Examining the Use of Blockchain Technology in Virtual Worlds: A Socio-Technical Systems Perspective

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Abstract

Recent developments, including the rebranding of Facebook to Meta, have led to large-scale media attention on the phenomenon of the Metaverse. Although not being a new phenomenon in Information Systems (IS) research, many intricacies in virtual worlds remain unexplored. In particular, prior research has directed attention to users' lack of ownership rights, creating tension between the creator and user. To solve this tension, we argue that blockchain technology can potentially help to structure ownership rights. Therefore, our research explores a blockchain-based Metaverse through the socio-technical system lens. Our study highlights that, in the underlying case, the use of blockchain technology goes beyond the application of Non-Fungible Tokens (NFTs) and can also be found in the general organizational structure, blurring the boundaries of existing stakeholders. Our work contributes to research by providing a gaze into blockchain-based Metaverses and highlighting the potential application and benefit of the technology in virtual worlds.

Keywords: Metaverse, Virtual Worlds, Blockchain, Socio-Technical System, Case Study

1. Introduction

With the rebranding of Facebook to Meta and ongoing developments in the blockchain space, virtual worlds - often referred to as and used interchangeably with Metaverses - have gained large-scale media attention. Much of this attention is driven by huge investments from established and reputable organizations (e.g., the company Adidas opened a store within the Decentraland Metaverse) and a high market valuation of different blockchain-based Metaverses (e.g., Decentraland: $1,906,724,203 (*Decentraland*, 2022a)). Some go even so far to claim that Metaverses would contribute $3 trillion to the global GDP (gross domestic product) within the next decade (*Metaverse Could Contribute $3 Trillion to Global GDP Within a Decade*, 2022).

However, beyond the hype, it is noteworthy that Metaverses/virtual worlds are not necessarily a novel phenomenon within Information Systems (IS) research (e.g., Boughzala et al., 2012; Wasko et al., 2011). In an early vision in the famous science-fiction novel "Snow Crash," Neal Stephenson draws a picture of a Three-Dimensional (3D) virtual reality-based space where people interact with each other through avatars and manipulating artifacts; yet, contemporary virtual worlds have evolved into considerably more sophisticated social systems (Boughzala et al., 2012). Nowadays, virtual worlds' use cases are vast and, among other things, include Massive Multiplayer Online role-playing games (MMORPGs) or conducing as tools to collaborate virtually in established organizations (e.g., Microsoft, IBM, e-Bay) (Boughzala et al., 2012). Within these virtual worlds, creators, who are responsible for designing the virtual worlds, and users, who are represented virtually by their avatar and experience the virtual world, are focal interest (Wasko et al., 2011). Essentially, it is the design of the virtual world that shapes its appeal and, thus, can attract users in order to reach a critical mass. According to Roquilly (2011), design choices can be structured along five key concepts, namely copyright, code, creativity, community, and contracts. Whereas the first four refer to the general design choices within the virtual world, the contract aspect is used by creators to regain control over the virtual world by specifying licensing and ownership rights on digital assets (Roquilly, 2011). Nevertheless, the latter is specifically argued to introduce issues for the creators due to heightened tensions between the users and creators (Roquilly, 2011). To make matters worse, these tensions are reinforced due to the virtual world running on the proprietary severs of the creators (Schmeil et al., 2012). To solve these conflicts and ensure that creators and users harmonize within the

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virtual world, it is argued that the recognition of users' property rights over their virtual items is vital (Roquilly, 2011).

It is precisely here where blockchain technology may be beneficial for virtual worlds. Many attributes of the blockchain technology, such as a tamper-resistant database, could extenuate tensions and provide a viable solution to the issues of virtual worlds (French et al., 2020). However, not much is yet understood how blockchain technology is used within virtual worlds in contemporary research. Hence, our research is guided by the following research question (RQ):

How is blockchain technology used in the Metaverse?

To provide an answer to our given research question, our study draws on an in-depth analysis of one of the largest blockchain-based Metaverses (by market capitalization), namely Decentraland (*Decentraland*, 2022a). To enhance our analysis, we use socio-technical system theory (STS) as an overarching lens. By answering our research question, we expect to contribute to existing research mainly in two ways. First, we gaze into the black box of blockchain-based Metaverses. Specifically, we dissect and investigate virtual worlds using STS; hence, we advance the scanty research on virtual worlds. Second, we illuminate and highlight how blockchain technology can be used and potentially benefit virtual worlds.

The remainder of this paper is structured as follows. First, we give an overview of the current state of research on virtual worlds and blockchain technology, followed by an introduction of our theoretical lens. In the next step, we describe our applied research methodology in detail and provide reasons for the chosen case and data analysis. Finally, we discuss and present the results of our study.

2. Theoretical Background

2.1. Virtual Worlds

The rise of virtual worlds dates back to the early 2000s and is closely tied to the emergence of such as MMOGs (massively multiplayer online games), or MMORPGs (massively multiplayer online role-playing games) wherein users can customize their avatars and play in large and complex worlds which are not necessarily guided by a pre-scripted environment (Alemi, 2007; Roquilly, 2011). In general, a virtual world can be defined as "a synchronous, persistent network of people, represented as avatars, [that is] facilitated by networked computers" (Bell, 2008, p. 2). These online virtual worlds operate on proprietary servers which are managed by the virtual world operator (Schmeil et al., 2012). Indeed, prior research has put a great emphasis on virtual worlds such as Second Life, or OpenSim (e.g., Animesh et al., 2011) as well as on Sun's Wonderland and Teleplace which focus on productivity in conventional tasks (Schmeil et al., 2012). Nonetheless, virtual worlds' use cases are not limited to these instances.

When considering the design and creation of virtual worlds mainly three distinct groups are of importance. Each role must be carefully considered when designing a virtual world due to prevailing tensions between the various groups (Roquilly, 2011; Wasko et al., 2011). The first group comprises *users,* who are essentially the participants in a virtual world. Users can participate in numerous ways, e.g., as player, or actor (Wasko et al., 2011). The second group is avatars, which represent the digital instantiation of an user within the virtual world (Wasko et al., 2011). Finally, the third group refers to creators, who can be an individual and/or an organization being responsible for creating the virtual world, including their underlying rules and licensing agreements (Wasko et al., 2011). Creators must not only consider how to model their virtual worlds along the two most dominant dimensions, namely a fantasy-realism dimension and a progression-emergence dimension (Schultze et al., 2008), but they also have to make substantial decisions with regards to the rights to create artifacts, the ownership of intellectual property, and the balance of decision making and control between creators and users (Wasko et al., 2011).

According to Roquilly (2011), there exist five key elements that creators use to develop and control their virtual world. While the first four, copyright, code, creativity, and community, relate to the design of the virtual world, the fifth, contracts, are a complementary component that creators use to regain control over the users (Roquilly, 2011). Although contracts can provide a very effective tool to structure the company's legal relations, they may pose legal risk for the companies rather than ascertaining security (Roquilly, 2011). In order to overcome the prevailing predicaments, Roquilly (2011) argues that notably the recognition of users' property rights over their virtual items within the virtual world can solve some of these issues. This solution indicates that blockchain technology, which can ensure clear ownership rights

in the digital assets, may be immensely valuable to the realm of virtual worlds.

2.2. Blockchain Technology

Within Information Systems (IS) research blockchain technology is not a new phenomenon (Nofer et al., 2017). In general, blockchain technology can be described as a distributed database consisting of several different blocks with each block compromising multiple transactions being validated by a network through cryptographic means (Beck et al., 2017; Glaser, 2017; Nofer et al., 2017; Rossi et al., 2019). Ever since its introduction by Satoshi Nakamoto in 2008 to revolutionize the financial system, blockchain technology has undergone numerous development and evolvement cycles. Today it has penetrated other sectors besides finance and its applications are no longer merely confined to cryptocurrencies (Risius & Spohrer, 2017). One of the major reasons behind this development was the inception of the Ethereum blockchain by Vitalik Buterin in 2014. Ethereum can be seen as an extension of the Bitcoin blockchain because it allows for more complex applications and functionalities by means of smart contracts and code that runs exactly on the pre-defined premises (Beck et al., 2018; Nofer et al., 2017).

Prior academic literature has put a great emphasis on blockchain governance (e.g., Beck et al., 2018; Lumineau et al., 2021; Zavolokina et al., 2020; Ziolkowski et al., 2020a). Nonetheless, more concrete use cases of the technology beyond supply chain (e.g., Pournader et al., 2020), decentralized finance (DeFi) (e.g., Brennecke, Guggenberger, Schellinger, et al., 2022; Meier et al., 2022), and hierarchically flatter forms of organizing, i.e., decentralized autonomous organizations (DAOs) (e.g., Mini et al., 2021; Ziolkowski et al., 2020b), are still missing (French et al., 2020; Risius & Spohrer, 2017). In particular, recent studies indicate that the intersection between virtual worlds and blockchain technology and the emerging phenomenon of non-fungible tokens (NFTs) may introduce many interesting mechanisms (French et al., 2020). Specifically, NFTs are digital tokens that represent the ownership of a digital asset verified through the blockchain network. Thus, NFTs could be able to contribute to addressing some of the prevalent issues mentioned earlier that plague virtual worlds.

2.3. Socio-Technical Systems

One way to examine and understand organizations or organizational work is through the lens of socio-technical systems (STS) theory (see Figure 1). The STS approach is a well-established and frequently used meta-framework in IS research (Sarker et al., 2019). Indeed, Sarker et al. (2019, p. 695) coin the phenomenon of STS "*the axis of cohesion for the IS discipline.*" In essence, the STS perspective views organizations or work in organizations as the outcome of two independent, but recursively interacting and

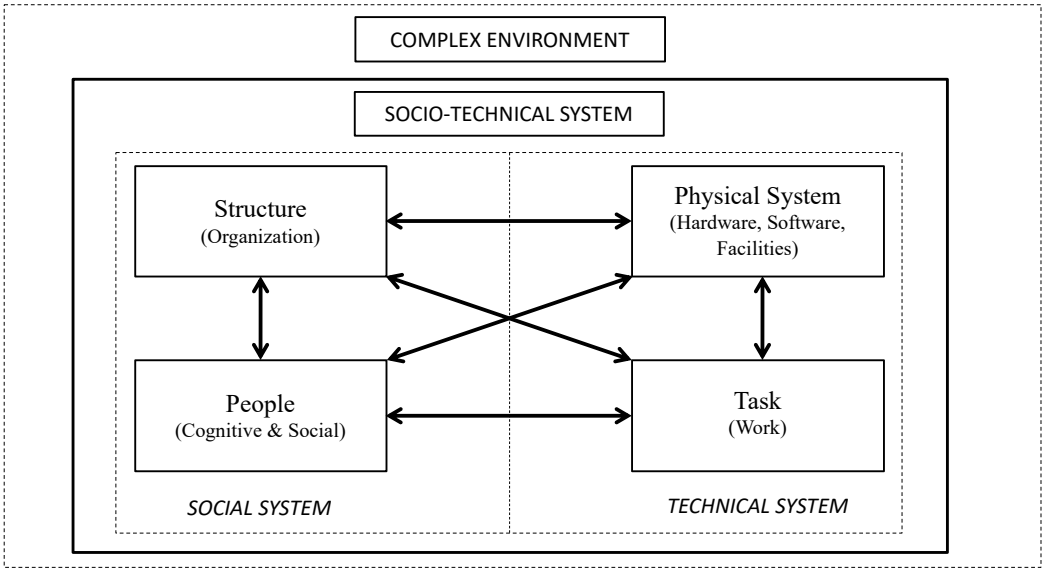

Figure 1. Socio-Technical System, adapted from Brennecke, Guggenberger, Sachs, et al. (2022), based on Bostrom and Heinen (1977)

affects subsystems – social and technical (Leonardi & Barley, 2010). Both subsystems are further decomposed into four interdependent multivariate building blocks - structure, people, technology and tasks. The former two components, structure and people, comprise the social subsystem and refer to various abstract social forces, e.g., roles and hierarchies, and stakeholders that govern or operate an organization (Bostrom & Heinen, 1977a, 1977b). By comparison, the latter aspects, technology and tasks, constitute the technical subsystem of an organization and refer to the technological artifacts, e.g., enterprise resources planning systems utilized and the (corresponding) work executed within an organization (Leonardi & Barley, 2010) Ultimately, it is the alignment and reciprocal interplay between subsystems and their respective building blocks that determine outputs and outcomes of organizations; thus, it is of utmost significance to aim for a "joint-optimization" (Mumford, 1995).

3. Research Methodology

To answer our given research question and to understand the role of blockchain technology within the Metaverse, we decided to conduct an in-depth single case study. Case studies allow to gain rich, contextual insights into a studied phenomenon (Keutel et al., 2014; Walsham, 1995; Yin, 2009). Our study design is shaped by one of the leading researchers in the IS discipline, Yin (2009) (Keutel et al., 2014). Yin (2009) argues that especially "how" and "why" research questions are well suited for a case study approach, which is the case in our research given our RQ "How is blockchain technology used in the Metaverse?". Such an approach can provide more detailed insights into the role of blockchain technology within those virtual worlds and its influence on actors. Our unit of analysis in this study is the Metaverse. More precisely, we investigated Decentraland, which is a virtual world operating on the Ethereum blockchain. We justify the choice of Decentraland as research object for several reasons. First, Decentraland is one of the oldest existing Metaverses running on the Ethereum blockchain with its introduction in 2016. It is currently one of the largest existing blockchain Metaverse based on market capitalization (*Decentraland*, 2022a). Thus, Decentraland allows for an in-depth analysis of the usage of blockchain technology. Second, Decentraland operates as a Decentralized Autonomous Organization (DAO). Hence, the case profits from ongoing and transparent discussions revolving around the Metaverse which enable us to gather a holistic view of the phenomenon.

To set the boundaries of our case and avoid unsystematic beginning and end points of our case study (Yin, 2009), we are grounding our work in the STS to examine and answer the RQ.

3.1. Case Description

Decentraland was founded in 2015 and is a 3D virtual world which can be accessed by its users through a browser. Decentralands' native cryptocurrency MANA has currently a market capitalization of $1,906,724,203 (*Decentraland*, 2022a), making it one of the largest blockchain-based Metaverses (by market capitalization). The Metaverse itself is characterized by the possibilities for users to create and monetize their content and applications as well as experience other users' content and applications (for a detailed overview of the key concepts of Decentraland see Table 1). To create their own content within the Metaverse, users have to buy a virtual space called LAND, which is further divided into parcels that are identified by cartesian coordinates (x,y). The content or application which is then created on these parcels ranges from static 3D graphics to interactive applications or games. For example, several larger companies have bought parcels and opened stores within the virtual world such as Adidas, PWC, or Samsung. Indeed, even live concerts have been performed. These parcels are owned by users and can be purchased using Decentralands' native cryptocurrency MANA. Furthermore, users can use MANA to buy digital goods and services as well as wearables through the marketplace.

In addition to this, Decentraland is controlled by a DAO. The DAO is thereby characterized through an online community being responsible to manage, improve, and govern a given product, in this case, the Metaverse Decentraland.

Key Concept	Explanation
MANA	"MANA is Decentraland's fungible, ERC20 cryptocurrency token." (Decentraland, 2022b)
LAND	"The finite, traversable, 3D virtual space within Decentraland is called LAND, a non-fungible digital asset maintained in an Ethereum smart contract." (Decentraland, 2022b)
Parcel	"LAND is divided into parcels that are referenced using unique

	x,y cartesian coordinates.“ (Decentraland, 2022b)
Decentraland Marketplace	A marketplace in which users can buy or sell their land, avatar names, or collectibles for the avatar. (Decentraland, 2022b)
Decentralized Autonomous Organization	“Decentralized autonomous organizations (DAOs) are globally distributed networks of actors who align around a common overall purpose governed with the help of blockchain infrastructures, the algorithms in the form of smart contracts that run on top of them, and a shared constitution or set of rules and processes for operating and changing the network.” (Mini et al., 2021, p. 1)

Table 1. Key concepts of Decentraland

3.2. Data Collection and Analysis

Despite the recent large-scale attention to virtual worlds and, notably, the Metaverse by the media due to various circumstances, such as social media giant Facebook’s announcement to rebrand to Meta, there is an overall paucity of literature researching the topic. However, there exists a rich body of grey literature that has actively engaged with the Metaverse. Thus, our primary data sources for this case study consisted of secondary data, including Decentraland’s white paper, developer documentation and blog articles posted on their website, and newspaper articles from the press with a particular interest in the Metaverse such as Forbes, Coindesk, or Medium. The latter is significant because it is utilized by spokespersons of Decentraland to communicate ongoing developments and news. Considering the rapidly changing and evolving ecosystem the investigated research object is operating in, these data sources represent appropriate choices to outline a rich and holistic picture of our underlying case.

Our data analysis followed a deductive approach using STS as an overarching lens to inspect Decentraland. Initially, we examined the Decentraland’s official whitepaper, which proffered valuable insights into the technological dimension of STS and the underlying economic system of the DAO. Later, we also incorporated other data sources listed above to study the other dimensions conceptualized in STS theory. Overall, our dataset included 175 of pages.

4. Mapping the Decentraland Metaverse

Based on our analysis, we provide Figure 2 as an answer to our initial research question how blockchain technology can be used to mediate the Metaverse. Our results indicate that when embedding the Metaverse of Decentraland within the socio-technical system framework, blockchain technology is used in various aspects within the Metaverse. While initially it was expected that the technology is only used to represent

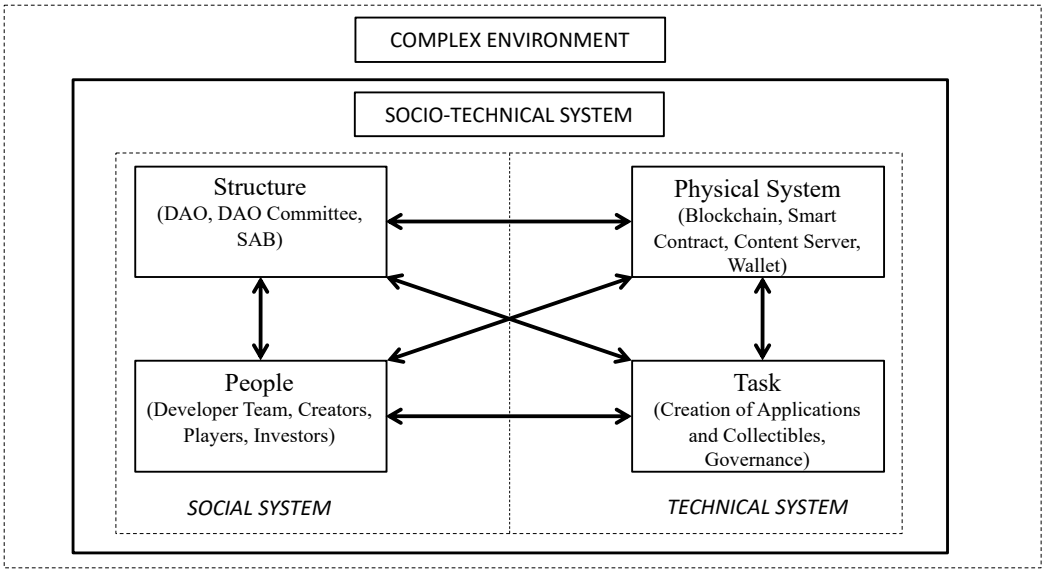

Figure 2. Decentraland as a Socio-Technical System

ownership rights for the digital assets in the form of, for example, NFTs, we also found proof that the technology is used for the in-game currency as well as the organizational structure around the Metaverse.

4.1. Structure

Decentraland is structured as a DAO. The DAO owns the most important smart contracts, such as the smart contracts owning the virtual land, the digital collectibles, the marketplace, or the content servers. According to Decentraland, the DAO structure conduces to confer control to the users, who create, roam, and play the virtual space. Thus, users, or more precisely those owning MANA, NAMES, or LAND, are eligible to decide upon several ongoing issues concerning Decentraland. These decisions include, but are not limited to:

1. Determining what kind of wearable items are allowed (or not) within the Metaverse
2. The size of the marketplace fees
3. Extension/Replacement of community-run content servers
4. Grant allocation for further development efforts
5. Content moderation

Nevertheless, decisions made by users are not arbitrary and random; instead, they are based on a transparent, pre-defined governance process. In the case of Decentraland, we can observe two different governance processes. The first process is primarily used for simple, and less complex matters, like banning a name from Decentraland. The second process is employed when more intricate matters are involved and consists of a tripartite process (see Figure 3).

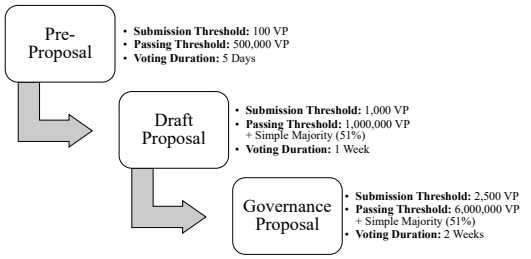

Figure 3. Governance Process, adapted from Decentraland (2022b)

In the first step, users can submit suggestions or issues to Decentraland's official discussion forum concerning governmental decisions for a pre-proposal poll. Within the pre-proposal poll, the goal is to evaluate whether a suggestion or issue receives support from the community, i.e., if it is deemed an important matter. Nonetheless, Decentraland imposes specific restrictions that hinder users, who do not fulfill the formal requirements of 100 voting power (VP), which is determined by their MANA, NAME or LAND (1 MANA = 1 VP, 1 NAME = 100 VP, 1 LAND = 2,000 VP) from starting a pre-proposal poll. To pass the pre-proposal poll and move to the next stage, a minimum of 500,000 VP from the community is necessary within five days. In the second step, the proposal draft, the submissions' potential impact, and implementation pathways are presented in a structured format. Here, the submission threshold increases tenfold, necessitating 1,000 VP. By the same token, the necessary support by the community must surpass 1,000,000 VP and a simple majority (51%) of the participating voting power within a time period of one week. If a submission manages to fulfill these requirements, it enters the final stage, the governance proposal. This step is tailored towards formalizing the passed version of the proposal into a binding governance outcome. Unsurprisingly, passing the governance proposal is accompanied by the most formidable hurdles and necessitates a minimum of 2,500 VP, passing a threshold of 6,000,000 VP by the community, and a simple majority (51%) within a period of two weeks.

Subsequently, Decentraland attempts to implement proposals that withstood the aforementioned requirement process. To do so, Decentraland delegates responsibilities associated with the implementation and its oversight to the DAO committee and the security advisory board (SAB). The former, the DAO committee, is a group comprising three individuals that have been elected by the broader community and enacts any passed vote. The latter, SAB, is responsible for overseeing the DAO committee. The SAB is vital in this structure because it is responsible for the most relevant part of the Decentraland Metaverse, the underlying smart contracts. Therefore, the SAB has the ability to stop any action taken by the DAO committee due to an automatic 24-hour transaction delay. To ensure that the changes being made to the smart contracts are protected from vulnerabilities and devoid of bugs, the SAB consists of five Solidity experts, which the Decentraland development team has elected. This brings us to the next building block of the STS, the involved people.

4.2. People

Decentraland's Metaverse comprises various significant stakeholder groups who inhabit heterogeneous interests, namely the developer team, creators, players, and investors. What is noteworthy and interesting about these groups is their fluidity. More precisely, it is principally possible for all users of Decentraland to interchange their stakeholder

groups. Still, some constraints, such as users' economic status, limit this interchangeability.

Overall, the developer team represents the most important stakeholder group of Decentraland. Without this stakeholder group's presence, Decentraland would not exist or, without their active evolvements, cease to exist. The second most significant group are creators. Their value to Decentraland is attributable to the various artifacts they construct, e.g., applications and 3D models and which they offer for sale. This brings us to those that explore and enjoy the diverse activities of the Metaverse, namely players. Decentraland enables players to experience copious events within Decentraland, such as attending a concert, visiting art galleries, or utilizing the applications built by creators. In addition, players are afforded with a myriad of possibilities to create an authentic and unique look. Lastly, investors – as their title already suggests – aspire to profit from Decentraland, either by an increase of value in the underlying cryptocurrency MANA or a value increase in the virtual real estate in the form of LAND within Decentraland.

4.3. Technology

Viewed from the lens of STS, the most interesting finding is the technology Decentraland operates on. Specifically, its approach separates it from other virtual worlds and builds on a dual technology stack. On the one hand, Decentraland uses the Ethereum blockchain to store and verify information about LAND ownership and additional information about the location of the content which is built on top of the LAND. On the other hand, Decentraland does not store the content built on the LAND in a blockchain but rather in community/DAO-owned content servers. However, it is notably the usage of blockchain technology that is of grave significance because it affords users to fully control and own virtual assets while introducing other interesting mechanisms within the Metaverse. These ownership rights are not limited to LAND in Decentraland. Players create an avatar to roam the domain of the Metaverse, which they can continuously change by reshaping its look and through acquiring wearables in the form of NFTs. These wearables can represent everything, ranging from specific clothing looks, such as a casual outfit, to names (NAMES) for the avatars. By implementing wearables or collectibles, creators can determine and guarantee the rarity of the given item. For instance, it is possible to determine and ascertain that a specific collection comprises a limited number of items. Since users can buy or sell items and LAND through the marketplace, smart contracts play a crucial role in ordering Decentraland. More precisely, smart contracts enable changes to the content on the LAND and the transfer of ownership of LAND, NAMES, or wearables. In addition, blockchain technology is essential for the cryptocurrency MANA as well as the aforementioned governance processes, allowing to secure voting transactions.

Besides the artifacts necessary for Decentraland to operate, users, too, must fulfill specific technological requirements. Evidently, users require a stable internet connection and accessibility to a browser. Moreover, to make use of the full spectrum of Decentraland's affordances, users require a digital wallet to store their NAMES, LAND, or collectibles in.

4.4. Tasks

Having identified the general structure of Decentraland, its involved people, and the underlying technology, this section is aimed at shedding light on the different tasks within the given Metaverse. Here, we can identify two main tasks within Decentraland.

First, creating applications and digital collectibles. To keep users interested and continuously grow its network, this task is of utmost importance and basically determines Decentraland's appeal and long-term survivability. Therefore, constantly creating new experiences for the players in the form of applications (e.g., art galleries) takes a central stage. To ensure that every creator has the best possibilities to develop their content, Decentraland offers rich documentation possibilities and several software development kits (SDKs). Creators can, for example, develop buildings on the existing LAND or develop and design new collections of wearables to sell to other players through the marketplace.

The second essential task is participating in the governance of Decentraland. The DAO structure that forms the foundation of Decentraland's hierarchical structure leads to a state where much of the Metaverse is owned and, thus, governed by the user base. Specifically, users participate in the governing of Decentraland by making suggestions and developing ideas with the help of the community, and active participation in the voting process ensures ongoing development.

5. Discussion

Our study highlights how the blockchain-based Metaverse, Decentraland, has established a working system on the basis of blockchain technology, thereby mitigating the tensions between users and creators that have been studied in previous virtual worlds

(Roquilly, 2011). Contradicting to the indications of previous research wherein it was expected that blockchain technology in virtual worlds would be confined to the use of NFTs, we observed a far more complex and extensive system. While, for example, previous virtual worlds have used proprietary servers to run their worlds (Schmeil et al., 2012), Decentraland stores the crucial aspects, the ownership rights, on the Ethereum blockchain and the content which is built upon the LAND in community/DAO-owned content servers. By integrating blockchain technology, and thereby providing the users of the virtual world with greater ownership rights, we identified that roles within the complex socio-technical system are blurred. Whereas players have previously only been eligible to "enjoy" the experience of the virtual world, they can now own digital assets. This ownership of their digital assets allows them to act with greater autonomy by providing them with active decision rights over the development and various parameters in the Metaverse. Relatedly the structure, which is used to govern all these different stakeholders, the DAO, is based on blockchain technology. This structure, including the use of smart contracts, ensures a proper decision-making process. Furthermore, by means of blockchain technology, user roles are fluid and emerging. That is, within Decentraland, players can become investors or creators, for example, by building an application on their LAND, which is expected to increase in value.

5.1. Implications for Research

Our research has two main implications for research. First, by opening up the black box of blockchain-based virtual worlds/Metaverses, we identified the complex underlying socio-technical system with shifting and more blurred roles in the virtual world. Hence, our research extends existing research on virtual worlds by providing nascent insights into how the introduced issue of ownership rights within virtual worlds might be addressed and even solved under the blockchain technology. Nonetheless, while we argue that blockchain technology might solve the identified issue by Roquilly (2011) with regards to the ownership rights of the digital asset, the use of blockchain technology introduces other issues and tensions that need to be solved. For instance, due to the transferable ownership rights, users can trade their assets for "real" money. Hence, the underlying digital assets can become subject to speculation. Ultimately, this can easily spark new quandaries in the virtual world between players, investors, and creators. Therefore, research should further study the implications of blockchain technology on this phenomenon.

This brings us to yet another implication for research: the ethical dimension of the blockchain technology. The DAO structure of Decentraland fosters democratization and participation. Hence, it can empower users and enable these to act with greater autonomy. At the same time, there is the question how smart contracts ought to be in order to ascertain their ethical fiber. Relatedly, there is also the question whether the current governance process of decision-making is ethically justifiable or raises concerns. For instance, while the requirements and procedural guidelines are conveyed transparently, there is still the question whether they are ethical in the first place. In particular, the necessity to achieve a simple majority or surpassing other thresholds can and should be open to an ethical discourse. Thus, future research should critically examine the ethical potential and implications of the blockchain technology within Metaverses.

Lastly, our work exemplifies how blockchain technology can be implemented in virtual worlds. Specifically, we shed light on the complex interplay between structure, people, technology, and tasks within Decentraland, including the blockchain technology's impact on the prevailing interactions between these dimensions. Our work has, therefore, also significant implications for blockchain research. While this research stream addresses use cases, scientific studies have heretofore neglected investigating blockchain technology's use in other cases, such as the Metaverse. Researchers in this area can use our findings as a basis to further analyze this emerging phenomenon.

5.2. Implications for Practice

The results of our study can be especially helpful for designers and creators of virtual worlds. While one of their main concerns is to reach a critical mass and enhance the network effects within their virtual world, blockchain technology might provide them with a competitive advantage due to the solved ownership issue. With our in-depth case study of Decentraland, we provide practitioners with a holistic view how the technology can be implemented in the Metaverse. We show in great detail which technology is used for which task and their influence on the various aspects of the virtual world.

Moreover, our work has implications for the ethicality of the blockchain technology in the Metaverse. As we have seen, blockchain technology can augment users' positive freedom and, ultimately, empower them. Much of the transparency, including

the democratic processes that prevail within Decentraland are afforded notably by blockchain technology. Nevertheless, there are also ethical concerns, such as the speculation of digital assets, or how smart contracts and procedural governance processes ought to be formalized. This moral sphere is only implicitly mentioned in the investigated data. Hence, we require more explicit discourses devoted to the normativity of the Metaverse, which, to a substantial part, is fueled by blockchain technology.

5.3. Limitations and Future Research

Our study is subject to some limitations. To begin with, while our single case study approach provided us with an in-depth analysis of a blockchain-based Metaverse, we cannot make claims that go beyond the case of Decentraland. Accordingly, while we were able to dissect and decipher the implementation, use and implications of blockchain technology within Decentraland, it is not possible to draw a picture of how blockchain technology is utilized in different virtual worlds. For example, it may be possible that other virtual worlds only apply NFTs to solve the ownership issue but continue running the virtual world on the proprietary severs of the creator. Therefore, future research should study additional blockchain-based Metaverses to contrast or expand our findings. This would be especially helpful to extend our understanding of the implications of blockchain technology in virtual worlds.

Second, although our data provides a detailed view on the studied phenomenon, it might not uncover all existing tensions between different stakeholders. Here, it might be fruitful to investigate the phenomenon through other approaches. For instance, it may be interesting to conduct interviews to generate additional insights on emerging tensions in blockchain-based virtual worlds.

6. Conclusion

In conclusion, the aim of our research was to study how blockchain technology can be used in the Metaverse to overcome existing issues, e.g., ownership rights (Roquilly, 2011). Our findings show in great detail that blockchain technology is used in various, fundamental aspects in the virtual world, including the organizational structure, or in the form of NFTs to clarify ownership rights on the digital assets. This shift of ownership rights and the roles being more blurred could have significant implications on network effects within the virtual world making it an interesting use case of blockchain technology for future research.

However, we want to emphasize that although blockchain technology might have a potential benefit for virtual worlds, there are currently several critical aspects that need to be addressed. One of the most pressing issues concerns scalability of the used blockchain. More precisely, it refers to the number of transactions that can be processed by a blockchain in a given time (Rossi et al., 2019). To address this potential challenge, scalability is sometimes traded for decentralization, which, in turn, raises another critical concern: security (Ciriello et al., 2018). Security issues are often found in the underlying smart contract code due to the fact that blockchains are tamper-resistant and their resistance and endurability to change once deployed on the blockchain (Wang et al., 2019). In the past this has led to vulnerabilities, like hacks, e.g., TheDAO in 2016 (DuPont, 2017). More recently the blockchain-based game Axie Infinity lost $600 million by virtue of such security issues (Nicolle, 2022). Therefore, smart contracts need to be carefully designed to avoid such security breaches. Last but not least, DAOs' governance structure remains unclear from a legal perspective (Wang et al., 2019). At first glance, this might seem like a minor issue for players; yet, players' digital assets in the form of, for example, NFTs represent ownership within the DAO and thus, exposes them to risk for potential liabilities or debts of the DAO (Wang et al., 2019). Therefore, all stakeholder groups should inform themselves and be informed about potential issue that could occur.

7. References

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