Blockchain in the Sharing Economy

Will Blockchain Disrupt Today's Winning Business Models?

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ABSTRACT

The increasing popularity of sharing economy business models led to some of the most successful startups in the last ten years. Blockchain technology could disrupt these businesses, as it offers unique opportunities for automatization and for giving back the power to the users by decentralizing the settlement service. Most prior research focusses on either blockchain technology or the sharing economy. This paper provides insights into the characteristics of blockchain technology and the success factors of sharing economy businesses. Furthermore, the chances and challenges of using blockchain technology in the context of sharing economy business models are discussed. Based on that information, a general model for decentralized sharing economy organizations (DSEO) is given, discussing the design choices that are crucial to be made.

Keywords

Blockchain, sharing economy, smart contract, decentralization

1. INTRODUCTION

The so-called sharing economy is an emerging concept for businesses that enable particularly private persons to share their property or to offer services through online platforms. The leading companies such as Uber and Airbnb offer a centralized settlement service to connect providers and consumers with each other. For offering this service, the platforms charge fees to the users, which in the case of Airbnb can be up to 20% of the reservation subtotal [3]. According to PwC, the five main sharing economy sectors travel, car sharing, finance, staffing, and music and video streaming could potentially increase their global revenues from 15 billion USD in 2015 to up to 335 billion USD in 2025 [35]. However, these business models could get interrupted by blockchain technology, which facilitates decentralized data storage and communication. Furthermore, it is possible to deploy so-called smart contracts as part of these blockchains, which can automate processes in a decentralized manner. Using this technology, several shortcomings of the centralized systems could be tackled, such as high service fees and the centralized storage of private data [25].

Although extensive research has been done on blockchain technology as well as on the sharing economy, there is relatively little research on the combination of these two fields to create a decentralized sharing economy platform. There are proposals for protocols that can be used to build decentralized peer-to-peer marketplaces [8, 25]; however, they suggest specific design choices and provide little theoretical reasoning. Therefore, we want to contribute to the advancement of knowledge in the application of blockchain technology in the sharing economy by giving a general model for sharing economy organizations based on blockchain technology. Our aim is not to give a specific protocol, but to present the design choices that have to be made and elaborate on the opportunities and challenges connected to them. This way, we intend to assess the overall potential of blockchain technology to disrupt the current centralized sharing economy businesses.

29th Twente Student Conference on IT, July 6th, 2018, Enschede, The Netherlands.

2. METHODOLOGY

2.1 Research Question

The main research questions that this paper aims to answer is:

What is the potential of blockchain technology to disrupt the successful sharing economy business models and what design choices are crucial to be made?

In order to answer this research question in a structured way, we defined the following four sub-questions:

1. What are the characteristics of blockchain technology?

2. What are the success factors of sharing economy business models?

3. How can these factors be included in a decentralized system?

4. What are the chances and challenges of this decentralized system?

2.2 Approach

Literature study is an essential building block in this research, as comprehensive research has been done on blockchain technology as well as on sharing economy business models, but way less on the interplay between the two. To structure the process, we make use of the five-stage grounded-theory method for reviewing literature, as suggested by Wolfswinkel et al. [50]. A criterion for inclusion of literature in the literature study is its currentness, as blockchain and sharing economies are both new and fast-moving phenomena's. As sources, scientific articles, as well as popular literature and press articles, are used. The search terms are mainly "blockchain", "sharing economy", "smart contract", and the terms combined. We use the literature databases FindUT, Scopus, Web of Science, and Google Scholar.

Based on the findings, we develop a general model for decentralized sharing economy organizations. We use the framework for design science given by Wieringa to build the model in a structured manner [49]. However, the suggested implementation of the designed model (i.e. programming a decentralized sharing economy application) falls outside the scope of this research. Therefore, instead of the implementation, the model is validated by experts in the field of blockchain technology. Afterwards, the model is evaluated and enhanced

based on the results of the expert validation analysis. Furthermore, we present the case of decentralizing Airbnb to demonstrate the use of our model.

3. BACKGROUND

3.1 Blockchain

A blockchain can be described as a database (also called *ledger*) documenting all transactions that have ever been executed on it. The most well-known blockchain is the Bitcoin blockchain which keeps track of all Bitcoin transactions [44]. A Bitcoin transaction consists of a sender and a receiver address and the amount of Bitcoin that is sent. To assure that a transaction is valid, the sender signs the transaction with his or her private key [23]. The Bitcoin blockchain is publicly accessible and therefore, it is called a public blockchain. This makes it possible for everybody to trace back and check the status of transactions [16]. However, it is also possible to restrict access to a blockchain to a particular audience (e.g. within an organization) – this is referred to as a private blockchain [11].

As the name already suggests, blockchains consist of blocks which are data packages with transaction records. These blocks are validated by the miners and then get added to the blockchain in chronological order [44]. Each block links to the hash value of the previous block, forming a chain of blocks. The miners can be described as a peer-to-peer network of virtual bookkeepers, as they store a complete copy of the blockchain and make sure that all new transactions are valid before they get added to the blockchain. For example, a transaction is not valid if the money that is sent is not on the sender's account or is double-spent.

It is essential that the miners follow the consensus mechanism defined for the blockchain to validate transactions, as it ensures that transactions are validated in a decentralized manner. For instance, the Bitcoin blockchain makes use of the Proof-of-Work (PoW) system, which uses computational power as security for the consensus [11]. That means that the miners use their computational power to solve a mathematical puzzle to verify a block. If a miner solved the puzzle, which takes around 10 minutes on average [23], it broadcasts the verified block to the other miners and a new block is getting verified. The miner that verified the block gets a reward, which currently is 12.5 Bitcoin [46]. This consensus mechanism grounds on the assumption that no miner has that much computational power that it could use its power to interfere with the functionality of the blockchain.

In contrast to most centralized systems, transactions that have been validated and stored on the blockchain are immutable [33]. This means that data stored in the blockchain cannot be changed, as any change would alter the hash value of the block that the data is stored in. Therefore, all following blocks would need to be recalculated since the hash value of a block is incorporated into the next block [23]. This principle paired with the decentralized and consensus-based storage of data makes the blockchain a "*trust-free system*" [16]. Also, using a blockchain has the advantage of having no single point of failure, as the blockchain is redundantly stored at all participating nodes, which guarantees a high availability [4]. Another advantage of blockchain is the facilitation of international microtransactions, which allows for new global business models with low transaction costs [45].

Nevertheless, blockchain technology also faces some challenges and limitations. As blockchains are often publicly accessible, privacy protection is an important issue when storing sensitive data on a blockchain [16]. It is possible to use a new pseudonymous public key for every transaction; however, balances are still visible, and deanonymization attacks are possible [24, 38]. Also, scalability is a major challenge, as consensus mechanisms such as PoW require much computational power. For instance, Bitcoin has a peak throughput of seven transactions per second, whereas the leading global credit card payment companies can process up to 10,000 transactions per second [48]. Moreover, a recent study shows that the Bitcoin network consumes at least 2.55 gigawatts of electricity, which is almost as much as the power consumption in Ireland (3.1 gigawatts) [47].

3.2 Smart Contracts

Smart contracts can be described as scripts that are stored on the blockchain [11]. These scripts are executed automatically when addressing a transaction to it. The given transaction data is then processed according to the protocol defined for the smart contract. This mechanism can be illustrated by the example of renting a bike:

Alice wants to rent a bike from a stranger called Bob. Bob creates a smart contract, which mainly has two functions: rent and return. In the smart contract, it is defined that when renting the bike, Alice has to transfer a deposit of 0.01 Bitcoin to the smart contract. The costs for the rental are 0.001 Bitcoin per 24 hours. When Alice returns the bike, she gets back the difference between her deposit and the actual rental price. So, Alice transfers the deposit of 0.01 Bitcoin, and the rent function of the smart contract is triggered. It registers the date and time of the rental on the blockchain and Alice may now use the bike. She returns the bike after four days, and Bob triggers the return function of the smart contract, which returns 0.006 Bitcoin back to Alice's wallet and sends 0.004 Bitcoin to Bob's wallet.

This was a rather simple scenario, but smart contracts have the potential to automatize even complex organizations [21]. These so-called Decentralized Autonomous Organizations (DAO) are entirely run by its members, and all proposals to change something within the organization have to be approved by the members [21]. This offers a great chance to democratize organizations and abolish hierarchies. However, there are some drawbacks to smart contracts. As data on a blockchain is immutable and smart contracts are stored on a blockchain, smart contracts are also immutable. Thus, a smart contract either needs to be written correctly at once, or there needs to be a function included to edit or delete the smart contract [11]. Another limitation is that smart contracts are not self-executing and therefore always need to be triggered by a (possibly artificial) person [14]. Also, the legal status of smart contracts is still uncertain [21].

3.3 Sharing Economy

As sharing economy is an umbrella construct, there is considerable variation in definitions for it [1]. Hamari et al. [15] define the sharing economy as "*the peer-to-peer-based activity of obtaining, giving, or sharing the access to goods and services, coordinated through community-based online services*". PwC [35] emphasizes the commercial character of sharing economies, as they "*allow individuals and groups to make money from underused assets*". Sundararajan [45] describes the sharing economy as an economic system with "*blurring lines between the personal and the professional*" as well as "*blurring lines between fully employed and casual labor*".

The current centralized sharing economy businesses all offer certain characteristic services. Killeen [22] names three of them: *"(1) aggregated supply and/or demand, (2) customer relationship management tools, and (3) payment processing*". According to Killeen, these services lead to the users' willingness to pay for the systems. Also, sharing economy businesses typically offer certain technical features to their users. Narasimhan [31] defines these "*technology-enabled features*" as

the offering of a mobile app and cashless transactions, a rating system, and dynamic pricing.

It is clear that the sharing economy is a successful business model, with Airbnb being valued at 31 billion USD in 2017 [43]. There are various reasons why people use sharing platforms. According to a PwC survey, participants' motivations are mainly affordability, convenience and efficiency, sustainability, as well as social aspects [35]. However, these motivations cannot explain the success of the sharing economy businesses completely. An important factor that led to wide adoption is the establishment of a "*digital trust infrastructure*" [45]. By providing a review system, insurances, and identity verification, the sharing economy businesses succeeded in gaining people's trust [16, 45]. This trust in the brand of a sharing economy business is of major importance because it makes it more likely that users also have trust in the providers on that platform [45].

Also, the success of peer-to-peer marketplaces is influenced by network effects. The platforms directly benefit from an increase in users as that makes the platform more valuable for all users [9]. For instance, an increase in providers increases the supply and therefore makes the marketplace more attractive to users, and an increase in users increases the value for providers. According to Bhatt, these dynamics are strengthened if peers of an individual use a certain platform, as that makes it more likely that the individual will also use that platform.

3.4 Blockchain in the Sharing Economy

3.4.1 Research

There is some literature that assesses the application of blockchain technology within sharing economy businesses. In his book about the sharing economy, Sundararajan [45] devoted a whole chapter on blockchain technology, where he gives historical information about decentralized marketplaces and outlines the opportunities and challenges connected to them. In a report from Goldman Sachs [28], the weaknesses of centralized sharing economy businesses are analyzed, and solutions based on blockchain technology are given. Huckle [17] gives use cases for decentralized sharing economy applications using Internet of Things architecture and blockchain technology. Killeen [22] adds an interesting point of view to this topic, as she outlines the opportunities of blockchain technology for the around 2.5 billion unbanked adults in developing countries.

Concerning the technical implementation, it has been proven that running a basic sharing economy application based on blockchain technology is possible. Bogner et al. [10] showed a demo of a decentralized sharing app running on the Ethereum blockchain. The core of the application is the smart contract functionality of the Ethereum blockchain, which makes it possible to sign a rental agreement and manage the rental process, which is all documented within the blockchain.

Furthermore, there are some papers suggesting methods of how privacy can be ensured when using smart contracts [24, 51]. This is an important issue since sharing economy applications could potentially store sensitive information about the users. Kosba et al. [24] developed a decentralized smart contract system that guarantees on-chain privacy, i.e. transactional data is not viewable for anybody not involved in the transaction. This system encrypts the data before sending them to the blockchain and is based on zero-knowledge proofs. Furthermore, Xu et al. [51] developed a privacy-respecting contract platform (PrC) which can be used to build sharing economy applications. The PrC conceals the identity of the users by making use of proxy agents that function as a second-layer for the user. However, the platform cannot support a review function as the users remain anonymous.

3.4.2 Practice

Some companies proposed protocols for decentralized sharing economy applications using blockchain technology [8, 25]. Origin works on a decentralized sharing economy application that is supposed to build the foundation for new sharing economy businesses using blockchain technology. An interesting design choice is that data is not directly stored on the Ethereum blockchain since data is merely referenced by storing a hash of it on the blockchain. One of the companies that built on Origin's decentralized application is The Bee Token, which itself also proposed a general protocol for decentralized sharing economy applications [7, 8].

The Bee Protocols include three main systems: a payment system, a decentralized arbitration system, as well as a reputation system [8]. All three systems work together and are fully automated by using smart contracts. Only the arbitration system makes use of human arbiters who judge about disputes and get a reward for it. However, the arbiters are randomly selected and do not need to meet any criteria or verification before making decisions, which could lead to manipulation and poor arbitration. To assign reputation scores to participants, the reputation system makes use of algorithms which are publicly stored in smart contracts. This guarantees full transparency, but it also could enable manipulation as frauds exactly know what to do to improve their score.

Moreover, there are attempts to combine the strengths of blockchain technology and the internet of things within the context of a sharing economy business. The German company Slock.it developed a blockchain infrastructure that enables the complete automatization of sharing economy businesses by using so-called "smart objects" [42]. For example, a smart object can be a lock, an apartment, or a vehicle that automatically gives access to the renter. This makes it possible to rent objects without any interaction between the renter and the owner, which saves time and is convenient for both parties.

3.4.3 Chances and Challenges

The sharing economy platforms offer many opportunities for a more sustainable use of resources; however, the centralized systems have several issues that could be resolved through blockchain technology. Extensive research has been done on the impact of the sharing economy on public interests. In a report of the Rathenau Instituut, twenty recommendations for governmental policies towards sharing economy platforms are given [12]. These include, inter alia, that the reliability and transferability of reviews and reputation data need to be ensured. This is indeed an issue, as there are cases that Airbnb deleted user reviews [39], and until now, it is not possible to transfer reviews to other platforms. Blockchain technology could resolve this problem, as review data stored on a blockchain would be immutable, traceable, and accessible for other platforms [28]. The decentralized storage could hence enhance the trustworthiness of the reputation systems.

Also, [12] recommend helping low-income groups to benefit from the sharing economy platforms. As there are rather low transaction costs when paying with cryptocurrencies, microtransactions are possible, which enables the users to rent low-valued objects [22]. Therefore, low-income groups could also afford to participate in a decentralized sharing economy. Furthermore, the possibility to pay with cryptocurrencies enables unbanked people, which are about one-third of the global population, to take part [12, 22].

The democratization of ownership of sharing economy businesses is an often-addressed issue. Schor [41] criticizes that the sharing economy turned into a "business-as-usual economy"

without social factor, and Scholz [40] reports poor working conditions for contractors. Blockchain technology has the potential to democratize the businesses and turn them into cooperative platforms, as there is no central authority needed [27, 40]. This could make sharing more social since the parties can connect directly with each other, and there's no middleman charging service fees to its contractors [27].

Furthermore, blockchain technology could give the control of identity data back to the users. As suggested in a paper of Goldman Sachs, a general ID verification platform on a blockchain could be built (possibly by the government), which allows users to identify themselves in a secure and comfortable manner [28]. This would make it more easy and safe to register for sharing economy platforms, as users could choose which data they want to share, and do not need to fill in their data manually. The platforms also benefit from that, as they do not need to provide their own verification service.

However, using blockchain technology in sharing economy platforms also comes with challenges. A central challenge of current blockchain technology is the scalability, as the transaction throughput is still very low compared to the centralized payment providers [6, 48]. For instance, a Bitcoin transaction currently takes at least ten minutes to be confirmed [44]. This problem could be solved in the near future, as there currently are various initiatives to speed up transaction processing, such as the Lightning Network [34] or the concept of sharding [36]. Also, privacy concerns are widely spread as blockchain technology is still new and the idea of a public database can be perceived as insecure [28]. Moreover, the legal status of decentralized organizations still needs to be clarified, which is fundamental for the success of decentralized platforms [11].

4. MODEL

When using blockchain technology to build a decentralized sharing economy organization (which we refer to as *DSEO*), several design choices have to be made regarding the IT infrastructure and platform features. We aim at providing a low-level view of the elements of a DSEO by giving a general model for it and discussing the design choices connected with the elements. We chose to use the term *organization* instead of business in our model as business gives the impression of the platform being for commercial interests, which is not necessarily the case for decentralized platforms.

Our model (see Figure 1) is based on the Blockchain Market Engineering Framework by Notheisen et al. [32], which is designed to support researchers in analyzing the elements of blockchain-based platforms. We used the framework to identify and categorize the main elements of DSEO's. Also, we adopted four of the six layers suggested in Notheisen's framework. The remaining two layers, being the environment layer and the agent layer, were not relevant for the purpose of our model.

Our model consists of two main layers: the *infrastructure layer* and the *application layer*. The *infrastructure layer* forms the technical backbone of the platform and is divided into a *protocol layer* and a *hardware layer*. In the *protocol layer*, the blockchain infrastructure is defined, which is implemented by the interconnected devices in the *hardware layer*. Building on this infrastructure, the *application layer* represents the platform features and services offered to the users. Part of the application layer is the digital trust infrastructure which consists of trust-building elements. The platform design, which we define as the *application layer* and the *infrastructure layer* combined, is influenced by the organization structure and the user requirements.

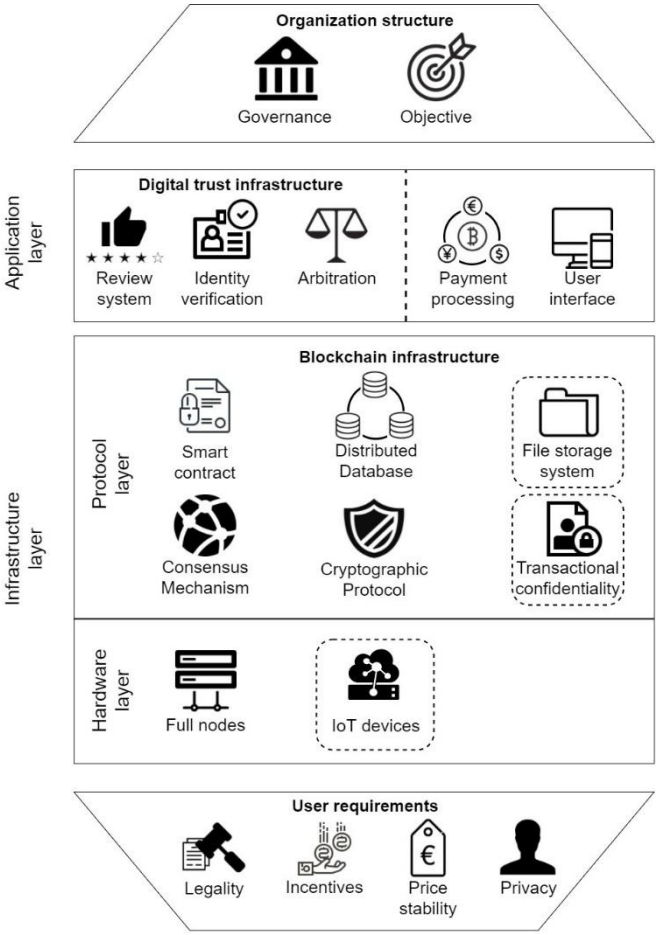

Figure 1. Model for decentralized sharing economy organizations

In the **protocol layer**, fundamental design choices have to be made concerning the blockchain infrastructure of the platform. The first decision is whether to create an entirely new blockchain or to use an existing one and build the platform on top of it. Using a widely adopted blockchain has the advantage that there are already sufficient miners that guarantee the stability and security of the network. When choosing an existing blockchain, it is crucial that the blockchain supports smart contracts, as that is a significant functionality to automatize the processes within the DSEO. A natural choice for a DSEO would be the Ethereum blockchain, as it is the most established blockchain supporting smart contracts at the moment. However, choosing an existing blockchain leads to less control, and there is no possibility to customize the blockchain to the specific needs of the DSEO.

Furthermore, it needs to be decided on whether to use a public, private, or a hybrid blockchain. Originally, blockchains were meant to be public, as the vision of the Bitcoin founder Satoshi Nakamoto was to introduce a system with publicly announced transactions [30]. However, public blockchains have the disadvantage that complex consensus mechanisms are needed to guarantee a stable and secure network [20]. Additionally, the public storage of transaction data can lead to privacy concerns. These issues do not exist for private blockchains, as every participant needs to be invited and approved. This option is primarily used as a means of testing or as an internal system within organizations [14]. One well-known example of a private blockchain is Hyperledger Fabric developed by IBM and Digital Asset [18]. A hybrid blockchain is a combination of a public and a private blockchain. The private blockchain stores the privacy-sensitive data and the public blockchain stores hashes of this

data. Using this system, high transaction speed and privacy can be guaranteed while still offering a publicly accessible transaction database. The first and only hybrid blockchain at this time is XinFin, which is built on the public blockchain Ethereum, and on the private blockchain Quorum [13]. For DSEO's, creating a public or a hybrid blockchain is a logical choice, as private blockchains would not make sense when offering the service to a broad audience. In principle, a hybrid blockchain offers more benefits than a public one, but it remains to be seen whether it will get established.

When creating a completely new blockchain, a suitable consensus mechanism and a cryptographic protocol have to be decided on. The choice for a certain consensus mechanism and cryptographic protocol have an influence on the security and the efficiency of the blockchain network, so it is essential to make a deliberate choice. There are two main consensus mechanisms: Proof-of-Work (PoW) and Proof-of-Stake (PoS). PoW is used inter alia by the Bitcoin blockchain and uses computational power as security for the consensus [11]. This consensus mechanism is highly established and has proven its right to exist; however, it is very inefficient and energy-consuming [47]. PoS uses the balance of a certain miner as security for the consensus, assuming that harming the network by manipulating the transaction flow would be against the self-interest of the miner. This mechanism is foreseen to be implemented in a future version of Ethereum, as it is less energy-consuming and reduces centralization risks [37]. Thus, for a DSEO with a high number of transactions that have to be processed in a timely manner, the PoS consensus mechanism is the better choice. The cryptographic protocol defines how the blocks are created and encrypted. When choosing for certain cryptographic algorithms, the balance between security and efficiency has to be considered in the context of the data that is processed by the DSEO. For an in-depth insight of a cryptographic protocol, we refer to [24].

Furthermore, there are two optional protocol features that are especially relevant to DSEO's: a file storage system and transaction encryption. As sharing economy platforms often offer a user interface with detailed profiles and listings, a considerable number of non-transactional data such as reviews and photos have to be stored somewhere. It would be possible to store these files on the blockchain; however, at the moment this option is very inefficient as the scalability, and the low transaction throughput of blockchains is still an issue [6]. The Origin Protocol suggests using the Interplanetary File System (IPFS) to resolve this problem [26]. When using the IPFS, only the hashes of the files are stored on the blockchain, which guarantees the authenticity of the files while not overloading the blockchain. As transactions on sharing economy platforms often involve privacy sensitive data [28], using a system to guarantee transactional confidentiality is undoubtedly beneficial for the users' perception of privacy when using a platform based on blockchain technology. Kosba et al. [24] developed a framework called Hawk which can be used to build privacy-respecting smart contracts. This way, transactional details can only be seen by the parties involved in a contract.

In the **hardware layer**, decisions must be made concerning the storage of the blockchain. This choice is intimately connected to consensus mechanism and whether the blockchain is public, private, or hybrid. The Bitcoin blockchain is fully decentralized and is hosted by the so-called full nodes, which can be described as all computers connected to the Bitcoin network and storing a copy of the blockchain [44]. As the Bitcoin blockchain is public and does not have validation restrictions included in the consensus mechanism, anybody can set up his or her computer as a full node. Therefore, there is no central instance that provides the storage of the Bitcoin blockchain. However, when using a private blockchain, access is restricted, and the owner (e.g. a company or organization) can define where the blockchain is hosted. For instance, nodes could be set up within the company's intranet or by using a blockchain-as-a-service provider such as Microsoft [29] or Amazon [5]. Besides full nodes, a DSEO might also choose to use light nodes such as Internet-of-Things devices, as they can facilitate the connection between the blockchain and the real world [11].

In the **application layer**, design choices about the implementation of platform features and services are required. An important element for DSEO's is the creation of a digital trust infrastructure for the users, as gaining the people's trust is one of the main success factors of current sharing economy businesses [45]. The digital trust infrastructure mainly consists of three features: a review system, an identity verification service, and an arbitration system. The review system's credibility can benefit from storing the reviews or their hashes on the blockchain, as that makes the reviews immutable and fully transparent. This, however, also means, that the reviews cannot be edited anymore, even for legal reasons. To solve this problem, the online platform could show a version history of reviews, making it possible to add a new edited review to the blockchain without losing the positive effects of immutability. Concerning identity verification, it is a highly discussed option to choose for using a global decentralized identity platform, as proposed by Goldman Sachs [28] and IBM [19]. This makes the process more efficient and trustworthy, although it goes with giving up control of the identity verification process. The review system could also benefit from using a global identity platform, as reviews could be connected to the digital identity of a user, which would make it possible to build a reputation profile with aggregated reviews from several platforms [28].

There are some considerations to be made when implementing the arbitration system. Blockchain technology coupled with smart contracts offers the opportunity to automatize and decentralize the arbitration process. The Bee Protocols, as well as the Origin Protocols, suggest a decentralized tribunal system where randomly picked community members are supposed to decide how a dispute is solved [8, 26]. This system has the advantage of being decentralized and is, therefore, more independent than having central arbitration staff. However, the arbiters are not verified and only limitedly responsible for their choices. Therefore, it might be an obstacle for users to believe in fair decisions made by arbitrary community members. Hence, it might also be an option to centralize this part of the platform for the sake of user acceptance.

Furthermore, DSEO's need to offer payment processing and a user interface. The first decision to be made when implementing a payment system is whether to offer an own token or to use an existing cryptocurrency. A substantial number of blockchain startups choose for an own token, as that provides a way to fund the project by means of an Initial Coin Offering (ICO) and offers more control over the cryptocurrency. Then again, it needs to be considered that using an own token could be another barrier for user acceptance, as users first need to buy that token in order to be able to pay. However, apart from offering the possibility to pay with a cryptocurrency, a DSEO might also choose to offer payment in fiat currencies such as Euro or US dollar, as that could enable people who do not own cryptocurrency to participate in the platform. The DSEO then needs to change the fiat money into the platform's cryptocurrency to enable smart contracts to dispose of such. The design of the user interface is intimately connected to this design choice since these decisions are depending on the target group of the DSEO. For instance, if the DSEO chooses also to target people without knowledge of blockchain, and offers payment in fiat currencies, the design of

the user interface should support this target group by e.g. leaving out technical details about the blockchain infrastructure that might lead to confusion.

The choices made regarding the platform design are influenced by the **organization structure** of the DSEO as well as the **user requirements**. The organization structure includes the governance and the objective of the DSEO. If the DSEO is a commercial business such as Airbnb, the organization has an interest in having control over the platform and therefore might choose for centralized governance. The objective of a commercial business naturally is maximizing profit. These circumstances have an influence on the choices the DSEO makes. For instance, a commercial business perhaps does not want to disclose their business logic and therefore could choose to use a hybrid blockchain to store the smart contracts on the private blockchain. On the other hand, if the DSEO is a non-profit organization, it might tend to more decentralism and give more control to the community as that can reduce staff costs.

Four illustrative user requirements influencing the platform design are the demand for legality, incentives to participate, price stability of the offered services or products on the platform, and privacy. DSEO's need to take into consideration that the legal status of decentralized autonomous organizations is still unclear and therefore, the organization might be restricted in its design choices [21]. Furthermore, users need incentives to participate as new sharing economy platforms at first are less attractive for users because of a smaller offer than at the established competitors [9]. This promotes the choice of using an own token for the platform since the token can first be sold for a reduced price in order to attract users. Also, price stability on the platform needs to be guaranteed, as cryptocurrencies tend to be volatile. This can be done by e.g. fixing the prices to a fiat currency like the Euro. Another user requirement is privacy, as there might be sensitive information stored on the blockchain. This also has an influence on the choice of the accessibility of the blockchain and promotes the use of transaction encryption such as suggested by Kosba et al. [24].

5. EVALUATION

5.1 Approach

To validate our model and the assumptions connected with it, we asked four blockchain professionals working in the finance, logistics, security, and IT consultancy sectors to give their opinion on the model and the design choices we presented. This has been done by means of video and audio calls. Our approach was that we first presented the visual representation of the model and explained its purpose and its layers. The experts were then asked to give their first impression of the model. Afterwards, we described the elements of the model and the design choices in detail, and the experts were asked to validate them. After the model has been described, the experts were again given room for further thoughts and opinions.

5.2 Results

The visual presentation of the model was found to be clear and easy to understand; however, some experts remarked that the position of the organization structure on top and the user requirements at the bottom of the model gives the impression of a top-down approach, which was not intended. Also, the naming of some elements was seen as unclear, such as "servers" or "transaction encryption". These names have been improved in the final model (Figure 1). Furthermore, the element "organizational structure" was found to be too unspecific and has therefore been split into the elements "governance" and "objective".

The design choices given in this paper were generally approved by all experts. However, some experts gave further input on solutions for design choices. All experts stated that they would use the Ethereum blockchain because of its stability and smooth implementation. Also, the choice of using either a public or a hybrid blockchain was approved, as private blockchains do not offer the transparency public blockchains can offer. Concerning the consensus mechanisms, some experts said that they would not use the PoW consensus system because of its inefficiency and vulnerability. All experts found PoS to be a reasonable consensus system because of its excellent performance; however, it was remarked that it is not an established algorithm yet. One expert suggested using the Proof-of-Authority algorithm as a reliable and fast consensus mechanism. Other suggested consensus mechanisms were the Stellar Consensus Protocol and RAFT. All experts agreed that storing non-transactional files in a file storage system makes sense because the blockchain is at this point not efficient enough to store big data files. One expert noted that files that are not relevant for everybody should generally not be stored on the blockchain. Also, transactional confidentiality was found to be an integral part of the model, as it resolves possible privacy concerns. One expert referred to Monero as a recommendable privacy-preserving blockchain. Regarding the use of Internet-of-Things devices, one expert added that decisions have to be made with respect to the real-time or rule-based processing of sensor data and the link between blockchain transactions and the devices.

The elements and the connected design choices of the application layer were found to be logical and complete. Using a global identity verification system was seen as a good solution, as the DSEO can profit from the authenticity and efficiency of a global platform. One expert referred to the Estonian xRoad project as a relevant digital identity initiative based on blockchain technology. A community-based decentralized arbitration system was seen critical by some experts, and it was suggested to use a centralized approach for this feature because the users might not trust in the decisions by randomly picked community members. For the payment, using Ethereum-based tokens was suggested due to the stable network. However, one expert recommended to not use cryptocurrencies because of the low user acceptance compared to fiat currencies. Instead, fiat currencies should be integrated into the smart contracts by using bank API's. The organizational structure and the user requirements have been found to be relevant for the platform design choices. Privacy has been noted as the most important user demand, as sharing economy platforms often store sensitive data about their users.

Overall, the consulted experts believed that the model could help to analyze the elements of a decentralized sharing economy organization and understand the design choices that have to be made. It was also noted that the model might be used for other industries as well. The experts consider the use of blockchain technology in the sharing economy as disruptive and anticipate a high potential, as sharing economy businesses are typical middleman companies that could be replaced by trust-free systems. Keeping the balance between decentralization and control was seen as one of the major challenges of building a blockchain-based platform since all design choices have an influence on this balance.

6. CASE: DECENTRALIZING AIRBNB

Our presented model can be used not only for research purposes but also to create a decentralized sharing economy organization in practice, which we will demonstrate using the case of Airbnb. First, the organization structure and the platform-specific user requirements need to be defined to be able to make design

choices. Since Airbnb is a commercial privately held company targeting the mass market, we assume that the company wants to have control over the platform and aims at offering a platform that can be used by the masses [45]. Also, we assume that the most significant user's demand is privacy because blockchain is still a new technology and users might be reluctant to have their sensitive data such as their stays at Airbnb hosts or private messages saved on a blockchain. Thus, the organizational structure and the user requirements build restrictions as to the level of decentralization and the transparency of the platform.

Furthermore, it needs to be defined whether to use a public or hybrid blockchain. As Airbnb certainly has the necessary budget to create a stable solution, the company might choose a hybrid blockchain supporting smart contracts. This choice gives the company more control over the platform, as the permissioned part of the hybrid blockchain is in its control. Since Airbnb has a vast network with over four million listings, scalability and efficiency is of major importance for the platform [2]. Therefore, a consensus mechanism needs to be chosen that supports high transaction throughput, such as Proof-of-Stake. Also, Airbnb stores a lot of non-transactional data such as listing photos or reviews, so a file storage system like IPFS should be used. Since privacy is a main user demand, Airbnb should guarantee transactional confidentiality by using e.g. the Hawk compiler and needs to make sure that the files stored in the file storage system are encrypted. To further enhance the privacy and convenience of the platform users, Airbnb could also choose to provide door locks connected to the blockchain which automatically grant access to the accommodations. However, this should be optionally, as hosts might refuse to give up control over their own door and it could also be a technical hurdle for users.

Besides the blockchain infrastructure, Airbnb would also need to decide on the implementation of the platform features. As Airbnb wants to keep control over the platform, the company might choose for somewhat centralized approaches. Airbnb could profit from storing hashes of reviews on the blockchain since it can improve the trustworthiness; however, due to legal reasons, the company might still choose against that option to be able to censor reviews containing illegal content. Moreover, the business would probably choose to use an own identity verification system to keep control over this process. Since Airbnb already has arbitration staff, the company might decide against a community-based arbitration process to prevent dismissing employees while offering a more accurate solution for the users. Using a cryptocurrency as main payment would be a rather unfavorable solution for Airbnb, as the business targets the mass market. Therefore, the company should choose to use a fiat currency-based solution at this point in time.

This case shows that there are difficult considerations to be made when decentralizing an already established company. As Airbnb is a private commercial company with full-time staff, a complete decentralization would take the control out of their hands and could lead to a massive decrease in employees. These circumstances prevent the company from unleashing the full potential of blockchain technology. A full decentralization of the company must, therefore, go in line with fundamental changes in the business structure of Airbnb.

7. CONCLUSION

This research examined the potential of blockchain technology in the context of the sharing economy. First, the main characteristics of blockchain technology, namely the decentralized consensus mechanism, transparency, and immutability, were examined. The literature review showed that offering a digital trust infrastructure is an essential element that made current sharing economy business models successful. The success factors can be included in a blockchain-based platform by offering trust-building features and minimizing the hurdle for users to participate, such as suggested in our model.

The advantages of decentralization are various: Blockchain technology can be used to create a reliable review system that allows transferring reputation data from one platform to another. Furthermore, it can give the control of private data back to the users by letting the users govern their own data using a global ID platform. Also, blockchain technology has the potential to make the sharing process more social by connecting individuals directly with each other without the need for a middleman charging fees. Furthermore, the use of cryptocurrencies facilitates low transaction fees and microtransactions and does not require a bank account, which could enable the inclusion of low-income groups and unbanked people. The main challenges of using blockchain technology are scalability, privacy concerns, and the unclear legal status. Taking these chances and challenges into account, our model presents the design choices that need to be made when creating a decentralized sharing economy organization. The presented case illustrates these decisions and shows that decentralizing a privately owned commercial company goes in line with difficult considerations regarding the balance between decentralization and control.

8. FUTURE WORK

Since blockchain and the sharing economy are rather new concepts, there are various issues and questions further research can focus on. Regarding blockchain technology, the major challenges privacy and scalability need to be further investigated, and practical solutions are necessary. More specifically, an efficient consensus mechanism that offers both scalability and security is required. Also, hybrid blockchains should be studied more extensively. Concerning smart contracts, a good solution that allows for editability and integration of fiat currencies could be a driver for wider dissemination. Furthermore, there needs to be more research on the communication and integration between different blockchain-based platforms as that could potentially disrupt the way how platforms work right now. As to the sharing economy, empirical research on the success factors is still rare. Also, the impact of blockchain technology on a more social way of sharing services or property leaves room for further research.

9. ACKNOWLEDGEMENTS

I want to thank my supervisor Hans Moonen for the excellent guidance through our weekly meetings which provided me with a lot of good ideas and encouragement. Also, I want to thank the consulted blockchain experts Djuri Baars, Frank Bloo, Sjors Hijgenaar, and Ronald Teijken for their constructive feedback on my model.

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