Assessing the Impact of Tokenized Financial Assets on Blockchain for Start-Up Fundraising and the Significance of Decentralized Governance

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Lee Kai Maikel Lee
Student number: 4255011
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GRADUATION COMMITTEE

Chair & First Supervisor : Dr. ir. A.F. Correljé, Faculty of Technology, Policy and Management
Second Supervisor : Dr. ir. V.E. Scholten, Delft Center for Entrepreneurship
Advisor : Dr. ir. R. van Bergem, Faculty of Technology, Policy and Management

Executive Summary

The start-up industry is known for its disruptive, innovative, and fast-paced nature, but it also faces significant challenges, particularly in early stage financing. While Silicon Valley is home to the largest concentration of venture capital in the world, the funding is highly concentrated in this region, making it difficult for start-ups outside of this hub to access financing. The Silicon Valley model is not necessarily effective in other regions, industries or countries. Crowdfunding relies less on demographic or geographic factors and can act as a solution for founders who do not have the necessary resources, network or experience to tap into the ecosystem that Silicon Valley has to offer. However, transparency and trust issues can arise in crowdfunding because the start-up will target a broader public. By introducing dequity as a blockchain token, the concerns regarding these transparency and trust issues can be eliminated.

This research investigates the potential impact of blockchain based start-up crowdfunding. The emergence of blockchain and cryptocurrencies paved the way for a more decentralized finance system, which offers alternative funding opportunities for start-ups. This study analyzes the benefits and drawbacks of blockchain based crowdfunding for start-ups, and how it could impact the traditional financing models. With this research, we wish to better understand the role of tokenized financial assets for blockchain ventures and how blockchain technology can change how start-ups, who are less resourceful, can be financed. The research objective is to understand what impact tokenized financial assets on blockchain can have on new ventures, by understanding how tokens are being used by blockchain based ventures, and how this could improve trust and transparency.

Existing literature was reviewed to identify the research gap. The literature discusses the use of blockchain based tokens for start-up financing. The findings highlight the importance of tokens for a decentralized governance system, tokens representing ownership in a company. Dequity tokens are explored by comparing them to the traditional funding mechanisms of equity and debt.

The study adopts a qualitative research approach in which the Institutional Analyses and Development framework was used to provide a clear structure to the research. The research was conducted by analyzing data from Ethereum, Polkadot and Terra that consult their communities for important decision making within its ecosystem. The findings suggest that blockchain based crowdfunding allows to raise funds for start-ups from a broader pool of investors, without the necessity to tap into the ecosystem that Silicon Valley offers, and a potential faster funding method than traditional methods. However, there are some concerns regarding trust and transparency with crowdfunding. Additionally, the study found that adopting dequity can increase transparency and trust for the investors, while granting the crowd investors more control.

The proposed solution is a dequity token with a governance system that has quadratic voting, a voting multiplier and locking a large portion of the raised funds during the crowdfund. However, the proposed solution is not without fail-safe as dequity is based on the behavior and goodwill of its stakeholders. Stakeholders with bad intentions, who own significant amounts of tokens, can split their tokens into multiple wallets to bypass quadratic voting, which can compromise the company's liquidity and its sustainability.

Overall, the research suggests that blockchain based crowdfunding can offer new opportunities for entrepreneurs to raise capital, in an inclusive manner, without the need for venture capitals or banks. However, the study recommends that further research should be done on the behavior of stakeholders before the proposed dequity model can be adopted by start-ups.

Contents

1 Introduction

1.1 Problem Definition

Our society is becoming more digitalized and connected, digital technologies have become a part of everybody's life. Smartphones and the internet make it possible to be connected to global information and to each other within a single click, regardless of where you are (Dufva & Dufva, 2019). Innovators are rapidly building new technologies and products to improve efficiency and convenience. The ongoing digital revolution could potentially lead to a radical shift from the traditional model of monetary exchange to a digital one (Brunnermeier, James, & Landau, 2019). Digital money facilitates near instantaneous peer-to-peer money transfers that were previously impossible. New payment methods can emerge to stimulate and benefit social and economic platforms, redefining the way we process payments and how data interacts to transcend national borders (Brunnermeier et al., 2019). With WeChat and Alipay's digital wallet dominance in China, digital money is already available. Facebook announced its own digital currency in 2019, called Libra, as a cryptocurrency based on an emerging technology called blockchain (Brunnermeier et al., 2019).

There is one specific industry that is the foundation of recent innovatory development, and that is the start-up industry. The start-up industry can be characterized by disruptive, innovative and rapid growth. However, the start-up industry faces some significant challenges, especially when it comes to financing in their early stage of development (Cegielska, 2020). Start-ups need capital in order to invest in innovation.

Silicon Valley is a thriving economic region in California that is known for its innovation and entrepreneurship (Wonglimpiyarat, 2006). Silicon Valley was founded by top-tier universities for the development of semiconductors in the 1950s and 1960s. It was only later that Silicon Valley turned into a hub for entrepreneurs and innovation (Wonglimpiyarat, 2006). It is home to the largest concentration of venture capitals in the whole world, with a dense and wide network of entrepreneurs, researchers and investors for the sole purpose of innovation. Silicon Valley's development in risk-taking, entrepreneurship and innovation was mainly supported by venture capital financing. There are several factors that contributed to the success of Silicon Valley in capital funding (Wonglimpiyarat, 2006):

- Network effects: since Silicon Valley is a hub of large high-tech firms, there is a strong network of experienced investors and entrepreneurs. This network effect is beneficial for start-ups to connect with other investors or entrepreneurs.
- Access to capital: there are many venture capital firms and angel investors in Silicon Valley who want to invest in start-ups.
- Strong ecosystem: by being a hub for innovation, Silicon Valley has a strong ecosystem which benefits start-ups to access talented individuals, research and development institutions.
- Risk-taking culture: the culture of Silicon Valley encourages entrepreneurs to take high risk and focus on innovation, because it is acceptable to fail.
- Reputation: due to its reputation of being a hub of innovation, Silicon Valley attracts entrepreneurs from all over the world who wish to start a start-up.
- Government support: government programs and incentives have stimulated the growth of Silicon Valley by attracting talent and investments.

However, the funding in Silicon Valley by venture capitals is highly concentrated in a hub with strong networks, some issues or inequality can arise. The Silicon Valley model is not necessarily applicable or effective in other regions, industries or countries, as other regions do not have the same level of resources or cultural support for entrepreneurship. If entrepreneurs or start-ups do not have access to Silicon Valley due to their geographic or demographic background, they cannot tap into the ecosystem and its benefits that Silicon Valley offers. This means that not all international talents have the necessary tools or resources to move to Silicon Valley, as housing in the region is becoming more scarce and costly(Gabbe, 2019).

Silicon Valley has also been criticized for lacking diversity in the types of companies that receive funding and for the demographic of people involved. Since capital funding is limited, combined with the fact that there is high competition in Silicon Valley, founders who are less resourceful in terms of network or inexperienced founders may find it difficult to secure investment for their start-up (Dallaway, 2008). So even though Silicon Valley offers a great solution for founders, if a founder cannot tap into the ecosystem that Silicon Valley offers, it can be hard to secure funding elsewhere from venture capitals.

Crowdfunding on the other hand, relies less on demographic or geographic factors of the start-up founders, and could act as a solution for founders who do not have the resources, network or the experience to tap into the capital funding that Silicon Valley has to offer (Chen & Ma, 2023). However, since crowdfunding targets a broader public, the regulatory rules are not consistent, and goals between the founders and crowd investors can be misaligned. Transparency and trust issues can arise. Whenever lead investors or founders take the lead of the direction of the start-up, it does not eliminate risk of investment. On the contrary, it might create another layer of conflicts of interest (Chen & Ma, 2023). Whenever the founders or lead investors have too much insider ownership of the start-up, it can lead to a reduction of crowd investors' investments during a crowdfunding event (Chen & Ma, 2023). It seems like the crowd investors do not want founders to have the majority of insider ownership, for them to invest into the start-up.

This creates another dilemma of how the power within a start-up should be divided to increase transparency and trust for the investors. The trust issues could be improved by borrowing money from investors by issuing debt, but this means that the start-up does not issue equity as they do in Silicon Valley. If the investors want to maintain a percentage of ownership in the start-up and have a share in profits of the start-up, equity should be sold during the crowdfunding event (Cegielska, 2020). However, for a crowdfunding event with investors from a global public, selling equity while maintaining the trust which are present in debt is not possible due to the different regulatory rules (Williamson, 1988). For debt to work, there has to be a governing body that enforces the rules. This means that for a global community of investors to work well, the solution would be a trustless governing body that executes rules based on contract (Williamson, 1988). The lack of trust and transparency could potentially be improved with an innovative system that can act as a governing body, which leads us to the next topic.

1.2 Blockchain and Tokenization

To drive further innovation in fundraising sources, an emerging technology called blockchain could potentially be used to help finance start-ups. Blockchain technology can be used to issue digital tokens that represent ownership of a firm, which can be exchanged for capital during a fundraising round. Blockchain is a public ledger of all transactions that were processed in a peer-to-peer network. Before a transaction can be processed in this ledger, it needs to be verified by consensus and shared among a group of computers. Therefore, blockchain typically does not have a central authority. The information on the ledger is immutable and fully public, making it extremely easy to monitor and maintain transparency. However, blockchain transactions are anonymous as they are not directly tied to an individual, unless the owner of a specific wallet is already known (Crosby, Pattanayak, Verma, & Kalyanaraman, 2015). Bitcoin is the first blockchain in existence and was designed in 2008 by a pseudonymous individual or group called Satoshi Nakamoto (Ammous, 2018) (Crosby et al., 2015) (Nakamoto, 2008).

Bitcoin allows online payments to be sent directly without going through a centralized financial institution, such as a bank (Berg, Davidson, & Potts, 2019). Electronic payments rely on financial institutions as trusted third party middleman to process those payments. The role of these trusted parties is to validate, safeguard and preserve transactions (Crosby et al., 2015). Traditional financial institutions have proven to work well for the majority of transactions, however, its weakness lies in the trust based model of payments (Nakamoto, 2008). These kinds of money transfers cannot be completely irreversible due to potential disputes. A middleman increases transaction costs and this indirectly limits smaller money transfers, while the loss of reversed transactions for irreversible paid services should also be considered. Blockchain provides a platform with irreversible transactions based on cryptographic proof, which removes the need for trust (Nakamoto, 2008).

The trustless factor of blockchain can be explained with smart contracts (Ante, 2020). A smart contract is a script of codes on a blockchain that predefines the rules and boundaries of a specific blockchain or application. Smart contracts can be described as cryptographic boxes that contain value which are unlocked when certain conditions are met, such as a blockchain transaction (Buterin, 2013). This means that certain processes can be automated without a trusted third party. Smart contracts can represent legally binding processes (Ante, 2020). This opens blockchain up to many other use cases than just monetary purposes, some of which are shown in Table 1. In other words, blockchain can be used to increase transparency, decentralization and efficiency by using smart contracts to automate certain tasks of tokenized financial assets.

Table 1: Blockchain use cases through smart contracts (Zile & Strazdina, 2018).

(Data) management	**Data verification**	**Financial**
Network infrastructure	Identity verification	Equity issuing
Cloud storage	KYC	Currency exchange
Identity data management	Product quality verification	Peer-to-peer payments
Contract management	Data history verification	Supply chain management
Content distribution	Proof of origin	Insurance
Corporate governance	Voting verification	Crowdfunding

Interestingly, cryptocurrencies are mostly discussed for their financial properties. Blockchain has been widely used as a crowdfunding platform. Similarly to how initial public offerings (IPOs) are launched to sell equity, initial coin offerings (ICOs) are launched to sell cryptocurrencies, also known as tokens (Burilov, 2019). The tokens that are minted for the ICO are based on smart contracts and are fully deployed on a specific blockchain. These tokens can have an actual utility or an economic function. Whenever these tokens represent an economic function, the ICO can also be referred to as a Security Token Offering (STO). During an STO the company also sells tokens, but these tokens represent a traditional asset such as equity (Burilov, 2019).

With the correct tokenomics, tokens can become superior or complementary to traditional financial assets. Tokenization of financial assets could be the reason why start-ups and corporates should start raising capital through an ICO instead of an IPO. ICOs proved to be a successful model to raise a significant amount of capital for start-ups. From 2013 to 2020, 29 billion USD was raised from ICOs. An ICO, however, has various downsides, including but not limited to the uncertainty surrounding its regulatory and legal status, potential lack of transparency leading to risks for investors, and a higher susceptibility to fraudulent activities (Boulianne & Fortin, 2020). These crowdfunding events happened in a pseudo-anonymous manner between blockchain projects and a global community.

Blockchain, and its trust through decentralized governance, makes it possible for global communities to come together to build decentralized infrastructures and receive funding from a global community. Smart contracts and tokenized financial assets on a blockchain can be of significant importance in financing infrastructures and projects by increasing trust through set rules in the smart contract. Blockchain can transform the strategies and alter the resource base of a firm (Schallel, Lieshout, Massey, & Hough, 2020). However, the relationship between corporates, start-ups and the financial markets has to be redefined for blockchain technology to be adopted to finance start-up (Crosby et al., 2015). The traditional relationship between corporates, start-ups, and financial markets is often hierarchical, with established corporations dominating the financial market and controlling where capital flows (Wonglimpiyarat, 2016).

However, blockchain technology has the potential to change this relationship by enabling decentralized networks and P2P transactions, which eliminates the need for intermediaries like banks and financial institutions. Therefore, to promote the adoption of innovation and new technologies within the blockchain industry, a new framework for collaboration and investment that promotes the adoption of innovation and technology is necessary (Burilov, 2019). This could potentially involve new fundraising methods, partnerships between corporates and start-ups, and a radical change in the mindset of financial markets regarding disruptive technologies . It is interesting to understand how it is possible, through which set of rules and incentives, that global communities which have never met and do not know each other can trust each other to collectively invest in and successfully fund blockchain start-ups.

1.3 Research Objective

With this research, we aim to better understand the role of tokenized financial assets for blockchain ventures and how blockchain technology can change the way start-ups, which are less resourceful, are financed. The research objective is to understand the impact that tokenized financial assets on blockchain can have on new ventures by examining how tokens are being used by blockchain-based ventures and how transparency and trust could be improved. The research question reads:

What is the impact of tokenization of financial assets on blockchain in start-up financing and how can it improve trust and transparency?

We have formulated three different sub-questions that can assist in addressing the main research question and eventually lead to a conclusion.

Sub-questions

1. What is the current landscape of tokenized financial assets and how do they relate to equity and debt?

2. How do blockchain ventures approach the governance system design to make important decisions in their ecosystem?

3. How can the functionality of token models be enhanced to increase trust and transparency for investors?

1.4 Research Overview

This research is structured into several chapters, in which each focuses on specific aspects of the research topic. A literature review follows the introduction to identify the research and knowledge gaps in Chbapter 2. In this literature review, we shape the understanding of debt and equity, the core concepts of blockchain technology, blockchain crowdfunding, tokenized financial assets and a theoretical framework used for the research. The literature review plays a crucial role to inform and contextualize our research. by summarizing the relevant literature that relates to our research topic, we gain insights into the existing knowledge and can form a research gap. With this knowledge, the first research question '**What is the current landscape of tokenized financial assets and how do they relate to equity and debt?**' can be answered.

Chapter 3 describes the methodology. The Institutional Analysis and Development framework (IAD) is selected to be used for our research. This framework serves as a powerful tool for analyzing decentralized governance in blockchain ventures, offering valuable insights into the dynamics of decision making within these ecosystems, by examining the five core concepts: action situation, actors, network resources, governance system and outcome. The methodology concludes with a case study criteria and selection overview, with the selected cases being Ethereum, Polkadot and Terra.

Chapter 4 presents the research results. Each case is examined separately using the five core concepts of the IAD framework, after which a schematic overview based on the framework is provided for clarity. By analyzing the cases through the IAD framework, we can understand how governance models work and how blockchain ventures address any issues related to decentralization and anonymity. The IAD framework demonstrates how protocols are used by communities and stakeholders to make important decisions through voting. We compare the five core concepts and their token utility across all cases to determine the financial properties of these tokens. With the results and its comparison, we can answer the second sub-question: '**2. How do blockchain ventures approach the governance system design to make important decisions in their ecosystem?**'

Chapter 5 opens the discussion based on the presented results. Specifically, the focus will be on how tokens can be utilized to enhance trust and transparency in start-up financing. By exploring the potential benefits and drawbacks of tokenized financial assets, and looking for ways to improve the current token models, we can answer the third sub-question: '**3. How can the functionality of token models be enhanced to increase trust and transparency for investors?**'. This makes crowdfunding more accessible and inclusive across different regions, industries, and demographics. Ultimately, the goal is to provide valuable insights into how the role of tokenized financial assets for blockchain ventures can change the way how start-ups are financed.

In Chapter 6, we offer a summary of the key findings of our research and provide answers to the research objectives, including the main research question: '**What is the impact of tokenization of financial assets on blockchain in start-up financing and how can it improve trust and transparency?**'. Additionally, this chapter discusses the implications of the conclusions and recommendations for future research, providing valuable insights for a further study into this field.

Finally, Chapter 7 takes the reader into a reflective research journey of the researcher, including the up and downs, challenges along the way and how Williamson's pioneering vision influenced this research.

2 Exploring the Potential of Blockchain Based Tokens in Start-up Financing

With Silicon Valley having limitations of not being able to provide capital for every geography or demographic, crowdfunding could be a solution for founders who cannot tap into the benefits that Silicon Valley has to offer. However, crowdfunding also comes with limitations due to the global network of investors. Crowdfunding can create a conflict of interest between the founders and investors, while there are issues with trust and transparency. A governing body that executes based on contract can provide a solution for these issues.

In recent years, blockchain technology has emerged as a disruptive innovation in the world of finance and investment. One of the most common use cases of blockchain is the issuance of digital tokens. These digital tokens can be used to represent different types of assets, such as equity, debt, or utility. These tokens can be issued on a blockchain network, making them easily accessible to a global audience and enabling new forms of financing and investment that were previously impossible. Despite the growing interest in those blockchain based tokens, there is still a lack of research in blockchain based decentralized governance and raising capital. Particularly, there is a need to explore different token models in existence and what kind of benefits and features they have. Additionally, the role of blockchain based decentralized governance should be explored to understand its role and impact on transparency and sustainability.

The sole purpose of this chapter is to address the research gap mentioned above and to provide a comprehensive overview of the current state of knowledge regarding certain financial assets, blockchain based tokens and the current state of governance. This literature review shows what kind of opportunities and challenges can arise with the emergence of blockchain technology and can identify where further research is needed. This review can contribute to the development of a more effective and efficient decentralized ecosystem for blockchain based financing and investments.

2.1 Pros and Cons of Debt and Equity Financing for Start-Ups

The ideal market is when the prices of financial assets fully reflect all available information. Market prices are based on expected returns, while the reflection of information fluctuates every moment in time (Fama, 1970). According to Fama (1976), for the market to be fair, the available information should be sufficient. Full transparency regarding information cannot be available to everybody, as this goes into the nature of innovation.

Financial markets do not always stimulate efficient resource allocation in companies. It is observed that companies spend resources on stock buybacks and high dividends rather than investing in innovation and RD to please shareholders (Lazonick, 2011). Shareholders and the managing board of a company might have different goals, leading to potential conflicts. These goals can be better aligned through incentives for the managing board such as bonus compensations. The managing board would then base their decisions on maximizing financial returns for the shareholders and themselves (Lazonick, 2011).

Over the last decade, 58% of profits of SP 500 firms were allocated to stock buybacks, 41% of profits were paid out as dividends, and only 1% of the profits were invested in innovation and RD (Lazonick, 2011). It shows that there might be a problem in which the long-term goals of an organization do not align with the short-term goals of capital providers. The current financial markets cannot properly force firms to be more efficient due to the fact that the goals of the organization and the capital providers have diverged. A different route would be to take a loan from a bank. This loan would fall under debt. Banks do not always commit to a loan, as they prefer to invest in assets that are already issued to reduce risks (Hudson, 2012). The characteristics of both equity and debt are discussed below.

Debt is a rules-based financial instrument. Borrowers are subject to liquidity requirements and have to agree to a fixed schedule of repayments with a fixed expiration term. These terms are unforgiving, if the borrower cannot repay the loan, the underlying assets of the project or company will be liquidated to compensate the lender. The properties of debt are (Williamson, 1988):

- Interest repayment at regular intervals
- Business will continuously be tested for liquidity
- Sinking funds will be set up and principal repaid at expiration date of loan
- Failure of payment will result in liquidation of underlying assets of company or project

Debt has a lower setup cost than equity and is more predictable, which makes it easier to align expectations and allows for more certainty. This makes debt well-suited for projects in which the assets are highly redeployable. Equity, on the other hand, has a higher setup cost, as it introduces uncertainty to the equity holders and is a governance system that allows discretion, which is mostly used for projects in which assets are less redeployable. The value of debt decreases whenever asset specificity is increasing; in this case the production costs can increase or the quality can decrease. Equity could pose a solution to higher asset specificity. Equity is favored over debt if assets become non-redeployable. The properties of equity are (Williamson, 1988):

- Has a residual claimant status to the company in earnings and asset liquidation
- Equity is tied to the duration of the company
- Equity has the power to replace management
- Equity holders have access to internal performance measures
- Equity holders can authorize audits
- Equity holders are updated on important investment and operating proposals before implementation

With the different properties of debt and equity, start-ups will have to look into what option best suits their long-term strategy. The long-term strategy determines what kind of financing the firm needs to opt for, as there are several ways that tech companies can get financed: venture capital raise, angel investors, crowdfunding, bank loans, initial public offerings (IPOs) and strategic investments. By receiving funds from venture capitals, angel investors or crowdfunding platforms, the firm receives capital for its start-up in exchange for equity (Cegielska, 2020).

By opting for bank loans, the start-up receives funds through a bank loan, which involves borrowing money from a bank while having to repay the borrowed money with interest over time. With an IPO, the start-up goes public and raises funds by selling shares of their company on the stock market. Lastly, funds can be raised through strategic partnerships in which start-ups form a partnership with other firms and exchange capital for a share of the company, or for a percentage of future profits.

Alongside the benefits that the company is allowed to grow with the raised capital to drive innovation, companies struggle with the aforementioned financing sources, as start-ups are typically in their early stage of development and do not have a proven track record of success, which makes it difficult for traditional financing sources to evaluate the potential of the start-ups versus the risks involved. Moreover, the availability of capital is limited, which results in angel investors or venture capitalists being highly selective of how they would allocate their funds (Cegielska, 2020).

Many start-ups struggle to grow and succeed, if they cannot tap into the Silicon Valley ecosystem, as many start-ups have limited access to funding sources like venture capital or angel investors. Even if they manage to find venture capital, it means they are relying on venture capitals whom can pressure the start-up to spend their resources with the priority to increase the value for their shareholders, which comes at the expense of actual innovation or product development. In other words, the company could be pressured into making short-term decisions rather than long-term sustainability. It is important for the start-up to carefully look for venture capitalists for funding, while also considering the support and strategic guidance and its connections within the industry (Wonglimpiyarat, 2016). In start-ups where the business model does not specifically favor using rules or discretion, a puzzle arises. In such business models, neither equity nor debt can be considered a solution under different conditions, as neither rules nor discretion can be said to dominate the other (Williamson, 1988).

However, with a innovative system, these two assets could potentially work together. This would mean that instead of choosing between equity or debt, start-ups could find a way to use the advantages of both assets. By utilizing the advantages of both assets, the start-ups may find a better balance between rules and discretion which could potentially create a better solution for their funding needs. According to Williamson (1988), utilization of such financial assets requires a system that binds individuals and companies to their promises. Fortunately, blockchain technology emerged which can provide a solution. With blockchain, transactions and agreements are recorded in an immutable and transparent manner, creating a trustless environment in which smart contracts can automatically execute agreements when predefined conditions are met (Hileman & Rauchs, 2017). We shall explore the potential of blockchain technology and its ability to adopt financial assets, along with its implications for start-up financing and decentralized governance systems, in the next sections.

2.2 The Core Concepts of Blockchain Technology

As mentioned in the introduction, bitcoin is the very first blockchain which was introduced by Satoshi Nakamoto (Nakamoto, 2008). Blockchain is a decentralized peer-to-peer (P2P) network based on distributed ledger technology (DLT). Blockchain could also be described as a type of database that is replicated over a P2P network (Hileman & Rauchs, 2017). However, this definition by Hileman et al. (2017) could also apply to other distributed databases. This subsection will dive deeper into blockchain technology and its core concepts according to Hileman et al. (2017), which will make it clearer to the reader how blockchain can be a solution for our research goal.

2.2.1 Blockchain Core Concepts

Blockchain technology has five core concepts: cryptography, P2P network, consensus mechanism, ledger and validity rules. These concepts are shown in figure 1, which we shall briefly describe.

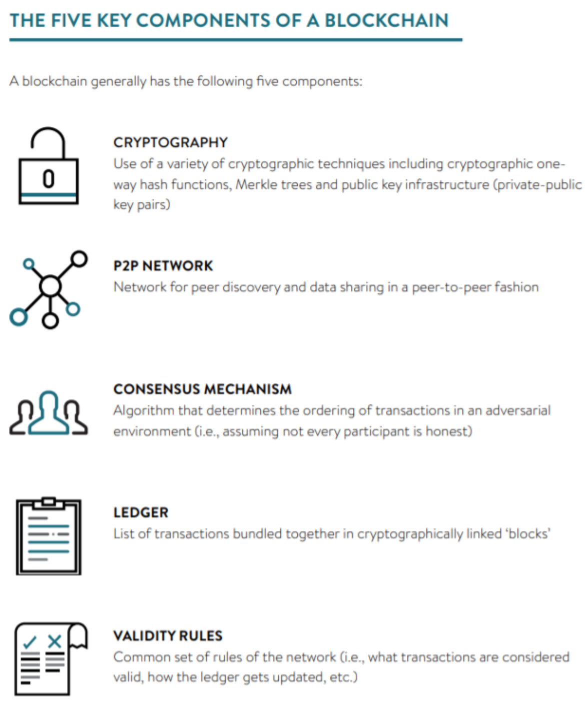


Figure 1: The five core concepts of blockchain (Lo & Medda, 2020).

A **P2P network** is referred to as a secured network that has no involvement of trusted third parties (TTPs). It basically means that all involved individuals and entities are directly connected to each other due to the lack of a centralized database. Blockchain is a decentralized P2P **ledger**, in which the ledger represents a bundle of data/transactions that are connected through blocks. Whenever a transaction is verified on the ledger, a block will be minted. These blocks with transactions are stored on various nodes in the network, resulting in duplicated versions of the verified blocks in the system.

Blockchain technology has a **consensus mechanism** that acts as a solution to the double-spending problem (Nakamoto, 2008). A TTP is usually used to make sure cash is not spent more than once. However, the double-spending problem exists because centralized parties. Hileman et al. (2017) refers to this consensus mechanism as an algorithm that determines the ordering of transactions in an adversarial environment. Tasca et al. (2018) breaks a blockchain down in two categories: a private blockchain and a public blockchains. The key difference between public and private blockchain is the consensus mechanism used in the blockchain. The most commonly used consensus mechanisms are Proof-of-Work, Proof-of-Stake and Proof-of-Authority, which are discussed below (Tasca. & Tessone, 2018).

- Proof-of-Work (PoW) is a consensus mechanism that is the core algorithm behind bitcoin. PoW is used to ensure the immutability of transaction records to a certain degree. In this setup, the validation process of a blockchain is done through miners who are connected to a P2P network to validate the transactions in the distributed ledger (Nakamoto, 2008). These validations are tied to **validity rules**, which could be described as rules that miners or validators of a blockchain have to follow. The generation of a block in a PoW blockchain requires finding the solution of inverting a cryptographic function by brute force. This algorithm checks data from all nodes in the ledger, however it requires a lot of computational power and can be time consuming. The probability of mining a block depends on the ratio of the computational power of the miner and the total instantaneous computational power from all miners connected to the blockchain. PoW consumes a large amount of energy, has no provable finality and has no effective strategy to remove cartels. PoW is typically a public blockchain, because miners can be part of the network without any permission from an authority.

- Proof-of-Stake (PoS) is a consensus mechanism that links the block generation to the proof of ownership of a certain amount of digital assets. The probability that a validator is selected to verify the next block depends on the ratio of the assets that is contributed to the network. The assumption is that anybody with a large share of the assets in a system are more incentivized to provide trustworthy information, thus should be considered as a trusted validator. PoS is typically a public blockchain.
- Proof-of-Authority (PoA) is a consensus mechanism which has pre-determined miners, chosen by an authority to make sure that the content on the blockchain can be controlled. PoA is typically a private blockchain and the least used consensus mechanism of the three.

Cryptography is traditionally provided by a TTP, however, with the addition of blockchain technology these TTPs are usually not necessary anymore due to its data encryption. Cryptography refers to the method of encrypting and decrypting data through a mathematical algorithm. With blockchain, data encryption is applied using digital signatures and hashing. A blockchain based transaction is encoded with transaction details. Every block on the blockchain is digitally signed, through a private key, by both the sender and the receiver. Cryptography refers to a digital signature that links to an identity. Therefor, a private key should not be shared with other parties, while a public key can be shared with other parties as it is required for the receiver's side. The digital signature of the private and the public key is the proof of the consent of the transaction. After a transaction is confirmed by a digital signature, the block is added on top of the previous block, creating a chain of blocks. The tying and grouping of the blocks using a cryptographic technique is called hashing (Swa, 2015). Hashing is what makes the blockchain tamper-proof and immutable. It is how blockchain distinguishes itself from other distributed ledgers.

2.2.2 Smart Contracts

The term smart contract was defined by N. Szabo in 1994. Smart contracts were defined as computerized transaction protocols that execute contract terms. Another definition could be that smart contracts are computer programs that can be executed in a network of trusted nodes, without any intermediary of a trusted authority (Prata, Araújo, Santos, & Patel, 2021). The latter definition could be referred to the blockchain use of smart contracts. While smart contracts are not a key component of blockchain according to Hileman et al. (2017), they are key for applications based on blockchain technology. Smart contracts on the blockchain were introduced by the Ethereum foundation (Buterin, 2013).

Smart contracts are computer programs that can automatically perform certain functions that they were supposed to perform. They are one of the core concepts of blockchain, which makes the technology applicable for businesses. Smart contracts can automate a large number of business processes, without any central authority. The difference in coding them into a distributed ledger technology, such as blockchain, is that the execution of smart contracts is governed by the system rules with verifiable and auditable outcomes by miners and validators. Due to the versatility of smart contracts, blockchains allow for data storage for multiple utilities. Any physical asset can have its own characteristics in the computing world, such as price and ownership but also digital data such as personal data, certificates etc.

Blockchain can serve as a safe and reliable storage of those digital assets, as smart contracts serve to execute certain commands on predetermined instructions in an automated manner. Even though smart contracts have the word 'contract' in them, smart contracts are not considered legal contracts in modern law, they serve as instruments to execute clauses which are present in the smart contract (Prata et al., 2021). Traditional contract are usually instruments that create, modify or extinguish legal relations between two or more contracting parties in modern law. The elimination of an intermediary in modern law due to automated triggers from a smart contract can save money on maintenance and administration. One of the advantages of a smart contract over traditional contracts is that risk reduction can be cited due to the fact that smart contracts cannot be arbitrarily changed once they are issued. Smart contracts can be grouped into two categories: stateless systems and stateful systems (Hileman & Rauchs, 2017).

- Stateless systems are transaction-optimized and have limited functionality, with relatively low complexity of computations. For stateless systems, smart contracts can be coded into a blockchain to automatically execute once triggered by an event, for example the confirmation of a payment once an asset has been transferred. These can also be referred to as financial smart contracts which are used for monetary value transactions.

- Stateful systems are logic optimized and have extensive ledger functionality in terms of computational complexity. This system is used to create decentralized apps based on blockchain technology, for example, performing a transaction to unlock content stored on the blockchain.

Smart contracts are automated and self-sufficient, being of a software nature without any intermediary party, which increases the certainty of the execution of contractual clauses. In this research, smart contracts play a key role in governing certain transactions and executing settlements.

2.3 Risks and Benefits of Initial Coin Offerings

Initial Coin Offerings (ICOs) are an innovative new fundraising model used by blockchain start-ups to receive initial capital. During an ICO the start-up mints (financial) assets as their own token for use in their own application or platform. The tokens are sold to the public in exchange for well established cryptocurrencies, such as Ethereum (Berg et al., 2019). The raised capital is used to support the development of the platform or application. Raising capital from the public is normally a heavily regulated activity, but since blockchain is not yet regulated, as cryptocurrencies are not yet considered as money, participants should be wary of the risks and benefits involved with ICOs.

Boulainne et al. (2020) developed a framework identifying the main risks and benefits for start-ups for launching an ICO. The results were determined from a case study on impak Finance which was the first regulated ICO in Canada. Since it is a case study, this literature might consist of internal validity. ICOs have a low entry barrier and capital could be raised at low cost. Many ICOs were launched without the involvement of (financial) regulators (Boulianne & Fortin, 2020). Since the majority of ICOs are unregulated, Boulainne et al. (2020) researched risks and benefits of both regulated and unregulated ICOs.

The key benefits of raising capital through ICOs are the speed of the launch of the ICO, low costs and the fact that there are very few compliance requirements (Boulianne & Fortin, 2020). These benefits are especially attractive to start-ups and small businesses. In addition, transactions on the blockchain are anonymous, reliable, efficient and not restricted to any geographical location. Rrustemi et al. (2020) and Andrés et al. (2019) agree with these benefits. Distribution of tokens to the appropriate buyers can be automated with smart contracts, whereafter the buyers have full ownership over the assets and can do whatever they want with them which stimulates liquidity, according to Burilov (2019). On top of these benefits, Doszhan et al. (2020) mentions the fact that the bought tokens can be traded in to receive certain goods or services or could even be used to express rights to participate in the management of a company, similar to company shares.

By reflecting on the benefits and approaching it from multiple perspectives, we can find some design flaws in the current system of ICOs, which can be backed by the reviewed literature. For example, as a consequence of little to no regulation, ICOs come with significant risks. The aforementioned benefits can become risk factors for either the entrepreneurs or the investors. The entrepreneurs share both their risks and rewards with investors. Start-ups can operate in regions that have limited asset protection for investors against bankruptcy, so ICOs might be prone to scams and capital losses of investors (Doszhan, G., Kalymbekova, & Talasbek, 2020) (Laurent, Chollet, Burke, & Seers, 2020). No centralized authority, such as a bank, has access to the company funds; all ownership of the funds is with its company.

The ICO hype and the regulation difficulty combined could be described as the "Wild West". For example, there was a case with a blockchain company, QuadrigaCX, in which the founder and CEO died (Boulianne & Fortin, 2020). This specific person was the only person who had access to the company funds, and as a result, the company went bankrupt and clients lost their money. The anonymous transactions on the blockchain were mentioned as a benefit, but it could also cause problems. Blockchain start-up teams can fake their identities and remain fully anonymous while raising capital through an ICO and disappear after the ICO. These funds are hard to trace due to the nature of anonymity, and as a consequence, tax reports and revenue can be neglected, faked or manipulated (Burilov, 2019) (Andrés, Arroyo, Correia, & Rezola, 2019).

LakeDiamond is another example of what could go wrong with ICOs. They had launched their own ICO for their own TVK token in 2018 during the "Crypto Winter" in which token valuations were diminishing (Rrustemi & Tuchschmid, 2020). Due to the volatility, the raised funds and their own token valuation crashed. In addition to the crypto winter, LakeDiamond had a lack of clarity of their model and platform in their smart contract which made investors wary of the company which eventually caused bankruptcy due to lack of trust and a diminishing token valuation (Rrustemi & Tuchschmid, 2020). The fact that it is easy and cheap to launch an ICO might be the reason why they had an incompetent team, while the lack of regulation made the investors powerless. These claims were backed by Boulianna et al. (2020) and Rrustemi et al. (2020). In addition, Doszhan et al. (2020) adds that a large number of ICOs will fail just like the majority of traditional start-ups fail.

We believe Blockchain needs to have solutions to reduce risks or single points of failure where a bad actor can steal all funds, or have a fail-safe to prevent another QuadrigaCX disaster and protect investors' funds. It should be possible to have a smart contract send the funds to a different wallet, if the owner of the initial wallet has not signed a transaction for many weeks. However, this could be dangerous for the initial person, as they can be held hostage for a certain amount of time, to have the funds sent to a different pre-determined wallet. If it is not possible or it would require a long time to achieve protection and security, the entree barrier of ICOs should be raised with stricter regulation. Designing frameworks for this purpose is definitely a challenge, but it should be possible by making it less anonymous and making KYC an obligation. Too many retail investors are at risk because of opportunists who are exploiting the naive investors of the ICO craze.

2.4 Tokenization of Financial Assets and the Emergence of Dequity

With cryptocurrencies still in their infancy stage, as mentioned previously, they might not replace or complement traditional money just yet. However, as long as the tokens are minted from the same smart contract, they are interchangeable and can have unique parameters, allowing for multiple use cases. Tokens could potentially be issued to investors to replace equity. Tokens as stock asset brings multiple added features. According to Davydov et al. (2019) tokens are a good solution to provide automated dividends. Companies can distribute profits to token holders in proportion to the amount of tokens investors hold. In the traditional market, a shareholder has some kind of voting rights in the company. With tokenized assets on the blockchain, these voting rights can be verified and the votes can be processed automatically. Lo et al. (2020) believes that further research could lead to the tokenization of more abstract assets and liabilities, besides equity, and that true ownership plays a key role in the adoption of tokenized assets.

Schaller et al. (2020) believes that with the emergence of blockchain, the shortcomings of subsidies for companies to generate network effects are becoming apparent. Since the majority of people can buy a token and own a share of a start-up company, investors want the token valuation to perform well, which stimulates direct network effects. Tokenization of assets can be a serious contender to subsidies as an incentive mechanism. Tokenization allows the creation of a more democratic, efficient new financial system in assets. However, the obstacles are the necessity of adoption and regulation, which could be overcome with the support of actors from all levels (Laurent et al., 2020). If tokens are representing equity or shares, they will be deemed as security tokens. The jurisdiction of security tokens is more strict than for utility tokens. Not just the fundraising, but also trading of the token on secondary markets has to comply with stricter rules (Laurent et al., 2020).

As learned in the previous section, there are a lot of risks involved with cryptocurrencies and their unregulated nature. It is unclear what the laws are during any illegal activities and under what jurisdiction they fall under. However, there are many single points of failure which can lead to a loss of funds. Whenever funds are lost, blockchain based start-up companies may opt to ask their stakeholders what the next steps of action are to potentially recover the funds or move on from the theft. There appears to be a relationship between the founding team and stakeholders.

Thus, even when a stakeholder owns tokens of a start-up company, their share of tokens still does not represent control in the company. Meaning, there is still a separation of ownership and control. According to Williamson, the division of control and ownership creates a principal-agent dilemma where managers may prioritize their own interests over those of shareholders. This can create a conflict of interest for shareholders. To mitigate this issue, corporations need to establish a governance system that can ensure efficient monitoring and incentives for managers (Williamson, 1988).

During traditional IPOs, start-ups can raise money by selling equity or issuing debt. Debt is more rules-based, while equity has better asset specificity, while tokens can have both of these attributes, as shown in Figure 2. A token could in theory be the best of both assets: having equity properties but bound to debt-like rules (Berg et al., 2019). A puzzle is posed in all systems where rules versus discretion are compared. Neither equity nor debt are assets that work in all conditions, discretion does not dominate rules and vice versa.

However, if there would be a system in which a discretionary system can replicate rules in activities that work well for rules, then this new system will do everything as good as a discretionary and a rules-based system and sometimes can even outperform the rules-based system (Williamson, 1988). Instead of referring to a discretionary system or rules-based system, Williamson (1988) suggests several methods to achieve this, which includes the board of directors, executive compensation, and the corporate control market. One of the suggestions, which is the instigator of our research, is a financial instrument called dequity. Dequity is a hypothetical financial instrument devised by Oliver Williamson in 1988 and includes all the beneficial constraining features of debt (Williamson, 1988).

Dequity is not yet available because holders of the equity or a token can act opportunistically and abandon the rules whenever they seem fit. Dequity can only become successful if contracts and rules are governed by promise. However, the central problem with promises is that they lack credibility during contract execution (Williamson, 1988). This is where tokenized dequity on blockchain could step in, as this technology makes it possible to open up and verify promises

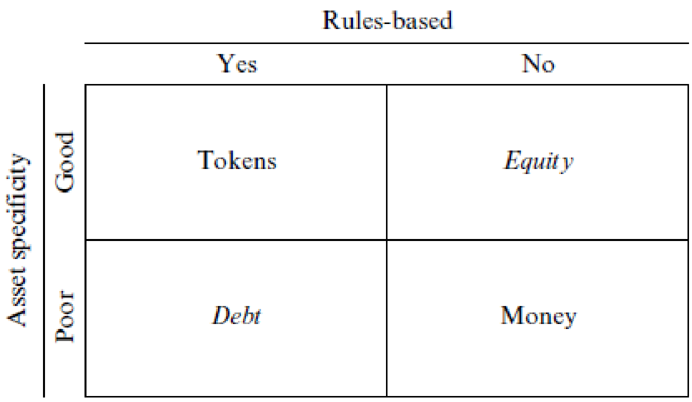


Figure 2: An illustration of how tokens can be superior to equity, debt and money (Berg et al., 2019).

due to the existence of smart contracts (Berg et al., 2019). The governance structure should be designed in a way to ensure that the founding team has the necessary incentives to make financing decisions that are aligned with the interests of shareholders. A true characteristic of dequity is the governance system. Unlike informal governance systems, which use offline and online methods to affect changes, tokenized dequity's governance system works on-chain. Changes to the ecosystem are proposed through code updates, which can then be voted for by certain individuals. On the contrary, off-chain governance behaves similarly to politics, in which groups of interest want to control a network by convincing other individuals to support their ideas or proposals. In this case, there is no specific code or contract that can bind those groups to their promises, so the individuals can choose what is best for their own interests by complying with the interests of other stakeholders (Williamson, 1988).

Code proposals on the blockchain are submitted by developers or a core group of the project. Those groups are usually responsible for coordination and consensus between stakeholders. Stakeholders can be miners, developers, promoters and users who have a vested interest in the dequity token to perform well. Through voting, it can be determined whether the proposal was agreed upon and should be executed. If the proposal was not accepted, the stakeholders can usually still try to convince the other stakeholders in favor of the proposal, but if consensus was not reached, the proposal cannot be executed. This on-chain governance system removes opportunistic behavior, which can be damaging to any ecosystem.

2.5 The Role of Venture Capitals in Blockchain Start-Ups

Hays et al. (2021) recently published a report regarding Venture Capitals (VCs) and their endeavors. Global private equity investments are vital for innovation, job creation, and economic growth, as VCs can provide seed capital and expertise toward research, innovation, and development. According to Hays et al. (2021), 942 VCs have invested in more than 2,700 private equity deals in blockchain start-ups since 2012. Dedicated blockchain VCs have consistently outperformed traditional VCs, resulting in the top blockchain VCs outperforming the entire technology sector.

The importance of VCs can be derived from the increase in investments in start-ups from VCs. Historically, 82% of the investments in blockchain start-ups happened with no VC involvement, but since 2020, the VC involvement in those start-ups increased to 78%. An increasing number of traditional VCs are starting to invest in the blockchain industry, however, the private equity in blockchain start-ups still accounts for less than 1% of the total VC market, as shown in Figure 3 (Hays, Elkov, Rosenberg, Malkhasyan, & Kravchenko, 2021). In a sense, VCs are making it harder for retail investors to participate in blockchain start-ups during crowdfunding events.

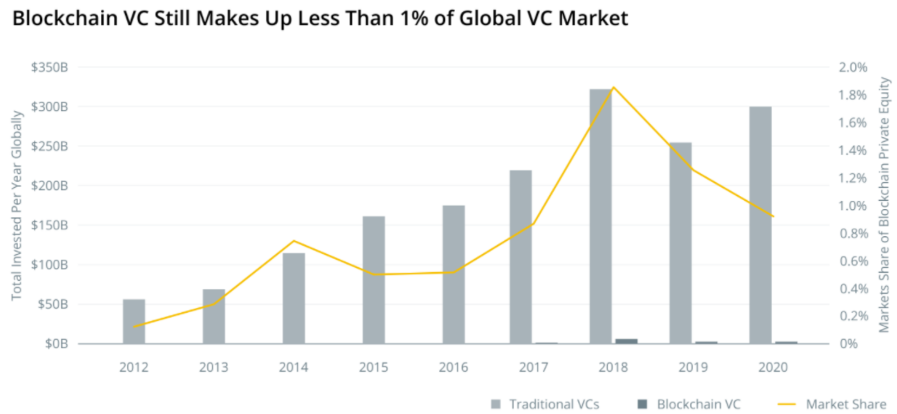


Figure 3: Comparison between blockchain VC and traditional VC investments (Hays et al., 2021).

Interestingly, blockchain private equity is uncorrelated with traditional private equity, stocks and commodities. Blockchain investments are becoming more attractive due to the high returns for the limited partners and private round investors. There are multiple types of investors, and depending on the strategy and the phase of the blockchain start-up, some investors are more necessary than others. While the private rounds are still saturated, the start-ups have many options to pick from: angel investments, VC funding, accelerators, incubators and crowdfunding. Angel investments are the initial seed of capital to start the project, while leveraging their network as support. VC funding can provide more capital, and can be involved in a later phase compared to angel investments.

Accelerators provide more support than angel and VC investors, as they work more closely with the project's team to realize their goals. A brief overview is shown in Figure 4. However, due to the many options, good ideas, capable teams and guidance are the scarce assets instead of actual capital. This differentiates top VCs/investors from other investors. VC funding is a good replacement for funding through a bank. While VCs are buying tokens, banks prefer to issue debt due to the rules which are tied to debt.

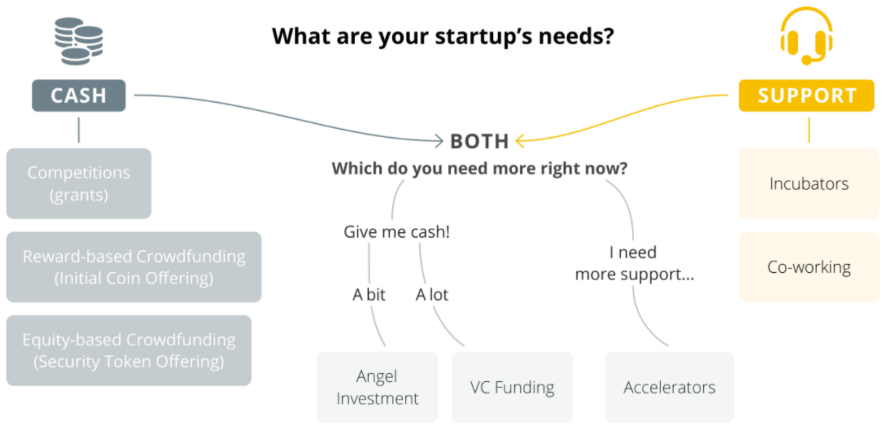


Figure 4: An overview of how to pick investors to finance a new project based on blockchain (Hays et al., 2021).

This section clearly shows that a bank loan is not necessary in blockchain start-up financing, thus, the crowdfunding possibilities in blockchain based start-up financing are a relatively new topic that can be researched.

2.6 Institutional Analysis and Development Framework

For the research we shall use the Institutional Analysis and Development (IAD) framework. The IAD framework is a useful tool for understanding complex interactions between actors, institutions, resources and other social-ecological systems. This specific framework was developed by, among others, Elinor Ostrom in the 1990s to provide a comprehensive framework to analyze designs, implementation and outcomes of institutions in managing resources. The IAD framework works well with a governance system which gives an outcome by interactions of participants. This theoretical and generic framework can give the researcher a better understanding of how actors interact to form an international public infrastructure that can shape collective decisions and individual actions (Ostrom, 2011). The IAD framework conceptualizes the outcome of decentralization reforms as a result of how the governance of blockchain can organize the infrastructure of tokenization of financial assets. A schematic overview of the IAD is presented in Figure 5.

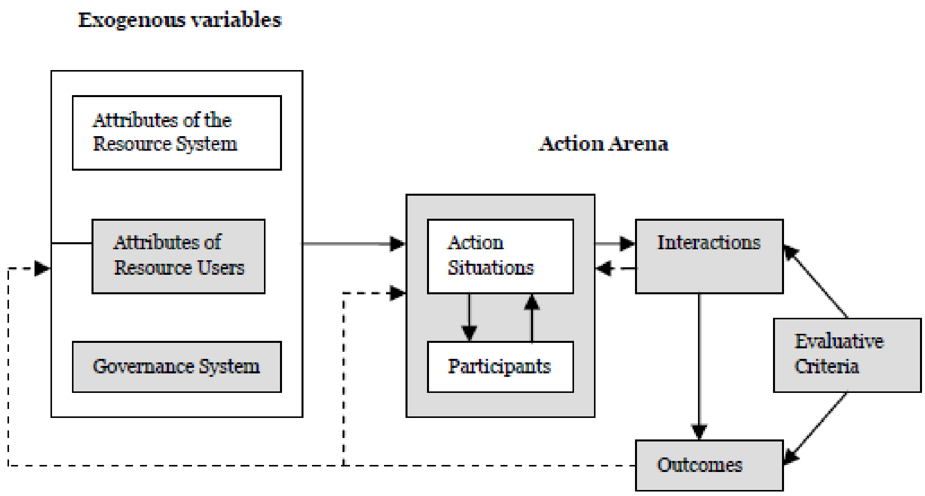


Figure 5: The Institutional Analysis and Development Framework (Zachrisson, 2015).

The IAD framework consists of a few core concepts and principles that help guide the analysis of the institution. The core concepts of the IAD framework are the action situation, the actors, the resource system, the governance rules and the outcome of the action situation. The framework highlights the importance of studying the interaction between different actors who are involved in managing resources and the institutional rules and arrangement that shape those structures (Ostrom, 2011). The core concepts of the IAD framework can be briefly described as follows (Ostrom, 2011):

- Action situation: the action situation refers to the specific context or situation in which individuals or actors interact to make decisions and take actions. It involves identifying the relevant actors, their roles, and the factors that influence their behavior and decision-making within the given situation.
- Actors: actors are the individuals, organizations, or entities involved in the action situation. They are the key players who have the ability to make choices and take actions that affect the outcomes within the system.
- Resources system: this concept includes what resources are used that are relevant to the action situation. These resources can include physical assets, knowledge, information, or even social norms and rules that shape the interactions and decision-making of the actors.
- Governance system: this concept refers to the rules, institutions, and mechanisms that regulate the behavior of actors within the action situation. The governance system defines the incentives and constraints that guide the decision-making and interactions of the actors.
- Outcome: the outcome represents the results or consequences of the actions and decisions made by the actors within the action situation. It can include both intended and unintended outcomes, as well as potential changes in the resource system or governance system over time.

2.7 Exploring Dequity's Potential in Blockchain Based Governance Systems

Despite the fact that blockchain technology is increasingly being used for start-up financing, there is still a lack of research on the purpose of various token models. Additionally, there is a lack of research on how communities can behave in a protocol with a decentralized governance. For a blockchain based decentralized governance system, tokens are a necessity. These tokens refer to digital assets that are issued on the blockchain and can serve multiple purposes, such as representing ownership in a company, providing access to services as utility tokens, and even acting as assets with monetary value within certain ecosystems.

We have learned that utility tokens are designed for accessing specific services or products and do not grant any ownership rights. On the contrary, security tokens do represent ownership in a particular company and can provide financial benefits to the token holder, such as interest payments and dividends, as these security tokens are similar to traditional securities such as stocks and bonds.

Regarding funding mechanisms, equity and debt are two traditional ways of raising capital. Equity refers to ownership in a company, which is represented by shares of stock. Equity investors may receive a share of the company's profits, while also receiving voting rights and other ownership privileges. Debt, on the other hand, refers to borrowing money from a bank or other lenders, that must be repaid with interest over a predetermined period of time. However, for founders who lack the network, resources, or experience, tapping into the resources that Silicon Valley has to offer is not easy.

The literature suggests that crowdfunding could offer a solution to raise capital by selling tokens instead of equity and debt. This could potentially be done in a way that combines the properties of both equity and debt, also known as dequity, to increase transparency and trust for the investors. For example, dequity tokens can be issued to represent ownership in a particular asset or project, with the token holder receiving financial benefits such as interest payments or dividends, while the issuing company is bound to rules. Moreover, dequity tokens can also be designed to grant voting rights or other ownership privileges to the token holder, similar to equity financing. However, utilization of dequity requires a system that binds individuals and companies to their promises, which did not exist yet.

As mentioned within this chapter, blockchain can pave the way for dequity tokens, as blockchain transactions and agreements are recorded in an immutable and transparent manner which creates a trustless environment, in which smart contracts can automatically execute agreements when predefined conditions are met. The use of blockchain based dequity token financing could potentially make it easier for start-ups and other small ventures to have easier access to capital, as it removes some of the hurdles associated with traditional equity and debt financing. Additionally, those dequity tokens can be the foundation for the emergence of decentralized governance systems that provide more transparency and a democratic decision making for those companies, ensuring the interests of all shareholders are considered. Furthermore, by studying the effectiveness of different token models and the behavior of communities participating in the decentralized governance protocols, we can provide valuable information on how these governance systems can be optimized for more effectiveness and efficiency. Ultimately, this can lead to a more robust and self-sustainable blockchain based ecosystem, which benefits both the ventures and the investors.

Overall, tokens offer a unique way of raising capital that combines the properties of both equity and debt financing. These tokens can represent ownership in a particular asset or project, provide financial benefits to investors, and have ownership privileges such as voting rights, while the issuing company is bound to predetermined rules. These properties can help create an atmosphere that is safer for investors by increasing trust and transparency. Furthermore, by addressing the current research gap regarding token models and blockchain based decentralized governance financing, new opportunities are provided for researchers to contribute to the current financing landscape. By researching how these governance systems can be optimized with dequity based tokens, we can work towards a more sustainable, democratic and transparent ecosystem that benefits all stakeholders.

The governance systems are researched through a case study analysis, using IAD framework to gain a deeper understanding of how blockchain tokens and dequity tokens are utilized and can be utilized for decentralized governance systems. The IAD framework provides a structured approach to the research. By analyzing the data through the IAD framework, the research can offer insights into the functioning of governance models and how blockchain ventures address any flaws arising from the decentralized and anonymous nature of blockchain technology. The literature review helped in clarifying the core concepts of the IAD framework and relating them to concepts within our research, as presented in Chapter 3.

The IAD framework showcases how the protocols are being used by communities and its stakeholders to derive an outcome of important decision making based on voting. The analysis through the IAD framework contributes to answering the second sub-question: **How do blockchain ventures approach the governance system design to make important decisions in their ecosystem?** By gaining insights and knowledge from the IAD framework, we can initiate discussions about the deficiencies present in the current token models and explore other ways to enhance the functionality of tokens to behave like dequity. This leads to addressing the third and final sub-question: **How can the functionality of token models be enhanced to increase trust and transparency for investors?**.

3 IAD Framework and Data Collection Method for Blockchain Governance Analyses

The aim of this research is to explore decision making on blockchain based governance systems. To achieve this goal, we utilize a research approach that consists of qualitative data collection, which is then analyzed. This chapter serves to provide a detailed overview of the methods and data used for the research. First we shall describe how the case studies were analyzed through the Institutional Analysis and Development (IAD) framework, whereafter we provide which criteria were used to select the cases.

The majority of data for the case study was collected from whitepapers and the official websites of the specific projects. The collected data was then analyzed by consulting the IAD framework. The properties of both debt and equity from Chapter 2.1 are used to check whether the token models have debt or equity properties embedded into their token model.

The methods and data used in this study help provide a better understanding of the effectiveness and efficiency of various token models and decentralized governance systems in blockchain based decentralized governance systems. Through this analysis, we aim to provide valuable insights for researchers, investors, and entrepreneurs who wish to be involved in these decentralized governance systems.

3.1 Institutional Analysis and Development Framework

In Chapter 2.6 in the literature review, we have provided a comprehensive explanation of the IAD framework. The decision to use the IAD framework was motivated by its relevance to the decentralized governance aspect of blockchain. By using the IAD framework, our objective is to introduce and understand the context in which actors interact to form an international public infrastructure that shapes their collective decisions and individual actions (Ostrom, 2011). The blockchain protocols studied through the IAD framework, and the criteria for their selection, are shown in Chapter 3.2.1. A schematic overview of the IAD is presented in Figure 6.

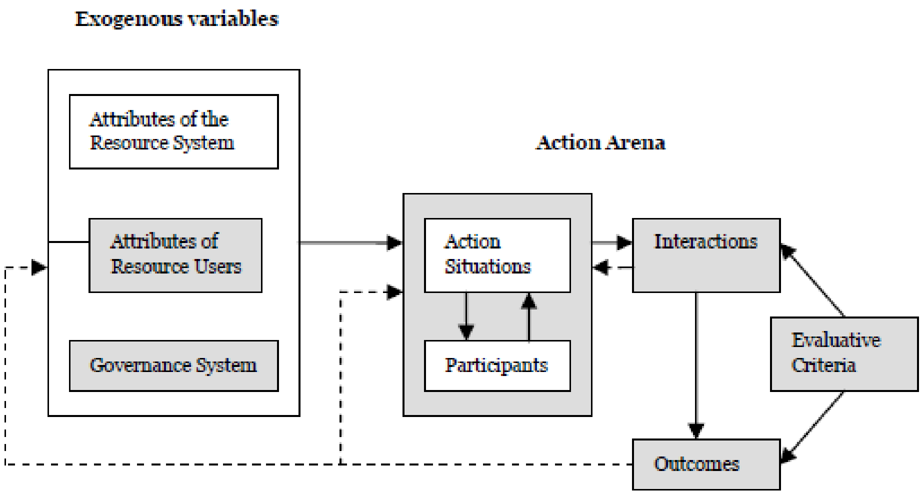


Figure 6: The Institutional Analysis and Development Framework used for the case study (Zachrisson, 2015).

This overview shall also be used after the results are presented, to provide a schematic overview of the governance system of the cases. The IAD framework highlights the importance of monitoring and evaluating the governance system continuously to ensure that the protocol remains effective. For this research the core concepts are described as:

- Action situation: voting to make important decisions in a protocol.
- Actors: the important actors who play a role in the governance system. These actors are referred to as process owners, blockchain architect, network operators, blockchain developers and blockchain end-users.
- Resources system: the natural and physical resources utilized and managed by the actors in a governance system. In this research the resource system are the token and the validators.
- Governance system: the blockchain rules which is active to determine how actors can be involved with the action situation.
- Outcome: the result of the action situation, based on the interaction between actors.

The suitability of the IAD framework for our research lies within the fact that it helps understand how people interact and make decisions in a decentralized governance system. Since blockchain ventures rely on decentralized decision making, this framework provides a structured way to study how the actions of different people affect the outcome.

3.1.1 The Action Situation

Within the fields of social sciences, an action situation represents a particular social context or setting in which individuals or groups engage in actions or behavior with a purpose. These situations are marked by specific conditions or circumstances that influence the conduct of individuals or groups within that particular context. Action situations can range from simple interactions between individuals to complex interactions involving many actors, resources and rules. By studying action situations, we can gain a better understanding of social protocols and dynamics that may influence human behavior. The action situation can be defined by the goals or objectives of an individual or collective groups involved.

In this research, the action situation refers to a specific situation in which an action or decision needs to be taken, including proposing a new change or improvement, voting on a proposal, allocating funds and resources or resolving a conflict. Specifically, the action situation in this research is the voting for proposals, changes and managerial decisions.

3.1.2 Who are the Actors and how do they interact with other actors?

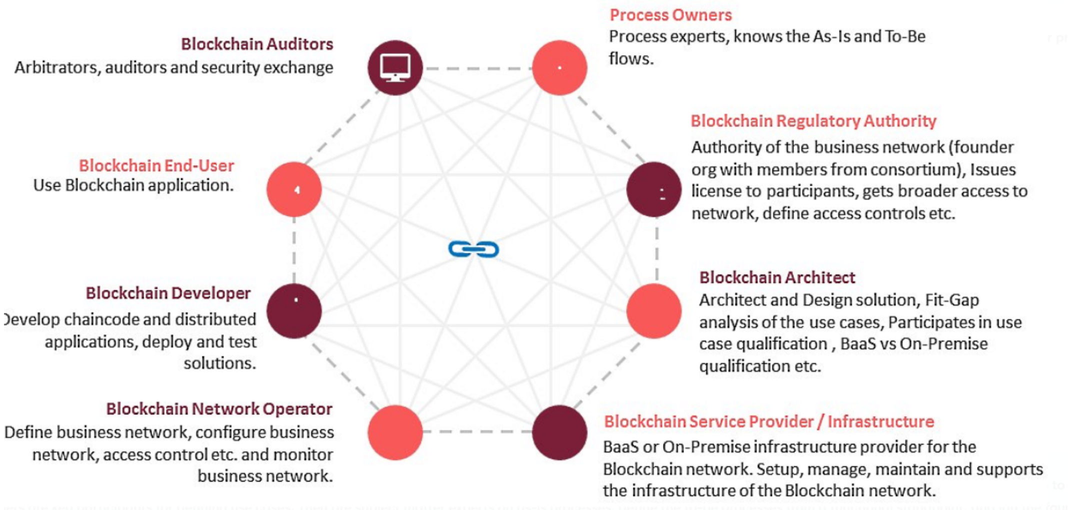


Figure 7: The categories of all eight actors (Packt, 2022).

Alongside the action situation, it is important to identify the main actors. In the IAD framework, actors are individuals or groups who are involved, independently or in collaboration with others, in an action situation and are in a position to affect the outcomes of the action arena. Not only is the behavior of actors shaped by their preferences, beliefs and the resources available to them, but it is also shaped by the rules and incentives present in a protocol. It is critical to understand the behavior of actors to be able to analyze the effectiveness in addressing the action situation.

The actors in the blockchain industry can be categorized into eight different categories, as shown in Figure 7: process owner, regulatory authority, blockchain architect, solution provider, network operator, end-user, blockchain developer and blockchain auditors. However, for the research we shall only describe and analyze the relevant actors, which are presented and described in Table 2. An actor analysis helps predict and react to changes that happen in a protocol. This also supports the development of the technology by identifying the roles and positions of various actors. There will be an actor analysis for all the case studies, in which the key actors for the action situation are highlighted. Key actors are defined by their active involvement in the action situations in which they have a high influence on the outcome. Thereafter, the roles of the key actors are described for the cases.

Table 2: The category of active actors and their respective descriptions (Packt, 2022).

Actor role	**Description**
Process owner	Process owners are individuals who are knowledgeable about the various aspects of the industry. They can help identify common problems and develop a set of use cases that will serve as the foundation for a blockchain network. They are also key members of the project's development team. Process owners are additionally responsible for defining the foundation for a blockchain.
Blockchain Architect	A blockchain architect should have the necessary skills and knowledge to ensure that the blockchain operations are performed properly. They should also have the necessary knowledge about the various aspects of the industry, such as security, consensus, and integration. As part of the team, they are additionally responsible for developing and implementing the consensus algorithms that will serve as the foundation for the blockchain operations.
Network operators	The network operators are responsible for the various operational aspects of the blockchain. They mainly focus on the operational part of a blockchain: security and privacy of the network's peer-to-peer and consensus functions. They are not involved with the user interface codes and smart contracts.
Blockchain developer	Blockchain developers mainly focus on the blockchain code, including smart contracts, as well as the integration of the blockchain chain code into other applications. It is necessary that they understand the fundamentals of a blockchain.
Blockchain end-user	With access to decentralized applications (dApps), end-users are capable of consuming blockchain smart contracts through a UI or web application. This allows the end-users to execute transactions against smart contracts.

3.1.3 The Necessary Resources

In the IAD framework, a resource system refers to a natural or human-made system that produces a resource that can be used to benefit humans (Ostrom, 2011). The IAD framework emphasizes the significance of understanding the characteristics of resource systems, including their physical and biological properties, the way they are managed, and the external factors that can affect them, to develop effective governance systems (Ostrom, 1990). These characteristics need to be understood to achieve effective governance of the resource systems. Different governance systems may exist for different types of resource systems, depending on variables such as the complexity of the system, the number of actors involved, the level of uncertainty in the system, or the diversity of the actors involved.

In this research, a resource system refers to assets that are available to users of the ecosystem. These resources may include tokens or other assets that have a specific value within the blockchain, or assets that are stored on the blockchain. In a decentralized governance system, the resource system includes a token which can be used for voting rights, or any other tokens that can be traded or exchanged for services within the ecosystem. For example, in a cryptocurrency based governance system, the resource system may include the cryptocurrency tokens used to represent voting rights, as well as any other digital assets that can be traded or used within the network. The resource system is an important asset of any blockchain which can have a significant impact on the effectiveness of a governance system. Thus, in this research the resource is the token and the computational power by network operators.

3.1.4 Rules and Blockchain Governance System

For any organized society or group to function properly, the ecosystem needs rules and a governance system. The rules refer to the instructions or principles of an ecosystem that dictate how individuals within that ecosystem should behave. The rules can be both formal or informal, depending on the purpose for which the rules exist. Governance refers to a mechanism that ensures the rules are enforced upon the users. A governance system must be designed to stimulate cooperation between resource users, which requires a balance between rules that are flexible enough to adapt to changing conditions with rules that are clear and enforceable (Ostrom, 2011).

The governance system can typically be divided into three key components: the decision making, the implementation and the enforcement process. The decision making process determines what rules and policies are necessary to achieve a specific outcome. The implementation process puts the rules and policies into action and the enforcement process ensures that individuals within the ecosystem will comply with the outcome (Ostrom, 2011).

Traditionally, governance systems are used by governments to ensure that laws are enforced, while companies and businesses have governance systems to make sure that employees adhere to company policies (Ostrom, 1990). Blockchain technology allows for the existence of new governance systems that are based on consensus mechanisms and decentralized decision making. The rules influence the incentives that each actor has, which can help determine the behavior of the stakeholders (Ostrom, 2011).

The rules-in-use are not just some rules that are written, but they refer to what rules are actually acted upon. This is important to determine how blockchain can actually solve dilemmas of financing certain projects which are not eligible for financing through equity or debt. In other words, the effectiveness of the governance system depends on the ability to make decisions, implement and enforce those decisions, which is exactly what shall be analyzed in the case study analysis.

In this research, the blockchain itself can be referred to as a tool to enforce the rules it has, as the processing of transactions is validated and recorded by the consensus mechanism of a blockchain's protocol. Another tool would be the smart contracts which can be written in the code of a blockchain. Additionally, the governance system can also include the mechanism of decision making, changing codes or rules within the ecosystem by allowing token holders to vote on proposals within the protocol.

3.1.5 The Outcome of Actions taken by Actors

In the IAD framework, the outcome situation refers to the effects or results which were taken by actors in the governance system, and how they could potentially affect the resource system.

The outcome situation is impacted by the behavior of actors, the specific rules and norms within the ecosystem, and the distribution of power and resources within the protocol. It is important to evaluate the outcomes of a process to identify areas for improvement when the system's outcomes do not align with its intended goals.

In this research, the outcome situation refers to the overall result and impact of the governance system on its users and the ecosystem. In other words, the outcome situation refers to the effects after a proposal was accepted or rejected by a governance vote. This analysis will help understand the effectiveness of the governance system in achieving its objectives and the implications of decisions made within the ecosystem.

3.1.6 Schematic Overview Cases

After presenting the results, we shall provide an overview of all the cases in a schematic format. This schematic overview is useful to provide for efficient and effective way for the reader to understand the main findings, it can help identify differences and inconsistencies and it can be used for future references and recommendations. The schematic overview serves as a starting point for discussion in this research on how those token models can be enhanced to better resemble dequity, which addresses the third sub-question. The schematic overview is derived from the results and based on the IAD framework overview previously shown in 6.

3.2 Case Studies Criteria and Selection

The data for this research was collected through a case study review based on three different blockchain protocols. The case study review is a qualitative research method which is often used in exploratory research. The case study review was designed to gather information about the actors, resource system, governance rules and the outcome of the governance system.

In this chapter, the criteria for selecting the cases are presented and the cases which were reviewed are chosen. During the research the actors are identified, the resource system is analyzed, the governance rules are examined and the outcomes are studied. Hereafter, the data is collected, from official whitepapers and official sources from the protocol, using the IAD framework to organize our findings and to identify relationships and patterns among the core concepts of the IAD framework to develop a better understanding of the governance system of the blockchain protocols. Subsequently, the collected data are compared which enables us to draw conclusions from it.

3.2.1 Project Selection Criteria

In this chapter the data collection criteria and project selection for the case study are presented. The criteria are determined to accommodate the literature study and ultimately the IAD framework. The first criterion is a "Layer-1 blockchain" that operates independently without relying on other blockchains or protocols. The second criterion is that it supports smart contracts, which are necessary for automation and decentralization.

The third criterion is having a decentralized governance system, which refers to the set of rules for decision making and changes. The fourth criterion is the fact that the case has launched its own token after a successful crowdfunding event, in which the token is a resource. The fifth and final criterion is to have a significant market capitalization, indicating that the protocol has gained traction and is widely used. The key criteria are presented and elaborated in Table 3.

Table 3: Criteria for the selected cases in this research, which accommodates the IAD framework core concepts.

Layer-1 blockchain	A layer-1 blockchain is blockchain that operates by and on itself, as it does not rely on other blockchains or protocols to operate. Layer-1 blockchains have their own consensus mechanisms and protocol that determines how transactions are processed and validated. Layer-1 blockchains can tell us a lot about the rules which are used in a blockchain.
Supports smart contracts	As mentioned in the literature, smart contracts are computer programs that execute the terms of a written contract and can be executed in a blockchain protocol. They automate business processes without intermediaries and are governed by system rules on the blockchain with verifiable outcomes. Smart contracts are necessary for automation and decentralization, as dequity can only exist in a system in where contracts and rules are governed by a promise.
Has a decentralized governance system	A governance system refers to the set of rules of how decisions are made and changes are implemented. It is an important aspect of the blockchain technology to stimulate decentralization and transparency within the protocol. A governance system should be present for the sole purpose of being able to make decisions, this means that decisions are made by a network of participants rather than a central authority. The cases should have a track record of decision making by key actors.
Crowdfunded their project by selling own token	Having its own token is important as it essentially creates a digital asset that can be used within a specific blockchain. These tokens serve a specific purpose. In our research the main purpose of the token for token holders to be able to vote on proposals and decisions in a governance system. The token can be referred to as a resource.
Significant market capitalization	This is an indication that the protocol has gained traction and is widely used.

Based on these criteria, Ethereum, Polkadot and Terra were selected to be reviewed and analyzed. The IAD framework describes how global communities can collectively work together to make important decisions in a protocol based on a decentralized governance. That is why the selected cases are layer-1 blockchains. The newer generation layer-1 blockchains are open-source blockchain infrastructures which allow users and developers to launch their own project and tokens through integrated smart contracts. The rules and properties of the layer-1 blockchains are hard-coded. The consensus, scalability and tokenomics are all hard-coded into layer-1 blockchains. These layer-1 blockchains all have their own token with similar properties: staking, inflation, burning and governance. These blockchains are selected due to the fact that they can provide insights into the on-chain governance systems that currently exist while also showing potential flaws which can be improved upon.

4 IAD Framework Analysis: Exploring Current Token Utility and Governance

We began this research with a literature review to identify the knowledge and research gap. Whereafter the methodology of the research was presented in chapter 3. By expanding upon the methodology and research that was done up until now, this chapter presents the results of the case study reviews regarding the layer-blockchain protocols Ethereum, Polkadot and Terra. By analyzing the results, we can answer the second sub-question '**How do blockchain ventures approach the governance system design to make important decisions in their ecosystem?**' of our research.

The three layer-1 blockchains are reviewed based on the criteria in Table 3. These criteria are determined by consulting the IAD framework and its core concepts of the action situation, actors, resource system, governance rules and the outcome.

4.1 Ethereum

Ethereum is a decentralized, open-source layer-1 blockchain protocol that allows developers to build smart contracts and decentralized applications. It was co-founded by Vitalik Buterin, among others, in 2013 and was launched in 2015 (Buterin, 2013). Similarly to other blockchains that existed prior to Ethereum's existence, Ethereum uses a distributed network of computers to validate and record transactions. This method enables a transparent and secure protocol that is resistant to hacking and censorship. As mentioned before, Ethereum allows developers to build smart contracts, which is what sets it apart from other blockchains prior to Ethereum, as it is the first blockchain to support smart contracts.

Those smart contracts allow developers to create their own decentralized applications based on Ethereum. Ethereum has its own token, also referred to as ETH. ETH is the utility token of the ecosystem used to pay for transaction fees and provide incentives to stakeholders who validate and process transactions within the Ethereum ecosystem (Buterin, 2013). Ethereum is the second largest cryptocurrency based on total market capitalization, with a value of $410 billion on April 5th, 2022, accounting for 19,1% of the total cryptocurrency market capitalization (CoinMarketCap, 2023). The Ethereum Foundation raised $16,0 million in 2014 through a crowdfunding sale, which means that the recorded market capitalization is a multiplication of roughly 25.600 times the raised amount.

4.1.1 Actor analysis and Action Situations

There are multiple action situations within the Ethereum ecosystem. Among others are: sending and receiving ETH, building dApps, deploying smart contracts, participating in ICOs and using the dApps. These action situations all revolve around different sets of actors. However, in our research we focus on the action situation of making important decision within the Ethereum protocol. From the list of actors, there are a few actors who have an active role in this action situation: the process owners, the blockchain architect, network operators, blockchain developers and the blockchain end-users.

The process owners of Ethereum consist of the Ethereum foundation and their core developers. These people understand the potential impact that any decision has on the business operations and need to ensure that the decisions made align with the goals of the Ethereum stakeholders. The process owners are actively working to find solutions to actively improve Ethereum and its protocol and are usually the ones who submit proposals, fund research and development promote adoption and collaborate with other stakeholders. The core developers are responsible for making technical decisions regarding development and improvement of the Ethereum protocol.

The blockchain architects design and develop the blockchain infrastructure. These architects understand the technical implications of any decision which was made and ensure that those decisions align well with the technical architecture of Ethereum. If it is not feasible to have a decision pushed through, due to limitations of the protocol, they are the first to know and they can design the protocol in a way that such decisions would be possible.

In the literature review we mentioned the different consensus mechanisms. Ethereum is based on the PoW consensus mechanism. Since Ethereum is based on the PoW consensus mechanism, the network operators are responsible for the network of computers which validate and process transactions, in which those computers are often referred to as nodes and the people installing those nodes as miners. The process to become a network operator in Ethereum is decentralized, as any person can install a node and become a miner. These miners ensure that the blockchain remains secure and reliable. Additionally, the network operators are the ones who have to adopt the upgraded codebase, whenever an upgrade is available.

The blockchain developers focus on the blockchain code, including smart contracts and dApps. They are the ones who develop the smart contracts for a decentralized governance system, and they are also responsible for developing the code whenever a proposal is accepted. Developers can also submit proposals and may overlap with process owners.

The blockchain end-users are the regular stakeholders who have a share in the ETH token without any other mentioned role. These users are the people who use the blockchain applications, make transactions and may provide feedback on user experience. The user does not directly impact the outcome of any proposals, but can voice their concerns or ideas through user feedback.

4.1.2 Blockchain Resources

Ethereum has two important resources which are considered for important decision making on the Ethereum ecosystem. The first is computational power, also referred to as hashpower which is provided by nodes, required to run the Ethereum network and validate and process blocks. This resource is provided by network operators.

The second resource of Ethereum is their token ETH. ETH is the native cryptocurrency token of the Ethereum blockchain with the purpose of making payments for transaction fees and paying for gas fees whenever a smart contract is executed. Additionally ETH is used as an asset with monetary value, serving as a store of value and collateral for certain applications to borrow or lend tokens. Since ETH has monetary value, it is used as an incentive for network operators to reward them for keeping the Ethereum network safe and secure (Buterin, 2013).

Ethereum has an inflation rate of roughly 3% and supports 25 TPS with a block time of 6 minutes, which is considered slow and not feasible as a payment system. Besides the slow block time of Ethereum, the transaction fees are also significantly higher than other blockchains. The fees per transaction ranged between $3,- and $50,- throughout 2021 (Raczyński, 2021).

4.1.3 Blockchain rules and Governance System

Blockchains with fast confirmation times suffer from reduced security due to the fact that blocks need to be processed through the network. In PoW, miner A and miner B simultaneously mine a different block, but block A got processed earlier into the blockchain, the block which was mined by miner B will end up wasted and not add anything to the network security. The miner with the most hashpower will increase its odds to actually produce a block and decreases the odds to produce a stale block which is not being used. This creates a centralization problem among miners, this means that the miner with the most hashpower will contribute the most blocks to the blockchain.

Since Ethereum is the very first layer-1 blockchain to support smart contracts, Ethereum also adopts a traditional consensus mechanism with a basic governance system. Ethereum uses a simplified version of the Greedy Heaviest Observed Subtree (GHOST) protocol, which is a PoW. GHOST solves the issue of network security. GHOST includes stale blocks in the calculation of the longest chains, which means that the stale blocks are also added to the calculation of which block has the most hashpower. To reduce centralization, the mining rewards are also split among the miners who produced a stale block (Buterin, 2013).

Regarding the governance system of Ethereum, it is as mentioned very basic. The stakeholders consist of Ethereum process owners, architects, core developers, miners and users of the Ethereum blockchain who have a common interest in ETH performing well in monetary valuation. While the process owners are the ones who push out proposals or code upgrades, the miners can choose to opt for the changes or not. The process owners and developers can basically propose changes whenever and however they seem fit, but the miners need to reach a certain consensus for the changes to be executed.

Miners need to accept the proposal and fork into a new blockchain. The history of the chain will be used, while going a separate route from the original chain. Reaching consensus is necessary to make sure that the 51% majority of the miners will accept this new forked chain. Ethereum developers have their own motivations for code changes, but since the miners and therefore potentially users are the ones who decide what changes are accepted, the developers will have to propose changes in which they believe will be accepted to benefit the users. Unless the majority of miners are acquaintances, opportunistic behavior for individual benefits is not possible (Buterin, 2013). The ETH token has no direct impact on important decision making on Ethereum.

4.1.4 Outcome of Actions by Actors

Following whenever an action situation was accepted by the actors, this means that new upgrades are available, or proposals are accepted, is what is being referred to as the outcome. Since the ETH token has no direct impact on important decision making on Ethereum, the token resource is not important for this action situation. However, the network operators are increasingly important. The network operators are the only ones who decide what upgrades are accepted or not, which means that the way how the network operators collaborate with each other is most important.

When Ethereum network operators upgrade the code, they are basically updating Ethereum's protocol software to a new version. This is usually done to implement improvements to security, stability, and performance. Upgrading the codebase of a PoW consensus mechanism blockchain could also be referred to as a "hard fork". During such a hard fork, Ethereum is split into two different and separate blockchains, with the upgraded software running simultaneously with the old software. The network operators can choose which version to adopt. The code is upgraded by downloading and installing the new software, the software being tested by developers, architects and network operators. After the testing phase is approved, the network operators switch to this new version.

During the upgrading process, network operators will have to coordinate with other network operators to ensure that the new version is adopted from a specific block, to make sure that the same version is active on the mining computers to avoid conflicts with different versions. Whenever the upgrade is completed, the miners are simply running the upgraded software, which offers more security, stability, performance and additional features.

Even though proposals can be voted upon by all Ethereum end-users, through an off-chain poll, these votes are not final, as it is up to the network operators to adopt the new software. However, since the process owners are rewarded in the ETH token, they usually want the token to perform well. This is the network effect of Ethereum. The Ethereum end-user can provide feedback based on their experience, or put pressure to the process owners and architects to implement changes. Since the process owners are usually behind the funding of developers and network operators, the upgraded version is usually the most adopted version of the blockchain. If the new software is not accepted by the majority of network operators, two different chains may exist in which one does not dominate the other in hashpower, or both have equal hashpower. The end-user can decide which version it wants to take part in, and make transactions with.

Since transactions and any other smart contract interaction on Ethereum comes at a cost of ETH to pay for transaction fees, the network operators have more revenue whenever there is more volume. So even though the end-user does not play a direct role in deciding which proposal is accepted or adopted or not, they do have an indirect impact on what software version is adopted by the network operators.

4.1.5 Schematic overview of Ethereum based on IAD framework

The findings of the IAD core concepts of Ethereum are presented with a schematic overview in Figure 8, which is based on Figure 6. This overview shows the important aspects of the governance system that Ethereum uses and can help the reader understand how it works.

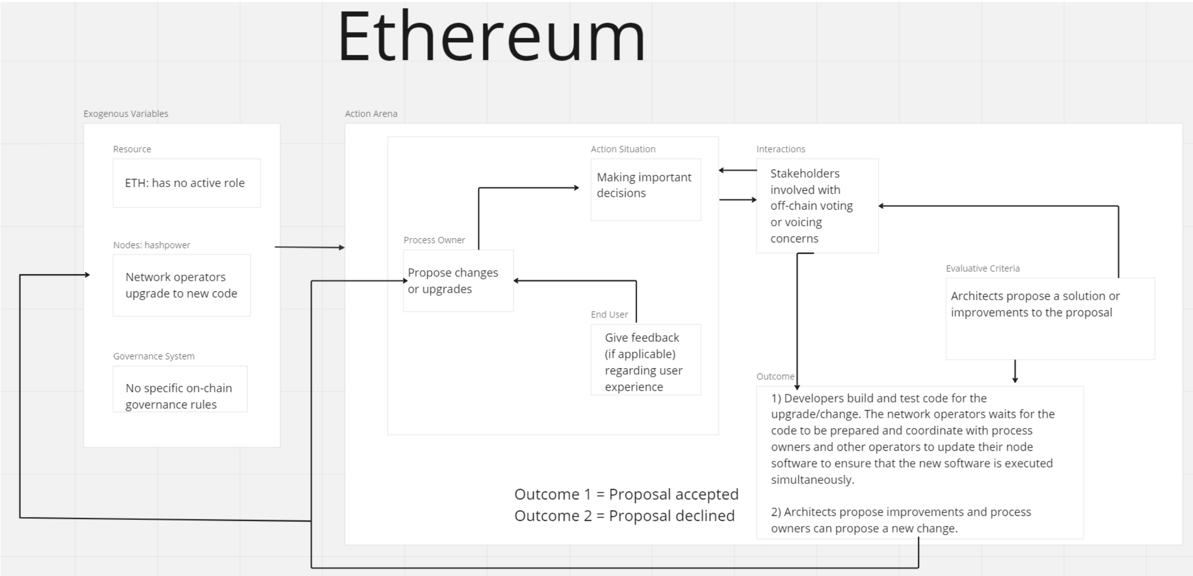


Figure 8: Schematic overview of Ethereum with Exogenous variables bracket to include the governance rules and the resources. Ethereum has no on-chain governance system, as the network operators simply have to upgrade to the new version, while the resource ETH has no utility for the action situation. The action situation bracket includes the actor interactions, action situation and the outcome. There are two different outcomes, in which 1) is whenever proposal is accepted and 2) is whenever the proposal is declined.

4.2 Polkadot

Polkadot refers to itself as a next-generation blockchain protocol designed to address the limitations of existing blockchain protocols, by creating a more scalable and interoperable blockchain ecosystem. Polkadot was co-founded by, among others, Gavin Wood, who is also a co-founder of Ethereum. The goal of the Polkadot project is to create a completely decentralized web that allows users to control its content. Through the power of decentralized applications and services, Polkadot aims to make it easier for people to create and connect decentralized applications, services and institutions.

Polkadot claims to have introduced the necessary tools and security for a decentralized ecosystem in which large institutions cannot violate the trust of its users, this means that teams of other projects can just focus on their own project (Wood, 2021). Polkadot is one of the largest blockchains in the blockchain industry. What distinguishes Polkadot from other blockchains is that Polkadot is designed to operate two types of blockchains. Polkadot has a main network, also referred as a relay chain, and Polkadot has parachains.

With these parachains, developers can customize their own network on Polkadot which has the same benefits as the relay chain (Wood, 2021). Polkadot has its own token called DOT. Polkadot is the 10th largest cryptocurrency based on total market capitalization with a value of $22 Billion on April 5th 2022, with a market share of 1,1% of the total cryptocurrency market capitalization (CoinMarketCap, 2023). Polkadot has come a long way since its ICO, during which they raised $144,6 Million through a crowdfunding sale, indicating that the market capitalization is a multiplication of roughly 140 times of the amount raised.

4.2.1 Actor analysis and Action Situations

Besides making transactions with the DOT tokens, the action situation in Polkadot can be classified into two different categories: technical and governance. The technical action situations involve activities related to the maintenance and development of the Polkadot protocol. The technical actions can among others refer to: creating parachains, participating in consensus mechanism and implementing upgrades and changes to the Polkadot protocol.

The governance action situations involve activities related to managing the Polkadot ecosystem. The governance actions can among others refer to proposing network upgrades, voting on proposals, managing treasury funds and establishing rules for the ecosystem. The action situation in this research is voting on proposals to make decisions.

Once again, we shall highlight the actors who play a key role in the action situation of voting. From the list of actors, there are a few actors who have an active role in this action situation: the process owners, the blockchain architect, network operators, blockchain developers and the blockchain end-users.

The process owners of Polkadot consist of Web3 Foundation and Parity Technologies. Web3 Foundation is a Swiss-based nonprofit organization that aims to stimulate the development and adoption of decentralized solutions, such as Polkadot. Parity Technologies is a company founded by Gavin Wood, and is responsible for the development of the Polkadot protocol. These actors, along with some others, form the Polkadot Council which is responsible for managing the treasury and can propose and vote on upgrade proposals and changes to the Polkadot protocol.

Blockchain architects are developers who are members of the Polkadot Council. They create technical specifications and the codebase for the protocol and ensure that the network capabilities meet the necessary requirements for the growth of the ecosystem. They help identify and address technical challenges during development. Some architects are from Web3 Foundation and Parity Technologies.

Individuals or entities who ensure that Polkadot is stable and secure are the validators, also referred to as the network operators. Validators participate in the consensus mechanism by verifying transactions before adding them to the network. Network operators play a role in synchronizing their nodes. The network operators reap financial rewards for the quality of their work.

Blockchain developers are developers of the Polkadot ecosystem who build dApps, smart contracts and other tools. The developers can be external developers or developers who are members of Web3 Foundation and Parity Technologies. These developers work closely with the architects, as these architects have more knowledge about the technical capabilities of Polkadot. Thus, the developers are informed by architects about what is possible on Polkadot and they can propose ideas and provide feedback to the architects. Additionally, developers can be responsible for testing and debugging the codebase.

Polkadot end-users are individuals or entities who use Polkadot to make transactions, stake their DOT tokens, or participate in governance through voting. By staking DOT and participating in governance, the end-user is involved in the decision making process within the ecosystem. The blockchain end-users play a role in the rewards of network operators, by staking DOT on validator nodes of their choice.

4.2.2 Blockchain Resources

Polkadot has three important resources which are considered for its ecosystem. The first one is the technology that enables interoperability between multiple blockchains. The second resource are the Polkadot nodes and is provided by the network operators. Similar to Ethereum, these validator nodes are responsible for the consensus mechanisms by validating transactions and processing them.

The third and final resource is the DOT token, which is the native cryptocurrency token of Polkadot used for staking, bonding, governance voting and paying for transaction fees. DOT also holds monetary value. By staking more DOT tokens into a validator node, the validator receives more rewards for their work, while the person who staked the DOT tokens also receives a small amount of rewards for their dedication to a validator node. Since the action situation is voting on proposals to make decisions, we shall focus on the DOT resource.

DOT has an inflation of 10% per year. Polkadot promotes itself as a blockchain capable of supporting 80.000 TPS with a block time of 6 seconds. The transaction costs of Polkadot are relatively low compared to Ethereum, ranging between $0,10 and $0,40 throughout 2021 to make a transaction (Raczyński, 2021).

4.2.3 Blockchain rules and Governance System

Instead of PoS or PoW, Polkadot is based on a hybrid consensus mechanism with the protocols named Ghost-Based Recursive Ancestor Deriving Prefix Agreement (GRANDPA) and Blind Assignment for Blockchain Extension (BABE). This hybrid consensus splits the finality gadget from the block production mechanism to benefit from probabilistic finality and provable finality. This hybrid consensus avoids certain drawbacks of PoW or PoS, such as forks of a blockchain and stalling new blocks. Polkadot allows rapid block production with slower finality, as the finality process runs independently alongside block production, enabling blocks to be produced without stalling or slowing down transactions (Wood, 2021).

BABE is the mechanism responsible for producing actual blocks, running among validator nodes. BABE assigns block production slots to validators based on their stake of DOT tokens and uses a randomness cycle to randomly select a validator node to produce specific blocks. A lottery determines whether a block producer can be selected for a specific slot to produce blocks. The slots are six seconds in length. Due to the randomness, multiple validators can be selected, but it is also possible that no validator nodes are selected. This randomness results in inconsistent block times, as some slots can be empty by skipping a whole empty slot. Whenever a slot has multiple validators, they have to race to produce the block.

GRANDPA, on the other hand, is the finality process implemented in Polkadot. If more than 66% of the validators prove the validity of a chain containing certain blocks, all blocks leading up to this specific block are finalized simultaneously. A key difference is that GRANDPA reaches agreements on the blockchain itself rather than reaching an agreement on individual blocks, which can significantly speed up the finalization process.

The combination of BABE and GRANDPA ensures clear block choice on Polkadot. It is obligatory for BABE to choose the block that has been finalized by GRANDPA. Whenever there are forks after the head of the chain has been finalized, BABE will always build on the chain with the most primary blocks (Wood, 2021). This way of fork choice is illustrated in Figure 9.

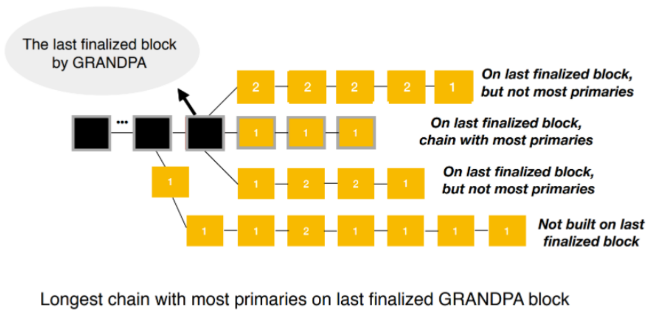


Figure 9: By combining GRANDPA and BABE, Polkadot always chooses the chain with the most primary blocks, even if it is not on the last finalized block or the longest chain. Blocks marked with "1" are primary blocks and blocks marked with "2" are secondary blocks (Wood, 2021).

Polkadot uses an advanced governance mechanism that allows the blockchain and its ecosystem to evolve over time at the command of the stakeholders. Due to the consensus mechanism, the majority of the DOT tokens can always influence the network. To make changes in the network, active stakeholders and the council can administrate a decision for a potential network upgrade. The council is represented by stakeholders and actors through an on-chain account. The council will have a fixed number of seats, with a current number of 13 which is expected to increase to

24 in the future. Their tasks include proposing referenda, canceling uncontroversial dangerous referenda and electing the technical committee. Council motions will only pass if 60% agree with the referendum.

Finally, the suggestion will go through a referendum, allowing all DOT holders to vote on the proposed network upgrade. Any proposal is tied to a minimum amount of DOT deposited. To agree with the proposal, a user needs to endorse the proposal by matching the amount of DOT tokens which was deposited by the proposer. Each referendum has a specific proposal attached to it by participating in a simple stake-based voting scheme. All changes must be agreed upon by a stake-weighted referenda, where the vote is weighted by stake and is completely binary with the options being in favor or against the proposal. However, a proposal can still be canceled by the technical committee if it is unanimously agreed upon, regardless of the number of endorsements. Additionally, a referendum can also be canceled whenever more than 66% of the council votes to cancel a referendum. In the case of a cancellation of a proposal, the deposited DOT is burned. The referendum has an enactment delay, which is the time period between the end of the referendum and the changes being approved. A proposal or referendum can be started in four different way (Wood, 2021):

Public proposals. Any user of the Polkadot ecosystem can propose a referendum by depositing the minimum amount of DOT tokens for a set amount of blocks. The proposal which has the highest amount of endorsements will be upgraded to a referendum for the next voting cycle. The endorsed tokens are released once the proposal is brought to a vote. This kind of referendum has a fixed time window of 28 days.

Council proposals. These kind of proposals are from proposals submitted by the council. The referendum passes once all council members have unanimously agreed on a proposal. Another way for this proposal to pass as a referendum is whenever a majority of the council agrees. Like the public proposals, this kind of referendum has a fixed time window of 28 days.

Proposals submitted as part of prior referendum or emergency proposals. There are two additional ways to start a referendum. the third option is whenever a referendum results into a necessity of starting a new referendum, for this type of referendum the longevity is completely flexible and can be set as it is deemed necessary. The emergency proposals are proposals submitted by the technical committee which deal with major problems in the blockchain which needs to be solved as soon as possible. These will have a much shorter enactment delay.

There can only be one active referendum at any given time with the exception of an emergency referendum. Every 28 days, a new referendum will be picked from the queued proposals to be voted on. The referenda alternate between the largest endorsements of the community proposals and the council proposals, unless the community proposal has zero endorsements, in which case the referendum will be picked from the council proposal and vice versa. The referendum is referred to as "baked" whenever it is closed and approved, and the referendum is referred to as "unbaked" if it is still being voted upon.

To become eligible to vote, a voter must possess DOT tokens in their wallets. These votes are worth only a small fraction of a vote compared to staked DOT tokens. Voters can stake their DOT tokens for at least the enactment delay. This incentivizes actors to purchase DOT and discourages potential voters from selling. Apart from the amount of DOT tokens and whether they are staked or not, the amount of days the DOT tokens are staked also matters. A smaller holder of the DOT token could potentially exercise more voting power by keeping their DOT tokens staked for a longer time compared to somebody who has more DOT tokens but has not staked for that long; this is the time-locking rule. The voting power increases by one whenever the lock periods of the DOT tokens are doubled. The multiplier starts with a multiplier of 1 for stakers and 0.1 for non-stakers. The maximum vote multiplier is 6, with a lock period of 32 periods. One period is a full referendum of 28 days (Wood, 2021). The voting multiplier is shown in Figure 10.

Lock Periods	Vote Multiplier
0	0.1
1	1
2	2
4	3
8	4
16	5
32	6

Figure 10: The multiplication factor of voting with the multiplier increasing by one every time the lock period is doubled (Wood, 2021).

Besides governance for blockchain update proposals, Polkadot has a special feature to vote for parachains, which requires the use of DOT tokens: the parachain auction. The parachain auction was designed as a fair method to determine which projects or decentralized applications can actually be built on the Polkadot blockchain. Parachains optimize functionality for specific use cases and usually support their own native token. Before a project can be granted a parachain, they need to participate in the parachain auction. Essentially, it means that there is community governance which takes place before parachains are awarded to new projects. However, Polkadot will only support up to 100 parachain slots in its blockchain. The projects decide in which parachain auction round they want to participate.

During a parachain auction, users of the Polkadot blockchain can place bids on projects they wish to be awarded a parachain slot (Wood, 2021). DOT holders choose to bond their DOT tokens to specific projects during the parachain auction, which is called a crowdloan. In return, the project will give its supporters their own native token, which will be launched simultaneously with the parachain win. However, Polkadot parachain slots are not simply awarded to the highest bidder. The winner of a parachain slot is randomized. The parachain auction has a starting date and ending date for Polkadot users to bond their DOT tokens. However, the actual winner will be decided by picking a random point in time during the auction and looking at which project had the most bonded DOT tokens at that specific moment (O'Bere, 2021). Polkadot chose to implement such a method for their auctions to nullify some weaknesses of auctions, such as:

Last-minute sniping. This is a strategy in which a bidder waits until the latest moment possible to place the highest bid. This way there is not much incentive to bid early, as the most vital bidding wars will be held at the end of the auction.

Transparency. The auctioneer has an incentive to anonymously bid on the auction, to raise the bar of the highest bids. By not rewarding the parachain slot directly to the highest bidder, there is less incentive to place a bid to raise the other bids.

Front-running opportunities. Since blockchain transactions are on-chain and fully public, other parties can gain information of the bidding war and act according to this information. Bidders can see and react to bids of other bidders and bid higher, and use a higher transaction fee. The bid with higher transaction fee will be prioritized, while the initial bid will not be recorded.

Bidders bond and lock their DOT tokens to their favorite projects or dApps, in which the tokens are stored safely and securely on the relay chain. Once a parachain is won, the bonded DOT tokens stay locked on the relay chain for the whole duration of the lease, which is 96 weeks (Wood, 2021). For all the parachains which did not win, the bonded DOT will be returned to their wallets. The parachains are deployed in batches of five, this means that five different parachains will be deployed simultaneously at the conclusion of every five parachain auctions.

To bond DOT tokens, the bidder goes to the Polkadot Auction dashboard, which shows a list of projects participating in the auction, as shown in Figure 11. A bidder can bond their DOT by clicking on "contribute" and entering the amount of DOT they wish to bid. All the participating projects need to attract a solid community or wealthy investors to actually win a Polkadot auction, as the amount of bonded DOT tokens is vital for winning an auction. It is rather interesting to witness that a community decides which projects can launch on Polkadot, instead of the project with the best use case or any other criteria.

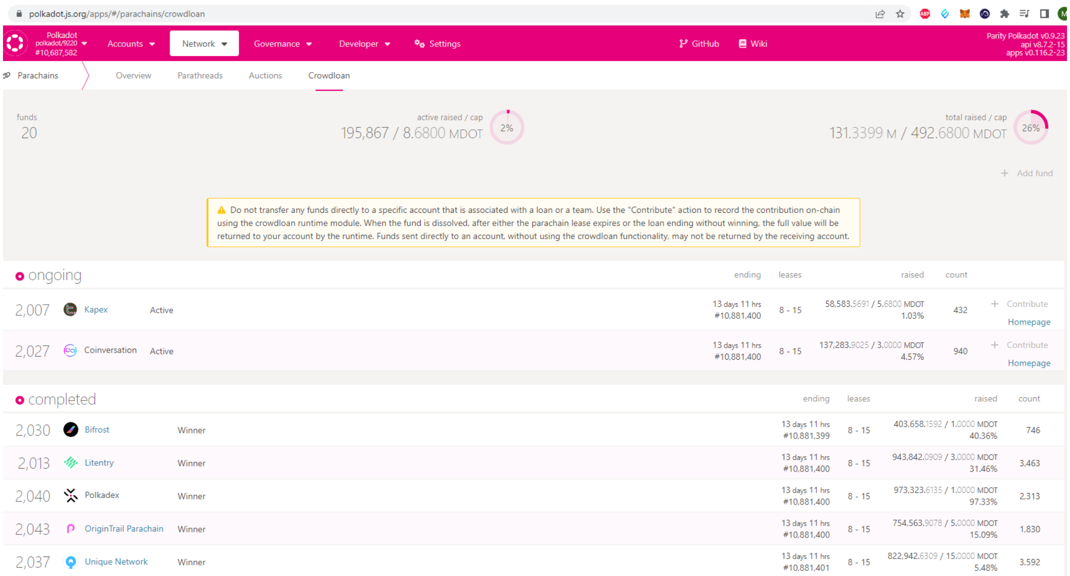


Figure 11: A screen capture of the Polkadot crowdloan landing page with active auctions and past auctions (Polkadot, 2022).

4.2.4 Outcome of Actions by Actors

The outcome of the action situation can allow the protocol to have simple changes implemented or more complex changes; the voting mechanism determines what upgrades are done and what changes are made to the Polkadot protocol. Either way, the outcome has a significant impact on the ecosystem of Polkadot. The process owners, or in this case the Polkadot Council, are responsible for the upgrade proposals or changes. The outcome of the voting process has a direct impact on all important actors. After the referendum was concluded regarding a proposal that the process owners submitted, the results are in. If a referendum was rejected due to a non-majority vote to approve or due to a lack of participation, a new referendum will be selected.

However, while the referendum happens on-chain, the implementation of the passed referenda and its codebase upgrade is solely dependent on the developers. This outcome is still based on trust, as the smart contract of the governance system does not automatically upgrade the code based on the outcome of the referendum. The code for the change or upgrade still needs to be developed by the developers, while the architects are finding a solution of how the upgrade or change should be best integrated into the new codebase.

Since the end-users are involved with the decision making process by voting during a referendum by staking their DOT tokens, the DOT token is an important resource in this decentralized governance system. The DOT tokens are locked for at least the duration of the enactment, which is 28 days. After the referendum is over, the end-user can decide whether to continue staking their DOT to accumulate more voting multiplication and endorse other proposals for the next referendum. Everybody in the Polkadot ecosystem is incentivized due to the network effects, which result from having a DOT token that has a monetary value within its ecosystem. This incentivizes all stakeholders to participate in the governance process, submit proposals, and make decisions that will benefit the overall health and longevity of the Polkadot ecosystem.

4.2.5 Schematic overview of Polkadot based on IAD framework

The findings of the IAD core concepts of Terra are presented with a schematic overview in Figure 12, which is based on Figure 6. This overview shows the important aspects of the governance system that Polkadot uses and can help the reader understand how it works.

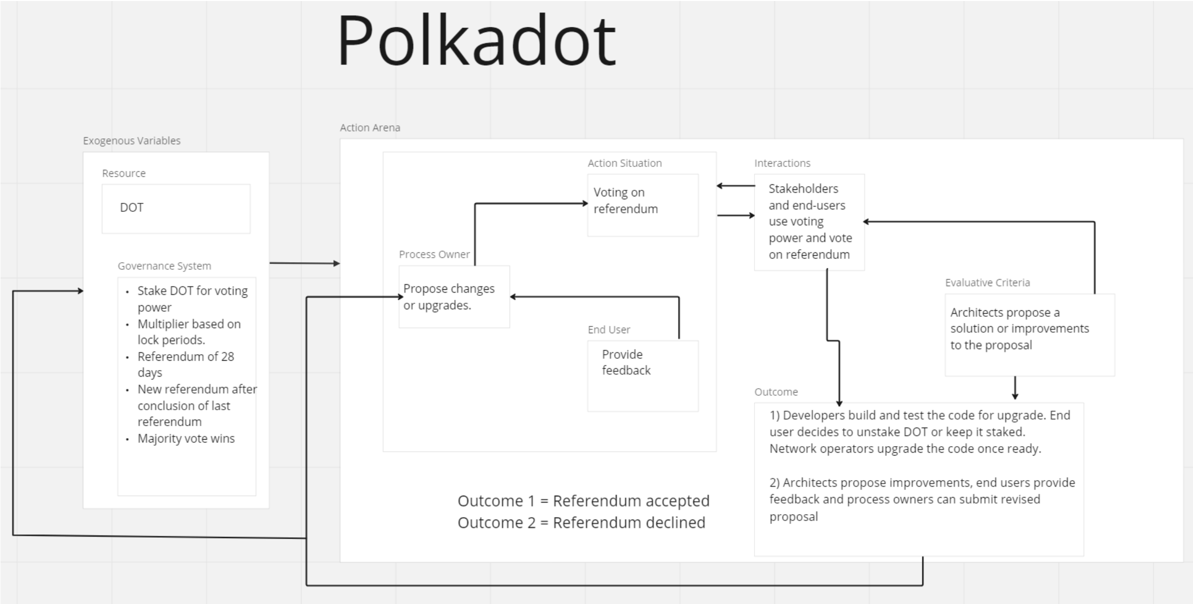


Figure 12: Schematic overview of Polkadot with Exogenous variables bracket to include the governance rules and the resources. Polkadot has specific rules in its governance system. The action situation bracket includes the actor interactions, action situation and the outcome. There are two different outcomes, in which 1) is whenever proposal is accepted and 2) is whenever the proposal is declined.

4.3 Terra

The Terra protocol is a leading open-source platform for creating stablecoins. It combines the advantages of open market arbitrage incentives and a decentralized oracle voting system to create stablecoins that track the price of any fiat asset. Most cryptocurrencies have a predetermined issuance schedule that, together with strong speculative demand, contributes to wild fluctuations in price. The founding members of Terra believe that Bitcoin's extreme volatility is a major reason why it is not considered a safe and reliable alternative to traditional fiat money. The complexity of transactions is also aggravated by the time it takes to resolve issues related to the use of cryptocurrencies. For example, a mortgage payment might take longer due to the volatility or be canceled altogether. The Terra Protocol aims to solve these problems by developing a stable and secure cryptocurrency that can be used in everyday transactions.

Its goal is to provide a monetary policy that can maintain a stable price and prevent the censorship of Bitcoin. Although price stability can help solve some of the problems related to the use of cryptocurrencies, it is not enough for everyone. For example, a customer is unlikely to switch to a new currency unless a significant number of consumers are ready to accept it. On the other hand, merchants have no reason to spend a lot of money educating their staff members about the use of cryptocurrencies. Due to the limited number of small businesses that accept Bitcoin, its adoption has been restricted to those who are personally invested in it. Terra's team believes that a more efficient fiscal policy can also help drive the adoption of cryptocurrencies.

Through the Terra Protocol's incentives, users can also participate in the network's various activities, such as its fiscal spending regime. This system, which is managed by a treasury, allows multiple stimulus programs to compete for funding. When the proposals are approved, they will be financed with the objective of increasing the number of people who adopt cryptocurrencies. The Terra Protocol's balance between the adoption and stability of cryptocurrencies is a significant factor that contributes to its potential to be a useful alternative to traditional fiat money (Kereiakes, Kwon, Maggio, & Platiask, 2019).

Terra has its own token called LUNA. The total market capitalization of the LUNA token is $37 Billion with a daily volume of $2,4 Billion. On April 5th 2022, LUNA was ranked 6th among all cryptocurrencies with a market share of 1,8% of the total market capitalization of all cryptocurrencies combined (CoinMarketCap, 2023). From this snapshot, Terra has performed well since its ICO, in which they raised $62 Million through a crowdfunding sale, which means that the market capitalization is a multiplication of roughly 600 times the raised amount.

4.3.1 Actor analysis and Action Situations

The action situations on Terra includes different situations such as proposing and implementing updates to the protocol or minting stablecoins, while there are also situations involving different stakeholders within the ecosystem such as how stakeholders collaborate in a governance system, voting, or making transactions.

Similarly, for Terra we shall once again highlight the actors who play a key role in the action situation of voting. From the list of actors, there are a few actors who have an active role in this action situation: the process owners, the blockchain architect, network operators, blockchain developers and the blockchain end-users.

The process owners in Terra are Terraform Labs and the Terra Alliance, which is a coalition of projects and organizations with the same goal of improving the Terra ecosystem. Terraform is primarily responsible for the development and maintenance of the core Terra protocol, including designing and implementing new features. The Terra Alliance was founded by multiple projects that build dApps, wallets and other infrastructure for the Terra ecosystem. Additionally, all process owners are responsible for managing the governance system of Terra, allowing stakeholders to propose and vote on important decisions regarding its ecosystem.

The blockchain architects in the Terra ecosystem are responsible for developing and designing the technical infrastructure. The architects consist of Terraform Labs, which includes its co-founder Do Kwon. The architects are the experts who design and implement the underlying technology, such as the software tools. The primary focus is designing a protocol which is secure and efficient, making it easier for external developers to build dApps.

Network operators are individuals and entities who are responsible for maintaining and operating the infrastructure. Similarly to Ethereum and Polkadot, the network operators run nodes to verify and process transactions. In return for the nodes to run around the clock, the network operators are rewarded in transaction fees and receive rewards for blocks they produce.

The developers in Terra are the ones who write the codebase for the protocol and for dApps. Many of the blockchain developers are members of Terraform Labs, this means there is some overlap with the process owners and architects. Developers work together with process owners, network operators and architects to ensure that they can deliver the best quality.

Terra users are individuals or entities who use the blockchain protocol to participate in activities, including are transactions, staking, using dApps and participating in governance. They can provide valuable feedback to developers to improve user experience.

4.3.2 Blockchain Resources

Terra has two important resources which are considered for its ecosystem. The first one is the nodes which are provided by network operators and the second resource if their own LUNA token. LUNA is the native cryptocurrency token of Terra, and similar to Polkadot is used for staking, bonding, governance voting and to pay for transaction fees. Since LUNA is tied to a stablecoin, LUNA has a monetary value. Network operators need to stake LUNA in order to validate transactions. The LUNA token is also used to govern the network through its on-chain voting mechanism.

LUNA has an inflation of 7% per year. Terra supports 10.000 TPS with a block time of 6 seconds. This block time is considered fast, as takes only a matter of seconds and is significantly faster than Ethereum. The transaction costs of Terra are low, as it costs well below $0,50 to make a transaction (Raczyński, 2021).

4.3.3 Blockchain rules and Governance System

The Terra blockchain is an open-source platform that allows users to create and manage decentralized applications. It utilizes ground-breaking technologies such as Terra Station and Mantlemint. With its fast emergence and evolution, it is one of the fastest blockchains in existence. The Terra blockchain is powered by the Cosmos SDK, and secured using the Tendermint consensus. Tendermint is a PoS consensus that allows users to become validators to verify the validity of transactions. Tendermint is notable for the simplicity, fork-accountability and the performance. Tendermint requires a fixed set of validators, where the validators attempt to reach consensus on a single block at any given time. The voting for consensus happens in rounds in which each round has a round-leader who proposes the block. The round-leader is determined from a list of validators based on the voting power (Network, 2018).

The validators are responsible for ensuring that the network's legitimacy is maintained. They perform various tasks, such as voting on the validity of transactions, adding new blocks and proposing blocks. A block of transactions is submitted by a validator or proposer, and they are then voted on by the other validators. If the proposed block is rejected, a new one is created. The block is then signed and added to the blockchain (Terra, 2019). The security of Tendermint is being governed by the super-majority voting mechanism, in which 66% of votes are necessary to reach consensus. If validators succeed in violating security of the blockchain, they can be identified and punished by the Tendermint protocol. The fees from the transaction are distributed to the delegators and the block's other members.

With Ethereum, all nodes have the same weight, however with Tendermint the nodes have a non-negative amount of voting power. Validators are the nodes which have positive voting power. With the ability to replicate an application on multiple machines, Tendermint is a great tool for distributed systems. It is secure and consistent, which helps ensure that the system can run smoothly even if one-third of all machines fail. This is a critical issue for any distributed system, as it allows for the continuous monitoring and analysis of various applications, such as currencies and elections (Network, 2018).

Byzantine fault tolerance (BFT) is a theory that states that machines can tolerate failure in arbitrary ways, such as becoming malicious. This concept is considered outdated, but the popularity of blockchains such as Bitcoin and Ethereum has led to the emergence of software implementations with BFT. Tendermint allows applications to perform transactions in any programming language. This consensus mechanism ensures that all transactions are recorded in the same order on every machine. Unlike other consensus and blockchain solutions, which are usually pre-packaged with state machines like a key-value store, Tendermint does not require state-machines to be written in. It is ideal for developing BFT applications that are written in any programming language. Its simplicity and high performance make it an ideal tool for distributed systems (Network, 2018).

Proposers get extra rewards to participate in the block to incentivize participation. After new blocks are added, the transactions are compared against the proposed block before voting takes place. Each vote is conducted independently to protect the validity of transactions. This ensures that the network can still function properly. Since there are multiple independent validators participating in the voting process, it's impossible for a false block to be accepted. In addition to being responsible for maintaining the network's integrity, they also play a vital role in the governance of Terra.

Terra only allows the top 130 validators to participate in its consensus. The ranking of these individuals is based on their stake and the amount of Luna they have bonded to each the validators. Although they can bond to themselves, delegators are more likely to bond their LUNA to validators for new blocks. Validators with large stake from delegators are also more likely to propose new blocks. Delegators are users who are passively participating in consensus to receive rewards without running a full node. Whenever a user stakes Luna, they are a delegator and add more weight to the validator. For incentives, the delegators receive a portion of the transaction fees that are collected by the delegators. Redelegation is also possible, in which it instantly sends the staked LUNA from one validator to another validator. By redelegating, the delegator bypasses the unbonding time. Even though the delegator's LUNA is staked and locked in a validator, the staked LUNA is not owned by the validators. There are three different stages of LUNA (Terra, 2019):

Unbonded. LUNA can be freely be traded or sent in a transaction to another wallet.
Bonded. LUNA that is staked and locked to a validator. Bonded LUNA accumulates staking rewards, but cannot be traded freely.
Unbonded. In this stage the LUNA is being be unbonded from a validator. This process takes about 21 days to complete and it does not accumulate staking rewards. During unbonding, LUNA cannot be traded. The 21 days of unbonding stimulates the long-term stability of LUNA, as the unbonding window acts as a discouragement to unbond and sell their LUNA.

The accumulated rewards for validators consist of two different pools. The first one is transaction fees. A minimum amount of gas fees needed is set by a validator to avoid spamming of the network. Transactions with a gas fee below this minimum threshold are to be rejected by the validator. The second pool for rewards comes from an annual inflation. LUNA is minted in every block and released to validators and delegators as staking rewards. The inflation rate is fixed at 7% per year. Before the delegators receive their rewards, the validators can keep a portion of the accumulated gas fee rewards as a commission for the services of being a validator. The excess rewards are to be distributed to the delegators.

Naturally, there are some side effects to staking, as running a validator comes with significant responsibilities. In order to become and remain a validator, they must meet certain standards such as continuous live-time monitoring and active participation in the consensus. If there is any misbehavior from validators, they will be penalized through slashing. During a slash, the validator loses a small portion of the staked LUNA from both the validator and delegator. On top of this, the validators get excluded from consensus for a certain time period to prevent further misbehavior in the near future. Slashing means that delegators need to understand, monitor, and research the validators that are currently up and running. Slashing can occur when the validators do not meet certain standards such as:

Double signing. Whenever a validator signs two different blocks at the same block height.
Downtime. Whenever a validator is offline for a certain period of time or whenever the validator is unresponsive.
Missed votes. Whenever a validator fails to participate in consensus, by missing votes.

Voting is the most important aspect of an on-chain governance protocol. Whenever the community deemed it necessary for changes in the Terra blockchain, the community can submit proposals alongside an initial LUNA deposit. These deposits protect the network against unnecessary proposals and spam. Other users can veto any proposal which was submitted. The proposal will be canceled and the deposited LUNA will be burned if one of three conditions was not met. However, the deposited LUNA gets refunded once the proposal proceeds to actual voting. This happens if the proposal survives the two-week deposit period including all other conditions. The conditions for refund or burned is shown in Table 4. One staked LUNA equals one single vote, so the users with more staked LUNA have more power in the governance. If a user does not vote, then the voting power gets allocated to the validator the LUNA are staked to. This means that delegators must actively vote; otherwise they are forfeiting their voting power to the validators. The voting process follows a clear set of rules (Terra, 2019):

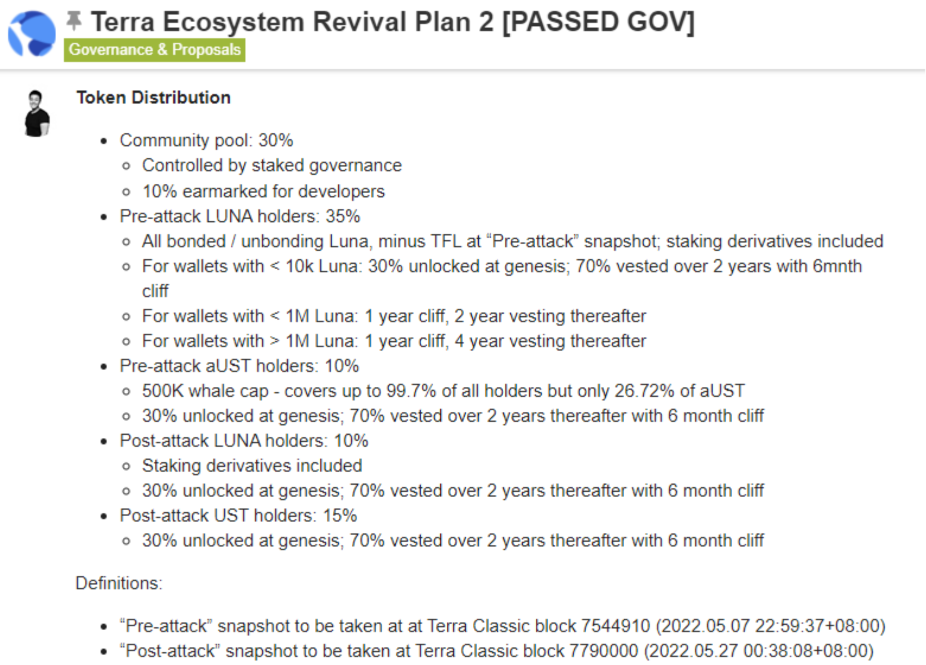
Submitting a proposal. A two-week deposit period begins after a proposal was submitted.
Deposit LUNA. The proposer deposits a minimum of 50 LUNA as collateral, during the two-week deposit period, before the proposal can enter the voting period.
Voting period. A one-week voting period starts with voting options yes, no, veto or abstain from voting.
Count votes. Votes are being counted and the proposal is passed once it meets the following three conditions: a minimum of 40% of all staked LUNA was used to vote, the total number of vetoes is smaller than 33,4% of the total vote and the number of votes in favor of the proposal reaches a 50% majority. If one of the conditions are not met, the proposal is rejected.
Action. The outcome of the vote is accepted and comes into effect.
Release of LUNA deposit. The LUNA which was deposited gets refunded of burned according to the outcome of the vote.

Table 4: The selected blockchains projects for the case study.

Deposit gets burned	**Deposit gets refunded**
Minimum deposit of 50 LUNA was not met during two-week deposit period	Minimum deposit of 50 LUNA was met within two-week deposit period
Total votes after a one-week voting period is less than 40% of all staked LUNA	The total number of votes is larger than 40% of all staked LUNA.
The number of vetoes is larger than 33,4% of the total votes	The number of vetoes is smaller than 33,4% of the total votes
	A proposal returns a majority vote of yes or no

On 10 May 2022, Terra's Anchor was exploited. This exploit was possible due to the volatility of both BTC and LUNA, which dropped 20% and 50% respectively since the day before. UST started to de-pegg from 1 single dollar by dropping below $1,-. This started a chain reaction of people wanting to swap their UST to LUNA by using Anchor and exit their positions by selling LUNA. LUNA started dropping in price even more by dropping 99% in a row over the next 3 days. At its lowest point, UST dropped to $0,10 while LUNA dropped to $0,00001. A total of $60 Billion was removed from the cryptocurrency market in a matter of a few days due to both LUNA and UST combined.

In the meantime, in an attempt to save Terra and the price of UST and LUNA, on 16 May 2022 the founders of Terra proposed a solution to fork away from Terra and create a Terra 2.0. Terra 2.0 will become Terra while Terra 1.0 will be called Terra Classic. Terra will be the same as what Terra Classic was, but without the smart contract of UST. However, to compensate for the losses of the initial Terra Classic, they planned to airdrop Terra 2.0 tokens to token holders of Terra Classic. The token distribution is shown in Figure 13.



Terra Ecosystem Revival Plan 2 [PASSED GOV]

Governance & Proposals

Token Distribution

- Community pool: 30%
  - Controlled by staked governance
  - 10% earmarked for developers
- Pre-attack LUNA holders: 35%
  - All bonded / unbonding Luna, minus TFL at "Pre-attack" snapshot; staking derivatives included
  - For wallets with < 10k Luna: 30% unlocked at genesis; 70% vested over 2 years with 6mnth cliff
  - For wallets with < 1M Luna: 1 year cliff, 2 year vesting thereafter
  - For wallets with > 1M Luna: 1 year cliff, 4 year vesting thereafter
- Pre-attack aUST holders: 10%
  - 500K whale cap - covers up to 99.7% of all holders but only 26.72% of aUST
  - 30% unlocked at genesis; 70% vested over 2 years thereafter with 6 month cliff
- Post-attack LUNA holders: 10%
  - Staking derivatives included
  - 30% unlocked at genesis; 70% vested over 2 years thereafter with 6 month cliff
- Post-attack UST holders: 15%
  - 30% unlocked at genesis; 70% vested over 2 years thereafter with 6 month cliff

Definitions:

- "Pre-attack" snapshot to be taken at at Terra Classic block 7544910 (2022.05.07 22:59:37+08:00)
- "Post-attack" snapshot to be taken at Terra Classic block 7790000 (2022.05.27 00:38:08+08:00)

Figure 13: The distribution of LUNA tokens in Terra 2.0 according to token holders of Terra Classic (Kwon, 2022)

This proposal went through the steps of Terra's governance, which means there was a minimum deposit of 50 LUNA and the proposal can only pass if a minimum of 40% of staked LUNA was used to vote. The proposal can only pass with a majority voting of 50% in favor and a maximum of 33,4% of vetoes. The results of the final day of the governance voting six hours prior to conclusion, which was on 25 May, can be seen in 14. The voting rate was 67,27% in favor, 20,41% abstained from voting, 0,34% voted against and 11,99% vetoes (Terra, 2022). As can be seen, the total vetoes is smaller than 33,4% and there is a majority vote of more than 50%. Eventually the voting proposal for Terra 2.0 passed and a new Terra blockchain was created which was to be called Terra. Although this fork was the result of on-chain governance, it is important to note that the decentralized aspect might still be argued.

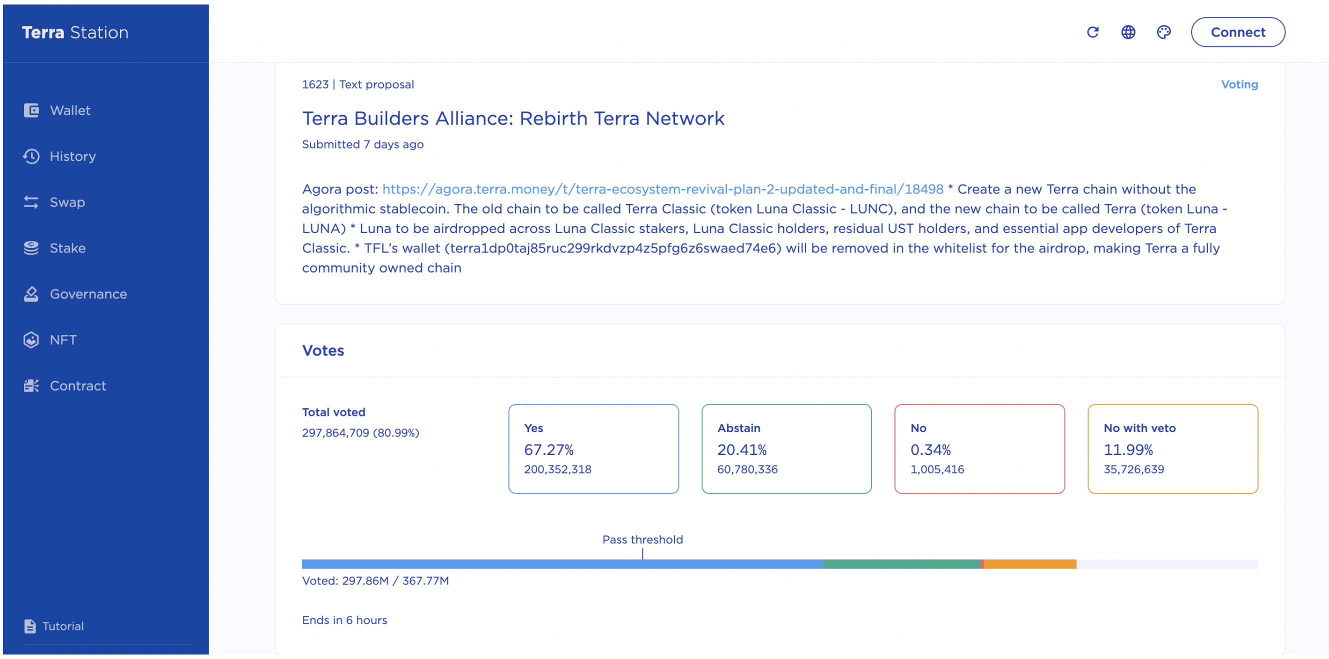


Figure 14: The distribution of LUNA tokens in Terra 2.0 according to token holders of Terra Classic (Terra, 2022).

In Figure 15, which was captured at a random day during the voting period, it can be concluded that roughly 14% of the voting power comes from five different validators. 96 validators have not voted yet, while 46 validators voted in favor of the proposal. The 46 validators in favor are roughly 32% of the total number of validators. Their vote counts for roughly 43% of the maximum theoretical votes, which is almost a majority vote, due to the amount of LUNA that they had staked. This could potentially show a weakness in such a PoS governance.

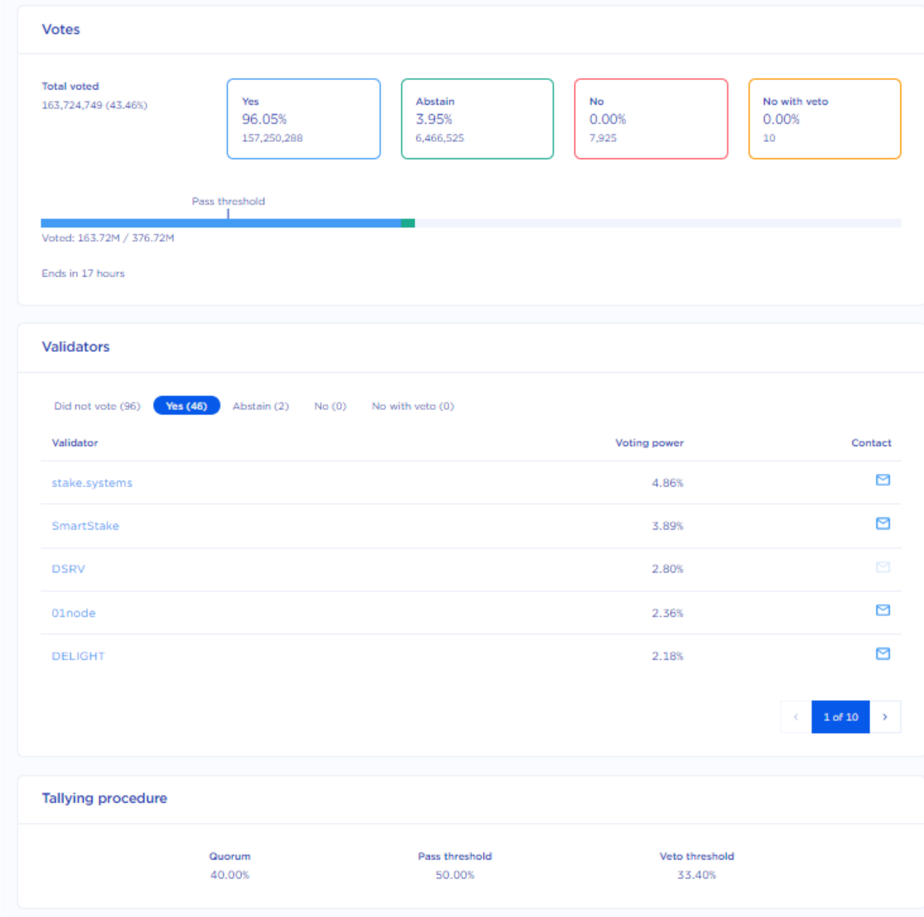


Figure 15: The distribution of LUNA tokens in Terra 2.0 according to token holders of Terra Classic (Terra, 2022)

4.3.4 Outcome of Actions by Actors

Whenever a proposal was accepted through a governance vote, the key actors are affected. Developers and architects are impacted if the proposal involves changes to the codebase or architecture of the protocol, this means they have to learn new skills and develop the new code to implement in the codebase. Validators are also affected as they need to update their nodes to comply with the changes.

The end-users who voted on the proposals are receiving their LUNA tokens back. Whether they have voted themselves or not, the amount of tokens they staked is used for voting since the validator can use the tokens for voting too.

If the proposal fails to meet the required upvotes or the proposal does not receive enough support from voters, the proposal is rejected and the changes will not be implemented. After such rejection, the proposer or process owner may choose to modify the proposal and resubmit it for a new vote in the future. It is up to the process owner to promote any proposals which are submitted for the governance vote.

It is interesting to note that even though the governance model allows for voting and decision making, the developers still need to develop the new changes. In this governance model, they are not bound to actually execute on the outcome. None of the investors can hold the developers and architects accountable for their actions. So this outcome is still based on trust.

4.3.5 Schematic overview of Terra based on IAD framework

The findings of the IAD core concepts of Terra are presented with a schematic overview in Figure 16, which is based on Figure 6. This overview shows the important aspects of the governance system that Terra uses and can help the reader understand how it works.

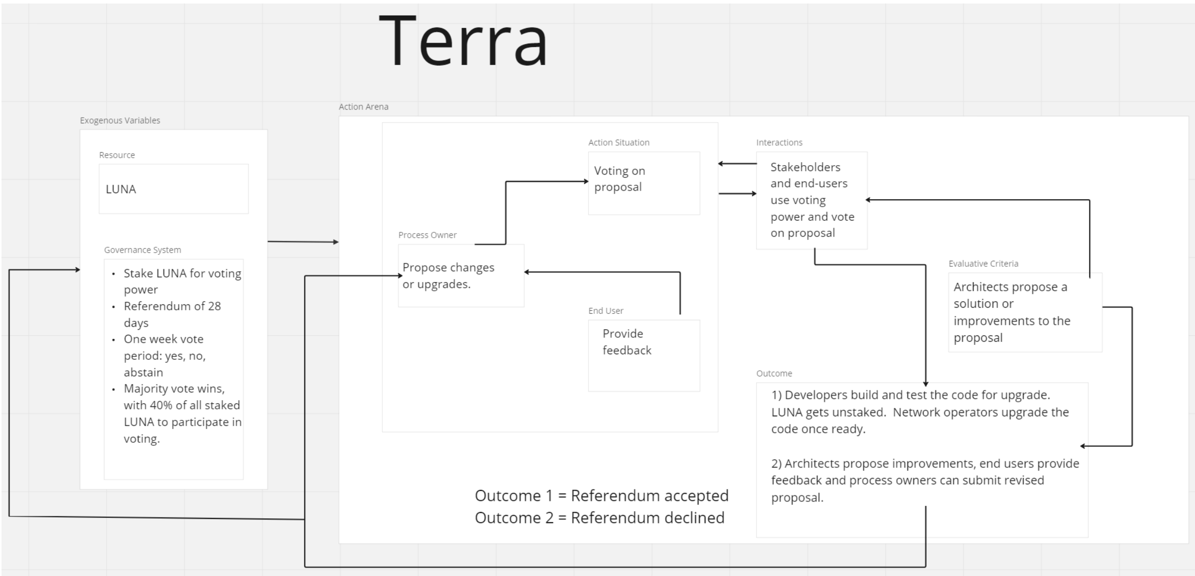


Figure 16: Schematic overview of Terra with Exogenous variables bracket to include the governance rules and the resources. Terra has a more simplified governance system as opposed to Polkadot. The action situation bracket includes the actor interactions, action situation and the outcome. There are two different outcomes, in which 1) is whenever proposal is accepted and 2) is whenever the proposal is declined.

5 Exploring Dequity: Enhancing Governance and Investor Trust in Crowdfunding

In this chapter we represent an in-depth analysis and interpretation of the findings from the previous chapters. The research aimed to investigate the impact of tokenization of financial assets on blockchain for new ventures, by understanding how tokens are being used by blockchain based ventures and how this could be improved. To accomplish this, we conducted a case study research through the IAD framework.

In the upcoming sections of this chapter, we shall provide a detailed discussion of the findings, their significance and their implications. The findings shall be compared with each other, allowing us to evaluate the strengths and limitations of the current governance systems. Understanding the strength and limitations can help us answer the third sub-question **'How can the functionality of token models be enhanced to increase trust and transparency for investors?'**. Consequently, we shall answer this question by discussing how the governance systems could be improved to create a more fair ecosystem which can increase transparency and trust for the crowd investors. Finally, the findings and discussions will lead to our conclusions, followed by suggesting directions for future research.

5.1 Token Properties: Debt, Equity or Dequity?

The reviewed cases can now be compared with each other, which could lead to a discussion on the flaws of their token models and how they could be improved to increase trust and transparency for the investors. In the literature review, we presented the properties of both debt and equity. These properties are used to clarify the nature of the ETH, DOT, and/or LUNA tokens.

Since the results are fully documented, we can now examine the utility of the blockchain tokens and compare them to equity and debt. By comparing the utility of the tokens with the properties of debt and equity described in chapter 2.1, we can evaluate whether some form of dequity already exists in the current layer-1 blockchains or not. The quantitative data is summarized in Table 5 for simplicity.

Table 5: A breakdown whether the analyzed layer-1 blockchains already have some properties of debt and equity or not.

Debt properties	**Yes or No**
Interest repayment at regular intervals	No
Business continuously tested for liquidity	No
Sinking funds will be set up and principal repaid at expiration date of loan	No
Failure of payment will result in liquidation of underlying assets	No
Equity properties	**Yes or No**
Equity holders have claimant status to company in earnings and asset liquidation	No
Equity is tied to duration of company	Yes in all three
Equity has power to replace management	No
Equity holders have access to internal performance measures	No
Equity holders can authorize audits	No
Equity holders are updated on important investment and operating proposals before implementation	Yes, Terra and Polkadot

It is noticeable that there are no properties of debt at all within the layer-1 blockchain tokens: there is no interest repayment, no liquidity testing and no risk of liquidation. However, some properties of equity are present. Without the tokens, none of the blockchain ecosystems would exist at all, as the tokens were sold during crowdfunding. While Ethereum, Terra and Polkadot token holders are updated on operating proposals before implementation, it is interesting to note that both Polkadot and Terra, which are based on PoS, have a on-chain governance integrated into their blockchain. Not only will Terra and Polkadot token holders be updated on operating proposals, they also have a say whether the proposals should be accepted or not. Coincidentally, one of the biggest difference is that Ethereum is PoW while Polkadot and Terra are PoS. So this might be the reason to actually update token holders on operating proposals.

But why does this only happen in PoS consensus and not in PoW? The validators of Ethereum do not necessarily have a stake of ETH, they mine ETH tokens as a reward for being a validator. The only condition to become an Ethereum validator is to purchase and control the hardware of the mining equipment. If the Ethereum validators were forced to hold some ETH in order to become or stay active as a validator, it would typically become a PoS consensus. Both Terra and Polkadot validators require a stake of their token to become and remain a validator.

This directly means that something is at stake (their tokens) and that the tokens could be slashed by the protocol if the validator becomes corrupt. It can basically be ruled out that Ethereum and any other blockchain running on a PoW consensus are not eligible for dequity.

It is clear that the properties of debt are not present, while some properties of equity are. So it looks as if these tokens of the layer-1 blockchains are not dequity tokens, although they do have properties of equity. This means that equity currently plays a much bigger role than debt in the financing of blockchain projects. In the next chapter, a discussion will follow in order to understand what the flaws are in the current token models and how they could be improved to allow for more trust and transparency for its investors. Moreover, since dequity was only a hypothetical financial instrument due to the lack of a trustless governing protocol, it will be discussed how dequity could become possible, and is only possible, due to an emerging technology such as blockchain.

5.2 Importance of Founders and Actor Roles: Lessons From Ethereum, Polkadot and Terra

After conducting the actor analysis, we notice that in all three case studies, the founders of the projects are important as they form the foundation of the team assembled to build a decentralized Layer-1 protocol. Some actor roles do overlap with one another. In Ethereum, Polkadot and Terra the founders are involved with at least the roles process owner and blockchain architect. Additionally, if they have the required skills they are also involved with the network operators and blockchain developers. If not, then they can assemble the team which can take on these roles. Having a more diverse and skillful founding team can also mean that the core team can be smaller, and personnel expansion may not be necessary in the early phases of development. However, it also means that the same people are responsible for more tasks and roles. If one of the actors is no longer committed, is corrupt, or is unable to perform their work, then the platform could face significant challenges. It would be disastrous for a platform to lose a key individual or, even worse, multiple key individuals.

Network operators are important as they keep the network intact by providing hashing power for PoW blockchains and by producing blocks for PoS blockchains. The community or the blockchain end-users are usually the ones who invested their funding in the project through a crowdfunding round. We have learned that an issue with crowdfunding is that whenever founders have too much insider ownership, it can lead to a reduction of the crowd investor's investments due to a lack of trust or transparency. In Chapter 2.3 of the literature review, we mentioned some of the risks and benefits of ICOs within the blockchain industry due to a lack of transparency.

From the case studies we derive that the founding team has too much power regarding decision making in a decentralized ecosystem. This goes against the principle of a decentralized ecosystem. Consequently, it would be best if the actor roles were more evenly distributed among multiple parties or if the founding team had less power in the governance system through a modified governance model. Since it is hard to control what roles are granted to the founding team, we will be looking at reducing their power in the governance systems. This can only happen if the token utility and the governance model are designed in a way that gives more incentives for staking long-term or which rewards long-term end-users who believe in the longevity and sustainability of the protocol.

5.3 Comparing PoW and PoS Consensus Mechanisms and Governance Systems

The difference between PoW and PoS was briefly described in Chapter 2.2.1, however in this section we compare the cases through the consensus mechanisms PoW and PoS, and how they differ from one another. The first finding is how Ethereum is the only PoW blockchain, while both Polkadot and Terra use a form of PoS consensus mechanism. What stands out is how Ethereum is also the only blockchain with a low amount of TPS, relatively high block time and a high transaction cost compared to Polkadot and Terra which are using the PoS consensus mechanism. However, Ethereum is the protocol with the larger market capitalization. Could it mean that those characteristics are not that significant? This could be the case, but we should also factor in that Ethereum was launched in 2015, while the other two blockchains were launched in 2019 or later. Ethereum is the market leader apart from Bitcoin since the very start of the launch of Ethereum.

From the case reviews it is clear that Ethereum does not allow for governance through the ETH token, but through miners who do not necessarily have a stake in the tokens, this is because of the PoW consensus mechanism. This means that end-users do not directly impact any decision making and that the founding team has the majority of ownership.

Both Terra and Polkadot actually allow for governance through the token via voting rights through staking. With dequity in mind, the tokens would need to have a utility in governance. Otherwise the governance of a blockchain cannot be decentralized. In Ethereum the majority of the miners need to agree on a code upgrade by forking away to a separate chain, without any input from the community. This governance system can somewhat feel like it is a unilateral system because the community cannot vote on proposals or code upgrades with a token. With Polkadot and Terra, it is not only validators or core developers who can submit proposals, but also the community. But the biggest difference is that those blockchains take the opinion of their communities into consideration through governance voting.

However, it cannot be without boundaries, so the proposals are usually limited in some way. The foundation of those blockchains is written in code, with numerical values, unbonding time, usage of funding and inflation for example which can be flexible. This way the community can decide on changes to make small but significant changes in the financial aspect. The community has an impact on what the platform will look like and how it will behave eventually by staking their tokens into a smart contract to gain voting rights. By this reasoning alone, PoW, and therefore Ethereum's ETH, cannot be a dequity token, but Polkadot's DOT and Terra's LUNA can be. Although, both Polkadot and Terra are lacking properties of debt and equity to be classified as a dequity model. More specifically, they do not have any debt properties and only little equity properties.

The major similarities between Polkadot and Terra are that both of them require staking of their specific token to participate in the blockchain governance voting, which is also the most interesting property of equity in the hypothetical dequity token. The stakers then have bonded their tokens within a contract until they want to release the tokens, in which it triggers an unbonding time. The major differences between Polkadot and Terra are that Polkadot uses a voting multiplier as an act of incentives for stakers to stake for a longer duration, while Terra does not. While both Polkadot and Terra are open source Layer-1 blockchains, Polkadot lets their community decide whether a project can build and when they are allowed to deploy their project on Polkadot. So even though Polkadot is open source, the threshold to join the ecosystem is higher than Terra's threshold to deploy a project on Terra because joining Terra's ecosystem does not require any community involvement. So the tokens have a huge role in both Terra and Polkadot and the governance voting seems to work properly with stakers actively voting on proposals.

However, it was discussed that there are a few flaws during the governance votes. Large token holders have more control over the outcome of any proposal, which was shown in Terra's case. In addition, during the voting period for Terra 2.0, it was speculated that Do Kwon used 20 Million LUNA to vote for his own proposal, although it was promised that they would not vote on their own proposals (Karunanidhi, 2022). There still seems to be a lack of transparency and with the founders and core team members being the core stakeholders, it is common practice that they usually hold the largest number of tokens.

5.4 Exploring Voting Systems for Blockchain Governance models: Quadratic Voting

One of the trends is that many blockchain based founders are taking governance into account whenever they design their whitepaper and tokenomics. Instead of simple utility tokens, a token can be designed with a utility that includes actual governance integration. However, there are many learning points which can be established by reviewing the cases. These learning points are discussed and addressed within the following this chapter.

5.4.1 Exploring Voting Systems of Blockchain Ecosystems

In the case of the collapse of Terra 1.0, it was rumored that the founder Do Kwon and its team used LUNA, which was in their possession, to vote on the proposals they submitted themselves. Whether it is true or not, it still suggests that it would be possible to have a significant say in the outcome of any submitted proposal as a founding member of the platform. Given the amount of votes which came in, and looking at largest voters, the majority of the voting power or tokens came from a concentrated amount of voters. It is evident that any governance token model is not fair if the founders and core team members can be the determining factor in a proposal.

In contrast, Ethereum has a PoW consensus mechanism, which does not allow the tokens to be used in the Ethereum ecosystem other than paying for the high transaction fees on Ethereum's blockchain. So we can conclude that a dequity inspired token needs to have a PoS consensus mechanism embedded into the blockchain.

In Polkadot's case it was learned that the DOT tokens are locked, and locking the tokens for a longer period can grant the owner more voting power. Even though this could be a potential fail-safe against opportunists, for a true potential adopted financial asset there should be more fail-safes embedded. Compared to Polkadot, Terra's governance voting system to prevent cartelization is limited. Polkadot integrated a voting multiplier which takes account the specific amount of time tokens are being staked in a specific wallet without being unstaked. If Terra had such a rule, then the founders of Terra would have to stake their LUNA to accumulate significant voting power. This means that their LUNA would be illiquid, something the Terra foundation would rather not want for their funds.

In the current case with Terra, they can keep their LUNA liquid, but whenever there is a proposal they could just use all their LUNA to vote. It takes little commitment and it is bound to manipulation by large holders of LUNA. Even if Polkadot team members are using their own DOT to vote on proposals or parachains, they need to allocate their DOT tokens wisely: what amount would be used for future expenses and what amount is needed for short-term expenses? By having a financial audit, Polkadot's team can allocate a specific amount for staking purposes, which is proof of commitment. However, this would still mean that a large holder of the token could have a significant portion of the voting power. This is a vital problem in platforms with a governance voting based on tokens. Based on the cases, even with the voting multiplication, a more fair system was not yet found to combat cartelization of the governance to stimulate transparency and trust. In order to find a more fair and ideal voting system, we go back to the basics of an electorate vote (Ray, 2019). In an electorate vote, one person gets to have one single vote.

First-past-the-post. The first option which gets past a certain threshold based on the number of votes. This does not necessarily mean that the winner has gotten the most votes, it would mean that the winner was the first to reach a specific amount of votes.
Proportional voting. With this kind of system, the electorate votes determine the amount of seats is allocated to a party in proportion of the number of votes.
Ranked choice voting. During ranked choice voting, each voter ranks the parties or candidates in an order from most favorite to least favorite. The candidate with the least amount of votes is eliminated and the second favorite candidate of the people who voted for the losing candidate in the current round will be counted towards the second round etc. It is a complex and time-consuming system.
Majority vote. This one is simple and straightforward, the majority vote wins. It is currently used in most blockchain platforms.

These systems have their strengths, but they definitely also have their weaknesses, with the most important feature being their opacity. With blockchain, the votes are public, traceable, and linked to a wallet, but not to a specific person. Since blockchain incorporates smart contracts, which enable collective decision-making through the use of tokens, more complicated voting systems could potentially be adopted. The fact that votes are not linked to individuals could be addressed with the right voting system.

5.4.2 Introducing Quadratic Voting for Fair Governance

For collective decision making, we must consider the voters who care about the platform, who are willing to commit and stake their tokens long-term. Additionally, we have to account for the majority of voters who have a relatively small stake compared to a few individuals with a significantly larger number of tokens. In other words, we have to protect the interest of the investors who have a smaller amount of tokens and/or who have a rooted interest to make sure the decisions are based to benefit their preferred platform or application.

To realize these terms, we wish to introduce quadratic voting. In quadratic voting, voters are allocated voting power based on the amount of tokens staked (Ray, 2019). At first there might not seem to be a difference, but the key distinction is that instead of a linear cost of a vote, the cost of a vote is quadratic. As a result, voting power becomes significantly more expensive for wallets that are staking a large number of tokens. Here, we refer to wallets and not individuals, as any individual can have multiple wallets.

In Table 6, we have displayed an example of how the costs of tokens increase significantly for more voting power. On the other hand, due to quadratic voting, a founder or core team member with more tokens has a much smaller voting power compared to their stake and might not agree with the quadratic voting system. However, because this crowdfunding approach is a global crowdfund event, we believe it is more important to protect the investors by providing them with more transparency and trust. In order for investors who want to invest more and buy a significant share of the tokens, properties of debt shall be added to increase trust and confidence, which shall be discussed later.

Table 6: A breakdown of the quadratic voting structure in which the cost of tokens are quadratic.

Voting power based on staked tokens	**The amount of tokens necessary**
1	1
2	4
3	9
4	16
5	25
10	100
50	2.500
100	10.000
1.000	1.000.000
100.000	10.000.000.000

It shows that the costs indeed increase significantly, resulting in regular end-users being able to participate in the voting schemes in a meaningful manner. We can find a good example looking back at Figure 15. The largest staker in that moment was stake.systems with a voting power of 4,86%, which is roughly 8 million LUNA. The voting power with a quadratic voting structure would be 2.820. DELIGHT had a voting power of 2.18% which is roughly 3,5 million LUNA. The voting power with a quadratic voting structure would be 1.889. In comparison, stake.systems had 228% of the amount of LUNA staked that DELIGHT had staked, while the voting power of stake.systems is only 149% of the voting power that DELIGHT had due to quadratic voting. Although there is a noticeable difference, we have been comparing two large LUNA stakers with each other.

If we compare a large holder such as stake.systems with an end-user with 100 LUNA tokens, we would only need 290 wallets with 100 LUNA tokens to be equal to stake.systems. Simple math would show that 29.000 LUNA tokens is as influential during a referendum as a wallet with 8 million LUNA. If we compare stake.systems with wallets holding 25 LUNA, then there needs to be 564 wallets with 25 LUNA staked to reach the same voting power. This is only 14.100 LUNA compared to the 8 million LUNA of stake.systems. With quadratic voting, the outcome of any referenda could still be decided by a majority vote, but instead of actual majority stake it will be a majority voting power.

With the addition of quadratic voting, the votes of the average end-users matter for the governance outcome, creating a more fair governance system. However, we have to keep adapting the model to reward long-term holders, especially long-term stakers. With quadratic voting, the voting power is still based on the amount of tokens that are staked. Thus, it does not matter how long a person has staked their tokens before they enter the referendum. A short-term holder is considered equal to a long-term holder in terms of voting power.

This still means that the token holders can keep their tokens unstaked until a referendum starts, allowing them to keep their tokens liquid to sell whenever an opportunity arises, as long as they are not staked with the sole purpose of a referendum. As a result, the majority of the tokens held by the team of VCs do not have to be staked at all times to maintain their voting power. To decrease the voting power of opportunists, there needs to be an implementation in which the actual investors who believe in the future, sustainability and longevity of the start-up they invested in will be awarded with more voting power. This way, long-term stakers who are committed to the project are incentivized to have a stronger voice in governance decisions, leading to a more stable and transparent ecosystem.

5.4.3 Enhancing Decision-Making: Quadratic Voting with Multiplier

In order to counteract this problem, we propose to adapt and combine the multiplier rule used by Polkadot with quadratic voting. The voting power in this combined approach is determined by multiplying the quadratic voting score and the voting multiplier based on the number of days the tokens are staked. This approach benefits individuals who have a genuine interest in the project's success, creating a more fair, rewarding, and meaningful decision-making process, while decreasing the influence of opportunists.

By adopting the voting multiplier based on the duration of token staking, long-term stakers will have more power compared to opportunistic holders who only stake tokens for specific referendums. This approach ensures that the decision-making process maintains its equity properties, giving more weight to the voices of committed and long-term supporters of the project. As a result, the governance system becomes more aligned with the interests of the project's long-term sustainability and growth.

An example: an investor who has staked 10.000 tokens for 365 days will have a voting power of 100 $\times$ 365 days = 36.500. Compare this with a large investor who only stakes their tokens whenever their is a referendum to stay liquid. In this case we use an example of a large investor who has 1.000.000 tokens staked for only 5 days: the voting power is 1.000 $\times$ 5 days = 5.000. However, a large investor who believes in the future of the start-up with 1.000.000 token staked for 365 days still has a voting power of 1.000 $\times$ 365 days = 365.000. This shows that whenever the amount of days staked are similar, the large investor still holds a significant influence over the smaller investor.

This adaptation could successfully reward long-term stakers and believers in the start-up by granting them more voting power, thereby increasing trust and transparency. This has the potential to encourage crowd investors to invest in a crowdfunded start-up, resulting in the increase of likelihood of raising capital for their start-up during a crowdfunding event, especially when they cannot tap into the benefits that Silicon Valley has to offer.

5.4.4 Start-Up Treasury Management

Although transactions on blockchain are public and traceable, there is still a major problem with transparency regarding the treasury of the foundation behind the blockchain start-up. Since investors who wish to buy a larger amount of tokens lose some of their voting power due to quadratic voting, we wish to compensate them with more trust and confidence in return. During ICOs, these start-ups sell their own future tokens to (smaller) investors for more legacy cryptocurrencies such as ETH, USDT and USDC. In traditional finance these future tokens have similarities with equity. The funds collected in the treasury of the founding team are solely for development, marketing purposes, and operational costs.

However, without traditional auditors such as creditors or equity owners who can test the liquidity of the treasury or authorize an audit, founders of a blockchain-based start-up can do whatever they wish with the collected funds. They could run away with all the collected funds, overpay themselves for little work, or spend more funds on marketing than actual product development, which might result in insufficient funds to complete the product or platform. If debt was issued to the founding team, they would need to adhere to certain rules. Obviously, with equity or future tokens, they do not have these rules to follow. Unless blockchain is used for more than just issuing equity tokens to investors, there might be a need for additional measures to ensure transparency and accountability in the use of funds.

Fortunately, with smart contracts it is possible to explore having certain rules to be followed, similar to debt. If we look at Polkadot, there is already a possibility to lock funds for a long time period. However, instead of locking the raised funds, they are locking the funds of the community or the stakers. To win a parachain or vote for decision making, the community needs to stake DOT tokens, in which the DOT tokens will be locked if the parachain was won and then it will be unlocked only after multiple years. If start-ups would lock a significant portion of their treasury for a long time period, it would increase the trust of investors. There needs to be a system that allows the foundation to access the treasury solely whenever necessary to pay for certain expenses.

Perhaps the funds could be locked until certain milestones have been met, such as alpha or beta release of the product, in which either the smart contract triggers the next batch of funds to be unlocked, or the community can vote on the release of further funds from the treasury upon reaching those milestones. By introducing this, blockchain start-ups are not relying on third party audit firms from different jurisdictions. Additionally, by locking the treasury, the developers and architects can actually be held accountable whenever an outcome of a governance vote tells them to make changes to the protocol, as they can be rewarded from the treasury.

For the start-up this means there will be a potential risk if the community votes against unlocking the funds whenever the funds are actually necessary, however since the funds will be used for their intended purpose, which is application development, it will benefit all token holders. This shifts the way of how investors need to trust the founding team, to the founding team having to trust token holders and investors to behave accordingly with the locked funds. While this may or may not sound ideal, the behavior of crowd investors has not been researched yet in circumstances where they have significant responsibilities.

With this uncertainty it is risky to lock the majority of the treasury for the crowd investors to vote on the release of those funds. It is still interesting to study the behavior of token holders and crowd investors if they are granted such a responsibility. One added benefit is that such a locked treasury system prevents scams from founders who have bad intentions, as they will not be able to run away with the treasury funds after the ICO. Blockchain does have the potential to solve the lack of a trustless governing body, and it would be interesting to see how the utilization of blockchain technology and its smart contracts can develop a new financial asset named dequity.

5.4.5 Learnings of Dequity Token Model

Our improvements and adaptations include quadratic voting and a voting multiplier based on the amount of days staked. With quadratic voting, smaller token holders will have relatively more power, while with the voting multiplier the true believers are rewarded. This removes the possibility that a large investor who wants to remain liquid with their tokens, but will only stake their tokens to vote on a proposal or important decision making. Through this adapted model, speculators of the token and its price will receive much less voting power, and have limited influence on the decision making of the start-up. With the multiplier and quadratic voting, the token can successfully represent a voting right by giving all crowd investors a voice, and with the idea of locking a portion of the treasury, properties of debt are integrated into this model.

Fortunately, this adapted governance model can also add properties of debt to increase trust and confidence of the investors even more, by allowing a portion of the treasury to be locked. Once such a smart contract is deployed with the adapted governance model it can be tested in practice and receive feedback from users. This dequity inspired model can still be tweaked based on the feedback for future ventures. In Chapter 5.1, we showed a breakdown of whether the properties of debt and equity were already present in the studied cases. The comparison between the case studies and our very own improved dequity inspired token model is shown in Table 7. This new token model could have all the mentioned properties of debt and equity, which means that a blockchain based token can indeed represent a dequity financial asset.

Table 7: A breakdown whether some properties of debt and equity are present in our adapted dequity inspired token model. Debt-like rules and equity properties can be integrated whenever the treasury is locked and only to be released after successful governance outcome.

Debt properties	**Yes or No** (case study models)	**Yes or No** (Dequity inspired model)
Interest repayment at regular intervals	No	Yes
Business continuously tested for liquidity	No	Yes
Sinking funds will be set up and principal repaid at expiration date of loan	No	Yes
Failure of payment will result in liquidation of underlying assets	No	Yes
Equity properties	**Yes or No**	
Equity holders have claimant status to company in earnings and asset liquidation	No	Yes
Equity is tied to duration of company	Yes in all three	Yes
Equity has power to replace management	No	Yes
Equity holders have access to internal performance measures	No	Yes
Equity holders can authorize audits	No	Yes
Equity holders are updated on important investment and operating proposals before implementation	Yes, Terra and Polkadot	Yes

Based on this research so far, we believe it is possible to improve the current token models, by adding debt and equity properties, in the form of a dequity token model. By combining the properties of debt and equity into a dequity, the founders, core team members and the crowd investors still have a stake and a say in important decision making through the on-chain governance, while there is an increased transparency and trust for the investors to invest in a team who wishes to raise funds through cryptocurrencies. However, while the founding team and other large investors can have too much power because of their large token holdings, we tried to create a more fair condition by adding quadratic voting. With these improvements, by giving up some control in return for capital funding, it might give founders the opportunity to raise capital in a crowdfund whenever they do not have the resources, network, experience or demographic to tap into the benefits that Silicon Valley has to offer. Additionally, by locking a portion of the treasury, crowd investors have increased trust and transparency in what happens behind the scenes of the start-up, as the start-up is bound to rules to have their treasury released.

6 Tokens and Dequity: a Solution to Crowdfunding Challenges for Start-ups

The start-up industry has been the foundation of recent innovative development and rapid growth. However, funding remains to be one of the biggest challenges for start-ups, especially in their early stage of development. Silicon Valley has become a hub for innovation and entrepreneurship due to the accessibility of its ecosystem to venture capital financing, network effects government support and a culture of risk-taking. However, the Silicon Valley model may not apply to founders who do not have the resources to tap into the ecosystem that Silicon Valley has to offer. For this reason, crowdfunding emerged as a viable solution for start-ups to raise capital that lack those resources. Unfortunately, crowdfunding has its own hurdles and challenges to overcome due to the lack of trust and transparency provided by the start-ups.

Blockchain technology has the potential to change the way how the start-up industry raises capital through crowdfunding. Blockchain introduces a trustless governing body that can execute rules based on a smart contract. As the opportunities have risen to raise capital through cryptocurrency crowdfunding, crowdfunding challenges have not yet been fully tackled. One of the most significant challenges is the lack of trust and transparency of the start-ups to the crowd investors. These challenges can be addressed by implementing a governance system that involves the crowd investors in decision making. In this research, we have explored the governance systems used by Ethereum, Polkadot and Terra. Through our analysis, we have identified strengths and weaknesses in those systems, and proposed a few ideas to improve them.

In this chapter, we will summarize our findings and discuss what impact they have on financing blockchain based start-ups. The goal of this research is to determine the impact of blockchain tokens onn start-up financing and how it can improve trust and transparency. Thus, the research question reads: '**What is the impact of tokenization of financial assets on blockchain in start-up financing and how can it improve trust and transparency?**'. Three sub-questions have been derived to answer the research question and to reach our goal.

6.1 Conclusions

The first sub-question reads '**What is the current landscape of tokenized financial assets and how do they relate to equity and debt?**'. The current landscape of tokenized financial assets is diverse as it offers multiple purposes, including ownership in a company, acting as a monetary value or accessing certain services. Utility token can be spent on products and services, while security tokens represent ownership of a company. The traditional ways of raising capital are equity and issuing debt, but blockchain technology allows for properties of equity and debt to be combined in a single token. This blockchain token can make it easier for start-ups to raise capital by bypassing VCs through crowdfunding. Whether these tokens can be effective for start-ups and how they can be used was examined with the next questions.

For the second sub-question we used the IAD framework to conduct a case study analysis and focused on the core concepts of the framework: action situation, actors, resource system, governance rules and the outcome of the action situation. This research was conducted on three layer-1 blockchains: Ethereum, Polkadot and Terra. The second sub-question is '**How do blockchain ventures approach the governance system design to make important decisions in their ecosystem?**'. The findings indicate that blockchain ventures adopt an on-chain governance approach, for PoS by enabling token holders to participate in the decision making process regarding managerial and development decisions, and for PoW the network operators are the ones who decide which decisions are adopted or not by forking a new chain. In a PoS consensus mechanism, the governance system includes a voting system that grants token holders voting power based on the tokens they have acquired. Overall, it seems that blockchain founders are trying to create a balance, by adopting on-chain governance to provide token holders the option to be of an influence, without sacrificing their own ability to continue innovation.

We have proposed a few ideas to improve the governance models and can now answer the third and final sub-question: '**How can the functionality of token models be enhanced to increase trust and transparency for investors?**'. In order for a blockchain based start-up to raise capital by selling tokens, the utility of the token needs to be clear. Tokens need to incorporate debt and equity properties, to increase trust and transparency and to give the investors a say in the start-up through the on-chain governance system.

To realize this, our research attempted to find a solution to improve the current on-chain governance systems by understanding the hurdles of the current on-chain governance systems of PoS blockchains. The findings show that the founding teams of new ventures have a significant influence during any on-chain governance referendum, due to their majority stake. To mitigate this, our token model consists of a quadratic voting mechanism which reduces the influence of minority large stakeholders, thus increasing the influence of the majority small stakeholders based on token stake. To reduce the number of bad actors during a referendum, the solution was to make use of a voting multiplier based on the number of days the tokens were staked and locked in a smart contract. These two combined, make the on-chain governance votes more fair for crowd investors.

To increase more trust and transparency, there needs to be debt-like rules. A proposed solution was to lock all or a large portion of the raised capital into a smart contract, where stakeholders can then vote to release portions of this treasury after certain milestones have been met. With this improvement, the start-up can be tested for liquidity, while the underlying locked assets could be liquidated whenever the company is deemed incompetent. These properties represent the properties of debt. With the treasury locked into a smart contract, stakeholders can express more influence as it is the stakeholders who decide whether more funds will be unlocked through a referendum. This represents the asset specificity in equities. Moreover, with quadratic voting and the voting multiplier, the fairness of the procedure during a referendum is significantly increased. As a result, the on-chain governance becomes more fair and transparent.

Finally, the goal of this research and the main research question '**What is the impact of tokenization of financial assets on blockchain in start-up financing and how can it improve trust and transparency?**' can be answered. The impact of tokenization of financial assets can be significant, as it enables start-ups that do not have the resources to tap into the ecosystem of Silicon Valley to raise capital through crowdfunding. This stimulates innovation throughout a wider area, instead of a concentrated region known as Silicon Valley.

Tokens have the potential to be more efficient and transparent for raising capital than traditional financial instruments such as debt and equity. By utilizing blockchain technology, tokens are transacted automatically and almost immediately, without the need for a trusted party. Adopting blockchain technology to issue a financial asset during a crowdfunding, paves the way for dequity to exist. The lack of trust and transparency in a crowdfund can be addressed by implementing a fair governance system.

Crowdfunding by selling dequity tokens can provide more transparency and trust for the crowd investors, as the raised capital can be traced on the blockchain and the crowd investors can participate in decision making through on-chain governance systems. This empowers the crowd investors and increases their confidence in investing in start-ups through token sales.

6.2 Implications of Dequity

As dequity is a hypothetical financial instrument, which aims to give more control to its shareholders, it ventures into unfamiliar territory due to its reliance on the behavior and goodwill of stakeholders. Consequently, the proposed solutions are not fail-safe.

Given the rapidly evolving nature of blockchain technology and the start-up ecosystem, it is crucial to consider a governance model that is adaptable and flexible. As new challenges and opportunities arise, the governance system should be capable of adopting improvements and updates to ensure its effectiveness and relevance for the governance outcome. This would enhance long-term sustainability, but the capacity to attract and retain investors should be closely monitored and evaluated.

The solution of quadratic voting reduces the influence of large stakeholders, unfortunately these stakeholders can potentially bypass the quadratic voting by splitting their tokens into multiple wallets to increase their influence on the outcome. However, if they wish to have significant influence, they would need to stake their tokens for a long period to benefit from the voting multiplier. Staking tokens for a long duration is something that long-term believers would do, and not speculators. Therefore, the model ensures that speculators have significantly less influence in any referendum, while long-term believers have more influence, and whether those long-term believers are large investors trying to bypass the quadratic voting is less significant.

Furthermore, locking the treasury in a smart contract to increase trust and confidence of investors means the company cannot use these funds freely. This measure is taken to counteract incompetency or bad actors within the company's team. However, this could pose as a significant challenge for dequity in the way it was described in this research. The liquidity of the company will be in the hands of the community and stakeholders. The stakeholders have a stake in the company with their tokens, so the general expectation is that the majority of the stakeholders will act only to benefit their own assets. But this model is designed with the expectation that the stakeholders are not bad actors. Companies will need to be cautious of this risk and may not be keen about adopting dequity in its current form.

If a significant amount of tokens falls into the hands of bad actors, the company's liquidity might be at risk. Fortunately, quadratic voting can help limit the influence of bad actors to some extent. However, how all stakeholders will behave in such a decentralized environment where they can vote on important decision-making of a company remains untested. If it turns out that bad actors can still manipulate the referenda, new rules could be added to provide more flexibility and facilitate continuous improvements.

These implications exist due to the holistic nature of the dequity model, which considers many different factors and interactions among stakeholders. Dequity heavily relies on the behavior and decision-making processes of these stakeholders, making it essential to take into account social, economic, and cultural aspects. However, the holistic approach to governance systems offer valuable insights into understanding stakeholder motivations for decision-making. With a detailed understanding of these factors, new rules can be implemented whenever deemed necessary to ensure flexibility and continuous improvements in the dequity model. By considering the broader context and dynamics, potential risks of dequity can be mitigated, which can lead to the refinement of the dequity model. This enhances the long-term sustainability and maintains investor confidence.

We acknowledge that our dequity model may encounter additional issues and problems once it is actually adopted by a start-up. Our dequity model will continue to evolve as more and more start-ups embrace dequity, resulting in a larger sample size and a better understanding of how global communities come to consensus regarding decision making. Ultimately, with more adoption the dequity model will continue to evolve and adapt based on real-world implementations and experiences, ensuring its effectiveness and reliability as a financing mechanism for start-ups.

6.3 Recommendations for Further Research

Further research is required to have a better understanding of the behavior of token stakeholders and whether the stakeholders have enough incentives to be trusted with such a huge responsibility to protect their own assets. Overall, the impact of tokenization of dequity on blockchain for new ventures has the potential to revolutionize the way how start-ups are financed, enabling crowdfunding across different regions, jurisdictions and demographics. Unfortunately, there are no start-ups who have already adopted dequity, so a case study is not possible. However, our dequity model requires careful testing and consideration of how stakeholders behave to ensure that investors can trust the founders and vice versa, for a fair result for both parties involved. This is a key learning point for the adoption of dequity. Therefore, we cannot recommend our dequity model yet for a start-up without understanding how stakeholders behave in a decentralized ecosystem.

With the aforementioned implications of dequity and its holistic nature, there needs to be an environment or a research in which the behavior of end-users can be tested without the necessity of putting a large amount of capital at stake. Before companies try to speculate or add new rules to dequity, it is important to understand the behavior of end-users. Perhaps a survey would suffice, in which some specific proposals are presented to the survey participant. The conditions in the survey would differ in terms of voting power and their stake amount and duration. This way, the researcher can gain more insight into whether the amount of staked tokens or actual voting power can have an impact on the behavior of participants. If it turns out that the behavior of potential stakeholders can compromise the longevity and sustainability of the start-up, it could indicate a lack of sufficient incentives in the governance model.

But how can the incentives be improved, if not for the greater good of the start-up and therefore the financial gain of the stakeholders? Perhaps the stakeholders wish to be rewarded in tokens for their participation in a referendum. But where should the tokens come from and what could be a threshold of the reward for stakeholders, based on their stake, to not compromise the longevity and sustainability of the start-up? Such a reward mechanism could be researched if the initial survey does not show that stakeholders would act accordingly without compromising the start-up. Eventually, after a better understanding of how stakeholders behave in a decentralized manner, dequity opens the way for longitudinal studies, by speculating and adding more rules after tracking the performance and evolution of start-ups which have adopted dequity. The longitudinal studies can reveal more trends, challenges and opportunities for improvement.

7 Reflections

The purpose of this chapter is to provide an overview of the research process, and to critically reflect on the research using the IAD framework and dequity. This reflection will discuss what challenges arose along the way and how the IAD framework and dequity helped to guide the research, analyze the research findings, and provide insights for future research.

The research initially started with an internship at Deloitte within their IT consulting team. However, topic of my research was not beneficial to their business, and they had little expertise in it. It took some time to find a suitable topic with my mentors at Deloitte. Ultimately, I decided to conduct a research based on my own preference, even though I understood that the research topic should ideally overlap in some ways with the division of the company providing the internship. This would have allowed the company to assist me better due to their network and expertise. Eventually Deloitte assigned me a mentor from their blockchain division within the company. I am grateful for Deloitte for my internship at the IT consulting team, as it introduced me to people who are fascinated by the blockchain topic.

Importantly, this research was conducted during the COVID-19 pandemic. The pandemic resulted in many restrictions, which reduced the contact between people. The offices were closed and working at home became the new norm during the pandemic. This resulted in having no or limited non-digital contact between the me, the employees at Deloitte and the supervisors. In these conditions, the benefits that Deloitte could provide me were also limited, so I decided to continue the research without the internship. The majority of this research was done at home, so it initially was a challenge to conduct the research in a student's residence. However, since there was no end in sight regarding the pandemic, I adapted to the conditions and changed the environment to create a separation between living and conducting research.

Personal issues arose along the way, which resulted in significant delay between the start of the research to the current version which was read by the reader. Fortunately, my interest in cryptocurrencies was a motive to keep on going and finish where things were started. I personally never approached tokens as a means of distribution of power in a governance. But thanks to Williamson and his vision of dequity, my vision was also expanded. The challenge to research and to understand if and how dequity could exist as a token was something what made me dive deeper into blockchain technology with an academic perspective.

Williamson's pioneering concept of dequity provided a unique perspective on how tokens could be designed to combine both debt and equity properties. Dequity challenged the traditional understanding of tokens as utility or monetary value within a blockchain ecosystem. Instead, it paved the way for new possibilities to leverage blockchain technology and create a new financial asset that combines the best aspects of both equity and debt. Williamson's dequity vision acted as a guiding tool for me to explore potential benefits and implications of introducing dequity into start-up financing. Ultimately, his innovative and creative approach laid the foundation for my research into how a dequity model could enhance trust and transparency, while granting a meaningful impact on decision making processes. I wish to sincerely and deeply thank Williamson for his innovative vision, paving the way for my research and for being way ahead of his time.

One of the most challenging aspects of this research was the data methodology and collection. It was not easy to start the research, as it was not easy to understand how and where to begin. It was hard to give structure to the research and how to approach such topic, as the topic of blockchain is relatively new. Many articles or ideas were exploratory in its nature, and some of the information used could only be provided through websites instead of credible articles. By combining both a relatively new technology with a hypothetical financial instrument dequity, it made the research even more challenging.

The supervisors of this research were aware that this was a substantial challenge and proposed me to look into the IAD framework to understand whether it could be used for this research or not. Using the IAD framework, I was able to identify key factors that influenced the effectiveness of governance systems in blockchain protocols. Additionally, the IAD framework provided structure for our research and documentation. The IAD framework helped identify core concepts for the case study analyses and made it possible to present a schematic overview of the cases in a single figure. Moreover, the IAD framework revealed the importance of addressing fairness among actors for a decentralized governance protocol, in which addressing it wrongly can lead to unequal distribution of voting power and harm the sustainability and longevity of the ecosystem.

The data for this research were collected from whitepapers and official websites. Initially, the case study analysis had no clear structure, and the documentation was all over the place. Eventually, whenever I had used the IAD framework correctly, The data collection process was simple and straightforward, given there was a clear structure of how the data should be analyzed and documented.

With my findings, I am pleased that blockchain technology could provide a platform to make dequity possible. However, I am not entirely happy with the fact that my findings would recommend to not adopt my adapted governance model for a start-up in its current state due to the implications of having to rely solely on stakeholders, as it has a holistic nature. The insights I have gained from my findings, conclusions, implications and recommendations emphasize the importance of understanding stakeholder behavior for the adoption of dequity. Ultimately, I am satisfied to be able to have started a study in which I could provide recommendations for a potential new study in this topic which can be conducted by a student in the future.

Throughout this research experience, I have learned the significance of having a well defined approach and structure in data collection. I have come to appreciate how an academic perspective can broaden one's understanding and vision of a topic. Moving forward, if given the opportunity to conduct a similar research again, I would prioritize gathering and documenting literature on the subject and implementing a clear framework for data collection and documentation, before collecting the data.

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