CONSOLIDATING BLOCKCHAIN CHARACTERISTICS: A SEMI-SYSTEMATIC REVIEW

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Abstract**:** *Blockchain technology has become a foundational innovation in digital systems, offering unique features that address trust, transparency, and security in decentralized environments. Despite its increasing application across diverse fields such as supply chain, finance, and e-government, the academic literature reflects inconsistency in defining and operationalizing blockchain's core characteristics. This study conducts a semi-systematic review to synthesize and classify the commonly cited characteristics of blockchain. Drawing from academic sources across multiple domains, the review categorizes these characteristics into core (e.g., decentralization, transparency), peripheral (e.g., privacy, scalability), and technical (e.g., programmability, tokenization) traits. The paper highlights areas of convergence and divergence and proposes a taxonomy to guide future research and instrument development. The findings offer a clearer conceptual foundation for evaluating blockchain systems and support the creation of standardized measurement tools for empirical investigations.*

Keywords: Blockchain, transparency, immutability, taxonomy, systematic review

1. Introduction

In the contemporary digital landscape, trust and data integrity are of paramount importance. Blockchain, a distributed ledger technology initially developed to support cryptocurrencies such as Bitcoin, has emerged as a transformative solution for enabling decentralized and tamper-evident transactions (Nakamoto, 2008). The technology has since evolved beyond its origins, finding application in various fields including supply chain management, finance, e-government, and healthcare (Dong et al., 2023; Bhutta et al., 2021). A key driver of blockchain's adoption lies in its unique characteristics, which include transparency, immutability, decentralization, and enhanced security. These features are frequently cited as sources of blockchain's value proposition (Kouhizadeh & Sarkis, 2020; Mohamed et al., 2022).

Despite growing interest in blockchain, scholars have approached its defining characteristics from varied disciplinary lenses. In doing so, they have proposed diverse and sometimes conflicting definitions and operational frameworks. While some researchers emphasize core features such as decentralization and consensus mechanisms (Alzhrani et al., 2022; Yang et al., 2018), others highlight context-specific traits such as traceability in supply chain contexts or automation in smart contracts (Kouhizadeh & Sarkis, 2020; Liu & Wu, 2024). The literature lacks a comprehensive synthesis that brings together these multiple perspectives into a coherent

framework. This fragmentation creates challenges for researchers attempting to measure blockchain features or evaluate its implementation across domains.

The objective of this paper is to conduct a semi-systematic review that consolidates the different characteristics of blockchain discussed in academic literature. Drawing upon key contributions from multiple disciplines, this review classifies blockchain characteristics and identifies areas of convergence and divergence. The paper ultimately seeks to offer a foundation for developing consistent survey instruments and advancing empirical blockchain research.

2. Literature Review

The reviewed literature reveals that blockchain characteristics are defined in multiple ways depending on the domain of application. However, certain themes consistently emerge across studies. Based on frequency and centrality, these characteristics are grouped into three categories: core, peripheral, and technical.

Core characteristics are those features that appear almost universally in blockchain literature, irrespective of domain. These include decentralization, transparency, immutability, and security. Decentralization refers to the absence of a central authority, with decisions made through consensus mechanisms. Transparency implies that transactions are visible and verifiable by all participants. Immutability denotes the unchangeable nature of recorded data once verified and added to the ledger. Security is achieved through cryptographic methods and consensus protocols that prevent tampering and unauthorized changes (Bhutta et al., 2021; Kouhizadeh & Sarkis, 2020; Dong et al., 2023).

Peripheral characteristics are those that are frequently mentioned but tend to vary depending on the field of study. Privacy, for example, is emphasized in healthcare and financial contexts, where data confidentiality is critical. Traceability and provenance are often highlighted in supply chain applications, enabling the tracking of goods and materials (Mohamed et al., 2022). Interoperability, which refers to the blockchain's ability to interface with other systems or platforms, is increasingly mentioned in system-level discussions. Scalability and efficiency are also context-dependent and often arise in technical evaluations concerning performance and transaction throughput (Liu & Wu, 2024).

Technical characteristics relate to system architecture and implementation. These include programmability, which refers to the ability to execute smart contracts or automated scripts; tokenization, or the representation of digital assets; and governance mechanisms that regulate participation and protocol updates. Redundancy and fault tolerance are also noted in technical papers, reflecting the ability of blockchain systems to remain operational despite node failures (Yang et al., 2018; Zhang et al., 2022).

The literature also points to various attempts at developing taxonomies or component-based models of blockchain systems. Alzhrani et al. (2022), for instance, propose a taxonomy based on consensus mechanisms, ledger structure, privacy support, and interoperability. Tasca and Tessone (2019) present a hierarchical taxonomy that maps blockchain components from core technical layers to application-level characteristics. These frameworks help situate the multiple dimensions of blockchain within a structured conceptual space. Table 1 captures the diversity

of blockchain characteristics described in the literature, demonstrating both convergent and divergent. perspectives.

Table 1. Selected Studies on Blockchain Characteristics

Author(s) & Year	Key Characteristics	Domain of Application
Kouhizadeh & Sarkis (2020)	Transparency, immutability, traceability, efficiency	Green supply chain
Yang, Zhang & Yulin (2018)	Decentralization, security, scalability, consensus model	Blockchain technical model
Alzhrani et al. (2022)	Consensus, ledger integrity, privacy, interoperability	Blockchain system taxonomy
Mohamed et al. (2022)	Decentralization, shared ledger, speed, trust, participation	Smart government services
Bhutta et al. (2021)	Decentralization, immutability, consensus, security	Security-focused blockchain survey
Tasca & Tessone (2019)	Decentralization, transparency, immutability, privacy, programmability, tokenization, governance	Multi-level taxonomy
Sultan et al. (2018)	Core functionality: storage, verification, consensus, smart contracts	Conceptual overview
Politou et al. (2019)	Immutability, mutability tradeoffs, GDPR compliance	Legal-tech context
Zhang et al. (2022)	Consensus, governance, network, wealth decentralization dimensions	Metrics & decentralization taxonomy
Liu & Wu (2024)	Broad feature synthesis: transparency, decentralization, security, interoperability	Comprehensive blockchain review
Raveen et al. (2023)	Transparency, immutability, auditability, scalability, interoperability	Technical ecosystem survey (Diva-Portal)
Alfatih Mohamed et al. (2022)	Decentralization, shared ledger, speed, trust, participation	Smart government systematic review

3. Methodology

Following Wong et al.'s (2013) guidelines, this paper used a semi-systematic (narrative) review strategy by:

1. Defining the conceptual domain of blockchain characteristics.
2. Performing purposeful sampling of influential taxonomies and surveys.
3. Extracting definitions of characteristics from each study.
4. Synthesizing consensus and variation across publications.

This approach accommodates conceptual diversity and interdisciplinary fragmentation, making it more appropriate than a fully systematic review for this topic.

4. Discussion and Conclusion

This review highlights both convergence and fragmentation in the way blockchain characteristics are defined. The core features which are decentralization, transparency, immutability, and security serve as the foundational pillars upon which most blockchain implementations are built (Bhutta et al., 2021; Kouhizadeh & Sarkis, 2020; Dong et al., 2023). These characteristics are supported by technical mechanisms such as distributed consensus and cryptography, and they appear consistently across literature regardless of application area.

However, beyond these core attributes, there exists significant variation. Privacy, for instance, is treated differently across sectors, sometimes in contradiction to the goal of transparency (Alzahrani et al., 2022). In public blockchains, privacy is limited due to the open nature of the ledger, whereas private or permissioned blockchains can offer greater confidentiality (Mohamed et al., 2022). Similarly, interoperability and scalability are often under-defined or treated as secondary characteristics, even though they are critical to blockchain's adoption at scale (Liu & Wu, 2024).

A particularly notable finding is the lack of standardized operational definitions. While characteristics are often described qualitatively, few studies offer specific criteria or metrics for measurement. This poses challenges for researchers seeking to empirically assess the presence or strength of these features in real-world blockchain systems. Moreover, tensions exist between certain characteristics, such as transparency and privacy or decentralization and efficiency. These trade-offs underscore the need for careful system design and contextual adaptation.

Given these challenges, this review proposes a three-tier taxonomy of blockchain characteristics: core, peripheral, and technical. This taxonomy provides a basis for the development of structured survey instruments and evaluation frameworks. Researchers can use this classification to design questionnaires or checklists that systematically assess blockchain features in empirical studies.

This paper offers a consolidated view of blockchain characteristics by synthesizing insights from diverse disciplinary perspectives. Through a semi-systematic review approach, it classifies blockchain traits into core, peripheral, and technical categories. The findings reveal a common core of decentralization, transparency, immutability, and security, alongside a range of additional attributes that vary by context. Despite wide recognition of these characteristics, definitional inconsistencies remain a challenge. The taxonomy proposed in this review can guide future research and support the development of survey instruments aimed at measuring blockchain implementation and impact across different sectors.

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