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EXECUTIVE SUMMARY OF THE THESIS

Governance of blockchain-based decentralized applications: an exploratory study

TESI MAGISTRALE IN MANAGEMENT ENGINEERING – INGEGNERIA GESTIONALE

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1. Introduction and objective

Since its introduction, blockchain has promised to reduce the need for trust in a central entity by distributing power and value across peer-to-peer networks, emerging as a technological solution capable of reinventing patterns and paradigms of human interaction and cooperation and producing more efficient, equitable, and collaborative systems and societies (Atzori, 2015; Lumineau et al., 2021). Public-blockchain-enabled applications can facilitate the rise of new types of organizations with coordination systems and incentive alignment that have traditionally been the domain of top-down hierarchical structures (Anderson, 2019; De Filippi, 2019).

As the expression of Web 3.0, decentralized applications may represent the transition to a decentralized social and economic paradigm. Understanding the meaning that is given to these systems and their governance models becomes crucial. Still, it is unclear how Dapps are governed, how powers are distributed, how they differ from traditional organizations' governance practices, and how these protocols can evolve through joint effort and collaboration among stakeholders.

This research aims to add to the limited literature on the subject by analyzing how blockchain technology affects governance systems used by decentralized applications, on their governance practices, the reasons behind their adoption and how decentralization is accomplished.

2. Literature review

First, the literature review focuses on describing the characteristics and functioning of the technology to gain a deep understanding of its working mechanisms and peculiarities, grasping the topic from a general perspective. Then the current state of blockchain technology, including its evolution and the notion of Dapps, is investigated. Finally, the existent literature on blockchain governance is examined, explaining the conceptual frameworks that support the empirical analysis by identifying the key characteristics that define this phenomenon.

Blockchain and decentralized applications

In October 2008, Satoshi Nakamoto published his concept for a peer-to-peer electronic payment system "based on cryptographic proof instead of trust, allowing any two willing participants to transact directly without the requirement for a trusted third party." With Bitcoin, for the first time, value could be exchanged reliably between two distant, mistrustful parties without the requirement for an intermediary (Catalini and Gans, 2016).

Since then, blockchain has gained popularity and evolved, finding applications beyond value transfer and offering possibilities to grow entirely new businesses and disrupt traditional incumbents (Iansiti & Lakhani, 2017; Morkunas, Paschen, &

Boon, 2019). The latest stage of the technology, blockchain 3.0, introduces general-purpose platforms that enable other organizations, startups, and developers to build applications on top of the provider's blockchain infrastructure, such as Dapps (Angelis and Silva, 2019).

Decentralized applications are often described as "trustless" applications that run on peer-to-peer networks with the distinguishing characteristic that there is no single server or entity controlling them like in a client-server model (Yano et al., 2020; Voshmgir, 2020). In contrast with traditional applications, the back end of Dapps consists of one or multiple universally accessible smart contracts deployed on the blockchain. Such contracts implement the logic and instructions on which the applications run, recording transactions and state transitions on the underlying blockchain network.

Governance

Blockchain has emerged as an innovation capable of redesigning interactions and coordination in business, politics, and society at large (Atzori, 2015). Because of its transparent and automated nature, it is often depicted as a solution to problems requiring coordination across heterogeneous stakeholders, challenging traditional hierarchical structures and replacing centralization with distributed consensus (Lumineau et al., 2021). Blockchain governance refers to two related but distinct concepts: governance of the blockchain and governance by the blockchain (Olnes et al., 2017; de Filippi & McMullen, 2018).

Governance of the blockchain involves the processes and structures determining the development, execution, maintenance, and operation of the technology and how users can engage with it. On the other hand, governance by the blockchain refers to governance by hard-coded rules directly embedded in a blockchain system. It mainly concerns the process of rule enforcement rather than the decision-making itself.

Voshmgir (2020) distinguishes two spheres of Web3 and decentralized applications' governance: social governance and algorithmic administration of governance. The first refers to the human decision-making processes around the development and release of potential protocol upgrades. The latter instead refers to machine-readable governance rules directly encoded in the blockchain itself and automatically enforced by the network.

The social process of finding consensus about policy upgrades can be conducted either off-chain or on-chain. "Off-chain governance" describes a protocol upgrade process where decision-making first takes place on a social level and is then encoded into the protocol by developers (Voshmgir, 2020). "On-chain governance" instead refers to the processes enabling the proposal, voting, and implementation of upgrades directly on the blockchain (Voshmgir, 2020).

Various scholars agree on the fact that blockchain networks involve political and social dimensions that cannot be dealt with the sole reliance on technological tools and the use of algorithmic governance because it lacks the flexibility needed to face unforeseen circumstances and does not resolve the human factor and broad involvement. A combination of on-chain and off-chain governance would likely be the best approach to regulate and resolve the decision-making process in blockchain systems. (De Filippi and Loveluck, 2016; de Filippi and McMullen, 2018).

Assuming blockchain promises to change how governance is implemented, little has yet been studied, on how Dapps are governed.

Decentralized Organizations Autonomous

Blockchain technology enables new ways of collaboration and the institution of new organizational structures and distributed governance models, the most compelling being a Decentralized Autonomous Organization (DAO).

A DAO is an organization run by pre-programmed algorithms and rules encoded in smart contracts and executed on the underlying blockchain network that all members must abide by (Chonan, 2017). These deterministic rules facilitate coordination between unknowing agents in a trust minimized setting (Wright and de Filippi, 2015). Instead of having a hierarchical structure, the participants of a DAO collectively control the organization and define the course of action towards a shared mission through proposals and voting systems specified by the code.

3. Methodology

The goal of this paper is to understand how Dapps structure their governance and how decentralization is actualized. As the knowledge in the domain is still limited, it is critical to collect data from those who are experiencing the

phenomenon under investigation (Gioia et al., 2013) "within its real-life context" (Yin, 2013). As a result of the phenomenon-driven (Eisenhardt and Graebner, 2007) nature of the research purpose, a series of exploratory case studies are conducted (Yin, 2013). For the analysis, the framework defined by Pelt et al. was adapted to better fit the purpose of the research, switching the focus from networks to applications. An additional framework was also constructed to capture how the decision-making process unravel in Dapps.

Case selection

As a starting point for case selection and to identify the target population of Dapps, dappradar.com, a comprehensive database of decentralized applications, has been used. A preliminary ecosystem analysis has been performed; conducted from March 19th, 2022, it includes the top 150 decentralized applications ranked by number of Unique Active Wallets (UAW) interacting with the dapps' smart contracts in the 30 days prior to the extraction of the data.

Starting from this database, multiple cases have been selected using a theoretical sampling method, relying on the following criteria: (i) only projects that have been running for at least a year have been deepened to ensure the integrity of the evidence; (ii) the focus was solely placed on projects that had issued a native governance token.; (iii) the cases have been selected only among the DeFi and Gaming sectors, given their consolidation and prominent role in the ecosystem evidence by the analysis.

Then, the next step consisted in contacting representatives for each initiative, asking for their availability to be interviewed. The selection process ended with the identification of 7 cases, synthesized in the table below.

DApp	Foundation year	Category	Native token
1inch	2019	DeFi – Aggregator - DEX	1INCH
Curve	2019	DeFi – DEX	CRV
Furucombo	2018	DeFi – Aggregator	COMBO
MakerDAO	2017	DeFi – Lending	MKR
SpookySwap	2021	DeFi – DEX	SPOOKY
The Sandbox	2018	Game - Metaverse	SAND

Year	2020	DeFi – Aggregator	YFI
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The Sandbox was later excluded from the analysis because the only gaming Dapp and did not fit with the decision-making framework drafted.

Data collection

To limit potential biases (Eisenhardt and Graebner, 2007) and gather stronger insights (Eisenhardt, 1989), the study relied on multiple sources of evidence: it drawn on primary data, namely, semi-structured interviews, one for each DApp, and secondary data, such as reports, whitepapers, social networks posts, online news-articles and websites.

Data was simultaneously collected and analysed. This cyclical process allowed to gather new information based on the evidence arisen from previous interviews (Gioia et al., 2010) and, following where the informants led the interview, the framework was adjusted during the research. Each interview lasted at least one hour, was conducted using online tools (Microsoft Teams, Zoom or Google Meet) by the author, and was recorded and transcribed verbatim.

Data analysis

The grounded theory approach was used in the data analysis process (Glaser and Strauss, 1967).

Within-case and cross-case analyses were carried out in accordance with the principles for multiple case study theory development (Eisenhardt, 1989). Primary data was independently analyzed and triangulated with secondary sources (Jick, 1979).

The interviews were then coded using an inductive technique (Saldana, 2013) to discover the early themes and then clustered together in second-order themes in a cross-case search.

The process cycled between case data, emerging concepts and dimensions, and academic literature to improve the emerging construct definitions, abstraction levels, construct measurements, and theoretical links while the cross-case research was underway (Gilbert, 2005).

4. Results

Within case analysis

The six cases were examined, and the results were organized in the framework derived by that of Pelt et al. (2021). Communication channels, membership, and incentives have been assessed.

Particular attention has been placed in understanding and illustrating how the decision-making process unfolds and who are the actors involved in each step of the process, namely proposal initiation, voting, and implementation. This enabled to determine the role that the community plays in governance and whether powers are equally balanced among stakeholders.

Cross case analysis

Leveraging on literature on the topic of blockchain governance, the study crosses the results stemming from the two frameworks adopted for the analysis to depict the role and impact of the governance variables identified and the decision-making systems on the governance models and the resulting decentralization of Dapps.

Communication and information systems

For decisions to be implemented and executed, specific proposals must be developed. Hence, governance of decentralized apps typically begins off the blockchain on various communication channels, where community members and development teams can engage in a permissionless manner. Discussions and debate can be used to openly exchange ideas to improve protocol, seek consensus and agreements to support and inform changes, gauge community opinion on existing concerns, and approve or reject formal processes and structures.

"For the governance, what the community can do is post something in the forum, and then it can eventually be turned into a proposal." (Yearn Finance).

"There are some coordination tools, like a forum, where governance discussions happen" (Curve).

Decisions about the application's operational structures and development need to align with the interests of numerous stakeholders and may require specific knowledge and proprietary information, which often lies in the developers' hands. Indeed, there is usually a disparity of knowledge and possession of information between development teams and the rest of the community which lacks deep technical or economical knowledge many decisions require.

"The technology is too complicated for anyone from the community to understand. So, the core things that are driving 1Inch forward are happening within the foundation only." (1Inch)

"To participate in Maker governance, it takes a lot of time and expertise. [...] it's not something that you can expect a regular MKR holder to do" (MakerDAO)

Due to information asymmetry, the community mostly discusses elementary or limited topics, thus being left out of complex-decisions formulation.

Often, the community makes suggestions without first defining an issue and data-driven remedies.

Despite being unstructured and non-binding, ideas arising from various stakeholders are often heard and serve as inputs for core teams' decisions taken on separate channels.

"Community can ask for new features [...] a user could express it publicly and we would pick up this thought [...] we listen for users and develop things, but that's not formally required [...]. It's not necessarily going on the governance forum; it's just expressed in how could be expressed when talking to users in chats." (Curve)

As a result, what is observed is that token holders are mainly confronted with yes-or-no proposals that they contribute themselves or with already drafted solutions and policies. The community is usually left out of problem identification, strategy formulation, and determining and assessing alternative solutions. In most cases, core teams have already determined policy details and how improvements should look before the community has a chance to express its views.

"What we do is propose something we worked a lot to make, like a proposal that makes sense, and it gets voted." (Facu – Yearn)

"[...] people with 1inch tokens sometimes offer something themselves without intervention of community managers, but it is extremely hard for them to reach the quorum, because it's hell of a job." (1Inch)

"When it comes to the DAO, it controls things on chain, where the code is already developed and deployed. [...] What the DAO actually does is decide which smart contract will get CRVs streamed into it or and which does not and also how much CRVs it gets." (Curve)

The structures set in place could be adequate to make complex decisions and answer complex questions, but the way in which they are used, often excludes part of the ecosystem. Instead of a real decentralization, it seems that the dispersion of decision-making power is fictitious: decisions are made by few powerful individuals and then proposed to the wider community, which only expresses its approval or rejection. Therefore, token holders tend to have a decision-making power that they are unable to exercise.

For proper decentralization, systems must be used to foster constructive and transparent discussions, enabling stakeholders to coordinate and identify the needed or desired changes. The governance

debate must become a consensus-seeking exercise to reach an optimal compromise, where communication channels force participants to focus on the underlying reasoning, theories, and data rather than polarizing contests.

Proposition 1: *Granting token holders the possibility to raise and vote on improvement proposals for the protocol is not enough to have an effective decentralized governance. The governance system should have well-functioning communication and information structures and use them properly to provide stakeholders with the proper data and knowledge to make decisions.*

Roles' influence

The core team usually oversees off-chain decisions given they are not implemented and executed on the blockchain, where token holders can exercise significant and effective power. Code cannot govern Web2 and the non-crypto world; a legal entity or other business organization may be required to follow national and supranational regulations and to do business with external actors. *"1Inch Foundation is the entity that you can make business with; it's the legal entity that has the rights to the pathfinder proprietary algorithm, that has bank accounts that pays core contributors money. It's important to understand that fully decentralized organizations cannot do business with non-crypto firms, it's just impossible."* (1Inch).

Despite smart contracts on public blockchains are accessible by sending transactions via a node, to improve accessibility for non-technical users and enhance experience, dapps resort to traditional web interfaces. Front ends must be hosted on servers and require designers and developers to build the UI, which again make dapps dependent on core teams.

"Upgrades and changes to the website, logos, all that concerns the front end is done without confronting with the community. We are working to make it the most user friendly as possible and have a great UI and UX." (SpookySwap)

"We develop features for the Furucombo website. [...] we haven't released the front end publicly yet, so only our engineer can develop it" (Furucombo)

Dapps use voting systems to decide whether to accept or reject a policy or change. Voting power depends on how many governance tokens a person holds or locks into a contract. The community, to which a substantial portion of the tokens is often distributed, should play an important role. However, token holders are usually not capable of developing the features themselves and can't force

the development team to do so either. If a proposal without executable code or voted off chain were accepted, it would merely serve as a signaling system. Therefore, before or after voting, core teams are usually needed to develop the code and executing decisions, increasing their importance in the ecosystem.

"Only a member of the Foundation, our chief or one of the lead engineers, deploys the smart contracts after the code has been run through several audits." (1Inch)

"Voting happens on Snapshot, if a vote has passed the proposal needs to be encoded by the developers of the team. [...] it is the team that enforces the decisions." (Spookyswap)

"The people that are in charge of development, doing the actual work and that are making the road maps and stuff are the people in the Core Units." (MakerDAO)

Proposition 2: *the roles of the actors influence the governance as there is a disparity in the weights of different roles between decision-making and execution. Core teams are more influential than the rest of the community even in more decentralized protocols.*

Incentive schemes

In dapps, it is crucial to introduce incentives for the core teams so they benefit from the improvement and growth of the protocol, since they are the primary contributors to its development and hold a higher influence in the governance. The cases show that core team incentives are well-structured and mainly consist of salaries and tokenomics. Protocol founders mint governance tokens to distribute decision-making power, usually keeping a share of the supply and eventually selling some to external investors to raise capital.

"Contributors get economic incentives like monthly grants or one-time grants. [...] Some time ago we minted 6666 more YFI to pay contributors and more stuff." (Yearn)

"The developers are typically employed by the company, and they get a combination of Fiat and CRV. The company gets code developed and when it is deployed it hopefully helps Curve ecosystem to grow. The company has a little bit of CRV, so this is its incentive." (Curve)

"Developers received an initial token allocation and have reserved a percentage of the future token emissions. It is not all distributed initially so that they do not lose the incentive to work on the project" (Spookyswap)

"The people in the core units are all paid out by the protocol. They have a salary that can differ per Core Units and then there's also an MKR bonus." (MakerDAO)

These incentive systems ensure that teams develop and grow the protocol in a way that benefits the entire ecosystem given that they earn from increasing the value of the governance token, whose price depends on its demand and utility.

In DeFi applications, liquidity providers (LPs) are well incentivized because their capital is needed for the protocol functioning. LPs get a share of user fees and token emissions when they stake tokens. Governance tokens are distributed to them to attract liquidity while keeping protocol fees low to encourage the application adoption and use.

Instead, the community is often not particularly incentivized to contribute to governance and development; rather, it has incentives to just hold or stake the tokens. Therefore, token holders might acquire tokens only as speculative investments and not because they are interested in participating in the governance of the protocol. The absence of incentives destined to governance activities might be one of the reasons explaining the general lack of community participation in discussions and decision-making procedures.

"Unfortunately, the community engagement is quite low. Most of the proposals have been proposed by the team." (Spookyswap)

"It takes a lot of effort for the users to actively participate in the DAO" (1inch)

"Participation depends on the topic. If the topic is controversial there is more participation in governance. But if the change is small, we don't have that much participation. There is some voting apathy." (Yearn)

"We haven't had formal proposals actually initiated from the community." (Furucombo)

Instead, some protocols, such as Curve, reward those individuals who lock their tokens to get voting power and also impose penalties for unlocking prior to the due date. In return, they tend to have a more active community. Finally, MakerDAO does not have incentives for passive holders, while it pays contributions for those members more involved in the governance, to foster more ideas and dynamic discussions.

"The 50% of trading fees going to the DAO gets distributed to those who have voting power." (Curve)

"There are quite many proposals from the community, and I don't even track all of them." (Curve)

"If you are a delegate, you basically commit to spending more time to becoming knowledgeable and becoming an informed voter. Recognized delegates are eligible for

receiving a DAI compensation based on how many MKRs are delegated to them." (MakerDAO)

"When it comes to other participants for example passive MKR holders, there is not really any incentive going on." (MakerDAO)

Proposition 3: *incentives schemes influence the participation in governance mechanisms and in contributing to the growth of the application. Distribution of decision-making powers needs to come with properly set, balanced and aligned incentives to ensure all stakeholders have aligned interests.*

Evolution and reasons for decentralization

Finally, it is important to understand the reasons why governance decentralization is sought in the first place. Understanding what leads founding teams to distribute governance tokens to the wider community and, with them, some decision-making power, might help explain the governance systems adopted. Three main reasons are behind the phenomenon: (i) ideological reasons aligned with the ethos of blockchain technology and its founding motifs, (ii) to make the protocols more efficient and resilient to censorship and external regulations, (iii) to gather community feedback and more ideas on how to move forward.

"Decentralization is super important because you cannot think that you have the best ideas in the world; if you involve more people, you are going to have a collective intelligence. [...] On another side, there's the reality that decentralization is better to avoid censorship." (Yearn)

"It's always interesting to have things decentralized, autonomous and existing without your wish, because then they are much more resilient." (Curve)

"I think one of the reasons is that it is something we should do as a Web3 team." (Furucombo).

All protocols share a vision of creating more decentralized organizations, increasing the community cooperation and involvement. As a result, dapps' builders are challenged to find ways to introduce community ownership to guarantee the long-term health of the system while ensuring the security of the code base and that decision-making does not stagnate, leading to inefficiency and a lack of action. This is usually done through the institution of DAOs. However, DAOs are not mature enough or able to run protocols independently, autonomously, and efficiently, as they are bound by the limits of algorithmic administration of governance. This is the reason why even more decentralized protocols have specifically appointed development teams

alongside the DAO, whose powers are delegated and supervised by the token holders themselves.

Proposition 4: *decentralized applications are still experimenting with the right form of organizational structures and community empowerment mechanisms by way of progressive decentralization. DAOs can help builders in achieving their vision of protocols running as designed without censorship from external regulations, but alone they are not suitable to ensure continuous development of the protocol.*

5. Discussion

On a theoretical level, the research finds that the decision-making systems and individual roles define power distribution in the extent to which different stakeholders have a say in protocol matters and dictate who has authority over certain processes and how it is exercised. On the other hand, communication systems and incentives can be considered variables supporting the good governance of blockchain projects, and they determine whether decentralization is real and works effectively and efficiently. Indeed, the dispersion of decision-making rights among stakeholders is not sufficient for governance to be truly decentralized if it is not supported by well-designed structures that empower and include the community from the proposals' ideation to their implementation and execution.

Switching the focus to the governance models of decentralized applications per se, the results shed light on who holds decision-making power, how it is dispersed among stakeholders, and what and how key decisions are made and enforced in Dapps. All applications analyzed show some recurring elements and similarities but still there is no prevailing governance system or structure in place. DeFi is a rapidly evolving space and thus protocols are still experimenting with the design of different models that can quickly react to the sudden changes and evolving market dynamics. To do so dapps rely on both off and on chain governance and still extensively use and need social governance and human involvement.

Additionally, the analysis show that decision-making processes are not copied and pasted across all types of decisions but are frequently tailored to the purpose. Operations and development are almost exclusively carried out by core teams, while token holders are often given control over the mechanisms for token distribution itself, treasury fund spending, and the setting of product

parameters. In more decentralized protocols, token holders can place a limit on the powers exercised by the platform builders and monitor their actions. Centralization does not necessarily have to be considered negative and decentralization positive. Dapps try to find a balance between the two extremes, but none qualify as fully decentralized. These blended forms enable more effective processes and outcomes and are less likely to reach deadlocks. As scholars state semi-decentralization seems to be higher performing as it enables recurring and operational decisions to be taken in a faster and more efficient way, while broad-impacting decisions can be shared among various stakeholders. (Chen, Y., Richter, J. I., & Patel, P. C., 2021).

As a result, the research finds that more than enabling alternative forms of governance, at this stage, blockchain seems to support or transform existing ones to increase collaboration and participation among stakeholders in a project. The governance structures observed resemble traditional ones, with the advantages of transparency and inclusiveness, privacy, control of the data, auditable code, and bottom-up feedback systems.

Finally, the findings of the research are somewhat at odds with the well-known and celebrated ethos of blockchain technology which seeks to eliminate the need to trust a central entity. In decentralized applications not all participants are equal; there are still groups of individuals that continue to take the reins and make crucial choices on behalf of a wider ecosystem of participants, and often without having real accountabilities assigned.

6. Conclusions

The study investigates the governance of multiple DApps, examining how decentralization is implemented in practice. This resulted in the identification of the fundamental components of DApp governance and their relationships. From a theoretical standpoint, this study contributes to the existing literature on blockchain and its effects on the governance of organizations by presenting insights on a topic that is virtually unexplored in the academic literature. From a practitioner's standpoint, this research may be valuable to individuals interested in designing the governance of a DApp or, more generally, to companies that wish to decentralize their governance using blockchain technology. As with any empirical

Commented [NM1]: Chen, Y., Richter, J. I., & Patel, P. C. (2021). Decentralized Governance of Digital Platforms. *Journal of Management*, 47(5), 1305–1337. <https://doi.org/10.1177/0149206320916755>

studies, this one has limits, which may open the door to new avenues of inquiry. The first relates to the generalizability of the conclusions obtained. The examined Dapps all belong to the field of decentralized finance. In light of this, it may be worthwhile to investigate DApps that provide different types of services. In addition, the study does not differentiate between DApp lifecycle stages in our research. Consequently, future research might concentrate on a more longitudinal examination of the evolution of a DApp's governance.

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