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Research on the Reciprocal Mechanism of Hybrid Governance in Blockchain

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ABSTRACT

This paper aims to discuss the reciprocal mechanism of governance-by-blockchain and governance-of-blockchain within the context of hybrid governance, a model that combines both on- chain and off-chain methods to create reciprocal structure. Assuming the contingency theory, the effectiveness of a hybrid model depends on the collective interactions between technology, management, and public sphere. We found that technical innovations in governing methods promote the formation of effective technology management and the performance of blockchain as a governing tool is symbiotically linked to the consistent regulation of blockchain. After considering the different possible implementations of blockchain for governance, we concluded that the probability of success is highest in consortium blockchain, followed by public blockchain and private blockchain. By studying the Dream Valley Blockchain Project, a site currently attempting to realize the hybrid model on the scale of a small city, we confirmed some of the concerns regarding blockchain governance. In conclusion, the interactions between blockchain and governance are mutually beneficial. A significant amount of research and development still remains before hybrid governance is achieved. However, the difficulty surrounding the task of managing rapidly developing technology can be alleviated best by incorporating technological advancements into the governance structure.

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Introduction

The distributed digital ledger, known as blockchain, is composed of encrypted blocks of data that autonomously keep track of all interactions in a decentralized manner [1]. Although the technology has inspired growing scholarly interest and financial applications, its use from the governance perspective is lacking to date [2]. Scholars define blockchain governance as separate on-chain and off-chain layers. On-chain refers to protocols that run automatically on the underlying infrastructure known as "rule of code" and off-chain refers to organizational committees that collaborate and cooperate outside of the blockchain (BC) [3]. The off-chain layer can be further divided into the off-chain community layer and the off-chain development layer, creating a distinction between administrative and technical roles [4].

However, the segments within of the overall structure are functionally dependent. The application of blockchain technology as a tool for governing hinges on policy that regulates the use of BC without limiting its effectiveness. This paper attempts to find identify the interactions between the on-chain governance-by-BC and the off-chain governance-of-BC by stakeholders using the contingency theory [5]. The advancement of technology and occurrence of novel situations in governance require a flexible and adaptable understanding of not only the infrastructure, but also the social environment and its implications.

The paper first introduces the definitions of applicable technologies and theories, then proposes the reciprocal blockchain governance model. Third comes the analysis of the case study of the Dream Valley Blockchain Project, followed by the conclusion and acknowledgements.

Blockchain Governance

Although BC as a technology has progressed far beyond cryptocurrencies, researchers point out emphatically how little is known about the application of BC for governance [6]. Pelt et al. adapted on Markus defined BC governance as "the means of achieving the direction, control, and coordination of stakeholders within the context of a given blockchain project to which they jointly contribute [7] [4]. Scholars did a lexicometric approach with 125 blockchain related articles and found governance as one of four main 4 epistemic communities [8]. have discerned the distinction between governance-by-blockchain and governance-of-blockchain [9]. The former is a governance method that adopts BC for processes and transactions control. The latter is the governance process to determine how BC should be updated to adapt to changes and ensure that public values and societal needs are fulfilled. The centralized hybrid governance method, where governance committees cooperate and collaborate with BC members off-chain while governance decisions are executed practically on-chain, has the potential to accomplish previously

unachievable multilevel governance goals [10]. Table 1 lists the recent relevant studies of blockchain governance. Most of the research focuses on the constituent parts respective to the on-chain and off-chain layers or aspects of the governance model rather than the interplay between blockchain's roles as the governing agent and the technology being governed.

Table 1: Blockchain Governance Review List

Title	Governance Objects	References
Now the Code Runs Itself: On-Chain and Off- Chain Governance-of- Blockchain Technologies	**On-chain governance** refers to rules and decision-making processes that have been encoded directly into the underlying infrastructure of a blockchain-based system as the 'rule of code', sovereignty asserts itself through **off-chain mechanisms** during the state of exception.	(Reijers et al., 2018)
Blockchain Governance: What We Can Learn from the Economics of Corporate Governance	Blockchain governance includes the definition of **stakeholders**, how the consensus mechanism distributes **endogenous bargaining power** between those stakeholders, the interaction of **exogenous governance mechanisms** and institutional frameworks, and the needs for **bootstrapping networks**.	(Allen & Berg, 2020)
Research on Mechanism and Method of Blockchain Governance	Three content levels of blockchain governance: **consensus protocol governance**, **resource governance and rule governance**. Three methods of blockchain governance: **on-chain governance, off-chain governance and hybrid governance**.	(Chao, 2020)
Defining Blockchain Governance: A Framework for Analysis and Comparison	A blockchain governance framework that defines the governance of a blockchain as a combination of six dimensions (**formation and context, roles, incentives, membership, communication and decision making**) and three layers (**off-chain community layer, off-chain development layer and on-chain protocol layer**).	(Pelt et al., 2021)
Decision Problems in Blockchain Governance: Old Wine in New Bottles or Walking in Someone Else's Shoes?	This research studied blockchain systems through the lens of six decision problems emerging from blockchain governance: **problems of demand management, data management, system architecture design and development, membership, ownership disputes, and transaction reversals**.	(Ziolkowski et al., 2020)
Blockchain Governance—A New Way of Organizing Collaborations?	The importance of **codifiability and verifiability** as two transactional characteristics that have an important impact on the efficiency of blockchain governance	(Lumineau, Wang, & Schilke, 2020)
Blockchain Governance and The Role of Trust Service Providers: The TrustedChain Network	The essential conditions are **confidentiality of transactions and long-term preservation of data** to thrive and accomplish complex tasks in an effective and reliable way for blockchain networks.	(Atzori, 2017)
The Generic Blockchain Ecosystem and its Strategic Implications	This paper identified three strategic implications where blockchain is fundamentally different from prior approaches: **governance, trust, and openness**.	(Riasanow, Burckhardt, Soto Setzke, Böhm, & Krcmar, 2018)
Governance in the Blockchain Economy: A Framework and Research Agenda	It discusses the blockchain economy along dimensions defined in the IT governance literature: **decision rights, accountability, and incentives**.	(Beck et al., 2018)

Contingency Theory

A variety of organizational characteristics are related to contingency theories, such as leadership [11]. business strategy and structural research [12,13]. Lex Donaldson summarized the contingencies as "the effect of one variable on another depends upon some third variable", including environment, organizational size, or strategies [14]. Fiedler developed the theory of contingency when he found

that leadership effectiveness and group effectiveness depended on the style of leadership and the situational context [15].

At its core, the contingency theory implies that a static model of governing cannot provide the best-case scenario for all possible occurrences. For example, high taxes and nationalistic policy that represent strong leadership in the midst of crisis are also the signs of an authoritarian regime in a different context. To some degree, most constitutions account for long-term shifts in political climate and progressive reform, but few take technological advances into consideration and most have turnaround times in the measure of years, if not decades. The rise of the internet, social media, and other technologies like blockchain test the ability of established organizations to respond to entirely new scenarios unimaginable to the founders, at an accelerating pace. The result is the need for a system that can adequately respond to those challenges.

The Reciprocal Governance Mechanism of Hybrid Blockchain Governance

Blockchain governance contains two processes: Governance-by-BC applies consensus protocol and node control by using BC as a medium, while governance-of-BC allow stakeholders and the social market evaluate the performance of the BC application within its active environment and make improvements. As activity increases, the feedback loop continuously improves the overall system. Figure 1 illustrates the reciprocal governance mechanism of blockchain.

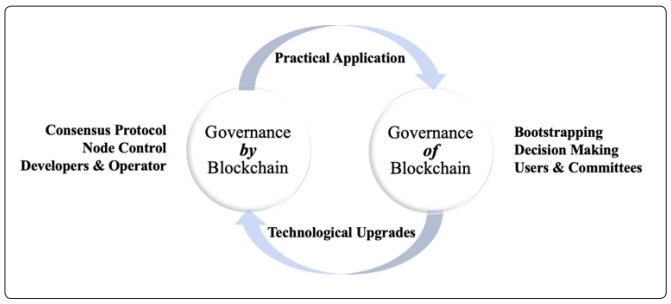


Figure 1: Reciprocal Governance Model of Blockchain

Practical Application Process

Developers are the authors and mechanics of blockchain governance, responsible for encoding the consensus protocol and make initial operation rules for participants on-chain. In this ex-ante governance phase, developers and project managers customize the transaction principles to fulfill the governance- by-blockchain. Developers and operators are on-chain top management in this governance-by- blockchain period. The autonomous tamper-proof encryption and distributed underlying infrastructure guarantee the security and reliability on-chain [16]. Blockchain maintains the on-chain sustainable fundamentals as a technological governance tool. Given that the regulators and developers are governance tools, transactions and users emerge as the governance objects once the protocol is put into practical application.

The application process of blockchain drives the formation of technological management, which is defined as governance-of-BC. While blockchain as a technology promotes a trustworthy environment, it is unlikely to perfectly handle unexpected social factors when it exits the developmental phase and faces reality. As a result, improvements in the management of blockchain are required.

Technological Upgrades Process

In the execution process of governance-by-blockchain, issues arise due to the inconsistencies between the technology and the public sphere. For instance, the implicit transactions without codifiability and verifiability cannot be transmitted in protocols like oral promises or latent norms [17]. Disputes between stakeholders cannot be resolved with regular on-chain procedures [18]. In these situations, user feedback provide a source of valuable findings and suggestions. The committees of users and developers can organize off-chain governance measures for optimizing system design and make consensus decisions for generational upgrades. In this upgrade process, blockchain is regarded as a governance object rather than a governance tool. Therefore, through governance-of-BC, developers will upgrade the infrastructure using the feedback and decisions from the social market, continuously improving the process of governance-by-BC.

Reciprocal Governance

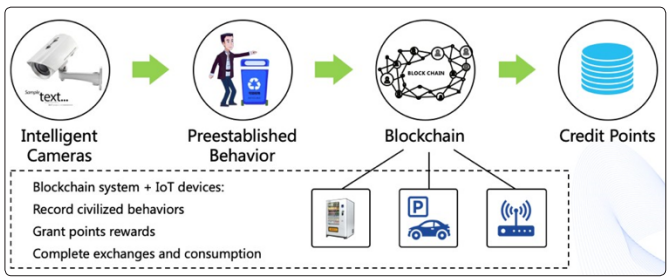
Technological upgrades require the synchronous update of BC management. Blockchain used to exert social governance functions require updates to the administrative process as well. Because the effectiveness of reciprocal governance varies with user engagement, the structure of the blockchain is a significant consideration. Due to the low efficiency in propagating transactions, large node counts, and a higher number of necessary validators, the public blockchain is generally less efficient than its consortium and private counterparts [19]. However, the efficiency and effectiveness of governance depend not only on the propagation of transactions, but also on the reciprocal process between user engagement and development updates. Table 2 shows a comparison of reciprocal governance in three blockchain types. Public blockchain implements a community-oriented governance model, where user demand plays the leading role in the promotion and upgrade of the system. Developers provide the infrastructure support based on the market bootstrap. Public BC meets the need for a decentralized structure and feedback, but it is possible that the underlying system is not able to encode protocols that test technical limits. Too much feedback could burden system to a point that damages functionality. Private blockchain is a developer-oriented centralized governance mode with high levels of control. However, dominant organizations could focus on their own management needs while ignoring the market demand, resulting in insufficient information from the market necessary for improving the internal structure. Consortium blockchain, a model where administrative control is divided between a group of organizations, makes it possible for mutual governance to occur between developers and selected nodes to practically share decision-making and improvement responsibilities. Taking technology, management, and the social market into consideration, the effectiveness is high consortium BC, followed by public BC and private BC. It is important to note that the conclusion here is focused on the reciprocal governance process and the effectiveness in any other situation depends on the particular context of technology, management, and public environment in question [20 to 22].

Table 2: Comparisons among public blockchain, consortium blockchain and private blockchain

	Consensus determination	Features	Hybrid Governance Type	Effectiveness of Reciprocal Governance
Public Blockchain	All nodes	Permissionless decentralized	Community- oriented	Medium
Consortium Blockchain	Selected nodes	Permissioned Partial centralized	Mutual Governance	High
Private Blockchain	Single Organization	Permissioned centralized	Developer- oriented	Low

Case Study: Dream Valley Blockchain Project Social Governance by Blockchain Technology

The Dream Valley Blockchain Platform (DVBP) is a blockchain platform designed to record personal credit points and promote civilized behaviors, started jointly by Xidian Lianrong Ltd. and Tianlang Technology Co. Ltd. in 2019. The project is currently under development in the Dream Valley of Chang'an University Town, a gathering area for high-tech incubation, university education, and research platforms. Through the use of intelligent devices, DVBP aims to bring into reality a sustainable ecological town that embodies service, good behavior, and a data-driven mentality. Citizens are rewarded with Civilized Points (CP) when they accomplish preestablished behaviors, which can be consumed by buying coupons or commodities within the city. DVBP is based on FISCO (Financial Blockchain Shenzhen Consortium) BCOS (Be Credible, Open, and Secure), an open-source Chinese blockchain platform. Information technology projects that focus on traceability, confirmation, custody, and intelligence of data requires the support of advanced technologies such as blockchain, digital watermarking, encryption, and ciphertext retrieval to ensure that the data flow process remains secure and efficient as it scales. Figure 2 illustrates the basic transaction process of DVBP. At its inception, DVBP aims to integrate smart IoT devices, such as vending machines, smart trash cans, and surveillance cameras. Later in its development, functionality will expand by including more social scenarios, such as meeting reservations, library checkout, parking guidelines, etc. DVBP also enables the administrators to gather data and analyze the Civilized Behavior Distribution, a measurement of how people normally behave on a daily basis. The number of positive behaviors is an indicator of good governance that, over time, can serve as a benchmark for progress. By recognizing frequent positive behaviors and tuning the vehicle of reward, DVBP creates a reciprocating system of understanding the reasoning behind user activities and reinforcing the beneficial aspects within society.



Source: Xi'an Xidian Blockchain Technology Co., Ltd., China

Figure 2: Basic Transaction Process of DVBP

Governance-of-Blockchain in DVBP

When DVBP put the pilot project into execution, users participated in preestablished behaviors and provided feedback to the Valley Center. As engagement continued, the set of incentives and behaviors must be adjusted accordingly to fulfill the social governance goals. Table 3 shows an example of the protocol in operation. Note that there is a limit on the maximum amount of points a user receives within a given time interval. The point awards and interval duration are needed to establish an equilibrium between user engagement and reward supply.

Table 3: Briefly Protocol Introduction

Activities	Registration	Registration	Behavior Identification	Maximum	Activity Interval
Credit Points (+)	100/User	20/Activity	20/Activity	50/Day	1 Hour

The Reciprocal Governance in DVBP

DVBP is based on a private blockchain operated by an organization, which takes a dominant position in protocol development and upgrades. The blockchain project was approved for practical application in valley and an analysis of the results found it necessary to expand the market through enhancing the incentive points and enriching the commodities. Operators also collected the feedback from users, but the data was ultimately limited by a lack of participation in decision-making. The current reciprocal governance exists primarily between developers and operators, who manage governance structure and execute improvements to technological design. The numbers of users increased at a lower-than-expected rate and became stagnant after the one-year pilot program. There are no formal communities or communication channels that provide reflections and feedback. Without the user engagement, the preestablished behaviors and credit points did not provide sufficient long-term motivation for users. In the meantime, the group in charge of operations stated their intent to revise requirements, improve compatibility and refine the complementary protocol on the platform. Developers of Xidian Lianrong are currently working on the underlying infrastructure.

Conclusion

Through the analysis of reciprocal governance in blockchain, we found that technical artifacts designed to assist in governing promote the formation of technology management itself. The interactions between governance-by-blockchain and governance-of-blockchain form a reciprocal relationship and determine the effectiveness of a hybrid system. After taking technological protocol, users engagement, and market environment into consideration, when comparing the reciprocal governance structure between public blockchain, consortium blockchain, and private blockchain, the effectiveness is theoretically higher in consortium blockchain than in public or private models, although real world applications depend heavily on the social and technological interactions. Feedback is vital to the adoption and tuning of a hybrid governance model that relies on user engagement to improve its underlying infrastructure. However, the successful implementation of such

a system results in a government that is faster, more secure, and capable of adapting to unprecedented challenges by constantly making improvements through feedback and development: a truly smart government.

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