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An Explorative Dive into Decision Rights and Governance of Blockchain: A Literature Review and Empirical Study

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Abstract

Background: *Blockchain technology and accompanying programmed protocols (smart contracts) offer disruptive opportunities for businesses, public institutions, society, and its citizens. However, blockchain is a relatively young research area: the number of publications available regarding blockchain did not begin to rise significantly until 2012, and certain fields of the blockchain domain remain to be explored. A similar situation exists with research into the governance of blockchain solutions focusing on decision rights: the limited number of theoretical and empirical contributions hinders the proper adoption of governance mechanisms in practice.*

Method: *A mixed-method approach was conducted in which 1) a structured literature review, 2) semi-structured interviews, and 3) a focus group discussion were utilized to determine the current situation regarding decision rights in the context of blockchain governance.*

Results: *The structured literature review resulted in a total of 23 relevant contributions. Those contributions were consolidated to serve as input for a total of twelve semi-structured interviews, and for a focus group session with five participants, who were not part of the interviewee pool. Using that approach, an overview of the concepts, relationships and mechanisms pertinent to decision rights was composed.*

Conclusions: *Considered together, the results show that decision rights are often overlooked at the start of a blockchain project, where technical considerations are dominant in the discussion with stakeholders. However, research also points out that the longer it takes to address decision rights in a blockchain consortium, the more complex and costly it becomes to introduce governance mechanisms at a later stage. Another important conclusion is that consensus is currently lacking as to what constitutes blockchain governance and what part decision rights play in governance processes, in both theoretical and practical terms.*

Keywords: Blockchain, Governance, Decision Rights, SLR, Empirical.

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Introduction

Blockchain solutions are built on the distributed recording of transactions within and between companies and individuals that is trustworthy, correct, and secure. Businesses, governmental organizations, society, and its individuals can all benefit from blockchain technology and its supporting programmable protocols (smart contracts) (Lemieux, 2016). Furthermore, blockchain technology enables trust in institutions backed by government (and institutions not backed by government) to be replaced by trust in computer code (United Nations Department of Economic and Social Affairs, 2018).

Naturally, governments have taken notice of this new technological trend. The European Commission, for example, has been researching blockchain technology since it is expected to be disruptive in the next decades (European Commission, 2015). As a result, the European Commission has launched a number of initiatives, including: INATBA is a non-profit organization that promotes (European Commission, 2019), The European Blockchain Observatory and Forum (European Commission, 2018b), and EBSI (European Commission, 2018a).

Blockchain is a relatively young research domain: the number of publications available regarding blockchain did not begin to rise significantly until 2012, and certain fields of the blockchain domain remain to be explored (Casino et al., 2019; Gorkhali et al., 2020; Yli-Huumo et al., 2016). Although the research conducted since 2012 has provided a solid foundation for the understanding of blockchain technology, few researchers have considered the relationship between the technology and its organizational implementation. Consequently, the strategies, tactics and governance of actor interactions remains largely unexplored terrain (Risius & Spohrer, 2017). Such topics are frequently addressed in other IS research domains, but blockchain research is not in line with the general pattern.

All governing processes, whether carried out by governments, markets, or networks, whether involving families, tribes, formal or informal groups, or territory, and whether effected by laws, conventions, powers, or language, are referred to as governance (Bevir, 2012). As a result, governance is defined as the process of developing, enforcing, and regulating rules, norms, values, and activities. This entails drafting policies and ensuring that they are applied correctly on a regular basis. It primarily refers to the interaction and decision-making process between parties who must address a common problem in a range of settings, including corporate, international, national, and local (United Nations, 2009). Effective governance rules are critical for the successful adoption of blockchain solutions, as well as their ability to adapt, alter, and interact with one another (Tasca & Tessone, 2019). In this paper, we adhere to the following definition of blockchain governance: ”the means of achieving the direction, control, and coordination of stakeholders within the context of a given blockchain project to which they jointly contribute” (Pelt et al., 2021).

In order for a blockchain to be effective in the long run, it needs a governance framework that encourages the flexibility to adapt and evolve in response to change (Curran, 2018). As a result, in order to secure the long-term viability of the organizations concerned, a specific governance structure must be added to the technical framework, allowing individuals to discuss and coordinate technological growth (De Filippi & Loveluck, 2016). For decades, the theoretical perspective of IT governance has piqued people's interest (Brown & Grant, 2005). In light of this, Weill (2004) proposed a three-dimensional IT governance paradigm (Weill, 2004) based on decision rights, accountability, and incentives concerning blockchain technology. A blockchain economy, according to Beck et al. (2018), is reliant on the establishment of appropriate governance structures. As a result, Beck suggests that those elements be looked into in relation to blockchain governance.

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One of those dimensions is decision rights: how decision-making works, and who is allowed to decide what, under what circumstances (Beck et al., 2018). Over the years, decision-making has gone from being an authoritative process to being a collaborative effort, and even a delegated activity. Now, with the emergence of a multitude of blockchain companies, the concept of decision-making is set to change again (van Rijmenam et al., 2018). However, few academic studies have yet investigated how blockchain affects organizational design in general and decision-making in particular (van Rijmenam et al., 2018). Decision rights are, first and foremost, concerned with 'who has the authority and responsibility to do what' on a platform: strategic decision-making. Second, it necessary to decide how decisions will be implemented: 'implementation decision-making'. Third and finally, the interoperability of a particular system can be decided by those with decision-making rights, who ultimately have control over inter-organizational boundaries (Constantinides et al., 2018; Tiwana, 2013; Tiwana et al., 2010; Wareham et al., 2014).

If everyone involved with a blockchain project agreed on what should be done and how, governance would not be a problem. However, as in most human endeavors, the interests of the various stakeholders are not perfectly aligned, so there is a potential for conflict between the parties. Such conflicts must be resolved and prevented if the use of blockchain technology is to be optimized. Given the research lacuna identified above, in this paper we aim to answer the following research question: 'What is the current state of decision rights within the governance of blockchain technology, from a theoretical and empirical perspective?'

A recent literature study identified a gap in the body of knowledge concerning blockchain governance and specifically on decision rights (Smit et al., 2020). The study reported here is an extension upon that literature study and sought to make an empirical contribution to description of the current status and the practical implementation of decision rights within the governance of blockchains. The motivation for the study was that few academic studies have yet investigated how blockchain affects organizational design in general or decision-making in particular (van Rijmenam et al., 2018). Contributions that have addressed the subject have mostly been theoretical or conceptual, not based on empirical evidence. The study reported here therefore aims to redress the balance.

The remainder of this paper is structured as follows. In the following section, we delve deeper into the background to blockchain, governance and decision rights, and the related literature. That is followed by a description of the research method used in the reported study. The next two sections describe the data collection and analysis processes. The results of the analysis are described in the following section. Lastly, the results are discussed, conclusions are drawn and directions for future research are presented.

Background and Related Work

The first well-known blockchain project, Satoshi Nakamoto's Bitcoin (Nakamoto, 2008), also known as a cryptocurrency and payment system, was introduced to the world more than a decade ago. Satoshi Nakamoto's Bitcoin is based on earlier work that was published 17 years before the Bitcoin paper was released. By calculating hash values of documents and preserving them with a date, the study improved on the core notion behind cryptographically linking blocks in an append-only data structure (Haber & Stornetta, 1991). The study's purpose was to ensure the data's immutability and authenticity.

While the concepts of cryptography and distributed systems were already in place, it was the combination of the two that established the foundation of blockchain technology (Nakamoto, 2008). Decentralization, persistency, anonymity, immutability, and auditability are all technological concepts that blockchain technology embraces (Cong et al., 2021; Halaburda & Mueller-Bloch, 2020; Zheng et al., 2017). Consensus is a critical component of a distributed system like Nakamoto's Bitcoin solution. As previously stated, consensus is essential to make important decisions such as infrastructure design, security risks, and community policing (De Filippi & Loveluck, 2016). The Byzantine Generals Problem, a classic Game Theory dilemma relating to consensus, was solved by Nakamoto (Mougayar, 2016). The study of mathematical models of conflict and cooperation between intelligent logical decision-makers is known as game theory (Myerson, 1991). Participants and nodes are equal in distributed networks like Bitcoin. Instead of requiring two parties to agree and verify, all members in this network must approve and neutralize any corrupt or deceptive players. The term "consensus" refers to the participants' agreement (Natoli & Gramoli, 2016).

Blockchain is a type of distributed ledger that is built on a particular technological foundation. Data sharing over a distributed data structure is enabled by distributed ledger technology (DLT), as well as data recording by participants in a DLT after obtaining consensus on the legitimacy of the entry mechanism. To ensure system dependability, a distributed ledger system usually includes a consensus mechanism (Ballandies et al., 2021). Because each ledger has the identical data entries, a distributed network of ledgers provides network integrity and security (Ballandies et al., 2021). More specifically, this means that a global network of computers acts as a global ledger. If a bad actor attempted to exploit the network, the actor would be unable to do so since the network's integrity and immutable data entries would be maintained by the other ledgers. Second, unique (and encrypted) mathematical values are attached to select data entries using a specific sort of encryption. This cryptographic system is put up in such a way that each item has its own unique value. Cryptography allows for the encryption of data entry in addition to assigning values to specific assets, ensuring that not all shared data is made public (Natarajan et al., 2017).

Blockchains can be categorized on the basis of their architecture types (Zheng et al., 2018). The various categories differ in terms of the rights that users have to read data or verify transactions. Public blockchains have no restrictions regarding reading data and processing transactions, while private blockchains restrict such actions to a defined set of users (Bhaskar & Chuen, 2015; Bitfury, 2015; Kosba et al., 2016). A third category called "consortium blockchain" has characteristics similar to those of a private blockchain, such as efficiency and transaction privacy, but does not feature the consolidation of power in the hands of a single party. Consortium blockchains operate under the leadership of a group instead of a single actor. In the context of our research, a consortium blockchain is perceived as a form of private blockchain, since in both cases the permission to read and verify transactions is restricted to a defined set of users.

Blockchain technology is a taxonomy for a collective of different types of blockchain, each with its own unique features. It is an emerging technology and, as such, it is at a stage where people across the globe are experimenting with it. Though initially intended to provide a decentralized and trustless network (Nakamoto, 2008), individuals, entities and groups are looking to apply the technology to their problems. With few, if any, comparable models to draw on, a variety of different types of blockchain have been designed (Zheng et al., 2018). Against that background, and in the absence of an established taxonomy, we decided to focus our research on the two most prevalent types: private and public blockchains, which can also be categorized as permissionless and permissioned blockchains (Peters & Panayi, 2016). A uniform distinction between the two can help outline and understand the main differences in decision-making processes (Ziolkowski et al., 2019).

As previously stated, governance is a key part of blockchain architecture and implementation. IT governance and open-source software (OSS) governance are two examples of different forms and viewpoints on governance. Because Bitcoin and Ethereum are both open-source projects, both IT and OSS governance are frequently mentioned in blockchain literature (Beck et al., 2018). Another study looks at IT governance, and the three pillars (decision rights, accountability, and incentives) are utilized to guide blockchain governance research (Beck et al., 2018). “IT Governance represents the framework for decision rights and accountabilities to encourage good behavior in the usage of IT” according to Weill (Brown & Grant, 2005; Weill, 2004). Weill expands on this description by drawing a distinction between IT governance and IT management: “IT governance is not about making precise decisions; that is management” (Weill, 2004). Instead, governance entails "Systematically identifying who makes each type of choice (a decision right), who has input into a decision (an input right), and how these persons (or groups) are held accountable for their roles." To manage and use IT to accomplish business performance goals, good IT governance draws on corporate governance principles (Brown & Grant, 2005; Weill, 2004). Tasca and Tessone (2019) argue that strong governance rules are critical for the successful adoption of blockchains, as well as their ability to adapt, alter, and interact, when considering emerging technologies like blockchain.

This study focuses on blockchain governance, as well as the placement and enactment of decision powers. In blockchain systems and projects, decision rights refer to who, what, and how decisions are made and enforced. They determine the degree of centralization, or whether decision-making power is concentrated around a single person or a small group (centralized) or distributed (decentralized) (King, 1983; Sambamurthy & Zmud, 1999).

Research Method

The goal of our study was to investigate decision rights in the context of blockchain governance. The research was conducted using an exploratory design due to the small body of knowledge available on this specific topic of interest. Exploratory research is research into a topic that hasn't been examined in depth before, with the goal of establishing priorities, developing operational definitions, and improving the final research design (Shields & Rangarjan, 2013). Furthermore, exploratory methods are ideal for gaining a better understanding of phenomena for which a theory is still being developed (Edmondson & Mcmanus, 2007; Sullivan & Sargeant, 2011). Our research was conducted in three phases: 1) literature analysis, 2) expert interviews, and 3) a focus group session, as depicted in Figure 1.

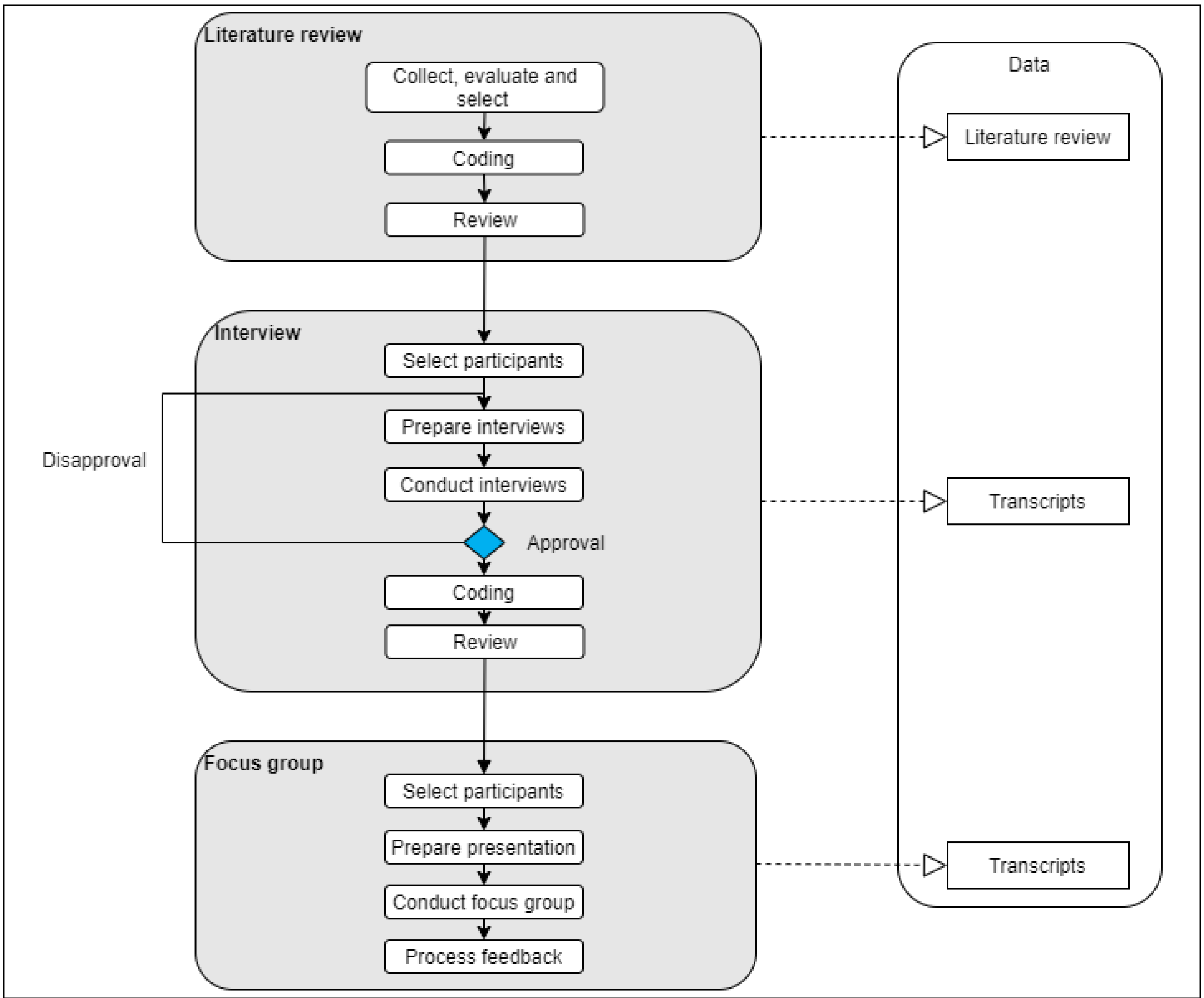

Figure 1 - Research method overview

Systematic Literature Review

The first phase involved reviewing the current body of knowledge to provide an overview of the status of current concepts and their relationships. The outcomes of this phase were intended to serve as the foundation for the following phases (Saunders et al., 2009). The literature review was conducted to gather and evaluate literature concerning blockchain governance and, more specifically, decision rights. This literature study was divided into five stages: 1) preparation, 2) collection, 3) evaluation & selection, 4) definition of connections & themes, 5) review. Those stages were defined by reference to multiple previous studies that focused on the design and execution of systematic literature studies, see (Booth et al., 2016; Kitchenham, 2004; Machi & McEvoy, 2016; University of Otago, 2017; Webster & Watson, 2002).

Expert Interviews

The second phase focused on expert interviews for the collection of data. Several earlier researchers have defined parameters for the number of interviews required for legitimate data collection. Bertaux stated that fifteen interviews should be the smallest acceptable sample size in qualitative research (Bertaux, 1981). Meanwhile, Morse argued that at least six interviewees are required for phenomenological studies (Morse, 1994). On the other hand, Creswell recommended between five and twenty-five interviews for such studies (Creswell, 1997). In light of those studies, we determined that fifteen interviews were necessary for our explorative research.

The interviews were conducted using a semi-structured approach. A semi-structured approach was chosen because of the scope it offers for obtaining knowledge on topics that are not yet adequately covered (if at all) by the published literature (Bogner et al., 2009). Therefore, semi-structured interviews are suitable for exploring the perceptions and opinions of the participants regarding the immature field of blockchain governance. They also enable the interviewer to probe for more information and clarification of answers (Louise Barriball & While, 1994). The structure of the interviews was shaped by an interview guide, which consisted of predetermined open-ended questions and topics. In order to capture data more effectively and enable proper analysis of the data, the interviews were audio recorded.

The participants were chosen from a set of individuals, organizations, information technology, or communities who best represented the phenomena under study (Corbin & Strauss, 1990), which was the governance of private and public blockchain applications.

Participants were recruited through the network of the Dutch Blockchain Coalition and relevant associated networks, whose members are mainly individuals and organizations that experiment with blockchain, conduct research on blockchain, or deliver blockchain solutions in practice.

Focus Group

The third phase involved additional data collection and validation of the results of the first phase by means of a focus group-based approach. The most common purpose of a focus group is the in-depth exploration of a topic about which little is known (Parker & Tritter, 2006). Focus groups can help the research by observing and noting how people think and feel about the designed artifact or think about a phenomenon. In the focus group session, the results of the SLR and interviews were discussed and validated. Several steps have previously been identified (Nyumba et al., 2018) for the design and execution of a focus group discussion.

The purpose of this focus group phase was to collect further data on decision rights in the context of blockchain governance and to assess the outcomes from the previous two stages. First, a list of key topics and questions were developed as a structure for the focus group session. The next step was to identify and recruit participants; it was one of the most critical steps in the process, because the focus group technique depends primarily on group dynamics and relationships among participants to generate data (Green et al., 2003). The selection also focused on the participants' background knowledge and other factors.

The amount of people who would be invited to the conversation was also a factor to consider. Six to eight persons are often considered sufficient (Krueger & Casey, 2014). Some researchers, on the other hand, have reported employing groups of as few as four people or as many as fifteen (Fern, 1982). A group with more than twelve members can become difficult to manage; the group may fragment into smaller groups, each continuing its own discussion. A potential pitfall of a focus group discussion is that not all the recruited participants actually attend on the day. We therefore decided to over-recruit by 10-25%, as recommended by Rabiee (2004). We sought to recruit ten participants in total, as that was considered to constitute a group "large enough to gain a variety of perspectives and small enough not to become disorderly or fragmented" (Krueger & Casey, 2014).

A focus group discussion requires a skilled facilitator and back-up facilitator (Krueger & Casey, 2014). The facilitator needs to have enough background knowledge and be able to manage discussions and create a comfortable environment. The back-up facilitator needs to observe the focus group and document the general content of the discussion. The focus group discussion was video-and-audio recorded to enable effective subsequent data analysis. The preparation consisted of the research team familiarizing itself with the discussion script, creating group dynamics, and taking care of peripheral matters like recording equipment.

A single focus group was used. The key feature of a single focus group is “the interactive discussion regarding a topic by a collection of participants and a team of facilitators as one group in one place.” (Nyumba et al., 2018). This type is the most common and accepted type of focus group and has been widely used by researchers across various disciplines (Lunt & Livingstone, 1996; Morgan, 1996; Wilkinson, 1998).

Data Collection and Analysis

Between July 2019 and October 2019, data collection and analysis for the first phase (SLR) were completed. To scope the study and the research topic, relevant keywords were chosen from the reviewed literature. The keywords "Blockchain" AND/OR "Decision" AND/OR "Making" AND/OR "Rights" AND/OR "Governance" were used. A manual search was used to make the identification. Because blockchain governance is still a young academic subject, no specific journals or conferences were chosen for the search method Dutch Advisory Committee on Blockchain Research et al., 2018; van Rijmenam et al., 2018; Ziolkowski et al., 2019). Google Scholar was used to conduct the literature search. The review did not include any papers that were not written in English. Recurring citations were noted to identify relevant articles that did not appear in the keyword search, and reference lists were searched to uncover further relevant sources. Table 1 shows the results of the search.

Table 1 - Search-query results

Search-query	Date (dd-mm-yyyy)	Results
Blockchain governance	25-07-2019	370
Blockchain “decision rights”	26-07-2019	149
Blockchain governance “decision making”	29-07-2019	136
Blockchain governance “decision rights”	30-07-2019	209

There were a total of 864 papers selected for review. There were 455 titles left after removing duplicates and non-English periodicals. As shown in Figure 2, the collected material was appraised and selected based on its relevance and quality during the selection process.

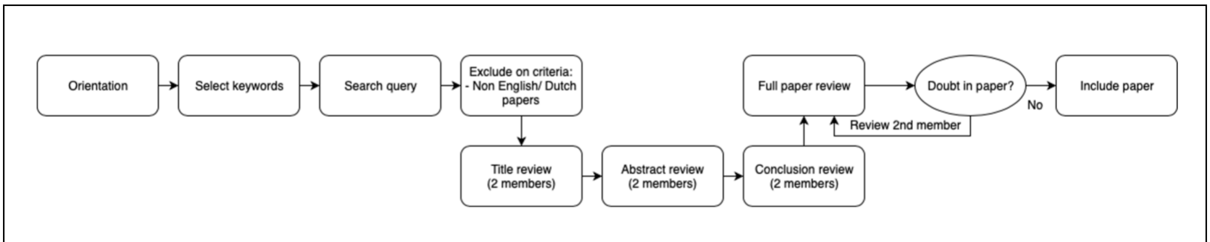

Figure 2 - Literature selection process

To avoid possible selection bias, the approach depicted in Figure 2 was carried out independently by two members of the research team. Disagreements among research team members were handled during the selection process by discussion and consultation with two additional team members. The process' outcomes are depicted in Figure 3.

The narrative (synthesis) technique was used to assess the findings of the selection process. Narrative synthesis is a method for synthesizing and summarizing findings from different studies that largely focuses on the use of words and text to summarize and explain the findings (Popay et al., 2006). The narrative synthesis was broken down into three stages, each of which was found to be useful: 1) the creation of a preliminary synthesis, 2) the investigation of data relationships, and 3) the evaluation of the synthesis's robustness. Nvivo 12 was used to examine the papers that were reviewed. Braun and Clarke's (2006) six-phase model of Thematic Analysis was used to find and generate themes, which included 1) familiarizing yourself with the data, 2) producing initial codes, and 3) looking for themes. 4) Themes review, 5) Themes definition and labeling, and 6) Themes conclusion.

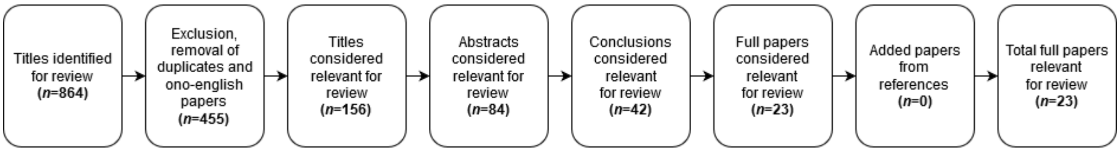

Figure 3 - Selection process & results

Expert Interviews

To collect empirical data and to validate the findings of our preliminary literature study, a selection of experts was interviewed. The semi-structured interviews were prepared using a protocol, which was utilized for all interviewees. The protocol included 1) an introduction where the expert's background was discussed, 2) definition of blockchain governance and decision rights by the expert, 3) structure of governance in blockchain projects undertaken, 4) key ingredients for optimal implementation of decision rights, 5) validation of the preliminary literature findings, and 6) governance lessons learned from blockchain projects. Topics 1 to 3 and 5 to 6 were included to provide proper context, while topic 4 served as vehicle for data collection in support of the main goal of the study. The interviews were all audio recorded and transcribed within 48 hours by two researchers. The process involved expert sampling, in which experts from the blockchain community were asked to participate. Experts were required to have at least two years' experience in the field of blockchain, and to be participating or have participated in at least two blockchain projects. The outreach led to 31 people being selected and invited to take part in the interviews. Twelve people accepted the invitation, equating to an acceptance rate of 38,7%, see Table 2. In the remainder of this article, interviewees are referred to using the identifiers as listed in Table 2.

Table 2 - Interviewee background classification

Interview identifier	Industries and branches	Experience with public blockchain	Experience with private blockchain
IE-1	IT and information services		X
IE-2	IT and information services		X
IE-3	Education		X
IE-4	IT and information services		X
IE-5	Banking		X
IE-6	Public administration		X
IE-7	Public administration		X
IE-8	Public administration	X	X
IE-9	Law	X	
IE-10	Insurance and pension funds		X
IE-11	Education	X	X
IE-12	Education	X	X

Nvivo 12 was used for analysis of the transcribed data. That involved breaking down the interviews and categorizing the content of the transcriptions using themes. The analysis was performed by identifying and generating themes using Braun and Clarke's (2006) six-phase model of Thematic Analysis, identical to the analysis process for the SLR results. Use of the six phases led to the breakdown of themes as shown in Table 3.

Table 3 - Interview Themes

Themes	Derived from # of interviews	# of references	Themes
Consensus mechanism	2	3	Consensus mechanism
Decision rights	7	16	Decision rights
On-chain and off-chain	4	6	On-chain and off-chain
Power	5	10	Power
Problem resolution	5	6	Problem resolution
Problems and challenges	8	22	Problems and challenges
Proposal	2	2	Proposal
Blockchain governance	9	38	Blockchain governance
Voting	3	5	Voting

Focus Group

In total, 28 people who had not taken part in the expert interviews were selected and invited to take part in the focus group session. The participants were selected based on the same criteria as the participants in the expert interviews. Expert sampling was performed, where experts from the blockchain community were asked to participate. Experts were required to have at least two years' experience in the field of blockchain and to be participating or have participated in at least two blockchain projects. Eight participants were willing and available to take part in the focus group session, of whom one cancelled a day prior and two others on the day itself, resulting in a total of five participants. The number of participants allowed for an orderly, structured session, in line with the theory of Krueger & Casey (2014), which states that smaller groups show better potential. The remaining twenty people declined to take part for various reasons, such as a lack of time or knowledge on the subject. The selection process meant that all five participants had proven experience in the field of blockchain governance and decision-making in public and/or private blockchains.

The focus group discussion was both video and audio recorded for data collection purposes. The preparation consisted of the research team familiarizing itself with the discussion script a few days prior to the discussion, creating group dynamics and taking care of peripheral matters like recording equipment. In order to ensure that the focus group discussion progressed as intended, several techniques, arguments and topics were discussed with blockchain professionals and researchers before the actual discussion, as per Toulmin (2003), as a means of structuring arguments during the discussion. Initially, the focus group session was intended to last up to two hours, but it eventually lasted 2.5 hours because a few breaks were included at a later stage. The participants consisted of professionals from both the public and private blockchain domains, offering a mix of unique viewpoints. In the rest of this article, focus group members are referred to using the identifiers listed in Table 4.

Table 4 - Focus Group Participants Background Classification			
Focus group identifier	**Industries and branches**	**Experience with public blockchain**	**Experience with private blockchain**
FG-1	IT and information services		X
FG-2	Education		X
FG-3	IT and information services	X	
FG-4	Insurance and pension funds		X
FG-5	IT and information services	X	X

In preparation for the focus group session, pre-set questions were formulated and answered on the basis of the results of the expert interviews and the preliminary literature review. Data was collected and evaluated during the focus group session by giving a presentation about the consolidated results, which led to a discussion regarding the following questions: 1) What comprises blockchain governance? 2) Why is blockchain governance needed? 3) What do you recognize as the right moment to start thinking about governance within a blockchain project? 4) What do you understand as decision rights within the context of blockchain projects? 5) Who can make decisions within a blockchain project? 6) What do you recognize as the right way to arrange decision rights within blockchain projects? 7) How would you resolve conflicts within a blockchain project?

Table 5 - Focus Group References	
Questions	**# of references**
1	7
2	4
3	4
4	5
5	5
6	8
7	6
Total:	39

Nvivo 12 was used for analysis of the results from the focus group. All video files were manually transcribed by the research team, then Nvivo was used to break down the session and categorize findings per pre-set question. A breakdown of the responses on the basis of the number of references to each question is presented in Table 5.

Results

The results presented in this section are grouped according to the three methods of data collection: literature review, expert interviews and focus group. The results thus grouped are presented thematically, the themes being perception of blockchain governance, consideration of blockchain governance, decision rights, and decision-making process.

Perception of Blockchain Governance

Systematic Literature Review Results

Several perspectives on blockchain governance emerged from the systematic literature review. Blockchain governance, according to Ziolkowski (2019), is just the placement and enactment of decision rights. Bosankic (2018) provides a more extensive definition, with governance referring to all acts, such as decision-making processes, involved in developing, updating, and abandoning a system's formal and informal rules. Code (e.g., smart contracts), laws (e.g., fees for malicious actors), processes (what must be done when X occurs), or responsibilities are all examples of rules (who must do what). At its foundation, according to Ziolkowski (2019), governance is a matter of how actors' responsibilities and powers are linked, who decides, how the decision-making process is carried out, and how decision-makers are held accountable.

Beck et al. (2018) connects blockchain governance to the theoretical perspective of IT governance, which has been a hot topic for decades, and references to Weill (2004), who defines IT governance as “the framework for decision rights and accountabilities to encourage desired conduct in the use of technology.” Beck et al. (2018) highlights three essential characteristics of IT governance, which he applies to blockchain governance, based on Weill's definition: decision rights, accountability, and incentives. Reyes (2020), in contrast to Beck et al. (2018), compares corporate governance to blockchain governance and suggests that corporate governance systems should serve as a model for blockchain governance. Furthermore, Reyes cites a number of reasons why blockchains should be governed by a corporate governance model.

Expert Interviews Results

The expert interviews provided several perceptions of blockchain governance. Interviewee IE-3 stated the following: “It all starts with the perception of what blockchain governance is, because people in different segments tend to have different visions. In business environments, the perception of blockchain governance could be different from a governmental environment.” One expert defined it as: “Who is in charge? This has to be worked out together and is one of the most difficult things to discuss because of financial and emotional aspects” (IE-1). Another expert shared that perception and added: “Who has what to say about which topics? Who makes which decisions at which level? What happens if you have to escalate if something goes wrong” (IE-2). At the same time another expert provided a more detailed definition: “Actually blockchain governance is about how you make decisions and take actions, and who is carrying the responsibilities. I recognize three phases of governance: design, operational, and evolvement. Governance is mainly only interesting while changes are happening or when they are not going as planned within a blockchain” (IE-11). The expert added that an adequate definition of governance is found in a study by (Weill, 2004) and that governance is just about how a project or organization is managed. Subsequently, expert IE-3 advised being sure to address and discuss everything that could happen beforehand. Moreover, the expert argued for arranging decision rights roles, as well as protocols, and how to achieve agreement. That allows for matching exit strategies to be created, which can be relied on when disagreement occurs, but also with a sort of escape clause which can evolve during the project (IE-3). Another expert acknowledged much the same by suggesting that “blockchain governance is often not needed when a good basis of trust is established” and added that “governance is a mechanism which can be relied on when disagreement occurs” (IE-10). Only one expert provided a more abstract view of blockchain governance, defining it as: “How companies and their stakeholders want to be seen and perceived by others, more like a value judgement” (IE-12). The topic of decision making was a recurrent feature of the experts' perceptions, and another expert described blockchain governance as: “All processes regarding decision-making which have impact on the blockchain” where the expert includes “processes around deciding who is allowed to partake in the blockchain project or not, how do we evolve and change the blockchain, who is responsible and who is building the blockchain?” (IE-4). Furthermore, one of the experts distinguished two different forms of blockchain governance, namely on-chain and off-chain governance.

Focus Group Results

The analysis of the focus group data yielded the following perceptions of blockchain governance. Participant FG-1 described blockchain governance as a: “management model which is used to achieve a result as a group. How do we manage things, and who has the

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rights to do certain things?" Participant FG-5 had a different perception and described blockchain governance as components like authorization, assigning rights, decision-making, change management, and determining incentives. Participant FG-4 mentioned: "we have to define, understand and distinguish what exact part of blockchain governance is being referred to." Two other participants FG-1 and FG-3 replied: "yes, which blockchain governance? What are we talking about? Are we talking about the initiation of a blockchain project, a consortium, or the software?" Participant FG-3 also mentioned that more clarity could be created by distinguishing two different forms of governance, namely the governance of blockchain, and governance by blockchain. Participant FG-4 expressed the view that blockchain governance can be seen as an organizational component defining who can or cannot participate in our blockchain and what the rules are in the blockchain environment. Finally, FG-1 concluded that key aspects and concerns regarding the governance of private blockchains show similarities to the governance of IT projects.

Regarding the perception of blockchain governance, the following key findings were made:

1. The perception of what blockchain governance really is was identified as important both in the literature and by the experts.
2. Experts did not seem to have a shared perspective of blockchain governance. Whereas the literature continuously broadens the definition of blockchain governance, the experts have divergent perceptions of blockchain governance as a whole.

Consideration of Blockchain Governance

Systematic Literature Review Results

Several considerations of blockchain governance emerged from the systematic literature review. To begin, Reyes claims that blockchain governance has followed a similar path to that of internet governance (Reyes, 2020). Reyes goes on to say that if blockchain governance development does not proceed with caution from now on, it may succumb to the same issues as the internet did. This could lead to greater state control, less privacy, and more centralization (Reyes, 2020). On the other hand, according to Bosankic (2018), the goal of efficient transformation is the most important motivator for blockchain governance. People will abandon the service or refuse to participate if it takes too long to fix faults, according to Bosankic (2018). Such behavior underscores the reality that, in terms of preferred governance, participants in a particular blockchain face considerably lower exit costs than, say, an employee subject to centralized policies set by private firm leadership (Alston, 2019). Tasca and Tessone (2019) embrace Bosankic's perspective, claiming that blockchain governance is critical to the adoption of blockchains as well as their ability to adapt, alter, and interact. Effective governance mechanisms can be a competitive advantage in the long-term success of a blockchain project, with speed and ability to react being critical factors (Finck, 2018). Because blockchain governance facilitates debate among stakeholders and provides a framework for making decisions about how a blockchain should evolve, it is critical for the blockchain's long-term viability (De Filippi & Loveluck, 2016; Dirose & Mansouri, 2018; Garagol & Nilsson, 2018).

Mosley et al. (2019) examined blockchain governance from a managerial standpoint and concluded that it may not be appropriate in scenarios requiring maximum participation (e.g. voting). If members are left to rule themselves, the study found that a considerable majority of them will disconnect.

Expert Interviews Results

During the expert interviews, IE-2 stated that blockchain governance is important because all active parties within a blockchain project have different needs, and those needs must be managed accordingly. IE-1 and IE-2 added that parties have different perspectives regarding what they want to achieve within the projects, resulting in long processes of stakeholder interest alignment. IE-1 added that one of the most difficult aspects within blockchain projects is deciding who has which rights and who is in charge. IE-10 said that, on a technical level, different parties are able to cooperate well together, but made the following observation regarding the governance aspect: “If parties cannot resolve conflicting interests or encounter egoism between different stakeholders, the process of governance becomes rigid, slow and eventually could fail.” The financial and emotional aspects within blockchain projects, and most importantly trust, determine the success or failure of the projects (IE-1). If a single party distrusts other parties, the project is liable to be unsuccessful (IE-1). IE-11 also acknowledged the importance of trust, saying: “My vision of governance emphasizes not just the importance of technology, but also the cooperation between people, and how blockchain technology can be used to facilitate this cooperation. We all have to start by trusting each other before moving on within the blockchain project.” Furthermore, IE-12 made a statement regarding the vision of governance from a blockchain founder's perspective. IE-12 recognized that founders of blockchains are terrified by governance, since others could influence the system or project if, for example, a system of voting on decisions is implemented.

Three experts contended that blockchain governance is most important when things are not going as intended, and when mistrust develops (IE-3, IE-10, and IE-11). IE-10 stated: “Governance is for when things are not going as planned and when there is no trust. When this occurs, governance and rules are what we can fall back and/or rely on.” IE-10 added that, when a sound basis of trust exists, governance is not really needed. IE-11 responded: “Governance really matters at moments of change within blockchains and especially when things go wrong.” IE-4 saw governance as a document with rules (e.g. contracts) and emphasized that this document can be consulted when parties within blockchain projects start making their own plans instead of doing what has been agreed. Another expert, IE-6, also depicted governance as a change and managerial or organizational document containing in-depth information regarding how decisions are made. IE-4 and IE-7 also advised starting the process of governance as early as possible in a blockchain project.

Focus Group Results

Within the focus group, when asked about the importance of blockchain governance, all participants agreed that governance is always needed. FG-4 stated that, without governance, a chaotic situation is liable to develop. Blockchain governance is necessary to orchestrate changes, decide who can join the system, and who has which decision rights. FG-2 expressed the importance of blockchain governance with the question: “who determines the rules of the game?” and identified that as an essential question to ask within every blockchain project. FG-5 suggested that the governance of a blockchain could become a unique selling point for the users of its application. Eventually, the governance of a blockchain will serve not only as a mechanism for internal processes, but also as an external image with the potential to attract users and customers to the system. FG-5 also indicated that, for a user of a blockchain system, governance has become a top-of-mind consideration in relation to whether to use that particular blockchain or move on to other options. FG-1 acknowledged that same point by providing an example involving Ripple, a blockchain project for global payments. “Some people do not want to use Ripple because it is seen by some as a centralized, bankers’ currency. Ripple co-operates with financial institutions which goes against the vision of why Satoshi Nakamoto created Bitcoin. Bitcoin was especially designed to allow a decentralized currency and keep it away from the control of banks.” FG-1 concluded that the way a blockchain system is governed needs to align with the preferences of its users, who otherwise might abandon the system. Finally, FG-4 stated that governance as a mechanism is essential to adequately protect minorities. FG-3 added: “governance is always necessary. You may wonder what a blockchain without governance would look like. It would probably be a mess.”

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Regarding the consideration of blockchain governance, the following key findings were made:

1. Multiple blockchain governance considerations are related to different types of governance.
2. Experts refer to a context-specific type of governance. A different type of stakeholder implies a different type of governance.
3. Trust is identified as a key aspect of blockchain governance.

Decision Rights

Systematic Literature Review Results

Beck et al. (2018) describe and categorize decision rights as decision management rights and decision control rights, respectively. The management rights cover things like making decision suggestions and carrying out or implementing those decisions. The approval, monitoring, and measuring of decisions are all covered by the control rights. The authors also predict the blockchain economy to be more decentralized than the digital economy in terms of decision powers. Beck et al. (2018) goes on to say that the nature of consensus-building in particular fosters this growth. The center of consensus-making is decentralized, which means that not only are the records that form the backbone of the blockchain economy retained decentralized, but they are also decided decentralized.

A blockchain's consensus algorithm determines how decentralized modifications to the common ledger are made. This consensus method is one of the first algorithms designed and coded into a blockchain's architecture (Alston, 2019). It is one of the most technically challenging aspects of a blockchain, and it has the most impact on its governance. It determines (or regulates) which copy of the transactional database should be disseminated to network members (Zachariadis et al., 2019). The integrity of a ledger is automatically maintained by this algorithmic consensus process, according to Howell et al. (2019). More specifically, nodes in such networks vote on the authoritative version and agree on it. In effect, the consensus algorithm works in the same way that a governance system's decision-making process does. During the systematic literature review, several consensus mechanisms were discovered. The proof-of-work approach is the most common decentralized consensus mechanism used by the largest blockchains (Ferreira et al., 2019). Miners "vote" for their favorite set of rules by assigning their computer power to one of the chains if a split happens and there are competing copies of the same blockchain, each with its own set of rules. Proof-of-work is effectively one-CPU-one-vote, and it addresses the problem of determining representation in majority decision-making, according to Nakamoto (2008). A proof-of-stake consensus process is an alternative to proof-of-work. Proof-of-stake is a system in which a node's stake in the network determines the likelihood of that node being chosen for block validation (Saleh, 2021). A user can stake their tokens in order to become a validator (someone who can create blocks), which locks up their tokens for a set period of time. The number of tokens staked and the length of time the tokens are staked could be factors in determining whether a node can produce the next block. The delegated proof-of-stake consensus process, for example, is used by the EOS blockchain. Users can stake their tokens to vote for delegates who then directly monitor the blockchain and produce blocks in a delegated proof-of-stake system (Ferreira et al., 2019). The value of a user's vote is determined by how many tokens they have invested. It is essentially a representative democracy that replicates existing corporate governance frameworks, in which stakeholders vote for corporate directors (Ferreira et al., 2019).

Carter (2017) conducted prior research that aided in the examination of the largest blockchains through a survey of market attitudes. Carter believes that investors are mostly bothered about getting voting/decision rights, and that even if they do, they do not exercise such rights effectively. Carter believes that most blockchain projects have a large concentration of power in the hands of a few individuals, but that with the introduction of projects like Tezos, Decred, and Dash, there is a shift toward explicit shareholder rights. End-user members, according to Howell et al. (2019), have very limited formal authority in governance and decision-making processes because they must ‘accept as given' the package presented by node members. That agrees with Zachariadis' point of view on the lack of formal legitimacy for any group or individual to act on behalf of the broader community (Zachariadis et al., 2019).

Although formal power concentrations favor miners, node operators, and developers, prominent personalities such as Vitalik Buterin (Ethereum Network) wield enormous influence over blockchain development and decision-making (Ziolkowski et al., 2019). Proof-of-stake projects are those that provide token holders rights, whereas proof-of-work projects concentrate power and rights among miners, node operators, and developers. Securing those rights, on the other hand, necessitates significant technical expertise, financial investment, and a desirable geographic location (with cheap electricity) to mine with a high hash power within the system (Carter, 2017). Existing members have a motivation to use their monopoly power or limit access by new players, according to study by Rey and Tirole (2007). Because of the concentration of mining power in the hands of groups of original users, blockchain creates a serious centralization issue within proof-of-work systems. The change to proof-of-stake systems aims to alleviate this issue by giving those with a stake in the endeavor more voting power (Howell et al., 2019). However, with proof-of-stake systems, further difficulties occur when significantly invested token holders have disproportionate power over the system at the detriment of less rich users (De Filippi & Mcmullen, 2018). Although blockchain is one of the most distributed foundational technologies yet invented, its governance is frequently based on simple majority voting techniques that are susceptible to lobbyists (e.g., investors, miners). As a result, the governance systems of blockchains appear to have a built-in degree of centralization (Azouvi et al., 2019). The openness of the blockchain is thus both a weakness and a strength, with decision-making privileges available to anyone willing to put in the effort (Zachariadis et al., 2019).

The Bitcoin software update from version 0.7 to version 0.8 demonstrates the centralization of power. The new version of the program was incompatible with the older one due to a defect in the upgrade, posing a problem that needed to be remedied. Bitcoin's core developers persuaded the network's two largest mining companies to revert to a previous software version for the sake of Bitcoin's integrity (Popper, 2015). The lack of suitable protocols to cope with the unexpected was exposed in the Bitcoin ecosystem when a few people, in this case core developers, fixed the issue by coordinating without telling essential parties (Crepaldi, 2019). Moreover, the same thing happened in the Bitcoin block-size discussion, where developers made decisions without a formal framework (Campbell-Verduyn, 2017). During the DAO breach, developers made unlawful decisions on the Ethereum network as well (DuPont, 2017).

Expert Interviews Results

The expert interviews provided a picture of what is understood regarding various aspects of decision rights. Firstly, IE-12 stated that a private blockchain differs from a public blockchain where decision rights are concerned. In a private blockchain, node operators are selected, whereas in a public blockchain environment, anyone can run a node (IE-12). IE-12 stated that, in a private blockchain, some decision rights allocation takes place as soon as node operators are selected; the selection indirectly translates to ‘who do we trust within this blockchain environment?’ IE-12 stated that discussing decision rights is an essential aspect of the governance design phase. Firstly, who has specific decision rights? But, more importantly, what can those entities do with their decision rights? IE-12 added that blockchain projects tend to focus a lot on the “who” aspect, instead of the “what” aspect of decision rights. In addition to the validation of transactions as a node operator, IE-12 defined the “what” aspect as how we deal with updates and forks that take place during the evolution phases of a blockchain. IE-12 concluded by stating that there are three decision rights holders within a public

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blockchain: miners, developers and the community. IE-12 acknowledged that miners have a lot of influence over a blockchain system, but argued that a large portion of the miners mine exclusively for financial gain. Moving on from mining and proof-of-work systems, IE-11 commented: “A delegated-proof-of-stake system in a public blockchain is one of the better systems because it helps to avoid not reaching voting quorums given the fact that delegates will vote.” A possible disadvantage of such a system is that certain delegates might secure too much voting power (IE-11). IE-11 added that one of the most difficult things in blockchain governance is the principle of one-person-one-vote. “How do we decide if a vote comes from one person while the ability exists to possess multiple token addresses to cast votes with” (IE-11). IE-4 said that, in private blockchains, leader-based consensus mechanisms are also seen. With such a consensus algorithm, one node in the network leads and validates transactions, and other nodes follow and replicate. Such consensus mechanisms are seen mainly where relationships such as that between a parent company and its subsidiaries exist. In these relationships, there is a high level of trust in which the subsidiary companies accept validated transactions from the parent company. The subsidiary company nodes do, however, monitor the actions of the parent company in case inappropriate situations arise. IE-4 also pointed to round-robin structures within private blockchains, in which nodes are selected on the basis of fair rotation to validate transactions.

In the Bitcoin and Ethereum blockchains, major disagreements arise in the community from time to time. That happens because there is no clear leader within the ecosystem. Anyone can contribute to the blockchain system by proposing new software updates or changes (IE-2). Core developers eventually decide whether to implement the proposal or not, and finally (e.g. in Bitcoin's proof-of-work system) miners choose whether they will use the new version/chain or not. To conclude, the community members/users have a certain degree of power, but at the same time the core developers still possess the centralized power to make a final and unanimous decision (IE-2).

IE-10, who runs a blockchain, made the point that a big benefit of having a private consortium blockchain is that a single party can be held accountable for the blockchain project. IE-10 added that that could benefit the progress of a blockchain project, but also acknowledged that the arrangement is at odds with the decentralized nature of a blockchain system. The allocation of decision and voting rights within IE-10's blockchain project took place at a late stage, because the construction of the application was prioritized. It was felt that a functioning application should be available to test and discuss, before consideration was given to decision and voting rights. All consortium members said that they wanted a working product before making agreements regarding decision rights and voting.

Regarding private consortium blockchains, IE-2 made the point that the sooner a party gets involved in a blockchain project, the more influence or decision rights they can secure. IE-2 also raised the scenario of a project where a group of initial founding parties were joined a few months later by other founding parties, who received the same decision rights as the initial parties. That could create a conflict, with the initial founding parties arguing that they had already invested a lot of money and therefore considered it unfair that the new founding parties were receiving the same decision rights. Such problems can be avoided using constructions such as basing investment payback periods on the amount of time a party has been a member of the consortium. However, in practice, when a large and important company does not join the consortium at the outset, but joins later, they are still able to demand certain decision rights and shares because of their importance and impact. In summary, all parties have to come to an agreement that is acceptable to everyone, and which is based not only on financial investment, but also on other valuable factors like “data” (IE-2). IE-6 shared that view and observed that a shift is taking place from “he who pays the piper calls the tune” to a broader concept, whereby other values come into play when allocating decision rights, such as sharing data and contributing knowledge.

Focus Group Results

Within the focus group, FG-5 said that determining decision rights within a private blockchain project is also difficult and time-consuming; it is a subject that does not receive much attention, especially in the initial phase of a project. Ideally, in the case of a private blockchain, stakeholders should first get to know each other and develop trust. In addition to determining who gets what rights, it is also important to take account of the possibility of participants joining or leaving the private blockchain. One should therefore specify who determines who may join the network, and what rights a new participant will receive (FG-4). Subsequently, FG-5 shared his thoughts about the possible distribution of decision rights within a private blockchain, and indicated that careful consideration should be given to the distribution of voting rights. The participant suggested assessing the relative voting power of each participant, in order to ultimately maintain an overall balance of interests. On the other hand, FG-2 indicated that, after the distribution of voting rights, the quorum to be reached within a voting round must also be considered. FG-3 responded by proposing the use of delegates, as in the Delegated-Proof-of-Stake (DPoS) consensus mechanism used in public blockchains. With such a mechanism, decisions are taken by a designated group, which is designated by the majority.

Regarding decision rights, the following key findings were made:

1. The literature depicts decision rights as mainly related to the different types of blockchain (eco)system.
2. Experts view the concept of decision rights mainly in the context of how a single node could influence a(n) (eco)system as a whole.
3. Experts tend to focus on the organizational aspects of decision rights, whereas the literature seeks to resolve the decision rights issue with specific (eco)systems.

Decision-making Process

Systematic Literature Review Results

In terms of decision-making, Ziolkowski et al. (2019) looked into the key decisions that must be taken in the governance of private and public blockchains. Demand management, data authenticity, system architecture, membership, ownership conflicts, and transaction reversals are among the six fundamental decision aspects identified by their research. Van Deventer et al. (2018) acknowledged the design phase of the dimension system architecture inside private blockchains, indicating that any blockchain project will sooner or later face a make-or-buy decision about the infrastructure that blockchain applications run on. Will the blockchain application run on a newly developed platform or on a blockchain managed by a third party, and if so, what type of blockchain should it run on? Van Deventer also provided a list of probable design-phase challenges that would benefit from a decision-making process, which were: 1) technical choices for the software stack, 2) version control of used third-party open-source software, 3) technical requirements on connectivity and firewalls, 4) monitoring and maintenance of key performance parameters, 5) division of cost and revenues, 6) procedures for onboarding new partners and new customers, 7) procedures for onboarding new partners and new customers, and 8) procedures for onboarding new partners and new customers." During the formation and management of a private blockchain consortium, the challenges were addressed.

When it comes to the decision-making process in public blockchains, the literature is mostly concerned with the evolution phase, during which the blockchain undergoes modifications. The Bitcoin governance mechanism is described by Zachariadis et al. (2019) as fully passive and cumulative. They are aware of two issues. 1) There is no official authority for any group or individual to act on behalf of the broader community when modifications to the system's rules are required. Instead, it is based on the overwhelming majority of users. 2) There is a

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lack of a universally acceptable election point or form for users who want to submit feedback on coding modifications. The timeline during which action must be taken is also unknown. Decision-making, according to Zachariadis, can be time-consuming and inefficient. Carter's study (Carter, 2017) looks at the decision-making process via the lens of crypto-assets. Carter reminds out that the decision-making process in Bitcoin and most crypto-asset systems is based on developer teams releasing software, which is algorithmically confirmed by miners and stakeholders. Furthermore, investors and speculators have no shareholder rights or safeguards. Honkanen et al. (2019) findings reveal that in the absence of good governance, which Honkanen et al. (2019) refers to as implicit governance, stakeholders have three options. Stakeholders first have the option of approving the (planned) changes. Second, they may separate themselves from the ecology. They can also make a fork as a third alternative. A soft fork is a modification to the blockchain protocol that tightens the ruleset, whereas a hard fork loosens the ruleset. Both possibilities have the potential to cause a chain split, resulting in two or more competing blockchain versions that share the same history until their rulesets diverge (Haque et al., 2019). According to Honkanen et al. (2019), those solutions enable a technocratic society with minimum regulation while still allowing it to function.

A blockchain system's governance consists of a set of rules and procedures that can be applied on-chain and/or off-chain (De Filippi & Mcmullen, 2018). The two implementation types are strongly related to the two governance concepts: by blockchain and for blockchain. According to Reijers et al. (2016), on-chain governance entails rules and decision-making procedures that are directly encoded into a blockchain system's underlying infrastructure, and so correlates to blockchain governance. The infrastructure within which the interactions take place establishes the rules of interactions between participants; interactions are governed only by rules inherent within the underlying blockchain code (De Filippi & Mcmullen, 2018). To put it another way, on-chain governance is attempting to hard-code governance principles into the consensus mechanism that is used to confirm transactions made using the blockchain protocol (Reyes, 2020). De Filippi and McMullen (2018) defines off-chain governance as all influences that exist outside of a technical platform but impact its growth and operations. Rather than operating on a technological level, such norms work on a social or institutional level. As a result, the regulations are not automatically implemented, and a third-party authority may be necessary for enforcement or oversight. Off-chain governance is typically implemented through a less rigorous and defined set of rules, procedures, and social conventions than a code-based system. Unlike their code-based cousins, these systems are more casual and unstructured. Furthermore, Reyes defined off-chain governance as a system in which people control the code rather than being controlled by it, but it also brings the issue of personal sovereignty (for example, strong individuals controlling decision-making processes) (Reyes, 2020). De Filippi and McMullen (2018) believes that because of its social component, off-chain governance is difficult to impose. However, it enables the system to respond to unforeseen situations more rapidly and seamlessly than on-chain structures can. On-chain governance requirements are strict, and if there is a weakness in the architecture, hostile parties could take advantage of it to hurt the system and/or enrich themselves. Even if governance rules are programmed into smart contracts, there is no guarantee that they will function as intended. New blockchain systems have begun to include on-chain governance in its evolution layers, allowing token holders to fully automate the modification of the underlying blockchain protocol's rules (De Filippi & Mcmullen, 2018).

Ehrsam (2018) recognizes a power shift towards users and away from the more centralized group of developers and miners, contrary to what earlier authors have suggested. In contrast to the more centrally organized Bitcoin and Ethereum, Tezos, an open-source blockchain platform, allows on-chain voting from any ecosystem participant. According to Ehrsam, the procedure is as follows: To change the governance structure, any participant submits a code modification. The upgrade will then be voted on by network participants on-chain, and if approved, it will be implemented on a test network first. A final vote is held when a certain amount of time has passed, and the code change is then uploaded to the main network. A "self-amending ledger" is a notion that boosts an individual's ability to exert influence on the network (Ehrsam, 2018). On-chain governance, according to Ehrsam, is a system that can have both positive and negative implications. On-chain governance has several advantages. For starters, it provides a consistent implementation procedure, which allegedly improves coordination and fairness while also allowing for faster decision-making. Because the governance method is hard-coded, the disadvantage of on-chain governance is that it may be difficult to apply changes (Ehrsam, 2018). Furthermore, the code could be found to be defective, allowing it to be abused more quickly and readily. Zamfir, a key creator of Ethereum's proof-of-stake system, came to a similar conclusion (Zamfir, 2018). Finally, Reyes (2020) discovered that protocol administration follows a delegated authority structure similar to that seen in businesses, providing an abstract picture of the decision-making process. Full node operators (node operators who are active participants in protocol administration) essentially operate as a board of directors, with key managerial decision-making authority. Meanwhile, both a network of open-source software developers and actual core developers maintain control over proposed code changes for smaller operational decisions (Reyes, 2020). Furthermore, Reyes emphasizes that core developers are not acting alone. Instead, any member of the community can propose a code update through a formal procedure known as BIP (Bitcoin Improvement Proposals) in the case of Bitcoin and EIP (Ethereum Improvement Proposals) in the case of Ethereum (Reyes, 2020). The mechanisms employed by Bitcoin and Ethereum for submitting, discussing, and executing improvement ideas are recognized as forms of off-chain governance in an essay by Bosankic (2018). Nagarajan (2018) also defines the BIP as a design document for introducing new features or information to Bitcoin, complete with technical specifications and justifications for implementation. Standards Track BIP, Informational BIP, and Process BIP are the three main categories of BIP identified by Nagarajan. The three categories of BIPs were described in Taaki's (2011) initial BIP (also known as BIP 001). The standards track BIP typically entails the most significant modification (e.g., a change to the network protocol, block size, or anything else that affects interoperability) that may be proposed, and so requires community consensus. An Informational BIP describes a design issue or gives the community broad guidance. An Informational BIP, unlike a Standards Track BIP, does not require community consensus and does not propose the addition of a new feature to the protocol. A Process BIP can be published to propose a modification to the Bitcoin development process or a Bitcoin change process (e.g., a change to the decision-making process). The BIP goes through several steps after it is submitted before being "Accepted," "Rejected," or "Withdrawn." If a BIP's progress slows, the author can modify the BIP's status to "Deferred" and reassign it to "Draft" status. The status of a BIP changes to "Final" once it has been accepted by the community and fully implemented. If a formerly "Final" BIP becomes obsolete, its status can be changed to "Replaced" in specific instances. Because they just give information, some Informational and Process BIPs are never supposed to be finished (Taaki, 2011). The first BIP 001 ever contributed, which explains how the BIP process works, is an example. The status of these informational and procedural BIPs is "Active."

In the end, it is up to the developers to select which recommendations are approved. After then, it's up to miners (who collectively control at least half of the processing power) to put the proposed change into effect, which can be thought of as a type of voting. A miner's vote, according to Haque, is better understood as a prediction of the broader mining community's collective stance than than a reflection of the miner's individual choice (Haque et al., 2019). Furthermore, according to De Filippi and McMullen (2018), off-chain governance can affect the functioning of on-chain governance rules, with developers typically altering the blockchain protocol to improve network functionality or fix technical issues. Off-chain governance has been utilized to change a blockchain's protocol for economic reasons rather than technical reasons in some extreme cases, such as the DAO breach.

Expert Interviews Results

During the expert interviews, IE-11 pointed out that many questions surround the handling of decision rights, the decision-making process, and how to ensure effectiveness. Firstly, IE-11 said that the effectiveness of a decision-making process is entirely situational. Different projects have different goals and operate in different situations, meaning that different decision-making processes are required to suit those goals and situations. IE-11 argued that, instead of trying to create new processes, one should consider adopting existing processes that have similarities and lend themselves to blockchain governance. IE-11 compared the way that decisions are made in the context of a joint venture to the way they are made in a private/permissioned blockchain. Another key element of blockchain governance is ownership: who is responsible for the blockchain and who retains ownership when things go wrong? IE-11 compared open-source development to blockchain because, theoretically, there is also no real ownership in either system. Most of the time, when new technologies emerge and new questions arise, the solutions adopted are not new or innovative; rather, existing solutions are identified and used in a way that is appropriate to the new challenge.

When the improvement and decision-making processes of Bitcoin and Ethereum (BIP and EIP) were discussed, IE-11 described the processes as vague. IE-11 added that it is not clear when a proposal turns into an official BIP or EIP. The only thing that is known is that when a proposal is made, core developers or the circle of Ethereum magicians decide whether the proposal will turn into an official BIP or EIP, where, in turn, voting will take place to decide whether the change/proposal is adopted. However, IE-11 pointed out that that does not always happen, and that some BIPs or EIPs are pushed through the process without any transparency or opportunity for the broader community to see what is happening. Sometimes, transparency regarding a change emerges only after the change has taken place. The Bitcoin inflation bug case was cited as an example. Core developers found a critical bug which was a fundamental threat to the whole Bitcoin blockchain. The bug allowed malicious miners to artificially inflate Bitcoin's supply by using a simple type of double input. Around ten core developers created a fix for this bug which was not shared with other developers or the community. The bug fix was disguised as a BIP, which was accepted immediately because the core developers contacted large mining pools with sufficient power to incorporate the new update straight away. Several days after the change was implemented, in-depth update information was released regarding the BIP used to disguise the update/bug fix. In the cited example, there was a clear rationale for the misuse of the BIP process. If information regarding the bug or fix had been leaked early, malicious miners could have abused the Bitcoin system. IE-11 therefore concluded that ethical considerations come into play in such situations, and that the corresponding decisions are made by only about ten developers. In the cited example, the process was effective, but the case nevertheless illustrates that the decision-making processes are not at all transparent or decentralized.

IE-4 stated that the onboarding process of new parties within a private consortium blockchain is governed through a voting process and is part of the governance structure. IE-4 gave the following example of how decisions are made amongst consortium members. Every consortium member has a delegate, who has the ability to vote; if more than 50% of the votes are cast in favor of a particular option, that option is selected. IE-4 added that the procedure is used not only for the onboarding of new clients, but also for software updates to the private blockchain or other major changes within the consortium. According to IE-7, setting up governance rules, voting, and making decisions mostly takes place off-chain in private consortium blockchains. Implementation involves both a working group and a steering committee. The working group is where all parties work together and focus on discussion or activity relating to a particular subject area. The working group eventually presents the results to the steering committee, where delegates from all the parties decide how to proceed. IE-6 said that it is a continuous process, but can take up a lot of time, especially in the early consortium design stages. IE-10 said that, if a private consortium blockchain has fifteen or twenty participants, unworkable and complicated situations can arise when the various parties all indicate the direction in which they want to proceed. IE-10 has created a blockchain in which each party has a delegate, and each delegate is classified as small, medium, or large, based on their size and impact. All parties have the ability to propose changes until two weeks before a meeting. When the parties have to vote in meetings, each member of the 'small' cohort is allocated one seat, each 'medium' two seats, and each 'large' three seats. If voting is tied or becomes overly complicated, a chairman intervenes. If the chairman cannot make a reasoned decision or does not want to decide because of the complexity or sensitivity of the issue, the centralized party/owner of the consortium intervenes and makes the final decision. Even when a decision is made by all parties or the chairman, the centralized party/owner of the consortium has the ability to reject the decision and make their own decision. IE-10 added that the decision-making process is backed by substantial service level agreements signed by all parties. IE-11 concluded that each business goal requires its own specific decision-making process metrics. For instance, some businesses will want to make decisions quickly (e.g. on a centralized basis), while others will prefer greater transparency, even though it slows down the process. IE-4 shared that view, pointing out that a private blockchain has to consider whether to prioritize speed or transparency in decision-making processes.

Focus Group Results

Within the focus group, various views emerged regarding what a decision-making process looks like, or should look like, within a blockchain. The shared views related mainly to private blockchains. FG-1 indicated that it is important that all stakeholders, including end users, are involved during the initial phase of the consortium. FG-1 also advised starting the discussion of decision rights as early as possible. Make sure everyone is at the table, not just the developers because, once a blockchain is implemented and operational, it is harder to make adjustments. FG-4 assumed that forks within a private blockchain are considered to be fairly disastrous for the consortium, since the participants in the consortium rely on each other and share data. FG-1 added that the way issues are resolved within a private blockchain does not differ much from the way they are resolved in the context of a joint venture: the relevant parties get together and try to find a mutually acceptable solution. Participant FG-1 added that consortiums also have to take account of the possibility of participants leaving. FG-3 agreed, and indicated that public blockchain improvement proposals could possibly also be used for a big consortium with a large number of participants. FG-3 also gave a practical example of a colleague who proposed a fix for a public blockchain. The colleague received funding from the community and in six months' time the nodes will decide whether to use the proposed fix. The final decision rests with the miners. This process could be used as a guideline for designing a decision-making process for a private blockchain.

Regarding the decision-making process, the following key findings were made:

1. The literature discusses the decision-making process throughout the whole software development lifecycle and stresses the importance of focusing on each step of the software development lifecycle.
2. The experts considered the decision-making process by reference to existing decision-making processes (used in other domains) with the potential for use in blockchain governance.
3. The experts highlighted the influence of groups of voters, and how a possible final vote could influence the robustness of the blockchain, on-chain or off-chain.
4. The experts stressed the importance of addressing the question of decision-making early in the blockchain development process. Otherwise, decision-making power is likely to be impaired.

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Conclusion

Our study's purpose was to present an overview of the current state of blockchain governance and decision rights using current knowledge and empirical evidence. To do so, a structured literature review was conducted, followed by a series of expert interviews and a focus group session to address the following research question: 'What is the current state of decision rights within the governance of blockchain technology from a theoretical and empirical perspective?'

A recent literature review discovered a knowledge deficit in the field of blockchain governance, notably in the area of decision rights (Smit et al., 2020). The research presented in this paper built on that literature review and aimed to provide an empirical addition to the description of the current state and practical application of decision rights in blockchain governance. The study was motivated by the fact that there have been few academic studies on how blockchain influences organizational design in general, and decision-making in particular (van Rijmenam et al., 2018). Contributions that have addressed the subject have mostly been theoretical or conceptual, not based on empirical evidence. The study reported here therefore aims to redress the balance.

From a theoretical standpoint, we wanted to give an overview of key topics in blockchain governance and decision rights, as well as their connections. Because the existing body of knowledge consists of fragmented issues with little organization to convey meaning, understanding this framework and its concepts is critical. The findings of our exploratory literature review are best used to inform future research into the structure of blockchain governance and decision rights knowledge.

From a practical standpoint, the findings provide an overview and framework of governance processes and advances that may motivate businesses to explicitly include decision rights in the design of blockchain solutions, resulting in solutions that are value-sensitive by design. Furthermore, the findings can be utilized to structure the solution design process, ensuring that blockchain governance is given the attention it deserves rather than being disregarded in the early stages of development, as is currently the case.

Because blockchain governance in general, and decision rights and decision-making in particular, is still in its infancy as a topic of study, answering the research question proved challenging. One of the major conclusions that we can draw from this study is that the practitioners involved agree on the fact that the governance aspect of a blockchain is not usually discussed with all stakeholders in the design phase of a blockchain development project. That observation reflects the fact that blockchain projects usually start with prototype construction in consultation with stakeholders, while aspects such as legal or conceptual modelling are deferred (self-reference). Additionally, it is important to note that, the longer consideration of governance and aspects such as decision rights is deferred, the more complex and costly it becomes to introduce governance mechanisms at a later stage.

Another major conclusion that can be drawn is the lack of consensus and clarity in current practice when talking about the governance of blockchain technology and the associated definitions. For example, when considering governance in the context of blockchain, one could be talking about the initiation and design (development) of a blockchain, the consortium, or the software itself. Essentially, these are layers in a governance context that are used conjointly, while not always compatible with the context and solutions they are described with. Also, while there is a growing body of knowledge concerning the governance of blockchains, our data shows that there still is considerable (linguistic) confusion about what exactly constitutes blockchain governance and its various aspects or dimensions (e.g. decision rights, decision-making, participation rights, authorization, change management, or determining incentives). Because blockchain projects and the governance of blockchain solutions often involve very diverse stakeholders, a common frame of reference for the consideration of governance is much needed. There seems to be similar confusion regarding both the governance of blockchain solutions (e.g. how decision rights are distributed amongst different types of stakeholder) and the use of blockchain to achieve governance (e.g. applying blockchain solutions to ensure citizens can govern their own voting rights). Furthermore, the data shows another phenomenon that is sometimes neglected in early decision-making about governance, namely the possibility that consortium members leave and what the effect their departure has on other members' decision rights and decision-making, amongst other things. It is important that such eventualities are also considered in the design phase of a blockchain project.

Lastly, another major factor is the aspect of trust in designing blockchain governance solutions. Trust is largely a human aspect, and a lack of trust could have a significant negative effect on the development, implementation and enactment of blockchain solutions. Conversely, if trust is high within a consortium, and governance is clear and transparent, potential members whose involvement could be advantageous can see that their interests will be taken into account. That is another reason for considering proper governance and trust from the start of a blockchain project. It is important to note, however, that trust and governance function differently in the context of a public blockchain than in a private blockchain. The same is true of accountability, which is often considered to be implemented more appropriately in private contexts than in public contexts.

Discussion and Future Research

The findings of this study are based on a comprehensive literature evaluation that looked at twenty-three studies. The systematic literature review offered information about public blockchains and their governance but did not go into great detail about decision-making rights. Many diverse aspects of governance were explored, although the majority of them scarcely mentioned decision rights. In addition, just one study was solely focused on private blockchain governance.

Our study included various flaws that could have influenced the outcome. The first flaw is a methodological one that has to do with data gathering. A rigorous literature assessment revealed that private blockchains were challenging to investigate. There was just one article regarding private blockchains found. We advocate conducting in-depth case studies in conjunction with observational research methodologies to acquire a better understanding of what is going on in the governance of private blockchains. Direct non-participant observation methods are advised in this scenario because they have the capacity to provide in-depth insight of a social group or organization (e.g., a consortium) from an external/independent perspective (Ciesielska et al., 2018). In line with the first limitation, the scattered nature of blockchain governance publications meant that no clear distinction between private and public blockchain types in terms of decision powers could be found in the literature (and accountability and incentives).

The second limitation is that only a limited number of practitioners were included in the study, all originating from and most working only in the Netherlands. Those characteristics limit the generalizability of our findings and therefore need to be borne in mind. This limitation is attributable partly to the strict participant selection criteria we applied with a view to ensuring that our practitioners had enough experience to provide us with empirical evidence. Therefore, we argue that, to ensure proper generalizability, more participants should be included in future research. Nonetheless, a low sample size does not necessarily mean that the quality of the data is low. The goal is saturation, which could be validated in future research by conducting additional expert interviews and focus group sessions with a view to potentially obtaining new insights. Another limitation is the narrow selection of blockchain governance aspects we addressed. We focused mainly on the perception and consideration of governance, and on decision rights and decision-making. While other seemingly important aspects of governance were discussed, they were not always pursued and analyzed further. We regard the pursuit of such aspects as a potentially fruitful direction for future research, which should be considered in the context of future studies into governance.

While we believe that our data collection and analysis approach yielded enough data to ensure adequate data validity, one possible direction for future research would be to more explicitly address the context of governance in blockchain projects. Therefore, we argue that case studies should be utilized in future studies, as our approach provides context, but not the kind of detailed context that case study research could provide.

Another limitation is the lack of a taxonomy for the consideration of blockchain solution governance (see also the previous section). The lack of a common framework of understanding of the concepts underpinning this subject could have impaired discussion during the qualitative phases of our research, especially the focus group session. However, we sought to structure the discussions by using topics and voting via mobile devices to guide the direction of the discussion and make explicit the degree of consensus present during the focus group session. An important future research direction would therefore be the development of a governance framework that includes all aspects and dimensions pertinent to the governance of blockchain solutions.

One could argue that the decision to start without adopting a frame of reference drawn from governance in other contexts (e.g. governance of global data management supply chains or governance of telecommunications standards such as 4G/5G) limits the value of our study. However, because our study was explorative, our approach was well-suited to the discovery of innovative governance-related concepts or aspects that might not be relevant in other contexts. Nevertheless, we believe it would be useful to investigate the potential of using governance mechanisms from other similar fields or applications as a basis for validation in the context of a blockchain solution.

In view of the lack of consensus and clarity in current discussions of blockchain technology governance, future research should aim to create clear definitions, with particular emphasis on the key aspects of blockchain, decision rights and blockchain-related governance.

Lastly, one research direction suggested by the findings of our study is examination of the ethical aspects of governance mechanisms in blockchain solutions. By way of example, one participant in our study cited a case where developers were deliberately non-transparent about an important update to a blockchain, in order to maintain the security of their nodes. Because our data shows that governance is very dependent on trust, governance of blockchain solutions should be designed, implemented and utilized in a value-sensitive way. With that in mind, more research is needed to ensure that current and new blockchain governance mechanisms take the ethical values of stakeholders into account.

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