De-centralized platform ecosystems

Development barriers and their implications on design approaches

Valeska Tullney, 2022

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Master of Arts thesis abstract

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Abstract

The recent emergence of blockchain technology is empowering an evolutionary step in the design of platform ecosystems. While proprietary platforms have been dominant so far, new ecosystem structures are under development that are no longer controlled by a single entity. Instead, the aim is to decentralize the technical and organizational infrastructure with the intent to transfer agency to all actors in the ecosystem.

This study investigates the challenges that Web 3.0 platforms are facing in the process of decentralization. The objective is to identify barriers and derive possible implications for new design approaches that can meet the needs in this new problem space. The current discourse focuses heavily on the technological aspects of emerging blockchain-enabled ecosystems. This study aims to contribute towards the less represented human-centered perspective on the matter.

The research framework is built around constructive grounded theory and a novel approach to ecosystem research through the lens of complex adaptive systems theory. Qualitative data was collected in a single-case study format, including semi-structured interviews, netnography, and other available data sources.

The research revealed five barriers that are currently hindering the process of decentralization. These barriers include 1) difficulties in accessing the Web 3.0 industry, 2) increased importance of communication between all stakeholders, 3) development of novel governance structures, 4) conflicting motivations towards the value of the project-specific token, and 5) an increased complexity and unpredictability induced by a multi-layered system's architecture. From the findings, implications for service designers in the Web 3.0 environment were derived. The identified possible areas of contribution include the support of communication and collaboration, increasing the diversity of actors, as well as enhancing the active acknowledgment of contributions from participants in the ecosystem. The outcome of this study indicates that the development of new service design approaches could help to deconstruct the identified barriers and add to the successful growth and maturity of the Web 3.0 industry as a whole.

Keywords ecosystem, platform, decentralization, ecosystem design, service design, Web3, blockchain, DAO, case study

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1
Introduction

1.1
Background

Many of today's fastest growing and most highly valued companies are proprietary platform businesses (Fortune, 2021). Platforms like Google, Facebook, or Alibaba that, with billions of users, already resemble nation-states and at this scale control economic systems larger than most of the world's national economies (Parker, Alstyne, and Choudary, 2016). In proprietary platforms, governance is centrally structured with the aggregated power in the hands of the platform owner. By providing and controlling the platform infrastructure, platform owners determine the rules for value creation and widely capture the created value.

Because of their rapidly increasing power and influence on society and economies worldwide, proprietary platforms have been facing criticism from multiple directions. Recently, in an act of libertarian rebellion, a new technology has emerged with the goal to provide alternative solutions to the prevalent proprietary model. This new technology, blockchain technology, is attributed with a transformative potential often compared to the general disruption that followed the introduction of electricity, computers, the internet, or smartphones (Perez, 2009).

The development of blockchain technology allows the decentralization of technical infrastructure, distribution of power from one to many, and new ways to share value fairly among those who contributed to the creation of it. Davidson et al. (2019) describe blockchain as an institutional technology (comparable to economic institutions like firms, markets, governments); a technology that brings freedom in the creation of new social and economic institutions.

Understanding blockchain technology as building blocks that are brought into the world to create alternatives to current social and economic structures presents an interesting emerging environment for the field of design. A statement by Bruno Latour (2004), the French anthropologist aligns well: "The critic is not the one who debunks, but the one who assembles. The critic is not the one who lifts the rugs from under the feet of the naïve believers, but the one who offers the participants arenas in which to gather" (p.246). Web 3.0, the industry of blockchain-based networks and applications, can be seen as such a critic, and design might help to facilitate the gatherings.

1.2

Research questions

This Master's thesis is an approach to understand the challenges that Web 3.0 platforms are facing in the process of decentralization. Driven by curiosity, I explored the current developments in an emerging Web 3.0 platform ecosystem. In this process, my research was guided by the following research question:

What are possible barriers that hinder the development of emerging decentralized platform ecosystems?

Learning about challenges within a development that is likely to influence many aspects of our life as individuals, as society, and businesses in the future, opened up a space of opportunities for potential contributions. Designers are trained to look at a problem from various angles and facilitate co-creation. The more I learned about Web 3.0, the more I saw the need for holistic, transdisciplinary work in this space. Transdisciplinary collaboration is an approach that was at the heart of my Master's studies in the International Design Business Management program at Aalto University. Combined with my interdisciplinary background in design, I arrived at the following sub-question:

What kind of implications are the barriers posing for design approaches to decentralized platform ecosystems?

1.3
Scope and Limitations

The scope is to understand the ecosystem structure of an example case in the Web 3.0 industry and to identify challenges in the ecosystem development that could inform service design research's task of adapting methods and tools to the changing needs in this new environment.
Due to the researcher's background in the field of design, the perspective on the subject is human-centered. The research's aim is to contribute to closing a gap in the literature that, today, is mostly focusing on the underlying technology, while less attention has so far been paid to managerial aspects and the co-creational nature of peer-to-peer networks.

The outcome of this study is limited by several aspects. Firstly, the time and scope only allowed for a single-case study. Due to the novelty of the researched problem space, a larger set of example cases would support a broader view on the status-quo of the platform development in the Web 3.0 industry in general. Secondly, the number of interviews as well as diversity of interview participants with backgrounds in different areas of the ecosystem was limited. Yet, through netnographic research and other available data, the data set was enriched up to a point that should ensure sufficient academic rigor and reliability. Thirdly, the novelty, complexity and dynamic nature of the research environment imposed challenges throughout the research that may have resulted in unconscious inaccuracies or misinterpretations by the author of this study.

1.4

The structure of this thesis

The overall structure of this thesis takes the form of six chapters. This includes the first introductory chapter where the research background, the research question, its scope and limitations, as well as the author's personal motivation are discussed.

The second chapter lays out the theoretical foundations of this research. It starts with a general definition of ecosystems and recent developments in the academic discourse, followed by the description of platform ecosystems as one stream of literature. Next, the development of decentralized platforms enabled by blockchain technology is presented, completed by an introduction to DAOs as a new emerging form of organization. This chapter concludes with an overview of recent developments in service design literature, focusing on service ecosystem design.

The third chapter is concerned with the methodology used for this thesis. It will introduce the methods used in the context of the constructive grounded theory methodology, and explain why a qualitative research approach in the form of a single-case study was the best fit.

The fourth chapter gives a detailed introduction to the studied case. This includes information about Streamr's mission, relevant stakeholders, the layered architecture, and the project-specific token.

In the fifth chapter, the research findings are presented, clustered into five key themes. Identified barriers to the development of decentralized platform ecosystems are found in the areas of access, communication, governance, tokens, and complexity of layered architecture.

Finally, the sixth chapter draws upon the entire thesis, tying up the various theoretical and empirical strands in order to discuss and reflect on possible future implications on design for decentralized ecosystems.

2
Theoretical foundation

2.1
Ecosystems

In recent years, the concept of ecosystems has seen a rapid increase of interest among scholars and practitioners (Jacobides et.al., 2018), with particular emergence in the fields of strategy, innovation, and technology (e.g. Aarikka-Stenroo and Ritala, 2017; Basole et al., 2015; Kolloch and Dellermann, 2018; Tsujimoto et al., 2018).

The term business ecosystem was introduced by Moore (1993) in reference to the complexity of biological ecosystems. It represents an advancement of the conception of linear value streams (Porter, 1985) by taking into account the increasingly interdependent and co-evolutionary nature of actor relationships in today's business environments (Phillips and Ritala, 2019). Moore (1993) defines a business ecosystem as follows:

> *An economic community supported by a foundation of interacting organizations and individuals – the organisms of the business world. This economic community produces goods and services of value to customers, who are themselves members of the ecosystem. The member organism also include suppliers, lead producers, competitors, and other stakeholders. Over time, they coevolve their capabilities and roles, and tend to align themselves with the direction set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments, and to find mutually supportive roles. (Moore, 1996: 26)*

Despite the continuing relevance of Moore's (1993) definition, a more recent definition by Adner (2017) defines ecosystems by highlighting its structure. Furthermore, it illustrates a development that is increasingly shifting the focus from focal companies towards the joint creation of a focal value proposition.

> *The ecosystem is defined by the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize (Adner, 2017; 42).*

Adner (2017) contrasts the above approach that he coined 'ecosystem-as-structure' with an actor-centric, 'ecosystem-as-affiliation' perspective. Following the commonly applied actor-centric approach (e.g. Autio & Thomas 2014; Jacobides, Cennamo, & Gawer, 2015; Rong & Shi, 2014), the value creation starts with existing actors affiliated with a focal actor, and explores the possible value propositions that could be generated by this specific set of actors. The strategic aim of actor-centric ecosystems is therefore to raise the number of (direct) links between the focal company and other actors in the ecosystem to increase value creations and thereby, "increasing [the focal actor's] centrality and expected power" (Adner, 2017: 40).

The 'ecosystem-as-structure' perspective, however, is less centralistic in regards to actor's positions and power. Instead, a shared value proposition becomes the focal point of all activities. Following this structuralist approach, the ecosystem can be understood as a mission-driven assemblage of interdependent actors that interact for a mutual value proposition to come about (Adner, 2017).

For a value proposition to materialize, Adner (2017) proposes four main building blocks as structural elements of an ecosystem: Activities, Actors, Positions, and Links. Table (1) provides a description of all four elements and shows the different perception of each element, determined by the chosen perspective.

During the single case study of this Master's thesis, Adner's (2017) 'ecosystem-as-structure' approach was applied to identify the structural building blocks of a discrete decentralized platform ecosystem.

	ECOSYSTEM-AS-STRUCTURE	ECOSYSTEM-AS-AFFILIATION
ACTIVITIES	Discrete actions to be undertaken in order for the value proposition to be created	Not applicable
ACTORS	Entities that undertake activities	Entities that are tied to the focal actor
POSITIONS	Specified locations in the flow of activities across the system	Derived from links to other actors
LINKS	Transfer across positions, which may or may not include the focal actor	Ties between the focal actor and other actors

Table (1) The elements of ecosystem structure - adapted from Adner (2017)

2.2 Platforms

Moore (1996) described ecosystems as „member organisms“ that are founded on „interacting organizations and individuals“. In order to coordinate the value creation and value sharing among a multiplicity of independent ecosystem members, platforms have taken the role of an infrastructural entity (e.g. Jacobides et al., 2018; Gawer, 2014). Ecosystems that are powered by platforms have, thus, formed a new stream of literature in the platfotm discourse. Parker, Van Alstyne, and Choudary (2016) define platforms as follows:

> *A platform is a business based on enabling value-creating interactions between external producers and consumers. The platform provides an open, participative infrastructure for these interactions and sets governance conditions for them. The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants (Parker, Van Alstyne, and Choudary, 2016:7).*

2.2.1 Centralized platforms

The most commonly adopted coordination structure in today's platform businesses is a centralized platform model (Pereira et al., 2019). Here, the central platform owner is controlling all value-creating interactions of external producers and consumers on the platform. In the specific case of digital platforms, the platform owner furthermore acts as platform architect providing and controlling the technical infrastructure (Parker and Van Alstyne 2017). Possibilities for a platform owner to exercise control are, among others, implementing restrictions regarding platform access, interoperability, stakeholder interactions, and decision-making rights (Tiwana, 2013).

However, several authors (e.g. Eaton et al. 2015, Ghazawneh and Henfridsson 2013) highlight the challenge of balancing generativity and control in the context of platforms. It can be argued that finding the right balance decides over the success or failure of the whole platform ecosystem (Boudreau 2010, Parker and Van Alstyne 2017, Tiwana et al. 2010). Constantinides et al. (2018) note that this is particularly challenging for central platform

owners because it contrasts the commonly known, "centralized, command-and-control governance structures found in linear value chains and hierarchical organizations" (p.384).

In addition to the above mentioned control mechanism, platform owners develop incentive structures that enable the steering of the behavior of platform participants. The participants can be incentivized, with monetary or social incentives, to interact with the platform and other stakeholders in a way that is beneficial for everyone in the ecosystem (Parker, Van Alstyne, and Choudary, 2016). However, several authors (e.g. Constantinides and Barrett, 2014) identified a research gap in regards to successful implementations of incentive structures.

The lack of research and missing knowledge about governance of platform ecosystems poses a significant challenge to the field because it appears to be highly important to the platform's success. Successful governance should enable fair division of value to all platform members that participate in the creation of it (Parker, Van Alstyne, and Choudary, 2016). If a stakeholder group gets disadvantaged, they might lose the incentive to participate any longer. Platform scholars reviewed many cases where losing a substantial number of participants from one stakeholder group led to a collapse of the whole platform business (e.g. Parker, Van Alstyne, and Choudary, 2016; Constantinides et al., 2018). In platform literature, this effect is called negative network effect.

Network effects, negative or positive, are fundamental principles of platforms and the reason for the characteristic speed of platform growth. Scaling a traditional business usually implies huge resource investments. In contrast, digital platforms increase their value creation with every new member who joins, with minimal to no investments involved (Parker, Van Alstyne, and Choudary, 2016). Furthermore, the increasing value creation opportunities continuously attract more producers and consumers to the platform. The result is a positive network effect created through virtuous cycles. Figure (1) illustrates the virtuous cycle of Uber, a digital ride-sharing platform.

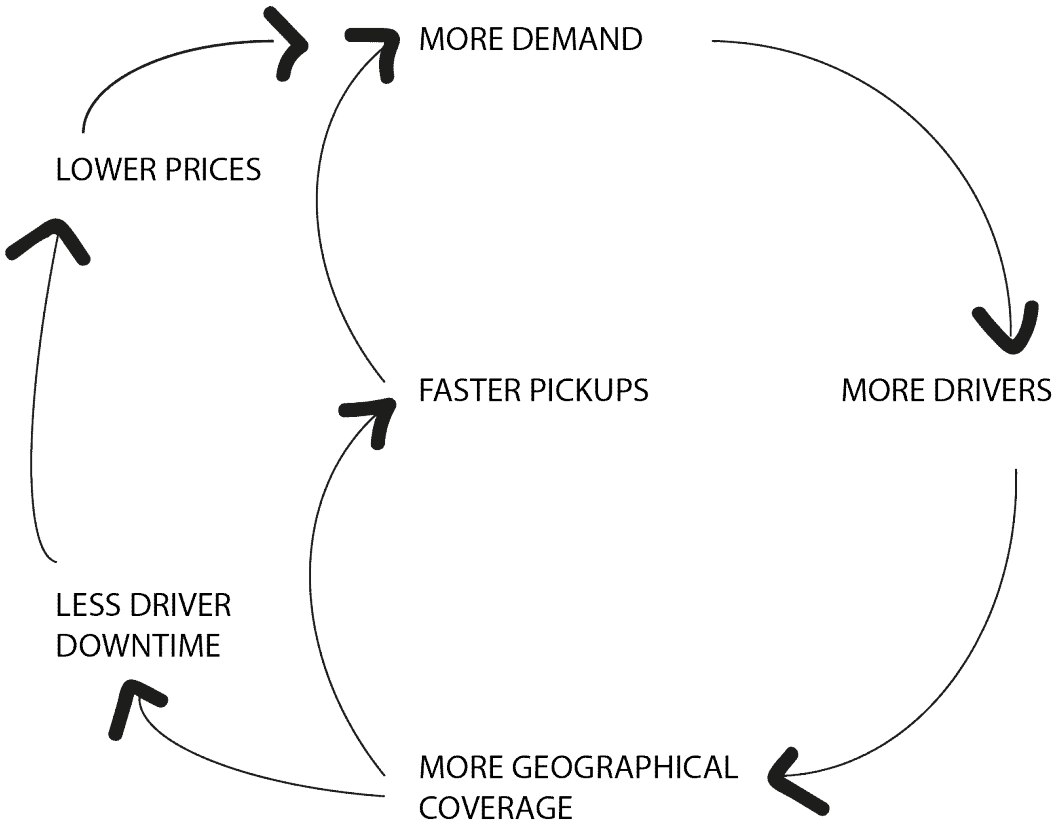

Figure (1). Uber's virtuous cycles - adapted from Parker, Van Alstyne, and Choudary (2016)

2.2.2 Decentralized platforms, enabled by blockchain technology

As presented in chapter 2.1, Adner (2017) distinguishes between two perspectives on ecosystems: the actor-centric 'ecosystem-as-affiliation' as well as 'ecosystem-as-structure' which centers around a focal value proposition. In the last chapter, the role of a platform owner was discussed as an instance with central steering power and as the exclusive provider of technical infrastructure. The role as platform leader therefore aligns well with the 'ecosystem-as-affiliation' structure which is built around a focal actor; the ecosystem leader. The 'ecosystem-as-structure' approach, however, is built around a focal value proposition co-created by all actors in the ecosystem. Centralized platforms as infrastructural entities controlling the value creation and capture within an ecosystem are, hence, misaligned with Adner's (2017) decentralized structural approach to ecosystems. The emergence of decentralized platform alternatives, that are enabled by blockchain technology, are therefore an interesting development.

In blockchains, the governance rules and the data infrastructure are defined by coded protocols. Yet, as Vitalik Buterin (2015) - co-founder of the Ethereum blockchain - claims:

> *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 (Buterin, 2015: na).*

Changes to the governance rules (in form of code) can be suggested by the platform community. While some centralized platforms also work with open-source code and consider suggestions from the community, the influence of platform members in truly decentralized platforms does not end here. Social media forums, discussion groups, and voting systems offer possibilities for members of decentralized platforms to discuss and actively shape the future direction of the platform, including the final implementation of changes (Pereira et al., 2019).

Not only is the governance decentralized in blockchains, so is the technical infrastructure that is underlying every platform. The enormous servers that are used for computing transactions on centralized platforms, are replaced with a peer-to-peer network. A peer-to-peer network consists of many independent actors, distributed worldwide, that are connected to each other. The distribution of network computing carries positive properties such as extinguishing single points of failure and inhibiting malicious attacks (Davidson et al., 2018). Furthermore, distributed networks waiver the need to verify transactions by

a trusted third party. The verification is instead, ensured by a system of mutual consensus amongst all participating network actors (Pereira et al., 2018). Blockchains are therefore also referred to as immutable "trustless consensus machine" (Swanson, 2014)

In a literature review of relevant journals on the topic of digital platform ecosystems, Schreieck et al. (2016) identified a differentiation between technology-oriented and market-oriented perspectives on digital platforms. However, they argue that opposed to other scholars (e.g. Tiwana, 2014), "our understanding of the design of a platform ecosystem refers to a conceptual blueprint of the whole ecosystem, including the partners and processes interacting on the platform and that includes both the technology- and market-oriented perspective"(Schreieck et al., 2016: 8). This view is shared by Constantinides et al. (2018) who strongly emphasize the fact that "computing and network resources" build the necessary infrastructure on top of which digital platforms can be built and curated. Therefore, both units of interest should be discussed simultaneously (Constantinides et al., 2018).

Decentralization of the platform infrastructure and governance demands active participation of all actors. To incentivize actor participation, many blockchain projects launch platform-specific crypto tokens. The tokens can usually be earned as a reward for performing an activity in the platform, exchanged for fiat money (e.g. EUR,USD), or bought during initial coin offerings (ICOs - crowdfunding initiatives of blockchain-related projects) (Pereira et al., 2018).

Tokens play an important role in blockchain-enabled platforms as a tool for coordinating platform activities and distributing value amongst platform participants (Davidson, 2018). Crypto tokens as a currency allow value transactions at substantially lower costs compared to the traditional banking system. Furthermore, the token value itself is often related to the overall success of the platform. It can therefore be seen as a direct incentive for platform members (token holders), to contribute to the platform in a beneficial way, which in turn would increase the token value. This reinforcing loop can be the basis for a previously introduced platform-characteristic network effect (Pereira et al., 2018).

However, along with the increasing degree of decentralization, increases the complexity and demand for coordination. An apparent strong focus on the technological aspects in blockchain publications (Risius and Spohrer, 2017) is demonstrating a lack of research regarding the managerial aspects of the technology (Pereira et al., 2018). As the blockchain technology is still young (initiated in 2008 with Bitcoin by Satoshi Nakamoto), the field is currently in an "experimentation period", described as "a thousand flowers blooming" (Pereira et al., 2018).

2.3 Platform organization

2.3.1 Access and control

Two dimensions that change during a transition from centralized, proprietary platforms to open, decentralized platforms are control and access (O`Mahony and Karp, 2020). Here, access can be understood as the "degree to which a platform is legally open and usable by external participants", while control refers to "the right to determine the rules guiding a platform's usage and technical trajectory" (O'Mahony and Karp, 2020:4).

Previous studies suggest that participation of platform contributors increases with open access (Boudreau, 2010; West, 2003). Increased participation results in diversity and vitality that can benefit successful open innovation (Chesbrough, 2003), and can further lead to platform adoption and relevance (von Hippel, 2005). The downside of open access, however, is an increased risk of forking, competition (Parker and Van Alstyne, 2017), and causing uncertainty (Greenstein, 2009). O'Mahony and Karp (2020) mention free-riding as an additional challenge that occurs by eliminating access barriers. Most innovation scholars see the problem of free-riders as a condition of over consumption (e.g. Ostrom, 1990; Jacobides, Knudsen, and Augier, 2006). Yet, O'Mahony and Karp (2020) challenge this perception by moving the focus from over consumption to the problem of overcontribution, which is less covered in the domain of open source and platform research (O'Mahony and Karp, 2020).

A 7-year, inductive field study showed that overcontribution emerged when the platform had open access but missed a clear agreement over the question who controls the platform (O'Mahony and Karp, 2020). It followed, that platform actors could not adapt their strategy to the platform's scope because the overall scope was unclear, and contributions of other platform participants were uncoordinated or sometimes even unwanted. Lacking control mechanisms, finally, caused platform members to reduce or even withdraw their active participation (O'Mahony and Karp, 2020).

Different streams of research in the broader context of non-hierarchical, "multi-actor assemblages" (Gulati et al., 2012) are providing insights and suggest possible solutions to the coordination challenge (Adner, 2017; O'Mahony and Bechky, 2008; Kolbjørnsrud, 2017;

Gulati et al., 2012). Ostrom's (1990) Nobel Prize-awarded contribution to the problem of sharing, building, maintaining, and using a commonly built resource, investigates the following:

> *How a group of principals who are in an interdependent situation can organize and govern themselves to obtain continuing joint benefits when all face temptations to free-ride, shirk, or otherwise act opportunistically" (Ostrom, 1990; 29)*

Kolbjørnsrud (2017) examined the agency problems and coordination challenges in collaborative communities. As possible levers, he identified three key governance mechanisms: peer-based control (Lee and Cole, 2003), shared rules and norms (Ostrom, 2000), and trust (Adler et al., 2008).

Peer-based control is the opposite of authority-based control as it is known in hierarchical settings (Fjeldstad et al., 2012). "Transparent task structure, resource commons, and membership let participants self-assign to tasks, contribute and find new uses for shared resources, and initiate new collaborative relationships" (Kolbjørnsrud, 2017: 143). Decisions are based on peer review processes, with no need for top-down decision-makers (Lee and Cole, 2003). As a consequence, peer recognition becomes a critical component for "reward, motivation, and social status" (Kolbjørnsrud, 2017; Stewart, 2005).

Shared rules and norms can guide interactions by providing "principles to self-organize; effectively identify and mobilize collaborators and resources; collaboratively solve problems; share knowledge and ideas; and distribute rewards" (Kolbjørnsrud, 2017: 143; Fjeldstad et al., 2012).

Trust is an important element in collaborative relationships. It empowers "effective knowledge creation and sharing" (Kolbjørnsrud, 2017: 143). "Trust in organizations is a multi-dimensional and multi-level construct that is viewed both as a governance mechanism in its own right (Bradach and Eccles, 1989), a contextual factor influencing the efficacy of other governance mechanisms, and itself being influenced by the use of other governance mechanisms (Hsu et al., 2007)" (Kolbjørnsrud, 2017: 143).

2.3.2 DAOs as an emerging phenomenon

The role of trust in current governance structures, however, is questioned by a novel form of organization; a decentralized autonomous organization (DAO). Enabled by the emerging blockchain technology, DAOs are designed as trustless systems. The organization's

governance relies (in extreme cases entirely (see DuPont, 2017)) on blockchain-operated smart contracts. Smart contracts are explicit rules, written in the form of computer code that is automatically executed by algorithms. Any alteration of the code would require community consensus and will be recorded in the history of the blockchain, visible to everyone. Hence, there is no trust required between the parties of a smart contract (Morrison et al., 2020).
With implementing smart contracts as governance mechanisms in decentralized organizations, the need to trust decision makers is equally removed. Instead, every DAO member has a right of putting forward and voting on proposals. Yet, despite the transparency ensured by the blockchain, information asymmetries regarding individual ambitions, values, and priorities can occur among the DAO members. Such information asymmetries can hinder the decision making in a voting process (Morrison et al., 2020). Besides that, the comprehension of smart contract's underlying code, and proposals to change the code may be another issue. It can be questioned if all members of a DAO have the expertise to exercise their rights according to their needs (Morrison et al., 2020).

A prominent example of a DAO that was entirely run by smart contracts, is "The DAO" project. The DAO started in 2016 and lasted only a few weeks before an anonymous member found a loophole in the code of the smart contracts that allowed this member to empty about half of the DAOs treasury. Although the malicious activity was noticed, the organization was unable to intervene because the required votes for a consensual decision to change the code in a way that would stop the activity, was not achievable in the short period of time. The DAO had no manager or instrument that would have allowed any corrective actions other than voting (Price, 2016; DuPont, 2017).

The explicit rules that The DAO strictly followed were designed to remove any chance for one party to act outside of the original intentions of the (smart) contract. The case of the inability to stop the misbehavior, that was mistakenly allowed by the rules, proves that The DAO succeeded in this sense. However, this example raises the question of the need for implicit contracts. A traditional work contract, as commonly known, would be an example of an implicit contract. Such contracts have no formal mechanism to exercise control. Instead, they are based on trust and good faith in the other party to behave appropriately. Morrison et al. (2020) suggest that a combination of explicit and implicit contracts may be necessary for DAOs to be successful and able to react to unforeseen events (Morrison et al., 2020).

The emergence of DAOs changes the role of trust as a key element of organization theory. According to Morrison et al. (2020), it is likely to find other forms of DAOs and hybrids in the future that would call for "legal and design research, perhaps experimentation, and eventually new theory building" (p.12).

2.4
Service Ecosystem Design

As the above theory indicates, decentralized platform ecosystems come with a variety of challenges. Coordinatation, collaboration, unpredictability, and trust are only a few to name. An approach to tackle these challeges may be derived from the latest research in the service design discipline as well as previous research in the field of systems thinking. Relevant ideas will be presented in this chapter.

2.4.1 Systems thinking

Environmental scientist and systems thinking scholar Donella Meadows (2001), claims that the behavior of self-organizing, nonlinear, feedback systems can not be predicted or controlled. Yet, systems thinking can help to build a holistic understanding of the system as a starting point for further engagement.

> *The future can't be predicted, but it can be envisioned and brought lovingly into being. Systems can't be controlled, but they can be designed and redesigned. We can't surge forward with certainty into a world of no surprises, but we can expect surprises and learn from them and even profit from them. We can't impose our will upon a system. We can listen to what the system tells us, and discover how its properties and our values can work together to bring forth something much better than could ever be produced by our will alone (Meadows, 2001; 2)*

During her practice, Meadows (2001) identified thirteen ways to engage with a complex system. Figure (2) shows excerpts from Meadows (2001) work.

GET THE BEAT.

Before you disturb a system in any way, watch how it behaves. Starting with the behavior of the system forces you to focus on facts, not theories; [it] directs one's thoughts to dynamic, not static analysis.

EXPAND THOUGHT HORIZONS.

Seeing systems whole requires more than being interdisciplinary. [Representatives from various disciplines] will have to go into learning mode, admit ignorance, and be willing to be taught, by others and by the system.

EXPOSE YOUR MENTAL MODELS TO THE OPEN AIR.

Remember, always, that everything you know, and everything everyone knows, is only a model. Get your model out there where it can be shot at. Invite others to challenge your assumptions and add their own.

STAY HUMBLE. STAY A LEARNER.

In a world of complex systems it is not appropriate to charge forward with rigid, undeviating directives. Pretending you are in control even when you are not is a recipe not only for mistakes, but for not learning from mistakes.

HONOR AND PROTECT INFORMATION.

A decision maker can't respond to information he or she doesn't have, are inaccurate, or late. You can make a system work better with surprising ease if you give it more timely, more accurate, more complete information.

MAKE FEEDBACK POLICIES FOR FEEDBACK SYSTEMS.

Especially, where there are great uncertainties, the best policies not only contain feedback loops, but meta-feedback-loops; loops that alter, correct, and expand loops. These are policies that design learning into the management process.

GO FOR THE GOOD OF THE WHOLE.

Don't maximize parts of systems or subsystems while ignoring the whole. It helps to remember that the parts of the system cannot survive without the whole.

CELEBRATE COMPLEXITY.

[Complexity] is what makes the world interesting, what makes it beautiful, and that's what makes it work.

EXPAND TIME HORIZONS.

In the strict systems sense there is no long-term/short-term distinction. Phenomena at different time-scales are nested within each other.

EXPAND THE BOUNDARY OF CARING.

The real system is interconnected. No part of the human race is separate either from other human beings or from the global ecosystem.

LOCATE RESPONSIBILITY IN THE SYSTEM.

Look for the ways the system creates its own behavior. Do pay attention to the triggering events, the outside influences that bring forth one kind of behavior form the system rather than another. Sometimes those outside events can be controlled, but sometimes they can't.

LISTEN TO THE WISDOM OF THE SYSTEM.

Aid and encourage the forces and structures that help the system run itself. Don't be an unthinking intervener and destroy the system's own self-maintenance capacities.

PAY ATTENTION TO WHAT IS IMPORTANT, NOT QUANTIFIABLE.

No one can precisely define or measure any value. But if systems aren't designed to produce them, if we don't speak about them and point forward their presence or absence, they will cease to exist.

Figure (2). Ways to engage with complex systems – excerpts from Meadows (2001)

However, systems thinking alone can not bridge the gap between understanding a system and implementing change (Meadows, 2001). It rather builds the groundwork for emerging disciplines that actively engage with complex systems (e.g. Vink et al.,2021; Koskela-Huotari et al., 2021).

Service research, for example, investigates complex service systems. Following Vargo and Akaka (2012; 210) "service system[s] can be a person, an organization, or even a nation". Depending on the scope, a service system can therefore either be seen as part of a larger ecosystem or as an ecosystem itself (Koskela-Huotari et al., 2021).

Service research is connected to theories of systems thinking (Meadows, 2001), as well as service-dominant logic (Vargo and Lusch, 2018), and service system transformation (Koskela-Huotari et al., 2021). While latter theories provide an analytical framework for the increasingly interconnected world and notable transformational pressure on service systems, service design is evolving into a discipline that offers an action-oriented approach to systems transformation (Wetter-Edman et al., 2014; Patricio et al., 2019).

2.4.2 Service Ecosystem Design

Traditionally, service design focused on incremental improvements and the human experience in dyadic, transaction-centric interactions between service providers and customers (Grenha Teixeira et al., 2017; Sangiorgi, 2009). Yet, following the transformational pressure on organizations and society as a whole, the focus of service design is on a trajectory towards a more holistic, inclusive, and co-creational approach (Yu and Sangiorgi, 2018). Emerging fields of research and practice that push this evolution of service design are transformation design (Yu and Sangiorgi, 2018), service ecosystem design (Vink et al., 2021), and design for sustainability transitions (Wahl and Baxter, 2008; Gaziulusoy, 2019).
The research on service ecosystem design by Vink et al. (2021) is heavily informed by the recent development in the field of service-dominant (S-D) logic (Vargo and Lusch, 2018). While S-D logic has informed the theory of service design in the past (e.g. Kimbell, 2011; Wetter-Edman et al., 2014), Vink et al. (2021) claim that S-D logic's new perspective on service ecosystems has not yet been widely incorporated by service design researchers and practitioners (Vink et al., 2021).

In S-D logic, a service ecosystem is defined as:

> *a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange (Vargo and Lusch, 2016: 10–11).*

Based on this understanding, Vink et al. (2021) frame service ecosystem design as a new service design approach with the following definition:

> *[Service ecosystem design is] the intentional shaping of institutional arrangements and their physical enactments by actor collectives through reflexivity and reformation to facilitate the emergence of desired value co-creation forms (Vink et al., 2021: 169).*

Four building blocks help to understand the definition of the new conceptualization of service design for ecosystems: purpose, design materials, processes, and actor involvement. Table (2) illustrates the building blocks in light of the increasing alignment with service-dominant logic's ecosystem view. Descriptio ns of the four blocks will follow next.

PURPOSE

The intention of design in general has been associated with purposefulness since the early days. Simon (1969) understood design as a matter of how things ought to be, later Rittel and Webber (1973) saw designing as goal-directed actions, and Bathany's (1996) definition of design includes the creation of a desired system (Vink, 2021). When looking at purpose from a S-D logic's perspective, the earlier presented definition finds the purpose of a service ecosystem in mutual value creation. Mutual value creation involves the interaction of a set of actors in order to "positively or negatively valence change in the well-being or viability of a particular system/actor" (Vargo and Lusch, 2018: 740). Depending on the social and cultural context, each actor might have a different perception of value that is subject to change over time (Akaka, Vargo, and Schau, 2015; Vink et al., 2021). The purpose of service ecosystem design is therefore to "facilitate the emergence of desired forms of value co-creation" (Vink et al., 2021:169).

DESIGN MATERIALS

In 1992, Schön characterized design "as a process of transforming the materials of a situation" (Vink et al., 2021: 174). What are the materials of a service ecosystem is therefore an important question to answer (Blomkvist, Clatworthy, and Holmlid, 2016). In a traditional sense, service design materials would be interfaces, touchpoints, and user journeys (Koskela-Huotari et al., 2021). Yet, S-D logic's perspective on ecosystems emphasizes the significant influence of invisible institutional arrangements (Vargo and Akaka, 2012; Vargo and Lusch, 2011). According to Wieland et al. (2016: 6), institutional arrangements are the "coordinating elements of service ecosystems that influence value co-creation efforts and provide the reference base for value assessment". Vink et al., (2021) therefore suggest adding

institutional arrangements in the form of rules, roles, norms, assumptions, and beliefs (Scott, 2014; Vargo and Lusch, 2016) to the set of transformable materials.

Although it is well-known that institutional arrangements are challenging to transform (Greenwood et al., 2008), they determine the boundaries for value co-creation and are therefore an integral part of system transformation processes (Vink et al., 2021). It follows that by incorporating institutional arrangements, service design is leaving the previous reductionist approach and opens up towards a holistic understanding of materiality (Vink et al., 2021).

PROCESSES

Because institutional actors are often unaware of the invisible arrangements that shape their behavior, they tend to reproduce a developed behavior routine (Greenwood et al., 2008). Yet, as a member of the system, they have the power to change the institutional arrangements (Mele et al., 2018). Institutional arrangements are internally generated by intentional and unintentional reactions of institutional actors to endogenous and exogenous triggers as well as by the existing system structure (Vargo and Akaka, 2012; Vargo and Lusch, 2016; Koskela-Huotari et al., 2021). Hence, in order to change the institutional arrangements towards a preferred future, every actor has to develop an awareness of the institutional arrangements that they are influenced by (Blocker and Barrios, 2015).

Reflexivity is a process that helps actors to build an awareness of the forces that guide their behavior as well as recognize the diversity of other institutional arrangements in the system. Reflexivity is a necessary step before institutional arrangements may be intentionally adjusted in a process of reformation (Vink et al., 2021). Reformation can include the creation or alteration of materials such as symbols, identities, and language, as well as relational work (Hampel, Lawrence, and Tracey, 2017). Hence, reflexivity and reformation combined can create a continuous feedback loop guiding a service ecosystem to self-adjust its boundaries for value co-creation (Chandler et al., 2019, Vink et al., 2021).

ACTORS

Institutional arrangements are shaped by the actions of every single actor (Vink et al., 2021). As discussed earlier, this can take the form of unconsciously guided behavior or happen intentionally. In the latter case, the activity can be classified as design. Yet, in order to have an effect on the wider system, a bigger collective has to be involved in the process (Vargo and Akaka, 2012), although parts of the collective may have conflicting motivations (Vink

et al., 2021). In the words of Latour (2018: 21) "all designs are `collaborative designs´ - even if in some cases the `collaborators´ are not all visible, welcomed or willing." "Collective designing" is therefore characterized by "dynamic and multi-directional processes" (Vink, 2021). These complex processes result in unpredictable outcomes and bring forth emergence. Service ecosystem design should thus not intend to restrict certain behavior but "open up pathways for potential new avenues to unfold" (Koskela-Huotari et al., 2021: 350; Sangiorgi et al., 2017). Hence, Koskela-Huotari et al. (2021) propose design-oriented scenarios (Manzini, 2015), design fiction (Coulton and Lindley, 2017), and speculative design (Dunne and Raby, 2013) as possible methods to generate communicative artifacts and thereby support the explorative process.

However, the intentional effort to change a system and its institutional arrangements does not automatically lead to an enduring transformation (Koskela-Huotari, 2021). On the contrary, Vargo and Lusch. (2016) argue that new practices first need to become institutionalized. Koskela-Huotari et al. (2016: 2966) follow that the "institutionalization of new rules of resource integration occurs through multiple adjustments and changes over time until a common template becomes accepted and shared". In order to increase the chances for successful transformation in dynamic systems, service design is therefore required to evolve from its traditional focus on discrete, isolated service design projects (Karpen et al., 2017) towards a long-term engagement. In this regard, Koskela-Huotari et al. (2021: 350) emphasize that "through the continued practice of designing new value co-creating systems and socio-material configurations, service design can assist in enduring transformation of institutional logics".

In brief, the implications of service ecosystem design manifest in cherishing the unpredictability of outcomes; developing a more holistic understanding of materiality in service design; moving away from a project-based, linear design towards circular, ongoing collective design processes; acknowledging the influence of institutional arrangements, as well as the multiplicity of ongoing design processes on an actor-to-actor basis; fostering awareness of conflicting processes that could hinder expected long-term change; and understanding the new role of designers not as authors but as a continuous part of a collective, supporting the ecosystem with research and tools to "strategically leverage the diversity of design processes within actor collectives, and [..] encourage alignment while acknowledging conflicting processes" (Vink et al., 2021: 181).

CONCEPTUALIZATIONS OF SERVICE DESIGN

	Design of Services	Design for Services	Service Ecosystem Design
Purpose	develop new service offerings	create the conditions for value in use	facilitate the emergence of desired forms of value creation
Design Materials	touchpoints and interfaces	sociomaterial configurations	institutional arrange-ments and their physical enactment
Processes	phase in new service development	ongoing processes including designing in use	embedded feedback loops of reflexivity and reformation
Actor Involvement	expert-driven approach by managers and designers	co-design with staff and service users	collective designing by all actors

Table (2). The conceptualization of service design through the perspective of service ecosystem design – adapted from Vink et al. (2021)

3
Methodology

3.1
Methodological approach

I decided to adopt the constructivist approach to grounded theory proposed by Charmaz (2006) as the primary methodology to follow in my study. The main reason to adopt this approach was the novelty of the research environment and the little background knowledge that I had when I started the research. Both aspects are prerequisites to work out the strengths of the grounded theory approach which is based on an open-ended, ideally unbiased thinking of the researcher (Charmaz, 2006). It is an inductive approach where the results are grounded in the research data, with a broad problem framing in the beginning that is becoming more defined with every new piece of information collected on the way.

The grounded theory methodology was developed by Glaser and Strauss in 1967. The common aim was to find a new way of theory building that was independent from existing literature (Corbin and Strauss, 1990). Over the years, however, a differing interpretation of their initial theory separated the authors into two schools: the "Glaserian school" and the "Straussian school" (Charmaz, 2006). Both schools were criticized for their heavy focus on empirical data and a risk to re-invent theory because themes are not derived from existing theory but grounded in the empirical data. The methodology of grounded theory, in the traditional sense, presumes that the researcher discovers theory in the data, convinced that it is already there to be found. Charmaz (2006), however, emphasizes that the researcher needs to actively construct themes. Following this constructivist interpretation, the absolute need for deriving theory objectively is being replaced by supporting a process of active reflexivity instead. This approach resonates best with my understanding about an explorative interaction with a new problem space and the process of making sense of emerging phenomena. To support a reflective approach to the collected data, memo-writing, diversity in data sources, and constant exchange with various participants for clarification became important elements of my research design.

Constrained by time and scope of a Master's thesis, I decided on a single-case study format. Although a comparative multi-case study would have provided more solid evidence to my research questions, the single-case study allowed me to investigate the multiple dimensions of a platform ecosystem within the emerging Web 3.0 industry in depth (Yin, 2003).

Ecosystems are an increasingly popular subject to scholars from various disciplines. The complexity induced by interdependencies and co-evolution of participants in a progressively self-organized ecosystem structure, however, challenge existing methodological approaches. Phillips and Ritala (2019), therefore, propose a new agenda for ecosystem research methodology based on a complex adaptive systems lens. The three conceptual dimensions in this research approach address epistemological considerations ("How we think about the system"), the ontological component ("What we know about the system"), and the temporary dimension ("How systems change over time") (Phillips and Ritala, 2019:10). The goal is to support more holistic viewpoints. The authors suggest that the framework in practice will have to adapt to individual project's needs with varying degrees of focus on each dimension. Inspired by the work of Phillips and Ritala (2019), I followed a proposed research process. The process starts with a group of experts. The information and personal connections gathered from the experts, I used for snowballing to open the search towards an increased diversity of participants that would guarantee a more holistic view on the ecosystem. Semi-structured interviews are key in this process to give room for new opportunities to emerge and lead the way. In the interview guides, I paid attention to consider all three conceptual dimensions.

3.2 Data collection

3.2.1 Semi-structured interviews

Starting in April until July 2021, I conducted a total of 10 interviews. Due to the COVID-19 pandemic, all interview conversations took place online in the form of video calls. Each interview had a duration of 60-90 minutes. With the consent of all participants, I recorded the video calls and saved the files in cloud storage provided by Aalto University. The recordings were then transcribed and I added notes that I had taken during the interviews to each file.

The selection of participants was based on their expertise and inside-knowledge about the case company. In the first four interviews, the aim was to develop an understanding of the ecosystem's architecture, identify relevant stakeholders, and learn about the business development process in the past including the challenges faced so far. Hence, the first four interviewees were members of the core team in the researched case company. The interview guide for the first round of interviews (see Appendix) provided a rough outline with a few, open-ended questions that pointed towards broader topics of interest related to the research questions. This semi-structured interview style was chosen to support my explorative research approach.

The next two interviews focused on the engineering of the project-specific crypto token and the token economics. The interviewees were working for a consultancy that has been advising the case company on their token development. Due to the different focus, these expert interviews were led by a new set of questions (see Appendix).

Based on the insights gathered up to this point, I revised the interview guide (see Appendix) for the interviews that followed. The focus shifted from the inside-perspective towards the individual perspective of other stakeholders connected to the case company with the aim to represent a more holistic view on the whole ecosystem. In this phase, the interview participants were two developers who were building different applications by utilizing the technology that the case company provides, one active community member, and one service designer who was familiar with the case.

3.2.2 Netnography

In order to gain deeper insight on recent developments and to be able to follow discussions among community members, I joined the case company's open online Discord server. The Discord server provides a platform for all stakeholders of the ecosystem to communicate and connect, serving as an excellent case for netnographic research (Bowler, 2010). Since April 2021, I have been passively observing activities on this platform on a weekly basis, taking notes and screenshots of interesting and relevant comments.

3.2.3 Existing data

Due to its open source nature, the case company has been publishing various openly available documentations, as well as frequently adding blog posts about updates, collaborations, comments on recent developments, and more. During June 2021, I have collected all available documentations (7 files) as well as every relevant blog post that was published between January 2019 and June 2021 (67 files).

3.2.4 Workshops

In the context of the research project that this work is embedded in, eight workshops were organized with the aim to describe the characteristics of key stakeholders as well as to identify value flows among stakeholders in the ecosystem. In this approach, the workshops followed an adapted version of the Platform Design Toolkit framework by Cicero et al. (2021). The workshops were scheduled as weekly video calls during September and October 2021. The duration of each session was about 120 minutes. All sessions were recorded and all material created during the sessions was saved in Miro, an online collaboration tool. The number of workshop participants varied between 4-7 people. Two participants, including me, were researchers from Aalto University, while all other participants were associated with the case company. I attended all workshops as an active participant but I did not facilitate the sessions. The generated workshop materials as well as relevant insights for my work, I saved as PDF downloads and notes.

3.2.4 Memo-Writing

During the whole research period, while investigating the Web3 industry in general, I used memo writing (Charmaz, 2006) to save relevant information from various sources such as news, podcasts, other project's Discord servers, blog posts, and social media posts. Furthermore, I was in constant communication with members of the case company for clarification of open questions that appeared throughout the process of data collection. Relevant answers and comments, I saved as memos as well.

3.3

Method of Analysis

Simultaneously to data collection, I started analyzing the gathered data. To allow for an open-ended, unbiased approach to analysis, I decided to use the open coding method. In grounded theory, open coding is the first analytical step to categorize and label raw data (Charmaz, 2006). In theory, open coding is a two-phased process. Initial coding, the first phase, is aimed at the identification of ideas that emerge from the gathered data. In the second phase, focused coding, the most outstanding ideas are grouped into wider categories of loosely related batches of data (Charmaz, 2006). However, in practice, my coding process was more fluid. I have coded each interview transcript shortly after every conversation which allowed me to create and also remove categories in a dynamic way. Although creating categories early in the process may influence the diversity of possible theoretical directions, I ensured that the codes stayed close to the text by using a line-by-line coding approach. In the end, I have coded all interview transcripts as well as all documentation and blog posts that I had gathered.

Previous experience with the method of affinity mapping (Friis Dam and Yi Siang, 2020) led me to translate all codes into single post-it notes. Using Miro, an online tool for collaboration similar to a whiteboard, I created a setting that allowed me to move the digital post-it notes freely. Following the process of affinity mapping, new clusters emerged organically and connections between different themes could be drawn easily. To keep track of the origin of each code, I used different color codes for the post-its. Each color refers to the document of the code's origin. Figure (4) shows the board during the analysis process.

As mentioned before, the evolution of the Miro board can be described as a highly iterative process. I constantly compared emerging themes with existing theory and with existing data that I had collected from other sources. In this regard, the data that I had collected in my memos was very helpful for validation and saturation of the key themes.

According to Charmaz (2006), data collection and sampling should be continued until themes are saturated to a point where no new information can be found anymore. In this study, however, I noticed that the research environment is changing at a fast pace to an extent where data that was collected only a few months earlier could already be enriched by data about more recent developments. Therefore, in the duration of this study, I could only achieve saturation to a certain degree.

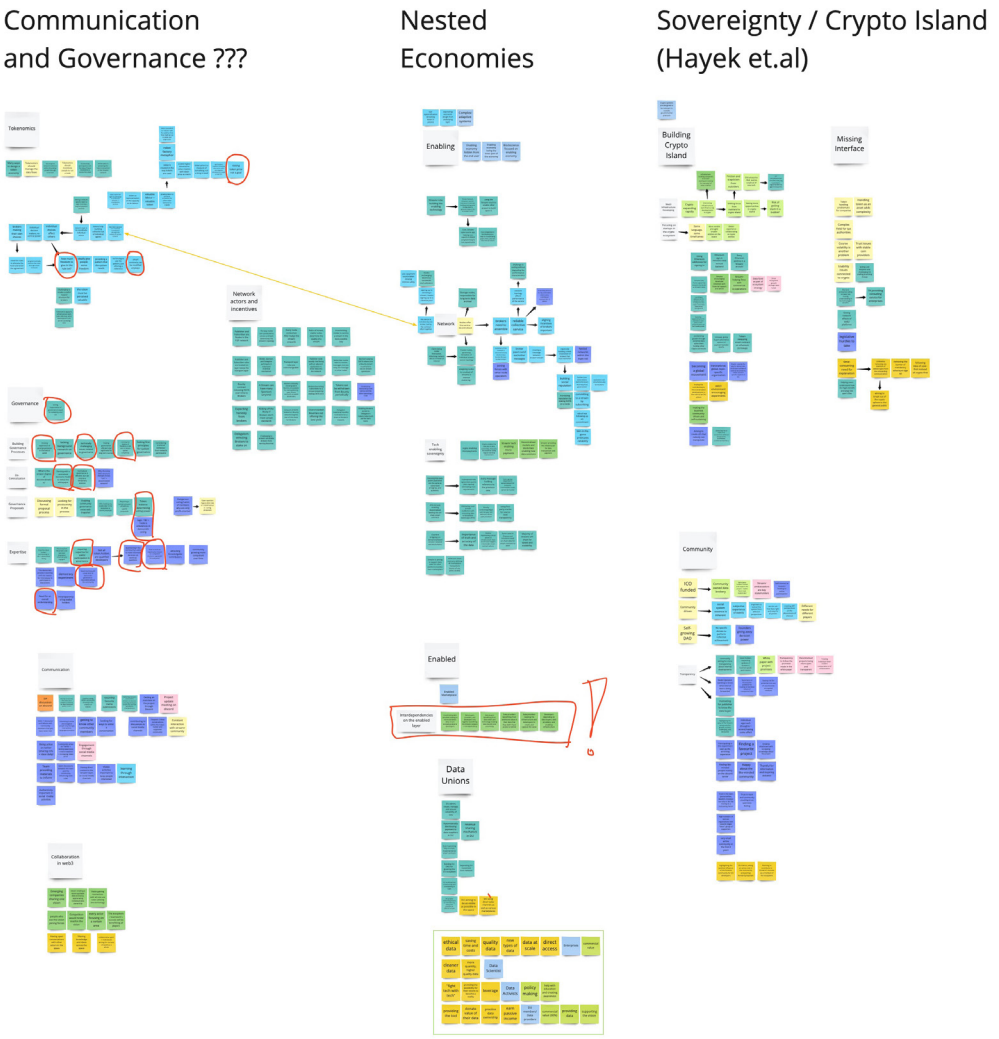

Figure (4). Forming categories from codes on a Miro board – Tullney (2021)

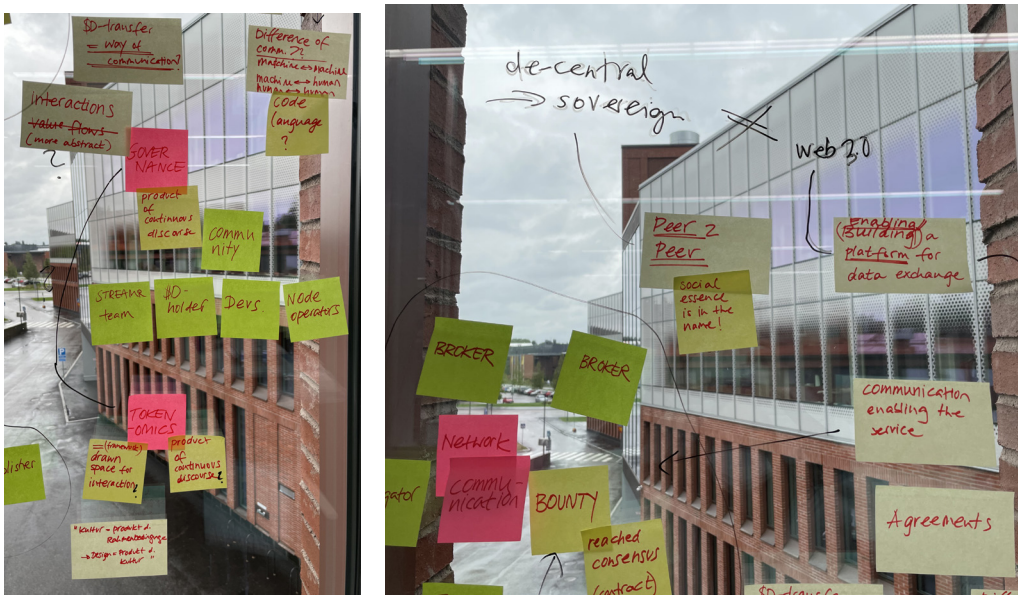

Figure (5). Memo-post its on a wall – Tullney (2021)

4

The Case

In this chapter, I will introduce the Streamr project, my collaboration partner and subject of this single-case study. Streamr was an excellent fit for my research purpose due to its decentralized approach to platform ecosystems, the open source nature, an invaluable expertise of the team and their welcoming supportive attitude.

4.1
Case Introduction

The Streamr project is developing a Web3 protocol that enables a decentralized infrastructure for real-time data transport. Real-time data becomes increasingly important for different purposes. Use cases can be found in applications within the decentralized Web3 environment, in autonomous vehicle communication, in the field of Internet of Things (IoT), and many more.

Motivated by the belief that decentralization of technical infrastructure as well as a decentralized data economy would allow a healthier distribution of power and money, the founders wrote the Streamr whitepaper and started the project development in 2017. Since then, Streamr has been following the predefined roadmap of the whitepaper, developing the protocol while incrementally increasing the degree of decentralization.

The Streamr protocol powers the open and scalable Streamr pub/sub network for real-time data transport, on top of which other applications can build and integrate. Along the way, the Streamr team collaborates with developers, corporations, and the Streamr community to explore possible use cases for the Streamr technology.

Streamr's mission is to build a decentralized real-time data network that enables users to "create, share and consume data streams on an open, scalable Web3 protocol with powerful tools for monetization" (streamr.network, 2022).

4.2

The token

In 2017, following an ICO (initial coin offering) process, Streamr launched a project-specific crypto token called $DATA. $DATA is an ERC-20 token, a standard token format on the Ethereum blockchain. $DATA, however, is not limited to Ethereum but can be bridged to other sidechains as well. The token is available on various centralized and decentralized crypto exchange platforms.

Streamr's $DATA token has been designed and engineered to have three main functions. Firstly, incentivization of network actors, secondly, governance properties, and lastly, means of payment within the Streamr ecosystem.

Coordination and Incentivization

To ensure a reliable transport of data streams in the Streamr network, the actors within the network that help to relay the data, need to follow certain patterns. The economics that are built around the $DATA token, therefore, aim to incentivize a behavior beneficial to the system.

Governance

Streamr's founding team aims to decentralize not only the infrastructure but also its governance. Instead of a centralized party, the network will then be run by its community of users. No specific model of decentralized governance has been chosen yet, however, already today, the community of users have an increasing influence on the project's development. Every holder of $DATA tokens has a right to vote on improvement proposals. In the current plutocratic governance structure, the voter's weight is determined by the amount of $DATA tokens in their wallet. Additionally, a certain amount of $DATA tokens is mandatory to submit improvement proposals to the team.

Payment

$DATA is the currency that is used for transactions within the Streamr ecosystem. Actors who are involved in the transport of data streams get paid for their service in $DATA tokens, data subscribers pay $DATA tokens for access to data streams, data publishers, in turn, receive $DATA for their products. Since $DATA is a publicly traded crypto token, the value of $DATA fluctuates constantly.

4.3

The layers and actors

Streamr's open source protocol provides a platform that should enable users to create, share, and consume data products. The decision to realize this mission in a non-proprietary, decentralized way implies that independent actors need to interact in order to make this mutual value proposition come about. The result is an emerging ecosystem that is in accordance with Adner's (2017) understanding of an ecosystem-as-structure (see chapter 2.1). I adopted this structural perspective to develop a holistic view of Streamr's ecosystem. Thus, part of the interview questions and workshop activities aimed at identifying activities, actors, positions, and links, the four structural elements according to Adner (2017).

During the research process, I started to build a 3D model that depicts the assembled data with the aim to make the overall structure more tangible. The initial purpose of this model was to aid my own understanding of the elements through visualization. In the context of this work, the model is used to visually support the case description.

Figure (6), on the next page, shows the 3D model of Streamr's multi-layered architecture. Main actors and their positions within the ecosystem are represented. In figure (6), the visualization of links between different actors are limited to value flows in the form of data streams and monetary $DATA streams. Activities of actors are described in the subsections 4.3.1 to 4.3.6.

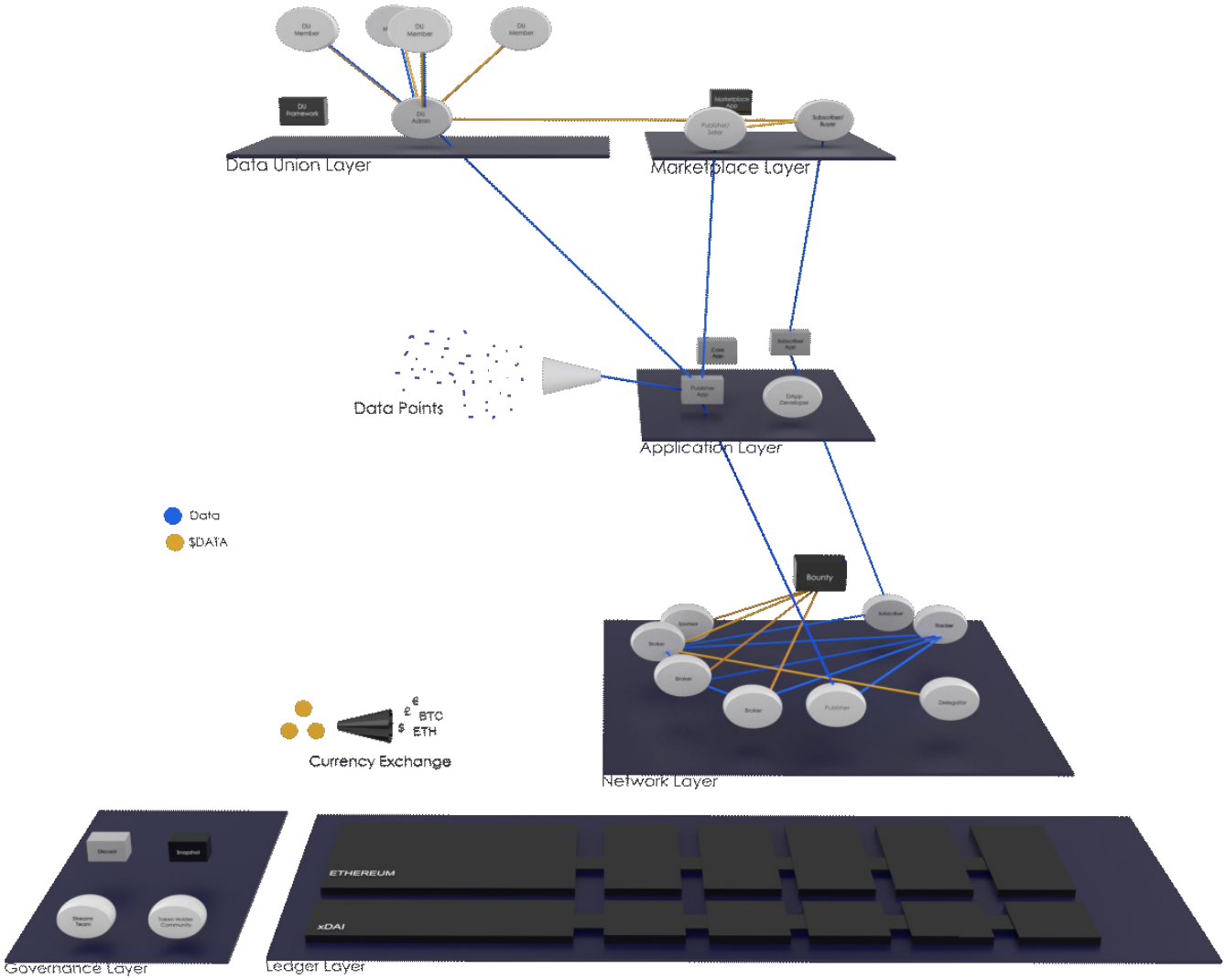

Figure (6). Streamr's layered architecture, rendered 3D model – Tullney (2022)

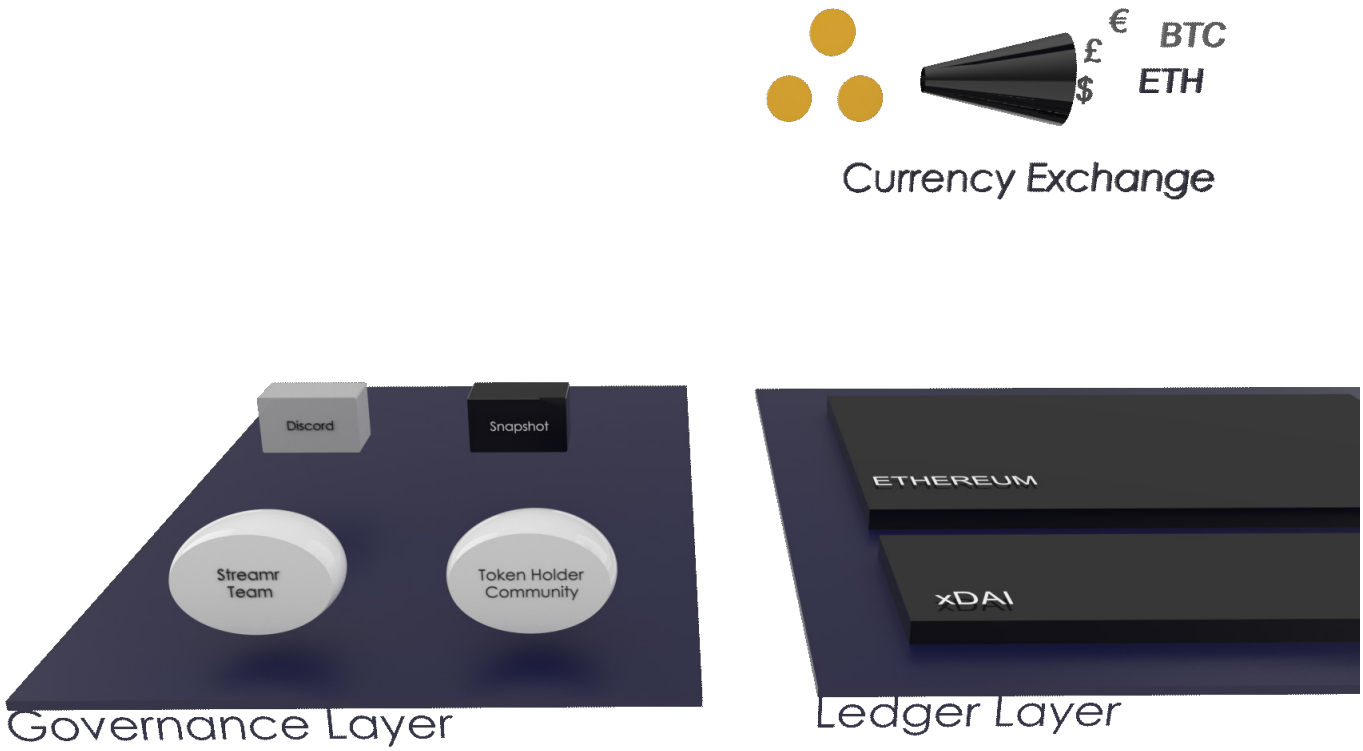

Figure (7). Rendering Ledger layer (Tullney, 2022)

4.3.1 Ledger layer

Streamr's tech stack is a combination of both on-chain and off-chain activities. The ledger layer is the base layer of the stack. Distributed ledgers (blockchains) are used for various kinds of transactions that happen on multiple layers in the Streamr tech stack. Initially, the Ethereum blockchain hosted all of Streamr's smart contracts that govern transactions regarding identity, security, and payment. However, due to high gas (transaction) prices, the focus shifted from the Ethereum mainnet to Ethereum-compatible sidechains which are more cost-efficient to use.

At the time of writing, Ethereum-based smart contracts still define all transactions that are happening on the marketplace layer, e.g. terms of use, price, and access, while Ethereum-compatible smart contracts on xDai (a sidechain) govern the transactions on the network layer and host the Data Union framework. Also the network-specific $DATA token is based on the Ethereum ERC-20 token standard.

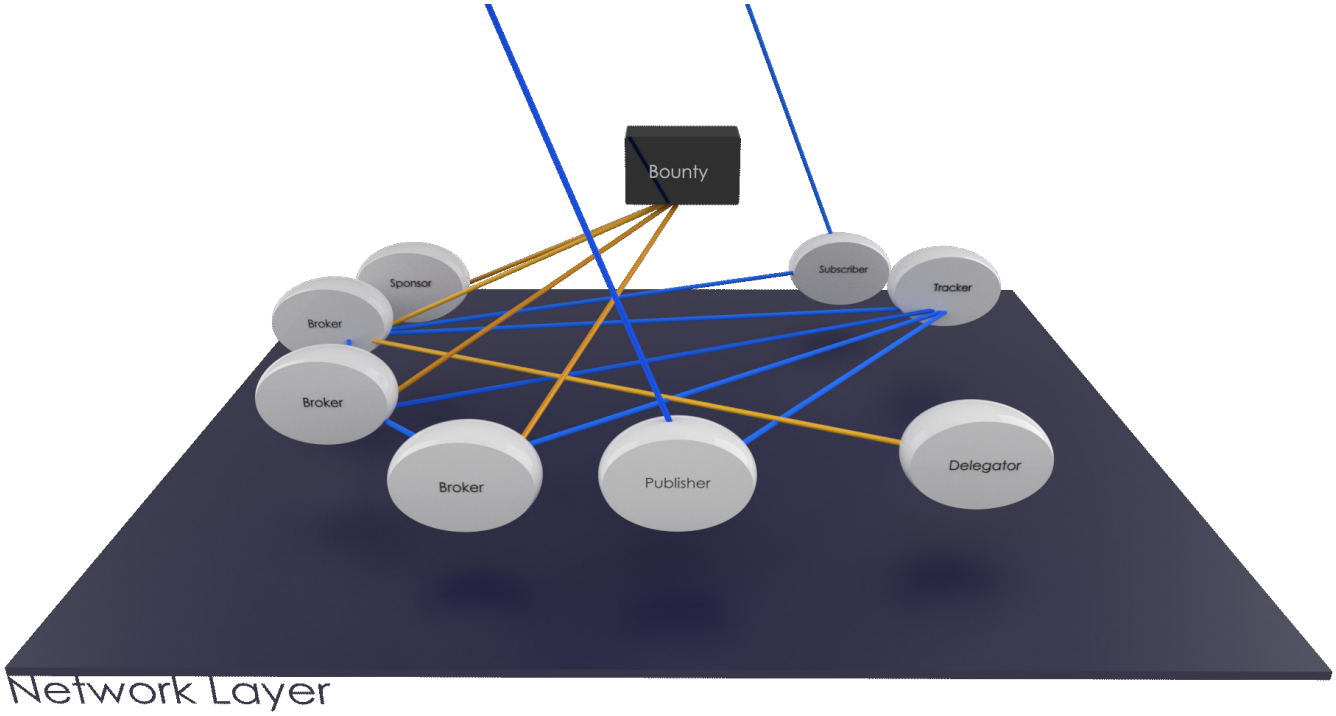

Figure (8). Rendering Network layer (Tullney, 2022)

4.3.2 Network layer

The Streamr network itself is operating almost entirely off-chain. The network layer consists of independent individuals that work together to provide the service of transporting real-time data in a decentralized way. In this peer-to-peer (P2P) network, individual actors have different roles, mostly interchangeable and sometimes multiple roles at once. To guarantee the authenticity and integrity of all data points that are running through the P2P network, where intermediate nodes cannot be trusted, single data points are cryptographically signed.

Single data points form a data stream and enter the network through Publisher nodes. Publisher nodes usually interface with an adjacent application where the data originates from. The goal of the Publisher node is to deliver that data to Subscribers via the network. Therefore, Publisher nodes relay the streams to intermediate Broker nodes or directly to Subscriber nodes that they are connected to.

Subscriber nodes are on the other end of a data stream. Subscriber nodes subscribe to a data stream to access the cryptographically signed data. Similar to Publisher nodes, Subscriber nodes often interface with an adjacent application that processes the received data.

To bridge the distance between a Publisher and a Subscriber, Broker nodes provide the service of relaying the stream. Broker nodes are not interested in the content of a stream, instead, they offer their service of transport and validation for a share of the $DATA tokens that are declared for the transport of a specific data stream. The amount of tokens available for servicing the stream can differ and are determined by the stream's Bounty. Bounties are smart contracts on a public blockchain. Broker nodes are constantly monitoring available Bounties and choose which Bounty they want to mine for $DATA. To mine a Bounty, Broker nodes first need to stake (deposit) $DATA on the chosen Bounty and join the stream's topology by connecting to other Broker nodes that subscribed to service the same stream. The topology of a stream is largely determined by Trackers. Trackers govern the formation by introducing nodes to each other that signal their interest in servicing a specific stream. A Tracker is either operated by the stream owner or by a trusted third party. Because Trackers communicate with every single broker node, they can make observations about the performance of each node. If a node does not provide the service that was agreed upon when signing up to the stream's bounty, the node can be kicked out and lose it's stake. Hence, staking $DATA on a Bounty should incentivize nodes to act according to the Bounty's terms and conditions that aim to secure a stable and reliable service.

The amount of $DATA a Broker node stakes on a Bounty determines the share of their earnings. However, Broker nodes can get backed by Delegators to increase their stake. Delegators do not run a node themselves, but provide liquidity to Brokers and receive a share of the Broker's yields in return. Broker nodes can claim their rewards periodically and withdraw their earned $DATA tokens from the bounty. The pool of $DATA in a Bounty is filled by Sponsors who are interested in a secure and reliable operation of the stream. Everyone with an interest in the stream can become a Sponsor.

At the time of writing, Streamr's decentralized public P2P network is about to launch. Previously, all nodes have been operated centrally by the Streamr company. Therefore, the structure of the network layer described above follows the underlying theory but has yet to be tested in real life operations.

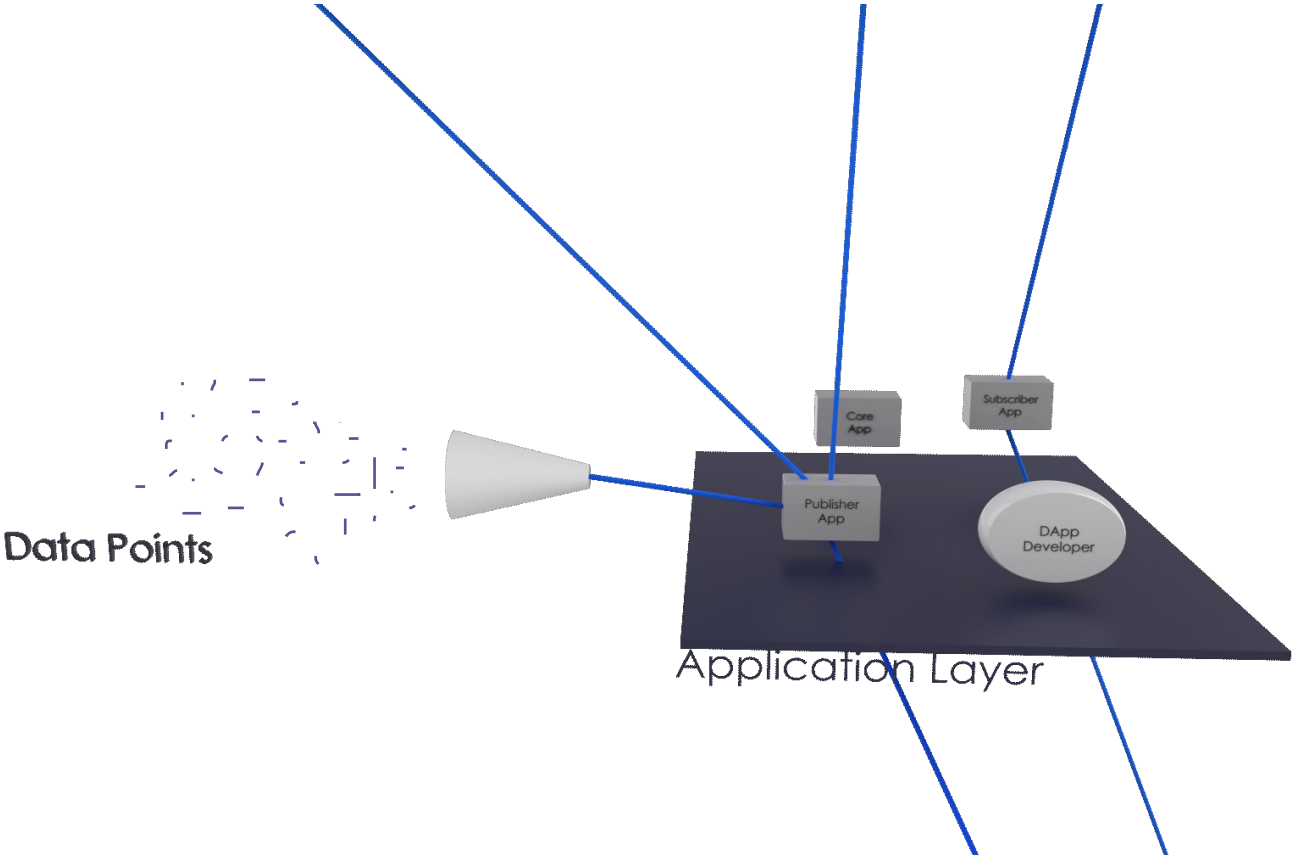

Figure (9). Rendering Application layer (Tullney, 2022)

4.3.3 Application layer

Streamr claims to build layer 0 for real-time data in Web3. All code is open source and invites developers of (decentralized) applications to integrate with the network or build on top of it. With the so-called Core, Streamr has built a toolkit for programmers and data scientists to conveniently push, fetch, and sell data products. The toolkit should lower the threshold for people who are not familiar with Web3 coding by simplifying the necessary steps. Furthermore, to enhance platform growth, the Streamr team actively supports projects that utilize the Streamr tech stack, with funding and technical expertise.

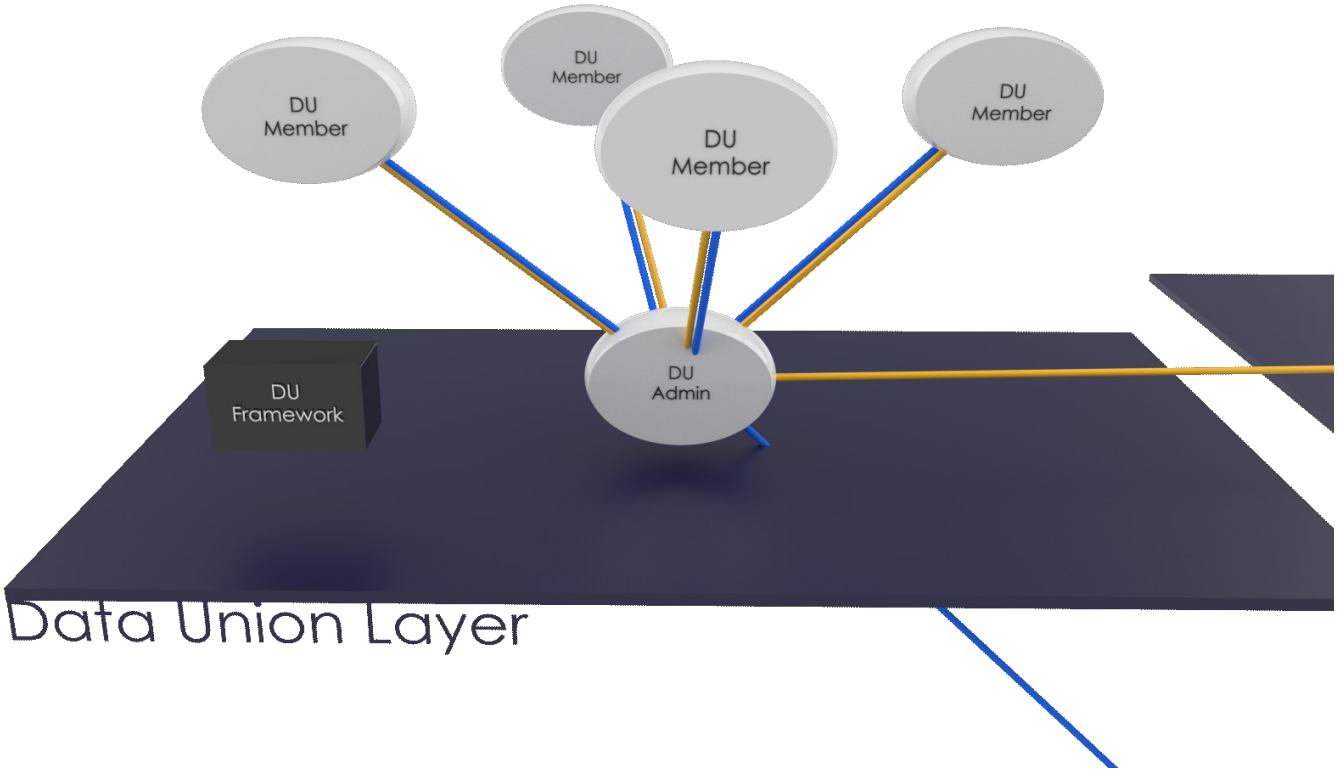

Figure (10). Rendering Data Union layer (Tullney, 2022)

4.3.4 Data Union layer

Streamr developed the Data Union (DU) framework as one possible application that utilizes the Streamr network. In a Data Union, individuals can become a Data Union member and publish their generated data alongside many other data providers. The type of data that is being shared varies between different Data Unions. In general, DUs are a way to crowdsource and crowdsell data. Aggregated data is of particular interest to data buyers because it allows for greater and more detailed insights. Another benefit of crowdsourced data is the ethical aspect of active consent. The individual person is empowered to decide what kind of data they are willing to monetize and therefore, share.

A revenue sharing mechanism, in the form of a smart contract, ensures that whenever a DU product sells, all contributors automatically receive a share of the payment. The one-to-many distribution of value is enabled by crypto payments. In traditional banking this form of micropayments would be too costly. A smart contract handles the automatic payment. To avoid the high gas fees on the Ethereum mainnet, the DU smart contracts now run on the Ethereum-compatible side chain xDai.

A Data Union consists of Data Union members who contribute their data, and Data Union admins. Data Union admins create the Data Union. Among other things, they are responsible for developing an application to use as an interface between the DU framework and the DU members. They are also handling all communication with relevant stakeholders, selling their DU products, and recruiting new members. A share of the revenue is being paid to the DU admins as compensation for their work.

The next step in the evolution of Data Unions will be the separation from the Streamr project by launching a separate DAO for Data Unions, including their own $UNION token. The Data Unions will use Streamr's DU framework and likely remain users of the Streamr network for data transport but will be decoupled from Streamr's tech stack.

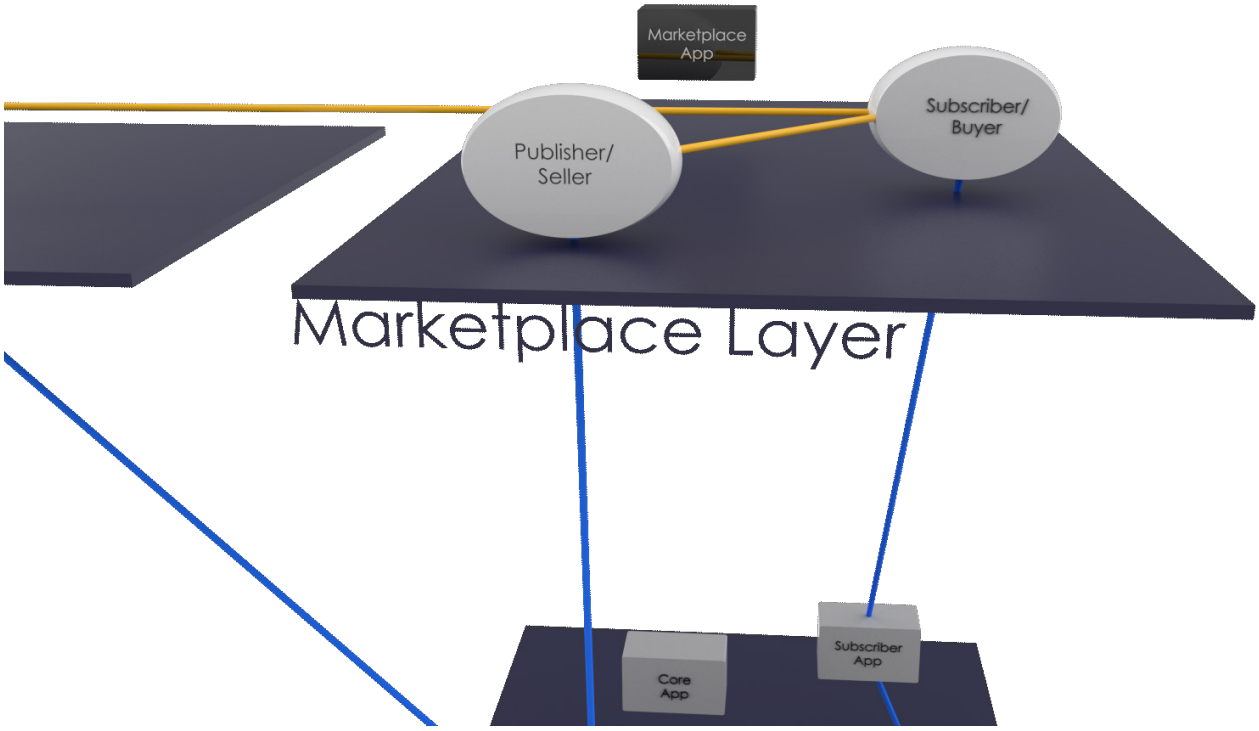

Figure (11). Rendering Marketplace layer (Tullney, 2022)

4.3.5 Marketplace layer

The Streamr marketplace is an application that Streamr built on top of the Streamr network and Ethereum blockchain. Ethereum is used for the Marketplace smart contract that handles the registry of data products, controls access to them, and secures the payment transactions. The Marketplace is an open source application that enables access to the real-time data content on the Streamr network. Data publishers can directly sell their data products to interested data buyers using the Streamr network for decentralized data transport, while cutting out middlemen. The Marketplace also offers the option for data producers to publish their data freely available to everyone. For all monetary transactions on the Marketplace, the local currency $DATA is used

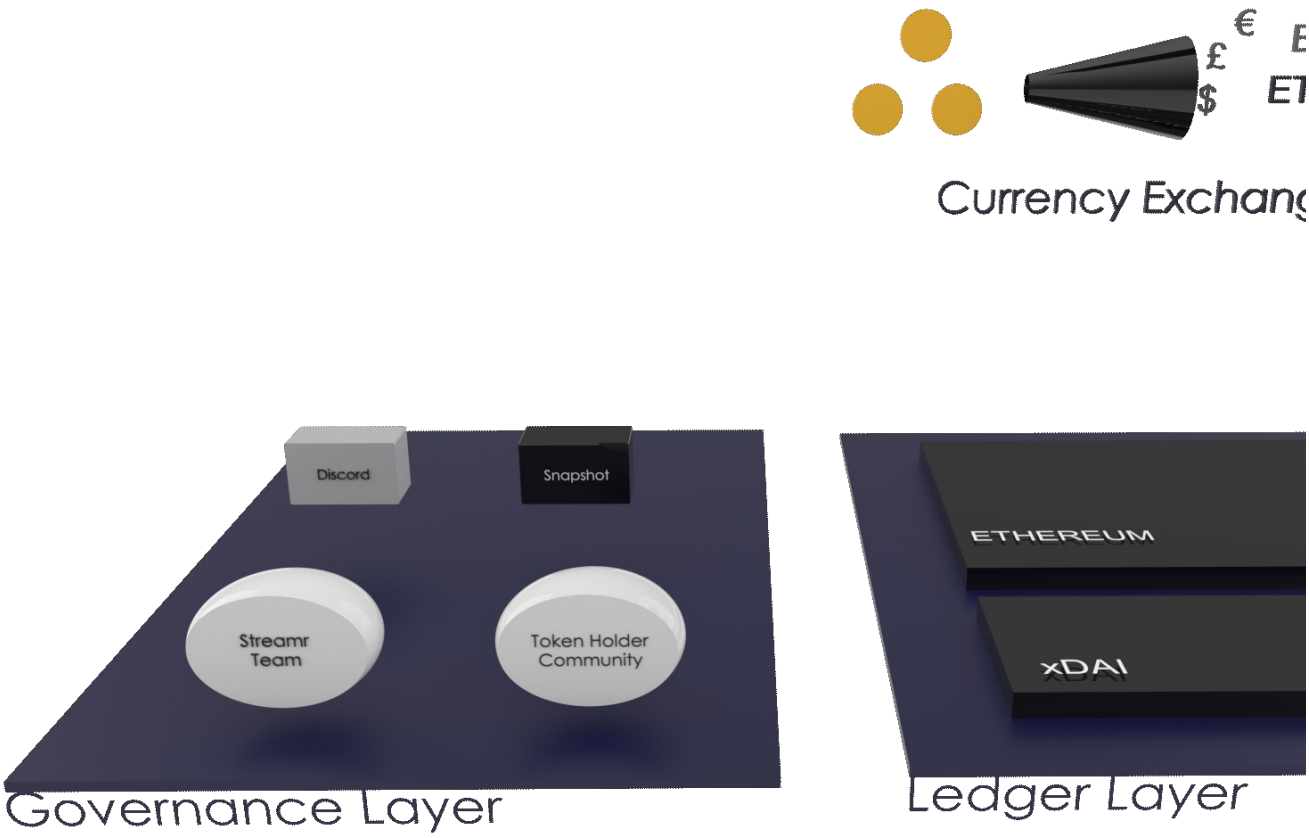

Figure (12). Rendering Governance layer (Tullney, 2022)

4.3.6 Governance layer

The governance layer is not directly part of the Streamr stack, yet, it is an important element in the system's architecture because activities on the governance layer have an influence on all other layers in the system. The processes, roles, and dependencies within the layer reflect the governance structure. Currently, a powerful actor on this layer is the Streamr team that still holds the majority of $DATA tokens. Other actors are all $DATA token holders in the Streamr community that are increasingly entitled to steer the development of the project through voting, submitting improvement proposals, and providing knowledge and feedback to the team. The main tools that are used for governance purposes are Discord, the primary medium of communication, and Snapshot, a tool that supports the voting processes.

5
Findings

5.1
Overview

In this chapter, I will present the findings that I derived from the analysis of the collected data. The research revealed several challenges that pose barriers to the development of decentralized platform ecosystems. Five key themes are visualized and described below.

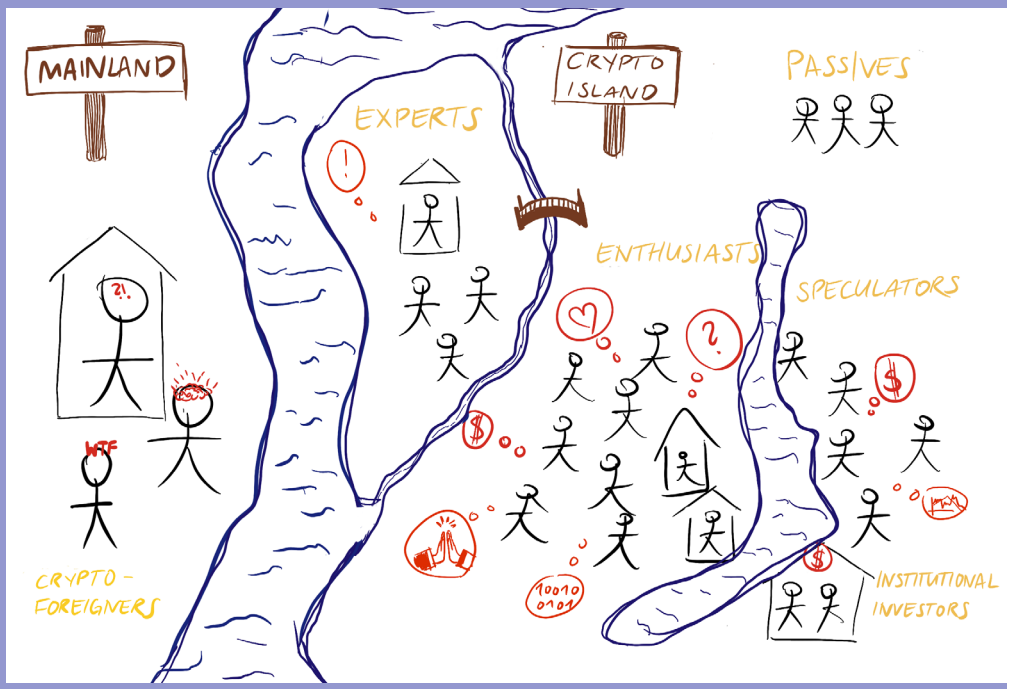

Figure (13). Visualization of research findings – Tullney (2022)

Access

Projects in the Web 3.0 industry are built on paradigms of openness and inclusion. Yet, in reality, foreigners to the industry have difficulties accessing the Web 3.0 environment. Among the identified challenges for crypto-foreigners are language barriers (code vs. non-code), troublesome user-experience, and a tech-dominant culture that causes confusion. The analogy, introduced by one interviewee, of a separation between the community on crypto island and foreign mainland actors illustrates the current situation well.

Incentivization and Communication

On crypto island, a new form of organization has been developing, decentralized autonomous organizations (DAOs). Many actors on crypto island are organized in DAOs. DAOs are mission-driven, self-governing communities, organized in a non-hierarchical way that rely on the active participation of DAO members. In order to coordinate the DAO's activities, successful communication is highly important. Especially because DAO members have the right to vote as well as submit their own improvement proposals and thereby, influence the direction of the DAO-governed project. However, different professional and cultural backgrounds and unsufficient tools make successful communication difficult. Yet, communication is particularly relevant when DAO members have different motivations and sometimes conflicting intentions. The biggest gap of interest was identified between DAO members who are mission-driven enthusiasts of a project, and on the other side, DAO members who are mainly monetary-driven speculators. Speculators are interested in the monetary value of project-specific tokens. In blockchain-based projects, crypto tokens often inherit coordination properties. Tokens can be designed and engineered to incentivize participants to act in a certain way beneficial to the system. However, if the token is solely seen as a speculative item for profit-oriented crypto trading, the initial purpose is conflicted. Apart from monetary incentives, the research showed that peer-recognition and acknowledgement for various contributions to the platform development is a strong incentivization mechanism for the group of enthusiasts. However, currently, contributions are intransparent and, therefore, less likely to receive acknowledgement by the community and the project team.

Governance

Although a DAO is supposed to be governed by their DAO members, the researched project is still largely controlled and developed by the project team. The findings show that for governance to be fully decentralized, an expertise is required that not all DAO members have. The empirical data suggests that successful communication is essential for knowledge exchange between experts and their peers. Yet, the commonly used channels for communication are open social media platforms where focused discussions are frequently interrupted by unqualified comments, and users are exposed to scamming attacks.

Complexity

Lastly, it was found that complexity, unpredictability, and emergence are elements of crypto island that pose challenges to all participants who interact in this environment. For design, this implies a need to adapt the tools and processes that would enable successful contributions to the development of projects in the Web 3.0 ecosystem.

In the following, the identified challenges will be described in more detail.

5.2

Access

Projects in the Web 3.0 industry are built on paradigms of openness and inclusion. Yet, in reality, foreigners to the industry have difficulties accessing the Web 3.0 environment due to language barriers (code vs. non-code), troublesome user-experience, and a tech-dominant culture.

Most projects in the Web 3.0 space are considered to be open for contribution and engagement without any artificial barriers.

> *Streamr is an open-source project creating a platform and tools for the world's real-time data to be owned and traded by those who produce it. (Blog Entry,15)*

Yet, research shows that barriers exist which cloud the idea of an inclusive space. Open source code is one example of the principle of transparency that many projects in the space follow.

> *We always keep them [stakeholders] kind of updated on our trajectory and what we're building. We build everything in open source so they can always just kick the tires of whatever we're building while we're building it, so that's, I think, very helpful. (Participant A)*

While open source code is transparent to those with a certain background in the respective technology and the capability of understanding and interacting through code, it might be incomprehensible to others. A knowledge gap in regards to understanding the new technology, the protocols, and its wider implications, has in the researched case, hampered collaboration with actors outside the Web 3.0 industry.

While there is clear willingness from these huge multinational conglomerates to try new innovative technology solutions like Streamr, if the benefits of using the technology are not clear, nor easy to understand, their ability to unlock internal investment to support R&D projects is pretty limited. (Blog Entry, 14)

As a result, the team in the studied case, has decided to focus on collaborations with actors who are already part of the Web 3.0 space instead.

We sort of scaled down trying to contact the enterprises and work with them because, it was quite, it's very time-consuming, all the sort of cycles are very very long […] so we sort of refocused more on the start-up side and on the crypto companies in the crypto ecosystem. There we have had of course much better success because […] it's the same language, the time frames are the same and everybody understands like this and you don't need to explain everything. (Participant B)

Consequently, an exclusive circle of actors is forming around an emerging industry. Those actors that have crossed the access barriers can be considered part of crypto island, as one interviewee described it.

We have this analogy of crypto-island essentially and the mainland. So, we've been trying to reach out to the mainland and get them to come over to crypto-island, so these big older enterprises that are very risk-averse and a bit skeptical of new technology. But at the time crypto was so small we thought this was the way to do it, we have to reach out to these bigger companies and sell them the vision but this has been a hard road and, during the last few years crypto has expanded very rapidly. They've built their own finance, they've built all sorts of interesting infrastructure and we start to see more opportunities on crypto island rather than trying to convince the mainland people to come over to crypto island. So, this year, sort of the focus is crypto island. (Participant A)

At the same time, the empirical data suggest that, once the access barriers are overcome, the Web 3.0 space is a very inclusive and collaborative environment.

It's a very collaborative space at the moment. I haven't met any friction with anybody or anybody keeping their cards close to their chest. I get the sense that everybody who is in it at the moment wants the space as a whole to be successful. (Participant I)

[Streamr is] helping us, first of all as one of our investors, so they encourage these kinds of initiatives. That's very important for those who are interested in this space, and they give you, kind of advise and support, financially and kind of, emotionally because as a start-up founder you have very, kind of intense life. There's a lot of ups and downs. So, they are next to you in that. And, yeah, they are open to share their services, their team members help, so they've been very helpful in that regard as well. (Participant H)

It is apparent that the motivation to favor collaboration over competition is rooted in the shared incentive to grow the industry and collectively bring it closer to the mainstream.

If we are going to [...] change a paradigm, for example, if you wanna go against Google [...], then one of us can't do that because they are already so big. So we have to join forces, [...], all these people who kind of see the vision. If we wanna compete, then that vision will be [...] wasted and the resources behind it as well. (Participant H)

If we are to join forces and get aligned, [..], everybody will focus on what they are good at and what they like and then the benefits of this kind of teamwork or ecosystem work will be distributed to all the players. (Participant H)

We're all going to make it! At least at this point there's a big blue ocean of opportunity for everyone to enjoy. Not only that but the confidence that we can grow the pie rather than just compete for how big our slice is. That's my opinion, maybe/hopefully it's the Zeitgeist of the space. That attitude will probably evolve over time but I think that's the current mood. (Participant A)

On their mission to make the new technology accessible to the broader public, one interviewee has claimed that their Web 3.0 application is aiming to bridge the gap from crypto island to the mainland.

"What we'll be doing in contributing and maybe leading in the space, is making it a mainstreamer. As in break outside the crypto sphere to general public. Which I don't think really anything a Web 3.0 has done yet." (Participant I)

Yet, one of the remaining issues on this mission is troublesome user experience. For the stakeholder group of end users, it could be observed throughout the space that tech-dominant app solutions are ruling. As one interviewee described, this fact leads to friction in the on-boarding process of users without technological background knowledge.

If we're trying to get end users and we want to get a good slice of the population, we don't just want 30–35-year-old males who are predominantly the crypto audience. We need a wide range of ages.[…] So we need to make it familiar to them, and the crypto space isn't familiar. (Participant I)

We don't want to be crypto first or Web 3.0 first. We want to be user first. […] We'll probably remove any mention of the crypto space from our onboarding process (Participant I)

The trouble of missing human-centered design was also attested by a service designer during the interviews.

Well, Web 3.0 is really tech-oriented and very much top-down until, well, traditionally until now. If you are the only person in the room who is defending the user-centric starting point then you easily feel alone. That's a given fact. (Participant E)

It seems to me that even though the mainstream of digital design has gone to a very user-centric direction; so if you are creating a new app, you have your start-up and new digital product, then it would be very strange if you don't do service design. If you don't have the guarantee that the market will actually accept what you are doing before you launch it; it's taken for granted. But for some reason in the blockchain and in the token space it's not like that. It's very top-down. It's very waterfall method and straightforward. Even worse because you write the white paper where you promise that it will be done exactly that way and then you just need to keep working that way. This is a really difficult thing for many projects. (Participant E)

5.3

Governance

A decentralized autonomous organization (DAO) is a crypto-native form of organization. DAOs are self-governing communities, organized in a non-hierarchical way, and relying on the active participation of DAO members. DAO members have the right to vote as well as submit their own improvement proposals and thereby, influence the direction of the DAO-governed project. However, to exercise their rights, an expertise is required that not all DAO members have.

On crypto island, value is co-created as a collaborative act. In the researched case, this means providing an infrastructure for real-time data transport.

> *The actual valuable service isn't an individual broker servicing a stream, it's a collection of brokers, doing an act together. (Participant F)*

In consequence, the project's community is tasked with an increasingly active role in the process of distributing the power from a centralized instance to the various stakeholders of the ecosystem.

> *The Streamr community is not only invaluable to the growth of the ecosystem and the ultimate success of the Streamr project, it energises the team with ideas, challenges and discourse on a daily basis. (Blog Entry, 32)*

> *We're trying to kind of, make a business that is community driven, that is self-sustaining. (Participant H)*

Throughout the industry of decentralized systems, it can be observed that in order to coordinate collaborative activities, a new type of organization is forming. Decentralized

autonomous organizations (DAOs) are a non-hierarchical way for stakeholders of a decentralized network to organize and participate in the coordination and further development of their ecosystem.

> *Behind every DAO is a group of token holders that is incentivized to achieve a shared mission. The DAO is a decentralized decision making system that helps token holders coordinate their efforts and reach consensus through governance proposals. Achieving this mission can be thought of as the objective function of the DAO. (Blog Entry, 63)*

Active participation is necessary because, in decentralized ecosystems, the success of the whole system and its provided services is built on the community's collective actions. In the researched case, it is not only the technical infrastructure that is provided by DAO members, in the future, they will also have the responsibility to actively shape the DAO's development.

> *So, I see DAO as being a big part of what we'll do. Like we'll want to see Streamr be as successful as possible because we're part of the ecosystem so we absolutely plan on playing a big part in the community and the development of ideas yes. Coming from the community and taking part in discussions about maybe other community led ideas that are put forward. (Participant I)*

A way for DAO members to influence the future direction of the project is by putting forward improvement proposals as well as by participating in voting processes about proposals submitted by other members.

> *Token holders can vote and participate in a project. The more tokens you have, the more „voting power" you have. (Discord Comment, 1)*

> *For the first two rounds of Streamr governance voting, only the Streamr team were able to submit governance proposals. This was a temporary limitation to first get some hands-on experience with how the Snapshot tool works, and to learn what participation level can roughly be expected from the community of token holders. However, for governance to be truly decentralized, any stakeholder in the ecosystem should be able to submit proposals, which is exactly what SIP-4 proposed. (Blog Entry, 68)*

> *The Streamr Improvement Proposal (SIP) 4 has been implemented. DATA token holders can now submit a proposal in Snapshot for the community to vote on. (Discord Comment, 2)*

Although DAO members are supposed to participate in far-reaching decision-making processes, individual members may be overtasked in this position. That is, in order to exercise their rights in an informed way, expertise is required that not all community members bring to the table to the same extent.

> *Usefully participating in governance may require expertise that is hard to find beyond a small group of developers and enthusiasts. (Blog Entry, 23)*

Besides expertise, a good understanding and an overview of the ecosystem were equally emphasized by another interviewee who pointed out that an overall grasp of the ecosystem can support stakeholders in their anticipation of the potential impact regarding improvement proposals as well as voting decisions.

> *I think we can, we'll also play a part in the community, [...] maybe in the future putting forward proposals. We can, from our experience of how we have to manage a Data Union and also being users of say something like [anonym.] or other Data Unions that come along, we should have a good overall grasp of the Streamr project as a whole. So we should be in a good place to put forward proposals to the DAO as well.(Participant I)*

During the interviews, one community member himself raised his concern over missing expertise within the community and therefore highlighted the need for a diverse community with members from different disciplines. The research data shows that due to the fact that many processes in decentralized organizations are governed by automated smart contracts in the form of computer code, many voting decisions are concerning a technical matter. Other cases may require the DAO members to find solutions and decide over questions from various fields such as organizational design or economic theory. Apart from different fields of expertise, the need for a thorough understanding of the ecosystem in order to make informed decisions and limit the risk of self-serving voting behaviors was further emphasized by the interviewee.

> *I sometimes wonder whether a community can really be trusted to make decisions that are of a technical nature or are also mechanical. That is, there are so many things that you simply have to have an overview of, in order to be able to make the right decision. I sometimes think that maybe a small token holder might not be able to do that. Or maybe some people can. As far as the technical things are concerned, there are all the developers who simply understand how the code works and so on. […] But many who then maybe want to participate and actually only think about that they hopefully make tenets or so. And only vote in that favor, then it becomes difficult. And that's one thing: I think the community has to expand and change first. So I think that then over time a lot more competent people will come in and deal with all these kinds of aspects, maybe even at the same time. (Participant J – translated by the author)*

As a consequence, many projects still feature largely centralized components in their governance structure. Usually, the project founders and a core team remain an instance with decision-making power. One explanation that can be found in the empirical data, is the need to ensure the project's development according to a previously agreed roadmap. The roadmap builds an important part of the whitepaper that most projects publish when they launch.

> *Since the Streamr project launched in 2017, the core team has been making decisions about the project in order to make progress on the roadmap and towards the project vision. While efficient, such a centralized governance model is only appropriate as a temporary placeholder. (Blog Entry, 49)*

Another reason for partly centralized governance might be that DAOs are still at an early stage of development considering the young age of the industry.

> *Most decentralized projects are still young. Business decisions and technical calls tend to be made by the original founding team or groups of core developers. This is because blockchain technology is still a relative novelty, and designing and implementing good governance is hard. […] When we started to think about the future governance of the Streamr project, we were struck by the lack of available background research. (Blog Entry, 23)*

Yet, a centralized governance model contradicts the original idea of a decentralized autonomous organization. A fact that was likewise pointed out by various community members who were requesting full transparency and equal rights of participation in all governance decisions.

> *One cannot in good conscience claim that a service is decentralized if it is effectively controlled by one entity or a select group of people in the know. Efficient and legitimate governance is crucial for the long-term success of decentralized technology. (Blog Entry, 23)*

For this reason, it can be observed that within the group of early DAO projects, an increasing effort is currently put into the transition towards a higher degree of decentralization. The research data shows that the particular importance of a functioning governance structure is acknowledged by the industry. Hence, solutions are being explored that would support a decentralized governance structure.

> *Getting it [governance] right is at least as important as scalability and user experience. Getting it wrong is a sure way for a platform or project to find itself mired in controversy. (Blog Entry, 23)*

5.4

Communication

Successful communication between all stakeholders is critical for the operation and governance of a decentralized platform ecosystem. According to the research data, however, the commonly used channels for communication are open social media platforms where focused discussions are frequently interrupted by unqualified comments, and users are exposed to scamming attacks.

The researched case shows that successful communication between all involved stakeholders builds the foundation for knowledge exchange that further enables informed decision-making. According to the data, social media channels are the most popular way of communication in decentralized ecosystems.

> *So, there's plenty of engagement through social media channels whether that be Twitter, whether that be LinkedIn or any other channels like Discord. We have Discord groups set up to talk about certain topics with the community of ambassadors as well as just generally interested people. (Participant C)*

Discord servers are developing into a preferred channel of communication among projects in the Web 3.0 industry due to features such as live streaming, the option to create a set of different topic-specific channels, as well as unrestricted access.

> *We've started to hold project update meetings where we do them on Discord, as a kind of live feed that people can listen in to, because it's this whole approach of decentralised projects being more open and transparent essentially. (Participant C)*

In the studied case, the Discord server not only hosts conversations between community

members, interested external individuals, and the project team, but also functions as an interface for all kinds of technical questions that are openly discussed between application developers, node runners, and the project team.

> *Discord is now also the home for Streamr's developer community and technical discussions. The old developer forum has been archived and the new section on Discord is your place to discuss the Network, Data Unions, Tokenomics, bug reporting and anything else focused on the tech stack. (Blog Entry, 60)*

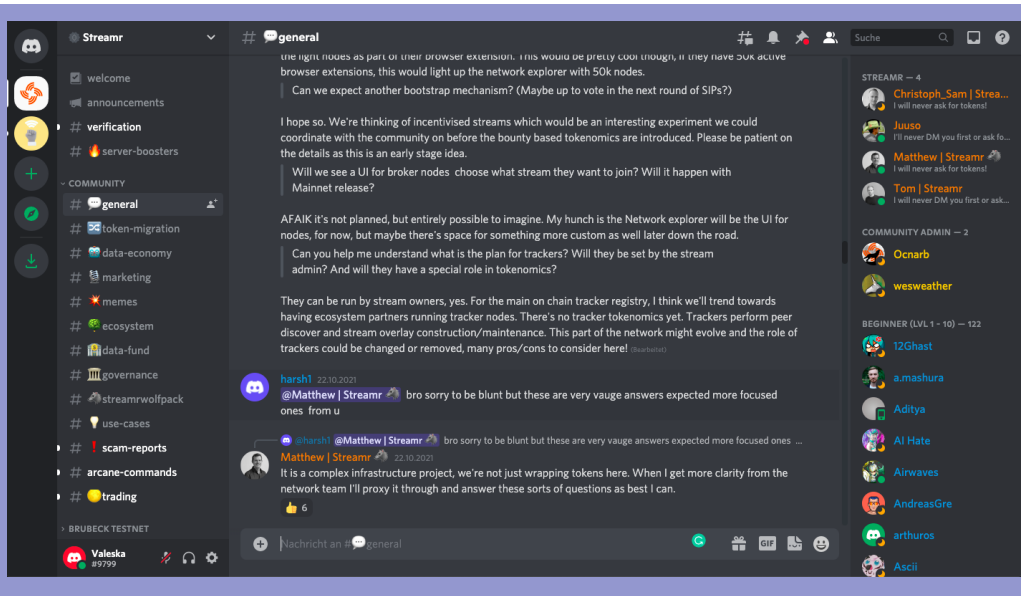

Figure (14). Screenshot of Streamr's public Discord server on 22.10.2021

The empirical data shows that an opportunity for knowledge exchange and discourse is of particular importance in an environment such as Web 3.0. In Web 3.0 projects, the community often consists of individuals with various professional and cultural backgrounds that are distributed around the globe. For most members, the chosen communication tool is, thus, the only way for interaction and meeting their peers.

> *When you make a comment and then get involved in a conversation, you slide deeper into it, and at some point you know the other participants, although you actually only know their user names and that's it. […] But somehow, it is, you actually don't know the person at all, only the written words, but you think: Oh, that's him again! That is funny in a way. That is exciting. Particularly, because - especially in this DAO setting – it's not only a community, but a real discourse and debates with people that you actually don't know. (Participant J – translated by the author)*

> *Well, I think that if I don't think subjectively, but rather as a group of token holders who are connected to the team, […] this is a constant exchange, a constant interaction. And there are always debates and both sides influence each other in these debates, so it is as it should be actually. It comes from the community, it's thrown over to the team: They throw something back and initiate something, which in turn brings in even more people. (Participant J – translated by the author)*

Despite the importance of the communication channels for thoughtful discussion, it could be observed that throughout the Web 3.0 space, the used social media channels are exposed to a substantial amount of unqualified content and scamming attacks as a result of many projects' open and unrestricted nature. Following the behavior pattern on Discord channels, this phenomenon is likely enhanced by the user's anonymity which is an elementary principle of blockchain technology.

> *We used to be on Telegram and that was even worse. Discord is much better. But it's also sort of descended into this madness (Participant A)*

Although Discord offers the possibility to organize discussions in various topic-specific channels, it is difficult to follow single threads of discussions within the channels. Threads tend to be interrupted by comments to unrelated topics, leading some well started discussions into a void. The empirical data reveals a need to design processes that support stakeholder interactions and facilitate communication. That is of particular importance considering the changing role of the community and the increasing interaction of single individual actors with various sometimes conflicting motivations. Furthermore, according to a comment from one interviewee, well-functioning processes should strengthen stakeholder relationships.

> *We want to offer participants the opportunity to actively contribute to Streamr's development in parallel with the advancement of their own project and business ideas. For this, I believe people need to have a real sense of control over how their own personal goals can be realised in conjunction with our shared ones. This ethos is one I've tried to weave into every external relationship I've developed over the last year. (Blog Entry, 19)*

5.4
Incentivization

Decentralized platform ecosystems need a specialized, predictable coordination tool. In blockchain-based projects, project-specific crypto tokens often inherit coordination properties. Tokens can be designed and engineered to incentivize participants to act in a certain way beneficial to the system. According to the research data, however, many actors understand the utility of crypto tokens to be speculative items for profit-oriented crypto trading which conflicts with the initial purpose. Furthermore, the empirical data shows that another incentivization mechanism is peer-recognition and acknowledgement for various contributions to the platform development. Yet, currently, contributions are intransparent and therefore, less likely to receive acknowledgement by the community and the project team.

Actors in a decentralized network are not following any higher order. Therefore, individual actors are sovereign in their decisions about how to interact with the network.

> *There's no central point of decision-making authority. There's a bunch of individual decision-makers, people choosing to publish streams, people choosing to run brokers, and those might be some of the same people but ultimately their choices are theirs. They can leave the platform, they can make more or less nodes, they can add resources to the nodes that they're running, they can, you know, there's this actually very very large, individual choice set or like decision surface. (Participant F)*

Taking the large decision surface into account, decentralized organizations are exploring ways to encourage independent actors to act in a way that is beneficial to the system. One result is the introduction of incentivization mechanisms. These mechanisms can take various forms.

Characteristic for the Web 3.0 environment are project-specific tokens. In the researched case, the token was designed and engineered, inheriting properties that enable a token economy that would help to coordinate transactions and other processes in the system.

> *Token economics are crucial because they are the mechanism by which the network captures the value created by user adoption. The mechanism incentivises people to participate in running the network, which enables decentralization, which enables the vision. (Blog Entry, 32)*

However, the research showed that many token holders see the sole utility of the token in its potential for speculative crypto-tradings.

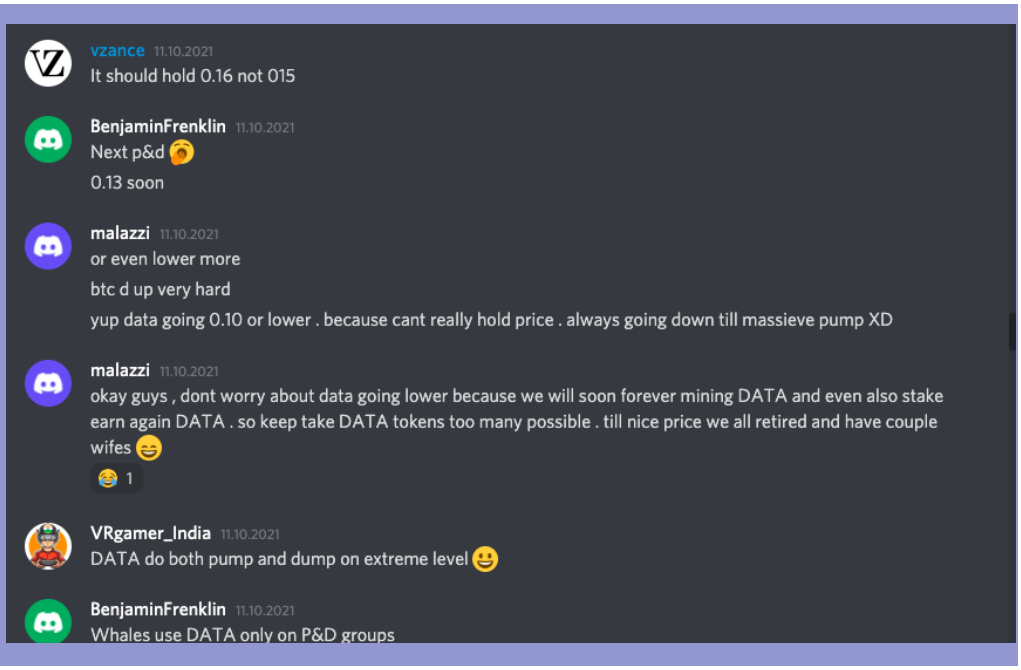

Figure (15). Screenshot of the #trading channel on Streamr's public Discord server, 11.10.2021

Yet, instead of understanding the token value as a speculative item or as a form of money, it can better be thought of as a metric for the creation of higher dimensional value. As one interviewee pointed out, the project-specific token in the network is a representation of the capacity to do labor.

> *The role of the token is just to coordinate that economy. No-one outside should necessarily care, they could speculate on it if they see it as increasing in value, but the role of the token is to basically turn a bunch of otherwise individual agent actors who are running brokers, into a collective, producer of a platform service that basically sends streams around the world, in a reliable way. (Participant F)*

Even if a substantial share of the community is directing their activities towards the goal of raising the token price, it was argued during one interview that this is not always beneficial for the overall success of the system.

> *I tend to canonically not take token price go off as a goal. Not because it's not a good thing to happen for the ecosystem, but it's [...] like a measure of something rather than a thing in and of itself. So, I'm hesitant almost always to take something like that and place it as a first article, because [...] it's often possible to optimize for that in a way that creates negative externalities on really useful properties. (Participant F)*

Besides monetary incentives that can be attached to the token as a metric of value, actors' behavior can also be incentivized through soft incentives such as reputation. Reputation is something that is especially important in the transport network layer and can be earned by protocol-conform acting brokers. Reputation is given by their broker-peers who learn through interaction which brokers are reliable and acting responsibly. For Brokers, a higher reputation can be equally valuable for their financial success.

> *We've been looking at this revenue sharing model where a broker actually isn't just the operator, it's the operator plus backers [delegators] and what the backers do is they put data tokens behind the brokers that they consider to be good actors, for a share of their revenue. And so, what ends up happening is, the brokers, they build sort of social reputation. [...] They can also sort of team up [...] The other brokers can effectively [...] learn through interacting with each other who's a good actor and then essentially invest in shares of each others' revenue streams. So you actually get an economic mesh network (Participant F)*

But also on a community level, where peer recognition of contributions to the development of the DAO can be motivating for community members, reputation can be seen as an incentivizing factor. As one interview participant indicates, among his motivations to engage with the DAO is the feeling of belonging to a collective of people that are bound by a shared mission.

> *For me, this is simply a life-enriching experience, being able to take part in this experiment. I'm happy that there is a community that thinks alike. (Participant J - translated by the author)*

> *I think we are at the stage where people aren't necessarily in it for money yet. I'm sure that will happen and I'm sure that there are probably some people who are just in it for money but I think most people who are in the space at the moment, because it's still early, are in it out of interest. Personal interest. Just find the topics fascinating or the possibility of what can happen with Web 3.0 and with data economies fascinating. So I think that's why it's so collaborative because everybody that's in it at the moment just wants the concept of Web 3.0 to succeed. (Participant I)*

> *I'd like to be a person who contributes to moving it forward and contributes to the whole space being a success (Participant I)*

Yet the observation of Streamr's discord server showed that non-coded contributions (i.e. onboarding, knowledge sharing, new use case scenarios) are difficult to track and less likely to be acknowledged, compared to coded contributions that are transparent to trace back through coding platforms such as GitHub.

> *Common to the design of any incentivizing factor is to build an understanding of existing motivations and of emerging developments within the system. The need to take on different perspectives was particularly emphasized for the design of a token. In a nutshell, the early token design stuff is almost entirely about creating a bunch of different perspectives on the phenomena of interest. (Participant F)*

Incorporating different stakeholders' perspectives on a system can further inform the set of rules that aim to restrict undesired behaviors. According to one interviewee, an extensive awareness of existing choice sets is key to anticipating the effect that certain behavior can have on other stakeholders and the system as a whole.

> *Long before you can start building economic models to [..] influence people's choice sets, you really need to map out their choice sets like what can you do, what happens when you do it, and furthermore how do my choices affect the other people; so the concept of externalities." (Participant F)*

However, to arrive at concrete token parameters, identifying stakeholders' motivations and behaviors may not be sufficient. Instead, the empirical data suggests that a combination of a design-led bottom-up approach with an engineer-led top-down approach may be the key to desired results.

> *I mean that although a codesign (bottom-up) approach is needed, it's difficult to end up with token parameters with just that process. The connection between ecosystem model and suitable token parameters is (at least with our insufficient knowledge) quite unclear, and so the token parameters cannot be derived from the codesign process results. Perhaps the only way is through „trial and error", creating different token models (top-down approach), and matching them with the ecosystem model (bottom-up approach), then validating with some kind of simulation which of the token options, if any, works in a desired way in this particular ecosystem. (Participant E)*

5.4

Complexity

Blockchain-based ecosystems are built of a modular architecture that can be divided into different interconnected layers (see chapter 4.0 for an example case). The multiplicity of interactions within and between the layers drastically increases the complexity of decentralized ecosystems. Along with increased complexity comes unpredictability in the form of emergence. To deal with emergence in complex systems a novel design approach is required that includes the development of new design tools.

In the researched case, the technology is claimed to be a layer zero protocol. In combination with a blockchain, the protocol provides a base layer for everything that is built on top. An ecosystem that includes several layers is characteristic for blockchain-based systems. Referring to the studied project, one interviewee describes the layered architecture as follows:

> *The lowest layer that we work on is the Streamr network, and that's where the data goes, that's the data transport. So it's basically a system that delivers data from data publishers to data subscribers in real time. In technical terms it's a publish-subscribe system or a pub-sub system but a decentralised one as opposed to a centralised one. So that's where the data goes. You don't want to put your data on a blockchain or anything because that would be just very slow and expensive and pointless. So, there's the Streamr network which is a peer-to-peer network that acts as the data transport. And on the other hand we of course build on Ethereum as well, using that for not only value transfers in terms of the token, but also keeping track of things like permissions to data and having those strong guarantees that only a blockchain can deliver. So we're sort of combining best of both worlds of having a non-blockchain, peer-to-peer network working alongside (its) companion chain which is Ethereum at the moment. And on top of this now that we have this value transfer mechanism and the data transfer mechanism. We can build quite interesting things based on these two pillars. So, for example [...] there's a marketplace, [...] it's like a shopping window of sorts where you can offer a view into what content, what data streams exist on the Streamr network and make them available to anybody against payment. So that brings in the value transfer*

layer on Ethereum. This was one of the, actually the original motivations for moving from the centralised world to the decentralised that we wanted to enable this data economy and marketplaces to be created. And there's no way in which this could have been done in the centralised space. It would just have been impossible. So the marketplace is a meeting point for data buyers and data sellers.[…] Going one abstraction layer higher, building more and more amazing things. One is this Data Unions network which is basically an implementation of data crowdselling. (Participant D)

The abstraction of a complex system into layers is helpful to understand the architecture, it also helps to understand the dynamics of different economies within the system. One interviewee mentioned a clear separation between the enabling economy and the enabled economy, both living on different layers within the same system's architecture. Here, the enabling economy is referring to the interaction of network participants that jointly provide a service, while the enabled economy describes the customer-facing interactions that are enabled by the service providers.

The sort of the top group under network, so publisher, subscriber, payer, broker, delegator, tracker, storage nodes, those could be referred to as the enabling economy, like meaning that it's sort of like this inner economy […], in the sense that, this is like, it would be sort of hidden from the end user, like it would be the network economy, things that happen under the hood, like for example when I […] order food from Uber Eats, I don't care, what the arrangement is between the restaurant and that driver […], all I care about is that, I mean, food arrives at my door and I made some payment, money's been taken out of my banking account or put on my credit card, and food arrives. As a consumer that's all I care about right. That's the enabled economy, which is addressed so, the enabled economy is like the marketplace where you're talking about a buyer and a seller. The buyer is me, I'm buying the food. The seller is the restaurant and the marketplace is Uber Eats. So that's the enabled economy, and whatever happens behind the scenes is the enabling economy. […] So, I think that's what's important here to point out at this point, is this difference between the enabled economy and the enabling economy. (Participant G)

Although these layers can be clearly separated, one interviewee suggests that they should not be viewed in isolation. Based on the complex nature of decentralized ecosystems, it is evident that some parts within one layer might not be able to work without or directly affect connections to the layer underneath or above. Activities within one layer can therefore have indirect effects on other layers. In order to take such interdependencies into account, a holistic systems view is required.

In crypto-economics systems I think it's actually a little better understood that things are correlated because people have experienced things like, say a system starts to run away in an undesirable direction. (Participant F)

Decentralized ecosystems work without a hierarchical structure, they don't have a central planning element. This leads to higher complexity and gives rise to the emergence of unpredictable behaviors among the stakeholders of a project.

The properties in these kind of systems that we're talking about, these economic systems, are emergent in the sense that, there are phenomena that are, sort of simplistic phenomena [...] there's a lot of [...] relatively simple interactions but the combinatorial [...] explosion of possible interactions within these systems, leads to this property called emergence where, we don't necessarily know, what to expect [...] So, even if you completely understand the simple rules behind this system, the outcome of the entire system, it remains unpredictable, and that's this notion of emergence. (Participant G)

Emergence within the Web 3.0 industry further manifests in a spirit that cherishes the unknowns and supports experimental approaches.

And then people are building products and it's that early that somebody might build something. A Data Union for X and it might fail and they might come back and just build a Data Union for Y. It's a very easy space to be in at the moment. I don't mean easy technically but I mean easy like to be part of it. […] So you can, yeah take a shot at something knowing that [..] if it fails it's fine. You can just start up again whereas in the real commercial world obviously people are a bit more out for themselves. I think that's the biggest difference. (Participant I)

Alongside the dynamic developments of actors in the field, the markets within the industry evolve as well. As observed by one interviewee, original expectations that were informed by traditional standards oftentimes do not hold anymore, instead surprising new opportunities emerge.

The markets are, every day, they are surprising us in many ways. For example, there's some stuff happening in the medical sector and with health data, which we initially steered away from because we thought that okay this is very regulated, this is very difficult, this is not going to fly because the data is so sensitive. But now it turns out that actually the medical space is very interesting because this kind of technology that we are building actually gives control

to the data subject, we can take care of things like end-to-end encryption and guarantee the safety of that data with this technology. So the expectation of how fitting or unfitting it would be for a particular market took us by surprise. (Participant D)

The aforementioned added structural complexity and the strong factor of unpredictability induced by emergence require a new design approach to ecosystem design since knowledge and tools about the design of decentralized ecosystems seem to be missing to date. To demonstrate the need for the development of new tools, one interviewee referred to practical experience where the use of traditional service design methods in a decentralized environment has not resulted in satisfying outcomes.

We have had different projects that I would call token ecosystems or let's say token platform projects at least. Not all the projects have been completely successful. Personally, I've been trying to apply the traditional service design tools on these projects. Then, I've also understood that it's not, it doesn't match completely because when we are talking about this kind of ecosystem it's quite complicated. It's not a typical platform start-up that we have for certain services. […] I started understanding in some point that it doesn't really work completely but I also didn't find, or maybe I just didn't do the background research to find, some alternative approaches until now.(Participant E)

It might be that probably in many ecosystems not all the connections and not all the possibilities have been completely mapped. There is some hidden potential so to say in that ecosystem. For example, some connections that could be activated, they might be very small value streams not happening all the time but they might add something to that ecosystem. (Participant E)

Currently, design in Web 3.0 is predominantly focused on visual design with a growing interest in user experience design. Yet, a greater involvement of other, more holistic design disciplines was emphasized during the interviews.

I think that the need for more people with a sort of more design-oriented background is present precisely because there's a lot of technical people jumping to the technical solution, to the ill-posed problem and so I think the emphasis should be on, how do you pose a problem well and that includes not just defining the goals and the stakeholders and the value flows […]. (Participant F)

6 Discussion

6.1

Reviewing the research question

In this chapter, I will discuss the outcome of the research in light of the research question:

RQ: What are possible barriers that hinder the development of emerging decentralized ecosystems?

Based on the identified barriers, I will, furthermore, derive implications for the design discipline answering the sub-question:

SQ: What kind of implications are the barriers posing for design approaches to decentralized platform ecosystems?

6.2

Barriers from a human-centered perspective

Blockchain-based technologies claim to run on trustless consensus. While this is true in a technical sense, it is arguable if trustlessness can and should be achieved throughout all dimensions of the Web 3.0 ecosystem. Blockchain technology can enable trustless transactions. But there is a social essence in peer-to-peer networks, as the term itself implies. In a space where many things are automated through smart contracts, it is easy to forget that, until the application of artificial intelligence matures, computers interact based on human motivations and needs. The theory and research findings of this Master's thesis allow the conclusion that while new technical solutions can already today provide alternatives for many of the current pain points in the Web2 world and beyond, the elements that involve human interaction in these emerging socio-technical systems still pose barriers in the transformation process of platform ecosystems towards decentralization. In the following, I will discuss these barriers from a human-centered perspective.

To begin with, a peer-to-peer network requires a collaborative effort, as was emphasized during the interviews. Collaboration is, thus, a distinct characteristic of the Web 3.0 industry. It enables decentralized services provided by a network of distributed actors. It is also the foundation for shared governance decisions and for future developments of a platform or project. Collaboration, furthermore, was described as the dominating spirit on the wider industry level. It was highlighted that collaboration is favored over competition for taking the Web 3.0 industry as a whole forward.

As emphasized by one interviewee, it is vital in collaborative relationships to ensure that personal goals can be realized simultaneously to the shared goals of the community. This, however, can only be achieved if the communication between the involved actors works well. Yet, sufficient communication tools and processes were identified as areas with potential for improvements. In an environment like Web 3.0, where actors are distributed worldwide, with different intentions and personal values, in a place where interaction happens online-only, communication becomes equally challenging and of major importance.

In the communication between different actors and the following eventual collaboration, the need for trust is apparent. According to Kolbjørnsrud (2017), the coordination of collaborative communities requires trust, besides peer-based control, and shared rules and norms. Kolbjørnsrud (2017) further argues that only trust combined with shared rules and norms allow for the effective sharing of knowledge and ideas.

Sharing knowledge and ideas, on the other hand, empowers learning and consequently grows the expertise of everyone involved. Considering the novelty and complexity of the Web 3.0 environment, continuous learning could be listed as a precondition. Willingness to learn also reflects in the experimental mode of working among Web 3.0 actors that is evident in the empirical data. The common experimental approach, furthermore, answers to the phenomenon of emergence that is implied by the complexity of the developing systems. Securing an efficient exchange of knowledge may, thus, become a requirement for successful decentralization and moreover, boost value co-creation processes.

To avoid that knowledge is growing in silos or remains focused on the technical aspects alone, the involvement of contributors with expertise in different fields of theory and practice may be of essence. Involving different disciplines becomes even more relevant considering the intended larger impact of the emerging developments on society, economy, and the environment. As claimed by Buterin (2015), blockchain technology allows us to experiment with new rules and structures for new economic and social institutions. While this opens an ocean of opportunities and the potential for positive impact, it also comes with a responsibility for everyone that is involved in the process of building it. Currently, those involved are predominantly tech-savvy people, often with a background in computer science or related fields. It can be reasoned that the responsibility for an impact as vast as declared by actors within the Web 3.0 industry and beyond, is too heavy to be carried by the previously mentioned actors alone.

In addition, increasing the number of participants as well as the diversity of expertise among actors was found to be beneficial for the success of open innovation (e.g. Chesbrough, 2003). In the respective literature, it was highlighted that open access builds the foundation for a growth in the number and diversity of participants. In theory, the Web 3.0 space is built in the open and free to access. According to the empirical data, however, the access is in fact restricted by barriers that are described in the findings part and discussed in this chapter. In this regard, the analogy to an island (crypto island), as introduced by one interviewee, visualizes the situation well. For mainland actors, accessing the Web 3.0 world built on crypto island currently requires the effort of a journey into the open waters.

Yet, for those who have reached the island, the environment was described as very inclusive and collaborative. Besides the sole need for collaboration illustrated at the beginning of this chapter, the crypto-native form of organizing in DAOs could be another factor that favors

the collaborative spirit. DAOs represent a community of single entities with a collective mission. The empirical data shows that the mission-driven nature evokes a feeling of belonging among DAO members. The status attached to the membership of a community that is governing a project towards a shared goal could thus be identified as a motivating factor for participation.

In fact, DAOs rely on the active participation of their members. In this regard, Kolbjørnsrud (2017) has identified peer recognition as a critical component that drives participation in collaborative communities. According to Kolbjørnsrud (2017), peer recognition can serve as reward, motivation, and social status. The empirical data, however, shows that contributions of community members are less likely to be acknowledged when they are non-code/non-programming-related contributions compared to coded/programmed ones. That is, the abstract character of non-coded contributions is less transparent and currently difficult to track other than following conversations on the Discord server. Considering the above-mentioned need for contributions from tech-foreign disciplines, missing recognition for their contributions could disincentivize participation and in turn, hinder the development of decentralized ecosystems.

THREE AREAS OF INTEREST

from a human-centered perspective

1	2	3
Communication and Collaboration	**Diversity of Actors**	**Acknowledgment**
enable continuous learning	increase value creation opportunities	driver for participation
mastering the interplay with a dynamic environment	grow expertise	non-monetary incentive in the mission-driven environment
	more holistic perspective on emerging solutions	

Table (3). Three areas of interest derived from the research findings – Tullney (2022)

Summarizing the discussion up to this point, three areas of interest have been identified that are important to consider from a human-centered perspective when looking at the process of platform ecosystem decentralization (see Table (3)). Firstly, communication and collaboration as enablers for continuous learning and for mastering the interplay with a dynamic environment. Secondly, a diversity of actors that increase value creation opportunities, expertise, and provide a more holistic perspective on the emerging solutions. And finally, recognition of various kinds of contributions as a driver for participation and a strong non-monetary incentive in the mission-driven environment of Web 3.0.

Returning to the beginning of this chapter and the open question about the new role of trust in the context of blockchain-enabled decentralization, it could be argued that the element of trust remains important in all activities that involve human interaction. In the example case of "The DAO" (chapter 2.3), removing trust completely through smart contract-based automated governance caused the initial project to fail. Consequently, Morrison et al. (2020) follow that a combination of trustless automated contracts and trust-based social contracts could be a functional governance model for decentralized organizations. However, the details of such a hybrid governance model are yet to be explored.

Currently, centralized governance structures are still prevalent in many Web 3.0 projects. According to the empirical data, the governance decisions of the project team are trusted by the project community. Now, transitioning progressively into modes of increased decentralization in terms of governance, the project team in turn has to be able to trust the community in their ability to govern the project independently. Finding answers to the challenges that were identified during this research could enable members of the community to exercise their governance rights according to their needs while being aligned with the shared mission. This, in turn, may increase the trust towards the DAO members and, thus, increase the pursued degree of decentralization.

6.3

Implications for design in decentralized platform ecosystems

Yu and Sangiorgi (2018) described the evolution of service design to be on a trajectory towards a more holistic, co-creational, and inclusive approach. It may be safe to say that the outcome of this Master's thesis underlines the need for these new paradigms. It could be argued that in an environment where decentralization is the goal, a co-creational, inclusive, and holistic approach to design is becoming more relevant than ever.

Value co-creation is the default in peer-to-peer networks and decentralized autonomous organizations. As previously discussed, communication and collaboration as well as the resulting knowledge exchange were identified as enablers for value co-creation. In this regard, Kolbjørnsrud (2017) has emphasized the importance of shared rules and norms to coordinate the value co-creation processes. Shared rules and norms can provide principles to self-organize, collaboratively solve problems, share knowledge and ideas, and distribute rewards.

On a more abstract level, Vink et al. (2021) consider rules and norms as part of institutional arrangements, along with roles, assumptions, and beliefs. The design of institutional arrangements (more details in chapter 2.4) could, thus, become a key focus area for designers in decentralized ecosystems. Vink et al. (2021:169) describe the potential role of design as "the intentional shaping of institutional arrangements and their physical enactments by actor collectives through reflexivity and reformation to facilitate the emergence of desired value co-creation forms."

With institutional actors distributed worldwide, interactions happening exclusively online, and blockchain technology as a baseline, the Web 3.0 environment is hyper-digital. It could further be reasoned that intangibility is characteristic of a hyper-digital environment. Institutional arrangements, per se, already hardly visible in non-digital settings, are likely to be even more intangible in Web 3.0 ecosystems. To respond to these circumstances, design methods that allow the creation of tangible artifacts may become of greater importance. Respective methods could be borrowed from the areas of speculative design, design-oriented scenarios, and design fiction, among others.

According to Koskela-Huotari et al. (2021), such methods could also be beneficial as tools, allowing a response to the unpredictability that is induced by the emergence in complex adaptive systems. Instead of trying to control processes with carefully designed solutions, explorative methods could help to utilize the opportunities for novel ways of value creation that dynamic environments inherit.

Furthermore, a holistic design perspective will be required to identify value creation opportunities and consider their potential impact. A request that is supported by Schreieck et al. (2016) who argue that the common differentiation between technology-oriented and market-oriented perspectives on platform ecosystems need to be unified into a conceptual blueprint of the whole ecosystem. This becomes especially relevant considering the interdependence of actors within and between structural layers. The multi-layered architecture, described in chapter 5.5, illustrates how different economies and diverse actors are interwoven. Identifying not only value opportunities but also potentially conflicting activities may be another important area that a holistic design approach could help with.

Finally, the last implication for design in decentralized ecosystems concerns the distinct need for an inclusive design. The outcome of this research emphasizes the importance of diversity for the development of decentralized ecosystems. Facilitating transdisciplinary communication and collaboration should therefore be seen as a key contribution of designers in the Web 3.0 industry. This might not only include human interaction with a focus on the actors` professional backgrounds but also the cultural diversity that is involved in the nation-spanning ecosystems of Web 3.0. If design could contribute towards lowering the identified barriers and help facilitate human interaction, more people may feel enabled to take responsibility in actively shaping our future.

7
Conclusion

7.1
Conclusion

Blockchain technology is seen as an enabler of the next evolutionary step in the design of platform ecosystems. This step involves the alienation of dominant proprietary models towards a decentralization of technical and organizational structures. Following the recent development, this study aimed to investigate challenges that are connected to the emergence of decentralization in platform ecosystems. Furthermore, the aim was to derive implications on possible design approaches to blockchain-based platform ecosystems. From a human-centered perspective, the research results incdicate that five areas pose barriers on the way to the aspired state of decentralization.

Firstly, since decentralization is based on co-creation, the coordination of collaborative activities between ecosystem actors requires new forms of governance. Yet, the development of appropriate governance structures that respect the various levels of expertise and engagement among all stakeholder groups is still at an experimental stage, thus, present a major barrier in ecosystem development. Further findings show that successful communication is critical for the operation and governance in decentralized platform ecosystems, as well as for collaboration between ecosystem mebers and external actors. This study indicates that, today, the used tools are insufficient for the needs of online-only communication in gloablly distributed networks, as is required from decentralized ecosystems. The third barrier, as indicated by the findings, concerns the broader topic of incentivization. Conflicting motivations of actors can lead to activities that may threaten the ecosystem. In this context, contradicting value perceptions of the platform-specific token may require special attention. The fourth barrier concerns the complexity that is increased by interdependencies in the ecosystem structure, by an explosion of possible interactions, and by the contant unpredictability of outcomes. The complexity was found to present challenges to all actors in the system. The findings indicate that all listed barriers combined have a negative influence on the accessiblity for actors outside the Web 3.0 industry.

The findings support the latest discourse about the need for a new paradigm in the theory of service design (e.g. Vink et al. (2021)). The identified barriers indicate a need for an approach to ecosystem design that highlight the importance of co-creation, inclusive design, and a holistic perspective.

7.1 Suggestions for future research

This study aimed to contribute to the under-represented human-centered discourse around blockchain-enabled dececntralization. The generalizability of the outcome, however, is limited. Therefore, a multi-case study that follows the research framework of this work could provide further insights about the relevance of the indicated barriers and implications.

Given the dynamic nature of decentralized platform ecosystems, a stronger focus on the temporary dimension may generate valuable additional insights about the question how the system changes over time. This is an element of Phillip‘s and Ritala‘s (2019) methodological approach to complex adaptive systems that was out of scope in this study due to time constraints.

Furthermore, the generated knowledge about the needs and challenges that may arise during the process of decentralization could inform the service ecosystem design discourse reagarding requirements for new methods and tools. In future research, new versions of the 3D model that was developed during this study may be co-created with different stakeholders to incorporate various perspectives and include other kind of value flows according the chosen focus. Testing the model in an action research approach may provide valuable insight about the utility of 3D ecosystem models as a tangible artifact (e.g. proposed by Koskela-Huotari et al. (2021)).

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Appendix

Round 1 - Interview(s) with Streamr

Date: tbd
Duration: 1:15 h
Participants:

OBJECTIVES

- Introduce the research topic
- Find out if there has previously been work done on: ecosystem maps / stakeholder maps / value flows
- Definition of all stakeholder groups for this project
- Suggestions of individual stakeholders from each group. Get contact details, if possible.
- Discuss timeline

QUESTIONS

- What is Streamr's vision?
- What is the current (ecosystem) strategy? How has it changed over time?

Stakeholder management

- What were previous approaches to foster ecosystem alignment?
- What is your current approach to it?
- Can you think of important learnings when it comes to stakeholder management?
- What was the role of stakeholders in innovation processes in the past?
- Have difficulties in stakeholder relationships occurred during innovation processes?
- If so, how have you overcome those problems?

Stakeholders and maps

- Has any kind of ecosystem map been created so far? If yes, what kind? Are they available?
- Is data from modeling the BlockScience project (Digital Twin) available?
- What information would you search for if you were asked to draw the Streamr ecosystem?
- Is it possible to get access to (some of) that information?
- Who would you like to include as stakeholders in this project to get the most holistic impression of the ecosystem's diversity?
- Can you help me to get the contact details of those listed?

- Do you think virtuous cycles (ecosystem network effect) exist in the Streamr case? (explain virtuous cycles if needed)

-> prepare platform canvas

x Do you feel like there alignment is strong today? Why?
x Is there a shared purpose, known to every stakeholder?
& how would you describe it?

Round 2 - Interviews with individual Stakeholders

Date: tbd
Duration: 1:00 h
Participants: tbd

OBJECTIVES

- Introduce the research topic
- Understand individual perspectives on stakeholder relationships:
  - value received / value provided
  - own purpose / shared purpose
  - governance
  - pitfalls
  - learnings
- Discover interdependencies
- Sketch the Streamr ecosystem from different perspectives

QUESTIONS

Values

- What does value mean to you?
- How would you describe the value that the Streamr network provides you?
- What are your (personal) drivers for participating in the network?
- How would you describe the shared purpose of the Streamr network?

Activities, Actors, Positions, LInks

- From your perspective, who are the actors that are needed for the focal value proposition to come about?

move to miro.

- Did we miss any other actors that have an influence on the system or are influenced by it?
- Which stakeholder groups are you directly connected to? Which indirectly?
- What is the value exchanged in each relationship/connection? (it can be different in every relationship)

copy frame, remove circles.

- Which relationships are mutually beneficial, which are uni-directional?
- Where do you see interdependencies?
- How is this value created?
- How is it captured?

Alignment

"If the heart of traditional strategy is the search for competitive advantage, the heart of ecosystem strategy is the search for alignment" (Adner, 2017, p.49)

- What are your thoughts when you think about this statement?
- What is working well in the Streamr ecosystem?
- Where do you see problems?
- What are your current approaches to align stakeholders?

Can you connect me to someone who I could contact to get the perspective of "XYZ"

Kiitos paljon!