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Blockchain Networks as a mode of Governance for the Digital Commons

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Executive Summary

The report synthesizes the key discussions from the Digital Commons Governance Summit held on November 7, 2024, by the Institute of Quantitative Social Science at Harvard University in partnership with The Digital Economist and AI Native Foundation. The summit explored the potential of blockchain networks and artificial intelligence (AI) in governance systems for the digital commons through the Ostrom Project, an initiative by The Digital Economist led by Mark Esposito. The report covers how blockchain technology, based on Elinor Ostrom's principles of polycentric governance, can offer decentralized solutions for managing resources that lack centralized control.

Key challenges in current blockchain governance models, such as risks of centralization and decision-making bottlenecks, are analyzed alongside the proposed solutions, including adaptive and anticipatory governance frameworks. The discussion is contextualized with examples like El Salvador's Bitcoin initiative, which highlights the need for balance between decentralized ideals and centralized oversight. Finally, the report navigates the potential of leveraging AI for blockchain governance and explores their combined ability to enhance democratic resilience, transparency, and inclusivity while addressing the scalability concerns and future research gaps.

The integration of blockchain technology and artificial intelligence into governance systems offers transformative potential for regulating the digital commons. Grounded in Elinor Ostrom's principles of polycentric governance, this report evaluates blockchain networks as a governance framework for collectively managed resources. Highlighting case studies such as El Salvador's Bitcoin initiative and AI applications in healthcare, the paper examines decentralized autonomous organizations (DAOs), their challenges, and implications for governance. Emphasizing transparency and scalability, this paper posits that blockchain networks have the capacity to enhance democratic processes while identifying the gaps for future research.

Introduction

The advent of digital technologies has revolutionized governance structures, particularly in the management of commons—resources collectively utilized and maintained without centralized control. Blockchain technology, combined with AI and DAOs, embodies an innovative governance model promoting decentralized forms of monitoring, sanctioning, and collective decision-making.

This report explores the intersection of blockchain governance and Ostrom's definition of the commons, which advocates for decentralized decision-making across multiple levels of authority. By applying these principles to digital commons, we assess blockchain networks' capacity to mitigate governance challenges while identifying barriers to its broader implementation.

Governance in the Context of Commons

Ostrom's polycentric governance principles emphasize decentralized decision-making through multiple centers of authority that operate independently yet collaboratively. This approach is well-suited for the digital commons, characterized by low excludability and a high degree of interconnectedness.

Blockchain networks exemplify digital commons, utilizing immutable ledgers to foster trust and transparency among users. Sahdev et al explores the application of Elinor Ostrom's polycentric governance principles to blockchain networks, proposing that blockchains should be managed as digital commons. This decentralized governance model addresses existing issues in blockchain ecosystems, such as centralization, power imbalances, and sustainability concerns. In this context, public blockchain networks resemble common-pool resources (CPRs). Like physical commons, they face challenges in governance, such as overuse or misuse by a few actors. Blockchains generate resources such as cryptocurrencies, smart contracts, and tokens that are non-exclusive and subtractable, making them susceptible to the "tragedy of the commons." To address these issues, blockchain networks can be treated as digital commons to emphasize decentralized, community-driven governance over top-down control under Ostrom's principles.

Governance in Blockchain and Comparison with Ostrom's Model

Blockchain networks represent a novel mode of governance that operates through decentralized systems involving various stakeholders, such as developers, node operators, and users. These networks aim to achieve transparency and trust through immutable ledgers and automated protocols. However, governance within blockchain ecosystems is often challenged by centralization risks, as power can concentrate in the hands of a few influential entities, such as large token holders or core developers. Additionally, decision-making bottlenecks and inequities in participation present significant obstacles.

Ostrom's polycentric governance model provides a framework for addressing these challenges. Her principles emphasize decentralized, multi-level governance structures where clearly defined rules, active community involvement, and equitable resource distribution are prioritized. Blockchain networks, particularly decentralized autonomous organizations (DAOs), reflect some of these principles in their community-driven approaches. However, they often fall short of Ostrom's vision, as governance mechanisms can lack inclusivity or fail to distribute power equitably. For instance, proof-of-stake systems in blockchain governance frequently consolidate voting power among a small group of wealthy stakeholders, undermining the decentralization ethos.

Despite these shortcomings, Ostrom's principles offer a pathway for improving blockchain governance. By treating blockchains as digital commons and implementing nested governance structures, networks can balance decentralized decision-making with the need for coordinated action. Such a framework mirrors Ostrom's design for interconnected authority levels, thus fostering collaboration while mitigating the risks of overuse and centralization.

Challenges in Blockchain Governance

The current governance of blockchain networks often leans toward centralization, which undermines blockchain's foundational promise of decentralization and trustlessness and leads to vulnerabilities such as centralized control over protocol changes, risk of forks and 51%

attacks, and a lack of community participation in regulatory decisions. Ostrom's polycentric governance system provides a potential solution through collaborative management. Ostrom's eight design principles for CPRs include clearly defined boundaries, rules tailored to local conditions, inclusive decision-making, external respect for community decisions, monitoring, sanctions, accessible conflict resolution mechanisms, and nested governance tiers for interoperable systems. These principles can extend the sustainability of blockchain networks as well as maintain the network's value and decentralized nature. Applying these principles to blockchain networks would allow communities to participate in governance while preserving the transparency and equity in managing shared resources.

Another challenge to governance in blockchain systems is posed by scalability, as increasing transactions often require trade-offs that impact community participation and decentralization. For example, solutions like Layer-2 technologies, which include Ethereum's rollups, enhance network capacity by processing transactions off-chain. However, these solutions often centralize governance decisions within a smaller subset of stakeholders, raising concerns about the inclusivity and resilience of the governance model.

Application of Blockchain and AI in Governance

Examining the innovative applications and frameworks, showcasing blockchain and AI's potential to reshape the governance dynamics:

El Salvador's Bitcoin Initiative

El Salvador's adoption of Bitcoin as legal tender illustrates a unique governance experiment. The establishment of the regulatory body CNAD to oversee digital assets demonstrates a polycentric approach to financial governance. Bitcoin's integration into the national economy aims to attract multinational investors and address economic stagnation. However, challenges such as money laundering and limited public understanding of cryptocurrency highlight the need for institutional regulatory frameworks.

El Salvador's experience contrasts with other nations, where outdated regulatory systems struggle to adapt to digital assets. Yet, the

pervasiveness of cryptocurrency as a decentralized legal tender somewhat paradoxically requires centralized governmental models in the form of task forces like CNAD to regulate consumer behavior and safeguard the trust in the system. A governance model in line with Ostrom's principles would involve a more decentralized and multilateral approach, regulating commons without the need for fully centralized oversight.

Scalability and Governance: Interconnections and Implications

The relationship between scalability and governance is intertwined. As blockchain networks scale to accommodate more users and transactions, the mechanisms governing these systems must adapt. Rapid technical advancements can outpace the ability of governance frameworks to remain participatory and equitable. For instance, scalability solutions may inadvertently reduce opportunities for smaller stakeholders to engage in decision-making processes.

To address this tension, blockchain networks can adopt adaptive governance models that evolve alongside their technical infrastructure. Ostrom's principles of polycentric governance provide a foundation for such frameworks by emphasizing flexibility, inclusivity, and the ability to respond to emerging challenges. Feedback loops and iterative decision-making mechanisms can help blockchain systems align their scalability solutions with the broader goal of maintaining decentralization and community-driven oversight.

Polycentric, Anticipatory, and Adaptive Governance in Public Sectors

Ostrom's concept of polycentric governance allows for coordination across national, subnational, and global levels, engaging multilateral support for regulatory efforts. Similarly, adaptive governance systems have authority distributed across multiple centers or stakeholders. This decentralized governance structure allows for flexible and iterative approaches tailored to changing circumstances. Applying adaptive governance models to blockchain networks can enhance regulation through a nested tier structure, where governance responsibilities are distributed across multiple layers, with rewards proportional to participants' stakes and commitments. This rewards-based incentive system targets long-term goals for the network that connect to a

framework for anticipatory governance. According to Signe et al., anticipatory governance focuses on foresight and proactive planning to prepare for future challenges before they materialize, which is particularly relevant for regulating emerging technologies. As such, enforcing a combination of polycentric, adaptive, and anticipatory models to blockchain networks can improve the governance of digital commons. Tools such as policy labs and regulatory sandboxes enable governments to respond dynamically to technological disruptions while maintaining ethical principles and public trust. However, in order to integrate blockchain's programmability with long-term equitable governance, human bias must be reduced. Programming automatic enforcement of regulatory guidelines can standardize the relinquishment of centralized control on a blockchain network, allowing networks to remain community driven. Yet, further research is required to determine the long-term efficacy of programmed automatic enforcement on blockchain networks, as the accumulation of tokens among a limited number of individuals can reduce the decentralization of network's programmed guidelines.

AI and Democracy

Ostrom's framework of polycentricity emphasizes multiple centers of decision-making that operate independently yet collaboratively. This approach, characterized by adaptability, interdependence, and localized problem-solving, aligns with the challenges of managing digital commons and AI-driven governance systems. Extending this framework to various political systems, it is possible to explore how decentralized governance structures can mitigate the risks of AI manipulation in democracies.

Analyzing the effects of AI on differing democratic systems, it is possible to measure the severity with which AI can influence electoral outcomes through the spread of digital resources and information. The analysis reveals vulnerabilities in first-past-the-post systems, where targeted misinformation exacerbates political polarization. In contrast, rank-choice voting systems exhibit greater resilience against the dissemination of misinformation due to AI. This underscores the need for governance models that mitigate AI-driven risks to democracy while leveraging its potential for transparency and inclusivity.

Use Cases and Sector-Specific Applications

Healthcare and AI

Innovations in medical technology include machine learning algorithms integrated with medical devices known as Software as a Medical Device (SaMD). Other novel tools include AI-driven clinical decision-support systems that increase the speed and scope at which patients can receive treatment. While AI-driven clinical decision-support systems offer significant benefits, challenges such as **biased datasets, privacy violations, and a lack of interoperability** hamper these emerging medical technologies. The current commodification of healthcare highlights the tension between viewing health data as a commons versus a commercial resource.

Humanitarian Applications of AI

Emerging medical technologies include artificial intelligence and machine learning algorithms that present transformative potential in humanitarian sectors. For example, the nonprofit Doctors Without Borders uses AI/ML predictive models for identifying the rate of antibiotic resistance in specific regions and addressing linguistic divides, showcasing AI's capacity to enhance healthcare delivery in low-resource settings. However, ethical considerations such as aligning AI applications with humanitarian values remain unresolved. The immutability of blockchain networks can act as a system through which technological abuses and ambiguities are recorded for public examination and regulatory action.

Technical Implementation and Frameworks

DAO Systems

Decentralized Autonomous Organizations (DAOs) represent a practical implementation of polycentric governance. Nikhil Varma shared his Mantra-Tantra-Yantra framework during the summit thus, elucidating an approach to understanding and deploying DAOs. While DAOs promise decentralized decision-making, issues such as voter fatigue, centralization of power, and competency gaps challenge their efficacy. Proposed solutions include reputation-based voting and holographic

consensus models to enhance participation and decision quality. Further research should examine the effect of anticipatory governance models on the efficacy of DAOs to explore new avenues for maintaining a multilateral, decentralized mode of digital commons governance.

Consensus and Participation Issues

The technical architecture of DAOs must address inherent limitations, such as the influence of wealthy stakeholders and rational indifference among smaller participants. Varma's exploratory analyses using agent-based models reveal that network connectivity significantly impacts the speed and effectiveness of decision-making. These findings emphasize the importance of designing inclusive and comprehensive smart contract algorithms to establish the foundation for governance mechanisms found in DAOs.

Broader Implications and Challenges

Economic Interests in Digital Commons

Massimo Morini's analysis of "tokenomics" introduces the challenges of balancing economic interests in commons like Bitcoin. The shift from centralized to decentralized governance models often meets resistance due to user preferences for simplicity and decision quality. Effective governance must reconcile this opposition without compromising the decentralized approach.

Decentralized governance in blockchain systems often focus on the balance between community participation and decision quality. Blockchain's reliance on consensus mechanisms, such as proof-of-stake or proof-of-work, underscores the importance of designing incentives that align with collective goals to avoid compromising decentralization. However, the translation of these principles into AI governance remains underexplored, presenting a significant research gap.

"Tokenomics" reveals the difficulty of designing incentive structures that ensure active participation without centralizing power. For instance, proof-of-stake systems may prioritize financial investment

over expertise, undermining decision quality by consolidating tokens among a few individuals or entities. These dynamics reflect broader challenges in integrating decentralized governance principles into democratic processes.

Digital Commons as Collective Action Problems

Eduardo Araral's insights on taxonomy of production functions for digital commons highlights the collective action challenges in ensuring cybersecurity and data cooperability. The weakest-link dynamic in cybersecurity underscores the need for minimum participation thresholds to produce collective benefits. Open-source models demonstrate the potential of collaborative approaches, but their scalability and sustainability remain areas for further research.

Research Gaps and Future Directions

Integration of Polycentric Governance with AI

While Ostrom's principles provide a robust framework for managing commons, their application to AI governance is still nascent. Additional research is needed to explore how polycentric governance can address AI's challenges, such as algorithmic transparency, accountability, and equitable resource allocation. Developing models that integrate blockchain's decentralized mechanisms with AI governance presents a promising avenue for exploration.

AI-driven governance systems risk exacerbating social and economic inequalities, particularly in resource-poor democracies. Comparative analyses across democratic models are required to highlight and investigate how AI implementation impacts representation and participation in diverse contexts. Future research should focus on creating inclusive AI systems that align with democratic principles, including those found in electoral systems.

Araral's conclusion on voting systems underscore the importance of electoral and technological reforms to mitigate AI-driven risks. However, practical solutions for integrating AI in electoral processes, such as voter verification and fraud detection, remain underexplored. Research into hybrid models that combine human oversight with AI.

capabilities could strengthen electoral integrity while preserving democratic values, leveraging the digital commons to enhance political governance.

The ethical implications of AI in governance demand greater attention. Issues such as algorithmic bias, data privacy, and the accountability of AI-driven decisions are critical to maintaining public trust. Developing polycentric frameworks that guide AI implementation in democratic systems is a priority for future research.

Decentralized Decision-Making

The potential of decentralized governance models to enhance participatory decision-making in democracies is an area ripe for exploration. Blockchain governance provides a foundation for investigating how decentralized systems can improve inclusivity and accountability in democratic contexts. Future research should examine the scalability of these models and their applicability to larger, more complex governance systems through an anticipatory governance model.

Conclusion

The integration of AI into democratic systems presents a transformative opportunity to enhance governance efficiency. However, significant challenges remain, including the proliferation of misinformation and polarization across the digital commons, which can accelerate the erosion of trust in democratic institutions. By leveraging frameworks such as polycentric governance and decentralized decision-making through blockchain networks, researchers and policymakers can address these challenges and develop better governance models for the digital commons.

Future research should prioritize the development of adaptive frameworks that integrate AI's capabilities with democratic principles. Areas such as electoral resilience, ethical AI governance, and the scalability of decentralized systems offer promising directions for exploration. Ultimately, the goal is to harness AI's potential to strengthen democracies while safeguarding their core values.

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