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Exploring the failure factors of blockchain adopting projects: a case study of tradelens through the lens of commons theory

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Blockchain is a transformative technology with the potential to metamorphose industries, including supply chains and logistics, owing to its promise of efficiency, transparency and traceability. However, many blockchain projects have failed, requiring an analysis of the underlying reasons. This research focuses on the failure factors by studying the case of TradeLens, a supply chain platform using Blockchain to improve the visibility and coordination of international shipments. Applying Elinor Ostrom's theory of the commons, we explored challenges related to governance, participation, interoperability, technological evolution and security. The study reveals that a lack of stakeholder engagement, unclear governance, and confidentiality concerns are major obstacles. Ostrom highlights the importance of participatory governance and a clear definition of boundaries and communities in the management of shared resources. To be successful, blockchain projects must adopt a holistic approach, with transparent governance, encourage collaboration, guarantee interoperability and invest in data security. By incorporating these recommendations and the lessons learned from past failures, future blockchain projects can improve their chances of success and make a positive contribution to the transformation of industries.

KEYWORDS

blockchain, ecosystem, logistics, theory of the commons, TradeLens

Highlights

- Participant Protection: The committee has verified that all necessary measures have been taken to ensure the confidentiality and safety of participants throughout the study. The protocol includes clear mechanisms to minimize any potential risks to participants.
- Informed Consent: The consent form you provided meets the requirements for transparency and comprehension. It ensures that participants are fully informed of their rights, the study's objectives, and the potential risks and benefits. It also guarantees their freedom to participate and their right to withdraw at any time without penalty.
- Data Confidentiality: The committee confirms that the measures you have implemented to protect data confidentiality and anonymization are appropriate. These measures ensure that participants' personal information remains protected throughout the study and after the publication of results.

- Risk and Benefit Assessment: The committee has determined that the potential benefits of the study outweigh the risks involved, and that the risks have been carefully assessed and minimized.

1 Introduction

Blockchain has emerged as a transformative innovation, with the potential to transform existing industries and processes. In particular, the application of blockchain technology in supply chain and logistics projects has captured remarkable attention due to its promise of operational efficiency, transparency, and traceability (Tsiulin et al., 2020; Jia et al., 2024). Nevertheless, despite the perceived benefits, many projects adopting Blockchain technology have faced challenges and failures, requiring in-depth analysis to understand the underlying reasons (Nguyen et al., 2023).

This research aims to explore in depth the failure factors inherent in projects using blockchain technology, focusing on the case study of TradeLens, a global supply chain platform that leverages Blockchain technology to improve the visibility and coordination of international shipments. To better understand the barriers to its success, we apply Elinor Ostrom's theory of the commons (Ostrom, 1990; 2000; 2009), which offers a rich and bold conceptual framework for understanding the management of common resources and cooperation within stakeholder ecosystems (Gazi et al., 2022a).

First, we present the current context of blockchain technology adoption in supply chain projects, highlighting the motivations and challenges surrounding this digital transformation. Next, we introduce Elinor Ostrom's theory of the commons and explain how this theory can inform our understanding of failure factors in blockchain projects. Finally, we define the scope and objectives of our exploratory case study focused on TradeLens, while highlighting its importance for informed decision-making in the design and implementation of future blockchain projects.

In sum, this study is sheds new light on the challenges faced by blockchain technology projects, using a strong theoretical perspective to assess the reasons for failure specific to the TradeLens case study. By combining the complex reality of blockchain technology adoption with the proven concepts of the commons theory, we aim to generate new ideas and provide relevant recommendations for a more successful implementation of these ambitious projects.

2 Literature review

2.1 Importance of blockchain technology in the maritime industry

As a disruptive innovation (Korpela et al., 2017), blockchain technology has ushered in a new era of transformation in supply chains, including the maritime industry, which is undergoing profound changes with its adoption (Nguyen et al., 2023a). Offering a multitude of benefits that transcend traditional boundaries, blockchain offers innovative solutions to solve complex problems (Caschili and Meda, 2012) and improve operations across the maritime supply chain (Nguyen et al., 2023a; Nguyen et al., 2023b; Nguyen et al., 2023).

Blockchain enables the creation of a decentralized (Bottoni et al., 2020), immutable ledger that records every transaction and event related to shipments. This provides stakeholders (Sunny et al., 2020) such as shippers, carriers, ports, and customs authorities, with real-time access to information on the location, status, and status of shipments. This transparency helps reduce litigation, delays, and fraud (Miehle et al., 2019; Baralla et al., 2021; Ho et al., 2021). Furthermore, in the shipping industry, which involves many stakeholders, complex documents, and lengthy approval processes (Carlan et al., 2020; Pu and Lam, 2021), blockchain can simplify these processes by enabling the use of secure and automated smart contracts that trigger actions when certain conditions are met. This can significantly reduce paperwork (Alles and Gray, 2020; Kuhn et al., 2021), administrative burdens, and manual errors (Bechtsis et al., 2019; Eryilmaz e al., 2020).

Owing to its secure and tamper-proof nature, blockchain can help verify the authenticity of goods and prevent counterfeiting (Tsiulin et al., 2020; Gerakoudi-Ventouri, 2022). Every step of the supply chain can be recorded on the blockchain, ensuring that the origin and history of the products are accurate and verifiable (Sun et al., 2024).

This enhanced security is all the more crucial in a context where traditional shipping systems are vulnerable to data breaches and cyberattacks (Tsiulin et al., 2020; Gerakoudi-Ventouri, 2022). This is because the cryptographic nature of blockchain makes it highly secure and resistant to unauthorized access. The information stored on the blockchain is encrypted and linked to previous transactions, making it extremely difficult for malicious actors to alter records without detection (Smart et al., 2007; Baralla et al., 2021).

In the maritime domain, where safety is paramount, these contracts can automate various processes such as customs clearance, payments, and the release of cargo when certain conditions are met. This reduces the need for intermediaries and speeds up transactions (Smart et al., 2007; Baralla et al., 2021). In addition, the efficiency of these processes is particularly beneficial in industry that rely heavily on physical documents, resulting in delays (Gerakoudi-Ventouri, 2022; Tsiulin et al., 2020), errors and inefficiencies.

Blockchain can digitize and automate documentation processes, ensuring that parties have access to accurate and up-to-date information in real-time. Finally, this increased traceability and transparency also facilitates the resolution of disputes. Litigation often arises in the marine industry because of discrepancies in documentation or misunderstandings (Xu et al., 2019; Alles and Gray, 2020; Kuhn et al., 2021). Blockchain's transparent and tamper-proof records provide an indisputable source of information, facilitating faster and more accurate dispute resolution (Bottoni et al., 2023).

2.2 The challenges of blockchain adoption

Although the promises of blockchain are substantial (Miehle et al., 2019; Dutta et al., 2020; Sternberg et al., 2021; Ahmed and Rios, 2022), the literature also recognizes the challenges inherent in its adoption (Wamba and Queiroz, 2020; Dutta et al., 2020; Ghode et al., 2021; Katsikouli et al., 2021). Factors such as interoperability, scalability, data privacy, and regulatory complexities have been identified as critical barriers. A common theme is emerging: the need for effective governance and collective action to address these challenges (Wimmer et al., 2018; Lumineau et al., 2021a; Lumineau et al., 2021b).

In fact, according to Valle and Oliver, 2021,interoperability is essential in blockchain projects. Its absence can lead to network isolation, limited utility, low fluidity, data issues, inefficient transactions, security risks, and regulatory compliance challenges. To be successful, blockchain projects must prioritize interoperability from the outset and collaborate with other networks to create interoperable solutions (Lee et al., 2023).

Additionally, although blockchain is renowned for its security and transparency, it can experience privacy issues that can cause failures (Alazab et al., 2021). These issues include a lack of complete trust, data protection breaches, risk of information leakage, compliances issues, and complex access permission management. It is essential for businesses to recognize these risks and implement appropriate measures to protect sensitive data when using blockchain.

Furthermore, regulatory complexities (Malik et al., 2018) can also cause blockchain projects to fail due to legal uncertainty, conflicts with existing laws, complex compliance requirements, unforeseen regulatory changes, high compliance costs, investor hesitation and reputational risk. Managing regulatory compliance becomes is essential to overcoming these obstacles and succeeding in the blockchain space.

Another challenge is scalability, which refers to the ability of a blockchain to handle an increase in the number of transactions and users while maintaining acceptable performance (Malik et al., 2018). Insufficient scalability can lead to problems such as performance slowdowns, high transaction fees, network crashes, potential centralization, and investor disinterest. To mitigate these issues, various solutions are being developed (Eklund and Beck, 2019), but scalability remains a persistent challenge in the blockchain space, and projects that fail to do so may be vulnerable to failure (Zhou et al., 2020).

Finally, cultural and organizational resistance can hinder the success of blockchain projects (Iacovou et al., 1995). Teams and stakeholders are likely to lack understanding and trust in this complex and new technology (Figure 1). Fear of change, organizational inertia, and internal compliance issues can also play a role. In addition, lack of expertise and external skepticism are additional barriers (Badhwar et al., 2023).

However, despite these challenges, concrete examples of blockchain project failures in supply chains, such as IBM's Food Trust, VeChain, and Walmart Canada, highlight the practical limitations of this technology (Table 1). These failures are often linked to high costs, technical issues, adoption difficulties, and coordination challenges among stakeholders. To better understand these obstacles and propose viable solutions, it is relevant to rely on a solid theoretical framework, such as Elinor Ostrom's theory on the governance of common-pool resources, which provides valuable insights into the collective management of resources and collaboration among stakeholders.

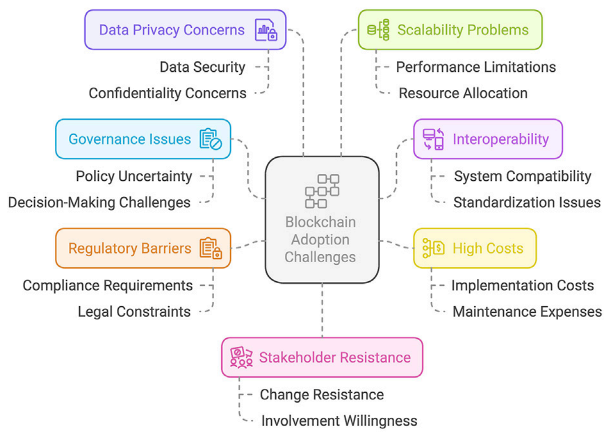

FIGURE 1
Blockchain adoption challenges in supply chains.

3 Theoretical framework

This section presents the theoretical framework guiding our analysis of the factors contributing to the failures of collaborative blockchain projects, using Elinor Ostrom's commons theory (Rozas et al., 2021). This perspective allows us to explore the complex interactions involved in managing shared resources, particularly in digital contexts such as blockchain-based initiatives (Pazaitis et al., 2017).

3.1 The commons theory as an analytical lens for collaborative platforms

Elinor Ostrom's commons theory (Rozas et al., 2021; Gazi and Sahdev, 2022; Jain et al., 2022) provides fundamental principles for

TABLE 1 Examples of blockchain project failures in supply chains.

Project	Objective	Failure factors
IBM Food Trust (Ellahi et al., 2024)	Blockchain-enabled food traceability and transparency	Scalability issues, high costs limiting SME adoption
VeChain (Hellani et al., 2020)	Supply chain tracking for various industries, including food and luxury goods	Technical integration difficulties, lack of widespread adoption
Walmart Canada Blockchain (Zhang et al., 2024)	Blockchain-based freight and invoice tracking system	Coordination challenges among stakeholders, system inefficiencies

understanding how shared resources are managed, preserved, and sometimes destined to fail when cooperation and appropriate governance structures are lacking. This approach is particularly relevant for analyzing collaborative blockchain projects, which rely on the creation and management of shared digital infrastructures among multiple stakeholders. These projects, often designed to enhance transparency, traceability, and efficiency in sectors such as supply chains, finance, and healthcare, frequently fail due to governance challenges, stakeholder disengagement, and a lack of incentives for collective action.

Although alternative theories such as Stakeholder Theory, the Technology Acceptance Model (TAM), and Network Effects Theory can help explain blockchain adoption and its associated challenges, we argue that they do not fully capture the structural factors leading to the failure of collaborative projects.

Stakeholder Theory (Freeman, 2017) primarily focuses on power relationships and negotiations between independent actors (Mahajan et al., 2023). However, it does not explain why shared resources, such as blockchain platforms, often fail to establish sustainable cooperation among participants.

The Technology Acceptance Model (TAM) (Davis, 1989) is designed to analyze individual perceptions of technology adoption. However, the failure of collaborative projects is not primarily due to usability issues but rather to governance imbalances and misaligned economic incentives at the ecosystem level (Yeo and Keske, 2024).

Network Effects Theory (Katz and Shapiro, 1994) assumes that the value of a platform increases with the number of users. However, in the case of collaborative blockchain projects, adoption often stagnates due to a lack of trust and governance issues, preventing network effects from taking hold (Otter and Robinson, 2024).

Thus, Ostrom's commons theory emerges as the most suitable framework for analyzing the failures of collaborative blockchain projects, as it emphasizes the importance of clearly defined governance rules, equitable access to shared resources, and transparent incentives for stakeholders. By structuring our analysis through the lens of commons theory, we provide a deeper understanding of the challenges associated with blockchain adoption and identify the necessary conditions to ensure sustainable cooperation and long-term success.

3.2 Key concepts of the commons

TheoryDigital goods are considered a subset of the commons, applicable to resources created and maintained online (such as digital infrastructure, the Internet, digital information repositories, and open source software, etc.). (Gazi et al., 2022b; Jain et al., 2022). The underlying purpose of putting a shared resource as part of the commons is to prevent the "tragedy of the commons", referring to a situation in which an individual's action is motivated by his or her own self-interest, resulting in the depletion of shared resources (Howell and Potgieter, 2019).

To prevent such tragedies, the commons must be monitored and managed. While early scientific work mainly discussed a top-down approach to governing the commons, Nobel laureate Elinor Ostrom (Ostrom, 1990; 2000) showed a third way of managing the commons—a bottom-up, polycentric approach empowering community members to manage the commons themselves. Ostrom based his thinking by opposing Hardin's pessimistic view of the "tragedy of the commons," using game theory to model interactions between individuals and groups, and drawing on the logic of collective action to understand the importance of rules, norms, and institutions for the effective management of common resources.

Her work (Hunhevicz et al., no date; Cila et al., 2020) have led to the identification of several principles for managing the commons, which are as follows (Ostrom, 1990; 2009; Lewis and Petersen, 2023):

- Clear Boundary Setting: Communities that successfully manage the commons clearly define the boundaries of these resources. It is essential to know who has access to the resource and who does not.
- Adaptive management rules: Communities establish management rules that can be adapted to changing needs and local conditions. Flexibility is important in responding to changes.
- User participation and cooperation: People who use resources are often involved in decision-making and management processes. Active user cooperation is crucial for avoiding overuse.
- Compliance monitoring: Compliance with the rules is monitored by the community itself. Penalties can be applied to violators to maintain order and sustainability.
- Conflict Resolution Mechanisms: Communities establish mechanisms to resolve conflicts that may arise over the use of common resources. Disputes are handled locally.
- Recognition of collective rights: Collective rights to manage and use the resource are recognized and respected by community members. Individuals have a sense of belonging to the community.
- Institutional adaptability: Commons management institutions must be able to adapt to changes and challenges that arise over time.
- Social Learning: Community members share their experiences and collectively learn from past successes and failures. This makes it possible to improve the management of common resources.
- Connectivity with higher levels: Sometimes it is necessary to establish links between the local management of the commons and authorities or organizations at higher levels to address cross-border or interconnection issues.

These principles highlight the importance of community management, cooperation, individual responsibility, and flexibility in maintaining the commons sustainability. They have been used to design natural resource management policies and approaches worldwide (Ostrom, 1990; 2009).

3.3 Application of the theory of commons to blockchain projects

Applying Ostrom's theory of the commons (Ostrom, 1990) to blockchain (Howell and Potgieter, 2019) requires thinking about how the principles discussed by Ostrom (Table 2) can be applied to

TABLE 2 Summary of the relationships between the identified affordances of blockchain technologies for Governance and Ostrom's (1990) principles.

Affordance\principle	Tokenization	Self-enforcement and formalization	Autonomous automatization	Decentralization of Power over infrastructure	Increasing transparency	Codification of trust
1. Clearly defined community boundaries	✓					
2. Congruence between rules and local conditions	✓	✓		✓		
3. Collective choice arrangements	✓			✓		
4. Monitoring		✓	✓	✓	✓	
5. Graduated sanctions		✓	✓			
6. Conflict resolution mechanisms			✓		✓	
7. Local enforcement of local rules		✓		✓		✓
8. Multiple layers of nested enterprises			✓			✓

the specific challenges faced by blockchain projects (Rozas et al., 2021). In the following, we have tried to explain the failures of some blockchain projects through the principles of Ostrom:

- Clear definition of boundaries: In a blockchain project, this means clearly defining the parameters of the network, such as protocol, consensus rules, access rights, and participation rights.
- Clear definition of user rights: In an effective commons system, there must be a clear definition of user rights. If a blockchain project does not clearly define who can do what (e.g., who can validate transactions or add blocks), it can lead to conflicts.
- Adaptive management rules: The rules in place in the commons must be adapted to the specific needs of the community. In the context of blockchain, this could mean that the rules of a project do not necessarily align with the needs or desires of the community that uses it.
- User participation in decision-making: Ostrom stressed the importance of involving users in decisions about the management of commons. If a blockchain project fails to actively engage its community, there could be a lack of trust or adoption.
- User monitoring: To prevent overuse or misuse of the commons, it is important for users to monitor the system themselves. In blockchain, this could mean that without proper oversight, malicious actors could manipulate or attack the system.
- Graduated sanctions: If actors violate the rules, graduated sanctions must be applied. Blockchain projects that do not have mechanisms to deal with harmful behavior could suffer from governance or security issues.
- Access to dispute resolution mechanisms: Conflicts must be resolved in a timely and fair manner. If a blockchain project does not have an effective mechanism to resolve disputes, it could discourage participation or lead to divergence.
- Recognition of the rights of local users to organize their own management institutions: Foster the autonomy of users and communities to organize initiatives, such as Decentralized Autonomous Organizations (DAOs), for specific blockchain use cases while respecting standards and interconnections with the mainnet (Rozas et al., 2021).

The analogy between blockchain technology and digital commons is based on the assumption that although a blockchain protocol, similar to physical commons (Gazi et al., 2022a), is not vulnerable to depletion or overuse, it can nevertheless face consequences arising from the abuse of participants voting power, the threat of secession of the community, the lack of liquidity and the premature liquidation. Unlike traditional commons, the "tragedy of commons" in the context of blockchain does not result from overconsumption. In contrast, the inherent risk of blockchain lies in under-provisioning, quality degradation, lack of innovation, environmental damage or an inadequate legal framework, which can hinder the availability of resources.

In sum, while Elinor Ostrom's theory of the commons did not focus specifically on blockchain technology, her principles offer a useful framework for understanding how pooled blockchain platforms can fail if they fail to effectively manage the challenges associated with governance, participation, and security.

4 Methodology

To answer our research question, an exploratory and in-depth case study was conducted, through the examination of the specific case of TradeLens.

This research adopts a theoretical elaboration approach ((Ketokivi and Choi, 2014), using the theory of the commons as an analytical framework, which was deemed appropriate because of the limited number of previous studies on this phenomenon ((Dubois and Gadde, 2002; Eisenhardt and Graebner, 2007).

In this section, we will detail the methodology we used to conduct our exploratory case study on the failure factors of projects adopting blockchain technology, using TradeLens as a case study. Our methodological approach is designed to capture the complexities inherent in these projects and explore how Elinor Ostrom's theory can inform our understanding of the interactions between actors and shared resources.

4.1 Case study choice: TradeLens

Case study research is suitable for examining a phenomenon in its natural context (Yin, 2003; Eisenhardt and Graebner, 2007). Simons (2009) noted that "the case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program, or system in real life" (Simons, 2009).

This allows us to explore specific situations, phenomena or cases in detail. It offers an in-depth understanding of the elements being studied, which is particularly useful when looking at complex or unique cases, such as tradelens.

The choice of TradeLens as a case study stems from its relevance as an exemplary project in the application of blockchain technology in the shipping industry and logistics. TradeLens, a platform developed collaboratively between IBM and Maersk, was designed to improve the visibility, transparency, and efficiency of shipping operations by using blockchain technology (Jensen et al., 2019). Its adoption and evolution provide fertile ground to exploring the challenges and opportunities associated with blockchain projects in this field (Jovanovic et al., 2022).

The choice of TradeLens as a case study is guided by several reasons:

- Relevance: The TradeLens was a large-scale project with considerable attention in the logistics and technology sectors. Its ambitions are closely aligned with the promises of blockchain technology transformation in supply chain management.
- Complexity: The nature of the supply chain ecosystem adds layers of complexity to the integration of new technologies. TradeLens, as a collaborative company with multiple stakeholders, provides a suitable backdrop for exploring the challenges faced in blockchain adoption.
- Documented Journey: The TradeLens project has benefited from substantial media coverage, reporting, and documentation over its lifetime. This provides a rich source of data for analysis, allowing for a comprehensive exploration of goals, challenges, and outcomes.
- Learning potential: The failure of TradeLens offers valuable insights into the challenges that can arise in blockchain projects. Learning from these shortcomings can inform future initiatives, making it a relevant case to study.

Through an in-depth examination of the TradeLens case, we aim to uncover the complex interplay of the factors that contributed to its eventual failure. Applying Elinor Ostrom's theory of the commons, we seek to gain a holistic understanding of how collective action principles, shared resources, and governance dynamics manifest themselves in the context of blockchain technology adoption in complex ecosystems, such as supply chains.

4.2 Data collection

The data collection process is essential to build a comprehensive and insightful analysis of the TradeLens case study through the lens of commons theory.

Data were collected from three sources between May 2023 and February 2024: i) in-depth semi-structured interviews; ii) informal conversations with people involved in TradeLens; and iii) secondary data, including TradeLens documentation, industry reports, industry conference presentations, news articles, and press releases.

4.2.1 Key data sources: in-depth semi-structured interviews

Semi-structured interviews were conducted with key stakeholders involved in the TradeLens project, selected through natural or convenience sampling according to the principles of (Collis and Hussey, 2009). These interviews targeted individuals directly involved in the development and deployment of the platform, including representatives from Maersk and IBM, the project's main partners, as well as partner organizations collaborating with TradeLens and blockchain and supply chain management experts with deep knowledge of the ecosystem.

Semi-structured interviews were conducted with experts, selected based on their involvement and knowledge of the subject. We contacted them through the professional social network LinkedIn over a period of 10 months, during which several reminders were made. Approximately 40 people were contacted. A total of 12 semi-structured interviews were conducted between 25 and 60 min (Table 3). All interviews were conducted via telephone or videoconference. The interviews were then transcribed and used in the analysis of the results.

The interviews took a semi-directive approach, allowing participants to share their perspectives, experiences, and perceptions of the TradeLens. This approach provides first-hand information regarding:

- The underlying dynamics of the project and the factors contributing to its development
- Challenges faced when implementing and adopting TradeLens

TABLE 3 Characteristics of the experts interviewed.

Code	Title	Organisation	Expertise
E1	Information System Director	International Logistics Company	Blockchain, logistics
E2	Senior Analyst	Supply Chain Management Consulting Company	Blockchain
E3	Supply Chain Manager	Shipping	Logistics, shipping industry
E4	Associate Professor	University	Blockchain, logistics
E5	Consultant	Technology consulting company	Blockchain, supply chain
E6	Chief Innovation Officer	Technology shipping	Shipping industry
E7	Security Manager	Logistics company	Security, blockchain
E8	Industry Analyst	Shipping Company	Shipping industry, logistics
E9	Executive Director	Blockchain company	Blockchain, Supply Chain
E10	Project Manager	Software Development Company	Blockchain, logistics
E11	Consultant	Management consulting Company	Supply Chain, blockchain
E12	Head of Research	University	Blockchain, logistics, Shipping industry

- The perceived reasons for the platform's failure

The sample size was determined based on the theoretical saturation principle, which allows data collection to be discontinued when new information becomes redundant. In our study, saturation was reached after 12 interviews, as the new data confirmed existing trends without introducing additional concepts.

4.2.2 Secondary data

Data were gathered from a variety of sources, including:

- Official TradeLens documentation
- Industry Reports
- Press articles and press releases

In addition, informal discussions with actors from the TradeLens industry enriched the analysis by providing contextual information and additional perspectives. This approach is part of a methodological triangulation, combining semi-structured interviews, document analysis, and informal exchanges, allowing for data cross-validation and verification from multiple sources. This method enhanced the reliability of the results and enabled a deeper understanding of the TradeLens ecosystem, its challenges, and its implications.

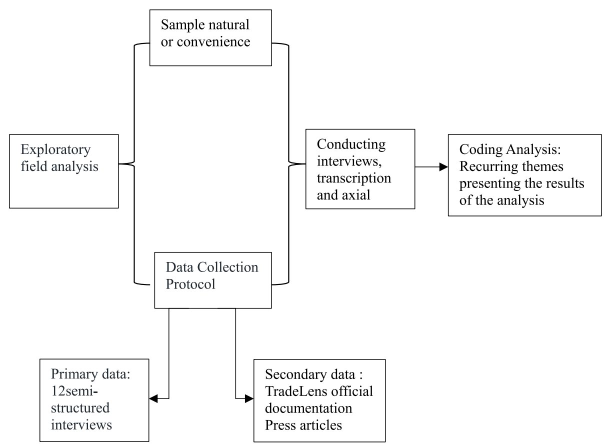

FIGURE 2
Steps of the exploratory methodology.

4.3 Data analysis

The interview processing process involves a thorough review of the interview transcripts to identify the key themes, motives, and ideas expressed by the participants (Figure 2).

First, each interview was transcribed to retain the expressions used in the interviews. Then, a careful review of the transcripts was carried out to familiarize themselves with the content and understand the context in which the participants expressed their opinions. Finally, an axial coding method was applied using the "QSR NVIVO" coding software, owing to the exploratory nature of the study. This approach helped to identify and link the key themes that emerged from the interview transcripts (Supplementary Appendix 1, summarizing the main verbatims received by the experts).

4.3.1 Thematic analysis and interpretation of results

An in-depth analysis of the verbatim associated with our literature review identified five recurring themes that could be correlated with the challenges faced by TradeLens in the adoption of blockchain technology. These themes, supported by excerpts from expert verbatim, are presented below (Supplementary Appendix 1, summarizing in detail the main verbatims received by the experts). To guarantee the confidentiality of the speakers, verbatims were not attributed to the companies interviewed.

4.3.1.1 Lack of stakeholder engagement

One of the key factors in TradeLens' failure was the lack of stakeholder engagement, as evidenced by verbatims collected from experts during interviews:

Expert 1:

> "TradeLens was a great idea on paper, but it failed because it failed to get buy-in from key industry stakeholders. Players were reluctant to share their data with a for-profit entity, and they were not convinced that TradeLens would provide them with enough added value."

Expert 3:

> "TradeLens was too ambitious. It was trying to be all things to all people and failed to focus on the specific needs of different stakeholders. This led to a platform that was too complex and difficult for many potential users to use."

Expert 4:

> "We found that some stakeholders were reluctant to share their data on the TradeLens platform."

Expert 9:

> "The complex ecosystem of the maritime industry required strong commitment from all stakeholders for TradeLens to reach its full potential. Unfortunately, the lack of consensus on data standards and protocols makes it difficult to align interests, jeopardizing the long-term viability of the project."

Indeed, the interviewees highlighted the lack of stakeholder engagement as one of the main obstacles. Key players in the maritime industry, such as carriers and shippers, may not have been sufficiently involved in or convinced of the usefulness of blockchain platforms.

The lack of stakeholder engagement in the TradeLens can be attributed to several factors. The first is resistance to change (Rogers, 2003). Many actors in the supply chain are committed to their traditional ways of working and are reluctant to adopt new technologies that could disrupt their established operations. Second, the costs and investments required to integrate and use the platform may deter stakeholders from fully engaging. Businesses may be concerned that the potential benefits of TradeLens will not outweigh the upfront and ongoing costs associated with using it.

Additionally, the lack of trust and transparency regarding the platform's governance and data privacy can raise concerns among stakeholders, prompting them to take a cautious approach. Finally, the technical complexity of TradeLens can also be a barrier, especially for companies that lack the resources or technical skills to effectively integrate the platform with their existing systems. Combining these factors, the lack of stakeholder engagement is a major challenge for the success and widespread adoption of TradeLens in the shipping industry.

4.3.1.2 Governance issues

Governance refers to the regulation of decision-making processes between actors towards common goals that lead to the development, reinforcement, or reproduction of social norms and institutions (Kolehmainen et al., 2021).

Governance issues also played a role in TradeLens's failure. Despite its bold vision of digitizing global logistics, the platform has not reached the level of business viability needed to continue operating as an independent company. Partners Maersk and IBM pointed out that the need for full global industry collaboration did not materialize, leading to the decision to end TradeLens.

Expert 2

> "Governance structures were too rigid to adapt to rapid market changes and new regulatory requirements".

Expert 5

> "TradeLens has suffered from a lack of leadership and coordination at the governance level. The lack of a central authority to direct the project and mediate conflicts contributed to its failure. Weak governance has made it difficult to set the rules of the game and adopt common standards."

Expert 10

> "Governance issues have exacerbated tensions between TradeLens' various stakeholders. Shipping companies, port operators, and regulatory authorities struggled to agree on issues of data ownership, liability, and revenue sharing, which jeopardized the project's viability."

Experts have also highlighted the difficulty of implementing projects like TradeLens due to technological complexity, high cost of operation, and the need for a high risk tolerance for innovation and adoption.

The governance issues in TradeLens can be attributed to several underlying factors. First, there was a lack of clarity on roles and responsibilities: It was not always clear who was responsible for making decisions on TradeLens. This led to delays and confusion, making it difficult for TradeLens to respond quickly to market needs. As the expert 11 testifies:' Power struggles have affected the governance committee's ability to make informed decisions.

The lack of transparency in this process can also lead to misunderstanding and mistrust among stakeholders. In addition, an inequality of voices and power within governance can arise if certain large companies dominate the decision-making process, leaving smaller companies feeling marginalized and their interests underrepresented.

In addition, the lack of formal dispute resolution mechanisms can aggravate tensions and disagreements between stakeholders, leading to blockages in the development and evolution of the TradeLens. Finally, concerns about data privacy and security can be exacerbated by the absence of clear protocols to protect participants' sensitive business information. Overall, these underlying causes contribute to the governance issues faced in TradeLens, which has compromised its long-term viability and acceptance in the wider maritime industry.

4.3.1.3 Technological complexity:

While powerful, blockchain technology can be complex to implement and integrate into existing systems, which has sometimes led to delays and compatibility issues.

Technological complexity also contributed to making the platform difficult for stakeholders to adopt, as it required a higher computing capacity and is expensive to operate (Manners-Bell and Lyon, 2022). In addition, the platform failed to convince stakeholders to pay for the services, which contributed to the decision to shut down the platform.

Expert 1:

> "TradeLens was a very complex platform, and it was difficult for many potential users to understand and use it. Blockchain technology is still relatively new and immature, and it is not easy to implement and maintain."

Expert 2:

> "TradeLens incorporated a wide range of features. This has made the platform very complex and difficult to use for many potential users."

Expert 11:

> "TradeLens was not able to easily connect with other players in the industry. Other shipping companies, terminals, and shippers were not able to easily connect to TradeLens or exchange data with the platform. This has made it difficult for TradeLens to create a truly global ecosystem."

The technological complexity of TradeLens stems from a various of causes. First, the nature of the platform, which aims to provide a digital solution for shipping supply chain management, involves the integration of multiple IT systems and the manipulation of vast amounts of data in real-time. This complex integration can lead to technical challenges, including interoperability issues between different systems used by supply chain actors.

In addition, the variety of actors involved, each with its own processes and requirements, can make data standardization and harmonization difficult to achieve. In addition, the need for robust and reliable connectivity to ensure real-time data transmission between different actors in the supply chain can pose challenges in regions with limited communication infrastructure. Similarly, the security and privacy of data on the platform require sophisticated safeguards to prevent cyberattacks and data breaches, which adds another layer of technological complexity.

Finally, the training and adoption of TradeLens by end-users requires a thorough understanding of the platform and its features, as well as a smooth transition from existing processes to new digital methods. Combining these factors, the technological complexity of TradeLens represents a significant challenge for its development and large-scale adoption in the shipping industry.

4.3.1.4 Limited interoperability

The Limited interoperability in the context of TradeLens manifests itself in the difficulty of ensuring smooth and efficient communication between the different IT systems used by actors in the maritime supply chain. This limitation stems from the diversity of existing systems, each with its own data formats, communication protocol, and security requirements. As a result, TradeLens faces complex challenges in understanding and processing these various data structures, as well as ensuring the security and privacy of the information exchanged.

To overcome this limited interoperability, it is necessary to promote the standardization of data formats and communication protocols within the industry, thus fostering smooth communication and effective exchange of information between different stakeholders in the shipping supply chain.

Expert 1:

> "Another challenge identified is the limited interoperability of TradeLens with other systems and platforms used in the industry. Tradeens's inability to seamlessly connect with companies' existing systems has hindered its widespread adoption and created inefficiencies in international trade processes".

Expert 3:

> "The proprietary standards and protocols used by TradeLens made it difficult to integrate the platform with the supply chain management systems already in place at many companies, limiting its usefulness and impact".

The limited interoperability of TradeLens, an international trading platform can be attributed to several factors. First, the use of proprietary standards and protocols makes it difficult to integrate with existing systems, making it difficult to synchronize data. In addition, the lack of collaboration with other similar platforms creates data silos and complicates the exchange of information between supply chain players. The complexity of the integration processes and the lack of flexibility in TradeLens application programming interfaces also add to these difficulties. Finally, the low adoption of industry standards limits TradeLens ability to harmonize with systems used by other companies. To improve interoperability, it is essential to promote open standards, foster collaboration across platforms, and develop more flexible integration solutions compatible with industry standards.

4.3.1.5 Limited modern business model

Interviews with experts revealed that TradeLens' business model significantly hindered its widespread adoption.

Traditional business models in the shipping industry often rely on one-off transactions and short-term commercial contracts. TradeLens, by promoting transparency and traceability throughout the supply chain, could disrupt these models by encouraging service- and long-term relationship-oriented approaches. However, this would require significant adaptation of existing business models, which can be difficult for some companies. In addition, the adoption of TradeLens raises questions about competition and cooperation between actors in the maritime supply chain. Some companies might perceive TradeLens as a threat to their competitive position, whereas others might consider the potential benefits of collaborating and creating value with other stakeholders. Managing these competitive and cooperative dynamics is challenging for TradeLens and its users.

Expert 1:

> "The lack of incentive or revenue-sharing mechanisms between different actors in the supply chain limits TradeLens' ability to drive collaboration and adoption at scale."

Expert 3:

> "TradeLens failed to develop innovative business models that meet the specific needs of different industries and types of businesses. This has limited its appeal to companies seeking for tailor-made solutions."

Expert 5:

> "TradeLens failed to build strong partnerships with other industry players to develop joint business models. This limits its ability to offer a full range of solutions to meet customer needs."

TradeLens business model, focused on subscriptions and data access fees, has several potential implications for its success or failure. On the one hand, this financial model can create financial barriers for small and medium-sized businesses, limiting their adoption of the platform.

On the other hand, it can neglect the creation of shared value between the actors in the supply chain, which could compromise the motivation of companies to actively participate. Additionally, a lack of flexibility in pricing options and a growing concern about data privacy and security could also discourage user engagement. Finally, the lack of incentives for collaboration could limit the overall impact of the platform. To be successful, TradeLens' business model must be designed to be accessible, foster shared value creation, offer flexible and secure pricing options, and actively encourage collaboration between supply chain stakeholders.

4.3.2 Analysis in the light of the theory of the commons

We now analyze these failure factors in light of the key concepts of Elinor Ostrom's theory of the commons, which represents one of the particular strengths of this study (Figure 3).

4.3.2.1 Lack of stakeholder engagement

In the theory of the commons (Ostrom, 2009; Gazi and Sahdev, 2022), cooperation is often seen as essential for overcoming the challenges of managing shared resources. However, competition between actors can hinder this cooperation by fueling opportunistic behaviour and the race for individual advantages. The adoption of TradeLens could intensify this dynamic by introducing new competitive challenges related to increased transparency and visibility in the maritime supply chain. To overcome to succeed in overcoming these challenges, it is crucial to promote incentives for cooperation and collaboration among actors, perhaps by fostering equitable benefit-sharing mechanisms and building mutual trust.

Ostrom's theory of commons highlights the importance of designing appropriate institutional arrangements and promoting cooperation among actors for effective management of shared resources (Ostrom, 2009). In the context of TradeLens, these principles can provide valuable insights into overcoming barriers related to traditional business models and competitive and cooperative dynamics, driving successful adoption of the platform in the maritime industry.

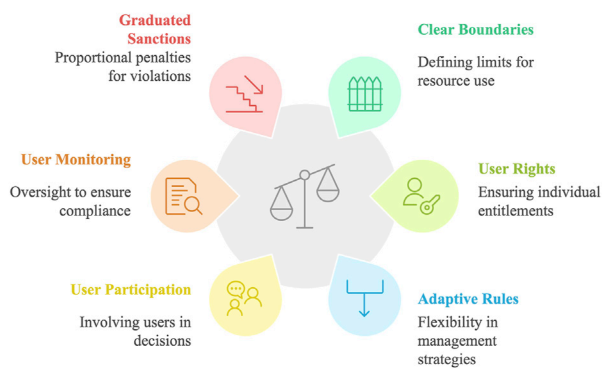

FIGURE 3
Visual representation of Ostrom's principles applied to blockchain.

4.3.2.2 Governance challenges

According to Ostrom's theory (Ostrom, 2009), the governance of common goods relies on clear rules and inclusive decision-making mechanisms, enabling stakeholders to collaborate effectively. However, TradeLens' failure highlights the limitations of a perceived centralized model, particularly due to IBM's dominant role as a co-founder and key technology partner. This position raised concerns among stakeholders, who feared disproportionate influence over the platform and an imbalanced governance structure.

The governance challenges in TradeLens, such as stakeholder coordination and incentive alignment, could have been mitigated through a more participatory and decentralized approach. Implementing multi-stakeholder committees or utilizing smart contracts could have fostered greater transparency in decision-making, thereby enhancing trust and promoting broader adoption.

4.3.2.3 Technological complexity

Technological complexity can also be addressed through the Ostrom Principles by promoting stakeholder participation and engagement in the design and implementation of technological solutions. This may involve creating mechanisms for knowledge sharing and collaboration between software developers, maritime supply chain companies, and regulators to design technological solutions tailored to user needs and capabilities. Additionally, by promoting the transparency and accessibility of technologies, TradeLens can help reduce information asymmetries and build trust among stakeholders.

In summary, Elinor Ostrom's principles offer valuable insights to address the challenges identified in TradeLens, with a focus on participatory governance, collaboration among stakeholders, and transparency in the design and adoption of technologies. By applying these principles, it is possible to overcome obstacles and drive the successful adoption of the TradeLens in the marine industry.

4.3.2.4 Limited interoperability

The limited interoperability of TradeLens has created barriers to entry for potential users. Businesses have struggled to connect their systems and applications to TradeLens, which has limited the adoption of the platform.

According to Ostrom's theory, graduated sanctions may be necessary to enforce rules and discourage harmful behavior. In the context of interoperability, this could involve the adoption of compliance and certification mechanisms as well as incentives to encourage compliance with established standards.

4.3.2.5 Limited modern business model

According to Ostrom's theory, successful management of commons often requires institutional arrangements that are tailored to local contexts (Lewis, 2021). Traditional business models are established institutions that govern how actors in the shipping supply chain interact and exploit shared resources. The adoption of TradeLens may require a transformation of these institutional models to foster more collaborative and sustainable management of marine resources. However, this transition can be hampered by resistance to change and lack of trust among stakeholders, making it difficult to put in place new institutional arrangements tailored to the scale of the shipping industry.

5 Discussion

This section focuses on the theoretical and practical implications of our results regarding the failure factors identified within TradeLens. We also examine the relevance of the theory of the commons in this context and make recommendations for both practitioners and future researchers. Finally, we discuss the limitations of this study.

5.1 Theoretical and managerial implications

The results of our study have remarkable implications for the theory and practice of supply chain management, blockchain technology adoption, and digital ecosystem governance.

First, our findings are consistent with previous work on the importance of governance in the success of blockchain-based supply chain platforms (Poux et al., 2020; Lumineau et al., 2021a; Rozas et al., 2021; Gazi et al., 2022a). Governance issues faced by TradeLens, such as a lack of clarity of roles and responsibilities, a lack of effective decision-making mechanisms, and a lack of trust among stakeholders, have hindered the adoption and use of the platform.

Our findings suggest that companies and policymakers should to pay close attention to designing and implementing effective governance structures and processes to ensure the success of such platforms.

Second, our results highlight the role of commons theory in understanding TradeLens' challenges. The commons nature of the platform, characterized by non-rivalry and non-exclusivity, has created unique challenges in terms of governance and sustainability. Our findings suggest that researchers and practitioners need to consider the theory of the commons when designing and managing blockchain-based supply chain platforms, which is consistent with early trials linking Elinor Ostrom's governance principles to the promises of blockchain (Wimmer et al., 2018; Howell et al., 2019; Lumineau et al., 2021a; Gazi et al., 2022b).

A third implication of our results is the model proposed by the new Global Shipping Business Network (GSBN) platform. Indeed, the GSBN has suggested that blockchain-based supply chain platforms should take a "hub-and-spoke" approach to governance (Liu et al., 2022). In this approach, a central entity (the "hub") is responsible for the overall governance of the platform, while smaller entities (the "spokes") are responsible for the governance of specific areas.

This approach could solve some governance issues faced by TradeLens. For example, it could enable more effective decision making by delegating responsibility for specific areas to smaller, more agile entities. It could also foster cooperation and trust among stakeholders by creating a central forum for discussion and problem-solving.

Businesses and policymakers should consider adopting the "hub-and-spoke" approach to the governance of blockchain-based supply chain platforms. This approach can help overcome governance challenges and ensure the success of these platforms.

5.2 Relevance of the theory of the commons

The theory of commons is relevant in explaining the challenges faced by TradeLens. The platform can be considered a common good, as it is non-rival (use by one party does not prevent use by another) and non-exclusive (it is difficult to prevent parties from using the platform).

The challenges faced by TradeLens, such as lack of cooperation among stakeholders, governance issues, and difficulty in ensuring the sustainability of the platform, are all consistent with the predictions of the theory of the commons (Ostrom, 2009; Rozas et al., 2021). Our findings suggest that the theory of the commons provides a useful framework for understanding and solving the challenges faced by blockchain-based supply chain platforms.

In particular, the characteristics of the commons, such as rivalry and exclusion, influence how stakeholders cooperate and coordinate their actions in a complex ecosystem such as blockchain. By examining at the incentives and governance mechanisms needed to effectively manage these digital commons, we can better understand the specific challenges faced by projects such as TradeLens.

5.3 Recommendations for practice and future research

For future practices, strengthening participatory and transparent governance mechanisms in blockchain-based projects is recommended. This could involve establishing inclusive decision-making processes, clarifying the roles and responsibilities of stakeholders, and promoting operational transparency. In addition, it is essential to foster a culture of cooperation and collaboration among the actors involved in these projects.

From a future research perspective, it would be beneficial to further investigate innovative governance models that foster effective collaboration and coordination in decentralized blockchain environments. In addition, further exploration of the interactions between the different dimensions of governance and their impact on the performance of blockchain-based projects would be valuable. Finally, a comparative analysis of the governance approaches used in various blockchain projects (including Global Shipping Business Network GSBN) would provide a better understanding of best practices and lessons learned to guide the future development of these projects.

5.4 Global Shipping Business Network (GSBN): a new model of governance

Global Shipping Business Network (GSBN), an alternative launched by major players in the maritime industry, is often presented as a response to the limitations of TradeLens. The primary difference between GSBN and TradeLens lies not only in their technical architecture but, more importantly, in their economic model and purpose. TradeLens was a for-profit platform, controlled by IBM and Maersk, which sought to monetize logistics data and blockchain-based services. This approach raised concerns among industry stakeholders, who perceived it as an imbalanced model dominated by a single entity, ultimately hindering its adoption.

In contrast, GSBN operates as a digital common, governed by a consortium of maritime companies, where data is shared without direct profit motives. This more collaborative model, in which no single actor holds absolute control, aligns more closely with Ostrom's commons governance principles, ensuring fair access to resources and fostering broader adoption. Its CEO expresses optimism about the platform's future, emphasizing that this cooperative approach could better address the challenges faced by TradeLens and establish a more sustainable alternative for the industry.

However, as GSBN remains a relatively recent initiative, further analysis is needed to assess its long-term viability. A detailed comparison between TradeLens and GSBN, focusing on governance, interoperability, and adoption, would help identify the key success and failure factors in these blockchain-based logistics platforms. Additionally, examining their impact on business practices, industry competitiveness, and environmental and social sustainability would provide valuable insights. Finally, research aimed at identifying best practices in blockchain governance and management for maritime transport networks could offer important recommendations for practitioners and policymakers.

5.5 Limitations of the study

Our study has some limitations. First, the sample size was relatively small, which could limit the generalizability of our results. Second, our data were mostly qualitative, which could have introduced some bias. Third, our study focused on a single case of failure, which could limit the generalizability of our results to other contexts.

Despite these limitations, our findings provide valuable insights into the factors influencing the success or failure of blockchain-based supply chain platforms. We encourage future research to deepen our understanding of these factors and identify the best practices for the design, implementation, and governance of these platforms.

6 Conclusion

This study highlights the main obstacles encountered in the deployment of blockchain projects, mainly in terms of governance, participation, interoperability, evolution, and security. Based on the TradeLens case study and Elinor Ostrom's theory, many lessons have been learned. Lack of stakeholder engagement, unclear governance, limited interoperability, difficulty adapting to technological developments, and privacy and security concerns were identified as the major obstacles. Ostrom's theory offers a valuable analytical framework by highlighting the importance of participatory governance, clear boundary definitions, and community in the management of shared resources. To be successful, blockchain projects must adopt a holistic approach, establish transparent governance, encourage collaboration between stakeholders, ensure interoperability, and invest in adaptability and data security. By following these recommendations and incorporating lessons from past failures, future blockchain projects can increase their chances of success and positively contribute to the transformation of industries and processes.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Ethics Committee of the Interdisciplinary Research Center in Economics and Social Sciences (IRCESS). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin because it did not involve the collection of sensitive personal data nor direct intervention with participants. The experts consulted were contacted solely to share professional information based on their specialized knowledge and experience in a non-confidential context. Additionally, their participation was entirely voluntary, with the option to withdraw at any time without consequence. Sufficient verbal information regarding the research objectives and participation modalities was provided before each interview, ensuring that the experts were fully aware of the context and purpose of the study.

Author contributions

IN: Writing–original draft, Conceptualization, Methodology.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fbloc.2025.1503595/full#supplementary-material

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