**DEPARTMENT OF APPLIED
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Public blockchain communities

A study on how governance mechanisms are expressed within blockchain communities

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Abstract

Blockchain technology is rapidly growing and can in the near future disrupt industries such as finance, cyber security, and political voting systems. The interest in the phenomenon has increased the past years, and as a result, more research within the field has emerged as a natural outcome. Previous research has to a large extent focused on technical and legal issues facing the technology. In contrast, this study aims to fill the research gap by bringing insight to the field of governance within public blockchain open source software (OSS) communities, whereas the most well-recognized blockchain projects, such as Bitcoin and Ethereum are OSS. Therefore, the following research question has been set to direct this study; *Which governance mechanisms are expressed within public blockchain communities?* By analyzing previous research on governance mechanisms within OSS, a theoretical framework was constructed. The framework was based on well-recognized OSS community literature and consists of six governance mechanisms. The similarities and differences between OSS communities and blockchain OSS communities are identified through the use of the theoretical framework. Moreover, by analyzing forum and blog posts on online communities where contributors communicate regarding development and visions of the researched community and platform. On those communities, by-products from communications has been left as digital traces, which is analyzed by conducting a methodology referred to as trace ethnography. Furthermore, an exploratory approach was included in this study, allowing the researchers to explore beyond the scope of the framework. The framework was used as a foundation for this study, and resulted in findings showing that several governance mechanisms are similar to those in OSS communities, whilst others differed. Five of the mechanisms were found to be similar to those in the framework. However, the sixth mechanism involving leadership differed from OSS communities since the community decide which road to follow. This does not make it autocratic, or democratic, since the contributors have an option to support the version of protocol they believe will prevail. Lastly, initiative-based progress is presented as an extended mechanism, and an implication from this study. This is due to it instigating a flexible and progressive approach towards rapidly developing a collaborative project within blockchain OSS communities.

Keywords: OSS communities, community governance, blockchain technology, blockchain governance, governance mechanisms

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Introduction

In the last few years, interest of blockchain technologies and cryptocurrencies has grown exponentially, which has resulted in more studies and an increased appeal in the phenomenon (Kiffer, Levin & Mislove 2017; Chakrabarti & Chaudhuri 2017; Yli-Huumo, Ko, Choi, Park & Smolander 2016; Porru, Pinna, Marchesi & Tonelli 2017). The starting point of blockchain-related projects took place during 2009, when an anonymous individual or group of developers presented Bitcoin, and got support from early adopters because of it being a decentralized system (Böhme, Christin, Edelman & Moore 2015). Zambrano, Seward & Sayo (2017) defines blockchain as a public decentralized database, and adds that some blockchain projects' code are open source software (OSS), which is what associates the two concepts. Johnson (2012) continues to explain the concept OSS as computer software that is developed by different contributors in collaboration with each other. Similarly, Shah (2006) explains OSS as software that can be used, modified and redistributed by contributors. Furthermore, OSS communities rely upon the voluntary collaborative actions of thousands of contributors (Shah 2006). There are prominent examples on blockchain projects that are OSS, such as the two largest, Bitcoin and Ethereum, which are both peer-to-peer networks. As of today, Ethereum is the second most valuable blockchain project with a market capitalization of -$67B. The contributors of Ethereum constitutes a large community, which makes the platform dependent on the collaborative actions from the OSS community (Kiffer et al. 2017; CoinMarketCap 2018; Chakrabarti & Chaudhuri 2017; Swan 2017; Zambrano et al. 2017; McPhee & Ljutic 2017; Kogure, Kamakura, Shima & Kubo 2017). Due to the magnitude of certain projects, structure and governance becomes a necessity in order to orchestrate and coordinate an entire virtual community towards the same goal. The contributors within blockchain communities may have diversified views, although the common values of the community unite them (Reijers, O'Brolcháin & Haynes 2016). Furthermore, the governance, organization and coordination of the communities are believed to be critical for success in projects (Von Hippel 2001; O'Mahony & Ferraro 2007).

Sadowski, Sadowski-Rasters and Duysters (2008) state that governance mechanisms are used to manage the contributors, coordinate the development and launch new releases within projects. Governance is important because an essential feature of peer-production communities is that they rely on volunteering contributors (De Filippi & Loveluck 2016). However, some project founders believe that if they implement a governance structure, they would lose control over the direction in which the project is heading. Others believe that formalizing the structure of an OSS project may hinder its growth (Ritvo, Hessekiel & Bavitz 2017). The formalization of governance would thereby be seen as something that makes the project less attractive to contribute to (Ritvo et al. 2017). This is according to Ritvo et al. (2017), the consequence of an inappropriate governance model, and not because of formalization, when it comes to governance. Therefore, Ritvo et al. (2017) believe that it is important to have a governance model that encourages the volunteers to contribute to the OSS projects, as does Shah (2006), who also state that the governance structures affect the motives of the contributors. Governance has been a tool for withholding control, supervision and monitoring, whereas the overall motivation is to merge together the different objectives within the collective (Sadowski et al. 2008). OSS communities are governed with different variations of control and openness. Some projects have directed roles to individuals, whilst others let the contributors act freely (Markus 2007). There is a belief that we lack knowledge of how governance mechanisms are combined within OSS communities, and there are many unanswered questions within OSS governance research (De Noni, Ganzaroli & Orsi 2013; Markus 2007). However, there are no reasons for future work to be independent from past foundations. Therefore, this study presumes that OSS theories might offer insight into blockchain OSS communities. There might be governance mechanisms that are aligned with OSS projects, and there might be some that differ. This assumption is based on the fact that blockchain projects are often OSS, and thereby might inherit governance mechanisms from OSS communities (Chakrabarti & Chaudhuri 2017; Zambrano et al. 2017).

In 2016, 80% of research within the blockchain research field was aimed towards Bitcoin, whereas a majority was on technical subjects (Yli-Huumo et al. 2016). A large amount of research has been focused on the technicalities and on the legal aspects of blockchain technology. As the user base

grows, areas such as management of blockchain platforms need to be researched (Lindman, Rossi & Tuunainen 2017). This study aims to bring insight to the governance aspects. The purpose of the study is to enhance and contribute to the research field on governance within public blockchain OSS communities. Public in the sense that the blockchain platform can be accessed by any individual (Xu et al. 2017). Furthermore, this study aims to identify which governance mechanisms are expressed within the Ethereum blockchain community and has similarities with OSS communities. The expected contribution is an extended and renewed appearance of governance mechanisms for blockchain-related OSS communities. Therefore, the following research question is set to direct this study.

Which governance mechanisms are expressed within public blockchain communities?

To answer this question, the study is structured as follows. A theoretical description of the concepts 'blockchain technology and governance', and 'OSS and governance' is presented to make sense of the findings and to enrich the reader with necessary knowledge of the concepts. Next, a theoretical framework is presented and works as a lens for the empirical data. The methodology is presented and explained in the section referred to as research methodology. Together the three categories; research context, data collection and analytical method aims to thoroughly provide insight on how the study was conducted. The result consists of empirical data and is systematically presented in the same order as the theoretical framework. Lastly, the discussion and analysis of the result and findings is presented together with limitations and implication for further research.

Theory

The theory is intended to give a fundamental basic understanding on the concepts of blockchain technology, OSS and how governance is expressed respectively to the two subjects. Both phenomena are defined and explained beneath their related headings. The association between blockchain technology and OSS is defined through development collaboration within open source communities and blockchain technology (Chakrabarti & Chaudhuri 2017; Kiffer et al. 2017; Kogure et al. 2017; McPhee & Ljutic 2017; Swan 2017; Zambrano et al. 2017).

Blockchain and governance

Murck (2017) presents five basic characteristics to blockchain technology. Firstly, it is a distributed database, which means that the database and its history are accessible to everyone. Therefore, it is not just one person who controls the data. The second principle of blockchain technology is the peer-to-peer transmission, which means that communication does not go through a central node, rather it is direct between two parties. Murck (2017) continues to present his third principle, transparency with pseudonymity which means that each and every transaction is visible to anyone who has access to the system. The fourth principle is irreversibility of record, which hinders anyone altering the data in the database. Therefore, all changes within the database are recorded and stored permanently and cannot be erased or tampered with (Engelhardt 2017; Murck 2017). The fifth and last characteristic is the computational logic, which means that the logics can be programmed through algorithms, so that specific actions are triggered between actors when this logic falls in place. Blockchain projects are often based on OSS, which refers to software developed in collaboration by diverse contributors. For example, Bitcoin, introduced in 2008, started off being developed as open source, and shortly thereafter depended on the global OSS community of contributors (Teigland, Yetis & Larsson 2013; Nakamoto 2008; Zambrano et al. 2017; McPhee & Ljutic 2017). For the early enthusiasts of blockchain, the political polarization of the innovation was what motivated them, considering that they were inclined towards radical decentralization (Lindman 2017). Furthermore, blockchain can be compared to the effect of electricity to telecommunication, television and the Internet, considering the massive scale of sub-inventions that the technology is believed to instigate (McPhee & Ljutic 2017). Nofer, Gomber, Hinz and Schiereck (2017) state that blockchain technology can be used in different industries. For example, the financial industry can make use of the technology by creating innovations such as cryptocurrencies, where value can be exchanged using cryptography for secure transactions (Nofer et al. 2017). It can also be used for decentralized proof of existence of documents and decentralized storage, where timestamps and signatures can be secured without the need of a third party. The technology is revolutionary but yet still uncharted, and there is much more to learn (Nofer et al 2017). This is due to many innovations based on blockchain technology still being in the genesis phase. As with the innovations continuously being improved and requiring updates, there are two different ways of doing it, involving changes in the protocol. This involves performing forks, which can be seen as a roll out procedure for protocol changes (Kiffer et al. 2017). One procedure is termed soft fork, which means that the update is backwards compatible. If it is not backward compatible, it is termed hard fork (Kiffer et al. 2017). Blockchain based systems rely on planned forks to roll out changes in a decentralized manner. If a community does not reach consensus regarding updates to the protocol, a separation in the network occurs. This leads to two differentiated systems, each with its own path and contributors (Kiffer et al. 2017; Arruñada & Garicano 2018). It could also be described as two different versions running in parallel due to clashing opinions within the developer team (Nyman 2015). Studies have shown that a majority of the virtual communities often adapt to the newer version of the fork (Kiffer et al. 2017).

The governance aspect of blockchain technology can be tricky, in fact, everyone could be seen as being in charge since governance is dependent on consensus within the community. There is no need for one individual to be in charge, since algorithms determine consensus (Zambrano et al. 2017). The communities are based on groups of people who wants to achieve a collective outcome, by voting in a decentralized manner (Zambrano et al. 2017). Furthermore, this also means that the community

contributors are voluntarily active, and the trust is decentralized and depersonalized. However, this does not indicate enhanced governance (Zambrano et al. 2017). The largest blockchain platform communities are open, which means that contributors join if they accept the conditions and are free to leave whenever they want (Kiffer et al. 2017; Zambrano et al. 2017). Besides working towards common goals, governance structures are set up within these communities in order to maintain power relations, and keep some degree of social order, all while ensuring legitimacy of the actions taken by the community (De Filippi & Loveluck 2016). There are two decisive features that are forming the governance structure of these communities, particularly the fact that they are self-organized and volunteer-driven (De Filippi & Loveluck 2016). Since the development of OSS relies on the contributions of developers, the governance structure has to be in line with the collective interests and goals. The development of entire platforms, projects or modules are dependent on the interests of the contributors (Nyman 2015). In contrast to previous developments within OSS projects, the interest from industries, companies and individuals cultivated more rapidly for Bitcoin and Ethereum (Lindman 2017). Furthermore, one of the motives for this is because the contributors within blockchain communities understood that they needed to incentivize and acquire support from the cryptocurrency space in order to grow and obtain benefits (Lindman 2017).

Summarizing blockchain from a governance perspective, the vision is to protect the networks from political pressure, so that it relies upon a decentralized infrastructure which cannot be controlled by one or a few individuals. The governance is instead encoded with protocols and processes within the original architecture. While taking part of the community, the original rules are accepted by the contributor. As the network grows, reaching consensus becomes more challenging, which is intentional. If consensus is not reached, the network splits and take different paths. This leads to a new protocol and a new community (Murck 2017). There is still a lot more to learn about blockchain technology; what we do know is that both Bitcoin and Ethereum still operate and are regarded as OSS (De Filippi & Loveluck 2016; Chakrabarti & Chaudhuri 2017; Zambrano et al. 2017; Kiffer et al. 2017).

Open source software and governance

OSS is an approach where contributors come together to create software on a global basis (Scacchi, Feller, Fitzgerald, Hissam & Lakhani 2006). A developer with an interest in contributing to the community can join without any geographical limitations (Von Hippel 2001). Thus, the organizational model for development and innovation is referred to as community-based innovation (Shah 2006). Von Hippel (2001) explains OSS as a community which is run completely by and for users, and argues that such community projects can lead to great innovations. Furthermore, OSS is often associated with high-quality and popular software, whereas it involves organized production by contributors (Johnson 2012). Nyman (2015) discloses two different types of OSS projects. The first one is when the community is serving as the leader and driver of the project. This means that the community itself diversifies the control and governance among the individuals within it, whereas sometimes the community decides to include a non-profit foundation to chart the project. In contrast there is also the project in which the owner and driver is the corporation. The corporate project is where the corporation is the driving force, and retrieves supporting action from the OSS community and the corporate community. Often, the corporate community is composed of several companies that benefits from the development of software (Nyman 2015).

As there are different types of OSS projects, they are all governed in some way, thus the definition of OSS governance has been defined differently. Markus (2007) argues that it is up to the researcher to decide what OSS governance means, thereby making it challenging for individuals to assess the research. Markus (2007) adapts the definition by Lynn, Heinrich and Hill (2001) to fit within an OSS context, thereby defining OSS governance as follows: "*the means of achieving the direction, control, and coordination of wholly or partially autonomous individuals and organizations on behalf of an OSS development project to which they jointly contribute*" (Lynn et al. 2001, p. 6). The definition by Markus (2007) is adopted and used in this study.

Within OSS, the model differs from proprietary models, because it does not rely upon rights or hierarchical control (Shah 2006). In contrast, the model is based on collaborative and voluntary efforts of the community (Shah 2006). De Filippi and Loveluck (2016) state that there are two features that are decisive in online peer-production communities, such as being self-organized and volunteer-driven. Within the academic field, the view of why people contribute to OSS differs. Some believe that it is the ideology of free software that drives the OSS development (Shah 2006), whereas others believe that it is defined by satisfying the contributor's own needs (Franke & Von Hippel 2003; Kuan 2001; Lakhani & Von Hippel 2003; Shah 2006). There are obviously different beliefs on why people contribute to OSS: whereas some contributors do it for fun, others for personal development, technical curiosity or success and intellectual challenge. However, the majority enjoy programming and have a desire to be a part of a community (Matei & Irimia 2014).

O'Mahony and Ferraro (2007) address the most significant problems within organizational research as to how communities coordinate, govern and organize the actions of individuals in order to achieve outcomes from the collective. The purpose of governance within OSS can be distinguished by three main positions, exhibited differently by the literature according to Markus (2007). One position is that OSS governance solves a dilemma regarding incentives. When individuals or organizations want to join a project, the incentives have to be clarified. The second position that Markus (2007) presents is that the coordination issues are easier to solve when there is a governance structure in place within the OSS. Lastly, the governance mechanisms hold a motivational potential, which could later determine if the contributor decides to join the project (Markus 2007). De Noni et al. (2013) believes that creating a good foundation for a OSS project depends on the quantity and the combination of resources. The argument is that competence of the people attracted to the project is critical for the innovation process (De Noni et al. 2013). Trust is another critical factor when dealing with the coordination of online efforts, and which the online socio-technical systems address through informal relations, technical solutions and formal rules (De Filippi & Loveluck 2016). De Noni et al. (2013) state that the governance mechanisms are used in order to create attractiveness and sustainability of the community. Furthermore, OSS is a collective process of knowledge creation (De Noni et al. 2013). All OSS projects have some kind of hierarchy, either by coordination or by rising as a natural outcome (De

Laat 2007). Anthes (2016) state that many successful OSS projects, such as Apache and Eclipse has distinct ownership and governance structure.

In summary, governance within OSS projects takes different forms. As mentioned earlier, the OSS projects depend upon voluntary contributions from individuals, whereas the community needs to be organized. By adapting a governance structure, a community has the means to support the direction, control and coordination in which the individuals jointly contribute to (Markus 2007; De Noni et al. 2013; O'Mahony 2007). To maintain control over relations, keep the social order and work towards the community's common goal, a governance structure is necessary (De Filippi & Loveluck 2016). This is to ensure legitimacy of the collective actions (De Filippi & Loveluck 2016). Through an array of certain governance tools, the OSS community will achieve an overall design of the governance structure, whereas in all projects some kind of hierarchy is inevitable (De Laat 2007).

Theoretical framework

De Laat (2007) has studied OSS with the focal areas being on three different types of governance, which are referred to as spontaneous governance, internal governance and governance towards outside parties. The mechanisms introduced by De Laat (2007) are widely recognized within OSS research. By introducing previous research on OSS, this study aims to gather insight into the governance that portrays blockchain OSS, which the chosen theory facilitates by providing a ground from previous research in a related field. When aggregating categories for governance mechanisms within OSS projects, De Laat's (2007) study of internal governance had a large amount of leverage and recognition from other researchers, whereas the corresponding authors that are aligned with the different categories are presented in the framework below. Furthermore, based upon the scholarly orientation of this study, the internal governance theory by De Laat (2007) was suitable as a framework for this study. De Laat (2007) believes that by combining the different governance mechanisms, the OSS community will assume an overall design. It was acknowledged that the research literature of OSS governance used in this study's framework is relatively old, due to the fact that the field of research has been mature for a while. De Laat's (2007) mechanisms presented in the study are grouped into the following six categories: modularization, division of roles, delegation of decision-making, training and indoctrination, formalization and autocracy/democracy. These mechanisms contribute to better understanding the phenomena of internal governance within OSS. The tools also help to coordinate efficiency and effectiveness within large communities (De Noni et al. 2013). Due to the large number of corresponding authors in the framework presented in the right row of the figure below, it is safe to assume that it is a common conception of governance mechanisms within OSS. As a result from an extensive search of previous research, the mechanisms presented by De Laat (2007) are well-fitted for this study. Furthermore, following De Laat's (2007) categories, this study uses them as a framework for identifying governance mechanisms within blockchain communities.

Governance mechanisms		
Categories	**Description**	**Corresponding authors**
Modularization	Projects are divided into modules.	De Laat (2007); Markus (2007); Mockus et al. (2002); O'Mahony & Ferraro (2007); Von Krogh et al. (2003); De Noni et al. (2013)
Division of roles	Individuals are divided into roles within the projects.	De Laat (2007); Markus (2007); Mockus et al. (2002); Jørgensen (2001); O'Mahony & Ferraro (2007); Von Krogh et al. (2003); Yamauchi et al. (2000); Shaikh & Cornford (2003); Ritvo et al. (2017); De Noni et al. (2013)
Delegation of decision-making	Centralised community: project leader decides. Decentralised community: decisions by voting.	De Laat (2007); Markus (2007); German (2003); Nakakoji et al. (2002); De Noni et al. (2013)
Training and indoctrination	Certain requirements has to be met in order to join the project.	De Laat (2007); Markus (2007); De Noni et al. (2013)
Formalization	Formalised communication tools are used within the community.	De Laat (2007); Markus (2007); Mockus et al. (2002); Jørgensen (2001); Shaikh & Cornford (2003); Yamauchi et al. (2000); Foss et al. (2016); De Noni et al. (2013)
Autocracy/democracy	Autocracy: inventor or self-appointed leader. Democracy: decisions by electoral process.	De Laat (2007); Ritvo et al. (2017); De Noni et al. (2013); De Filippi & Loveluck (2016)

Figure 1. Theoretical framework (own compilation).

The first mechanism presented by De Laat (2007) is 'modularization', which addresses the issue of large amounts of participants. When projects grow larger and the number of participants increases, the projects are often divided into several modules. This way, a project that consists of several modules can be worked on simultaneously and be coordinated, which means that many different modules can

coexist (De Laat 2007). Markus (2007) includes the process of dividing individuals into different parts of the project into a category called community management, whereas O'Mahony and Ferraro (2007) refer to it as a community form. An example of a project resulted from modular development is the well-recognized OSS project, Apache (Mockus, Fielding & Herbsleb 2002).

'Division of roles' is the second governance mechanism presented by De Laat (2007). Within projects, the individuals are either assigned a role or they invent new ones. For example, some individuals can access certain files related to the project, whereas others cannot. The observer may participate in discussions and have access to documentation and files, while the developer develops source code, and the project owner manages the project (De Laat 2007). Mockus et al. (2002) express the importance of dividing roles, and describe it as roles and responsibilities. However, in order to be effective within work processes, Markus (2007) believes that the community needs to be managed. Therefore, it is significantly important to divide roles when it comes to software development processes. Jørgensen (2001), O'Mahony and Ferraro (2007) agree that distribution of roles in projects is critical. For a project to be effective, it should have clearly defined roles and instructions (Ritvo et al. 2017). There are clearly a lot of differentiated roles, but what matter is that they are divided (De Laat 2007).

In all projects, decisions need to be taken regarding new activities, new methods to be used or other community-related issues. However, the most important decision within OSS has to do with code acceptance. This refers to 'Delegation of decision-making' and is De Laat's (2007) third mechanism. Who decides if certain code snippets are to be implemented within the experimental version or within the real version? In a centralized steered community, the project leader is in charge of decisions (De Laat 2007). Nakakoji, Yamamoto, Nishinaka, Kishida and Ye (2002) expresses that the influence of the project leader is important when taking decisions, due to the project leader being a decision-maker and responsible for the overall direction of the project. In a decentralized community it is up to the contributors, whereas a decision is often taken by voting (Nakakoji et al. 2002). This could mean that developers try the code in a personal copy of the source code, having it reviewed by peers, whilst in others, developers implement the change and have it reviewed on forums (De Laat 2007). Markus (2007) believes that all projects have someone who is chartering it, whether it is an elected individual or someone who voluntarily stepped up to take the lead. However, even if there either is a group of people or one person in charge, the creations of an OSS community are a collective process of knowledge creation.

In earlier years of OSS projects there were no conditions to participate in a project: everyone who was interested was welcome to join the project in some way. In later years, the communities grew larger and the division of roles were imposed, thereby initiating conditions on joining a project. This is how De Laat's (2007) fourth mechanism, 'training and indoctrination', comes into play. Since OSS communities grew larger, the contributors often had to prove their identity, e.g. through having cryptographic keys signed. They also had to demonstrate their technical skills, similar to an exam (De Laat 2007). De Laat (2007) mentions examples of times when individuals who wanted to become developers had to complete different stages of tasks to in order to apply for entry into a project. Markus (2007) state the importance of finding the right competence for specific projects, and refers to this as a part of community management.

OSS projects can be global, which means that there are no geographical limitations for the contributors within a certain project. While handling global projects, 'formalization' is called for, which is referred to as De Laat's (2007) fifth mechanism. In order to weave together contributors that are distributed across the globe, formal procedures and tools have to be forged. These tools have to enable contributors to discuss, ease the procedure of bug reporting and keep track of versions that has been taking place (De Laat 2007). Both Markus (2007) and Mockus et al. (2002) argue for the importance of having and using the right information and tools. This makes communication a key concept in OSS projects (Jørgensen 2001). Formalization becomes critical when people in the same project are located in different places around the world, since all the people involved need to be on the same page (Shaikh & Cornford 2003; Yamauchi, Yokozawa, Shinohara & Ishida 2000; Foss, Frederiksen & Rullani 2016).

Within OSS communities the appointment of a leader could be performed in different ways. The two main categories are 'autocracy' and 'democracy', which is also De Laat's (2007) final mechanism. If the leadership was self-appointed or the inventor stayed on as the leader, it is best described as being an autocracy. An example of this is Linus Torvalds, the founder of Linux (De Laat 2007). However, if the community chooses the leader or a core team with the use of an electoral process, is a democratic choice. For example, some projects have project leaders elected by the contributors of the project (De Laat 2007). An example of this is the Debian project, where the project leader is annually elected by the contributors (De Laat 2007). Ritvo et al. (2017) argues that the leaders of a project should be set by the community and that authority should be decentralized.

Research methodology

To be able to answer the research question "*Which governance mechanisms are expressed within public blockchain communities?*", a trace ethnography study was conducted. The methodology trace ethnography allows for gathering substance of data and reconstruct patterns. This type of methodology fits well with the scope of this study and has shown to previously being successful within technology and science studies (Geiger & Ribes 2011; Beaulieu 2010). Trace ethnography was chosen on the grounds of it involving the exploitation of documents or traces within technological systems in socio-technical environments. The methodology is used to collect data during a historical event, and to gather records of activities that have left a mark on the use of online information systems (Howison, Wiggins & Crowston 2011). Evidence of actions committed on online forums leaves digital traces. This type of evidence is best summarized by three characteristics. Firstly, the data is not produced, it is found. This means that the data is a consequence of certain activities rather than produced specifically for a research purpose. Secondly, the data is based on events. Because of the data not being produced in the present, the data has to be interpreted by the researchers, rather than for example, having respondents interpret their own interactions and summarize it. Thirdly, the data is longitudinal, meaning that the data has been produced over a long period of time. This makes it necessary to combine data in order for it to have meaning (Howison et al. 2011). Since the chosen event has already happened and the data has been produced as a by-product, the methodology is well-fitted for analyzing discussions during the specific timeline. It also leaves room for the researchers to interpret a structure from the produced data. Furthermore, the collection of data and analysis is based on governance mechanisms that De Laat (2007) has compiled and introduced to OSS communities. Based on De Laat's (2007) governance mechanisms, a table of criteria was created to study how the mechanisms would fit within blockchain communities. Previous research that have the same conclusions as De Laat (2007) were identified and found to have strengthened the relevance of the mechanisms. By combining previous research on OSS governance, it is possible to capture the literature and generate a theoretical framework that could potentially give insight to the subject of OSS governance in blockchain communities. In addition, an exploratory approach was combined with the methodology, in order to identify additional governance mechanisms. This was done to leave room for unexpected findings and to keep an open mind on new findings which could serve as a basis for future theories (Shields & Rangarajan 2013).

Research context

In the initial phases of deciding a research context of this study, the hard fork that resulted in Ethereum and Ethereum Classic matched with the methodology of a trace ethnography study. A timeline that spans from June to August 2016, was chosen. Due to the event being controversial within the Ethereum community, a large amount of digital traces is left around the online communities, thereby fitting with the research methodology (Howison et al. 2011). The hard fork was used as an opportunity to identify and analyze how governance mechanisms are expressed during a change in the Ethereum community. It was expected that the hard fork would lead to discussions that are not everyday problems regarding development and therefore result in discussions that would not emerge otherwise.

Ethereum is a blockchain platform based on OSS, which is intended to provide a protocol for building decentralized applications. Vitalik Buterin, the founder and a main contributor of Ethereum, wrote a white paper on Ethereum, explicitly communicating the ambitions of the project, where the emphasis of the platform is fast development time and high security (Kiffer et al. 2017). Ethereum did this by building a blockchain with a programming language, allowing individuals to create smart contracts and applications with their own rules. The platform was announced to the public in the early part of 2014. By then, the platform had already attracted many stakeholders. Two years later, a specific set of contracts was developed, which was intended to work as a capital fund and a crowdfunding approach within the crypto space. This was referred to as the Decentralized Autonomous Organization (DAO). Because of the DAO being decentralized, it reduced the costs and let the individual investors have

more control. However, after the release, the DAO was exploited, in which a hacker withdrew funds without the balance being updated. By exploiting it, the hacker got a hold of $50m worth of Ether, which is the currency used on the platform. During this time, many proposals were discussed within the community. One of the proposed measures was to perform a hard fork which would let the investors get their funds back. However, this involved a major change in the protocol, which lead to two different blockchains. The decision raised significant controversy, as the community were put to a vote through a website called carbonvote.com. This meant that depending on how much Ether an individual held in their wallet, the more the vote would count. The outcome of the voting clearly showed that the community wanted to perform a hard fork, which took place July 20, 2016, and resulted in two different paths for the Ethereum community. The supporters and non-supporters of the hard fork went in different directions. Ethereum Classic continued as the original protocol with a minor part of the previous community, and Ethereum went on as the new protocol, with a much larger support of the community, one being Vitalik Buterin. The final outcome were two different paths of the community, re-appropriation of the lost funds to investors and a large amount of discussions on the online communities. The timeline below illustrates the notable events prior, during, and after the hard fork in mid-2016.
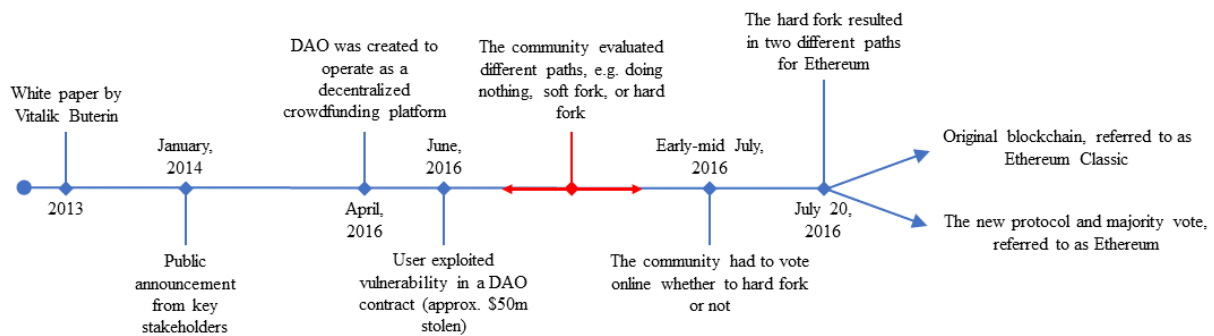

Figure 2. Timeline (own compilation).

Data collection

Before collecting data, predetermined criteria needed to be set to ensure gathering of relevant data. The screening and collecting of empirical data was delimited to what was appropriate in regard to the predetermined criteria. To reconstruct and summarize the description from the theoretical framework into statements that were used as predetermined criteria for the collection of the empirical data, a thematic analysis of the theoretical framework was made. This analysis resulted in a framework that deliberately eased the collection process. Based on the analysis of the description, criteria were introduced to ensure quality of the empirical data. The description of the governance mechanisms is based upon De Laat (2007) and corresponding authors (see figure 1). Furthermore, in order to gather data that would provide grounds for analytical work, the empirical data needed to comply with the predetermined criteria. The predetermined criteria for each of the governance mechanisms are described in the figure below (see figure 3).

Categories	Criteria
Modularization	The data shows that the projects are divided into modules.
Division of roles	The data shows that individuals are divided into different roles.
Delegation of decision-making	The data shows how decisions are made.
Training and indoctrination	The data shows that specific requirements are met in order for an individual to join a project.
Formalization	The data shows that there are formalised tools for communication.
Autocracy/democracy	The data shows how the community chooses its leader.
Exploratory outcome	N/A

Figure 3. Predetermined criteria for the data collection (own compilation).

The data consists of digital trace data such as forum and blog posts from different online sources, where contributors of the Ethereum OSS projects communicates. The empirical data was restricted to being posted on certain dates, strictly ranging from June 1 to August 31, 2016, which is one month ahead and one month after the hard fork, thereby constituting a historical event (Howison et al. 2011). The posts that were within the limited time frame, had a relevant tag or title and matched the predetermined criteria (see figure 3) were collected for analysis. Two Microsoft Excel spreadsheet was created in order to store the data from forums and blogs. The data was then categorized into seven various categories, which corresponded to the governance mechanisms. Collected data was initially gathered in two separate spreadsheets, one for each researcher. In the cells of the spreadsheets, data was inserted and structured in the same way for all columns. Each cell consisted of information regarding date of writing, author, URL, source, motivation for its relevance and a summarizing meaning of the post. It was organized this way so that it would be easy to return to a specific post, if needed. In the cases where the post could not be evaluated as relevant from the title, the content and discussions were evaluated. As the posts on the different online sources combined contains a lot of data, the saturated amount of fifteen posts per researcher, well-fitted for each category were set as a target, with the exception for the category referred to as 'exploratory outcome'. The 'exploratory outcome' category was the seventh and last column and included data that was not an immediate fit for the six categories, but was still considered of interest for the study, thereby being related to the research field of governance. This was since the 'exploratory outcome' category constituted an exploratory approach, aimed to provide new insights and grounds for further research. Furthermore, the target of fifteen posts was exceeded on certain categories, as a larger amount was expected to further strengthen the conclusion. However, it was believed that new insights would not appear simply by gathering and analyzing a larger amount of posts. The reliability of the data is deemed to be high because of it being natural appearing data, and a by-product of communications between contributors. This approach excludes respondents from interpreting and summarizing their own responses, and allows the researchers to interpret the found data into evidence (Howison et al. 2011).

Data was found on the websites Ethereum Blog, Ethereum Forum, Ethereum Stack Exchange, GitHub and Reddit (see figure 4). The sources were seen as the main channels by examining the official blog and from following the contributors, thereby the sources contained a large amount of activity.

The five different websites were the sole sources for the empirical data. Figure 4 presents and describes the five sources. The first source is the Ethereum Blog, where empirical data was collected by limiting searches to a desired time frame. The second source was the Ethereum Forum, which had categories simplifying the search. The categories 'general project discussion', 'mining', 'jobs and skills', 'education', 'all categories' and 'projects' were scanned briefly, because of the substantial

amount of posts. Remaining categories on the website were not directly related to the study and were therefore disregarded. Furthermore, the third source of empirical data was collected from Ethereum Stack Exchange. Empirical data was found by altering the URL to a specific page, which would include posts from the desired date. The fourth source for the data collection was GitHub. An advanced search was conducted on the GitHub platform, whereas the dates were restricted to desired time interval. In addition, the search word restriction was used and delimited to Ethereum-related posts. The fifth source for the empirical data was Reddit. Data was found through filters and by using a search engine that was specifically delimited to forum posts on Reddit. The searches were made within the subreddits 'ethereum', 'ethdev' and 'EtherMining', which were found by searching on Ethereum in their search function. By applying the necessary filters on the website and real-time analytics platform: redditsearch.io, the relevant posts were listed.

Sources	Description
Ethereum Blog	A blog where well known names within the Ethereum community post news, issues, thoughts and other information related to the community. (Ethereum Blog 2018)
Ethereum Forum	A platform for discussing issues that are both technical and non-technical. (Ethereum Forum 2018)
Ethereum Stack Exchange	A question and answer site, used by the community members to pose and respond to questions regarding the Ethereum platform. (Ethereum Stack Exchange 2018)
Github	A well known platform for managing, reviewing and hosting software development projects. (Github 2018)
Reddit	A website where people can post both general and specific news, links and issues. (Reddit 2018)

Figure 4. Sources and description. (own compilation)

Analytical method

A thematic analysis of the data was performed in five steps in order to interpret and make sense of the data. The figure below presents the analytical steps from the data collection where data was determined as relevant or irrelevant to the final analysis (see figure 5).
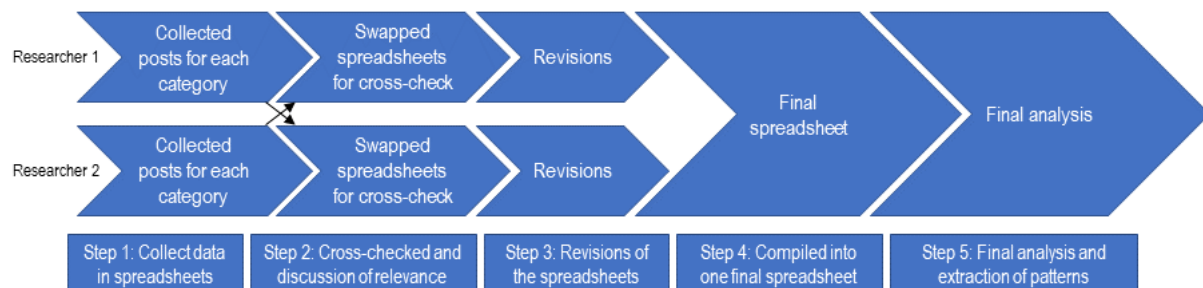

Figure 5. Step-by-step analytical method (own compilation).

As the first step in the analysis, each researcher collected data that was determined to fit the predetermined criteria (see figure 3) in separate spreadsheets. The spreadsheets consisted of the five sources on the y-axis, and corresponding governance mechanisms on the x-axis. The data was gathered and directly categorized into the corresponding columns, associating the post with a specific governance mechanism and source. It was organized this was in order to smoothly merge the documents in a later stage. Each researcher found approximately fifteen corresponding governance mechanisms for each category that fit with the predetermined criteria by making immediate

judgement calls, and because of the large amount of data circulating the web platforms, once a post was scanned, it was either determined as relevant or irrelevant. Each time a forum or blog post was analyzed, it was counted, which helped keep track on how many posts the researchers together had analyzed. The last category, referred to as 'exploratory outcome' did not have any predetermined criteria and was not limited to a certain number of posts in order to collect unexpected findings. Step two of the analysis; after the researchers gathered and analyzed posts separately, the researchers swapped spreadsheets. This was in order to cross-check and maintain accuracy and ensure reliability, as the initial collection of posts could be subjected to misconception (Miles & Huberman 1994). Therefore, the researchers discussed the relevance and misconceptions of the collected posts. The third step of the analysis was revisions of the spreadsheets. This was due to personal involvement which can result in data being perceived differently and may also alter the way in which the data is encoded (Miles & Huberman 1994). To further assure the quality of the posts, the data that was determined to be relevant was stored until it was determined irrelevant by both researchers, and thereafter disregarded. In the fourth step, the spreadsheets were compiled into one final spreadsheet. The jointly relevant data was structured and organized in a systematic way, allowing for the data to be analyzed one last time. The collected data was organized into different colors depending on the source of the data. Posts from Reddit were red, GitHub were yellow, Ethereum Blog were purple, Ethereum Forum were green, and Ethereum Stack Exchange were blue. This made it easy to view where the data was collected from, which was used to construct a summarizing table of the final data sources (see figure 6). The fifth and final step was the final analysis. By together analyzing each and every collected post again, examples for the result section were decided. This analysis also resulted in an emerging pattern that showed how respective governance mechanisms was expressed.

The results illustrated in the result section is a fraction of the pattern that emerged, and aims to give the reader a general picture of the collected data. A total of 938 posts were analyzed, whereas 134 posts were determined to be relevant to the study, and 804 did not meet the criteria for the final data collection. Figure 6 illustrates the amount of data that was compiled into the final spreadsheet.

Categories	Sources				
	Ethereum Blog	Ethereum Forum	Ethereum Stack Exchange	GitHub	Reddit
Modularization	3	3	0	11	2
Division of roles	4	1	0	9	1
Delegation of decision-making	7	0	0	6	2
Training and indoctrination	1	11	0	2	14
Formalization	6	2	4	7	15
Autocracy/democracy	8	0	0	0	8
Exploratory outcome	0	2	0	1	4

Figure 6. Showing number of collected and analyzed sources of the final spreadsheet (own compilation).

Result

In this section, results from the collected data are presented. During the gathering of empirical data, predetermined criteria were used as a guideline of which data should be collected. Only a small part of the gathered data is presented in this section, as the aim is to provide the main meaning of the empirical data. The findings are presented systematically in the same order as the theoretical framework. Each citation is an extraction from diverse posts of the five sources; Ethereum blog, Ethereum Forum, Ethereum Stack Exchange, GitHub, and Reddit. Prior to the quotes, the examples are explained.

Modularization

On the Ethereum Blog, a contributor of the Ethereum community posts an update of the progress on different projects. The blog post was made on July 8, 2016, and described the progress of C++ development. In the post, it is apparent that different actors are working on a set of differentiated tasks on the Ethereum platform. The contributors that are mentioned in the post below are working with coding projects on different parts of the platform.

"Apart from the features side, Bob has been working on a proposed process for re-licensing of the C++ runtime client code to Apache 2.0. [...] Dimitry Khoklov and others added some new RPC endpoints to the eth client which allow much more flexibility for testing smart contracts. [...] Greg Colvin spent the last months speeding up the C++ implementation of the EVM interpreter." - Ethereum Blog, July 8, 2016

As the community consists of many contributors, the individuals work on different parts of the platform. Therefore, the modules are worked on by various individuals simultaneously. A blog post provides an update of which projects are progressing forward within the Ethereum development ecosystem. The following citation includes information on updates to different projects, which provides a status report addressed to the community.

"Ethereum wallet has been refined significantly over the last several months expanding support to arbitrary contract interaction via the "custom contracts" tab. [...] After all the hard work spent reorganizing the C++ codebase, the CPP team has shifted gears from Mix to Remix, as the IDE now targets the web. Remix has hit it first alpha, and published with a demo online. [...] Nick Johnson has started work on the Ethereum Name Service." - Ethereum Blog, July 11, 2016

In addition to the progress of the projects, the example below provides an update on a project that is about to merge with the main repository. One tranche of the development will be connected to the main development. This means that one module of development code has to be integrated with the main code, clearly showing the use of modularization.

"Something to watch closely is light-client functionality entering public testing phase. Zsolt has been working on this code for months and the team looks poised to merge it into the main repo soon." - Ethereum Blog, July 11, 2016

Division of roles

The division of roles was apparent on GitHub, whereas code-related discussions take place. A community member started a thread on July 7, 2016 and asked a specific contributor for help with his project of developing infrastructure as code. By doing this, the post is exemplifying that roles are being divided within the community.

"I have been working on an infrastructure-as-code alternative to these tedious per-distro sets of instructions. [...] Please could help me out and copy [...] locally and run it, does it go into the right conditional?" - GitHub, July 7, 2016

15

As shown below, the member agreed to support the fellow community member, thereby inheriting an assigned role. A response to the request just one day after the initial post was posted, where an assigned contributor communicated that the issue is being addressed.

"I'm justing working on it. I was based on old script, but I'll adjust to the new one." - GitHub, July 8, 2016

Another thread on GitHub addressed issues that needed immediate attention by the community. The owner of the thread went through the code of the specific project and realized there was significant work to be done, and started a task list. The task list was used to organize the contributors into different roles, addressing a diversified set of tasks that needed to be settled within the project.

"I went through the code and it's pretty bare [...] So there's a lot of work to do. I'm starting this as a task list so we can organize what we're working on." - GitHub, July 30, 2016

As a response to the task list, many contributors of the community wanted to provide their support with the necessary tasks, and explained in the thread what they were interested in contributing with. The citation below shows that the contributors are dividing themselves into roles within a project. The first citation relates to the graphical interface part of the project, whereas the three following posts relate to other technicalities of the coding project. The final post shows an example of a contributor wanting to support with other parts of the project, asking what need that they can help with.

"I'm in, i'll start digging around and see what I can work out UX/UI side." - GitHub, August 2, 2016

"If it helps, I'm happy to build javascript wrappers [...]" - GitHub, August 3, 2016

"I will prepare a D3.js chart moduel [...]" - GitHub, August 3, 2016

"I'm going to crunch some CSS now, improving the desktop size and hopefully making a accessible mobile site. Stay tuned!" - GitHub, August 5, 2016

"[...] now that it is the weekend I can lend a hand either front or backend. What prominent need can I help with?" - GitHub, August 5, 2016

Delegation of decision-making

The third mechanism, delegation of decision-making, was shown on both the Ethereum Blog platform and on GitHub. Firstly, when the Ethereum community stood before a choice, whether to fork or not to fork, the community was called upon to take a vote. A blog post creator communicated that the community needed to vote on the issue of forking to solve a major issue involving reclaiming lost funds from investors. The post also clarifies which tools should be used and when the votes will be counted. From the voting, a majority decision would take place, involving changes in the protocol, or to leave the protocol as it is.

"The Hard Fork is a delicate topic and the way we see it, no decision is the right one. As this is not a decision that can be made by the foundation or any other single entity, we again turn towards the community to assess its wishes in order to provide the most appropriate protocol change. [...] The community tool carbonvote will be used to set the default fork option for Geth. At block number 1894000 the votes will be tallied, and the outcome will determine whether the default is set to fork or not to fork." - Ethereum Blog, July 15, 2016

In contrast to a community-wide issue, there are also decisions taken on a project level. As the community together compose different projects and modules, the contributors often work on different issues. The project owners often have an idea of how to solve an issue, and need contributors to support the coding development of the project. In the following case, the poster of the thread takes a deciding role regarding what way the project should be headed, and seeks support from the community. The thread owner clearly takes the deciding role in this case, by stating what is needed for the project to move forward.

"What I need:
- Feedback on each section by the appropriate leads. Unassign yourself when done.
- To fill out the contribute section [...]
- To write up a quote about multiformats
- To collect press for the last month
Then I think we should be good to go." - GitHub, August 25, 2016

There are also projects where code and implementation decisions are based on discussions in the forum, where one individual acts as the project leader, but still offers options for the contributors to vote in a decentralized manner. An example from GitHub is shown below where the writer of the post presents two options. From here, the community now needs to take a decision on which option should be taken. The writer of the blog post mediated recommendations, and urges the contributors to share their thoughts.

"Currently there is a web3.eth.sign method [...], Option 1 [...] Option 2 [...] To reconcile the current lack of a general purpose data signing method, I recommend we either endorse a new method or change the old." - GitHub, July 8, 2016.

The community responds to the post and a discussion regarding what is best is started. One contributor agrees with a previous reply, but still has concerns. The final decision within a project might not always be defined by a voting process, however, this example shows that discussions are encouraged in order to make a rational decision over the project's future.

"Yes, a decrypt function would be doable I think. But you would still need to define a corresponding encrypt function outside of web3, and make sure you can extract the public key in order for people to encrypt to you. It's a tricky problem design wise for sure [...]." - GitHub, July 26, 2016

Training and indoctrination

As a result from the split that occurred due to the hard fork on July 20, 2016, the community searched for new contributors. In the citation below, the community used GitHub to call for individuals to demonstrate their skills. The community then examined what they could contribute to the project. If the contributors did not have certain understanding and skill-level that the community are looking for, they may be considered as a potential harm to the project instead of an asset.

"Please post here if you would like to gain membership to the ethereumproject organization [...]
Please introduce yourself, tell us your skillset and how you can contribute to the project. We will try to remain open as possible but everyone will needed to be added on a trial basis to prevent potential abuse." - GitHub, July 25, 2016

Responding to the previous post, a contributor expressed their excitement to be a part of the project and demonstrated skills in the hope of being able to join and support the community. Below, the contributors presented and demonstrates which coding languages and frameworks they are proficient in, and present previous experience within blockchain development.

"I am very excited to try to help out this project [...]
I am a web developer, full stack capable but shine on the backend.
Languages: Ruby/PHP/JS (Node)
Frameworks: Rails/Laravel
Extra: Experience tinkering with custom blockchain deployment using Multichain, also wrote a simple block explorer on said custom chain." - GitHub, July 26, 2016

One day after the contributor's response to the initial post, the thread creator replies to the contributor that the individual seems to be qualified for different projects. This example is taken from a three-day conversation between two contributors, which exemplifies the pace of the discussions within the community.

"Thank you for volunteering your time to the project, your experience seems like you could fit in different projects." - GitHub, July 27, 2016

The following two examples show that additional individuals are interested in contributing. They presented their skills, with the hope that they would be paired with projects that would fit their area of expertise. The first contributor has experience in open source community organization, and state that they can contribute with documentation. Afterwards, the second contributor expresses that he has coding expertise, and presents what language he is proficient in. Additionally, that he wants to learn by working in a small project to start with.

"I can contribute to technical documentation. I'm experienced in open source community organization and currently transitioning to a more project management capacity focused on ICONIX and applying that to solidity/web3 development [...]. So I will volunteer to be the grammar and spelling editor with a rare code edit here and there, usually within a comment even then." - GitHub, July 27, 2016

"Hi:
I am Keylor, I can invest my weekend in doing something for community,I use Java, Language is not a problem,but I am new to BlockChain, maybe I can learn more in practice, especially in dong small project works. [...]" - GitHub, August 23, 2016

Lastly, contributors that are already part of a project sometimes call for help in order to attract contributors with specific expertise. For example, a merited individual within the community is looking for someone with specific technical skills, adding that he could help with providing an overview of the current code.

"Greetings, everyone!
Bob Summerwill, Developer on cpp-ethereum here.
If you have anybody who wants to maintain a Classic fork of that codebase, please do let me know, and we can coordinate on the branching, Appveyor/TravisCI automation - I can give an overview of the code, etc. [...]." - GitHub, July 23, 2016

Formalization

There are several different forums in which the community communicates, which may be seen as formalized communication tools. For example, GitHub, Ethereum Blog and Reddit are shown in the following quotes. The citation that follows illustrates an event in which a new contributor was invited to join the community, and an existing member on GitHub suggested to move the repository to the community's organization in order to make it easier to collaborate. The member also explained that there are formalized ways on how to maintain history on commits.

"It may be wise to discuss the possibility of moving that repository to this organization to make collaboration easier. [...] Doing it in this way also maintains all the commit history so every author is properly credited for their work." - GitHub, July 27, 2016

As can be seen on the Ethereum Blog, credited contributors regularly release posts regarding security flaws, technical updates, recommendations and other thoughts. In the citation below, there is a post describing the Ethereum Virtual Machine, adding information about the characteristics of it. Next, a post has been made about the security flaws that the Ethereum account has, alerting that a problem is not yet fixed. Lastly, a recommendation on how to use the wallets for storing funds securely. This exemplifies information that affects the whole community, therefore needs to reach the community through the formalized communication channels.

"In this post I'm going to explain some of the differences between the two implementations and describe some of the characteristics of the JIT EVM and why it can be so much faster than the byte-code EVM." - Ethereum Blog, June 2, 2016

"Security Alert – cpp-ethereum's account unlocking problem not yet fixed" - Ethereum Blog, June 3, 2016

"Do not use wallet contracts or owner accounts of those wallets that were created by the Ethereum Wallet 0.4.0 or earlier. If you send to (or interact with) a malicious contract it could take ownership of your wallet contract. Create a new wallet and move your funds." - Ethereum Blog, June 24, 2016

The Reddit forum constitutes different genres of discussions; it has a subreddit function letting individuals subscribe on the information regarding certain subjects. Consequently, within a subreddit, one community individual presents implications of entering the so-called 'proof of stake', which aims to achieve consensus. The individual also calls for discussions regarding the future of the community, in which the individual underlines the importance of discussion to further progress Ethereum. This, once again, illustrates that communication occurs in a formalized way on several different channels.

"I have no inclination to support one side over another; however, if Vitalik and the Casper team think their solution is a proper one, I am absolutely open to the idea of implementing a new consensus mechanism - the community is the reason I have supported, and will continue to support, this project." - Reddit, August 6, 2016

Autocracy/democracy

On Reddit, the founder of Ethereum presented his thoughts of forks and on the future of the community. Prior to when the post was made, the community had split into different directions, resulting from the hard fork. Subsequently, the founder of Ethereum was happy to see that the two branches went in different directions after the fork, and expresses his thoughts on future community disputes.

"If in the future there is that kind of a dispute in Ethereum, I'd definitely be quite happy to see Ethereum A go in one direction and Ethereum B go the other." - Reddit, July 26, 2016

The founder then continues to clarify that these are just their personal beliefs and thoughts, and continues to question if this was the correct approach.

"[...] But those were just my beliefs and intermediate values. How do we know that this "let a hundred flowers bloom" position is actually correct?" - Reddit, July 26, 2016

Furthermore, Buterin continues to share his thought on the matter of hard forks, as shown in the citation below. The founder does not believe in hard forks as a long-term means to resolve theft. However, six days prior to the post, a hard fork within the Ethereum community was performed, due to it being a majority vote.

"I may as well offer my own views on hard forking. I do not believe that using hard forks as a primary paradigm to resolve thefts or to deal with unethical applications is a long-term viable strategy." - Reddit, July 26, 2016

The forum post by the Ethereum founder was well received by the active community. Community members responded by commenting the forum post on Reddit. Below are five quotes from posts that responds to the founder; the majority of the posts praised the founder and thanked him for posting and sharing his thoughts. These responses were posted the same day as the initial post was posted.

"Vitalik always finds the right things to say. Can't upvote enough" - Reddit, July 26, 2016

"I highly appreciate your calm and honest posts" - Reddit, July 26, 2016

"Fascinating, thanks as always for your thoughts." - Reddit, July 26, 2016

"Thanks u/vbuterin you always bring calmness to the messed up situations the community finds itself in." - Reddit, July 26, 2016

"Great post, and a reminder why ETH is in such good hands" - Reddit, July 26, 2016

Another community member responded to the previous post that Ethereum is not supposed to be centralized, with an embedded meaning that Ethereum should be in the hands of the community, and not in Buterin's. It is apparent that the post is intended to make contributors understand that the community is decentralized.

"Not centralized, not centralized, not centralized!" - Reddit, July 26, 2016

In a different subject, one writer on the Ethereum Blog addressed the issues of developing smart contracts stating that it took more effort than what was anticipated. The DAO hack occurred due to a security flaw in a set of contracts, therefore leading to the hard fork. The post state that reaching consensus was more time consuming than they anticipated it would be.

"The last week was quite hectic for all of us in the Ethereum ecosystem. The DAO has shown us that it takes much more effort to write smart contracts than we originally anticipated; but also that it takes a surprising amount of debate to reach a consensus on issues of this scale." - Ethereum blog, June 24, 2016

Furthermore, before the hard fork, the writer confirms that everybody in the community had a voice regarding how the issue of the hack should be fixed; it is apparent that the community is engaged in decisions.

"Everybody in our community was very vocal and forthcoming about how the problem should be fixed in his/her opinion, or whether there's even a problem to fix in the first place." - Ethereum blog, June 24, 2016

A contrasting opinion was expressed by another community member who does not believe that the vote on the hard fork was correctly communicated to the community. The member was disappointed that the main contributors did not engage the entire community in the voting, stating that a vote that nobody knows about is not a vote.

"Apparently there is voting happening right now. I visit r/ethereum/ several times a day and I didn't even realize that it was happening right now. Whatever the results of this vote may be, they mean nothing if there was no widespread announcement of the vote beforehand." - Reddit, July 9, 2016

Exploratory outcome

This category is for the empirical data that did not fit any predetermined criteria but is still of interest to this study. The findings are related to governance and constitutes an interesting insight, by instigating that the community and the development is driven by initiatives from the contributors. The examples are findings from patterns that were discovered. For example, one community member had an interesting suggestion that seemed to be encouraged throughout the community. In case the contributors did not find any suitable project for their ambitions, they have the possibility to create their own project within the community, as shown in the citation below.

"As a reminder to everyone interested, you don't have to just work within the existing projects, you can find other relevant projects to maintain or even start new ones." - GitHub, July 27, 2016

In a different thread, it is shown that community members actually take their own initiative. After the DAO hack, community members proposed ways that would hinder theft in various ways. The following post is a proposal that would give the contributors some time to address the hack, however, it would not return the compromised Ether to the investors. The thread on GitHub was ultimately an alternative of a decision to pursue the problematics of the DAO that would have to be made by the community. If the implementation would have been pursued, the balance at the time of implementation of the DAO could have been protected.

"The strategy works in such a way that when a user enables mining -- either thru --mine or the RPC -- it will start to go in a sort of failsafe mode where it will start to ignore transactions and blocks that reduce the DAO's balance." - GitHub, June 18, 2016

As the same topic continues on Reddit, a well-known contributor of the community state that the changes would not return the Ethers to the DAO or the previous token holders. It would rather allow for the community to get breathing room to discuss the next steps. However, this is a good example of how the community works together, supporting each other's initiatives.

"To clarify, this PR only prevents ethers being withdraw and allows us (the community) with some breathing room to come up with the next steps. This does not, and certainly isn't intended to, to return the ethers to the DAO or the token holders." - Reddit, June 18, 2016

Discussion

In order to answer the research question, empirical data generated on prominent sources of discussion within the Ethereum ecosystem was gathered and analyzed. As previously mentioned, this provided the study with untampered data that was produced and communicated at the time of the event. Thereby, the empirical data is believed to provide a foundation for the mapping of governance mechanisms within blockchain OSS communities. Preceding literature indicates that there are similarities between governance mechanisms within OSS projects and blockchain OSS projects, which provided a foundation for this study. Data presented in the result section imply that blockchain OSS governance has inherited mechanisms from OSS governance. In addition to these inherited similarities, differences and uncharted perspectives were addressed, which was motivated by the exploratory approach of the study. From the empirical data, De Laat's (2007) first five governance mechanisms are applicable and inherited into the blockchain OSS. In contrast, the sixth mechanism is differently defined than what De Laat (2007) suggests. The exploratory approach allows the study to extend or map other potential mechanisms, where one eminent finding is especially interesting to discuss, referred to as 'initiative-based progress' and is presented as the seventh governance mechanism. Moreover, additional observations related to the study are presented.

From OSS governance to blockchain OSS governance

In this section, the governance mechanisms referred to as modularization, division of roles, delegation of decision making, training and indoctrination, and formalization are addressed. Several similarities were found between OSS governance and blockchain OSS governance. Presented in the result section, the empirical data was dependent on being aligned with the predetermined criteria, which were set to map blockchain OSS governance mechanisms. As for modularization, some modules were presented through a post on the Ethereum Blog by a community member, which clearly showed that the Ethereum community works modular with interoperable projects. Moreover, the community works in a modular fashion with both technical and non-technical projects. A large-scale project such as Ethereum seems to require contributors to work separately in order to progressively develop the platform. Another reflection on why it is important to work in a modular fashion is because of the constant progress of other platforms. There seems to be excessive pressure on contributors to continuously develop the platform towards the desired state. Within the modules, it was apparent that there is a distinct division of roles. In the result section, examples on the division of roles are illustrated. In some cases, a project owner assigns a specific contributor to an issue. In other cases, contributors assign themselves to different roles and tasks. This demonstrates that it is not always someone who delegates the community into different roles; sometimes the community divides themselves on the basis of their own knowledge. Contributors assigning themselves to certain tasks seems to be a recurrent theme within the Ethereum community. One of many factors for Ethereum's successful progress of development may be because of contributors eager to be involved. Moreover, the mechanism that involves delegation of decision-making is not as apparent as the previous two mechanisms. Depending on the issue, they are delegated differently. For example, forks may involve the entire community by bringing them to a vote, whereas smaller projects often have their project owner making the final decision. Presented in the result section, an example is provided by a community member that wants to get feedback and opinions from the community. The community member gave the contributors the power to vote on which of the two provided suggestions were to be pursued and encouraged them to decide which alternative they would like to be implemented. Contributors gave their thoughts on the issue, although it was up to the project owner to decide. Therefore, it can be argued that it is a mixture between a centralized community and a decentralized community in the matter of decision making. Out of the empirical data, smaller projects are often centralized when it comes to decision-making, with a designated project owner taking the final decisions. Issues related to mainstream development is however decentralized and needs to reach consensus within the community. The governance mechanism referred to as training and indoctrination shows how community members actively go out and seek contributors that has desired

skills for projects. The example involves contributors responding to a call for developers in order to present their skills with the hope of being matched with a project. Reflecting on the number of contributors that are willing to provide support to project, there is little doubt that the community is unified and appears to have incentives on progressing the platform. Additionally, after the Ethereum hard fork, the formalized tools underwent a change. It appears to be understood that the use of formalized tools within the diverse communities were divided after the hard fork, bringing one community to certain formalized communication channels and the other community to other channels. Moreover, the communities divided rapidly, since they are not any longer contributing to the same protocol and have contrasting views and goals for the future. However, contributors found a way to go back and review previously written code if needed. It is apparent that the community uses specific formalized tools to communicate within their community. While analyzing the empirical data, it was found that specific communication channels were used for different purposes. For example, the Ethereum Blog was used as a platform where the main contributors communicate thoughts and information that involves the community. In contrast, GitHub was mainly used for coding-related purposes, and Reddit for discussion and informing-related purposes.

A discrepancy in leadership

Deciding whether the Ethereum ecosystem has an autocratic leader or not is difficult. This refers to De Laat's (2007) sixth and last governance mechanism called autocracy/democracy. Vitalik Buterin, the founder and the informal leader of Ethereum has a large amount of influence, however is not seen as the leader, as the community and its authority is decentralized. Within Linux, Torvalds is the autocratic leader, deciding everything regarding mainstream development (De Laat 2007). This does not apply to all OSS projects, but may rather be the governance structure of smaller projects. Debian, however, chooses its project leader annually by voting within the community (De Laat 2007). In contrast from these examples, Buterin does not fit in as either one. It could be argued that because substantial changes related to mainstream development boil down to a democratic vote, the community as a whole is its common leader. It could also be argued that by making the weight of the votes dependent upon how many Ethers you hold in your wallet, it is not truly democratic, although it wishes to be perceived that way. The voting process used in the hard fork in July 2016 is referred to as 'coin voting'. By assuming that a majority of Ether is being held by Buterin, co-founders and a subset of contributors, the reality is that what they vote for may actually be the inevitable outcome, in the form of a majority vote. By gathering data during the hard fork, digital traces show that the voting did not reach out enough to the community; some contributors didn't even know there was a vote. This would question whether the voting was truly democratic. Arguably, this does not define a community-based consensus. However, what is important to understand is that just because a majority vote leans towards a certain suggestion, it does not hinder the minority vote from going through with their own vision and form their own community, with an old or new version of the blockchain protocol. Therefore, the contrast between OSS projects and blockchain OSS projects is inherently different. Even though an OSS project finds itself in a democratic vote, it is often not feasible for the minority vote to continue with their own version of the project. Forks do seem to be a progressive approach by eliminating differentiated opinions and providing a solution that lets the contributors continue with their own visions. However, the forking of projects may not always be the best solution, since the consensus of the community as a whole might be a more desirable outcome. Reaching consensus and keeping the community pleased is arguably the best way to keep contributors incentivized. Furthermore, Buterin has a lot of influence on the development of the Ethereum platform. Nonetheless, the empirical data suggests that the community largely respects Buterin and willingly follows his suggestions on development. When there are major concerns related to development, Buterin provides the community with potential solutions and thoughts. He also sometimes asks the community for advice. The study did not gather any data on how Buterin got his influence, preventing the study from confirming how the informal leader got to this position. Buterin's thoughts and concerns have a large amount of impact, but he does not own Ethereum and he does not decide the road of mainstream development, as long as a majority of the community follows the actual version of the protocol that they believe will prevail.

A seventh governance mechanism: initiative-based progress

This section refers to the findings from the category named 'exploratory outcome'. By including an explorative approach, the researchers' expectations were that at least one additional finding would be found and lead to further research. In addition to the reflections of the autocracy/democracy section prior to this, a seventh governance mechanism aims to introduce the suggestion that the Ethereum community is driven by initiative-based progress. This could be seen as an extension of the sixth governance mechanism or as an independent, seventh mechanism, which is excluded from the theoretical framework and compiled solely by the researchers to attempt to identify new findings. Moreover, the leadership has more of an informal nature. The direction is not defined by purely autocratic or democratic decisions, but rather by the initiatives of contributors, which could be referred to as the decentralized community. It is apparent that the environment in which blockchain projects find themselves in is highly competitive and rapidly progressing. The perspective that this study aims to present is that the seventh governance mechanism, initiative-based progress, is what drives the continuous progress of the platform. All the contributors have the freedom to start new projects, contribute to existing ones, or participate in mainstream development, which is seemingly a stimulating approach. Contributors are highly engaged in the vision of the platform and have the possibility to engage the community in different ways. This seems to all be dependent on the philosophy of initiating projects yourself. It also encourages the contributors to take their own initiatives. This approach can be seen as self-powered by the community, as it seems that as more projects are being developed, more people connect, contribute and make the project's community grow. To put it into perspective with OSS projects, this approach does not rely on the decisions of an autocratic leader or democratic votes, but is rather self-steered making it possible for all contributors to do their own thing. This coheres with De Filippi and Loveluck's (2016) statement about decisive features in peer-production communities, being self-organized and volunteer-driven. Even though Buterin, the founder, has a large amount of power and influence over decisions regarding the protocol, the decentralized community is composed of many visionary contributors regularly questioning how the platform should work. The approach of initiative-based progress is arguably a more flexible and progressive governance mechanism, resulting from radical decentralization, which so far is spurring innovation.

Limitations and implications for further research

This study contributes to governance literature within blockchain OSS communities by introducing which governance mechanisms are used. The similarities between OSS communities and blockchain OSS communities are identified through the use of a theoretical framework from previous OSS literature. In addition, a seventh governance mechanism was identified, based on an extended perspective of the sixth governance mechanism. This seventh governance mechanism is intended to provoke further research.

A limitation of this study is that the study is based on a methodology that is highly effective in examining digital traces, but may be weak when holistically examining systems and users. This may be argued to be because records on platforms can be seen as incomplete, and therefore make it difficult to observe. A suggestion would be to combine another approach of methodology, in order to further strengthen the research as the trace ethnography is interpreted solely by the researchers. A prior expectation of the study was to find differences in governance during the phases of the hard fork, e.g. before, during, and after the hard fork. This was decided later to not be included, because of the level of detail the study would have instigated. Another limitation of this study is that the research focuses on one blockchain platform, Ethereum. Additional blockchain projects may be researched in order to further strengthen the theory presented.

The implications from this study resulted in the introduction of five governance mechanisms that are similar to those within OSS literature. Those governance mechanisms provide introductory understanding of how governance within blockchain OSS communities takes place. Generating knowledge of governance within blockchain OSS was the essential intention when researching this

subject. Given the noticeable difference of autocracy/democracy, a foundation for added knowledge of the differences will further strengthen and cultivate the field of research. Additionally, initiative-based progress is intended to be further researched as it is an incomplete suggestion of theory. Further studies may also include investigating how the blockchain platforms are affected by the monetary environment. This could be an interesting approach to also combine with the governance aspect and how the communities are steered.

Conclusion

This study intends to identify which governance mechanisms are expressed within blockchain OSS communities. In order to answer this, a trace ethnography methodology was used, whereas data was gathered from sources in which the contributors within the OSS community communicates. The methodology in combination with the theoretical framework allowed the study to draw relations between OSS communities and blockchain OSS communities. Five of the governance mechanisms used in OSS communities were identified within the blockchain OSS community, having its roots in OSS theory. However, the sixth governance mechanism differed within the researched community, due to leadership being difficult to define since the blockchain community is decentralized. The concluding remarks points towards the community as a whole steering the development direction. There is an informal leader, mainly due to the respect he has from the community, however, he is not seen as the actor deciding the direction of mainstream development. In addition, initiative-based progress is presented as an extension of the initial governance mechanisms. This governance mechanism may be the driver of projects, as the community's common efforts, decentralized governance and opinions provide a progressive and flexible path of development within the blockchain OSS community.

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