Asia Pacific Academy of Science Pte. Ltd.

Sustainable Social Development 2025, 3(3), 3481.
https://doi.org/10.54517/ssd3481

Case Report

Blockchain in logistics: Critical insights for next-generation digital supply chains

Babu George

Alcorn State University, MS 39096, USA; bgeorge@alcorn.edu

CITATION

George B. Blockchain in logistics: Critical insights for next-generation digital supply chains. Sustainable Social Development. 2024; 3(3): 3481.
https://doi.org/10.54517/ssd3481

ARTICLE INFO

Received: 24 March 2025
Accepted: 21 April 2025
Available online: 27 June 2025

Abstract: The digital transformation of global supply chains seeks to enhance transparency, efficiency, and security, with blockchain emerging as a key enabling technology. This paper examines Maersk's TradeLens initiative, a blockchain-powered shipping platform, as a case study within the broader context of digital supply chain innovation. Although initially launched to revolutionize maritime logistics, TradeLens was discontinued in early 2023 due to challenges in scaling adoption and achieving commercial viability. Through a critical evaluation of the structural, strategic, and economic barriers that hindered its success, this study offers valuable insights into the practical limitations of blockchain in complex supply chain environments. Building on these insights, we propose a conceptual framework that integrates data acquisition, advanced analytics, and digital trust mechanisms to guide future digital transformation efforts. Our findings highlight the necessity of industry-wide collaboration, interoperable systems, adaptive governance, and sustainable business models to ensure the long-term success of blockchain-enabled supply chains.

Keywords: blockchain; supply chain management; TradeLens; digital transformation; logistics innovation; governance; industry collaboration

1. Introduction

Global supply chains have evolved into highly complex networks involving numerous stakeholders, cross-border transactions, and regulatory frameworks, making them increasingly vulnerable to illicit trade activities such as fraud, counterfeiting, and smuggling [1,2]. Traditional supply chain management has long relied on paper-based documentation and fragmented communication systems, leading to inefficiencies, lack of transparency, and security gaps. To address these challenges, digital technologies such as blockchain, artificial intelligence (AI), and the Internet of Things (IoT) have been explored to enhance security, efficiency, and resilience in supply chain operations [3,4].

One of the most ambitious attempts at applying blockchain technology in supply chain management was TradeLens, a platform co-developed by Maersk and IBM. TradeLens aimed to provide real-time, immutable, and decentralized data sharing among supply chain stakeholders, offering a unified view of shipment movements, customs documentation, and transaction histories. By reducing reliance on manual record-keeping and enabling seamless collaboration, the platform sought to improve efficiency, minimize risks, and combat illicit trade [5–7]. Its adoption by ports, regulatory authorities, and logistics providers demonstrated the potential of blockchain to revolutionize maritime shipping.

A simplified diagrammatic summary of the TradeLens blockchain model is presented in **Figure 1**.

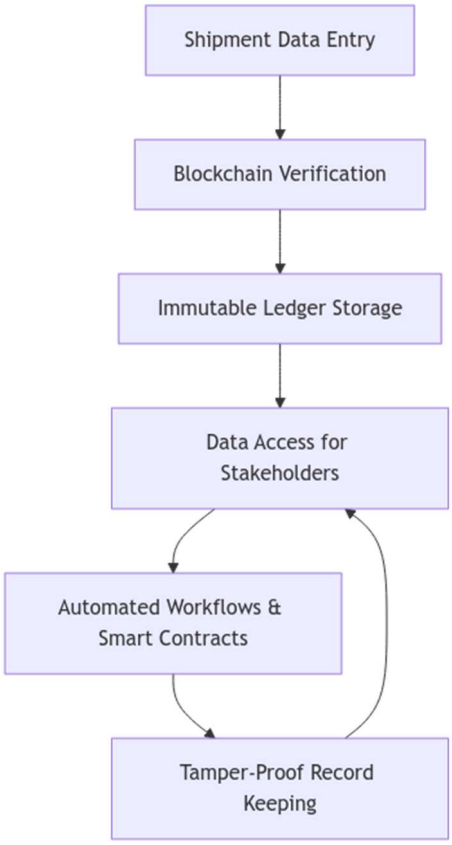

Figure 1. The TradeLens blockchain model.

Despite its early success and widespread industry participation, TradeLens was discontinued in early 2023, signaling the significant challenges associated with implementing blockchain in global trade. Maersk and IBM cited the inability to achieve the necessary scale and commercial viability as key reasons for the platform's shutdown. This development underscores a broader issue in digital transformation initiatives: technological innovation alone is insufficient without widespread stakeholder adoption, robust governance models, and economic sustainability.

This paper introduces a conceptual framework that explores how data-driven solutions can enhance supply chain security, using the TradeLens initiative as a case study. While TradeLens demonstrated blockchain's potential for improving supply chain transparency, its discontinuation highlights critical barriers that future digital transformation efforts must overcome. This paper examines these challenges, drawing insights from supply chain literature and the TradeLens experience to inform future blockchain applications in global trade. By analyzing both the successes and limitations of TradeLens, this study contributes to the ongoing discourse on the role of digitalization in supply chain risk management and regulatory compliance.

2. Literature review

2.1. Digital transformation in supply chains

Supply chain management (SCM) literature consistently highlights transparency and efficiency as essential drivers of competitive advantage within increasingly

complex value networks. Digital technologies, particularly the Internet of Things (IoT), blockchain, and artificial intelligence (AI), are recognized as transformative tools that enhance operational visibility, prevent fraud, and promote sustainability in global supply chains. Blockchain-based applications, spanning from financial transactions to supply chain management, have revolutionized numerous industries, and the impacts are still nascent, according to Ressi et al. [8]. The adoption of IoT has significantly improved product monitoring across supply chain nodes, resulting in enhanced operational efficiency and improved risk management [3]. When integrated with blockchain, IoT facilitates scalable and traceable solutions that foster trust among business-to-business (B2B) partners while streamlining warehousing, manufacturing, and transportation processes. Additionally, IoT-supported Supply Chain Risk Management (SCRM) strengthens resilience against disruptions by refining risk mitigation strategies [9].

2.2. Blockchain in supply chains

Blockchain has garnered particular attention for its ability to secure global supply chains by improving traceability, reducing fraudulent transactions, and increasing stakeholder trust [10]. By providing a decentralized and immutable ledger, blockchain ensures transparent and tamper-proof record-keeping in logistics. The integration of AI further enhances these capabilities by leveraging predictive analytics to detect anomalies, thereby mitigating risks associated with human error and fraud [11]. Collectively, these technologies foster a more adaptive and compliant supply chain ecosystem.

2.3. Blockchain governance in multi-stakeholder environments

Blockchain governance in multi-stakeholder environments is a complex and evolving field that seeks to balance the decentralized nature of blockchain technology with the need for effective management and oversight. This involves creating systems that allow various stakeholders to participate in decision-making processes while ensuring transparency, privacy, and security.

Several governance models have been proposed to address the challenges of blockchain governance in multi-stakeholder environments. A novel on-chain governance model utilizes policy-based management and decentralized identity technologies to enhance decentralization, security, and fairness. This model simplifies governance processes and is more user-friendly compared to traditional on-chain governance models [12]. Another framework defines blockchain governance as a combination of six dimensions and three layers, providing a structured approach for analysis and comparison [13].

In multi-stakeholder settings such as healthcare and supply chain management, blockchain-based data governance systems have been developed to ensure data provenance, privacy protection, and consent management. These systems use technologies like proxy re-encryption and Boneh, Boyen, and Shacham (BBS) signatures to allow data owners to control and selectively share their data while enabling data consumers to understand data lineage [14,15].

Blockchain governance faces challenges such as the need for human intervention

in node management and governance, which can reduce decentralization. Proposed solutions include employing smart contracts and modular designs to facilitate governance processes and enhance system adaptability [12,16]. Additionally, the integration of blockchain in e-government settings raises legal and ethical concerns, necessitating frameworks that ensure legal compliance and address these challenges [17].

Blockchain technology has the potential to enhance transparency and reduce corruption in governance systems. By leveraging smart contracts, decentralized autonomous organizations (DAOs), and self-sovereign identity authentication, blockchain can address issues related to data ownership and trusted third-party management, promoting transparency in the public sector [18]. The future of blockchain governance involves further exploration of its potential in various governance models, including corporate and social governance. The decentralized nature of blockchain offers numerous benefits, but it also requires ongoing research to address ethical, legal, and operational challenges [19,20]. As blockchain technology continues to evolve, its role in governance will likely expand, offering new opportunities for innovation and improvement in multi-stakeholder environments.

2.4. Measuring RoI

Blockchain technology is increasingly being integrated into supply chains to enhance transparency, traceability, and overall performance. Measuring the return on investment (ROI) in blockchain supply chain implementations is crucial for understanding its financial viability and strategic benefits.

Blockchain implementation in supply chains has been shown to positively impact firm value and supply chain performance. Studies indicate that blockchain can enhance transparency and traceability, leading to improved operational efficiency and sustainability [21–23]. The integration of blockchain with other technologies like IoT and cloud computing can further enhance visibility and reduce costs, resulting in a high ROI for stakeholders [24].

The following factors are known to influence the RoI:

Technology integration: Combining blockchain with IoT and cloud technologies can be more profitable than using blockchain alone, as it enhances visibility and reduces costs more effectively [24].

Supply chain processes: The ROI from blockchain is higher when it is used in downstream processes and with contract automation functions, which streamline operations and improve firm performance [21].

Stakeholder benefits: The benefits of blockchain implementation may vary among stakeholders. For instance, retailers may see quicker returns compared to transporters, highlighting the need for tailored strategies for different supply chain participants [24].

Successful blockchain implementation in supply chains requires addressing several critical factors:

Collaboration and governance: Effective collaboration among stakeholders and robust governance structures are essential for successful blockchain adoption [25].

Technology maturity: The maturity of blockchain technology and its integration

with existing supply chain practices are crucial for realizing its full potential [25].

Transparency and traceability: Enhancing transparency through blockchain can improve supply chain coordination and operational decisions, but it requires careful design to avoid competitive disadvantages [26].

Despite its potential, blockchain adoption in supply chains faces challenges such as managerial conservatism and unfamiliarity with the technology's characteristics. Addressing these challenges involves educating managers and demonstrating the tangible benefits of blockchain, such as improved traceability and compliance with environmental standards [23]. Future research should focus on developing comprehensive models to measure the impact of blockchain on supply chain performance and exploring its application across different industries [22,23].

2.5. Successes and failures

The IBM Food Trust platform has successfully leveraged blockchain to enhance transparency and traceability in the food supply chain. The success of IBM Food Trust can be attributed to its ability to provide a decentralized system that ensures data immutability and full traceability, which are critical success factors in supply chain management [27,28]. The platform's success is also linked to its integration with existing systems and its ability to reduce paperwork and improve customer service, as seen in other successful blockchain implementations [29].

VeChain has found success in industries such as luxury goods and logistics by providing a robust traceability system that enhances product authenticity and supply chain transparency. The platform's success is largely due to its focus on creating a decentralized network that eliminates intermediaries and ensures data security and reliability [30]. VeChain's ability to adapt to different industry needs and provide tailored solutions has been a key factor in its success [31].

Known for its application in the diamond industry, Everledger has successfully used blockchain to provide provenance tracking and fraud prevention. The platform's success is attributed to its focus on high-value assets where traceability and authenticity are paramount. Everledger's ability to integrate blockchain with existing industry practices and its emphasis on data security have been crucial to its success [32,33].

All these said, many blockchain projects fail due to technological immaturity and organizational resistance. Projects often struggle with scalability, integration with existing systems, and the high costs associated with blockchain deployment [34,35]. These challenges are exacerbated by a lack of clear business use cases and the failure to align blockchain capabilities with organizational goals.

Regulatory uncertainty and market resistance are significant barriers to blockchain adoption. Projects often face challenges in navigating complex regulatory environments, which can delay implementation and increase costs [35]. Additionally, market resistance due to a lack of understanding or trust in blockchain technology can hinder adoption [31].

Many blockchain projects fail because they do not offer a clear value proposition or fail to demonstrate tangible benefits. Projects that do not address specific pain points or fail to provide a competitive advantage are unlikely to succeed [32]. The

absence of a compelling business case often leads to projects being abandoned after the proof-of-concept phase.

Case studies like the ones given above highlight the importance of aligning blockchain capabilities with industry needs, ensuring data security, and providing clear value propositions. Conversely, failures often stem from technological, organizational, and regulatory challenges, as well as a lack of clear business use cases. Understanding these patterns can help future projects navigate the complexities of blockchain implementation and increase their chances of success.

2.6. The TradeLens solution

Despite its transformative potential, blockchain adoption in global logistics faces significant barriers. One of the most ambitious blockchain-driven SCM initiatives, the TradeLens platform, was developed by Maersk and IBM to enhance supply chain transparency through real-time data exchange.

TradeLens employed a sophisticated permissioned blockchain approach to handle sensitive supply chain data, balancing transparency with confidentiality requirements. Built on Hyperledger Fabric, TradeLens implemented access-controlled channels that allowed participants to share information selectively with relevant stakeholders rather than broadcasting all data to the entire network. For example, a shipping company could share cargo details with customs authorities without revealing this information to competitors. These channels were governed by smart contracts that enforced predefined access rules and business logic, ensuring that sensitive commercial information remained protected while still enabling verification of critical supply chain events.

Furthermore, TradeLens incorporated encrypted communications and digital signatures to secure data both in transit and at rest. Each participant maintained their own encryption keys, allowing them to authenticate the origin of information while preventing unauthorized access. Unlike public blockchains, where information is typically visible to all participants, TradeLens' permissioned approach required identity verification before network access, creating a trusted ecosystem of validated participants. This contrasts with public blockchain approaches that rely on zero-knowledge proofs (zk-SNARKs) or confidential transactions to achieve privacy. While these public-chain methods mathematically prove transaction validity without revealing underlying data, they often require more computational resources and complex cryptographic implementations. TradeLens' channel-based approach offered a more straightforward and less computationally intensive solution for supply chain participants who needed practical privacy protections without the overhead of advanced cryptographic techniques. This pragmatic balance between transparency and privacy protection made the platform more accessible to supply chain professionals without requiring extensive blockchain expertise, though the centralized governance ultimately contributed to adoption challenges.

Initially, TradeLens demonstrated blockchain's potential by reducing shipping delays, improving documentation efficiency, and mitigating illicit trade vulnerabilities [5–7]. However, despite early adoption by key industry players, TradeLens was discontinued in early 2023 due to challenges in achieving industry-wide collaboration

and financial sustainability. Its failure underscores persistent challenges in large-scale blockchain implementation, including reluctance among competitors to share proprietary data, regulatory fragmentation, and high system integration costs [36–39].

The challenges faced by TradeLens are presented in **Figure 2**. These reflect broader concerns in the literature regarding blockchain's feasibility in global supply chains [36]. Kshetri [36] acknowledges blockchain's potential to enhance efficiency, trust, and operational reliability but notes that adoption remains hindered by governance complexities and the necessity of extensive inter-organizational cooperation. Wieland [37] critiques traditional supply chain theories, advocating for adaptive strategies that better align with dynamic market conditions. TradeLens' failure exemplifies this need for more flexible, collaborative digital transformation models rather than rigid, centralized platforms.

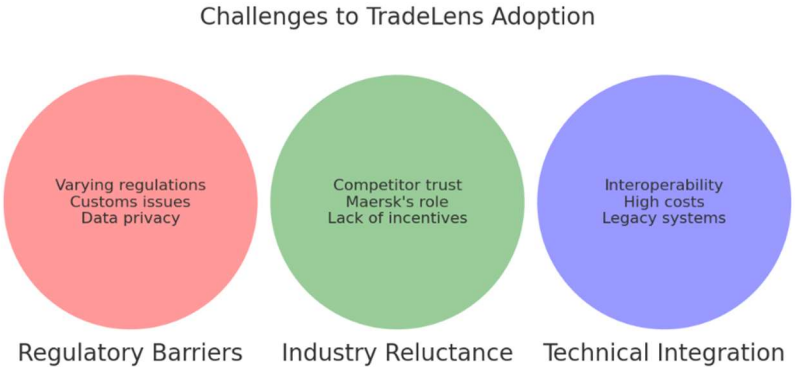

Figure 2. Causes of TradeLens failure.

The case of Maersk's TradeLens provides a compelling exploration of both the potential and limitations of blockchain-enabled digital transformation in global supply chains. While the initiative demonstrated how distributed ledger technology (DLT) could enhance supply chain transparency, efficiency, and security, its discontinuation in early 2023 reveals critical structural, strategic, and economic challenges. This discussion examines the key takeaways from the rise and fall of TradeLens and provides insights into how future digital supply chain innovations can overcome similar hurdles.

3. Why TradeLens failed: An analysis

Despite its technological sophistication, TradeLens faced several significant challenges that ultimately led to its discontinuation.

3.1. Industry-wide adoption and competitive concerns

One of the fundamental challenges was the reluctance of major industry players, especially competing shipping companies, to fully adopt TradeLens. Many stakeholders feared that Maersk's dominant role in the platform would give it an unfair competitive advantage, creating an uneven power dynamic [9]. Trust and neutrality are critical for digital transformation initiatives that rely on data-sharing ecosystems, and any perception of centralized control can deter adoption [4].

3.2. Lack of interoperability and standardization

For any digital supply chain solution to be successful, it must seamlessly integrate with existing logistics platforms and comply with diverse regulatory environments. While TradeLens aimed to be a single source of truth for supply chain transactions, its limited interoperability with other platforms created significant barriers [11]. A successful blockchain-based supply chain network requires open data standards to ensure compatibility across multiple industry stakeholders [7].

3.3. Economic and commercial sustainability issues

Blockchain-based platforms require significant investment in infrastructure, integration, and maintenance. While TradeLens offered efficiency gains, its financial model did not provide sufficient incentives for all stakeholders [38]. Many supply chain participants were unwilling to bear the costs associated with joining the platform, especially when the benefits were perceived to be unevenly distributed [1].

3.4. Regulatory and compliance barriers

Although blockchain has the potential to simplify compliance with customs regulations and trade policies, the absence of unified global digital trade regulations hindered TradeLens's adoption. TradeLens struggled to harmonize blockchain-based documentation with the varying requirements of different governments and customs authorities [39]. This issue highlights the broader challenge of regulatory fragmentation, which continues to be a major barrier to digital innovation in supply chains [28].

4. The future of digital supply chain management: Beyond TradeLens

Although TradeLens was discontinued, it laid the groundwork for future innovations in digital supply chains. The lessons learned from its failure highlight the importance of balancing technological innovation with industry collaboration, economic viability, and regulatory adaptability.

Moving forward, blockchain, AI, and IoT will continue to play a significant role in modernizing supply chain operations. However, success will depend on rethinking digital transformation strategies:

- Industry-wide standardization and collaboration must take precedence over proprietary systems.
- Regulators and trade organizations must play a proactive role in shaping digital supply chain policies.
- Financial models must ensure that all stakeholders see clear value from participation.
- Privacy, security, and competitive concerns must be addressed through customizable governance models.

5. Discussion

For blockchain-based SCM solutions to succeed in the long term, factors beyond

technological capability must be considered. Al-Nawafah et al. [40] argue that digital transparency can significantly enhance green supply chain management (GSCM) by optimizing routes, reducing waste, and minimizing carbon footprints. However, broad adoption of blockchain in SCM necessitates not only industry commitment but also supportive policy frameworks that incentivize data sharing and interoperability among stakeholders.

The COVID-19 pandemic reinforced the necessity of resilient supply chains, emphasizing the relevance of digital platforms like TradeLens [39]. Blockchain's ability to enhance logistics visibility and enable real-time collaboration among trading partners is crucial in mitigating disruptions. Huang et al. [28] link technology adoption to measurable improvements in logistics performance, resource allocation, and inter-firm coordination. However, the discontinuation of TradeLens suggests that achieving widespread blockchain adoption requires more than technological innovation; economic incentives, governance structures, and regulatory harmonization are equally critical.

The IBM-Maersk partnership that underpinned TradeLens highlighted blockchain's potential in supply chain finance [38]. By reducing transaction costs and improving financial transparency, blockchain offers significant economic advantages in global logistics. However, TradeLens' failure demonstrates that without a sustainable financial model to support multi-stakeholder collaboration, such platforms may struggle to remain viable.

In contrast, IBM Food Trust, another blockchain initiative, achieved widespread adoption among major retailers like Walmart and Carrefour. Its success stemmed from addressing a critical industry challenge, food safety and recalls, where blockchain provided immediate, tangible benefits. Additionally, the initiative faced less competitive resistance, as retailers were more willing to collaborate than players in the highly competitive ocean shipping industry. This comparison underscores the importance of industry-specific dynamics in blockchain adoption.

Similarly, VeChain's blockchain platform has gained traction in the luxury goods sector, particularly in product authentication for brands like Louis Vuitton. Unlike TradeLens, which targeted global logistics, VeChain found success in a niche market where data transparency directly benefits all participants. This illustrates that blockchain adoption is more viable in sectors where consumer trust and product verification are paramount.

Everledger also achieved initial success by using blockchain to track diamonds, ensuring authenticity and reducing fraud. However, like TradeLens, it encountered challenges in widespread stakeholder adoption. This suggests that blockchain is more effective in high-value, low-volume industries like diamonds than in high-volume, low-margin industries like global shipping, where adoption hurdles are more pronounced.

While blockchain, IoT, and AI offer promising advancements for SCM, their successful implementation depends on various factors, including industry collaboration, economic incentives, regulatory alignment, and sector-specific applicability. The cases of TradeLens, IBM Food Trust, VeChain, and Everledger illustrate that technological innovation alone is insufficient; successful adoption requires strategic alignment with industry needs and a supportive ecosystem for

collaboration.

The discontinuation of TradeLens does not indicate that blockchain and digital technologies have no future in supply chain management. Instead, it provides valuable insights into how future digital transformation efforts can be designed for long-term success. A major takeaway from TradeLens is that digital supply chain platforms must be built on neutral, decentralized governance structures. Instead of a single corporation leading the initiative, consortium-based models, where multiple industry players share decision-making power, can increase trust and encourage widespread adoption [40]. Future blockchain-enabled supply chain solutions must emphasize interoperability with existing logistics systems. Unlike TradeLens, which functioned as a closed ecosystem, next-generation platforms should adopt open APIs and industry-wide data standards to facilitate seamless integration and cross-platform compatibility [37].

One of the primary reasons TradeLens struggled was that stakeholders did not see a clear return on investment. Future platforms must ensure that economic benefits are equitably distributed; this could include cost-sharing models, incentive-based participation, or blockchain-powered supply chain finance solutions [10]. Tokenization models, where participants are rewarded for contributing data, could also provide new financial incentives for engagement [41]. TradeLens demonstrated that regulatory alignment is critical for digital transformation in supply chains. Future initiatives must actively collaborate with government agencies and international trade organizations to develop standardized, legally recognized blockchain documentation systems [42]. Ensuring that smart contracts and digital bills of lading comply with global trade laws will be essential for wider adoption. While blockchain provides enhanced traceability and trust, many companies remain hesitant to share supply chain data due to competitive concerns. Future platforms must offer flexible privacy controls, allowing stakeholders to decide how much data they share while still benefiting from blockchain verification.

6. Towards a conceptual framework

The growing complexity of global supply chains necessitates innovative approaches that integrate digital technologies to enhance transparency, security, and operational efficiency. Existing literature underscores the transformative potential of IoT, AI, and blockchain in addressing challenges such as supply chain fraud, regulatory compliance, and logistical inefficiencies [3,4]. These technologies, when effectively integrated, provide real-time insights, predictive analytics, and immutable data records that can fortify supply chain resilience and mitigate risks.

However, as demonstrated by the discontinuation of TradeLens in early 2023, technological innovation alone is insufficient to guarantee widespread adoption and long-term viability. Despite its promising features, such as secure digital documentation, real-time shipment tracking, and automated workflows, TradeLens faced barriers related to industry collaboration, competitive interests, and financial sustainability. This raises critical questions about how digital transformation efforts can overcome structural and strategic challenges in supply chain management.

To address these issues, we propose a conceptual framework that integrates key digital components necessary for a secure and efficient supply chain. This framework

consists of three interrelated components:

6.1. Data acquisition and integration

A fundamental challenge in supply chain management is the fragmentation of data across various stakeholders, leading to inefficiencies and vulnerabilities to illicit trade [4]. Effective supply chain security requires the aggregation of real-time, multi-source data, including logistics, customs, and sensor data, into centralized or interoperable platforms. TradeLens attempted to achieve this through blockchain-based data sharing, but its inability to secure universal participation among industry players limited its effectiveness [5]. Future digital platforms must focus on open data standards and interoperability to encourage broader adoption and collaboration.

6.2. Advanced analytics and decision support

Predictive analytics and AI-driven insights play a crucial role in modern supply chain risk management. By leveraging machine learning algorithms, companies can detect anomalies in shipment movements, anticipate supply chain disruptions, and optimize decision-making [11]. TradeLens sought to provide these capabilities, but its discontinuation suggests that digital platforms must offer clear economic incentives for participants to contribute and utilize data insights meaningfully [9]. Future frameworks should emphasize incentive structures that align the interests of various stakeholders, ensuring sustained engagement and data sharing.

6.3. Digital trust and transparency

Blockchain technology is often promoted as a solution for enhancing digital trust by creating immutable records of transactions [10]. While TradeLens successfully demonstrated blockchain's ability to streamline documentation and reduce shipping uncertainties, its closure highlights the challenges of implementing governance models that balance transparency with competitive concerns [36]. Moving forward, digital trust mechanisms must incorporate flexible governance structures that allow stakeholders to retain control over proprietary data while still benefiting from shared insights.

6.4. Adapting lessons from TradeLens

The discontinuation of TradeLens underscores several key takeaways for future digital transformation initiatives in supply chain management:

- Scalability and adoption: Digital platforms must prioritize industry-wide interoperability rather than relying on proprietary frameworks that exclude potential adopters [37].
- Economic incentives: A viable business model must ensure that all stakeholders, shippers, carriers, and customs agencies benefit from data participation [40].
- Regulatory integration: Governments and international trade organizations must collaborate to develop standardized digital compliance frameworks, ensuring alignment with evolving regulatory requirements [39].
- Sustainability and resilience: Digital solutions should not only enhance efficiency but also contribute to environmental sustainability and supply chain resilience,

particularly in response to disruptions like the COVID-19 pandemic [28]. The conceptual framework is presented diagrammatically in **Figure 3**.

Figure 3. The proposed framework for a sustainable, digitally transformed supply chain.

7. Conclusion

This paper has examined the role of digital transformation in supply chain management, using Maersk's TradeLens initiative as a central case study. While TradeLens was initially seen as a breakthrough in supply chain transparency and security, its discontinuation in early 2023 underscores the complex challenges of adopting blockchain technology at scale. The analysis highlights that while real-time data integration, advanced analytics, and blockchain technology can enhance supply chain security and efficiency, their success depends on overcoming critical barriers related to industry-wide adoption, governance structures, regulatory integration, and economic sustainability.

The case of TradeLens provides key insights into why technological solutions alone are insufficient for digital supply chain transformation. The lack of interoperability, competitive concerns among stakeholders, and unclear financial incentives ultimately prevented the platform from reaching its full potential. These findings emphasize that future digital supply chain initiatives must focus on collaborative governance, open data standards, and equitable economic incentives to ensure long-term viability.

7.1. Future directions in digital supply chains

Despite its discontinuation, TradeLens serves as a valuable learning experience that can inform the next generation of supply chain innovations. The following key areas will shape the future of digital trade networks:

(1) Decentralized and industry-wide governance models: Future digital supply chain platforms should adopt decentralized or consortium-based governance structures to ensure neutrality and build industry trust. Unlike TradeLens, which was largely controlled by Maersk, successful blockchain initiatives must encourage participation from multiple industry players with equitable decision-making power.

(2) Interoperability and open standards: The next generation of digital trade platforms must prioritize interoperability. Open APIs, standardized digital documentation, and cross-platform compatibility will be crucial in ensuring seamless integration with existing supply chain ecosystems and regulatory frameworks.

(3) Blockchain in trade finance: While TradeLens struggled in logistics, blockchain has immense potential in trade finance. Smart contracts, tokenized transactions, and decentralized financial solutions can enhance efficiency in areas such as letters of credit, payment processing, and fraud prevention.

(4) Regulatory collaboration and compliance integration: Governments and international trade organizations must actively collaborate to create standardized digital trade documentation laws. Future blockchain-based platforms should integrate compliance-friendly smart contracts that automatically enforce trade regulations, customs protocols, and tax requirements.

(5) The role of AI and IoT in enhancing digital supply chains: Artificial intelligence and IoT-driven predictive analytics will play a critical role in supply chain optimization, risk mitigation, and fraud detection. Blockchain-enabled digital

networks should incorporate AI to analyze vast amounts of supply chain data in real-time and proactively address potential disruptions.

7.2. Policy recommendations

To ensure the success of future digital supply chain initiatives, policymakers and industry leaders must establish regulatory frameworks that encourage transparency, interoperability, and widespread adoption. Governments should work with international trade organizations to develop standardized compliance models that integrate blockchain-based documentation, reducing administrative burdens and enhancing efficiency. Additionally, economic incentives, such as tax benefits or subsidies for companies adopting blockchain-based trade solutions, can accelerate adoption. Public-private partnerships should also be explored to create neutral, industry-wide platforms that prevent monopolization concerns, similar to the challenges faced by TradeLens. Clear legal guidelines for smart contracts and digital bills of lading will be essential in fostering trust and ensuring seamless cross-border trade.

7.3. Final thoughts

The discontinuation of TradeLens does not signify the failure of blockchain in global supply chains but rather highlights the need for better collaboration, economic incentives, and regulatory adaptability. Future digital supply chain initiatives will need to align technological innovation with industry-wide cooperation, governance transparency, and financial sustainability. Ultimately, blockchain, AI, and IoT still hold immense potential for transforming global trade, but their success depends on thoughtful implementation strategies. By learning from TradeLens' challenges, future digital supply chain initiatives can better position themselves to drive meaningful and sustainable improvements in international logistics.

Institutional review board statement: Not applicable

Informed consent statement: Not applicable

Conflict of interest: The author declares no conflict of interest.

References

1. Paraje G, Pruzzo L, Flores Muñoz M. Illicit trade and real prices of cigarettes in Chile. Tobacco Induced Diseases. 2023; 21: 117. doi: 10.18332/tid/169785
2. Owoade SJ, Uzoka A, Akerele JI, Ojukwu PU. Automating fraud prevention in credit and debit transactions through intelligent queue systems and regression testing. International Journal of Frontiers in Engineering and Technology Research. 2024; 7(2): 44–56. doi: 10.53294/ijfetr.2024.7.2.0048
3. Rejeb A, Keogh JG, Treiblmaier H. Leveraging the Internet of Things and Blockchain Technology in Supply Chain Management. Future Internet. 2019; 11(7): 161. doi: 10.3390/fi11070161
4. Saberi S, Kouhizadeh M, Sarkis J, et al. Blockchain technology and its relationships to sustainable supply chain management. International Journal of Production Research. 2018; 57(7): 2117-2135. doi: 10.1080/00207543.2018.1533261
5. Zheng Z, Xie S, Dai HN, et al. Blockchain challenges and opportunities: a survey. International Journal of Web and Grid Services. 2018; 14(4): 352. doi: 10.1504/ijwgs.2018.095647
6. Khan SAR, Piprani AZ, Yu Z. Supply chain analytics and post-pandemic performance: mediating role of triple-A supply chain strategies. International Journal of Emerging Markets. 2022; 18(6): 1330-1354. doi: 10.1108/ijoem-11-2021-1744

7. Ventura B, Vianello A, Frisinghelli D, et al. A Methodology for Heterogeneous Sensor Data Organization and Near Real-Time Data Sharing by Adopting OGC SWE Standards. ISPRS International Journal of Geo-Information. 2019; 8(4): 167. doi: 10.3390/ijgi8040167
8. Ressi D, Romanello R, Piazza C, et al. AI-enhanced blockchain technology: A review of advancements and opportunities. Journal of Network and Computer Applications. 2024; 225: 103858. doi: 10.1016/j.jnca.2024.103858
9. Birkel HS, Hartmann E. Internet of Things: the future of managing supply chain risks. Supply Chain Management: An International Journal. 2020; 25(5): 535-548. doi: 10.1108/scm-09-2019-0356
10. Chelh S, Ababou M. Improving green supply chain resilience through Blockchain innovation: A risk mitigation perspective. E3S Web of Conferences. 2023; 412: 01056. doi: 10.1051/e3sconf/202341201056
11. George B. Blockchain-Based Land Tenure Systems: A Conceptual Model for Using Decentralized Technologies in Managing Land Rights and Ownership Disputes. Land Management and Utilization. 2025; 1(2): 32-48. doi: 10.54963/lmu.v1i2.1527
12. Dursun T, Üstündağ BB. A novel framework for policy based on-chain governance of blockchain networks. Information Processing & Management. 2021; 58(4): 102556. doi: 10.1016/j.ipm.2021.102556
13. Pelt R van, Jansen S, Baars D, et al. Defining Blockchain Governance: A Framework for Analysis and Comparison. Information Systems Management. 2020; 38(1): 21-41. doi: 10.1080/10580530.2020.1720046
14. Garcia RD, Ramachandran GS, Jurdak R, et al. Blockchain-Aided and Privacy-Preserving Data Governance in Multi-Stakeholder Applications. IEEE Transactions on Network and Service Management. 2022; 19(4): 3781-3793. doi: 10.1109/tnsm.2022.3225254
15. Garcia R. Blockchain-based data governance for privacy-preserving in multi-stakeholder settings. In: Anais Estendidos do XLII Simpósio Brasileiro de Redes de Computadores e Sistemas Distribuídos. São Carlos; 2023. doi: 10.11606/d.55.2023.tde-06092023-102200
16. Shermin V. Disrupting governance with blockchains and smart contracts. Strategic Change. 2017; 26(5): 499-509. doi: 10.1002/jsc.2150
17. Mustafa G, Rafiq W, Jhamat N, et al. Blockchain-based governance models in e-government: a comprehensive framework for legal, technical, ethical and security considerations. International Journal of Law and Management. 2024; 67(1): 37-55. doi: 10.1108/ijlma-08-2023-0172
18. Ibrahimy MM, Norta A, Normak P. Blockchain-based governance models supporting corruption-transparency: A systematic literature review. Blockchain: Research and Applications. 2024; 5(2): 100186. doi: 10.1016/j.bcra.2023.100186
19. Tiwari CK, Pal A. Using blockchain for global governance: past, present and future. South Asian Journal of Business Studies. 2022; 12(3): 321-344. doi: 10.1108/sajbs-07-2022-0252
20. Laatikainen G, Li M, Abrahamsson P. A system-based view of blockchain governance. Information and Software Technology. 2023; 157: 107149. doi: 10.1016/j.infsof.2023.107149
21. Liu Y, Wang Q. Blockchain for supply chain: performance implications and contingencies. Industrial Management & Data Systems. 2024; 125(1): 364-383. doi: 10.1108/imds-05-2024-0457
22. Fosso Wamba S, Queiroz MM, Trinchera L. Dynamics between blockchain adoption determinants and supply chain performance: An empirical investigation. International Journal of Production Economics. 2020; 229: 107791. doi: 10.1016/j.ijpe.2020.107791
23. Yousefi S, Mohamadpour Tosarkani B. An analytical approach for evaluating the impact of blockchain technology on sustainable supply chain performance. International Journal of Production Economics. 2022; 246: 108429. doi: 10.1016/j.ijpe.2022.108429
24. Vasanthraj V, Potdar V, Agrawal H, Kaur A. Transforming milk supply chains with blockchain: enhancing visibility and cost reduction. Benchmarking: An International Journal. 2024; 32(5): 1686-1719. doi: 10.1108/bij-10-2023-0702
25. Hastig GM, Sodhi MS. Blockchain for Supply Chain Traceability: Business Requirements and Critical Success Factors. Production and Operations Management. 2020; 29(4): 935-954. doi: 10.1111/poms.13147
26. Cui Y, Gaur V, Liu J. Supply Chain Transparency and Blockchain Design. Management Science. 2024; 70(5): 3245-3263. doi: 10.1287/mnsc.2023.4851
27. Sun W, Antwi-Afari MF, Mehmood I, et al. Critical success factors for implementing blockchain technology in construction. Automation in Construction. 2023; 156: 105135. doi: 10.1016/j.autcon.2023.105135
28. Huang L, Zhen L, Wang J, et al. Blockchain implementation for circular supply chain management: Evaluating critical success factors. Industrial Marketing Management. 2022; 102: 451-464. doi: 10.1016/j.indmarman.2022.02.009

29. Sundarakani B, Ajaykumar A, Gunasekaran A. Big data driven supply chain design and applications for blockchain: An action research using case study approach. Omega. 2021; 102: 102452. doi: 10.1016/j.omega.2021.102452
30. Karame G, Capkun S. Blockchain Security and Privacy. IEEE Security & Privacy. 2018; 16(4): 11-12. doi: 10.1109/msp.2018.3111241
31. Drljevic N, Aranda DA, Stantchev V. An Integrated Adoption Model to Manage Blockchain-Driven Business Innovation in a Sustainable Way. Sustainability. 2022; 14(5): 2873. doi: 10.3390/su14052873
32. Khalfan M, Azizi N, Haass O, et al. Blockchain Technology: Potential Applications for Public Sector E-Procurement and Project Management. Sustainability. 2022; 14(10): 5791. doi: 10.3390/su14105791
33. Awasthy P, Haldar T, Ghosh D. Blockchain enabled traceability: An analysis of pricing and traceability effort decisions in supply chains. European Journal of Operational Research. 2025; 321(3): 760-774. doi: 10.1016/j.ejor.2024.10.019
34. Alabdulkarim Y. A Review of Blockchain Use Cases and Recent Failures in the Enterprise. In: Proceedings of the 2023 3rd International Conference on Computing and Information Technology (ICCIT); 13-14 September 2023; Tabuk, Saudi Arabia. pp. 641-646. doi: 10.1109/iccit58132.2023.10273891
35. Roth T, Utz M, Baumgarte F, et al. Electricity powered by blockchain: A review with a European perspective. Applied Energy. 2022; 325: 119799. doi: 10.1016/j.apenergy.2022.119799
36. Kshetri N. 1 Blockchain's roles in meeting key supply chain management objectives. International Journal of Information Management. 2018; 39: 80-89. doi: 10.1016/j.ijinfomgt.2017.12.005
37. Wieland A. Dancing the supply chain: Toward transformative supply chain management. Journal of Supply Chain Management. 2021; 57(1): 58-73. doi: 10.1111/jscm.12248
38. Lerman K. The Social Emotional Web. In: Proceedings of the 2022 IEEE 8th International Conference on Collaboration and Internet Computing (CIC); 14-16 December 2022; Atlanta, GA, USA. pp. 26-30. doi: 10.1109/CIC56439.2022.00014
39. Rai BK. BBTCD: blockchain based traceability of counterfeited drugs. Health Services and Outcomes Research Methodology. 2023; 23(3): 337-353. doi: 10.1007/s10742-022-00292-w
40. Alnawafah H, Alnawafah Q, Amano RS. Innovative Photovoltaic-Aeration Integration: Enhancing Energy Efficiency and Grid Stability in Wastewater Treatment. Journal of Energy Resources Technology, Part A: Sustainable and Renewable Energy. 2025; 1(3): 032103. doi: 10.1115/1.4067364
41. Phiayura P, Teerakanok S. A Comprehensive Framework for Migrating to Zero Trust Architecture. IEEE Access. 2023; 11: 19487-19511. doi: 10.1109/access.2023.3248622
42. Rodrigo N, Omrany H, Chang R, et al. Leveraging digital technologies for circular economy in construction industry: a way forward. Smart and Sustainable Built Environment. 2023; 13(1): 85-116. doi: 10.1108/sasbe-05-2023-0111