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Blockchain Applications in Supply Chain Management: Literature Review and Identification of Research Gaps

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Abstract: ***This paper explores the transformative potential of blockchain technology in supply chain management (SCM), highlighting its capabilities in enhancing transparency, traceability, automation, and digital trust. Through a systematic literature review of key academic sources published between 2017 and 2021, the study synthesizes findings from conceptual analyses, bibliometric reviews, and sector-specific case studies. The research identifies blockchain's benefits, such as improved product tracking and reduced inefficiencies, while also acknowledging significant challenges related to scalability, interoperability, governance, and empirical validation. Special attention is given to the integration of blockchain with emerging technologies like IoT and smart contracts, which promises further automation and operational efficiency. Despite its promise, most studies remain theoretical, with limited real-world implementation evidence. The paper underscores the need for empirical research, cross-disciplinary collaboration, and modular blockchain frameworks to address industry-specific requirements and regulatory complexities. It concludes with future research directions to bridge gaps in application, scalability, and stakeholder trust in blockchain-enabled supply chains.***

Keywords: Blockchain, Supply Chain Management, Smart Contracts, Traceability, Internet of Things, Logistics, Transparency, Digital Trust, Interoperability, Governance, Automation, Empirical Research

1. Introduction

The development of blockchain technology has brought about fundamental changes across several areas, primarily in financial services, digital identity systems, and, more recently, in supply chain management (SCM). Blockchain is a secure, distributed, and permanent record of transactions that can be accessed, processed, exchanged, and updated by different systems simultaneously without the need for a central authority, which was developed as the underlying technology for cryptocurrencies such as Bitcoin (Nakamoto, 2008) and is now being adopted in numerous "nontraditional" sectors (Crosby et al., 2016). As supply chains become more global, intricate, and data-rich, traditional systems have faced difficulties in achieving multi-actor and cross-regional trust, transparency, and traceability. Consequently, many have started to look for blockchain-based supply chain solutions to resolve these persistent inefficiencies.

More recent research suggests that blockchain technology has the potential to transform supply chain management (SCM) by improving product traceability, securing data, increasing operational productivity, and allowing trustless interactions among stakeholders (Francisco & Swanson, 2018; Kshetri, 2018). Additionally, the amalgamation of blockchain with other developing technologies like the Internet of Things (IoT), artificial intelligence (AI), and smart contracts offers opportunities for unparalleled automation and visibility in supply chains (Wang et al., 2019). Regardless of the theoretical and empirical promise, the application of blockchain technology in practical supply chain management systems (SCM) is still in the early stages. There is a growing body of literature examining the use of blockchain in supply chains, however, quite a number of these works are still in exploratory stages and more abstract in nature. The significance of this study lies in its potential to guide researchers and practitioners in addressing persistent inefficiencies in supply chains through a clearer understanding of blockchain's challenges and research voids.

This literature review synthesizes key academic works published between 2017 and 2021 to analyze literature on SCM technologies and assess blockchain's integration within them. Based on bibliometric analysis, thematic reviews, and case studies, this paper with broader objectives, looks for solutions to emerging challenges, analyzes methodology, and reviews critical gaps in research. With these explanations, the authors aim to develop a foundational framework capturing the conceptualization and application of blockchain technology in supply chains while redirecting attention towards addressing law-defining limitations. This paper aims to review existing literature on blockchain's application in supply chain management, identify conceptual and empirical gaps, and outline future research directions to address unresolved implementation challenges.

2. Background

As a fully digital and decentralized ledger, blockchain technology enables participants to securely document transactions within a distributed network. Each transaction is validated through cryptographic algorithms and consensus protocols, and once recorded, the entries are immutable and visible to all participants on the network (Vujicic et al., 2018). Blockchains were first praised for their application in cryptocurrencies, but have since received attention in fields where trust, integrity, and transparency are paramount. One of those fields is supply chain management (SCM), which describes the management of the movement of materials, information, and finances across a myriad of organizations.

A significant number of supply chains systems suffer from poor visibility, fragmented informational silos, and mistrust between different stakeholder groups. Traditional SCM systems make great use of a centralized data management coupled with high manual processes that are easy prey to fraud, inefficiencies, and delays (Lim et al., 2021). Blockchain solves the problem by providing a single, secure, and transparent ledger of transactions which is accessible in real time to authorized parties. Smart contracts further

eliminate the need of intermediaries, the blandishments of disputes, and automation of contractual obligations, thus reducing the risk of disputes.

A number of blockchain ventures have been set up in food and agriculture, pharmaceuticals, and logistics. For example, IBM and Maersk's TradeLens project utilizes blockchain technology to enhance cross border trade by tracking the provenance and movement of shipping containers (Chang et al., 2020). In the same way, Walmart has used blockchain technology for food traceability and has been able to track produce from farm to shelf is much less time than previously (Wong et al., 2020). These initial attempts illustrate both the possibilities offered by blockchain for supply chain transformations and the challenges for improvements in scalability, interoperability, and regulatory alignment.

Various academic scholars have studied the application of blockchain technology in SCM. Lim et al. (2021) did a systematic review of the 106 peer reviewed articles and categorized them based on their methodology and industry of focus. Moosavi et al. (2021) conducted bibliometric and co-citation analysis to map the prominent research clusters and emerging technologies such as IoT and smart contracts that were found to augment blockchain were also analyzed. These studies broaden understanding contemporarily but highlight the reliance upon the lack of empirical data and overdependence on conceptual frameworks.

An overarching gap in the literature is the lack of uniform guidelines for incorporating blockchain technology into SCM processes. The multitude of supply chain components, together with its technological ecosystem, stakeholder's interests, and varying SCM environments makes the formulation of universally acceptable frameworks impossible. In addition, the lack of data security, governance frameworks, and high implementation costs stifle large-scale adoption. While there is increasing attention and some initial successes, the potential of blockchain in supply chain contexts is still confronted with substantial barriers.

This paper attempts to address the challenges by conducting a systematic review of the literature on blockchain in SCM to articulate the primary research query set, analyze the processes and techniques used in the methodologies, examine the findings from the data analyses, and derive conclusions along with recommended steps for additional research. It is hoped that the findings from this review will identify the gaps in knowledge and provide guidance toward strategic and purposeful research and intervention for blockchain supply chains.

3. Research Questions

While blockchain technology is increasingly gaining attention in supply chain management (SCM), some researchers have started to make attempts in tracing the necessary fundamental questions to be answered in order to optimally utilize the technology. It is clear from the literature that there is a blockchain's transformative potential scarred in its adoption, but there are equally many shortcomings that require some attention. These shortcomings have constituted the fundamental research gaps put forth in the literature.

Perhaps the most common one has to do with the supply chain's value proposition of blockchain: what advantages does blockchain bring to SCM with comparative analysis to alternative systems? Moosavi et al. (2021) and Lim et al. (2021) argue that there is a significant lack in proving the tangible advantages of blockchain like enhanced traceability, decreased fraud, and improved efficiency on transactions. This question seeks to prove the hypothesis of "blockchain's promise" and validating proof should exist.

A second critical research question is: What the barriers of technology, organization, and regulation stop the use of blockchain from being used in supply chains? This stems from issues of interoperability, integration with legacy systems, data privacy, and absent governance frameworks (Moosavi et al., 2021; Batwa & Norrman, 2021). Developing practical implementations solutions requires understanding these barriers.

For example, another prominent issue is the impact of trust and transparency: Is it possible for blockchain to profoundly alter the trust dynamics in supply chains? Batwa and Norrman (2021) address this question by analyzing blockchain's dual role as a trust facilitator, but also a visibility risk oversharing data. They suggest investigating how trust is enacted and whether they can consider blockchain as an alternative or an augmenting device to conventional trust frameworks.

An outstanding question they raise is more of a model one: Which models and frameworks most effectively assess blockchain in supply chain management (SCM) ? Lim et al. (2021) point to the absence of a consolidated approach as well as the unlike-academic evaluative framework considering technical, economic, and organizational readiness.

Integration with emerging technologies now has a greater emphasis on how blockchain can be integrated with IoT, AI, and Smart Contracts to enhance SCM processes. Automation seeks to achieve visibility through blockchain and other digital tools; hence, this becomes a multidisciplinary investigation (Reddy et al., 2021).

All these research questions help in the methodological and analytical focus of recent studies while identifying gaps and setting future agendas in blockchain-enabled SCM.

4. Methodology

The blockchain research in supply chain management reveals its multidisciplinary character in the methodologies used in the studies. The majority of the literature is still mostly exploratory and theoretical, with conceptual frameworks outpacing empirical research. In this part, I focus on the primary research methods used in the four key sources.

Lim et al. (2021) performed a descriptive and content analysis of more than a hundred peer-reviewed publications from 2017 to 2020. Their method included grouping articles into categories based on their themes, methodologies, and industrial relations. They discovered that more than 60% of the studies were either exploratory or purely conceptual, while only a fraction employed real-world case studies or

empirical evidence. Additionally, their review demonstrated that SCM literature is fraught with arbitrary benchmarks of blockchain readiness or performance evaluation metrics.

Moosavi et al. (2021) used VOSviewer to conduct a bibliometric and social network analysis of 300 academic papers. Their study identified key collaborations, technologies, and recurring debates in the literature. Their bibliometric study was supplemented by citation and co-citation analyses, which mapped the intellectual backbone of the discipline and revealed research gaps in logistics, finance, and security.

Batwa and Norrman (2021) completed a systematic literature review (SLR) using a conceptual framework based on trust. Their study aimed at understanding the role of blockchain technology in fostering trust within the supply chain management (SCM) processes. They analyzed articles along pre-set trust parameters or metrics to establish how blockchain both depended on and contributed to the development of trust within the supply chain ecosystem. The researchers limited the scope of the study to peer-reviewed articles published within a two-year period in order to maintain currency and relevance.

Reddy et al. (2021) leveraged content analysis and cluster mapping in their SLR on blockchain technologies' use within the automotive supply chain. Their study featured the analysis of more than seventy research papers, categorizing them according to various application domains like inventory control, logistics optimization, and quality assurance. Additionally, they proposed a blockchain implementation framework for volatile, uncertain, complex, and ambiguous (VUCA) environments. Emphasis was placed on the applicability of the findings as well as on decisional guidance.

In terms of population or sample selection, the majority of the studies did not employ primary data collection. The bulk of the works relied on compiling and synthesizing secondary data from published articles, industry case studies, and pilot studies. Other researchers, such as Philipp et al. (2019) and Saberi et al. (2019), conducted expert and practitioner interviews which were incorporated into their analyses, although this was the exception rather than the rule.

As noted in the literature, there appears to be a methodological gap in large-scale empirical validations, longitudinal studies, and quantitative modeling. Currently, the majority of evidence supporting the role of blockchain technologies in SCM is still in the form of conjecture or, at best, principles. It highlights the need for practical implementation research, experimental studies, and econometric impact studies to assess blockchain's impact on systems.

5. Data Analysis

The literature reviewed in this study offers a range of insights into the impact, challenges, and applications of blockchain in supply chain management. While each study approaches the subject from a unique perspective, several common themes and patterns emerge. This section presents an integrated data analysis based on findings across descriptive, bibliometric, and conceptual frameworks.

Tangible Benefits and Use Cases

Several studies confirm that blockchain enhances **traceability, transparency,** and **efficiency** in supply chains. Moosavi et al. (2021) identified key areas where blockchain has been most impactful: food traceability, pharmaceuticals, logistics tracking, and counterfeit prevention. Reddy et al. (2021) found that in the automotive supply chain, blockchain supports just-in-time inventory, smart contract enforcement, and quality assurance through immutable data logs. These findings suggest that blockchain reduces data fragmentation and improves operational performance.

Challenges and Barriers

Despite its potential, multiple studies identified substantial barriers to blockchain adoption. Lim et al. (2021) noted that scalability and interoperability remain significant issues, particularly when integrating blockchain with legacy systems or across global supply networks. High implementation costs, the absence of regulatory frameworks, and insufficient technical expertise were common across the literature. Batwa and Norrman (2021) added that data privacy concerns, especially in permissionless blockchain environments, inhibit the willingness of firms to adopt blockchain broadly. These barriers are more pronounced in industries with limited digital infrastructure or strict confidentiality requirements.

Blockchain and Trust

A unique angle explored by Batwa and Norrman (2021) relates to the concept **of trust in supply chains.** Their research analyzed whether blockchain increases or decreases trust among supply chain actors. While blockchain eliminates the need for trusted third parties by providing immutable and transparent data records, it also introduces new complexities. For example, highly visible transactions may expose proprietary information, thereby creating reluctance among partners. The authors concluded that blockchain both complements and transforms traditional trust mechanisms, highlighting the need for a deeper inquiry into how digital trust evolves.

Emerging Technologies and Integration

The integration with other technologies is an emerging pattern. Smart contracts and the Internet of Things (IoT) were the most frequently cited technologies in the discussions (Lim et al., 2021; Moosavi et al., 2021). Real-time data is provided by IoT devices to the blockchain, which enables complete and real-time tracking of products. Moreover, intelligent contracts facilitate automated business processes through predefined terms. This combination improves agility and minimizes mistakes caused by humans. Despite these advances, challenges to interoperability between blockchain systems and other digital ecosystems persist.

Methodological and Empirical Gaps

One of the most consistent findings across the papers is the **lack of empirical studies.** Most publications rely on conceptual analysis, pilot case studies, or systematic reviews without testing blockchain applications in operational environments. For example, Moosavi et al. (2021) noted that while citation analysis shows a growing academic interest, few studies report real-world blockchain deployments beyond

prototypes. Similarly, Reddy et al. (2021) emphasized that many automotive companies are still in the proof-of-concept stage, and there's little data on long-term outcomes or return on investment.

Industry-Specific Adaptations

Although many studies argue for the universality of blockchain principles, Reddy et al. (2021) and Lim et al. (2021) caution against a one-size-fits-all approach. Different industries require customized blockchain configurations based on supply chain complexity, data sensitivity, and regulatory demands. For example, food supply chains prioritize traceability and speed (e. g., Walmart's mango tracking system), while automotive supply chains emphasize component authentication and logistics synchronization. This variation underscores the need for modular blockchain frameworks that can be adapted to specific contexts.

6. Conclusion

The scope of this paper centers around analyzing the impact of blockchain on the supply chain and logistics industries. A profound impact is anticipated from blockchain technology on numerous sectors, with the supply chain emerging as one of the most sophisticated. From the literature collected, it can be concluded that a unified perspective is still developing on the application of blockchain technology in various domains, especially in supply chains and logistics.

The literature review indicates that blockchain technology has merit in revolutionizing supply chain management in terms of automation, transparency, traceability, and digital trust. The studies scoped from the four sources make a compelling argument for blockchain as an answer towards the persistent issues in international supply chains related to trust, data silos, inefficiencies, and fragmentation. However, this potential is mostly theoretical and conceptual because of insufficient empirical evidence and practical application.

Simultaneously, there are clear gaps on how the areas of focus differ as well as their interpretations. While Moosavi et al. (2021) and Lim et al. (2021) look at overarching applications across sectors, Reddy et al. (2021) focus on the automotive sector, outlining specific frameworks for blockchain implementation per domain. Concurrently, Batwa and Norrman (2021) adopt a sociotechnical approach and analyze trust in blockchain and emphasize it as the primary lens of evaluation.

A lacking area of literature is the absence of empirical research and actual case studies assessing real-world scenarios. Most of the available research has been built around theoretical constructs, expert interviews, or bounded pilot projects. There are no longitudinal studies examining the enduring effects of blockchain technology on the resilience of supply chains, cost-efficiency, or stakeholder interactions. Additionally, governance frameworks and legal boundaries for SCM based on blockchain technologies are insufficiently addressed and create challenges for cross-border integrations.

From this point of view, many gaps in research can be identified from the text above. First, researchers can conduct large-scale empirical assessments regarding how blockchain technology affects supply chains and how it propels provide value through key performance indicators (KPIs) that measure value across different supply chains). Second, adoption issues regarding interdisciplinary combinations of supply chain management expanded by information systems, legal studies, and behavioral science are complex and require an approach. Third, permissioned ledgers that are less transparent yet reliable also require more focusing research in regard to scalable blockchain architecture, especially ones that balance privacy and transparency with selective leniency revealing information disclosure systems.

As discussed above, blockchain technology is transformative in value proposition supply chains, yet it has many emerging challenges to overcome. More research needs to shift from idealistic proposals and delve deeper into real-life application scenarios. Empirical examination and blended cross-discipline scholarship with applied research could successfully demonstrate the blockchain-enabled transformative future of supply chain management.

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