockchain technology, it has made relatively great progress at the application level. In particular, the application of blockchain in the industrial Internet, which is mainly oriented to supply chain management, telecommunication data sharing, trade finance and other scenarios, can give full play to the optimisation of business processes, reduce operating costs and other roles, and it is necessary to deepen the fusion of the blockchain and the industrial Internet application[7].

The purpose of the inquiry is to further our understanding of blockchain technology as it relates to operations and supply chain management (OSCM), to identify potential applications for the technology, and to provide a research agenda for additional inquiries into the topic. This research study aims to elucidate and evaluate the intricacies of blockchain technology, with a specific focus on its potential ramifications for Operations and Supply Chain Management (OSCM). The level of excitement and attention around the potential benefits provided by digital ledger technology is substantial[8].

It provides an in-depth analysis of the current and rising trends of blockchain technology implementation in logistics and SCM [9].

The primary objective of this study is to investigate the existing body of literature pertaining to the use of blockchain technology in the context of sustainable SCM. The research has undertaken an examination of the economic, environmental, and social consequences of blockchain technology. Additionally, it has drawn attention to the developing patterns within circular supply chains, taking into account the latest advancements in technology and their key determinants of success [10].

The intricacy of currently used technologies is the primary topic of this study, as well as the potential replacement application of Blockchain technology in the automobile industry[11].

It examines the considerable potential of using blockchain technology in the automobile sector, with a particular focus on its cybersecurity attributes. Therefore, the evaluation of the application of blockchain technology is conducted by thoroughly reviewing the present state-of-the-art and analyzing the prevailing issues faced by the key parties involved[12].

However, despite the huge potential of blockchain technology, practical applications still face challenges. Therefore, it is crucial to study the practical application of blockchain technology in the automotive supply chain and its impact on sustainability.

Automotive supply chain management is critical for productivity, product quality and sustainability. However, traditional supply chain management presents a number of challenges in terms of information asymmetry, poor transparency and data insecurity.

Caro, M. P., Ali, M. S., Vecchio, M., & Giaffreda, R. (2018) have highlighted the potential of blockchain in the food supply chain to reduce the risk of food safety issues[13].

Blockchain technology can help improve the sustainability of supply chains. By tracking sustainable materials and processes, supply chains can better meet environmental and social

responsibility requirements. Research by academics Leung, Wilson KS, et al (2023) highlights the use of blockchain in sustainable supply chains, including reducing environmental impacts and promoting social responsibility[14].

In a nutshell, researchers are in agreement that the blockchain technology has a significant function to play in the management of supply chains, especially with regard to the enhancement of visibility, the reduction of risk, and the promotion of sustainability. In this study, the application of blockchain technology in automotive supply chain management will be explored through a case study, analysing its business from the perspective of logistics processes.

3 Methodology

The application of blockchain technology in automotive supply chain management involves a number of aspects, including technology implementation, impact assessment and sustainability analysis. This paper, from the perspective of automotive manufacturing logistics process is a Discussion of research. Using a case study, the perspectives of relevant stakeholders will be gathered by examining the perspectives of H automakers and supply chain participants' concerns, which will help to understand the prospects of blockchain application in the automotive supply chain environment and to analyse its sustainability.

Among the methods of applying blockchain technology in the supply chain, Yin (2018) notes that the case study method is particularly useful in gaining a deeper understanding of the complex relationships in a given phenomenon and environment[15].

By focusing on H Automotive Manufacturing Company, understand how automotive supply chain management operates, collect information from multiple data sources, and analyse the stakeholders involved in the automotive manufacturing company. As shown in Figure 1.

The academic community currently lacks a widely acknowledged and well-established description for the concept of blockchain. Nevertheless, it has recently been implemented in a specific domain inside the supply chain[16].The blockchain service platform enables the pertinent stakeholders of Company H to exchange pertinent data, although with varying levels of data sharing authorization assigned to stakeholder.Hence, the feasibility of constructing a comprehensive tracking system for the whole of the automotive supply chain's logistical operations is very important.

The effective management of logistical information within Company H's supply chain necessitates the active involvement of both upstream and downstream departments, with the need for efficient processing capabilities. Consequently, the selection of a suitable federated chain becomes necessary.

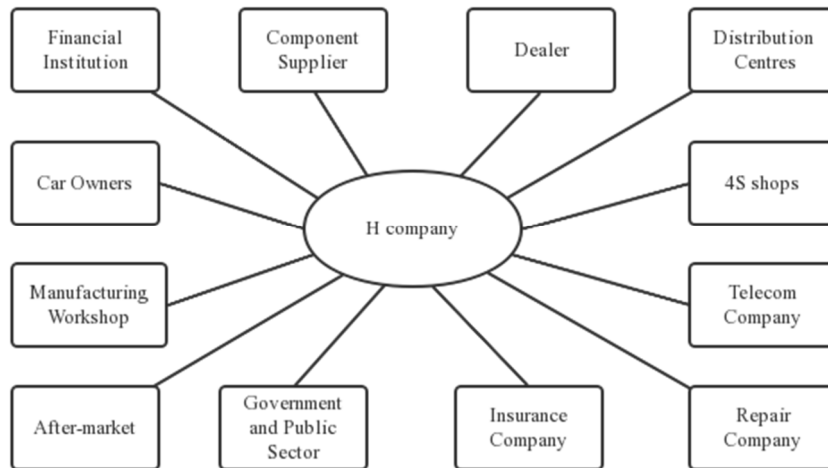


Fig. 1. Relevant stakeholders in Company H

Supply Chain Data will collect data about the automotive supply chain, including supplier information, parts tracking information, transaction records, and more. This data provides an understanding of the basic operations of the supply chain.

Blockchain Technology Data will collect data about blockchain technology, including the structure of the blockchain, transaction history, smart contracts, and more. This data will provide an understanding of the application of blockchain technology in the supply chain.

The infrastructure of the blockchain system is primarily categorized into many layers, including the data layer, network layer, consensus layer, contract layer, and application layer.

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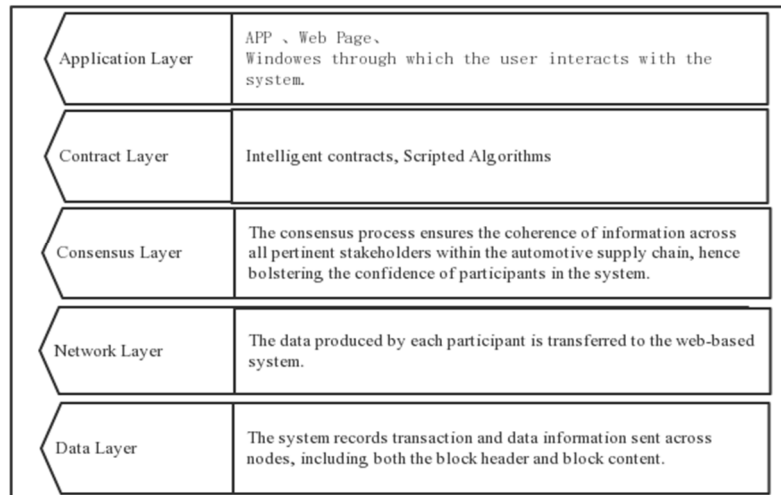


Fig. 2. Theoretical System Architecture of Blockchain

4 Application of Blockchain Technology in Automotive Supply Chain

According to IBM China WeChat Public, In the year 2019, a collaborative effort was initiated by Ford Motor Company, Huayou Cobalt, IBM, LG Chem, and RCS Global to implement a blockchain pilot on the IBM platform. The purpose of this initiative was to facilitate the controlled sourcing of cobalt. Ford wants to track the cobalt supply chain to ensure that the company doesn't use any low-quality cobalt in the production of its lithium-ion batteries and is committed to supporting people's legal rights as well as environmental causes while further improving transparency in the global minerals supply chain.

In 2020, German blockchain company Minespider helps automaker Volkswagen improve the transparency of its supply chain. Volkswagen aims to enhance the efficiency of its supply chain by using blockchain technology, therefore mitigating potential sources of mistake and assuring adherence to social and ecological norms.

This paper explores the application scenario of blockchain in the automotive industry by focusing on Company H as a logistics process. As shown in Figure 3.

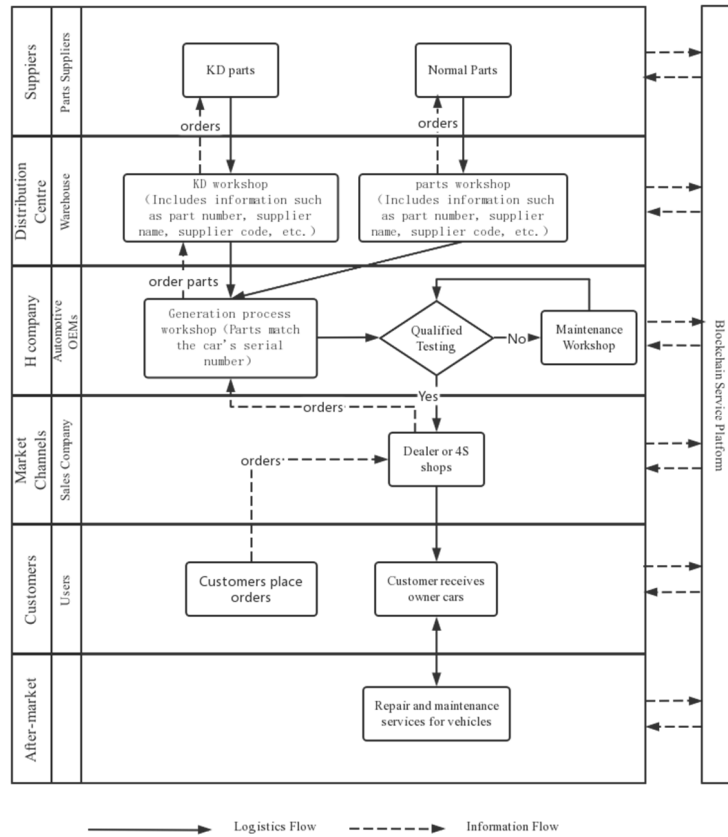


Fig. 3. Interaction of blockchain service platforms with automotive supply chain processes

4.1 Logistics and tracking

Supply chain participants can share and verify logistics information, including the location, status and delivery time of goods, in real time via blockchain. This helps to reduce information asymmetry and improve supply chain responsiveness.

The use of blockchain technology has the potential to facilitate the monitoring and tracing of the whole lifecycle of automotive components, including their manufacture, transportation, and final delivery stages. Each part has a unique blockchain identifier that records its production location, production date, quality inspection results and other information. By recording the production and distribution process of parts on the blockchain, their authenticity and quality can be ensured, reducing the risk of counterfeit parts.

4.2 Intelligent contracts

Blockchain supports smart contracts, which are programmes that automate the execution of contracts and agreements. In the automotive supply chain, smart contracts can be used to

automate order processing, payments and delivery confirmations. This increases the speed and accuracy of transactions.

Contracts and transactions between supply chain participants are also recorded on the blockchain. Smart contracts automate the execution of transactions and trigger payments based on predefined conditions, reducing the risk of contract disputes. Smart contracts help reduce transaction costs and improve supply chain efficiency while reducing the possibility of contract disputes.

4.3 Supply chain finance

Used for supply chain financing, it provides suppliers and financial institutions with more financing opportunities by recording transaction information in the supply chain on the blockchain. This helps ease the flow of funds in the supply chain.

H Manufacturers work with suppliers in various locations, involving a complex supply chain network that includes parts supply, production and distribution. This complexity means that supply chains require a high degree of collaboration, transparency and security, while also meeting sustainability requirements.

4.4 Constructing a theoretical solutions for H

The two-way interface between the application layer of the blockchain and the management platform enables the precise retrieval of specific component and overall product information by using transaction addresses. The whole of the data pertaining to components suppliers in a complete car corresponds to the serial number of such vehicle, hence enabling the traceability of such information back to the records of the final customer purchase.

Examined through the lens of the logistics process, the blockchain-based logistics monitoring platform encompasses three distinct platforms: a components supplier platform, a logistics information tracking platform, and a distributor platform (which includes sales networks such as 4S stores). The data included in the blockchain is immediately sent to the management platform in order to facilitate pertinent product categorization, quantity analysis, financial transactions, and other information management activities. As shown in Figure 4.

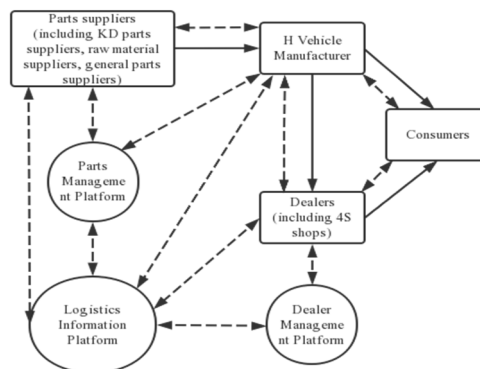


Fig. 4. Technical solutions for Company H's block supply chain

5 Conclusion

5.1 Potential challenges and limitations

Despite the many benefits of blockchain technology, it also faces a number of challenges and limitations. First, blockchain is expensive to implement and maintain. Establishing and maintaining a blockchain network requires considerable investment, especially in large-scale supply chains. This may limit the adoption of the technology by some businesses.

Second, standardisation of blockchain technology remains a challenge. Different supply chain participants may use different blockchain platforms and standards, which may lead to interoperability issues. Further standardisation efforts are needed to ensure interoperability between different systems.

Finally, data privacy and security is an ongoing concern. Despite the strong security inherent in blockchain technology, sensitive data in the supply chain needs to be properly protected against unauthorised access.

5.2 Summary

This study explores the application scenarios of blockchain technology in the automotive supply chain and analyses the application scenarios in Company H. Feasibility investigations were undertaken to assess the potential use of blockchain technology inside the organization, specifically in relation to its applicability in logistical processes within the automotive supply chain. The Company H chain is currently in search of a viable solution.

Future research can focus on the following directions. Standardisation of blockchain technology: further research on how to develop and promote the standardisation of blockchain technology in the supply chain to address interoperability issues.

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