

Blockchain and Traceability of Intangible Assets: Towards a New Era of Accounting and Financial Transparency.

- **AUTHOR 1** : KASMI Khansa,
- **AUTHOR 2** : ROUGGANI Khalid,

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- (1)**: PhD Student in Management Sciences, Laboratory of Economics and Management (LEG), Multidisciplinary Faculty of Khouribga, Sultan Moulay Slimane University – Béni Mellal, Morocco.
- (2)**: Professor of Higher Education, Laboratory of Economics and Management (LEG) Multidisciplinary Faculty of Khouribga, Sultan Moulay Slimane University – Béni Mellal, Morocco.



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Abstract:

This paper aims to theoretically examine the potential contributions of blockchain technology to the valuation and governance of intangible assets. Based on a critical literature review, the study draws on three conceptual frameworks, the agency theory, stakeholder theory, and the Technology–Organization–Environment (TOE) model, to explore how blockchain can enhance the traceability, transparency, and reliability of intangible resources.

The findings highlight that blockchain may reduce information asymmetries, automate control processes through smart contracts, and strengthen stakeholder trust. However, its adoption is constrained by technical, regulatory, and organizational challenges. The paper concludes by emphasizing the need to rethink accounting practices and to promote pilot initiatives to effectively integrate emerging technologies into intangible asset valuation.

Keywords:

Intangible assets, Blockchain, Governance, Smart contracts, Organizational theory, Digital accounting, Valuation

Introduction

In the era of digital transformation, value creation no longer relies solely on physical and financial assets. It increasingly depends on intangible resources such as organizational knowledge, intellectual property, reputation, innovation, and databases. Although this intangible capital is essential to corporate performance, it remains challenging to identify, measure, and reliably account for. The inherent complexity of these assets, their often subjective nature, and the diversity of accounting standards hinder their full and consistent integration into financial statements. This situation raises critical issues related to transparency, the comparability of financial information, and corporate governance.

In this context, technological advancements, particularly blockchain, emerge as a promising avenue to address these limitations. As a distributed ledger technology, blockchain has the potential to ensure the traceability, authenticity, and security of transactions involving intangible assets. Its potential lies in the possibility of automating certain accounting recognition processes, enhancing data reliability, and improving transparency for stakeholders. However, the integration of blockchain into the governance of intangible capital also raises new theoretical and practical questions that require rigorous examination.

Despite a growing body of literature on blockchain applications in finance and accounting, existing scholarship has yet to adequately address how blockchain mechanisms specifically interact with the distinctive characteristics of intangible assets namely their non-physical nature, context-dependency, and resistance to standardized measurement. Most prior studies focus either on blockchain for supply chain traceability of tangible goods (Iansiti & Lakhani, 2017; Tapscott & Tapscott, 2016) or on general accounting assurance applications (Dai & Vasarhelyi, 2017; Coyne & McMickle, 2017), without theorizing the specific mechanisms through which blockchain could address the valuation challenges particular to intangible assets. This gap constitutes the central motivation of the present study, which seeks to answer the following research question: To what extent can blockchain technology, through its core properties of immutability, decentralization, and programmable transparency, address the traceability and valuation challenges inherent to intangible assets?

The article is structured as follows: first, we revisit the conceptual foundations of intangible capital, its typology, and the issues surrounding its evaluation. Next, we present the operational principles of blockchain and the prospects it offers in terms of traceability and information

reliability. Finally, we analyze the theoretical implications of using this technology for the governance of intangible value, before concluding with avenues for further research in this emerging field.

I. Intangible Capital: Definition, Typology, and Evaluation Challenges

1. Definitions and Key Components

The absence of a universally accepted definition of intangible capital has led to a plurality of interpretations, making it difficult to fully grasp and incorporate into strategic business decision-making. This theoretical diversity reflects the richness of the concept, while simultaneously highlighting the need to clarify its boundaries in order to facilitate its integration into managerial and accounting practices.

Several scholars have proposed definitions that underscore the multiple dimensions of intangible capital. Brooking (1996) describes it as a set of non-physical resources brands, patents, skills, and organizational structure, that contribute to value creation. Bontis (1996) emphasizes its strategic power, while Roos (1997) defines it as the collective knowledge and expertise embedded in the company's processes. Stewart (1997) includes knowledge, know-how, patents, and experience, framing them as exploitable intellectual resources. Edvinsson and Malone (1999), drawing on the case of Skandia, highlight the importance of knowledge, experience, and customer relationships. Other authors, such as Ordoñez de Pablos (2003), associate intangible capital with the gap between a firm's book value and its market value. Overall, intangible capital can be defined as an aggregate of intangible assets, competencies, knowledge, and technologies that generate value and confer competitive advantages.

In terms of structure, the literature tends to converge toward a common typology, despite variations in terminology. Mortensen, Eustace, and Lannoo (1997) identify innovation capital, structural capital, contractual assets, and market capital. The OECD (1999) simplifies this framework by distinguishing between human capital and structural capital. Brooking (1996), for her part, identifies four components: human capabilities, infrastructure assets, intellectual property, and market assets. Roos (1997) adds renewable capital and relational capital, stressing the role of organizational culture. Stewart (1997) adopts a tripartite structure: human capital, structural capital, and customer capital. Bontis (2001) excludes intellectual property from intangible capital due to its distinct legal status and proposes a division into human, structural,

and relational capital. Cavalcanti and al. (2006) introduce an additional component, social capital, based on relational networks and organizational trust.

The classification proposed by Edvinsson and Malone, later adopted by the MERITUM project (2002), is often considered a reference model. It distinguishes between human capital, which encompasses skills, experience, and expertise, structural capital, including systems, processes, and internal documentation; and customer capital, comprising business relationships and external networks.

These approaches demonstrate that, although intangible, intangible capital represents a critical source of sustainable performance. Its recognition, evaluation, and effective management have become key challenges in the knowledge economy.

2. Traditional Methods of Valuation

The valuation of intangible assets has long been approached through methods originally developed for tangible assets. Although these traditional models may be appropriate for certain categories of intangibles, they often fail to capture the full complexity and specificity of intangible assets particularly their non-physical nature, their strategic contextual dependency, and their frequently indirect contribution to value creation. These methods are generally classified into three main categories: the cost-based approach, the market-based (comparables) approach, and the income-based (discounted cash flow) approach.

2.1 Cost-Based Approach

The cost-based approach assumes that the value of an asset can be estimated based on the resources invested to create or reproduce it. According to Reilly and Schweih (1999), this method is grounded in the principle of economic utility, what a rational buyer would be willing to pay to obtain a similar asset. This approach includes several variants: historical cost, production cost, reproduction cost, and replacement cost. While relatively simple to implement, this method does not always reflect the asset's current value, particularly when the asset generates future economic benefits that are difficult to quantify.

2.2 Market-Based (Comparables) Approach

The comparables approach consists of estimating the value of an intangible asset by referencing recent transactions involving similar assets. This method relies on the existence of an active and transparent market, a condition rarely met in the case of intangible assets due to their

uniqueness and low liquidity. Reilly and Schweih (1999) identify three variations of this method: analysis of past transactions, the royalty relief method, and excess earnings methods. However, the lack of reliable comparables as illustrated by the failure of the patent exchange launched by Ocean Tomo in 2007 (Guellec et al., 2010), limits the applicability of this approach, particularly for software, patents, or brand-specific assets.

2.3 Income-Based Approach

Discounted cash flow (DCF) methods are widely used to estimate the net present value of future economic benefits generated by an intangible asset. Several techniques fall under this category, including the royalty relief method (based on licensing rates), the excess earnings method (which isolates the cash flows specifically attributable to the asset), and the direct income method (which estimates cash flows independently of other business assets). Although conceptually robust, these approaches rely on highly subjective assumptions (such as discount rates, useful life, and future projections), which can undermine their reliability.

2.4 Accounting Treatment under IAS/IFRS Standards

In response to the limitations of purely economic models, international accounting standards (IAS/IFRS) have attempted to provide a framework for the recognition and measurement of intangible assets in financial statements. IAS 38 defines intangible assets as non-monetary resources without physical substance, controlled by the entity, and expected to generate future economic benefits. For an asset to be recognized, it must meet three cumulative conditions: it must be identifiable (either separable or arising from legal rights), controlled by the entity, and capable of generating future cash flows.

IFRS 3, which governs business combinations, requires the separate recognition of identifiable intangible assets acquired in a transaction, distinct from goodwill. Goodwill represents the excess of the purchase price over the fair value of the net identifiable assets. Unlike other intangible assets, goodwill is not amortized but is subject to an annual impairment test in accordance with IAS 36. This mechanism aims to reflect the actual value of expected synergies while mitigating the risk of sustained overvaluation following mergers and acquisitions.

2.5 Limitations of Traditional Approaches

Despite their usefulness in certain contexts, traditional valuation methods and current accounting frameworks exhibit several structural limitations. First, the lack of standardized

guidelines for evaluating many types of intangible assets leads to heterogeneity in corporate practices, undermining the comparability and transparency of financial reporting. Second, the increasing complexity of intangible assets, often specific, evolving, or integrated into broader systems, renders their valuation highly subjective. Finally, many intangibles, such as reputation, human capital, or tacit knowledge, are completely excluded from accounting recognition, leading to a growing gap between the book value and market value of companies with high intangible intensity.

II. Blockchain as a Traceability Technology: Technical Principles and Potential Contributions

1. Technical Fundamentals of Blockchain

Blockchain is an emerging technology based on a distributed digital ledger system. This ledger enables the recording and sharing of data in a decentralized, secure, and immutable manner. Initially developed as the foundational infrastructure for Bitcoin, blockchain technology has since evolved beyond the realm of cryptocurrencies. Its applications now span diverse sectors such as finance, asset management, healthcare, and supply chain traceability.

Technically, a blockchain is composed of a sequence of blocks, each containing a set of timestamped transactions. These blocks are linked together using cryptographic hash functions. Once validated, each new block is added chronologically to the chain, making any subsequent alteration virtually impossible without compromising the integrity of the entire ledger. This characteristic ensures the reliability and traceability of recorded information.

The functioning of blockchain is grounded in several fundamental principles:

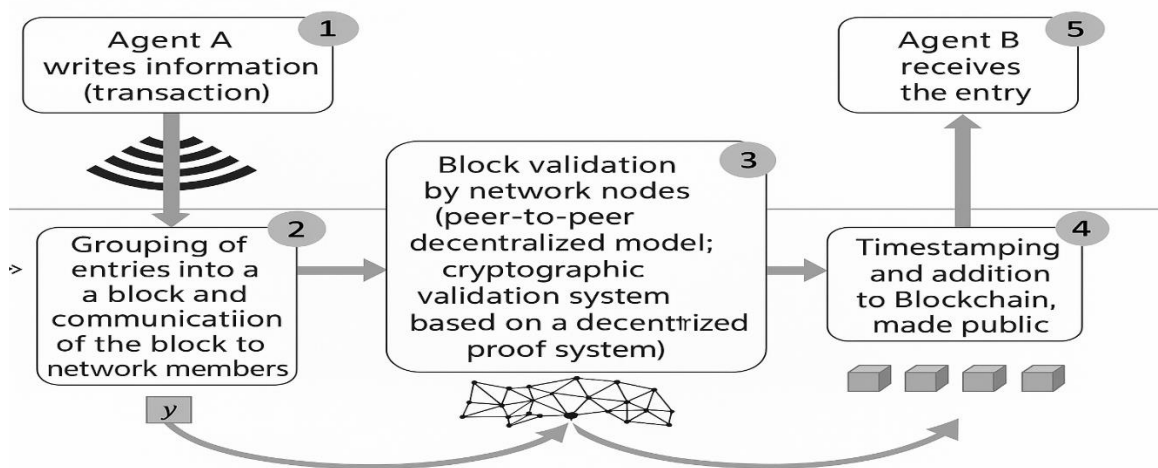
- **Decentralization:** No central authority controls the network; all participants (or nodes) hold a copy of the ledger.
- **Consensus:** Block validation is performed through distributed mechanisms such as Proof of Work (PoW) or Proof of Stake (PoS).
- **Immutability:** Once validated, data cannot be altered or deleted, ensuring permanence and integrity.
- **Transparency and traceability:** Information is visible to all network participants, fostering trust and auditability.

- **Cryptographic security:** Encryption protocols protect transactions and ensure the authenticity of data.

These foundational elements give blockchain transformative potential for information flow management, especially in the context of intangible assets, where traceability and security are of strategic importance.

The figure below visually summarizes the key components and core mechanisms that structure blockchain architecture.

Figure 1. Diagram of the Blockchain Recording and Validation Process



Source: *Blockchain Operating Process (Desplebin and al., 2018).*

The above figure illustrates the main stages of processing a transaction through a blockchain system. The process begins when a user—referred to here as Agent A—initiates a request for registration, such as a financial operation, a contract, or a delivery, directed to another network participant, Agent B. This request is broadcast to all nodes of the network via dedicated software.

Transactions collected over a specific period are grouped into a block, which is temporarily stored pending validation. This preparatory phase is followed by a crucial step: consensus validation. Specialized participants, called "validators" or "miners," mobilize computational power to execute a cryptographic protocol that ensures the authenticity and coherence of the block.

Once the block has been verified and validated by consensus, it is definitively added to the existing chain, along with a timestamp that secures chronological order. This integration is irreversible, thereby strengthening the reliability of the ledger. Finally, all network participants hold an identical, up-to-date copy of the ledger, ensuring full transparency and traceability of recorded information.

2. Blockchain Process and Its Specific Application to Intangible Asset Traceability and Valuation

The blockchain recording and validation process described above acquires particular significance when applied to intangible assets, whose inherent characteristics, namely non-physicality, context-dependency, and subjective valuation, have historically made them resistant to reliable traceability. We argue that the blockchain process addresses these challenges through three specific mechanisms.

First, the immutable timestamping mechanism enables the creation of a verifiable origin record for intangible assets. For a patent, this means that the moment of invention, the sequence of modifications, the chain of ownership transfers, and any licensing agreements can all be inscribed on the blockchain with cryptographic certainty. This origin traceability directly addresses the recognition challenge under IAS 38, where establishing control and identifying the precise moment of intangible asset creation has traditionally relied on documentary evidence susceptible to manipulation or loss.

Second, the consensus validation mechanism provides an auditable trail of intangible asset valuations. In practice, when a firm records the value of a brand, a customer relationship portfolio, or internal know-how, the blockchain process requires that multiple network participants (auditors, regulators, counterparties) validate the transaction before it is permanently inscribed. This multi-party validation directly strengthens the reliability of intangible asset valuation by reducing the risk of unilateral manipulation, a long-standing criticism of management-generated intangible asset estimates (Lev & Sougiannis, 1996).

Third, the distributed ledger structure enables continuous, real-time tracking of intangible asset utilization and value evolution. Unlike traditional periodic financial reporting, which captures intangible asset values at discrete points in time, a blockchain-based system could theoretically provide a dynamic, continuously updated register of how intangible resources are deployed,

transferred, or consumed. This is particularly relevant for human capital and relational capital, which are sensitive to organizational changes and whose value fluctuates in ways that static accounting snapshots fail to capture. Together, these three mechanisms suggest that the blockchain process, when specifically designed for intangible asset management, could serve as a foundational infrastructure for a more dynamic, reliable, and transparent intangible asset valuation system.

III. Blockchain and Intangible Capital: Theoretical Contributions to a New Governance of Value

1. Blockchain and Agency Theory: Toward More Transparent Governance of Intangible Assets

Agency theory, as formulated by Jensen and Meckling (1976), highlights the problems of information asymmetry and conflicts of interest between shareholders (principals) and managers (agents). These issues are particularly critical in companies with high intangible intensity, where assets such as patents, databases, or know-how are difficult to observe or measure. Blockchain, as a distributed ledger, enables the transparent, time-stamped, and tamper-proof documentation of transactions and rights associated with these assets. For example, the use of smart contracts in the management of licenses or patents allows for the automation of contractual compliance, reducing the need for external oversight. As such, blockchain enhances transparency, reduces agency costs, and improves the governance of intangible assets by embedding control mechanisms directly into the technological infrastructure. This evolution paves the way for a new form of algorithmic governance, in which digital traceability partially replaces traditional hierarchical control systems.

2. Blockchain and Stakeholder Theory: Building Legitimacy through Technological Transparency

Stakeholder theory (Freeman, 1984) broadens the traditional scope of economic performance by including all actors impacted by a company's activities: employees, customers, suppliers, regulators, investors, and civil society. Within this framework, transparency becomes a key driver of organizational legitimacy—especially regarding the management of intangible assets such as reputation, compliance, or personal data. Blockchain, through its ability to securely and verifiably record and share information, strengthens trust between the firm and its stakeholders.

It can, for instance, be used to certify product provenance, track the status of certifications, or ensure compliance with social or environmental standards. In this way, blockchain enables programmable transparency, where information flows are no longer centralized but distributed, traceable, and subject to real-time audit. The company thus becomes more legitimate in the eyes of its stakeholders by demonstrating its ability to account for societal commitments and responsibly manage its intangible assets.

3. Blockchain and the TOE Framework: Understanding the Conditions for Adoption in Intangible Asset Valuation

The Technology–Organization–Environment (TOE) framework, developed by Tornatzky and Fleischer (1990), provides a relevant lens for analyzing the conditions under which firms adopt innovations such as blockchain. This model distinguishes three dimensions:

- The **technological dimension**, which assesses intrinsic characteristics of blockchain (security, traceability, automation, but also technical complexity);
- The **organizational dimension**, which considers internal culture, available resources, digital competencies, and managerial support;
- The **environmental dimension**, which includes external pressures such as regulations, accounting standards, investor expectations, and competitive dynamics.

In the case of intangible capital, the TOE framework helps explain why some firms rapidly adopt blockchain to structure, value, or audit their intangible assets, while others remain cautious or reluctant. The strength of this framework lies in its ability to integrate both internal and external factors, while highlighting the interdependence of technological, strategic, and institutional dimensions in the digital transformation of accounting practices.

To clearly and systematically synthesize the differentiated contributions of blockchain according to the main theoretical frameworks mobilized, the table below highlights the core issues, specific technological solutions, and their respective impacts on intangible asset valuation.

Table 1 : Summary of Blockchain Contributions Based on an Integrated Theoretical Approach and Their Impact on Intangible Capital Valuation

Analytical Dimensions	Agency Theory	Stakeholder Theory	TOE Framework (Technology–Organization–Environment)
Core Issue	Conflicts of interest and information asymmetries	Multiplicity of actors and need for legitimacy	Factors enabling or hindering blockchain adoption
Role of Blockchain	Immutable transparency, automation via smart contracts	Secure communication and shared traceability	Technical security, organizational adaptation, external pressure
Key Mechanisms	<ul style="list-style-type: none"> – Reduction of agency costs – Reliable financial traceability – Automated control and audit 	<ul style="list-style-type: none"> – Trust enhancement through transparency – Stakeholder accountability and engagement – Secure sharing of critical information 	<ul style="list-style-type: none"> – Gradual technological integration – Managerial support and internal competencies – Regulatory compliance and industry standards
Impact on Intangible Asset Valuation	<ul style="list-style-type: none"> – Improved governance and reduced financial risk – Greater visibility of intangible assets 	<ul style="list-style-type: none"> – Strengthened reputation and legitimacy – Enhanced engagement of employees and partners 	<ul style="list-style-type: none"> – Strategic adoption promoting open innovation – Organizational resilience in the face of technological shifts
Methodological Innovations	Use of smart contracts to automate license and patent management	Use of decentralized ledgers for CSR certifications and labels	Pilot-based adoption strategies, staff training, and regulatory evolution
Limitations and Challenges	Technical complexity of smart contracts and bug risks	Resistance to open sharing of sensitive data	Scalability, interoperability, implementation cost, and cultural change

IV. Limitations, Challenges, and Development Perspectives of Blockchain in the Valuation of Intangible Capital

1. Technical and Organizational Challenges

Despite significant advances, the integration of blockchain into the practices of intangible capital valuation raises considerable technical challenges. On one hand, the scalability of blockchain networks remains limited, particularly for public infrastructures, which hinders their ability to process high volumes of complex intangible asset records. On the other hand, interoperability between platforms, essential for ensuring complete and reliable traceability, remains insufficient, especially in the absence of standardized industry frameworks.

In addition, implementation costs are often prohibitive, particularly for small and medium-sized enterprises. Integrating blockchain requires a thorough revision of internal processes and information systems, which entails a deep organizational transformation. These technical and organizational barriers slow down widespread adoption, especially in non-technological sectors.

2. Legal and Regulatory Constraints

Blockchain also raises major legal and regulatory challenges, particularly in the sensitive domain of intangible assets. The protection of personal data, compliance with the General Data Protection Regulation (GDPR), and the right to be forgotten clash with the immutability of blockchain records. Moreover, the lack of universal legal recognition for smart contracts creates interpretation and enforcement issues in case of disputes.

From an accounting perspective, current standards do not yet provide a clear framework for the recognition of intangible assets originating from decentralized systems, especially when these assets are tokenized. Their valuation, recognition, and traceability pose ongoing challenges for standard-setters, regulators, and accounting professionals.

3. Social Acceptability and Cultural Transformation

The adoption of blockchain in accounting and financial functions is not only a technical challenge but also a cultural and human one. Many organizations exhibit resistance to change due to the perceived complexity of the technology and the lack of internal expertise.

Transitioning to a decentralized management model for intangible assets calls into question traditional roles, often generating fears or internal opposition.

It is therefore crucial to support this transformation through targeted training for stakeholders such as accountants, auditors, financial managers, and strategic decision-makers. New hybrid professional profiles must emerge, combining accounting expertise, technological understanding, and strategic thinking.

4. Strategic and Technological Perspectives

Beyond current limitations, blockchain offers substantial innovation potential for intangible asset valuation, particularly when combined with other emerging technologies and renewed approaches.

- **Integration with Artificial Intelligence (AI):** AI can analyze blockchain-registered intangible flows (e.g., patents, know-how, human capital) to generate predictive and dynamic performance indicators.
- **Tokenization of intangible assets:** Patents, trademarks, customer data, or relationship capital can be represented as traceable, tradable tokens, paving the way for new liquidity in intangible value.
- **Creation of decentralized marketplaces for intangible assets:** These platforms could allow firms to directly monetize their intellectual capital, facilitating the financial recognition of assets often invisible in traditional balance sheets.

To highlight the prospective contributions of blockchain in intangible asset valuation, the following table summarizes the key current limitations and the corresponding innovative perspectives, combining technical, legal, cultural, and strategic dimensions.

Table 2 : Innovative Perspectives on Blockchain Adoption for Intangible Capital Valuation

Analytical Axis	Current Limitations or Challenges	Proposed Innovative Perspective
Technical and Organizational	Scalability issues, limited interoperability, high implementation costs	Development of hybrid, modular blockchains adapted to accounting constraints
Legal and Regulatory	Lack of clear legal framework for smart contracts; conflict between blockchain and GDPR; lack of recognition for tokenized assets	Creation of an international regulatory framework based on blockchain attributes (traceability, immutability, auditability)
Acceptability and Cultural Change	Internal resistance, lack of training, perceived complexity	Implementation of experimental “accounting sandboxes”; development of hybrid finance/technology academic programs
Technological and Strategic	Fragmented adoption; lack of valuation models for blockchain-based intangible assets	AI + blockchain integration to produce dynamic indicators; tokenization of assets to create new intangible markets
Long-Term Accounting Vision	Lack of tools to capture real-time value; invisibility of non-recognized intangible assets	Emergence of a decentralized, interoperable, and dynamic accounting system based on blockchain for continuous and transparent valuation

Conclusion

Blockchain represents a promising technological lever for enhancing the traceability, transparency, and reliability of intangible assets. This article offers a theoretical framework enriched by multiple approaches including agency theory, stakeholder theory, and the TOE model and highlights concrete applications at the intersection of digital technology, finance, and accounting.

It also opens avenues for reflection among decision-makers, who are called upon to invest in training and innovation, and for researchers, who are encouraged to explore the empirical dimensions of blockchain adoption. This theoretical contribution now calls for empirical validation, particularly in various sectoral contexts, to refine its practical implications.

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