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Editorial: Distributed ledger solutions in web 4.0 and their impact on enterprises and society

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Editorial on the Research Topic

Distributed ledger solutions in web 4.0 and their impact on enterprises and society

1 Introduction

Over the past decade, blockchain technology has evolved from a niche cryptographic innovation in the financial world into a foundational layer for digital infrastructure across industries (Henke et al., 2022). As the global economy accelerates toward Web 4.0 – an era defined by autonomous agents, semantic intelligence, and immersive digital environments—blockchain and other distributed ledger technologies (DLT) are no longer seen as just a backend utility but a central enabler of trust, coordination, and value exchange between machines, enterprises, and societies (Gürpınar et al., 2025; Fomin et al., 2025).

Recent developments highlight this shift. The integration of programmable payments into industrial systems, the emergence of AI-powered autonomous agents interacting over decentralized protocols, and growing demands for supply chain transparency and sustainability underscore the urgency to revisit blockchain's evolving role (De la Roche et al., 2024; De la Roche et al., 2025). At the same time, enterprises continue to navigate internal adoption dynamics, interdepartmental influence, and stakeholder tensions, revealing that the technology's promise is deeply tied to organizational, economic, and societal contexts (Zhuk, 2025).

This Research Topic explores blockchain's multifaceted applications in the unfolding Web 4.0 landscape. From taxonomies of blockchain-enabled business models in the emerging machine economy, to trigger-based smart contract mechanisms for autonomous production systems, to analytic hierarchy methods that unpack enterprise decision-making, each article in this Research Topic contributes to a broader understanding of how decentralized technologies reshape coordination, agency, and accountability. With this series, we invite the academic community to delve into the implications of distributed ledger technologies beyond their technical core—toward a future where systems think, act, and transact autonomously, yet remain grounded in transparency and trust, guided by humans who design and manage them.

2 The foundations of web 4.0: infrastructure, business models, and technological enablers

The first part of the article series explores how blockchain and DLT-based systems are laying the groundwork for Web 4.0, with an emphasis on the emerging machine economy, smart manufacturing, and AI-agent ecosystems.

The first article on blockchain in the emerging machine economy provides a timely overview of how DLT can be applied to enhance security, transparency, and coordination in digital production environments in general and additive manufacturing in particular. Through a structured taxonomy, the authors identify characteristic features of blockchain-based business models, using literature reviews, database analysis, and workshops to show real-world applications. The paper provides practical pathways to reduce skepticism in industrial adoption by illustrating working use cases (Grünwald et al.).

The second article addresses a critical enabler for autonomous industrial and financial systems: programmable payments. In particular, it introduces a state channel-based trigger solution (SCTS) that enables interoperability between decentralized and conventional financial systems. This is a key step for Industry 4.0 and Web 4.0 integration, as it allows for scalable and regulation-aligned high-frequency machine-to-machine (M2M) payments, a cornerstone for fully autonomous ecosystems (Lamberty et al.).

Pushing further into the future, the third article offers a conceptual and architectural perspective on how enterprises can transition into Web 4.0 ecosystems powered by autonomous agents and decentralized coordination. It presents a six-layer framework that combines infrastructure, governance, and behavioral norms. Importantly, it recognizes that trust and regulatory alignment are just as crucial as technological readiness in realizing the potential of autonomous AI agents. This paper provides a strategic roadmap for enterprises aiming to navigate Web 4.0 complexity while preserving accountability and trust (Gürpınar).

Together, these contributions highlight a shift from experimentation to strategic implementation, offering both practical tools and conceptual structures for the next era of digital-industrial transformation.

3 Blockchain adoption in complex systems: organizational dynamics and societal tensions

The second part of the article series shifts the lens from infrastructure to organizational behavior and systemic impact. These studies reveal how blockchain and DLT-adoption is shaped not just by technology, but by institutional structures, stakeholder values, and systemic coordination challenges.

The first article in this part analyzed stakeholder tensions in sustainable food systems and brings a rare qualitative depth to the blockchain research domain (Grünwald et al., 2024). Drawing on eleven co-creative workshops involving over 100 diverse participants—from farmers to policymakers—the authors uncover four key tensions around decentralization, inclusion, transparency, and tokenization. These are not just technical concerns but deeply social and political. The paper shows how blockchain's promise of

sustainability is not only technological but hinges on how datafication and power dynamics are negotiated in practice (Kingfisher et al.).

Complementing this perspective, a second article examines how internal organizational dynamics influence the adoption of blockchain technology. Analyzing responses from 156 professionals across 10 countries, the study reveals that adoption decisions are not primarily driven by technical departments, but heavily influenced by corporate functions such as finance and marketing. This hierarchy suggests that strategic alignment, risk perception, and institutional influence outweigh technical readiness—indicating that successful blockchain implementation often hinges on persuading key decision-makers outside of IT and operations (Gharehdaghi and Kamann).

Together, these two articles emphasize that blockchain adoption is not a purely technical act—it is deeply embedded in the organizational and societal context. The success of DLT initiatives will depend on understanding and addressing these layered dynamics.

4 Conclusion

Together, the contributions in this Research Topic illustrate the dual frontiers of blockchain development in the era of Web 4.0. On one side, we see technological innovation accelerating—with new frameworks for autonomous agents, programmable financial mechanisms, and digital manufacturing models redefining how value is created and exchanged. On the other, the organizational and societal layers reveal that adoption is deeply dependent on institutional dynamics, stakeholder trust, and strategic alignment. Bridging these dimensions—technological and socio-organizational—will be critical to realizing blockchain's full potential across enterprises and society. As the digital landscape evolves, these studies provide both a foundation and a direction for navigating the opportunities and tensions at the intersection of decentralization and autonomous decision-making.

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