NOVA IMS Information Management School

MGI

Mestrado em Gestão de Informação
Master Program in Information Management

Token Economy – Towards Building a Sustainable Blockchain Token Ecosystem Framework

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Dissertation presented as partial requirement for obtaining the Master's degree in Information Management

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TOKEN ECONOMY – TOWARDS BUILDING A SUSTAINABLE BLOCKCHAIN TOKEN ECOSYSTEM FRAMEWORK

by

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Dissertation presented as partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information System and Technology Management.

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July 2022

ABSTRACT

In the context of the internet's historical trajectory, blockchain technology represents a significant paradigm shift from Web 2.0 to Web 3.0. Web 2.0, the current world of the interactive and social web, is an internet siloed by centralized organizations that provide services in exchange for personal data. Web 3.0, on the other hand, is based on cryptographic blockchain technology and enables an economic institutional infrastructure that is natively available on the web, hands ownership back to the creators and users and operates without an intermediary. Blockchain tokens enable digital scarcity and a novel internet-native value transfer mechanism. Tokens can have a magnitude of different use cases ranging from serving as unit of account (currency), promoting usage incentive, as tool for governance, representation of ownership or as a funding instrument. The research field of token creation is still in its very infant stage and a lot of blockchain project launches still happen without proper structure and long term strategy – leading to suboptimal and short lasting results. Based on the Design Science Research methodology, this dissertation attempts to design a holistic conceptual framework that can serve as a base for a decision aid for organizations when creating a blockchain token ecosystem. This artifact will finally be evaluated by domain experts to ensure proper correctness.

KEYWORDS

Tokenization; Token Design; Token Economy; Token Economics; Token Engineering; Cryptocurrency

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LIST OF ABBREVIATIONS AND ACRONYMS

A	Assumption
BTC	Bitcoin
DAO	Decentralized Autonomous Organization
dAPP	Decentralized Application
DeFi	Decentralized Finance
DEX	Decentralized Exchange
DSR	Design Science Research
ETH	Ethereum
ETC	Ethereum Classic
ERC	Ethereum Request for Comment
EVM	Ethereum Virtual Machine
ICO	Initial Coin Offering
IDO	Initial Decentralized Exchange Offering
IEO	Initial Exchange Offering
i.e.	id est
KYC	Know Your Customer
MSP	Multi-Sided Platform
NFT	Non Fungible Token
P2P	Peer to Peer
SAFT	Simple Agreement for Future Tokens
SEC	U.S. Securities and Exchange Commission
SLR	Systematic Literature Review
TES	Token-based Ecosystem
TESs	Token-based Ecosystems

1. INTRODUCTION

1.1. BACKGROUND

Cryptocurrencies have gathered a lot of attention since the birth of Bitcoin in 2009. Bitcoin originated from a paper called “Bitcoin: A Peer-to-Peer Electronic Cash System” that was anonymously published in 2008 (Nakamoto, 2008). The underlaying technology behind Bitcoin is the concept of a blockchain. At its simplest level a blockchain is a corruption-resistant ledger of entries shared over a network by multiple parties (Crosby et al., 2016).

Since 2008 a great development of concepts has brought to the creation of many distributed and active blockchains. The first generation of the blockchain technology was initiated by Bitcoin focused on simple peer-to-peer payment transactions and is known as Blockchain 1.0. The next generation, Blockchain 2.0 mainly led by the creation of Ethereum, builds on smart contracts allowing to run arbitrary code on blockchains offering a broader range of functions besides simple transactions. Blockchain 3.0, with significantly wider and more complex applications beyond currencies, is currently emerging – mainly in the context of blockchain tokens (Swan, 2015).

Tokens are not a new phenomenon. They have existed long before blockchain networks. Tokens may historically reflect some sort of monetary value or access right. Shells and beads were most likely the first tokens used. Other types of tokens are, for example, casino chips, vouchers, gift cards, bonus points in a loyalty program, stock certificates, bonds, coins or paper money. Furthermore, tokens are used in computing, where they can represent a right to perform an operation or manage access rights. The token is an integral part of how a distributed system is incentivized. The validity and security of the blockchain tokens (cryptographic tokens) is governed by a smart contract that created them, in combination with the underlying distributed ledger by a majority consensus of the network nodes. Tokens incentivizes network actors to behave in a certain manner. These actors potentially don’t know each other, don't trust each other or don't even have binding legal agreements with each other. The only thing to make sure that everyone runs in the same direction is putting the rules into a transparent code and incentivizing people with “money”, i.e., tokens, to do the appropriate thing (Voshmgir & Zargham, 2019). Tokens can represent a magnitude of different things including an asset, a usage right or a unit of value issued by an organization. They are typically emitted throughout an Initial Coin Offering (ICO) and run on top of existing blockchains such as Ethereum (Schueffel et al., 2019).

The growing use of tokens in real-world blockchain projects – mostly visible in ICOs generating millions of dollars in funding – has revealed the need to understand what blockchain tokens represent and what the variables are, that must be factored in when creating such a token-based project.

Mougayar (2017), Oliveira et al. (2018), Kranz et al. (2018), Tönnissen et al. (2020), Weking et al. (2020) and Sunyaev et al. (2021) agree that academic research in this multidisciplinary topic of [Toke Economics–Tokeneconomy–Cryptoeconomics–Token Design–Token Engineering] is still at its very infant stage and a lot of further research has to be done to demystify the area and provide implications for both practitioners as well as researchers in this domain. Previous research showed contribution in this field by providing different taxonomies of token types, potential business models, token sales, investment, valuation and volatility and trust (Oliveira et al. 2018, Tönnissen et al. 2020, Chen et al. 2020).

Specifically, in their paper "To Token or not to Token: Tools for Understanding Blockchain Tokens" Oliveira et al. (2018) point out the need for further research in decision-aids on token design and addressing potential challenges alongside with that. Despite increasing investment in Initial Coin Offerings (ICOs) and similar constructs, to the best of my knowledge there is still neither sufficient theoretical knowledge nor a comprehensive understanding in academia of the token design/creation and its associated factors/challenges.

1.2. MOTIVATION

On February 19, 2021, Bitcoin's market value alone was calculated at one trillion US Dollars. This move was partly fueled by Tesla, one of Elon Musk's companies, converting some of its balance sheet cash into Bitcoin earlier this year and accepting the digital token as a form of payment. Furthermore, the oldest bank in the United States, the Bank of New York Mellon, announced that it was moving into the cryptocurrency space as well (Pound, 2021). Marc Andreessen, a famous Silicon Valley Venture Capitalist, listed the blockchain's distributed consensus model as the most important invention since the Internet itself and there are many more influential leaders following his thought (Crosby et al., 2016). According to CoinMarketCap (2021), the most-referenced price-tracking website for crypto assets, there are currently over 4000 blockchain projects on the market. Ethereum, the blockchain behind the token Ether, is seen as a key platform for so-called decentralized finance (DeFi) applications and non-fungible tokens (NFTs), leading to a total cryptocurrency market valuation of $2 trillion US dollar in April 2021 (Kharpal, 2021). Blockchain tokens exist because they can be used to represent something digitally as well as represent digital scarcity on a blockchain (Miscione et al., 2018). They can have a magnitude of different use cases ranging from serving as unit of account (currency), promoting usage incentive, as tool for governance, representation of ownership or as a funding instrument. All these dimensions require to have some sort of adequate value to the network's growth

(Pilkington, 2016). Due to their ability to trade, ease-of-use and divisibility, tokens have emerged as optimal value containers for agents in a network (Oliveira et al., 2018).

According to Oliveira et al. (2018, as cited in Sehra et al. 2017 and Tomaino 2017c) most of blockchain project launches happen without properly addressing the utility and value of the underlying token. This is also reflected by most online tutorials on the creation of blockchain tokens; The majority solely focuses on the technical deployment phase without ever addressing the complexity of factors that need to be addressed when creating a stable and successful token ecosystem. Moreover, blockchain tokens also pull on a range of other aspects such as legal and ethical questions. Shin & Ibahrine (2020) call blockchain systems complex socio-technical systems. All in all, the creation of a token ranges far beyond the actual coding/implementation aspect and needs to be addressed in a more holistic way.

1.3. RESEARCH OBJECTIVES

The goal of this thesis is to propose a framework for the creation of a token-based ecosystem that can be followed by organizations who want to incorporate decentralization and blockchain technology in their business model. In order to reach this goal, the following intermediate research objectives will be defined:

- Establishment of a solid understanding of blockchain technology and how it evolved over the recent years.
- Establishment of a solid understanding around the idea and use case of blockchain tokens and the token economy.
- Identification and analysis of the ecosystem around blockchain tokens and its components.
- Identification of challenges and possible problems.
- Proposal of a framework to implement a token-based ecosystem for organizations.
- Validation of the suggested token ecosystem framework by consulting and interviewing blockchain experts from academia and the private industry.
- Description of the implications of the thesis regarding possible further academic research as well as implications for practice.

2. METHODOLOGY

2.1. DESIGN SCIENCE RESEARCH METHODOLOGY

The Design Science Research (DSR) Framework of Hevner et al. (2004) will be used to structure the methodology of this dissertation due to its exploratory nature. In the field of information systems, this research approach focuses on designing solutions for the needs of the business and its environment (IS). The main aim of DSR is to create solutions in the form of theories and artifacts. DSR requires the creation of an innovative, purposeful artifact for a special problem domain. This artifact must then be evaluated to ensure its utility for the specified problem.

The DSR methodology has multiple ways of sequencing the steps to present new solutions. Following the approach from Vaishnavi et al. (2004), the DSR process model that will be used for this dissertation is comprised of five main process steps: Awareness of Problem, Suggestion, Development, Evaluation and Conclusion (Figure 1).

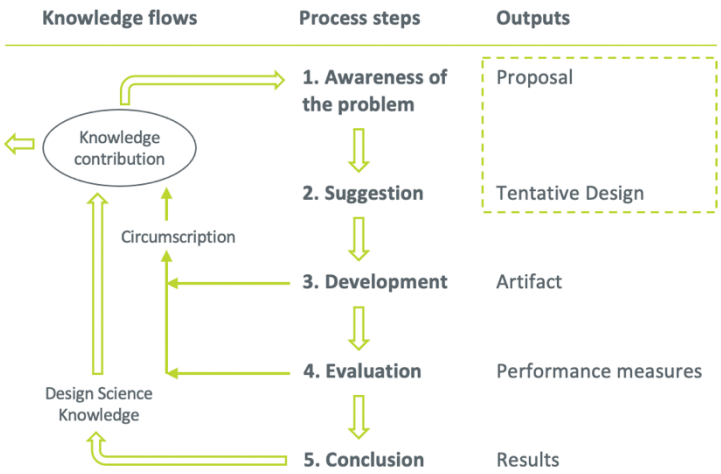


Figure 1: Design Science Research Process Model (Adapted from Vaishnavi & Kuechler, 2004)

1. **Awareness of Problem.** In a first step the researcher becomes aware of a problem. is characterised by identification of a problem, a need or an idea where design and creation of an artifact, model, construct, method, theory or framework can lead to possible solutions. The outcome of this phase is a research proposal.

2. **Suggestion.** In the second step a solution or possible design is suggested that is based on existing knowledge or theories.

3. **Development.** In this phase the artifact is developed.

4. **Evaluation.** The evaluation phase measures the performance of an artefact. The artifact is evaluated and tested based on quantitative or qualitative methods.

5. **Conclusion.** The final step is the conclusion. Here, the results of the research make a useful contribution to the body of knowledge in the form of an acknowledged, approved, accredited artefact.

2.2. RESEARCH STRATEGY

The aim of this dissertation is to create a conceptual framework that serves as a decision aid for designing and creating a blockchain token by following a DSR approach. Following Gregor & Hevner (2013) publication schema, to reach this objective the steps and results depicted in Table 1 will be obtained.

Step	Results
1. Introduction	• Statement of background and motivation for dissertation • Research question and research objectives
2. Literature Review	Prior work that is relevant to the study: • Blockchain Fundamentals • Ethereum and the Emergence of Smart Contracts • Blockchain Tokens, Digitalised Economies, and the Token Economy including components of a token-based project
3. Method	• Design science research method
4. Artifact Description	• Graphical and textual representation of the conceptual framework for the creation of a blockchain token project
5. Evaluation	• Interviews with blockchain domain experts
6. Discussion	• Synthesis of developed artifact and interview results • Theoretical significance and practical significance • Limitations of dissertation
7. Conclusions	• Summary of what was learned • Further research opportunities

Table 1: Research Strategy Steps and Results following Gregor & Hevner (2013)

1. **Awareness of Problem.** According to Vaishnavi et al. (2004) awareness of the problem may come from multiple sources, such as new developments in industry. As the new trend of blockchain technology emerged, hundreds of millions of dollars were being invested in TESs. The reality showed that the majority of these projects were doomed to fail due to a lack of a comprehensive understanding of the variables in such endeavors. A detailed description can be found in the chapter *1.2 Motivation* of this thesis.

2. **Suggestion.** After studying the area of blockchain technology and token economy from a scientific point of view, it can be concluded that research in this multidisciplinary topic is still at its very infant stage and a lot of further research has to be done to demystify the area and provide implications for both practitioners as well as researchers. The lack of a holistic and comprehensive understanding of the building parts of a TES make it essential to propose a holistic conceptual framework that can serves as a guideline for designing and creating more robust and healthy TESs.

3. **Development.** Based on the fundamental learnings and key takeaways from the researched literature a visual and textual guideline for the creation of a TES is developed.

4. **Evaluation.** The validation of the artifact will be performed qualitatively, by carrying out interviews with domain experts from academia as well as relevant industries. Blockchain technology and more specifically research around the token economy is still in its infancy. Ambiguities in the literature are still common and thus, exploring and discussing the concepts in depth rather than on a quantitively measure helps solidify the framework. Typically, in a DSR process the researcher has follow an iterative feedback loop between development and evaluation. Due to the constrained time of this dissertation, this cycle will be repeated once. Multiple iteration would allow for more possible modifications and critical review and is suggested for further studies using this as a base.

5. **Conclusion.** After the development and evaluation a reflection on the gained information and developed framework will performed which will further solidify the research. In addition, important limitations of the research will be laid out and further guidance on possible future research will be provided.

3. LITERATURE REVIEW

In order to acquire a comprehensive understanding of the subject matter of blockchain token ecosystems, this chapter is divided into three subchapters. The first two chapters establish a common understanding of the most important blockchain technology characteristics as well as the concept of smart contracts and decentralized applications. The third chapter will dive deeper into the theory of blockchain tokens and its surrounding ecosystems. All three chapters combined will provide the groundwork for the initial development of the token ecosystem creation framework.

3.1. BLOCKCHAIN FUNDAMENTALS

3.1.1. The Main Characteristics of a Blockchain

Blockchain is a distributed ledger technology that stores data in a secure and immutable way (Swan, 2015; Van Adrichem, 2019; Zutshi et al., 2021). The blockchain was originally invented by Satoshi Nakamoto in 2008 as the backbone of the cryptocurrency Bitcoin. The idea was to create a new form of money that would not be controlled by any government or company and would not require banks or other intermediaries to operate. The blockchain is a peer-to-peer network of nodes, which are computers connected to each other. Each node contains a copy of the blockchain, making it secure and immutable. The data in the blocks are protected by cryptography and cannot be modified after the fact without changing all subsequent blocks in the chain and the collusion of the network. Through a variety of consensus mechanisms, blockchains enable all nodes on the network to come to an agreement on whether new transactions are valid or not without any single node being able to control what happens on the network (Swan, 2015; Zutshi et al., 2021). Cooper & Stanway (2018) mention five distinct principles underlying this technology:

1. ***Distributed Database:*** Each participant on a blockchain has total access to the database and its history. No single party has complete control over the data or information. Each party can independently verify the records of its transaction partners.
2. ***Peer-to-Peer Transmission:*** Instead of communicating through a central node, communication occurs directly amongst peers. Each node stores and transmits data to and from the other nodes.
3. ***Transparency with Pseudonymity:*** Anyone with system access can see every transaction and its related value. A unique 30-plus-character alphanumeric address identifies each node, or user, on a blockchain. Users have the option of remaining

anonymous or providing confirmation of their identity to others. Transactions take place between addresses on the blockchain.

4. ***Irreversibility of Records:*** Once a transaction is put into the database and the accounts are updated, the records cannot be altered since they are linked to every previous transaction record on a chain of data blocks. Various computer algorithms and approaches are used to ensure that the database recording is permanent, chronologically structured, and accessible to everyone on the network.
5. ***Computational Logic:*** Because the ledger is digital, blockchain transactions can be linked to computer logic and hence programmed. As a result, users can configure algorithms and rules to trigger transactions between nodes automatically.

3.1.2. Three Types of Blockchains

Blockchains are classified into three types: private, permissioned, and public (Abadi & Brunnermeier, 2018; Swan, 2015; Zutshi et al., 2021). On a private blockchain, only one central entity has complete control over what is written on the ledger. The blocks are validated by this single entity and can therefore be modified. Moreover, new nodes must be accepted by the central entity as well.

A permissioned blockchain (sometimes also called consortium blockchain) is one in which the write privilege is assigned to a group of entities rather than to a single entity. To some extent, the read privilege may be offered to the public or kept secret. Blocks are validated according to predefined rules and new nodes are accepted based on a consensus. If one writer deviates and begins verifying false ledger entries in his block, other writers may reject him and refuse to extend his chain.

Last but not least, public blockchains allow for both entirely unconstrained read and write privileges. The network is open to any new participants and all participants are encouraged to validate the blocks (Abadi & Brunnermeier, 2018). This thesis will be primarily focusing on public blockchains.

3.1.3. Value Proposition of Blockchains

Blockchain Technologies provide several novel and interesting value propositions (Lee, 2019; Swan, 2015; Zutshi et al., 2021). The blockchain, occasionally also called “Trust Machine” increases trust between participants. Allowing participants to transact with each other without intermediaries and automating conflict-prone contracts massively reduces the transaction costs between these parties (Lee, 2019; Zutshi et al., 2021).

Based on an extensive literature review and analyzed success stories in the blockchain space, Zutshi et al. (2021) map out five discrete value propositions for blockchains: Decentralised Data Infrastructure, Membership Management, Analytics & Automation, Cryptoeconomic Models and Decentralised Governance.

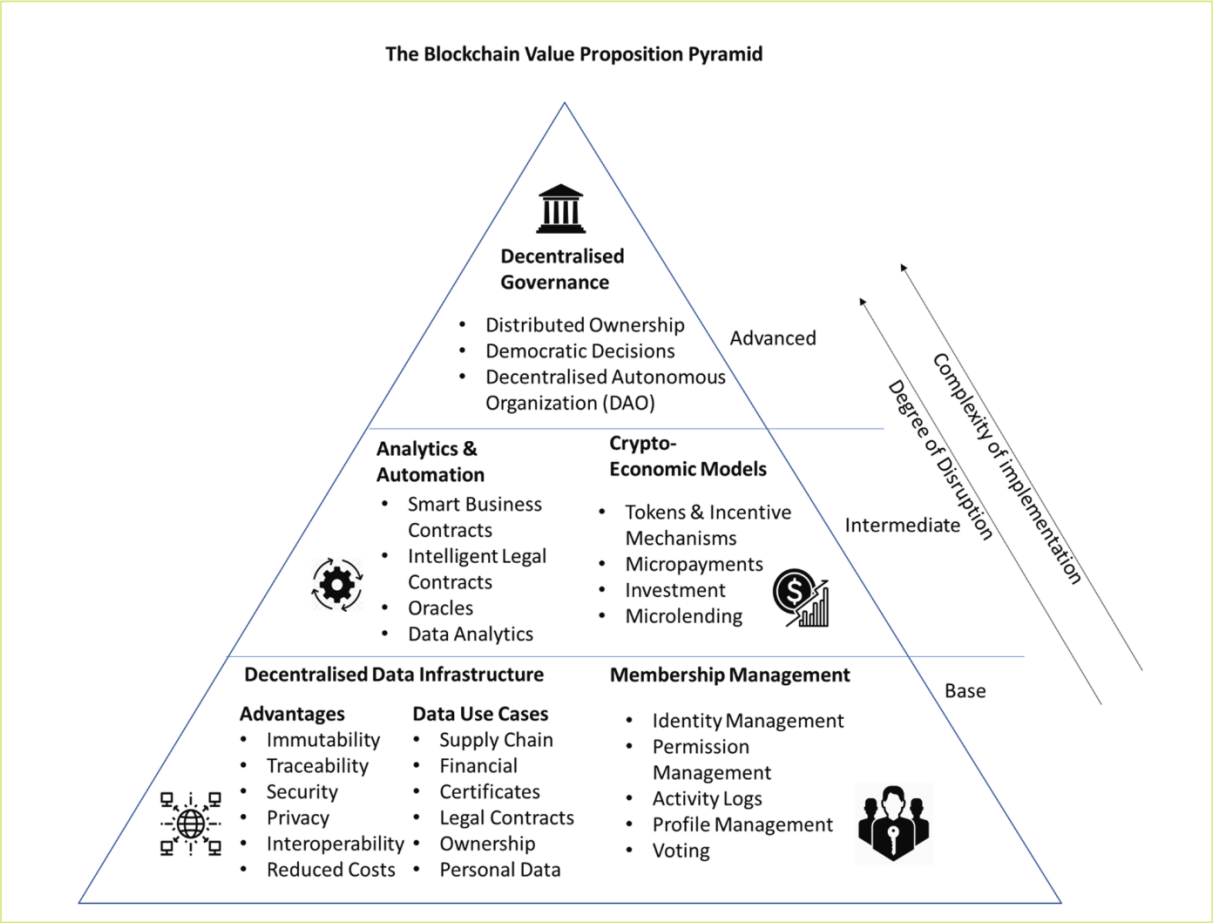


Figure 2: The Blockchain Value Proposition Pyramid (Zutshi et al., 2021)

The value framework is presented in the form of a pyramid (Figure 2), representing varying levels of complexity and disruption to existing platforms. At the most fundamental level, all blockchains deliver two key value propositions: decentralized data infrastructure and membership management. At the intermediate level, numerous blockchain technologies enable the automation of business processes and the implementation of cryptoeconomic models. Additionally, these two ideas face technical, social, and business difficulties that impede their acceptance. While various firms and open source communities have experimented with blockchain models, they have not yet achieved widespread real-world adoption despite their enormous promise. The decentralization of governance is the pyramid's apex, which can be considered the holy grail of decentralization. Due to the far-reaching ramifications and disruptive potential of Decentralized Governance, its practicality for implementation in existing Platforms remains the most difficult.

While Blockchain technologies offer some unique and potentially groundbreaking value propositions, they also carry various challenges. Chong et al. (2021) raise issues such as scalability, security, energy consumption and ethical issues revolving around privacy and regulations.

According to Swan (2015) we can divide the development of blockchain technology into three distinct stages. Payment and remittance systems that leverage cryptocurrencies are examples of Blockchain 1.0 innovation. Bitcoin was the first attempt to introduce a single global decentralized financial system. Whereas Blockchain 1.0 is concerned with the decentralization of money and payments, Blockchain 2.0 is concerned with the decentralization of markets in general and considers the transfer of many other types of assets other than currency using the blockchain. This is made possible by using the concept of Smart Contracts which are programmable contracts of rules that get automatically executed when it reaches certain predefined conditions. Finally, Blockchain 3.0 is the stage at which blockchain technology is broadly adopted and used in all aspects of society. As the backbone of the fourth Industrial Revolution, blockchain is predicted to establish a new industrial ecosystem as it is utilized in a variety of disciplines beyond financial sectors.

3.2. SMART CONTRACTS, ETHEREUM & DAPPS

3.2.1. Smart Contracts

A smart contract is a computer program or a transaction protocol that can run automatically based on the terms of the agreement stated in the contract code. The contract code governs execution, and the associated transactions can be tracked but not reversed (Xia et al., 2021). The term “Smart Contract” was first coined in 1994 by Nick Szabo, a computer scientist and lawyer. His ambition was to find a means to increase the efficiency of written agreements while also ensuring that they were automatically enforced (Metcalfe, 2020). An often-mentioned analogy to smart contracts are vending machines. Vending machines enforce the contract of selling a product at an advertised price to the customer who inserts a sufficient amount of money into the machine without the need for an intermediary such as a shop clerk (Metcalfe, 2020; Xia et al., 2021; Xu et al., 2019).

3.2.2. Ethereum

When it came to developing the first generation of blockchain systems, Bitcoin was at the forefront of the movement, providing a public ledger for recording cryptographically signed financial transactions (Xu et al., 2019). In 2013, following the encouragement of his father, Vitalik Buterin became interested in Bitcoin. After countless hours of researching and writing articles about Bitcoin, Buterin eventually realized that expanding the platform's capabilities beyond basic currency exchange could become extremely powerful. It could turn into something that could execute any type of processing (Metcalfe, 2020). As Bitcoin only had limited support for programmable transactions, Buterin started experimenting with virtual machines that are touring complete and would allow for arbitrary code execution. With the support of Gavin Wood, this experiment eventually resulted in the creation of the Ethereum blockchain (Davidson et al., 2016). When compared to the first generation of blockchain systems, the second generation initiated by Ethereum provides a general-purpose programmable infrastructure in which the public ledger not only stores financial transactions, but also provides facilities for deploying and running programs on top of the blockchain system through making use of Smart Contracts (Metcalfe, 2020). Buterin later talks about the notion of a "world computer" that allows applications to run with global reach and without national or geopolitical boundaries:

"A blockchain is a magic computer that anyone can upload programs to and leave the programs to self-execute, where the current and all previous states of every program are always publicly visible, and which carries a very strong cryptoeconomically secured guarantee that programs running on the chain will continue to execute in exactly the way that the blockchain protocol specifies. … Blockchains are not about bringing to the world any one particular ruleset, they're about creating the freedom to create a new mechanism with a new ruleset extremely quickly and pushing it out. They're Lego Mindstorms for building economic and social institutions."

Presently, Ethereum is the world’s largest platform of smart contracts. Millions of smart contracts have already been deployed (Cai et al., 2018). On the Ethereum blockchain, smart contracts can be defined in high-level programming languages such as Solidity. A small smart contract code sample of simply sending and receiving Ether as well as a “Hello World” sample written in Solidity can be seen in Figure 3.

helloWorld.sol

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.10;

contract HelloWorld {

  enum LANGUAGE {EN, PT, DE}

  string english = "Hello World!";
  string portuguese = "Olá Mundo!";
  string german = "Hallo Welt!";

  function sayHello(LANGUAGE lang) public view returns(string) {
    if (lang == LANGUAGE.EN) {
        return english;
    } else if (lang == LANGUAGE.PT) {
        return portuguese;
    } else {
        return german;
    }
  }
}
```

sendReceiveETH.sol

```
// SPDX-License-Identifier: MIT
pragma solidity ^0.8.10;

contract ReceiveEther {
    // Function to receive Ether. msg.data must be empty
    receive() external payable {}

    // Fallback function is called when msg.data is not empty
    fallback() external payable {}

    function getBalance() public view returns (uint) {
        return address(this).balance;
    }
}

contract SendEther {
    function sendViaCall(address payable _to) public payable {
        // Call returns a boolean value indicating success or failure.
        (bool sent, bytes memory data) = _to.call{value: msg.value}("");
        require(sent, "Failed to send Ether");
    }
}
```

Figure 3: Example of two smart contract codes written in Solidity

Solidity code is compiled into low-level stack-based bytecode that is run by the Ethereum Virtual Machine (EVM) on every Ethereum node in the network. Every smart contract has a unique blockchain account address that can hold Ethereum's native cryptocurrency Ether and an internal state. A smart contract is deployed onto the network by making a creation transaction (Cai et al., 2018; Xu et al., 2019).

Xu et al. (2019) argue that rather than looking at smart contracts in Ethereum as representations of legal contracts that should be "complied with", they can be seen more as agents as they need to be externally invoked. As seen in Figure 4, users can invoke the functions defined in the smart contract by sending a contract-invoking transaction to the smart contract's address. Moreover, smart contracts are also able to invoke other smart contracts.

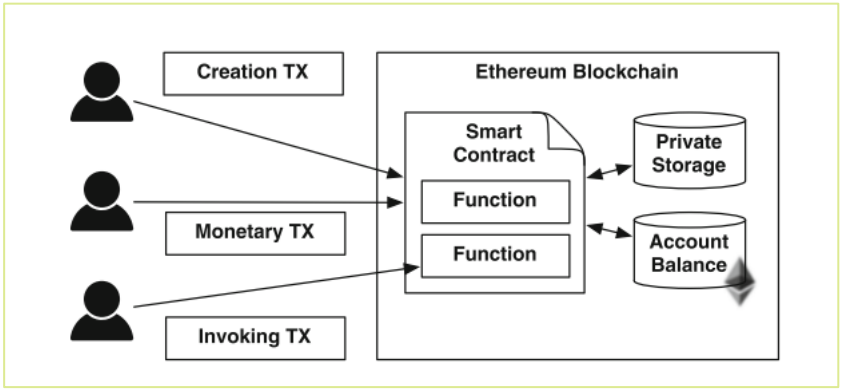


Figure 4: Ethereum Smart Contract Flow (Xu et al., 2019)

When a smart contract is executed on the Ethereum blockchain, it is performed locally by each miner, consuming their computational resources in the process. Programming in a Turing-complete language does not always make it possible to anticipate the amount of computational resources that a given program will require. In order to keep resources from being used and to pay miners, the network uses the concept of “gas” fees. The cost of gas is converted to Ether in accordance with a user-defined gas price, which is the amount of Ether-per-gas that the transaction's issuer is willing to pay. Additionally, there is an additional gas cost for the deployment of new contracts (Xu et al., 2019).

Over the past few years, as the gas fees on Ethereum are increasing due to scalability issues, blockchain users are seeking for smart contract enabled blockchains with lower transaction fees. Besides Ethereum, other blockchains such as Avalanche C-Chain, Binance Smart Chain and Fantom are also EVM-compatible, meaning that they can all execute smart contracts (Finneseth, 2021).

3.2.3. Decentralized Applications (dAPPs)

With Ethereum and Smart Contracts, the idea of decentralized applications (dApps) has gained popularity (Xu et al., 2019). When describing dApps, the terms "trustless" and "peer-to-peer" are frequently used, with the differentiating characteristic that no single server or entity is running the service, as in a traditional client-server architecture (Metcalfe, 2020). In contrast to the traditional backend of web/mobile apps, the backends of dApps are built on decentralized peer-to-peer open-source networks such as Ethereum or Avalanche rather than on centralized servers (Sunyaev et al., 2021). As a result, users are not required to place their trust in a single institution; instead, they can examine and verify the code's validity and thus trust its faithful execution (Xu et al., 2019). While the UI for a dApp is usually created through a traditional website or desktop/mobile application model, dApps handle their business logic through a nexus of modular services represented by smart contracts that are autonomously executed (Metcalfe, 2020; Xu et al., 2019). See Figure 5.

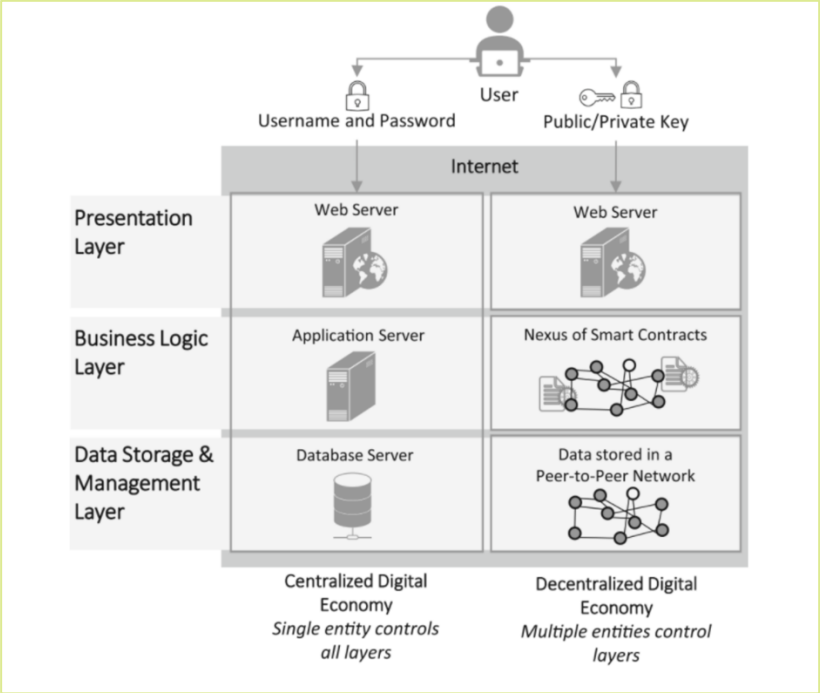


Figure 5: Centralized vs. decentralized architecture of digital economies using browser application (Sunyaev et al., 2021)

Given the fact that this way data and information is controlled in a decentralized and a more trustful manner, dApps reduce power and economic imbalances by design. Usually, dApp providers issue cryptographic tokens to represent assets or rights residing on the given blockchain network that users need to use. These tokens enable dApp providers to develop viable business models around their dApps as they incentivize users to buy and use the token as well as other providers to build complementary products and services. Tokens can be traded for other dApp tokens on particular exchanges and often have a limited supply that increases in value over time (Kranz et al., 2019a; Sunyaev et al., 2021). According to Raval (2016), dApps are characterized by the following four features:

- ***Open Source:*** Blockchain-based dApps must make their code open source so that third-party audits can be performed.
- ***Internal Currency:*** Internal currency is the vehicle that powers the ecosystem of a specific dApp. A uses tokens to quantify all credits and transactions among system participants, including content providers and consumers.
- ***Decentralized Consensus:*** The foundation of transparency is consensus among decentralized nodes.
- ***No Central Point of Failure:*** A completely decentralized system should not have a single point of failure, as all application components would be hosted and operated on the blockchain.

3.3. SYSTEMATIC LITERATURE REVIEW: BLOCKCHAIN TOKENS & TOKEN ECONOMY

In *3.1* and *3.2* we have laid out the fundamentals of blockchain technology and its evolution into general purpose smart contract based trust machine. As Vitalik Buterin once said, blockchains are building blocks for new social and economic institutions. At heart of these new systems is the concept of blockchain tokens and its ability to help organizations to build viable business models around them. The first objective of the upcoming systematic literature review intends to demystify the understanding and use-case of blockchain token. The second objective is to synthesize and describe the key components that are necessary for organizations to build a healthy and viable ecosystem around a token. Moreover, the findings will be enriched with challenges and potential future research opportunities around the current status-quo. At the moment of writing this thesis, there is no definite terminology describing a business that is operating in a decentralized manner and utilizing the concept of tokens to capture value. “Token Ecosystem”, “Token-based business”, “Decentralized Application”, “dApp”, “Blockchain Startup”, “Decentralized Autonomous Organization or DAO”, “Crypto Project” are one of the various terminologies used in academia and the professional industry. For the upcoming sections of this thesis we will be making use of the term “token ecosystem“ (TES) when referring to a business that is built around the concept of digital ledger technology and tokens.

Kitchenham & Charters (2007) describe a systematic literature review (SLR) as a systematically and rigorously conducted means of identifying, evaluating and interpreting all available research relevant to a particular research question. In order to attain insights and draw conclusions about the new research fields, an SLR will help summarize existing knowledge in a holistic and unbiased way. Conforming to Webster & Watson (2002), following a concept- rather than author-driven literature review approach enables better literature synthesis. Thus, this dissertation follows an SLR approach for the new phenomena of blockchain tokens and the token economy in order to create a sound theoretical foundation. The SLR will help create a theoretical foundation for the conceptual framework artifact and identify gaps in current research to suggest further research (Kitchenham & Charters, 2007).

Systematic reviews must follow a pre-determined search strategy that is as holistic and comprehensible as possible. Researchers performing systematic reviews must make every effort to locate and present literature that contradicts as well as support their desired study hypothesis (Kitchenham & Charters, 2007; Moher et al., 2009). The methodological approach follows Kitchenham & Charters (2007) four suggested steps of conducting an SLR: (1) identifying the resources; (2) studying

the selection; (3) extracting the data; and (4) conducting a data synthesis by summarizing and discussing the results.

In order to provide a comprehensible and logical structure this systematic review uses the commonly applied PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) for reporting the SLR approach (Moher et al., 2009).

3.3.1. Resource Identification

In order to find and gather relevant papers for pre-selection, the search process was conducted on multiple scholarly scientific databases. The databases that were used were: ACM Digital Library, IEEE Xplore Digital Library, Web of Science, EBESCOhost, SSRN and SpringerLink. For the beginning of the SLR, it is recommended to start with a fundamental understanding of the underlying topic, which allows defining meaningful search terms for the literature search (Kitchenham & Charters, 2007). Based on the conducted literature review up to this section, the following strings have been derived from querying databases for relevant papers:

(Blockchain* OR Crypto* OR “Distributed Ledger Technology”) AND (Token* OR Coin*) OR (Token* OR Crypto*) AND (”Economy” OR “Economics”)

The exact search parameters deviate slightly depending on the database website used.

Additionally, as recommended by Webster & Watson (2002) a forward and backward search on the relevant publications have been conducted (cross-references). The forward search was used to find all of the articles that cite back to the specific article was conducted by using the respective functions of the different database websites. For articles that were found, database websites that did not offer this functionality, ResearchGate and Google Scholar were used to try to find all cited articles. The backward search was conducted by analyzing the references of the papers. The systematic literature search was carried out during November 2021.

3.3.2. Selection Screening

In order to achieve an accurate and contemporary view of the literature research process, a set of explicit inclusion and exclusion criteria in accordance with the research goal has been derived. First of all, only papers published in the last five years, respectively, between January 2016 and November 2021, have been considered. Blockchain technology, especially related to tokenization is an evolving new subject that can change significantly over a short period of time (Potts, 2020). Therefore, this defined time period allows the use of the most recent scholars and eliminates the use of earlier scholars who may be outdated or which theories were underdeveloped. The primary intent for the

inclusion criteria is to gather papers that discuss various variables concerning the use and creation of blockchain tokens. Journal articles and conference papers were the preferred media of publication. In regards to the exclusion criteria, papers with the status "research-in-progress", paper without access to the abstract or full text as well as studies in another language but English were excluded.

3.3.3. Data Analysis & Extraction

The first step in the literature review was to determine whether or not there were any duplicates. To conduct the review the literature review software Mendeley was used. Out of a total of 3224 identified records, 135 duplicates were removed. Through the forward and backward search, an additional 35 references were added, leading to 3124 records that were eligible for further screening. Next, records that did not meet the inclusion criteria as mentioned above were removed, resulting in a total of 1345 records left to be examined. First, for the remaining 1779 records, the title was screened for eligibility. Out of these 1779 papers, 1627 were excluded. Secondly, the abstract of 152 papers was screened for eligibility. When it was determined that the remaining articles were still critical for the overall dissertation objective, the articles' main content was read and examined. In the end, a total of 44 papers were selected to be included in the literature review. The workflow can be observed in the PRISMA workflow depicted in Figure 6.

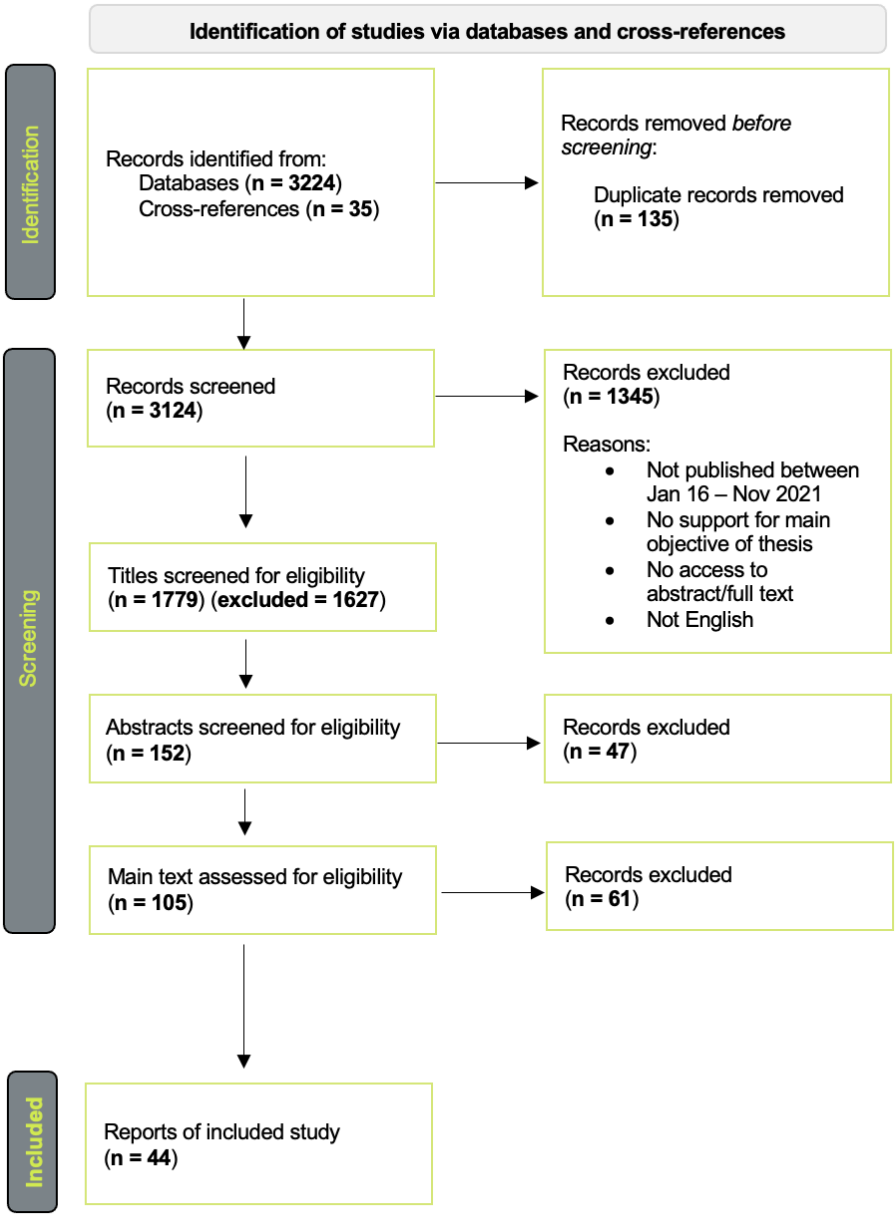


Figure 6: PRISMA Flow Chart (adapted from (Moher et al., 2009)

The next step was to extract information from each study that was relevant to the dissertation's objective and create a concept matrix following Watson and Weber. The following parameters were extracted from every relevant paper: Title, Author, Year, Publication Type, Takeaway, Study Objective, Key Categories, Key Targeted Components, Limitations and Research Gap. Kitchenham & Charters (2007) stress the importance of employing good data management practice. Thus, the relevant data were extracted and recorded into a pre-prepared extraction data form using a Notion (Note-taking software tool) database to prepare for the data analysis and synthesis. Alternatively, a similar approach could have been done with a spreadsheet. Following Webster and Watson, the idea was to develop

the key targeted components parameters that try to map each article into a concept that makes up one component of a TES. The approach to coming up with these components was an iterative analysis of coding each article's key categories based on its' study objectives and outcomes and then mapping them to a component section. The inspiration for the first set of components was inspired by the work of Tan (2019) and her Token Economics Framework and Oliveira et al. (2018) with their Token Classification Taxonomy. For example, an article might have received the key categories of "Incentive Structure" and "Game Theory" evolved into the component of "Token Incentives". Another example would be the categories of "ICO" and "Airdrop" that merged into "Token Distribution".

The result was a total of nine identified components: Token Type, Token Business Model, Token Incentive, Token Distribution, Token Monetary Policy, Token Legal, and Token Governance. Additionally, two categories were identified to describe the fundamentals of a blockchain token and its surrounding economy. The result was the concept matrix, seen in Figure 7, that helps to synthesize the literature.

	Definitions				Token Project Components				
Reference	Token Definition	Token Economy Definition	Token Type	Token Business Model	Token Incentive	Token Distribution	Token Monetary Policy	Token Legal	Token Governance
Ankenbrand et al. (2020)							x		
Barreiro-Gomez & Tembine (2019)	x			x	x				
Burilov (2019)			x					x	
Catalini & Gans (2018)							x		
Cong & Xiao (2021)		x	x						
Davidson et al. (2016)		x							x
Dimitropoulos (2020)		x							
Drasch et al. (2020)				x					x
Dursun & Üstündağ (2021)									x
El Faqir et al. (2020)									x
Elsden et al. (2018)			x						
Esq (2020)			x			x		x	
Ferreira et al. (2021)								x	
Filippi (2020)									x
Fischer & Valiente (2021)									x
Freni et al. (2020)	x		x						
Fridgen et al. (2018)				x			x		
Furnari (2021)						x			
Gritz (2018)								x	
Kaal (2018)			x				x		
Kaal (2020)									x
Kang et al. (2019)			x						
Kim & Chung (2018)					x				
Kranz et al. (2019)				x		x	x		
L. W. Cong et al. (2020)				x					
Lesavre et al. (2021)			x						
Momatz et al. (2019)						x			
Myalo (2019)						x			
Oliveira et al. (2018)			x				x		
Pelt et al. (2021)									x
Potts (2020)		x							
Schmeiss et al. (2019)				x					x
Shirole et al. (2020)			x						
Soonduck (2020)					x				
Sunyaev et al. (2021)	x								
Tan (2019)		x		x	x				x
Tasca (2019)				x					
Trabucchi et al. (2020)	x			x					x
Van Adrichem (2019)								x	
Voshmgir & Zargham (2019)		x							
Weking et al. (2020)				x					
Xia et al. (2021)						x			
Zhao et al. (2019)	x			x					
Zwitter et al. (2020)									x

Figure 7: Concept Matrix for Literature Synthesis

3.3.4. Results and Discussion

This study analyses 44 research papers published between 2016 and November 2021. Out of these final 44 studies, 31 (70%) are journal articles and 10 (23%) are conference papers. The remaining seven percent consist out of two reports and one book section. The year with the most included research papers was 2020, with 15 (34%) selected papers. 12 (28%) papers were published in 2019, nine (21%) were published in 2021, seven (16%) in 2018 and only one paper was published in 2016. The increasing trend that the majority of papers were published in just the past three years perfectly depicts the infancy of this research field.

In the next section, based on the derived concept matrix, an important fundamental understanding of the concept of blockchain tokens and the economies surrounding them will be established. Equipped with a thorough understanding of the token economy, we will then go through each component of a TES and discuss its characteristics step by step. Ultimately, the learnings from this chapter will be utilized as the underlying building block for creating the conceptual framework.

3.3.4.1. Blockchain Tokens

When talking about blockchain tokens (in related literature also mentioned as “crypto tokens”, “cryptocurrencies”, “coins” or “crypto assets”) it is helpful to dissect the word into its two parts; Blockchain and Token. Tokens historically reflect some sort of monetary value or access right that provides a way to socially coordinate. Shells and beads were most likely the first tokens used in history. Other types of tokens are, for example Casino chips, vouchers, gift cards, bonus points in a loyalty program, coat-check tokens, stock certificates, bonds, concert- or club-entry tokens represented by a stamp on your hand, dinner reservations, ID cards, club memberships, or train or airline tickets. Paper money or coins can also be characterized tokens (Barreiro-Gomez & Tembine, 2019).

Digital information on the internet can be easily duplicated and is not scarce or rivalrous by nature; it can be shared for little or no cost, with no loss of availability or quality. While this concept has drastically shown benefits compared to traditional ways of saving information such as paper, it struggled with providing real digital scarcity when transferring value (Sunyaev et al., 2021). The introduction of blockchain technology solved this double-spending problem by providing an algorithmic solution – based on cryptography – that enables pure digital scarcity (Freni et al., 2020). The key part for enabling blockchain-based digital scarcity is the token. While there are no standardized definitions of a token, multiple authors seem to commonly agree on a definition where tokens are defined as digital “dummy” value containers that are easily tradable, incentivize network participation, and facilitate trust.

Zhao et al. (2019) describe a token as a „credible digital representation of rights, interests and commitments in the real world based on blockchain technology. The generation, distribution, trading and circulation of tokens can truly map responsibilities, rights and obligations in the real world to the digital world. It not only can realize large-scale group collaboration and value delivery in the form of multicenter in the digital world with the characteristic of weak trust, but also can realize the process reengineering of social organization operation and business models.“ Furthermore, they mention three distinct characteristics of a token: Low-cost, Security and Isomorphism.

Low-cost means that since tokens are established on the blockchain using cryptographic algorithms and consensus mechanisms, users do not need to rely on a trusted third-party agency at a considerable expense to verify their legitimacy in the token system. Thus, token transactions will significantly lower the transaction cost of real-world economic tasks, reduce the coefficient of trade friction, and increase transaction efficiency.

Security pertains to the fact that tokes use a cryptographic algorithm, a consensus mechanism with distribution and fault tolerance capabilities and a distributed consensus mechanism to consolidate rights and commitments on the blockchain. This cryptographic technique ensures tamper resistance and traceability based on time sequence for these rights and commitments.

Isomorphism describes that tokens accurately reflect the trade or business logic of real-world economic operations. A token is an accurate map of rights and interests from the physical world to the digital world with the help of the blockchain.

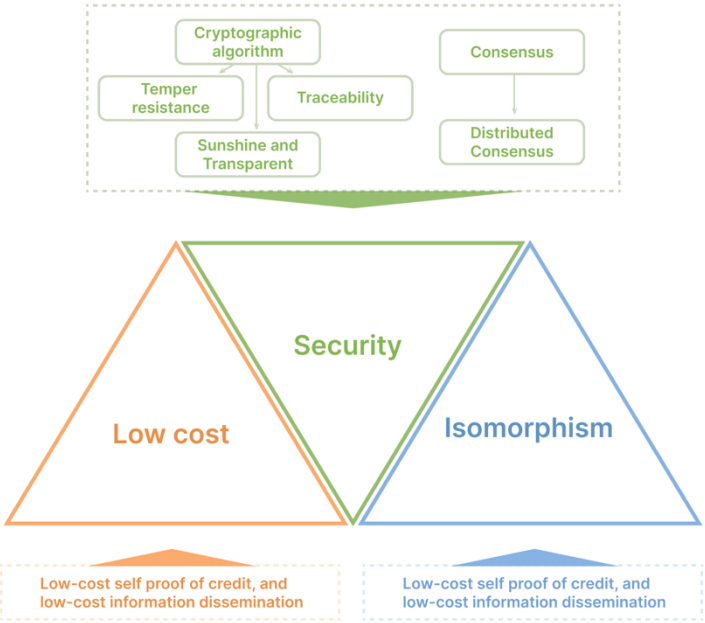


Figure 8: The three characteristics of a token (adapted from (Zhao et al., 2019)

3.3.4.2. The Token Economy

Over the past few decades, digital platforms and online networks such as Airbnb or Uber have fundamentally altered the way in which economic activities are performed. Amazon, Facebook, Google, and Tencent, to name a few of the most valuable corporations, are all platform businesses in one way or the other (L. Cong & Xiao, 2021). These platforms operate on a successful business model that employs technology to link people, companies, and resources in an interactive ecosystem where vast amounts of value can be created and transferred while utilizing only a fraction of a traditional company's assets (Trabucchi et al., 2020).

The "Gig/Sharing economy" is a result of digital platforms and networks, in which on-demand workers from various physical locations receive instantaneous payments rather than long-term employment contracts, consumers demand fast digital payment options both online and offline, and central banks and regulatory bodies compete for control with private enterprises. The lack of trust among anonymous agents is a significant impediment to business transactions on online platforms. Thus, these platforms significantly depend on payment innovations such as Stripe or Paypal that allow users to interact with each other directly (L. Cong & Xiao, 2021).

In the context of the internet's historical trajectory, blockchain represents a significant paradigm transition from Web 2.0 to Web 3.0. Web 2.0, the current world of the interactive and social web, is an internet siloed by centralized organizations that provide services in exchange for personal data. Web 3.0, on the other hand, is based on cryptographic blockchain technology and enables an economic institutional infrastructure that is natively available on the web, hands ownership back to the creators and users and operates without an intermediary (Potts, 2020).

L. Cong & Xiao (2021), Davidson et al. (2016), Dimitropoulos, (2020), Potts (2020), Tan (2019), Trabucchi et al. (2020), Voshmgir & Zargham (2019) commonly agree that blockchain technology is more than a general-purpose technological innovation; It is a social technology for the coordination of individuals. Potts (2020) also refers to blockchain as an "institutional technology" that is "driving evolution in base-layer digital economic institutions for peer-to-peer or distributed money, payments, commercial contracting, asset registries, identity, certification and credentials and other administrative infrastructure to record economic facts (e.g. ownership, payments, trade, contracts, debt, etc)" (p.6).

In order to handle coordination issues within blockchain networks, blockchain developers have resorted to economic theory. Therefore, a new discipline of "tokenomics (also seen as cryptonomics)"; the economics of cryptography have been proposed. It aims to be a formal discipline that analyzes

protocols that govern products' production, distribution, and consumption in a decentralized digital economy (Davidson et al., 2016).

All economics is founded on a value theory and tokenomics is no exception. Commodities gain value due to the interaction of supply and demand on a market through a price determination mechanism. On the blockchain, this commodity is the token, which serves as a purely symbolic representation of trade value in the token economy. Within the decentralized peer-to-peer network, tokens can be exchanged for a range of goods and services (Dimitropoulos, 2020).

Jensen & Meckling (1976) characterized the business as a "nexus of contracts". Blockchain tokens seem to be the logical progression in the pursuit of an organizational form that can bridge geographical borders and more efficiently distribute resources by implementing the right incentives.

The token economy is a new form of economy. Each TES can be seen having its own economy surrounding its token but unlike the regular economy where the government and central banks set the rules, token economies are completely controlled by code. The underlying protocol defines things such as what the token is used for, what the inflation rate is, who receives tokens as rewards, etc., are all defined by the underlying protocol.

TESs are essentially creating their own micro-economies tied to a specific use case with the goal of becoming self-sustaining and self-governing (Zhao et al., 2019).

3.3.4.3. Components of a Token-based Ecosystem

A TES consists out of a variety of different core components. The following section will provide a critical review of the literature on the each of the nine individual components: Token Type, Token Business Model, Token Incentive, Token Distribution, Token Monetary Policy, Token Legal, and Token Governance.

Token Type

A token is a dummy tool and does not have any value or utility by itself. Its value and utility are determined by what it represents. This value can represent a wide variety of properties such as the right to a reward for fulfilling a specific task, the proof of ownership of a gold nugget, access to an exclusive community and much more. There is no univocal description of that represented value. Thus, a deep understanding of the embedded value, i.e., the token type, is crucial for building a TES (Freni et al., 2020).

Given the large possibility of token value representations, several authors such as Burilov (2019), L. Cong & Xiao (2021), Elsden et al. (2018), Freni et al. (2020), Lesavre et al. (2021), Oliveira et al. (2018) developed token classifications that make it easier to distill the differences. Given the infancy of the research field, these token-type taxonomies vary quite a bit from each other and emphasize different characteristics. By synthesizing these papers, we can develop four distinct approaches of viewing token types: Fungibility View, Property Right View, and Purpose View. It is essential to point out that these token-type views are not mutually exclusive and might overlap.

Ownership Right View (*Utility Tokens vs. Security Tokens*)

The most commonly agreed distinction of tokens from the literature is between utility and security tokens. Utility tokens allow their owners to access and consume products or commit work to the platform. In contrast, security tokens entitle their holders to ownership of the organization and economic interest. Therefore, the main difference is the ownership right.

Security tokens resemble traditional securities that have to comply with federal securities laws. Thus, operating a security TES increases the operation difficulty due to legal complexity. To classify the two types of tokens, the U.S. Securities and Exchange Commission (SEC) has generally used the “Howey test” which will be further described in the *Token Legal* section. It is important to notice that due to the possibility of both types of tokens to generate profit and appreciate in value, it is far from easy to come up with a clear distinction and often results in a grey area for regulators (Burilov, 2019; Esq, 2020; Shirole et al., 2020).

When closer examined, utility tokens can be further split up into protocol and application tokens (Burilov, 2019; L. Cong & Xiao, 2021).

Protocol tokens (sometimes also called “cryptocurrencies” or “coins”) are created to be transferred on their native public blockchain network. They serve as a medium of exchange on their own network. In the case of Ethereum, the Ether protocol token (ETH) functions as a transaction fee paid by network participants to miners for the processing of smart contracts, in addition to its general payment function. The nature of smart contracts is distinct enough to suggest that Ether is an integral part of providing specific services to network users in this scenario.

As discussed in *section 3.2.1*, the primary purpose of Ether is to allow Ethereum network users to run autonomous computer programs known as "smart contracts." One specific function for smart contracts is the creation of application tokens. Software developers can develop online services/platforms, also known as dApps (Decentralized Applications) and assign their platform token with various economic, voting, participation, consumptive, or utilization rights. Application tokens are created on top of the existing protocol token infrastructure. Contrary to protocol tokens that derive their value mainly from being a medium exchange on the native network, application tokens derive their value from the aforementioned rights.

Most of the existing app tokens are issued on top of the Ethereum network; however, other blockchain platforms also support smart contracts and app tokens, such as EOS, Polkadot, Avalanche or Binance Smart Chain (Burilov, 2019).

Fungibility View (*Fungible Tokens vs. Non-Fungible Tokens*)

Fungible tokens are intended to be fully interchangeable units, operating as digital money and allowing payment systems to function. Once in circulation, tokens cannot be copied or accidentally removed from a user's account. By using the blockchain's transaction processing capabilities that prevent double-spending, tokens can be debited and sent from accounts in a proper manner. Examples of fungible tokens are Ether, Bitcoin, Compound or Filecoin.

Non-fungible tokens (NFTs) are tokens that are used to identify objects or data uniquely. Once in circulation, moving an NFT involves reassigning the owner's account. An example for NFTs are digital collectibles such as the game Cryptokitties or artwork collections such as Cryptopunks.

Tokens created on top of existing blockchains, i.e., application tokens are either fungible or non-fungible, whereas tokens native to the blockchain network, i.e., protocol tokens, are always fungible(Burilov, 2019; L. Cong & Xiao, 2021; Lesavre et al., 2021).

Purpose View

The purpose view from Oliveira et al. (2018), arguably the most fine-grained view, defines eight token archetypes based on their main purpose, denoting that token's core utility factor. This depicted main purpose does not have to be a token's single purpose; there can also be additional secondary purposes extending the token's utility and long-term value. Table 2 describes these archetypes in detail.

Challenge	Main Purposes	Description
Cypto Currency	Currency	A token with the ambition to become a widespread digital form of currency
Equity Token	Earnings, Store of Wealth	A token which confers to its holder a right to equity-related earnings, such as profit-sharing, application rents or platform fees.
Funding Token	Store of Wealth, Funding	A token which is perceived as a long-term investment from the holder's perspective, and as a financing vehicle for the project's team and/or the community (bounties).
Consensus Token	Validation Reward, Store-of-Wealth	A token which is used as a reward to nodes which ensure data validation and consensus.
Work Token	Work Reward	A token which is used as reward to users who complete certain actions or exhibit certain behaviour.
Voting Token	Voting Right	A token which confers a voting right to its holder.
Asset Token	Voting Right, Asset Ownership	A token which represents asset ownership.
Payment Token	Payment	A token which is used as internal payment method in the application.

Table 2: Eight Token Archetypes (adapted from Oliveira et al., 2018)

In a quantitative report, Kaal (2018) examines the top one hundred tokens by market capitalization and found out that about 55% of issued tokens were utility tokens, 34% payment tokens and just 6% were security tokens. The remaining percentages were characterized as "other". This data shows a significant trend in the utility token model. Payment tokens are also well established. The reason for being less than utility tokens might be that payment tokens require much more development time. The underlaying blockchain network has to be built

first in contrast to the utility model, which is built on top of an existing blockchain network. The substantially low percentage of issued security tokens might be related to the aforementioned complex federal securities laws.

Another critical aspect of token types is the importance of open standards. In general-purpose smart contract platforms, open standards that provide interfaces for various implementations are often followed because they reduce implementation complexity and uniform a common language for developers to understand and follow.

To find a standard, a developer often first offers an improvement on the project's public code repository, which is then thoroughly discussed. Finally, the project's committee either approves or rejects the improvement. If it is accepted, it will become a new standard. On Ethereum, this process is called Ethereum Improvement Proposals (EIP) and Ethereum Requests for Comments (ERC) but similar concepts exist on other blockchain networks.

The most widely used standard for implementing fungible coins on the Ethereum network is ERC-20. The standard facilitates the sharing, exchanging, and trading of different tokens. The interface includes six methods*:* `totalSupply`, `balanceOf`, `transfer`, `transferFrom`, `approve` and *allowance* as well as two events: `Transfer` and `Approval`.

ERC-721 is a token standard that defines an interface for smart contracts to manage, own, and trade non-fungible tokens. The interface includes the following ten methods: `name`, `symbol`, `totalSupply`, `balanceOf`, `ownerOf`, `approve`, `takeOwnership`, `tokenOfOwnerByIndex`, `transfer`, and `tokenMetadata`, as well as two events: `Transfer` and `Approval`. The `transfer` and `takeOwnership` functions specify how the contract will handle token ownership and how ownership can be transferred. The function `tokenMetadata` renders a token non-fungible due to its distinct attributes.

Security tokens can be implemented using the ERC-1400 standard (Burilov, 2019; Lesavre et al., 2021; Shirole et al., 2020).

Last but not least, the question of the need to issue multiple tokens instead of a single one arises. Kang et al. (2019) argue that the primary motivation for implementing a multi-token economy is to decouple a base currency from other uses and make the other tokens more suitable for economic activities within the network. Moreover, in terms of the token functionality, while one can bundle all the functionality into a single token, splitting up the

tokens for a single-encapsulated use case can create more mental clarity for participants as well as incentivize these participants to stay longer within the network. A multi-token system may also reduce the risk of a network collapse. While in a single-token world, participants can rush to external exchanges and sell their token, in a multi-token world, the network provider can prevent the listing of a token on external markets.

An example of a multi-token network is Steem. Steem is a blockchain-based project launched in 2016 that aims to build and power incentivized online communities while also providing content creators with direct income opportunities. Steemit sits on top of the Steem network and is a decentralized social blogging platform where participants can create articles and earn tokens when readers upvote their articles. Steem's system uses three different token units: Steem (STEEM), Steem Dollars (SBD), and Steem Power (SP). Steem and Steem Dollars can be traded on exchanges, while Steem Power can not.

Steem is the underlying currency of the network. All the other tokens derive their value from it. To participate in the Steemit platform, users have to convert their Steem to either Steem Power or Steem Dollars. Converting Steem into Steem Power provides users voting rights for the written articles on the platform. Users with more Steem Power, i.e., voting power, have more influence as their vote earns the creator more tokens. Steam Dollars are the reward currency. Article creators get paid in Steam Dollars for their articles. One SBD is pegged to one US dollar. In addition, the Steem network incentives users to hold their Steem Dollar token, i.e., not leave the network, by giving out a 10% annual interest on the total amount.

While multi-token networks encourage participants to stay longer, there are also some caveats. In the analysis of the Steem case, Kang et al. (2019) found out that their multi-token economy worked noticeably well during the growing phase but did not function well in a recession. Finally, the more tokens come to play; the more complex is the overall system.

Token Business Model

Blockchain-based technology, such as technology in general, often requires enough capital to turn an idea into reality. The use of alternative token-based finance mechanisms has grown exponentially during the previous few years. Startups have started to raise money by selling tokens on the open market rather than relying on more traditional methods like equity issuance or bank loans (Tasca, 2019). For a while, especially during the ICO era in 2017/18, the de-facto standard business model for the TES was to keep a particular share, usually between

5-20%, of their to-be distributed tokens for the founders/team. Through the issuance of the remaining tokens to investors, the project gains capital to turn the idea into an actual useable product and thus hopefully increase the value of the token. After years of building a successful project, the initial project members can exchange parts or all of their kept tokens for the increased value and thus perform a quasi-exit (Fridgen et al., 2018; Kranz et al., 2019b). Since the goal is that the project eventually becomes self-sustaining, i.e., owned and performed by the community, the project should not depend on the founding team's effort anymore (Schmeiss et al., 2019; Zhao et al., 2019).

One overarching tendency that authors such as Drasch et al. (2020), Tasca (2019), Trabucchi et al. (2020) seem to subscribe to is comparing the token-based business model to Web 2.0 like platform businesses (Figure 9). The difference is that there is a shift from two-sided platforms, where centralized entities mediate buyers and sellers, to peer-to-peer platforms on the top of open and decentralized networks where buyers and sellers directly interact with each other (Tasca, 2019).

As Ethereum co-founder Vitalik Buterin once said:

"Blockchain does not make the taxi driver lose his job, the network technology makes Uber superfluous".

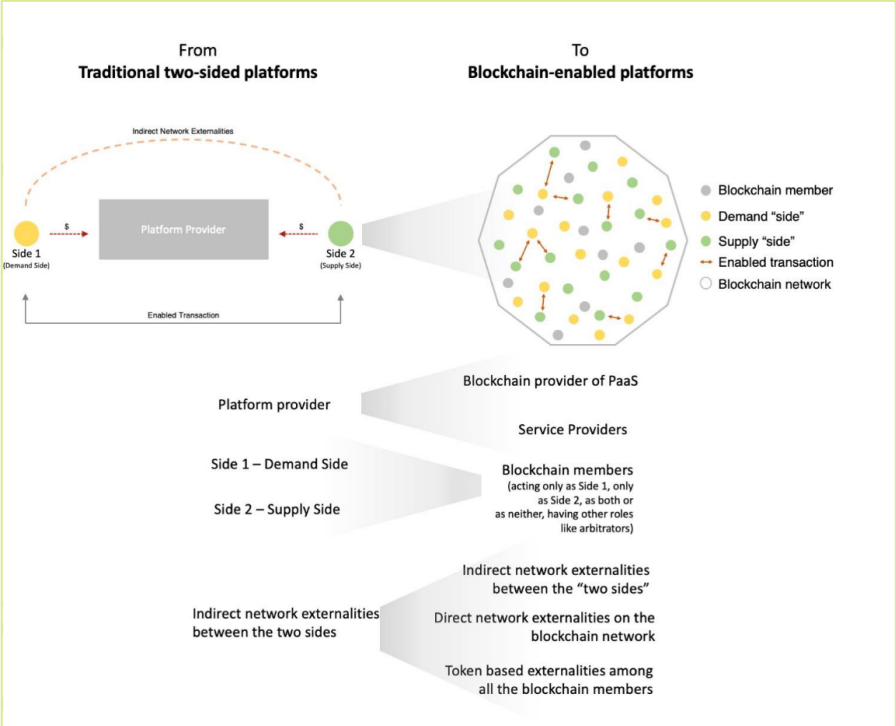


Figure 9: The shift from centralized two-sided platforms to blockchain platforms (Trabucchi et al., 2020)

TESs are similar to multi-sided platforms (MSP) with multiple actors (Drasch et al., 2020; Trabucchi et al., 2020; Weking et al., 2020). As previously mentioned, TESs are essentially creating their own micro-economies with participants following pre-designed incentives tied to a specific use case to become self-sustaining and self-governing (Trabucchi et al., 2020). In this new concept, users are also producers/shareholders (also called "prosumers"), and value is created fairly and transparently redistributed (Tasca, 2019).

Tasca (2019), describes the driving forces behind token-based business models with four major trends: (1) platform business models, (2) peer-to-peer networks, (3) open-innovation, and (4) crowdfunding.

TESs benefit from those four factors as they extend on the ideas of the platform models by providing a digital way of transferring information and value. While doing so, they make use of the most recent developments in the blockchain area, which raise the potential of decentralized peer-to-peer networks. Furthermore, blockchain software is often based on an open-source license model. Since the source code for protocols and smart contracts are typically publicly available, anyone can check it for errors and make improvements to the project. Additionally, participants can build, exchange and share their ideas, essentially forming an open community around the project. Tasca (2019), uses the concept of Wikipedia as a point of comparison, noting that community consensus determines which information is deemed accurate. Last but not least, crowdfunding – a request for monetary donations made via the internet in exchange for future products, services, or rewards – help TESs easily raise significant funds from the retail market as legislative regulation has been limited so far.

Due to the open-source nature of TESs, they are at risk of being easily duplicatable (forkable) by competitors. This can be inherently bad for the project as mass adoption is needed and users might switch to the competitor (Tan, 2019). Schmeiss et al. (2019) calls this the paradox of openness:

> *"The paradox of openness is an inherent problem in open innovation because the creation of innovations often requires openness, but the commercialization of innovations requires protection."* (p. 136)

However, it turns out that tokens accelerate network effects due to their unique incentive structures. Participants are motivated to help the platform succeed either by using tokens directly or contributing in other forms such as voting. Thus, the project can create defense mechanisms similar to MSPs by leveraging network effects. These network effects lead to

switching costs, which allow for the possibility of another business model option of charging a fee as long as the fee that is charged is less than the cost of switching to a new platform. Hence, creating network effects as quickly as possible is essential for the success of a platform (Drasch et al., 2020; Schmeiss et al., 2019; Trabucchi et al., 2020).

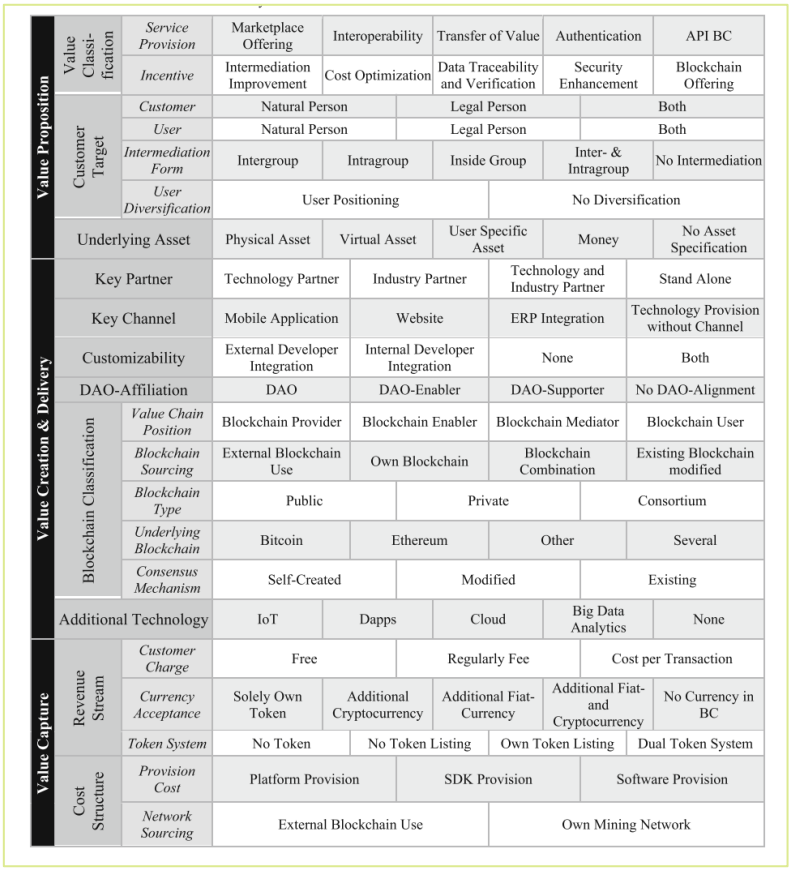
In addition to accelerating network effects, tokens also seem to help with the chicken-egg paradox of MSPs. The challenge for all MSPs is to incentivize the various sides to join the platform. A platform requires at least two participants: consumers and producers, to function properly. However, a new platform does not generate enough value to attract new users initially, rendering the platform participation of the consumer not economical and vice versa for the producer (Drasch et al., 2020). Tokens solve this by incentivizing participants proportionate to their adoption stage, the value they offer, and the risk they incur (Drasch et al., 2020; Trabucchi et al., 2020). This benefit also emphasizes the dynamic nature of the token's value as the anticipated token price increase encourages additional users to join the platform even more (L. W. Cong et al., 2021).

The field of business model innovations in the TES space is still in its infancy, where a lot of experimentation is still to be made. Based on 99 blockchain ventures, (Weking et al., 2020) have identified five business model patterns as seen in Figure 10.

Pattern (P)	Definition	Number of firms
P1: Blockchain for Business Integration	Provision of a standardized shared database to improve interoperability among users	14
P2: Blockchain as Multi-Sided Platform	Provision of a marketplace without regulating intermediaries	44
P3: Blockchain for Security	Reinforcement of security aspects by using several aspects of the blockchain technology	7
P4: Blockchain Technology as Offering	Provision of blockchain-APIs	21
P5: Blockchain for Monetary Value Transfer	Enablement of direct value transfer among peers	13

Figure 10: Blockchain Business Model Patterns (Weking et al., 2020)

Furthermore, a taxonomy on the impact of blockchain technology on business models has been developed that depicts the Value Proposition, Value Creation, and Value Capture of TESs (Figure 11).



Value Proposition	Value Classification	*Service Provision*	Marketplace Offering	Interoperability	Transfer of Value	Authentication	API BC
		Incentive	Intermediation Improvement	Cost Optimization	Data Traceability and Verification	Security Enhancement	Blockchain Offering
	Customer Target	*Customer*	Natural Person	Legal Person	Both		
		User	Natural Person	Legal Person	Both		
		Intermediation Form	Intergroup	Intragroup	Inside Group	Inter- & Intragroup	No Intermediation
		User Diversification	User Positioning	No Diversification			
	Underlying Asset		Physical Asset	Virtual Asset	User Specific Asset	Money	No Asset Specification
Value Creation & Delivery	Key Partner		Technology Partner	Industry Partner	Technology and Industry Partner	Stand Alone	
	Key Channel		Mobile Application	Website	ERP Integration	Technology Provision without Channel	
	Customizability		External Developer Integration	Internal Developer Integration	None	Both	
	DAO-Affiliation		DAO	DAO-Enabler	DAO-Supporter	No DAO-Alignment	
	Blockchain Classification	*Value Chain Position*	Blockchain Provider	Blockchain Enabler	Blockchain Mediator	Blockchain User	
		Blockchain Sourcing	External Blockchain Use	Own Blockchain	Blockchain Combination	Existing Blockchain modified	
		Blockchain Type	Public	Private	Consortium		
		Underlying Blockchain	Bitcoin	Ethereum	Other	Several	
		Consensus Mechanism	Self-Created	Modified	Existing		
	Additional Technology		IoT	Dapps	Cloud	Big Data Analytics	None
Value Capture	Revenue Stream	*Customer Charge*	Free	Regularly Fee	Cost per Transaction		
		Currency Acceptance	Solely Own Token	Additional Cryptocurrency	Additional Fiat-Currency	Additional Fiat- and Cryptocurrency	No Currency in BC
		Token System	No Token	No Token Listing	Own Token Listing	Dual Token System	
	Cost Structure	*Provision Cost*	Platform Provision	SDK Provision	Software Provision		
		Network Sourcing	External Blockchain Use	Own Mining Network			

Figure 11: Blockchain Business Model Taxonomy Service (Weking et al., 2020)

Token Incentive

TESs combine economics with information technology, relegating economics to a more technological world. One key component of this is designing various incentive systems using game theory models. Mechanism design is a branch of economics and game theory that takes an engineering approach to create economic incentives to accomplish desired goals (Barreiro-Gomez & Tembine, 2019; Tan, 2019).

The crucial part of a token-based ecosystem is good coordination between participants. Good coordination leads to more efficiency. However, people naturally do not cooperate unless there is an incentive to (Tan, 2019). Based on the ideas of (Smith, 1776), the "Father of Modern Economics", people are always motivated by self-interest and selfishness:

> *"It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own self-interest. We address ourselves not to their humanity but to their self-love, and never talk to them of our own necessities, but of their advantages"* (bk. 1, ch. 2).

Coordination within distributed systems – such as token economies – is accomplished through interaction between members and the incentive structures provided by a token exchange (Tan, 2019). While in a centralized world, a central entity can deal with situations that do not achieve the pre-set objectives, in a decentralized world, there must be rules put in place to mitigate undesirable behaviors and outcomes.

The idea is to incentivize good actions, de-incentivize bad actions and ultimately influence participants' behaviors in a way that is beneficial to the overarching network's goal. A well-designed incentive mechanism has a direct impact on the long-term viability of a decentralized token ecosystem (Soonduck, 2020; Tan, 2019).

One prominent example of incentive mechanism design is Bitcoin. Senders and recipients are guaranteed that money cannot be moved from insufficient funds, and third-party miners are rewarded for providing this assurance by the promise of earning Bitcoins (Kim et al., 2021).

According to Tan (2019), a token ecosystem should consider financial and non-financial incentives.

Financial incentives play an important role in helping a TES reach network effects and thus mass adoption. Financial incentives can be based on the participants' platform activity or the amount of owned equity. Platform activity can include for example, rewards for joining the network, receiving redistributed transaction fees, rewards through referral links and mining. Return on owned equity usually derives from performed action called "Staking", where participants lock up their tokens and receive a token reward (think interest) for supporting the objective of the network, such as security or price stability (Tan, 2019).

In addition to appealing financial incentives, non-financial incentives can also help strengthen the achievement of the overall network's objective. Non-financial incentives can be how participants can vote on network issues or how the ecosystem allocates resources. Quadratic voting, where people express the degree of their preferences in addition to the direction of their preferences or delegated voting, where votes are transferable and grouped by voters, are two among dozen possibilities of voting protocols. Besides voting, reputation is also a noteworthy component for reducing information asymmetry and incentivizing low-quality sellers to disclose truthful information (Tan, 2019).

Soonduck (2020) further emphasizes the importance of penalties (reverse compensation) and creating an evolving, i.e., adapting sustainable mechanism design. Penalties are required to deter individuals from committing malicious actions in the network. Strategies to prevent

bad actors from colluding can be bargaining (auction) protocols such as Highest Bidder where the person with the highest amount is chosen or Vickrey-Clarke-Groves where the bidder whose offer maximizes the network's total social good is chosen. Another way is to use so-called "Oracles". Blockchain oracles are third-party services that provide smart contracts with external "truthful" information that is aggregated and filtered through multiple resources. (Tan, 2019). Participants are prone to change their behavior over time and therefore, the design needs to take into account the incremental, evolutionary development possibility of the network as well. An effective possibility to allow this adaptability are smart governance mechanisms that will be thoroughly explained in the Token Governance section (Soonduck, 2020; Tan, 2019).

It is of utmost importance that a project's mechanism design is carefully thought through and well simulated. Incentive design is programming human behavior and, therefore, can also rival against participants' ethical compasses (Tan, 2019). One example by Athey et al. (2017) highlights the effect of small incentives with their digital privacy paradox; People claim to care about privacy, but when they are offered a relatively small amount of Bitcoin, they are more than eager to hand over personal information. Another example of a negative externality is Bitcoin's mechanism design of using a Proof-of-Work consensus mechanism to secure the network. For mathematical proof, Bitcoin is wasting an immense amount of energy, consuming more energy per year than the country of Bulgaria (Huang et al., 2021).

Token Distribution

The component of token distribution is all about defining the network's ownership. The question is: "Who owns how many tokens?" The most common token distribution goal today is to raise funding. However, there can also be other goals for token distributions, such as incentivizing and targeting user participation or simply determining the market price for a token. Ultimately, a TES has to distribute tokens so that people can start using the service (Momtaz et al., 2019).

The way tokens are distributed can impact the network's overall performance and system security. Like regular startups, some TESs need to raise capital via a so-called "token sale" to jumpstart their network development and invest in user acquisition. This way, tokens are used as a form of equity in the company. Focusing the initial token distribution within early investors

bears the risk that these investors might not become actual users in the project and therefore endanger the future viability of the network (Kranz et al., 2019a).

In May of 2021, Messari, one of the most renown crypto research organization, has conducted a study about the "Power and Wealth in Cryptoeconomies" (Figure 12) and found out that while earlier projects such as Ethereum, Cosmos or EOS allocated more than 70% of their token supplies to their community, more recent projects such as Binance, Solana or Flow have a much higher concentration of insiders. In some cases, these insiders own even more than 40% of the projects' token supply (Watkins, 2021).

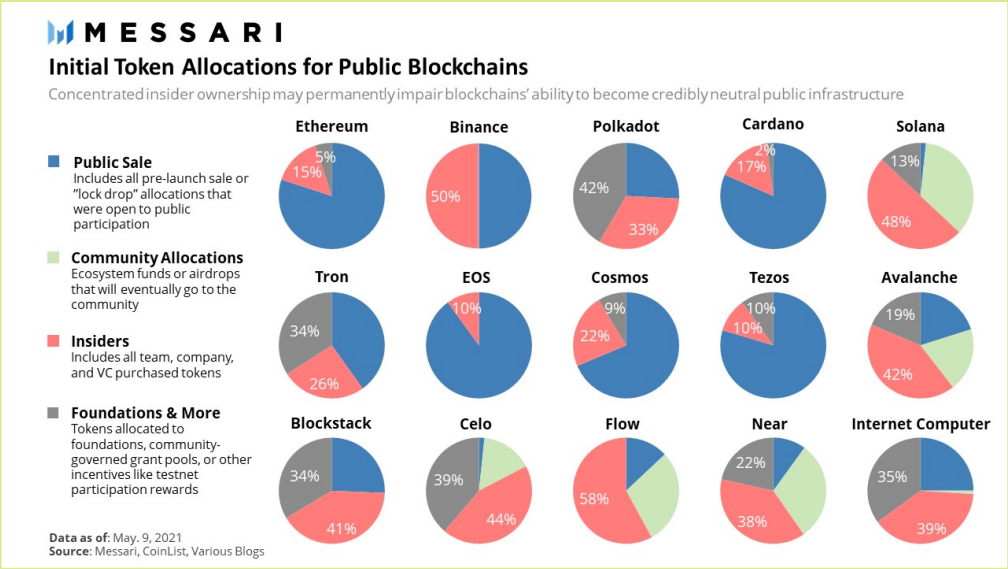


Figure 12: Initial Token Allocations for Public Blockchains (Watkins, 2021)

When it comes to token allocation in a decentralized network, it is therefore imperative to allocate tokens to the community (the users) as much ownership as possible. While no exact allocation percentage could be found in the literature, Messari suggests allocating a minimum of 50% supplied tokens to the community. Similar to legacy startups, a vesting scheme for the founding team's token allocation can also improve the long-term incentive structure of the project. A fair and transparent token allocation is an essential pillar of a successful TES (Kranz et al., 2019a).

Two token distribution stages could be identified:

- The genesis token distribution that defines the starting token allocation of the network.
- The ongoing token distribution that continues to allocate tokens through hard-coded rules which mainly serves as participation rewards.

Based on the literature, two main methods of distributing tokens could be identified: the token sale and internal allocation.

Token sales are used to initially issue and sell tokens to early investors to raise capital for funding the project development. The term “token sale” refers to an Initial Coin Offering (ICO) phase in which the tokens are sold. In the implementation and execution of a token sale, smart contracts play a crucial role. As aforementioned a smart contract is a source code that executes predetermined rules and is stored on the blockchain. These rules apply to parameters such as token price and sale duration in the case of a token sale. Smart contracts are then used by the developers (or also known as issuers) to generate (also known as minting) and distribute tokens with a set of specific features.

The smart contract is activated once the token sale is live and can receive funds from investors, most commonly in the form of fiat money or established cryptocurrencies like Bitcoin or Ether. Smart contracts issue a corresponding number of tokens to the investor and transfer the funds to the issuer’s wallet when they receive these funds (Kranz et al., 2019a; Momtaz et al., 2019). The token sale campaign is usually presented to the public with a so-called whitepaper. A whitepaper is a document that presents the business idea, a technical description of the service solution to the business problem, project team, token allocation and a roadmap for the future. It is important to note that this whitepaper is issued by the token issuer and is typically not controlled by a third party (Furnari, 2021; Myalo, 2019).

Following a token sale, the token can be listed on cryptocurrency exchanges such as Bittrex, Binance or Kraken for token holders to trade (Kranz et al., 2019a). The decentralized, immutable, and transparent nature of blockchain technology allows token sales to eliminate many of the intermediaries used in traditional venture funding, such as banks, venture capital firms, and payment providers. Therefore, token sales are a new sort of peer-to-peer crowdfunding enabled by blockchain technology. Figure 13 depicts this token sale ecosystem.

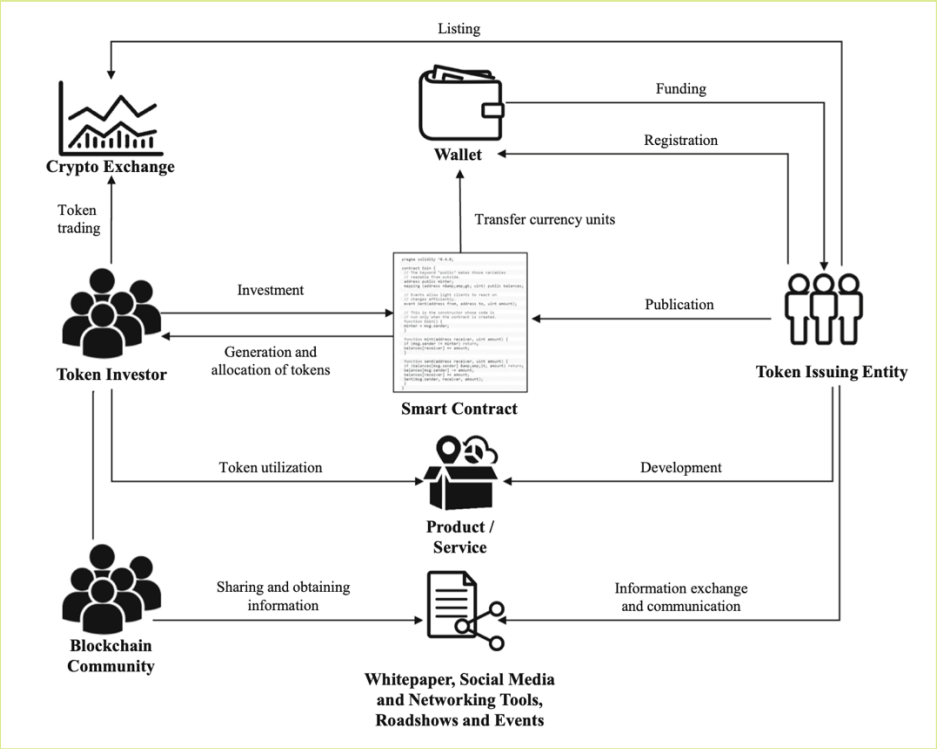


Figure 13: Token Sale Ecosystem (Kranz et al., 2019a)

In the narrower sense of the word, a token sale does not necessarily require an ICO; tokens can also be sold via a variety of other token sale strategies. The four in the literature mentioned strategies are:

1. **Initial Coin Offering (ICO)**

   Initial Coin Offerings are the most traditional and used crypto crowdfunding method (Furnari, 2021). They exactly refer to the above-mentioned token sale process. ICOs have come to be associated with distributing utility tokens, while Security Token Offerings (STOs) describe a more regulated and matured form in which security tokens are distributed (Kranz et al., 2019a). The most significant disadvantage of an ICO investment is the possibility of fraud. According to statistics published by Satis Group, a leading ICO advice firm, around 81 percent of ICOs up until 2018 were scams. Furthermore, cybercriminals stole 10% of the money raised by ICOs. Another significant downside is legal compliance issues, as it was often not clear whether a token should be considered a security or not (Myalo, 2019). To overcome these concerns, new models for token sales have been created.

2. **Simple Agreement for Future Tokens (SAFT)**

The Simple Agreement for Future Tokens model addresses legal concerns in the ICO offering model and is mostly employed in pre-offerings. The idea is that SAFT aims to be an actual investment contract, a security that is compliant with security laws. Inspired by the Simple Agreement for Future Equity contract (SAFE), SAFT allows investors to fund the development team and, in exchange, receive the right to receive future tokens once the tokens are fully functional and provide actual utility. This way, TESs can be funded without violating (Momtaz et al., 2019).

3. **Initial Exchange Offering (IEO)**

An Initial Exchange Offering can be simply defined as an ICO conducted on a cryptocurrency exchange. While there is no mediator in an ICO, the IEO is intermediated by the cryptocurrency exchange. A cryptocurrency exchange is a platform that allows clients to purchase tokens with fiat currency or trade tokens. An IEO provides the issuer with a significant advantage: a ready audience of investors. As they are already signed up for the exchange it is much easier to perform investments. It also benefits the issuer from a regulatory standpoint since they will fulfill most of the law's compliance regulations for the offer, such as Know Your Customer (KYC) and Anti-Money Laundering (AML). There are also some drawbacks when it comes to IEOs. Due to taking over these compliance tasks, exchanges are highly selective and are unwilling to accept many projects. For this reason, IEO have not found extensive mainstream adoption when it comes to token sales strategies (Furnari, 2021; Myalo, 2019).

4. **Initial Decentralized Exchange Offering (IDO)**

A decentralized exchange (DEX) does not keep user funds or personally identifiable information on centralized servers. Instead, it connects buyers and sellers of digital assets directly via smart contracts and their respective personal wallets. There are two kinds of DEXs - the first is order-based P2P exchange such as dYdx or Ether Delta. The second is a liquidity pool based exchange that uses automated market makers such as Uniswap, Bancor or Balancer. Instead of a typical market of buyers and sellers, digital assets can be traded without authorization and automatically using liquidity pools (Figure 14). Users can contribute tokens to liquidity pools, and the price of the tokens in the pool is decided by a mathematical formula. Liquidity providers are compensated for supplying tokens to the pool, and traders engage with the pool. Initial

Decentralized Exchange Offerings share similarities with IEOs. Both methods strive to collect funding to bootstrap a product while also allowing instant trading. The difference is that there is no intermediary, which reduces listing costs and increases speed-to-market. First, the project has to publicly request funding through an IDO service called “Launchpad”. Once accepted, investors can then purchase IOUs (acknowledgment of debt) of that token. Finally, on the initial token generation event they receive the actual tokens and can immediately trade them. While this token sale strategy has many advantages, it also comes with drawbacks. DEX launchpads do not require KYC, making them a target for potential law regulators. Moreover, IDOs can easily lead to scams, and thus, investors are more cautious. The most common scam is a “liquidity rugpull” where the token developers abandon the project and run away with the funds (Xia et al., 2021).

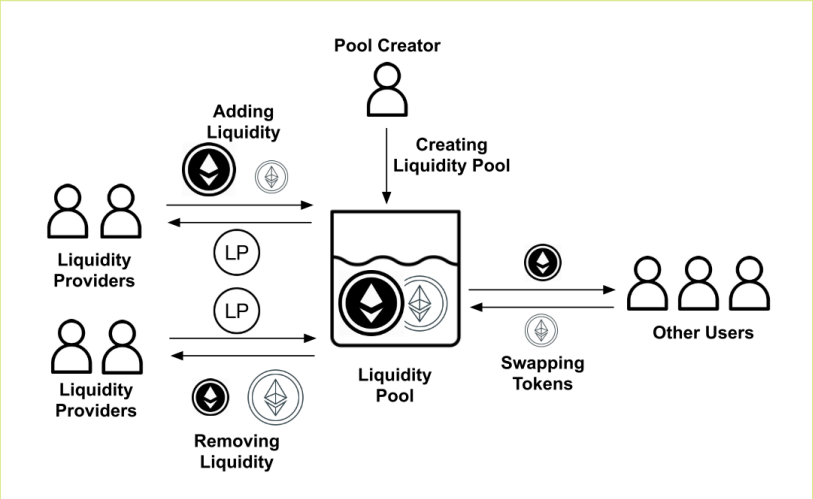


Figure 14: Interacting with DEX Uniswap and the major participants (Xia et al., 2021)

The second method of distributing tokens is internal allocations. Rather than allocating tokens to early investors, internal allocations are a helpful method to distribute tokens to actual network users. The most widespread method is called “Airdropping” (Esq, 2020; Momtaz et al., 2019).

An airdrop is a method that distributes tokens to potential or actual network participants for free. The idea is that these free airdrops can serve as a marketing and incentivization tool. In May 2018, the Tron Foundation airdropped $1.7 million worth of its TRX tokens to users owning the Ether token. By rewarding users with these free tokens, project developers hope to build a community for their token and jumpstart long-term network growth. Moreover, free

tokens incentivize users to explore, test and experiment with the network without spending their own money. Thus, creating more interest in the project's usage. An airdrop can either be announced or unannounced prior to its distribution. It can be passive through which tokens are allocated automatically to all passive participants and interactive through which tokens are granted to specific participants who perform actions beneficial to the project's development.

An example could be posting (self-marketing) the project on social media forums or interacting with the network by using certain services. The airdropping strategy appeals to developers as a low-cost marketing strategy, though critics argue that giving tokens away for free does not guarantee that the recipients will use them. Consequently, distributing too many tokens can unnecessarily dilute the token supply and harm the project's growth (Esq, 2020).

All in all, there is no single one-size-fits-all distribution model. Successful token sales need to ensure a fair distribution and strike a balance between short- and long-term considerations, especially when it comes to legal compliances. Not enough tokens in a projects' treasury may lead to its incapacity to pay for future expenses. On the other hand, if a small group of owners controls a large share of the token supply, the other investors may see the price falling when these owners decide to sell.

Monetary Policy

While the token distribution component looked at the issuance of tokens from an allocation and ownership perspective, the monetary policy is concerned with the inflation or deflation of the token supply, or how quickly tokens will be released in the future and how that rate will change over time. The monetary policy has important implications for the adoption and sustainability of the TES.

According to Fridgen et al. (2018) and Ankenbrand et al. (2020) tokens can either have a fixed supply, a fixed inflation rate or an adaptive inflation rate.

A fixed token supply means that no further tokens are issued in the future through mining or otherwise minting activities. A fixed token supply is inherently also characterized as a deflationary policy. With a deflationary policy, prices are expected to increase due to the fundamental scarcity of the token supply (Fridgen et al., 2018).

An example of this strategy is Bitcoin. Bitcoin has a programmatically hard-coded fixed token supply of 21 million. These tokens are distributed to miners as a reward for contributing work to the network with each block (Figure 15). Every 210.000 blocks mined (approximately every four years), Bitcoin automatically cuts the reward, i.e., its inflation rate in half until all 21 million bitcoins are in circulation (Kaşkaloğlu & Ostrovska, 2013).

While a fixed token supply can establish a higher token price, it also may increase market volatility and speculation (Catalini & Gans, 2018).

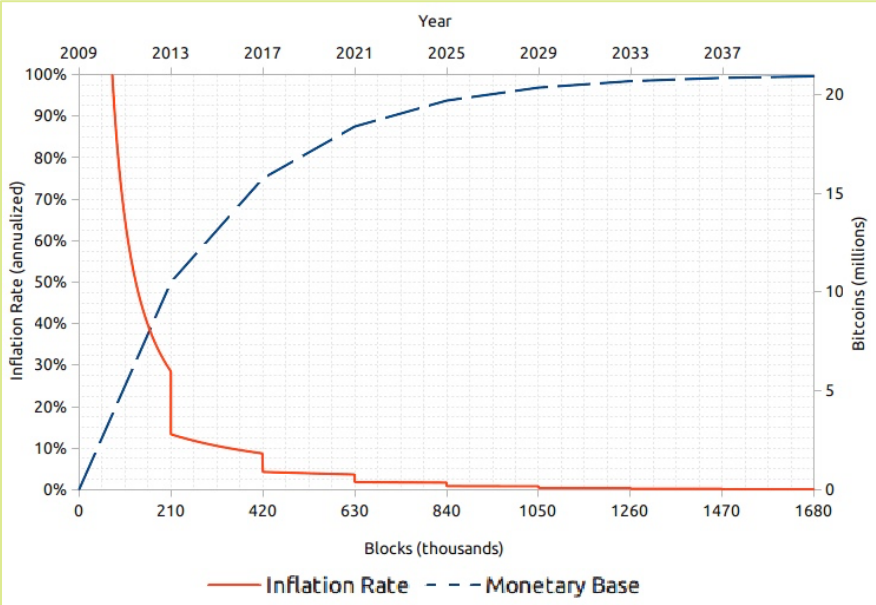


Figure 15: Bitcoin's deflationary money policy model (Kaşkaloğlu & Ostrovska, 2013)

Besides the halving method applied by Bitcoin, there is another method that enables a deflationary policy called token "burning". Token burning is the process of removing a certain amount from the token supply. It is performed either automatically by the smart contract based on certain events or by the founding team. In some instances, the founding team might have to first purchase tokens back from the market in order to burn them. On a technical level, it usually works by sending the tokens to a wallet address that is publicly visible but not accessible by anyone (Fridgen et al., 2018; Kranz et al., 2019c; Oliveira et al., 2018).

According to a study conducted by Kaal (2018), out of 100 researched TESs, 72% had a fixed token supply, i.e., a deflationary model, while the other 28% used variations of the inflationary token model.

Token that make use of an inflationary model try to operate similar to a fiat currency. This usually implies that there is not a cap on the quantity of tokens that can be issued. For example, tokens on Ethereum are continually minted to reward ongoing active participation of the miners in the network; the token supply is always growing.

A continuous token minting process gives the issuer additional flexibility depending on the current condition of the token and the overall market environment (Kaal, 2018; Kranz et al., 2019c).

Token Legal

The legal component intents to elaborate on the regulative aspect that blockchain tokens are exposed to. When determining or attempting to indicate a token's legal status, we must consider several factors, including the legislation relevant to the token agreement, the circumstances under which it is formed and disposed of, as well as the substance of that agreement. A token is an instrument whose function is determined by the laws that govern it. As a result, one can claim that a token is not a novel legal instrument but rather a new medium for an already existing legal instrument. The prevailing question is whether a token is characterized as a security or not (Burilov, 2019; Ferreira et al., 2021; Gritz, 2018; Van Adrichem, 2019).

The Securities Act of 1933 is the predominant act governing securities regulation in the United States, monitored by the Securities and Exchange Commission (SEC). It was designed with the purpose of making sure that investors receive specific financial and other information of the issuer as well as to prohibit fraud and deceit in the sale of securities (Van Adrichem, 2019)

Another U.S. regulating body that concerns international TESs is the federal department of the treasury that deals with money laundering and terrorism financing issues. Depending on the organization's location, other international jurisdictions such as these from the European Union or Singapore may apply (Burilov, 2019)

The most observed analysis method in the literature of determining whether an investment contract exists with a token, i.e., is it a security or not, is the so-called "Howey test" (Burilov, 2019; Ferreira et al., 2021; Gritz, 2018; Van Adrichem, 2019).

Under the Howey Test, developed by the U.S. Supreme Court in SEC v. W.J. Howey Co.,1946, an investment contract for the purposes of the Securities Act is fulfilled when there is (i) an investment of money (ii) in a common enterprise (iii) with a reasonable expectation of profits (iv) deriving from the efforts of others.

All four parts have to be satisfied for tokens to be very likely considered as a security. As of now, there is no bright-line standard in terms of what type of token needs SEC registration and which not. This leaves token issuers in a discomfited state as the security token registration is burdensome, costly, and time-intensive (Gritz, 2018).

Governments worldwide agree that the determination of the applicabale laws for tokens is a continuing area of development (Ferreira et al., 2021; Gritz, 2018; Van Adrichem, 2019).

Every country has slightly different approaches to governing the new technology of blockchain tokens. Countries like China have banned cryptocurrency entirely and South Korea has banned ICOs (Ferreira et al., 2021). In addition to the USA's regulations, Ferreira et al. (2021) , have investigated the regulatory recognition for crypto assets in Europe.

While E.U. regulators initially remained passive towards blockchain innovation, individual countries such as Lichtenstein took the leap in developing unique concepts. The Law on Tokens and T.T. Service Providers (TVTG), which came into effect on January 1, 2020, was the first complete regulation of the token economy in Lichtenstein. In the "Token Container Model" tokens are defined as a container that can hold any sort of right. This model allows the token to be used for things other than securities, such as patents, music rights, trademark rights, and software rights. In late 2020, the E.U. followed a new and unique regulation framework for tokens called Markets in Crypto-Assets (MiCA). MiCA aims to streamline crypto asset regulation in the European Union and help protect users and investors. As of now, MiCA provides legal guidance on specifically payment, stable and security tokens and does not directly address the case of utility tokens (Ferreira et al., 2021).

Besides the token type, the token distribution and timing also play a role in determining a security case. Utility tokens, for example, can be distributed before or after the project is developed. Tokens distributed before completion of the development very likely create an incentive for investors to hold on to the tokens. Later, once the project is finished and has gained more value, investors may want to sell it for a profit (Van Adrichem, 2019). This is also why Gritz (2018) states that most ICOs can be generally considered as securities. On the other side, tokens distributed after the development is finished are more likely for token purchasers

to be purchased for a desire to be used/consumed and not to expect profits (Van Adrichem, 2019). To counteract the security characteristic of an ICO, Van Adrichem (2019) suggests alternative token distribution mechanisms such as mining, forking, or airdropping as they are likely not considered an investment contract. That said, in a later article, Esq (2020) emphasizes that airdropped "free" tokens are not free from regulatory compliance either.

TESs want to avoid the legal complications that security tokens oppose as best as possible. However, the line between security and utility tokens is blurry for both issuers and regulators. As a de-facto standard, the Howey test can be applied to determine the security likelihood of a token.

Governance

As we have established in the Token Business Model section, TESs are platform ecosystems. Such an ecosystem aims to promote collaborative value generation while ensuring effective value capture for all stakeholders (Trabucchi et al., 2020).

The more open a platform is, the more participants can contribute and create value. On the flip side, creating value, negotiating and participating in more open platforms becomes increasingly difficult and complex. To fix these issues, platform leaders can use different governance mechanisms that set the rules of interaction between all participants (Pelt et al., 2021; Schmeiss et al., 2019). Schmeiss et al., (2019) identifies three overarching governance mechanisms.

The first is access, which defines who can join the platform and under which conditions. The goal is that participants with complementary skills interact to create value. The second mechanism is control. Control mechanisms define the rules by which participants interact. This involves establishing a clearly defined set of rules that allows competing actors to collaborate while still keeping their individuality.

Furthermore, control systems ensure that individual actors are held accountable. The third governance mechanisms are incentives. As mentioned in the Token Incentive section, incentives encourage participation and actions towards the platform's goal. In addition to Schmeiss et al. (2019), Pelt et al. (2021) complement these three governance mechanisms with five governance dimensions: Roles, Incentives, Membership, Communication and Decision Making.

In traditional governance, whether a company or a country, there is usually a strong centralized leader or board of leaders that effectively implements these governance mechanisms. However, decentralized TESs propose much more of a direct form of democracy where token holders can vote directly on proposals that affect the project's future. Thus, having more control over the platform's future (Tan, 2019).

Dursun & Üstündağ (2021), El Faqir et al. (2020), Pelt et al. (2021), Schmeiss et al. (2019), Tan (2019), Zwitter & Hazenberg (2020) commonly agree that governance in decentralized ecosystems is a crucial factor for the success of the project. Governance constrains the ecosystem in different ways depending on the token function, use-case and objective function (Tan, 2019).

The overarching guideline of a TES should be decentralization, i.e., eventually community ownership of the project. Thus, a high degree of centralization in the governance should be avoided (Davidson et al., 2016; Pelt et al., 2021; Schmeiss et al., 2019; Tan, 2019).

Token-based platforms can facilitate decentralized governance in the form of either off-chain or on-chain governance (Dursun & Üstündağ, 2021; Kaal, 2020; Pelt et al., 2021; Zwitter & Hazenberg, 2020).

Off-chain governance follows a more traditional approach to collective governance where participants take decisions through public discussions such as in online forums or conferences to find decisions that all stakeholders agree on (Fischer & Valiente, 2021; Zwitter & Hazenberg, 2020). The disadvantage of off-chain governance is that it can lead to shadow hierarchies where only a few anonymous people make decisions or the possibility of a fork of the project (Dursun & Üstündağ, 2021; Fischer & Valiente, 2021).

On the other hand, on-chain governance is a novel mechanism where participants can dictate project updates by voting on new proposals directly. These updates are encoded into the system itself. Based on various voting protocols, participants use their own tokens to vote on proposals that get automatically – without any intermediary – executed when a consensus is reached (Fischer & Valiente, 2021; Zwitter & Hazenberg, 2020). While this new mechanism drastically can reduce transaction costs and increase efficiency, critics point out the importance of carefully choosing the proper voting protocols. On-chain governance can quickly result in plutocratic power dynamics when the weight of each individual's vote is determined by the amount of tokens it holds. Furthermore, the lack of voting participants of token holders

can drastically hurt the project's long-term health (De Filippi, 2019; Fischer & Valiente, 2021). While off-chain agreements are still dependent on the project leaders to take the final action, on-chain agreements get immediately executed by the smart contract (Fischer & Valiente, 2021).

One of the most significant novelties of blockchain technology, especially related to on-chain governance, allows us to experiment with new organizational structures that are more transparent and less hierarchical than traditional organizations. Blockchain technology, combined with on-chain governance, allows for the creation of so-called decentralized autonomous organizations (DAOs) (Fischer & Valiente, 2021).

DAOs are a new form of organization that is more transparent, globally open for anyone to join and leave whenever wanted, does not depend on a strict hierarchy and fosters idea generation through the wisdom of the crowd effects (El Faqir et al., 2020; Kaal, 2020; Zwitter & Hazenberg, 2020). DAOs allow people to coordinate themselves peer-to-peer using a set of protocols and rules included in self-executing smart contract code (De Filippi, 2019).

Companies are traditionally considered distinct entities whose primary goal is to increase their competitive advantages and profits while decreasing the benefit for everyone else. DAOs instead can be more productive than hierarchical organizations because they may allocate power to the best talent at the best time by encouraging fruitful collaboration through their token incentives. Moreover, because users are equal owners, profit distribution is much fairer (Kaal, 2020).

The original first DAO was developed on the Ethereum blockchain by a group of developers in 2016 and was called “The DAO”. The DAO functioned similarly to a venture capital hedge fund, with contributors voting directly on proposed projects. During an Initial Coin Offering, investors would trade Ether for tokens. Then, these investors would use their tokens to vote on future ventures that should receive capital (El Faqir et al., 2020). The project raised around $168 million from approximately 10,000 investors and was at the time considered the largest crowdfunding campaign (Kaal, 2020).

While these new governance forms seemingly offer many advantages over their traditional counterparts, these new mechanisms are by no means excluded from severe risks that can endanger the entire health of the project.

One outstanding example is the infamous hack of The DAO in 2016. Bugs in the original 2016 DAO code allowed hackers to move one-third of the funds into a subsidiary account that

neither they nor The DAO members and founders could control. Along with other technological restrictions, the breach ended the original The DAO venture (El Faqir et al., 2020; Kaal, 2020). Besides the learned security lessons, The DAO hack was also a case study for the entanglement of both off- and on-chain governance mechanisms (Zwitter & Hazenberg, 2020). After the theft of $250 million, leaders of the Ethereum community decided to hard fork the network to return the stolen funds back to the investors. The original network became Ethereum Classic (ETC), while the new forked version kept the name Ethereum (ETH). The significant decision to fork the system was based on off-chain governance mechanisms. While investors were happy with the decision, it was not free from criticism. Due to the lack of clear legal frameworks, opponents of the fork argued that the hacker gained those funds in accordance with the rules set out in the smart contract. Therefore, the DAO hack opened a critical discussion of whether the concept of "Code is Law" is as promising and safe as it initially was thought so (Zwitter & Hazenberg, 2020).

Kaal (2020) further points out that the unresolved legal difficulties must be addressed for future generations of DAOs to succeed. It is still unknown what legal system will regulate DAO token issuance, whether minority DAO token holders will be safeguarded and if coded smart contracts that coordinate DAO member conduct are legally binding.

Dursun & Üstündağ (2021) conducted a more holistic list of difficulties and challenges related to governance that must be overcome. The results have been summarized in Table 3.

Challenge	Description
Consensus of stakeholders	It is necessary to find a reconciling way for too many stakeholders to protect the interests of everyone. Low voter participation, lacking technical knowledge of voters on proposals, bribery risk, game theoretic-attack of profit maximizers and centralization due to non-technical participants following dominant experts.
Security of governance	Blockchain has generally pseudonymous and sometimes completely anonymous users and the identities and roles of actors may not be clear. The system must be resistant to attacks exploiting weaknesses to hack, take control, manipulate, block or abuse the governance process. Control mechanisms such as abuse reporting, bribery prevention, blacklist and not counting votes of banned actors should exist.
Centralization risk	Average users with incomplete technical knowledge may refrain or be reluctant to participate in the decision-making process or may follow the majority or experts instead of proposing and defending the best alternatives for the platform. This low participation might cause blockchain to easily be dominated or manipulated by a few community members.
Fairness	Decisions must be objective and must not violate the ultimate goals of the blockchain project and should maximize the number of actors satisfied by the results. Participating in the decision process should be open to as many actors as possible. However, the impacts of actors on decisions must be proportional to their roles and amounts of their digital assets. Centralization and resulting inequity in voting power are other obstacles to fair governance.
Misalignment of incentives (Conflicting interests)	Governance decisions are made globally by loosely coupled community members having different incentives to participate in the governance process. The stakeholders have conflicting interests. However, for properly working governance, it is important to provide sufficient incentives to the com-munity members to join the decision-making process. Due to lack of motivation or incentive, proposal votes may not fair better with turnout never reaching a majority of the community.
Effectiveness	Governance procedures should not require excessive effort, time and, resources. The complexity of the process and tools reduces the effectiveness. The costs related to the lifecycle of a proposal should be minimized. Governance decisions sometimes cause contentious hard forks splitting the blockchain into two different blockchains having different rules. The governance process itself should not increase the risk of contentious hard forks and should facilitate implementing accepted changes.
Complexity	The procedures should be simple and employ fewer different tools and steps. For average users, governance frameworks and tools must be easy to use. Complexity and usage difficulties might both reduce the number of participants and increase the time and resource requirements of the governance process.

Table 3: Difficulties and challenges related to governance (Dursun & Üstündağ, 2021)

4. DEVELOPMENT AND PROPOSAL OF A TOKEN ECOSYSTEM CREATION FRAMEWORK

4.1. ASSUMPTIONS

A1: Blockchain tokens are dummy value containers that allow us to easily transfer value which could be stocks, intellectual property, art, music, votes, identity, and money over the internet, with small transaction fees, in a trustless, secure and verifiable manner. Tokens drastically reduce transaction costs and provide a way to reward and incentivize network participants. Tokens can be seen as “programmable value”. A2: TESs are new forms of digital economies disguised as distributed systems. They are complex socio-technical systems overshadowing a multidisciplinary field of economics, game theory, monetary theory, computer science, cryptography and law. TESs create their own micro-economies with participants following pre-designed incentives tied to a specific use case to become self-sustaining and self-governing. A3: TESs differ from traditional centralized companies in the way that they should have the ultimate goal of being highly decentralized and autonomous. They should be community-governed, community-owned and eventually transforming into a new self-sustainable form of an organization called; decentralized autonomous organization (DAO). A4: Not every organization needs a token and not every organization is advised to pursue a decentralized Web 3.0 / token approach to business. In order to pursue a token-based project, an organization should be guided by values such as open source and transparency, decentralization, interoperability and composability, community governance, economic sustainability, consistency and stability. A5: Before issuing a token, it is important to define the token ecosystem's goal, context, and objectives. A6: Incentives play a key role in token-based projects because they enable efficient and effective cooperation between participants. The idea is to incentivize good actions, de-incentivize malicious actions and ultimately influence participants’ behaviors in a way that is beneficial to the overarching network’s goal. They should be elegant and morally appropriate as they are essentially programming human behaviour. A7: It is important to thoroughly determine all ecosystem stakeholders, their roles, and contribution to establish the ecosystem’s goal and truly benefit from the value creation opportunities. A8: The token-based business model can be compared to Web 2.0-like platform businesses. The difference is that there is a shift from two-sided platforms, where centralized entities mediate buyers and sellers, to peer-to-peer multi-sided platforms on the top of open and decentralized networks where buyers and sellers directly interact with each other. In this new concept, users are also producers/shareholders and value is created more fairly and is more transparently redistributed. A9: Given the open-source nature of TESs, they are easily duplicatable by competitors. Reaching a critical mass of network participants as fast as possible thus becomes an important factor for the

endeavor's success. TESs need to find ways to effectively create an economic moat around their network to maintain competitive advantages over their competitors. Marketing efforts, enticing incentive and participation structures, and emphasized community ownership are some ways to shape this moat. A10: Through their unique incentive structures, tokens accelerate network effects and can help solving the chicken-egg problem. Tokens incentivize participants proportionate to their adoption stage, the value they offer, and the risk they incur. A11: The way tokens are distributed can greatly impact the network's overall performance and overall system security. The majority of the total token supply should not be concentrated in the hands of early investors and the founding team but rather the community. Typically, 50% or more should be allocated for community ownership. The rest can be split up for founders, team members, investors and potential marketing budget. A12: Legal compliance plays a crucial part when creating a TES. While there's no definite bright-line standard for the regulation of tokens, one typically differentiates between utility and security tokens. Tokens deemed as a security are already heavily regulated by the SEC and require considerable paperwork and due diligence. These legal complications can drastically slow down the process of building a TES and shift the focus away from finding product-market fit. It is generally advisable to pursue a utility token model if the nature of the project allows it. Typically, TES raised capital via ICOs by early issuing tokens to investors. Given that the project at its very early stage is highly dependent on the founding team and investors most certainly invest expecting future profits, the token fails the Howey Test and is very likely deemed as a security. If bootstrapping is not an option, an alternative idea for raising development capital would be to defer the issuance of a token until the project is fully functional and relying on more traditional funding mechanisms such as Venture Capital. As soon as the TES can prove its utility, it is much easier to be categorized as a utility token and therefore, avoiding the tedious and demanding legal consequences of a security token. A13: As opposed to Web 2.0 startups and the "ship fast and break things" mentality, TESs are meant to be immutable and infinitely running. Given this decentralized-autonomous aspect, it appears to be the right path to make the ecosystem design as complete and robust as possible before launching the project. While updates can still be made through implemented structured governance mechanisms, they will take significantly longer and decrease development agility and the potential of the TES to reach mass adoption. A14: One possible solution to find a balance between identifying product-market fit for the TES and the need for a "complete token design" is gradually introducing decentralization to the project. A TES can start first by being shared with the community while still fully controlling the network. This allows for quick changes for the network without depending on slow on-chain governance voting. Once the project's key stakeholders reach a certain satisfaction level, more power can be given to the community by first introducing off-chain governance possibilities and then ultimately introducing on-chain governance and a full transfer of ownership to the community. Being vocal about this gradual decentralization

approach and thus showing transparency with all stakeholders is crucial for gaining the trust of the community and, ultimately, the project's success. A15: TESs are ultimately written on a nexus of smart contracts. Since the majority of rules are coded into the system, making sure that these systems are robust, well-evaluated and secure is extremely important. A "complete token design" must undergo multiple iteration and improvement loops that are driven by network tests such as experiments and simulations. Additionally, smart contracts should be audited by third-party auditors to serve as an additional security boost and communicate trust to the network's community of participants. A16: A good decentralized governance structure is arguably one of the most important aspects of a TES. The more open a platform is, the more participants can contribute and create value. On the flip side, creating value, negotiating and participating in more open platforms becomes increasingly difficult and complex. TES governance mechanisms allow participants to propose and decide on new features or even change the governance mechanism itself. A good governance mechanism aligns the interests of all ecosystem participants and gives them enough flexibility while potentially still remaining room for leadership of the initial founding team.

4.2. Token Design Framework

The following TES creation framework (Figure 16) has been designed based on the gained knowledge from the literature review and the derived synthesized assumptions. At first sight, the proposed framework describes a blueprint of the necessary components to consider when creating a TES. The components are encapsulated by four trust principles that should serve as an overarching guideline throughout the whole ecosystem creation. Moreover, the framework depicts the implementation flow of the creation process, starting with the Blockchain Justification Check. After the project proves its blockchain and token use-case potential, it flows through three layers until it reaches a minimal viable ecosystem that can be shared with the community to test product-market fit. Lastly, the bottom of the framework depicts the proposed gradual increase of the project's decentralization that ultimately results in a self-sustaining and self-governing ecosystem that generates fair value for all stakeholders. The following sections will dive into the details with recommendations for each individual component and layer. Additionally, questions will be raised to further serve as a decision guideline.

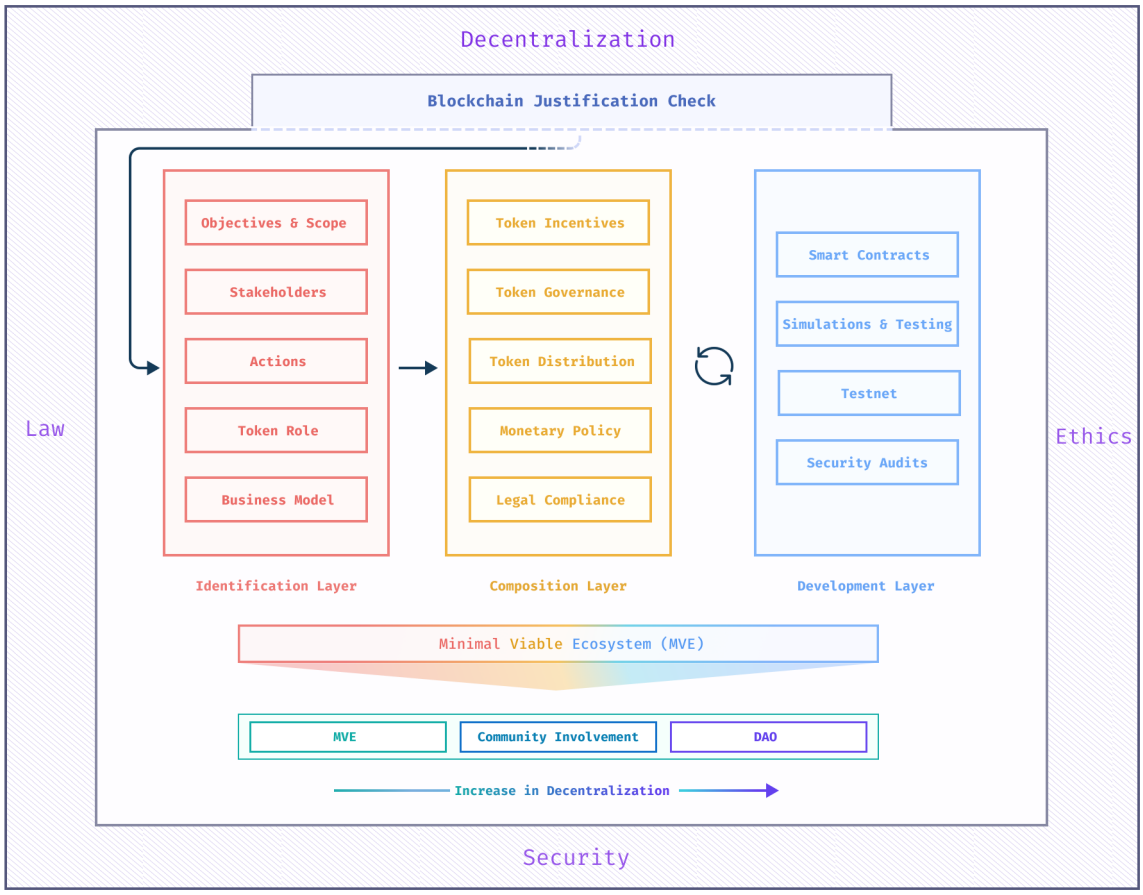


Figure 16: Proposed framework for creating a token ecosystem

4.2.1. Four Trust Principles

To begin with, the proposed Token Ecosystem Creation Framework is surrounded by four guiding trust principles: Decentralization, Law, Security and Ethics. In a traditional centralized system, participants have to trust a single third party to act as the intermediary, whereas in a TES, participants involved do not need to know or trust each other in order for the system to function. Consequently, the trust is placed in a combination of cryptography and digital ledger technology. While participants do not necessarily have to trust each other in a TES, we believe that establishing trust in the TES itself is of utmost importance. As learned from the extensive literature review reaching mass adoption and thus creating a moat around the project is a key part of the TES's success. Therefore, a TES should always keep these guiding principles in mind when creating the ecosystem. The more a TES fulfills these four principles, the more likely potential participants will use this project over its competitors.

Decentralization

The more decentralized a project is, the more participants are involved in its development, leading to more trust in the project.

Questions to ask:

- Is our ecosystem increasingly getting decentralized?
- Are we making sure we involve the community as much as possible?
- Are there any negative power concentrations in our project that can potentially harm the community's trust in the project?

Law

Especially since laws around creating TES are ever involving, TESs have to consider multiple local laws of each jurisdiction and make sure that they are compliant. Making sure TESs is as legally compliant as possible will increase the trust of potential project participants.

Questions to ask:

- In which countries do we plan to operate and how is their respective legal system structured around the concept of working with blockchain tokens?
- Are there any necessary extra steps that need to be done to be fully compliant? How can we effectively communicate our compliance to potential participants?

Security

TESs have the potential to accrue a lot of value over time. This naturally exposes security risks as the more value a TES contains, the more likely hackers will try to exploit the system. Due to the fact that once a smart contract has been created, it is very hard to update it, the code needs to be as secure and bug-free as possible. The more secure a TES seems, the more trust it will gain from the community. Making sure that the code is easily accessible by the public is another crucial component.

Questions to ask:

- What are the potential target vectors of our TES?
- How can we make sure to protect ourselves as best as possible against malicious behavior?
- How can we provide transparency around the security of our TES to our community?

Ethics

TESs are so powerful because they use clever incentive mechanisms to reach their global objective. Incentive design is programming human behavior and, therefore, can also rival against participants' ethical compasses. Designing appealing incentive systems in an every evolving complex system is by no means an easy task. Nevertheless, a TES's moral responsibility is to ensure that these incentive mechanisms align with commonly agreed-upon moral and ethical codes.

Questions to ask:

- Are our incentive structures carefully thought through and evaluated?
- Are there any potential side-effects our incentive structure can cause in our TES?
- Are we aware of how easily incentives can deter participants' moral compasses?
- What could be the worst-case scenario outcome of our incentive structures?

4.2.2. Blockchain Justification Check

The first step in the framework is to examine if the identified business problem actually requires blockchain technology and, consequently, a token to be solved. This step is crucial as not every organization is advised to create and pursue a TES. It is vital for decision-makers to fully understand the value proposition of blockchain technology and not just become a victim of the herd mentality in

following the trend for sheer uneducated fear of missing out. When wanting to create a TES, an organization should be guided by values such as open-source and transparency, decentralization, interoperability and composability, community governance, economic sustainability, consistency and stability. The following is a list of questions that help to assess a blockchain justification.

Questions to ask:

- Do you need to increase trust for your customers?
- Do you want to give more ownership power to customers?
- Is there a necessity to remove the need of trusting a single party?
- Do you need to provide your customers more transparency and transaction verifiability?
- Are we willing to open source our intellectual property?
- Do we plan to pursue and support this endeavour on a long-term – optimally infinite – timeframe?

If the answer to most of these questions is yes, using blockchain technology can be a viable strategy for the use case at hand. If most of the questions are answered with no, it is suggested to rethink the necessity of creating a TES.

4.2.3. Identification Layer

After identifying a valid and justified use case for blockchain technology, we start with the Identification Layer. This layer is intended to lay out a solid ground base of the to-be-built token ecosystem. The goal is to identify the purpose and objective of the ecosystem as well as find out all relevant stakeholders and how they are going to be exchanging value between each other. Note that only the initial round of fulfilling this layer is meant to be done in chronological order. Through constant iterative feedback loops with team members and other potential stakeholders, there will likely be a back and forth cycle between these components until the solid base of the TES has been identified.

Objectives & Scope

One of the most important factors in the Identification Layer is defining the ecosystem's main objective. Blockchain tokens help achieve this objective. While a TES can have multiple sub-goals, it is advised to focus on one main objective. The main ecosystem objective establishes the reason for which incentives, disincentives and governance will be built. In Bitcoin, the main objective is to operate a decentralized currency where users can transact money without the need and constraints of a centralized authority. Ethereum’s main objective is to be the world’s

largest supercomputer. TerraUSD's main objective is to provide a token that attempts to maintain a value of US $1.00 so that users can make use of the blockchain to transact value without being exposed to the common high validity of most assets.

In most cases, this main objective needs to be split into sub-goals. It is advised that a token is always used for one specific goal and not multiple goals at once, as this would increase the complexity and lead to confusion for potential investors. This means that a TES can potentially consist of more than just one token. For example, the Steem ecosystem's main objective is to be an incentivized, blockchain-based, public content platform. In order to achieve this objective, one token was not sufficient, so they came up with a three token structure that each helped reach a different sub-goal of the system. As the TES should ultimately be self-governed and self-sustainable, one subgoal should always be to have a proper governance mechanism in place. Lastly, it is vital to develop specific constraints for the TES. Complex Systems can be infinitely granular and thus, it is important to limit the TES to a specific scope that can be modeled, coded and released.

Questions to ask:

- What is the one main objective that can fit the entire ecosystem?
- Are we making sure this main objective aligns with the values discussed in the blockchain justification check?
- Do we have to split up our main objective into different subgoals and if yes, what are they?
- Why do we need a token?
- Do we need multiple tokens?
- What is the exact purpose of the token(s)?
- What are constraints that can be implemented so that we limit the scope of the ecosystem and make it approachable?

Stakeholders

After the objective and scope have been defined, a comprehensive map of all stakeholders should be conducted. A token ecosystem, i.e., essentially a micro-economy, is a network of participants that transact between themselves to gain value. Listing out all possible participants is crucial for finding the optimal solution to the TES objectives. In order to reach mass adoption, stakeholders need to be incentivized enough to join and stay active in the network. In the beginning, the value they get out of the TES must be at least the opportunity

cost related to the stakeholders giving the project a try. Besides thinking about all potential participants that will be beneficial to the system, malicious actors should not be neglected. The more valuable a TES is, the more likely it will also attract participants who want to exploit the system and have negative intentions to the main objective.

Questions to ask:

- What are all the potential good and bad actors of the ecosystem?
- How are the stakeholders related to each other?
- What do these participants get in exchange for being part of your ecosystem?
- What are the possible opportunity costs of potential participants to join the ecosystem?

Actions

After a comprehensive overview of all relevant stakeholders has been established, it is suggested to take a closer look at the role of each stakeholder. The role should be determined in two ways: First, the role in relation to the overarching TES, and second, the role between other stakeholders.

Questions to ask:

- What is each stakeholder's role in the TES?
- What actions should the stakeholders perform so that they can obtain value from the TES?
- What are the potential side effects of these actions?
- What are potential actions that malicious stakeholders can use to exploit the system?

Token Role

The next step is determining the token type(s) and role(s) for the objective or, rather, sub-goals. This will help communicate the token's value to potential participants and indirectly involved parties such as law regulators. As aforementioned, a token is a dummy tool and does not have any value or utility by itself. Its value and utility are determined by what it represents. This value can represent a wide variety of properties such as the right to a reward for fulfilling a specific task, the proof of ownership of a gold nugget, access to an exclusive community and much more. The token archetype decision tree by Oliveira et al. (2018), as seen in Table 4, can be a useful tool to determine the token type's needed by the TES.

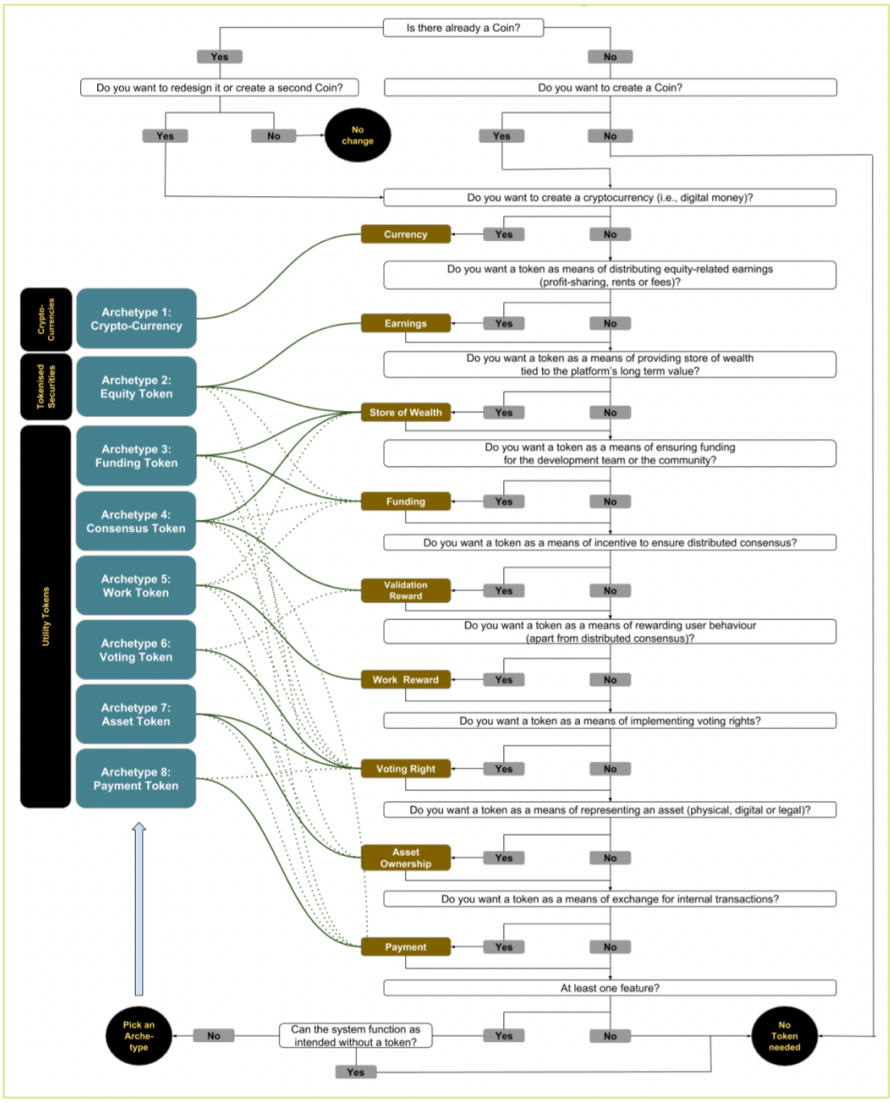


Table 4: Token Archetype Decision Tree (Oliveira et al., 2018)

Business Model

A token is a dummy tool and does not have any value or utility by itself. Its value and utility are determined by what it represents. In a way, the token itself is the actual business model of the TES. A token's unique liquid characteristic creates a novel dynamic where the value of the project is directly tied to the token's price, effectively allowing the organization to earn profits through token price increases. While tokens can be used solely as a funding mechanism, they have more potential when serving a unique utility. So how do we determine the value of a token when it is not backed by assets with a known value such as real estate but rather backed by assets of latent or unknown value? Ultimately the value in these cases is derived from a combination of the token's role and all of its components described in this framework. On a

high level, it comes down to network effects and how cleverly incentive mechanisms of the TES are aligned. TESs operate under a similar business model as multi-sided platforms (MSPs). According to Metcalfe's Law the value of a network increases in proportion to the number of users in the network. TES can create defense mechanisms similar to MSPs by leveraging network effects which lead to switching costs. These switching costs allow for the possibility of charging a fee as long as the fee that is charged is less than the cost of switching to a new platform. The more participants actively participate in the network, the more valuable it will become. When it comes to pricing it is suggested to avoid fixed pricing and rather adhere to auction-based or periodic-adjusted pricing because the token price can heavily fluctuate rendering the service too expensive and thus hindering network growth.

Questions to ask:

- How does our token capture value for each stakeholder group?
- How can we make joining and participating in the TES as easy and frictionless as possible?
- How can we make sure participants are seamlessly interacting with each other?
- What underlaying incentives and mechanisms will attract potential participants, foster value creation, and avoid leaking value?
- How can our TES increase switching costs for participants?
- How do we make sure our pricing factors in token price volatility?

4.2.4. Composition Layer

As soon as all the fundamentals of the TES have been laid out, the next layer to consider is the Composition Layer. This layer consists of composing high-level decision choices regarding modeling the token. The idea is that the parameters designed in this stage act as the blueprint for the final development layer. Both layers are meant to follow several feedback loops to develop an ecosystem that is optimized for long-term health and growth. The components that need to be designed are the token incentives, governance model, token distribution and monetary policy. Lastly, a high-level overview of these parameters of the token will provide enough information so that the legal aspect of the TES can be properly evaluated.

Token Incentives

A The first component we have to look at is the incentive structure. The goal is to find mechanisms that attract new users, keep them active and stay long-term. We need to incentivize good behavior, de-incentivize poor behavior, and ultimately influence participants' behavior to benefit the network's overall goal. A well-designed incentive structure has a direct impact on a TES long-term survival. Since we do not fully know if incentive structures will perform as planned, it is suggested to develop various incentive hypotheses that have to be thoroughly tested. Potential testing methods can be interviews, surveys or running simulations. It is important to note that the final result can still differ due to the TES complexities even with testing. In theory, the more hypotheses can be tested and successfully evaluated, the better the mechanism will get. Lastly, it is of utmost importance to make sure the incentive mechanisms align with social and ethical norms, as incentive design is programming human behavior that can be potentially fatal. Based on the stakeholder and action mapping in the Identification layer, form hypotheses based on.

<u>Questions to ask:</u>

- What good actions can we reward financially to support our TES goal?
- What good actions can we reward non-financially (f.e. by means of reputation or voting) to support our TES goal?
- What are possible attack vectors and malicious actions that users in the network could perform?
- What penalties are required to deter individuals from colluding and committing malicious actions in the network?
- How can we test, measure and evaluate these hypotheses?
- What constitutes a successful incentive?
- What are the most likely outcomes of our incentive mechanism?
- What are the least likely but possible outcomes of our incentive mechanism?
- Are our incentive mechanisms ethical and lead to a net-positive social outcome?

Governance System

Because TES should aim for decentralization, governance structures are inherently crucial for aligning the interests of all stakeholders and shaping the future of the project. The idea of a

governance system is to allow stakeholders to participate in the decision-making process concerning the project, such as allowing them to propose or vote on new feature ideas and the governance system itself. Off-chain governance encompasses the decision-making process taking place in the real world with a focus on the broader community of the project. Participants make decisions through public discussions such as in online forums or conferences to find decisions that all stakeholders agree on. On the other hand, in on-chain governance, decision-making takes place directly on the blockchain through smart contracts and voting mechanisms/rules of interaction. Structures that are completely on-chain and let their stakeholders control the development of the entire system are called DAOs. One of the key decisions to make is which decision processes will remain off- and on-chain. While off-chain governance can lead to shadow hierarchies where only a few anonymous people make decisions, on-chain governance can easily lead to plutocratic power dynamics when the weight of each individual's vote is determined by the amount of tokens it holds. Literature suggests that the best solution might be a mix of both.

Furthermore, it is essential to be aware that governance is an emergent phenomenon. Due to its unpredictability, it can not be fully engineered and one has to factor in the flexibility of the system to handle unplanned circumstances. A good governance structure aligns the interest of all stakeholders, is decentralized and democratic, fair, effective and is not too complex to use. The more complex the governance structure is the easier technocracies can occur, which should be avoided.

Questions:

- What are the key components of the TES that need to be governed?
- Who will be part of the decision-making process?
- How will these decision-makers be chosen?
- What will these decision-makers be responsible for?
- How can decision-makers be made responsible for their decisions?
- How can decision-makers be exchanged if necessary?
- How can sufficient and efficient participation of the decision-makers be ensured?
- Is the governance fair and does not result in inequity?
- How is the TES protected against centralization?
- How will the governance mechanism be implemented practically?
- Will there be an off-chain, on-chain or hybrid governance model?

Token Distribution

Token distribution is about defining the network's ownership and project funds. One will commonly distribute tokens to all the network's stakeholders and keep some for future marketing operations, strategic decisions, the founder, and the team. The main goal of the tokens should be to be used for doing specific actions in the network but can also be used as a form of crowdfunding the project via a token sale. The most common token sale strategies are ICOs, SAFT, IEO and IDOs. Successful token sales need to ensure a fair distribution and strike a balance between short- and long-term considerations, as not enough tokens in a project's treasury may lead to its incapacity to pay for future expenses.

On the other hand, if a small group of owners controls a large share of the token supply, the other investors may see the price falling when these owners decide to sell. While there is no single one-size-fits-all distribution model, it is suggested to allocate a minimum of 50% of the tokens to the community, which in most cases are the users and developers of the TES. A fair and transparent token allocation is an essential pillar of a successful TES. Similar to legacy startups, a vesting scheme for the founding team's token allocation can also improve the long-term incentive structure of the project. Similarly to allocating +50% to the community, it is essential to allocate a fair portion to the founders as they have to be properly incentivized to continue working on the project.

<u>Questions:</u>

- Do we need a token sale and if yes, which strategy are we going to choose?
- How many tokens will be allocated for the founder, the team, marketing operations, and more?
- What will the vesting scheme look like for the founder and team token allocation?
- Have we maximized the number of tokens being allocated for network users?
- Is our token allocation emphasizing long-term usage from users over short-term gains from investors?
- Is our token allocation fair and transparent?

Monetary Policy

The monetary policy is concerned with the inflation or deflation of the token supply, or how quickly tokens will be released in the future and how that rate will change over time. The monetary policy has important implications for the adoption and sustainability of the TES. It

should work to enable price growth as well as the stability of the token. The token issuance process has two first. The first step, also known as the genesis step, is the token generation, where an initial generated supply and a maximal supply have to be defined. The exact amount of tokens depends a lot on the purpose of the TES, the incentive mechanism in place and much more. The next step is to define the behavior of the token supply as time goes on. TES can have programmatic inflation, programmatic deflation or be fixed altogether. Through various mechanisms, the supply can be further manipulated and managed. The creation of new tokens is called minting, whereas burning tokens achieves the reduction of the token supply. Most projects in the literature seem to go with either the fixed or deflationary token supply approach, following the footsteps of Bitcoin and Ethereum. One of the big reasons is that the more people buy the token, the scarcer its supply gets, which leads to an increase in price, i.e., the value of the TES. While this might seem perfect initially, a hyper-appreciated token can lead to stakeholders not wanting to use the token but instead just holding it, effectively hurting the long-term health of the network. Albeit much more complex, a more algorithmic monetary policy approach that adjusts over time seems to be the most promising approach.

Questions:

- What will be our initial supply amount?
- What will be the max supply?
- To which limit can tokens be generated?
- Will the token supply follow a fixed, inflationary or deflationary monetary policy?

Legal Compliance

Legal compliance is essential when designing a TES. It is vital to have a clear view of the legal aspects associated with the project as it can make or break it. Therefore, we need to evaluate that in the next step. The most important question is whether the TES is considered a utility or security token. Securities are heavily regulated and can drastically hinder agility which is crucial in the early stage of a new project. Thus, TESs generally want to avoid the legal complications that security tokens oppose as best as possible. Users should ultimately be part of the network for utility reasons and not as investors for the sheer expectations of future profits. As a de-facto standard, the Howey test can be applied to determine the security likelihood of a token. Besides the security question, TESs have to adhere to crypto-specific regulations such as tax, sales regulations, anti-money laundering requirements, ownership and licensing requirements

and reporting requirements. Due to the ever-changing nature of crypto-related law and complexity, consulting legal professionals is inevitable. Now that we have gathered the most important parameters/components of the TES we can use them to evaluate the Howey test and use it as a blueprint for talking to legal professionals. Note that nothing is set in stone at this stage yet, giving us the flexibility to optimize the project to increase the likelihood of it being classified as a utility. The earlier the project is, the more likely will it be classified as a security. Should the project be pre-launch and bootstrapping is not an option, an alternative idea for raising development capital would be to defer the issuance of a token until the project is fully functional and relies on more traditional funding mechanisms such as Venture Capital. As soon as the TES can prove its utility, it is much easier to be categorized as a utility token, therefore avoiding the tedious and demanding legal consequences of a security token.

Questions:

- Does our TES get qualified as security or utility? Do we fail the Howey test?
- What are the relevant jurisdictions that we have to adhere to?
- What regulations exist in these jurisdictions?
- What exactly are we distributing? How are we distributing it?
- Are we planning to perform a token sale and if yes, which strategy are we following?
- At what stage of the TES are we looking for funding?

4.2.5. Development Layer

After the identification and composition layer are done, the theoretical and conceptual parameters need to be coded into a real system. The development layer makes sure that these parameters are reflected via smart contracts. Since the majority of rules are coded into the system, making sure that these systems are robust, well-evaluated and secure is extremely important. A "complete token design" must undergo multiple iterations and improvement loops that are driven by network tests such as experiments and simulations. Additionally, smart contracts should be audited by third-party auditors to serve as an additional security boost and communicate trust to the network's community of participants.

Smart Contracts

TESs are ultimately written on a nexus of smart contracts. A smart contract is a computer program or a transaction protocol that can run automatically based on the terms of the agreement stated in the contract code. Since the contract code can not be easily updated in

the future, it is very important to get the code as perfect as it can be. Every line of code in a smart contract costs money to execute. Storing data is expensive; hence, keeping smart contracts small and modular is suggested. Try to avoid storing unnecessary data on-chain. Functions that are very common to every project can mostly be found in an open library, ready to be used. Reusing these components is advised as it allows not to reinvent the wheel and use safe and battle-tested code. Standards are a big part of programming. Therefore, it is advised to use open standards such as the ones proposed by ERC to allow full interoperability with other projects.

Questions:

- How could the code be exploited? Do we have security risks?
- Are we adhering to standards such as ERC 20 or BEP 20?
- Is our code self-explanatory and well documented?
- Can we use parts of already battle-tested contracts?
- Is the code 100% immutable or is there a way to be able to make changes later?
- Are we making sure not to reinvent the wheel?
- Do you we have minimized on-chain data?
- Does the code what we expect it to do?

Simulation & Testing

It is critical to ensure the TES is well tested before it goes live. There are different types of tests that can be performed at various stages in the development process, such as unit tests, integrations tests, end-to-end tests and API tests. The main objective of testing is to ensure full test coverage. In a TES, there are many architectural and parameter questions needed to be considered. Testing them by trial-and-error or experimentation is not advised due to the perpetual nature of a TES. Hence model-based simulation is required. In the simulation, a software program tries to replicate the behavior of the real network in various operating conditions, effectively helping to identify the network performance and potential bottlenecks. The goal is to identify problems, understand the root cause and then fix the problem before deployment.

Questions:

- Is our test coverage enough? Are we testing the right things?
- How are we going to model the TES for the simulation?

- What software will we use for the simulation?
- What problems have we identified and how will we fix them before production deployment?

Testnet

Deploying the TES directly to the mainnet is extremely dangerous. In a TES, actions are immutable. If buggy code would get deployed live to production, it could irreparably affect millions of users in seconds. A testnet (test network) is a copy of the original chain's network that has no reflection on the public blockchain of the original. This testnet creates a "sandbox" environment where all code can be tested without affecting the mainnet. It is advised to have not only developers using the testnet but also real potential users. Similarly how pilots that test flying in flight simulations, users can engage with the TES and learn to use the service without any consequences, building up confidence in the system. After a certain period, hopefully, bugs have been found and can be fixed before the project goes public.

Questions:

- On which test networks will we publish our TES?
- How long will the testnet phase be?
- What are our primary objectives to test with the testnet phase?
- How do we incentivize users to join our TES on the testnet?

Security Audits

Lastly, a TES should consider undergoing multiple security audits from well-established and trusted auditing firms. Smart contract audits use formal verification and pen testing to screen the contracts on various kinds of bugs before they get published on the public blockchain. Such as any other development endeavor, TESs are prone to various cyber threats and mishaps. Smart contracts can have vulnerabilities, developers can make flaws and the team might have blindspots when it comes to the security. Auditing firms provide a comprehensive security assessment and fix to crucial security risks. Besides the extremely important security aspect of an audit, a system review by an external auditor serves as a form of approval to the user and enhances the chance of adoption.

Questions:

- What is the scope of the audit?
- Do we have a specification that helps the audit team understand the project's goals when testingthe code?
- Which audit provider will be chosen?
- Is the audit provider trustworthy and well-known in the industry?

4.2.6. Minimal Viable Token Ecosystem

After all three layers have been thoroughly exercised, we should end up with a minimal viable ecosystem (MVE). A minimal viable product (MVP) is a product with enough features to attract early-adopter customers and validate a product idea early in the product development cycle. Similarly, an MVE is a network with the simplest but powerful enough design that allows to achieve the network's goals under the determined constraints in the three layers. The MVE does not have to be fully complete at launch but must be flexible and adaptable for further improvements and iterations. The idea of the MVE is to launch it with the community to test its Product-Market or, rather, Token-Market fit.

4.2.7. Road to Decentralization

The last part of the proposed framework is the so-called "road to decentralization". Rather than Web 2.0 startups and the "ship fast and break things" mentality, TESs are meant to be immutable and infinitely running. Given this decentralized-autonomous aspect, it appears to be the right path to make the ecosystem design as complete and robust as possible before launching the project. While updates can still be made through implemented structured governance mechanisms, they will take significantly longer and decrease development agility and the potential of the TES to reach mass adoption. One possible solution to find a balance between identifying product-market fit for the TES and the need for a "complete token design" is gradually introducing decentralization to the project. A TES can start first by being shared with the community while still fully controlling the network. This allows for quick changes for the network without depending on slow on-chain governance votings. Once the project's key stakeholders reach a certain satisfaction level, more power can be given to the community by first introducing off-chain governance possibilities and then ultimately introducing on-chain governance.

4.3. VALIDATION

This section will provide a detailed explanation of the scientific evaluation technique used for the thesis framework. It will be followed up by chapter *4.4 Discussion*, where the commonalities and differences of all conducted interviews will be thoroughly synthesized and evaluated.

In order to evaluate the framework, three in-depth qualitative interviews have been conducted. It has been decided to limit the interviewee size to three experts due to the extreme novelty of the subject and the limited time capacity of the master's thesis. All three interviewees are experts in the blockchain/token economy field and were selected based on their expertise and experience. The three experts are from different backgrounds, such as academia, enterprise and startup. The interviews were carried out to obtain feedback on whether the framework is considered valid and to get any recommendations for improvement. A qualitative interview approach was held to be the best decision to evaluate this framework as it ideally allows for the exploration of individual differences between the interviewees' experiences and opinions.

The expert interviews were carried out through a scheduled 30-45 minute video call and a thoughtfully crafted presentation deck. First, the presentation started with an overview of the motivation and problem statement of the thesis. Then, the framework with all its integrated phases were explained step by step. In the end, the presentation included a set of three questions. The three questions were:

1. Do you consider the proposed framework as useful? If so, why? If not, why do you believe it is not?
2. Would you consider implementing the proposed framework at the current stage?
3. Do you have any recommendations or suggestions for further improvements to the proposed framework?

The experts draw their knowledge from their theoretical and practical experience in the fields of blockchain, computer science, game theory, economics, innovation, and entrepreneurship. The first interviewee was a computer scientist who has been working with permissionless startup and enterprise blockchains for over five years. He has worked on digital identities, layer two scalability algorithms as well as the official Ethereum foundation building micropayments and dApps. The second interviewee is a former blockchain market researcher and is now leading an open blockchain-focused consultancy that architects distributed solutions for the future economy, specifically building decentralized autonomous organizations. The third interviewee has a university professorship in entrepreneurship and innovation focused on blockchain-driven application and use case research. The following table displays the mentioned experts and briefly describes their area of expertise.

ID	Field of employment	Area of expertise	Domain
E1	Blockchain developer at Reddit (previous Ethereum foundation)	Computer Science, Web3, Permissionless Blockchains, dApps, Layer Two Scalability	Enterprise
E2	Blockchain ecosystem architecture consultancy focusing on building DAO	Decentralized Autonomous Organizations, Game Theory, Token Ecosystems, Web3	Startup
E3	Professor in entrepreneurship and innovation	Entrepreneurship and Innovation focusing on blockchain-driven applications and use-cases	Academia

The interviews were conducted with each listed expert individually between June and early July 2022. All interviewees agreed on their audio being recorded for transcription and further review purposes. One of the interviewees expressed the need of staying anonymous due to industry/privacy related intricacies. Therefore, respecting the request, it has been decided to not mention the interviewees identities but rather use the unique identifier of E1, E2 and E3 (E indicating “Expert”). The transcription of each interview can be found in the annex section.

4.4. DISCUSSION

All experts, E1 to E3, believe that the proposed framework is useful when building a sustainable blockchain token ecosystem. All experts agree that the framework serves as a comprehensive and structured guide through the vast amount of variables that are involved when building a TES. E3 described it as: *"I think it can be a great blueprint for organizations that are thinking about building their own ecosystem"*.

Furthermore, when asked whether they would implement the framework at the current stage, all experts agreed. In particular, E2 and E3, emphasized the helpfulness of each component's predefined set of questions. Nevertheless, all experts have shared very important suggestions for further strengthening the framework and making it even more robust. The mentioned feedback provides worthy input for the revision of the model as well as opportunities for future research.

The most interesting and commonly mentioned feedback revolves around the concept of decentralization and governance or in other words how decentralized a project should be and how and by whom decisions get made within the organization. One big assumption resulting from the extensive literature review was that TESs differ from traditional centralized companies in the way that they should have the ultimate goal of being highly decentralized and autonomous. They should be community-governed, community-owned and eventually transforming into a new self sustainable form of an organization. According to all three experts, an extremely high degree of decentralization and autonomy turns out to be highly ineffective and creates an extremely slow and bureaucratic process. All experts agree that there should always be a part of the project that is centralized. E1 and E2 mention that the reason for keeping parts centralized are twofold. First, it allows the project to keep some sort of business secret for themselves that will increase the long-term success chance of the project and second, forcing every participant to democratically vote on the project's changes and future is very ineffective as some voters might not be skilled enough to be able to know what proposals they are voting or in general just don't want to always participate. A successful TES should have strong leadership with a rich enough playing field for participants to propose changes and participate in the direction of the project. Interestingly enough, two experts, E1 and E2, mention that the perfect governance model would reflect the model of a republic with elected representatives rather than a direct democracy where every participant has equal participation. E1 describes it as:

> *"If people will vote for everything, you will have no business secrets. You don't want people to decide everything about the direction of your company. There's a reason only execs do that and that's because they actually understand what's happening. And that's also the problem of democracies versus republics. So we've seen in TES that democracies basically never work. You*

get what is called voter apathy or voter fatigue, because some can't decide on things due to lack of knowledge etc and some just don't want to. So you need something like a republic. Basically, what you want to have is to have sub DAOs where each DAO focuses on specific things of the company, think something like functions within a traditional company. Decentralization for the sake of decentralization does not work. The whole decentralization process has made these crypto companies insanely slow".

E1 mentions an interesting concept here where instead of having a single DAO where everyone decides on every decision, there should be sub-DAOs that act similarly to functions in a traditional company. E2 supports this argument as well:

"Now, if you look at decentralization in terms of let's say something like labor decentralization where different subunits of the DAO different squads different, you know, business segments have less integration and more autonomy to define their objectives… I see the perfect DAO as a very well designed state that has, you know, any elected or non elected assembly of folks, a relatively horizontal distribution of ownership or authority and the network experts working in to their expertise, you know, you wouldn't have something like a political theorist, you'll be managing the local economy, right?"

Other challenging thoughts around the framework were brought up around the importance and complexity of terminology. For example, for E2, the first layer, the identification layer seemed very categorically wide and it was perceived that the word "identification" does not necessarily fit in that case. It was suggested to call the identification layer "social layer" instead. E2 really liked the three framework layers and perceived it as a great "parallelism to socio technical systems that we design". Therefore, having a social layer on the left, an economic design layer (the composition layer) in the middle and a technical layer on the right (the development layer) seems to be a more accurate representation of what is going on.

Another important remark was mentioned by E3 addressing the legal compliance component in the composition layer. Given that the legal component is positioned within the composition layer, it appears that there is no dependency on the other composition components in order to determine the legal compliance which is incorrect. In order to figure out the legal compliance, the other composition components, namely the incentive, governance, distribution and monetary structure, should be designed first. Hence, E3 recommends encapsulating the legal compliance component from the composition layer. On the legal component, E2 also specifically pointed out the extremely unfair regulatory environment, led by the SEC, that creates a lot of paranoia and makes it hard for startups to come up with truly innovative token-based ecosystems. Besides, the E2 attributes the legal difficulty

to the fact that designing TES is not just about an organizational structure but rather a "state" like structure that current legislations have difficulty understanding and even more legislating. E2 also further elaborated on the importance of clearly differentiating the business models of typical goods and services and those of TES. While typical goods and services sit on the very end of the spectrum of capital flow, token-based ecosystems business models need to be articulated through the lens of that these projects are "creating money" and behave almost like a nation. Money has very specific properties that give it value, such as scarcity. However, there are also other upcoming concepts, especially around the concept of savers who receive a currency (token) and exchange that currency for some good or service that they provide and then keep that currency. According to E2, much exploration and experimentation still need to be done.

When asked for any further recommendations, E2 and E3 both briefly touched on the framework's development layer, which appeared to be not completely mapped. E2 argues that:

> *"You know, having gone through the research of a product or protocol all the way to the delivery of an application and then everything that happens after that if you do want to decentralize the interface, it seems to me that technical process wasn't completely mapped. It was mapped from the perspective of a back end, sort of smart contracts engineers or architect, but it was not mapped you know, with front end in mind with product design and mind. You know, some of these other technical things that are required actually to have a successful ecosystem."*

E3 shared a similar idea, effectively saying that while most TESs serve more as a technical infrastructure/backend layer, better projects also seem to have one or two showcase apps that serve as inspiration for developers. As an example, the DeFi lending and borrowing protocol Compound was mentioned. All that being said, both remarked that the exact technical part of implementation did not seem to be to the goal of the framework and hence they were not sure to which extent they would incorporate it in the framework.

On the assumption of token economic systems being immutable and therefore needing to move slowly and a lot of tests, E1 agreed that while this is certainly true to some extent there is also an argument to be made that since so many TES relay on each other due to interoperability reasons it gets extremely hard to impossible to test its behavior in a testing environment. E1 thus mentioned that a common practice is to deploy projects on the mainnet and then when things do go wrong, one can always deploy a new version. It is then up to the community to adapt to the new version or stick with the old one. This, according to E1, is the exact “beauty of building decentralized and open ecosystems”.

Last but not least, one more commonality that was observed was that all experts agree that the field of TES is still in its very early stage and a lot of experimentation has still to happen to find patterns that more likely guarantee a successful and long-term sustainable TES. All experts seemed to be highly enthusiastic and almost very altruistically or philosophically driven when talking about TES and its potential future.

4.5. Revised Framework

Following up on the input of the previously conducted expert interviews, it has been decided to revise the framework to more accurately reflect the knowledge gained from literature and the validation interviews. While the initial framework was deemed to be useful by all three experts, there was some important remarks that influenced the revised model.

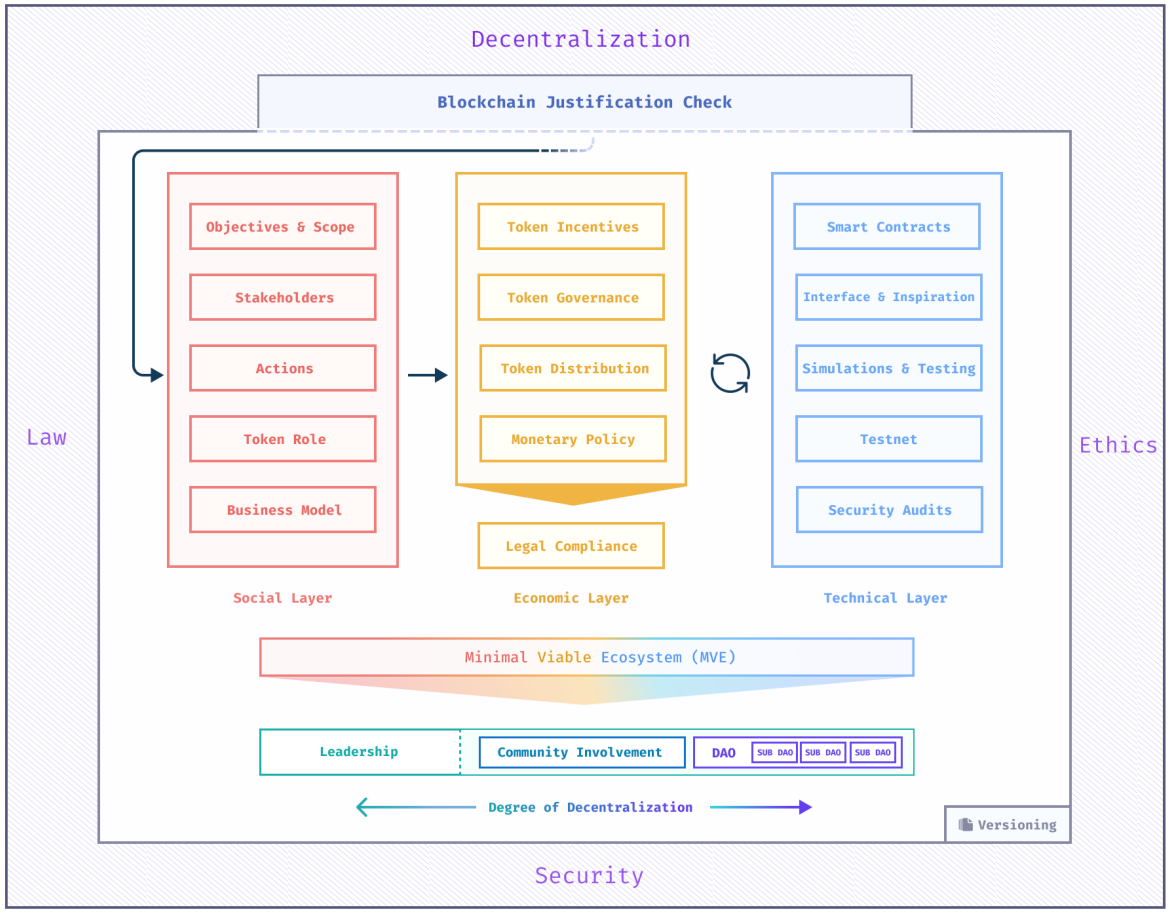


Figure 17: Revised framework for creating a token ecosystem

In the first step, it has been decided to rename the three layers “Identification”, “Composition” and “Development” layer to “Social”, “Economic” and “Technical”. These new terms seem to describe the socio-technical/socio-economical system, that is, a token-based ecosystem, in a much better way.

Second, the legal compliance component has been encapsulated out of the Economic layer in order to clearly showcase that it is dependent on the design of all components within the Economical layer. Next, the technical layer has received a new component called “Interface & Inspiration” that serves as a guiding point for TES creators to also keep in mind that a TES might have a user-facing product, i.e., an interface that needs to be designed. This product most likely will serve as an inspiration as an “app 0” to developers wanting to enter the TES. Note that while this is not necessarily required, it is recommended. One of the most significant changes were made in the bottom part of the framework, where we initially had a right-facing arrow indicating an “Increase in Decentralization”. The need for ever-increasing decentralizations has been proven to be not quite accurate and therefore it has been changed with an arrow that represents a spectrum of decentralization. It is ultimately up to the project how decentralized it wants to be. It is strongly suggested to keep some sort of centralized leadership that guides TES future. Hence the “MVE” block has been removed and replaced with a leadership block. Furthermore, from the expert interviews, we learned that instead of having a single DAO where everyone gets to decide on every decision, there should be sub-DAOs that act similarly to functions in a traditional company and have their own autonomy over a specific function. Last but not least, a “Versioning” block has been added to the bottom right corner to indicate that the TES can be iterated and shipped over multiple versions.

5. CONCLUSION

In the following last chapter of this thesis, first, an elaborate synthesis of the conducted research will be performed. As a next step, research limitations will be pointed out that were a result of the limited timeframe and complexity of the studied subject. Lastly, guidance for further research opportunities will be provided.

5.1. SYNTHESIS OF THE RESEARCH

Until recently, most blockchain project launches happened without properly addressing the utility and value of the underlying token, which was also reflected by most online tutorials on the creation of blockchain tokens; The majority solely focuses on the technical deployment phase without ever addressing the complexity of factors that need to be addressed when creating a stable and successful token ecosystem. The goal of this thesis was to propose a framework for the creation of a token-based ecosystem that can be followed by organizations who want to incorporate decentralization and blockchain technology in their organization. In order to achieve this goal, the following research objectives were defined:

- Establishment of a solid understanding of blockchain technology and how it evolved over the recent years.
- Establishment of a solid understanding around the idea and use case of blockchain tokens and the token economy.
- Identification and analysis of the ecosystem around blockchain tokens and its components.
- Identification of challenges and possible problems.
- Proposal of a framework to implement a token-based ecosystem for organizations.
- Validation of the suggested token ecosystem framework by consulting and interviewing blockchain experts from academia and the private industry.
- Description of the implications of the thesis regarding possible further academic research as well as implications for practice.

After an extensive analysis of both existing literature as well as input from domain experts, a solid understanding of how token-based ecosystems work could be established. The gained knowledge subsequently led to the creation of a framework artifact that helps organizations create such a TES themselves. All three interviewees were experts in the blockchain/token economy field and were selected based on their expertise and experience. Their background ranged from different backgrounds, such as academia, consulting, enterprise and startup. The framework has been well received by the experts and was considered to be useful. Through the experts' combined feedback, a

revised framework has then been created, which aims to bring together the knowledge gained from the SLR as well as years of professional experience, effectively leading to a robust and comprehensive framework.

In summary, the research on the topic of TES has allowed expanding the academic body of knowledge in a field that is commonly agreed on as very new and unexplored. TESs are new forms of digital economies disguised as distributed systems. They are complex socio-technical systems that require knowledge in a multidisciplinary field of economics, game theory, monetary theory, computer science, cryptography and law. One of the most crucial factors when creating a TES turned out to be trust and a well-thought-through governance mechanism. Gaining the ecosystem participants' trust is extremely important so that they stick to the network and the TES can create a moat around its project, hopefully outcompeting competitors. Incentives play another key role in token-based projects because they enable efficient and effective cooperation between participants. The idea is to incentivize good actions, de-incentivize malicious actions and ultimately influence participants' behaviors in a way that is beneficial to the overarching network's goal. All experts commonly agreed that one of the biggest obstacles when building a TES is legal compliance. Current legislations appear to be either not intended for blockchain projects or are directly hostile against them. This is a massive hindrance to true innovation in the field. Lastly, the research has shown that in contrast to the initial thought that every project has to be eventually 100% governed and controlled by the community, in reality, it needs a healthy balance of centralized strategic leadership and a republic-like democratic governance system that involves all the network's participants, split in function-like sub-DAOs. A good governance mechanism aligns the interests of all ecosystem participants and gives them enough flexibility while potentially still leaving room for leadership of the initial founding team.

5.2. Research Limitations

One of the most significant limitations this research faced was that this research topic is still in its infant stage and hence there is little holistic research on token-based ecosystems. As a result, the thesis required a lot of effort in the SLR in order to synthesize and categorize the scattered topics around the token economy research field. It is hard to validate that the components mapped out in the framework are 100% covering all the necessary steps when creating a TES. Due to the research field's infant stage, there is still much ambiguity when it comes to definitions and terminology. Different authors use different terminus for the seemingly same concept, which naturally opposes another limitation. Since the concept of creating TES is so new, everything suggested in the framework should be considered as a starting point, a blueprint, rather than a fully conceptualized technical step-by-step guide. Another

limitation is the process of validation. It was very hard to find experts on this topic who were suitable for the interview and had availability in the given interview timeframe. Thus, a sample size of three experts can be seen as a limitation and a possibility to expand on in future research. Last but not least, due to the time restriction, it was not feasible to revalidate the revised model built upon the expert interviews' feedback.

5.3. Further Research

The research topic around token-based ecosystems is yet in its infant stage and thus opposes many opportunities for future research. The first possibility could be to perform further research on specific practical tools for each component laid out in the thesis' framework. Another opportunity would be to define and evaluate the potential success metrics of a TES. What metrics signal a potentially successful TES in the mid- to long-term? Is it the token price, token velocity or maybe number of members in the network? Furthermore, the framework could be extended and mapped onto real-life token projects and serve as a utility to compare different projects. As we learned, TESs can live through multiple stages and versions. Further research on the lifecycle approach of a TES can also be considered. Another possibility for further research would be to look at the research performed around local currencies, trying to learn from them and eventually finding best practices and commonalities that can used to improve TESs. Last but not least, governance and leadership within a TES plays an immensely important role and thus, future researchers could look into methods of determining the optimal amount of centralization that is required for steering a successfully decentralized TES.

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ANNEXES

Conducted expert interviews:

Interviewee: Expert 1, Date: 19.06.2022

Q1: Do you consider the proposed framework as useful? If so, why? If not, why do you believe it is not?

I think it's useful, yes. It gives a great overview of all the pieces that might compromise such an ecosystem. One thing I noticed you need to be careful about is using the word protocol vs token because a lot of these things are actually useful for protocols in general, right? Like I remember in the beginning, you're talking about how it when a token has a lot of value, then this is what attracts hackers to hack, right? And that's why they need to be secured. That's actually not true. Hackers want to hack if a protocol has a lot of value locked inside it. And that's irrelevant of the price of the token. So if Sushi, a DeFi token only has $10 million locked inside, even though the price of sushi is $20, I will not attack sushi. You can't attack a token you can only attack a protocol itself because the token is following the ERC 20 standard is pretty much not hackable because it's a standard. Right? So what you're actually attacking is the protocol which has all the other usefulness, like people depositing in random other coins. And that's the one that has way more value. So that's one thing. And then in the legal and compliance section, so you spoke about how token ecosystems need to consider if they are a security or utility. You are 100% right, there's another there's another thing they need to consider. Where do they want to register a their company and be eventually the DAO? Basically, because where they want to register also impacts a lot of things from hiring to also like security and economic considerations. Legal compliance is a huge grey area and a lot of company struggle with it. All the projects that neglected that portion back in 2017/2018 are now facing serious problems. But I get it, it's also extremely hard because back then the legal landscape also looked even scarcer than it is today.

Q2: Would you consider implementing the proposed framework at the current stage?

I think it's pretty good and with some minor modifications and add-ons I could see myself using this a good point of references for designing the entire ecosystem and making sure one does not forget a crucial part in the process. The framework might not be extremely technical but I also don't think that was the goal of it. So yeah, if you want I can go over some of my more detailed thoughts about some modifications or add-ons?

Q3: Do you have any recommendations or suggestions for further improvements to the proposed framework?

Yeah, so in the identification layer you say the whole ecosystem revolves around having more or less like one specific goal, right? You are correct, this is super important, but it's pretty much impossible to do. I agree with you that it's important the define it in the beginning but just know that the whole idea of the decentralization is that things are ever evolving and there's some sort of underlaying uncertainty here. When it comes to you composition layer and specifically the governance part it seems to me that this is more or less what we call a DAO stack. Let's say you want to create a DAO what's the minimum things you need to consider? Right? And it actually

ends up being about how you want to handle memberships. By memberships I mean, like, does each coin have one voting power? Is it like 50 coins will only give you one, or like 50 coins and only let you enter into this Discord server or whatever, right? That's the easiest one to do. But there are other complexities right, like so. Governance proposals are very important thing as well. So just because you create a DAO it does not mean that the DAO holds all the power to decide everything. Ultimately my point is that in my opinion something should always be centralized. Not every project should be 100% decentralized. Every project should decide how decentralized they want to be. You pretty much never want to be 100% decentralized always all the time. There should be some things that should always be controlled centrally, no matter how much the centralized Maxis tell you. So for example, the Uniswap (a decentralized token exchange platform) DAO never decided that Uniswap should start working on Uniswap version three. The development team started silently without telling anyone in the world to work on it and then they just launched it out of thin air. And that's, that's normal. That's what everyone does. So you have to think about what are the kinds of proposals that you will allow people to work for because of otherwise it ends up in a catastrophe. If people will vote for everything, you will have no business secrets. You don't want people to decide everything about the direction for your company. There's a reason only execs do that and that's because they actually understand what's happening. And that's also the problem of democracies versus republics. So we've seen in DAOs that democracies basically never work. You get what is called voter apathy or voter fatigue, because some can't decide on things due to lack of knowledge etc and some just don't want to. So you need something like a republic. Basically, what you want to have is to have sub DAOs where each DAO focuses on specific things of the company, think something like branches within a traditional company. Decentralization for the sake of decentralization does not work. Think of the development of new products. An example would be Synthetix, one of the largest DeFi protocols in the world. If someone wants to build a new feature, they have to create a governance proposal, which now takes like three to four weeks to pass because there's a lot of formality you need to go through. And after four weeks of proposing, then you go then it goes into the sprint board and then someone would eventually decide to pick it up and then it gets built and then there are a tons of other things. The whole decentralization process has made has made these crypto companies insanely slow in building which makes me thing like “Okay, wow, see you aren't even at the level of big tech, but you already work as slow as big tech companies” . So that’s one of these things were we really have to think about how to find a good balance, you know? There are no good answers as of now. The second one that I had a bone to pick was in this slide when you talked about these token economic systems being immutable and you have to move slowly, and you can't be as agile. I don't actually think that's quite true, because there are things which you just can't figure out while testing, doing simulations or even on a testnet. If you're creating a DeFi token ecosystem, it's very hard to actually test it on test net, because DeFi has a lot of building blocks (think of lego) where on project relies a lot on another project. Furthermore, for some things to surface you need a lot of liquidity and some extremely irrational degenerative behavior of some participants, which you very likely don't see on test. So the only way to pretty much do it is to deploy it on the mainnet and when things go wrong, you just deploy a new version such as v2 v3, v4 etc.

Interviewee: Expert 2, Date: 20.06.2022

Q1: Do you consider the proposed framework as useful? If so, why? If not, why do you believe it is not?

Yes, I would say so. I think the framework is useful because it seems to provide a comprehensive overview of the components of such blockchain token ecosystem. I found the most useful part to be the composition layer. This seems very thorough and makes sense. Now in the in the right hand column, where you have the development layer, I think there was there was a bit missing. You know, having gone through, you know, the research of a product or protocol all the way to the delivery of an application and then, you know, everything that happens after that if you do want to decentralize the interface even or if you want to, like, it seems to me that technical process wasn't completely mapped. It was mapped from the perspective of a back end, sort of smart contracts engineer or architect, but it was not mapped you know, with front end in mind with product design and mind. You know, some of these other technical things that are required actually to to have a successful, ecosystem or whatever.

Q2: Would you consider implementing the proposed framework at the current stage?

In general, I could see myself using it yes. As I just said, I am missing a bit of the technical side of things but perhaps it might also be a bit too much for this more more generic and wide framework. I think your framework could also be improved by including more real life projects being projected onto the framework and most importantly trying to mapping the default as well. Also another thing is, you mentioned business models in the identification layer, right? I would like to elaborate on this because it is really important and not commonly understood that there are big differences to the traditional way. I think you need to zoom out. When you look at business models, and you need to you know, when when we go to school, we learn about business models from like, oh, if you run a lemonade stand, and you have more money than what you started out with then you've earned the revenue, you've earned a profit and you can grow your lemonade stand. Well, that makes sense if you are the one at the tail end of the distribution of finance that makes sense if you have no connection to if you are not the issuer of the currency. That makes sense if you are not a bank, involved in the act of manipulation of a currency for a currency to have a certain price. You know, against another price globally. When you get to the complete opposite side of the chain of financial transactions that have to occur for that money to get to Sally and her lemonade stand. You get somewhere like the Federal Reserve, right? Then you get Jay Powell waking up in the morning deciding what he wants the interest rate to be. And a lot of business models are just really capturing and monetizing the alpha. Monetizing the market information that is privileged to them and them alone through having direct access and improving their access to the primary sources of liquidity in the global economy. So they become gatekeepers, right. And that that is how they run their revenues. That is how Deloitte earns their revenues. That's how JP Morgan aren't the revenues if you you look at the top 20 businesses that exist in the world today. 18 of them are finance. Okay, that's because they sit next to the primary creator of money. So, what really is important in articulating a business model in the world of cryptocurrency is to articulate it through the lens of we are creating money. And money money has very specific properties that give it value. Some of those properties we've paid pretty good attention to. One of those properties is for instance, scarcity,

right? If you have a demand for money and only so much supply of money, the value will go up and that is where the mathematics of Bitcoin or Ethereum emission schedules really, really make sense from the arguments of this thing is digital gold. You know, it does have a logic to it. But there are other qualities of money that we haven't really paid too much attention to. And one of the key things backing money is savers. It is savers who receive a currency exchange that currency for some good or service that they provide, and then keep that currency. And when you look at, for instance, the debit cards that are being issued by Visa or crypto.com or Coinbase, none of them are really keeping the currency. They are liquidating it and exchanging it for Fiat. So if you really want to have a successful form of money that the business model for a new form of money that you are creating, you need to make sure that people that there is a an economy of goods and service backing this thing. And it doesn't surprise me that the first economy that has emerged in the world of web three is actually financial. Because this this is global in scope, you can build a formula which calculates interests like right it's and simply earns more than it lends. And that is what compound did and that formula is applicable to anywhere globally at any time. When it comes to, you know, creating an ecosystem where I can go to the tattoo parlour, and I can get a tattoo and I can pay him in a common currency and a local currency and we both use it and we both move that currency through a local economy without disposing of it. That is much harder to do. So, I think we have mapped out and created business models around services of global scope, that are primarily financial in nature. But when it comes to articulating business models, which are tied to goods or services that are local in scope, and again, sort of bridge that virtual physical divide to move from global scope to local scope, we still have a lot to learn and a lot to practice. And on top of that all of it is being slowed down in a lot of ways by an unfair and chaotic regulatory environment.

Q3: Do you have any recommendations or suggestions for further improvements to the proposed framework?

Let’s look at the first column. This one I felt was very categorically quite wide. I think you're trying to shove a lot of things in here. Like it's kind of like a mix of of generalized sort of organizational consulting with token sale thrown in as well. Maybe the better way to frame us is sort of the social layer rather than the identification layer. You know, you're sort of like taking this perspective that these are socio technical systems. We are doing socio technical systems design so you get a nice sort of parallelism. Okay, between a social layer and between the technical architecture, this back end, on the far right, and then the middle. You know, the middle column, which is sort of this this monetary or this economic design these that the way I like to frame dollars is they are programmable organizations with programmable assets. And there's a lot to unpack there, right. New design patterns as we go along. Another thing I have written down is you need to to be very specific about using the word decentralization. You know, this word is often thrown around, and it's not very helpful when it's thrown around because we don't know if somebody's speaking in terms of political decentralization of architectural decentralization. If you define something like decentralization as the, you know, the Gini score of the proportional level of authority in the network, as going through the governance system, then most of these projects are not de facto decentralized. There are a handful of whales. You know, there. You can you can look at the voting patterns and you can see like, Okay, actually like three or four people, you know, kind of control the direction of this network. Now, if you look at decentralization in terms of let's say something like labour decentralization where different

subunits of the DAO different squads different, you know, business segments have less integration and more autonomy to define their objectives. I would you know, personally I actually push back on that. I think that's a I think they're everyone should like try to move in a single direction but I also understand the value of having sort of complex organizational topologies makeup ecosystems you look at Toyota, Toyota has 173 entities globally. Like Toyota is extremely decentralized Toyota is more decentralized than the most decentralized out today. In fact, I don't think there's any dollars that exists presently that are more decentralized than the top 100 corporations. Once we begin to really dive into the definition of what decentralization means, you know, and let me and let's just go back to that. That definition I use a non integrated business segments that has autonomy over its own budget. So there are 40 or 50 entities in Toyotas business empire that fit that definition. They they all have autonomy over their own budgets. They're all jurisdictionally operating in many different places around the world. And most of you know, their their business. Yes, it is b2b in that they're, they're sort of like vertically and horizontally. Integrating their chains with each other you know, but but for the most part, like this is a very decentralized ecosystem, even though we're talking about Toyota the company, right. I see the perfect DAO as a very well designed states that has, you know, any elected or non elected assembly of folks, a relatively horizontal distribution of ownership or authority and the network experts working in to their expertise, you know, you wouldn't have something like a political theorist, you'll be managing the local economy, right. Last but not least l would like to narrow down on the regulatory component of your framework. There's a lot of regulatory uncertainty. There are a lot of very unfair laws being drafted. In addition to your framework I would love to see a mapping of the current default. So we all live in a default social system. We all have a default form of money. We all have a default interaction with the states. We all have a default law that we are subjected to we all have a default ethics exists in the markets. And every person lives under these defaults many of them aren't even aware that they live under these defaults. And if you map that out, and you show that this framework can actually be used to move away from this point, which is the default point. I think that will be extremely useful. As if we map the default and we see that the law is not just then designing an organization that is just while ignoring the law of the state is a form of justice. In terms of the whole token ecosystem creation thing we are very early and we haven't quite got our foot in the real world yet. There are not so many DAOs or crypto networks with that kind ambition or the execution of that ambition. That's kind of where I've, you know, put the majority of my interest for the last two years. And even then, you know, I can name the number of entrepreneurs who are looking this direction and actually executing on this direction on less than 10 fingers. Sure. When we look at the, you know, application of regulation, what's being done now, for instance, by the SEC is the regulatory framework they're applying is regulation through litigation. So they will find a project a high profile project to sue and they will sue them and they will try to create new law or new regulations from these lawsuits. Which to me is the same as if you had a small child and you wanted to teach them to be a good parents. You basically just try to pick fights with it. The reason you would beat up your new players is if they are challenging the business models of the old players and you have been captured by the interest of the old players. That is the only reason you attack your infant industries and that is exactly what is going on today. Imagine giving all of the tools that the US uses to impose its financial authority on other nations. Imagine giving that to other nations? Would the US be very happy with that? With the corporations that are incorporated in the US who you know, go through this resource extraction process to you

know, essentially cut off the mountain tops in Chile to get rare ores that they can then turn into Apple iPhones at a certain price point. Will they enjoy it if Chile suddenly has the same level of monetary authority as the US to protect and leverage its own resources towards its own aims? I don't think they would. And this is what I mean by unfair regulatory environment, it is not an environment, which is inviting to new players.

Interviewee: Expert 3, Date: 04.07.2022

Q1: Do you consider the proposed framework as useful? If so, why? If not, why do you believe it is not?

Yes, I in general I think you have come up with a really good framework, especially since I personally have not come across that tries to map the creation of such a token project in a more generalistic way. I think it can be a great blueprint for organizations that are thinking about building their own ecosystem, but maybe are overwhelmed by all these I think you call them components or maybe variables, if that makes sense. I really like the layered approach you have chosen with the outer layers and then it goes into these inner layers with the blockchain justification check in the beginning this is a very important step this way. Most commonly, we see that projects seem to focus a lot on the technical side. And so your framework seems to be a more holistic view to it, which I think is a very good, good, good thing to have to follow. When I look at the framework, one thing that I'm not 100% sure about is the increase in decentralization part at the bottom you have an error that says increase in decentralization and I am not 100% sure about how we should see the centralization in terms of these types of projects. Because I think decentralization is more should be more on a spectrum that needs to be identified rather than it being something that has to ever increase and then end up in what you call like obviously, the decentralized autonomous organisation. I don't think every organisation should or needs to be a fully automated decentralized organisation where the voting happens on chain and everything is 100% decentralized, I think a lot of projects are probably better off being in a, let's say, having some sort of middle ground or some sort of clearly clearly identified hierarchy that is obviously decentralized, but not 100%. That's like your framework I would I would read your framework, right.

Q2: Would you consider implementing the proposed framework? Please clarify why/ why not.

Yes. If I would be in the situation of creating an token based ecosystem. I would definitely use it because it's a very generic framework that I think describes the main steps that need to be done very well. It seems very holistic with all the sets of questions you each of these components have. And I think that for that use case, it's a very useful tool. There is one thing that I would like to point out in terms of using this implementation. I think I would have loved to get a bit more of a technical detailed view behind each component that you have set up. I get it, your framework seems to be more of a holistic overview rather than a technical step by step implementation manual. But yeah, I think that in order to implement it, there would need to be some sort of more fine granular steps needed probably. I do like that you have these predefined set of questions for all of these components, and they seem to be very thorough and helpful to go through the steps. So I think in terms of details they are a really great start. And and I mean,

probably you probably know this, but I think this would be a fantastic point for your further research section that people could build up on the framework with more technical step by step guideline approach or something similar. One more thing in regards to the technical side, on the very right you have the development layer, right. And I think that what I'm a bit missing here is that it seems to be that you don't really have covered, let's say if you think about the OSI model, like the very top layer, the application layer. I know that the ecosystem framework that you have serves more as a marketplace or infrastructure layer, but there's still ecosystems that maybe have let's say example projects or applications for potential developers to showcase how to best build on top of the ecosystem. I'm not an expert in this development layer. But for example, if you think about Compound, a DeFi lending and borrowing protocol, while they are entire an ecosystem, basically a protocol, they also have an app that you can interact with, and it serves as a sort of guideline for further development and for potential inspiration. So your development layer seems more concerned about that the underlying infrastructure and maybe less about the user interface and the application layer, which again, I'm not entirely sure if that should even fit the purpose of this framework, but I think it's important to mention.

Q3: Do you have any recommendations or suggestions for further improvements to the proposed framework?

Maybe just to re elaborate on the things that I mentioned earlier. Like I said, I think the decentralization part shouldn't be this ever-increasing type of thing where every project needs to be 100% decentralized. Overall, again, I really like what you have come up with. If we take a look at the four outer layer security, ethics, law and decentralization, while I think that they are some sort of good general proxy to keep in mind, I think it could be really interesting to have these four principles more engrained into each individual component or step in the framework to go through. So maybe having an additional specific set of trust questions for each component when going through them that allows to validate the four trust principles with every step along the design process. There is one thing I do want to point out which is I'm not 100% sure about. How would define a trust principles such as the ethics one for example? Like based on which ethical values do you want people to adhere to when building an ecosystem? I think this might related more to a deep philosophical practice than anything else, so it might not be so important for you framework, but I wanted to point this out nevertheless. Making something ethical is a very complex endeavor. In terms of further improvements besides what I already mentioned, I think I think that's pretty much it. Let me think maybe one more thing, if I take a take a look at the composition layer in the middle of the framework, we can see that at the very bottom we have the legal compliance, right? And looking at this from a visual perspective, it looks like that legal compliance can be done at any point of going through the composition layer while I think that this is not really the case. I think having all of the composition components figured out to some extent before going into the legal compliance component is very important. So what I want to say is, maybe it makes sense to encapsulate the legal compliance layer into its separate thing. As a next step after the composition. So that from a visual perspective it is obvious that the other components should be exercised before looking at the legal compliance component. But I think other than that, like I said, I really like the framework and yeah, I don't have any other recommendations that I couldn't come up with right now. So I think I think that's pretty much it.