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DOI
10.1145/3325112.3325262

Publication date
2019

Document Version
Final published version

Published in
Proceedings of the 20th Annual International Conference on Digital Government Research

Citation (APA)
Batubara, R., Ubacht, J., & Janssen, M. (2019). Unraveling Transparency and Accountability in Blockchain. In Y.-C. Chen, F. Salem, & A. Zuiderwijk (Eds.), *Proceedings of the 20th Annual International Conference on Digital Government Research* (pp. 204-213). (ACM International Conference Proceeding Series). Association for Computing Machinery (ACM). https://doi.org/10.1145/3325112.3325262

Unraveling Transparency and Accountability in Blockchain

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ABSTRACT

Blockchain technology is heralded for improving trust and can provide a new approach for creating transparency and promoting accountability of government activities. However, it is still not clear how and in what ways blockchain technologies can improve this. This study examines the mechanisms and capability of blockchain technology to contribute to improved transparency and accountability in government. We use a set of system transparency and accountability concepts and mechanisms to critically assess the capabilities of blockchain. By means of a land registration case in Indonesia, we investigate the effects of blockchain on the transparency and accountability of the system. Creating transparency and accountability might be more difficult than expected, as non-technical issues need to be addressed. Based on our assessment we discuss key issues, including digital ID, privacy, interoperability, connectivity and technology aware population, computational efficiency and storage size, acceptability, check and control mechanism, data validity, digital signature, algorithm transparency, law and regulation support, and dispute resolution, that must be considered in developing a transparent and accountable blockchain-based e-Government system.

CCS CONCEPTS

• Applied computing ~ E-government • Computer systems organization ~ Peer-to-peer architectures • Social and professional topics ~ Governmental regulations

KEYWORDS

blockchain, transparency, accountability, e-Government, land registry

dg.o 2019, June 18-20, 2019, Dubai, United Arab Emirates

ACM ISBN 978-1-4503-7204-6/19/06...$15.00
https://doi.org/10.1145/3325112.3325262

ACM Reference format:

F. Rizal Batubara, F. Rizal Batubara, Jolien Ubacht and Marijn Janssen. 2019. **Unraveling Transparency and Accountability in Blockchain. In *Proceedings of dg.o 2019: 20th Annual International Conference on Digital Government Research (dg.o 2019), June 18-20, 2019, Dubai, United Arab Emirates***. ACM, New York, NY, USA, 10 pages. https://doi.org/10.1145/3325112.3325262

1 INTRODUCTION

Transparency and accountability can be used as an instrument to improve public services delivery, better budget utilization, to attract more citizen engagement, prevent fraud and corruption, and increase trust in government [20, 36]. Transparency and accountability promote orderly and efficient functioning of government organizations and in turn can enhance economic performance in a country by encouraging more credible government policies [55].

However, empirical evaluations have found that the impact of transparency and accountability initiatives are often limited and can result in undesirable effects since the initiatives often induce polarization, indecision of government officials, and dysfunctions in government [14]. Some challenges need to be considered in improving transparency in public services such as: the reluctance of governments and social elites to avoid personal risks, lack of proper mechanisms for establishing transparency, misinterpretation and misunderstanding of information, and transparency may cost more money [1, 20].

The use of information and communication technology (ICT) in government, often named e-Government or digital government, has been advocated by governments globally to improve transparency and accountability [25]. Nevertheless, most ICT initiatives for transforming government organizations towards being transparent and accountable fail to achieve their intended outcomes [49]. Current e-Government systems still have limited access to public service information (data, processes, decisions), entail complex business processes, and are inefficient and costly in their daily operations [29]. Especially in developing countries, high levels of fraud and corruption [17] along with a low index of information transparency and accountability [60] encourage the need for more specific and effective solutions that address these specific challenges.

	Blockchain types			
	Public		Private	
	Permissionless	Permissioned	Permissionless	Permissioned
Participants	Anonymous	Identified	Identified	Identified
Data access	Anyone	Anyone	Authorized participants	Authorized participants
Initiate transactions	Anyone	Authorized participants	Authorized participants	Network operator only
Participate in the consensus mechanism	Anyone	Authorized participants	Authorized participants	Network operator only
Network types	Decentralized	Partly decentralized	Hybrid	Centralized

Figure 1: Blockchain Types.

Blockchain technology unfolds a novel technology to create trust among parties by facilitating transparent and accountable transactions using an innovative combination of a distributed architecture, cryptography, and consensus protocols [41]. Blockchain was originally introduced by Satoshi Nakamoto [44] to store and share transactions of the Bitcoin cryptocurrency. A blockchain is a distributed ledger in which data (can be a record, a contract, cryptocurrency or other types of information) are stored in a chain of data packages (blocks) and shared across a peer-to-peer network [44]. Each block consists of a unique hash value, which cryptographically commits to the contents of the block, a timestamp, the previous hash value and the transaction details [48]. Transactions have to be verified through a consensus mechanism before they are added to the blockchain and all nodes in the blockchain network hold a copy of the blocks [44].

To perform a transaction, a user has to sign the transaction digitally [44]. Each user owns a digital signature, a pair of private key and public key based on an asymmetric cryptographic mechanism to validate the authentication of the transaction [45]. The private key that shall be kept confidential is used to sign the transaction [44]. Then a timestamp is added as a proof of the data existence at the time [44]. Subsequently, the block is broadcasted to all the nodes in a decentralized network, which will then act as validators for the transaction by using a specific consensus mechanism. The consensus mechanism consists of a set of rules and procedures that allows to maintain and update the ledger and to guarantee the trustworthiness of the records in the ledger and to prevent double spending [48]. If the majority of nodes in the network agree on the validity of transactions in a block and on the validity of the block itself, the transaction is recorded in a new block and linked to the previous chain of blocks with a cryptographic hash function as a link to the previous block [44]. In this way, blockchain provides a secure, decentralized, persistent, fault-tolerant and auditable transaction platform which allows for a transaction to take place in a decentralized fashion without the need of a central intermediary [44].

Depending on its purpose, blockchain technology comes in many different possible architectural configurations to which access and control to data is allowed. These configurations constraint which users have permission to read or write the data and who will participate in the consensus mechanism [56]. Based on the access and control to data, blockchain can be categorized into four main types as shown in Figure 1 [27, 46, 48, 56, 62]. A public or private blockchain determines who has access to read data on the ledger whereas permissionless or permissioned blockchain regulates who can initiate transactions and participate in the consensus mechanism [46].

A public permissionless blockchain allows anyone to join and participate in the blockchain network, meaning that they can read data on the ledger, initiate transactions, and participate in the consensus mechanism. In public permissioned blockchain, even though anyone can read the data, only authorized participants are allowed to initiate transactions and are involved in the consensus mechanism. Moreover, in private permissionless blockchain, also known as consortium blockchain, only authorized participants allow to read data on the ledger, initiate transactions, and participate in the consensus mechanism. A private permissioned blockchain allows only network operator to initiate transactions and participate in the consensus mechanism while authorized participants are only able to read the data.

Governments need to select the most appropriate type of blockchain architecture for a particular application scenario since there are trade-offs for every blockchain type [46]. Some aspects such as access control, data ownership, security, privacy, availability, interoperability, scalability, transaction cost, and performance should be taken into account in design decisions [9, 46, 48, 62].

An important field of application for blockchain is the smart contract. The concept of smart contract was originally introduced in 1994 by Nick Szabo [53]. However, technological availability at the time was considerably behind the theory level so the idea was never implemented in practice. After Satoshi Nakamoto introduced the blockchain technology in 2009, the construction of smart contract platforms became possible. A smart contract is essentially a piece of software that stores rules for negotiating the terms of an agreement in the blockchain, automatically verifies the fulfillment and then executes the agreed terms [8]. While a standard contract outlines the terms of a relationship (usually one enforceable by law), a smart contract enforces a relationship with cryptographic code that contains value and only unlocks it if certain conditions are met [8].

Smart contracts can increase the reliability of transactions and facilitate exchanging of money, property, shares, service, or anything of value in an algorithmically automated and conflict-free way [11]. Hence, smart contracts can implement a wide range of applications, including financial services, life sciences and healthcare, technology, media, telecommunications, energy and resources, public sector, and across industries [57].

Some key characteristics of blockchain technology such as the distributed architecture, immutability, and auditability provide useful ways to enhance transparency and accountability of government activities [6, 26]. Blockchain can be a solution for environments that lack the trust function of a central authority or trusted third parties [37]. Therefore, blockchain technology can be an appropriate solution for developing countries since they are more vulnerable to fraud and corruption. With the use of the technology, every transaction in public services can be recorded more securely and persistently and enables better transparency and subsequently can improve accountability of government activities.

However, to date, there have been limited attempts to examine the mechanisms on how and in what way blockchain can enhance transparency and accountability in government organizations. Most work tends to focus on the idea, potential benefits, current issues, potential use, approach and evaluation of blockchain adoption [2]. Therefore, it is unclear whether blockchain technology will in fact be feasible for enhancing transparency and accountability in government organizations. This study evaluates the contribution of blockchain towards transparency and accountability in e-Government systems.

In the following section, we describe the research approach of our study. In Section 3, we discuss the concepts, types, and mechanisms of transparency and accountability. This is followed by an illustration of the case of the land registration system in Indonesia in Section 4. Section 5 examines the contribution of blockchain in improving transparency and accountability. In Section 6, we analyze some issues that should be considered in developing transparent and accountable blockchain-based e-Government system. The paper concludes with a summary and reflection on the potential of blockchain technology to enhance transparency and accountability.

2 METHODOLOGY

As discussed in the previous section, due to the novelty of blockchain technology, there is limited existing knowledge on how and in what ways blockchain can enhance transparency and accountability in government organizations. Therefore, this study is of explorative and conceptual nature. In this study, we present an in-depth analysis of the land registration system in Indonesia to explore how and in what ways blockchain technology can improve transparency and accountability. The choice for the land registration system in Indonesia is motivated by its high relevance for the functioning of the public sector and the considerable impact in economic growth, especially in developing countries. A trusted land registry system allows for legal stability in land ownership which is at the basis of many economic activities for businesses and citizens alike towards innovation and welfare.

To critically assess the capability of blockchain technology to enhance transparency and accountability in the land registration system, we use the types of transparency by Bannister & Connolly [1] and accountability mechanisms by Vance, Lowry, & Eggett [58]. Based on the types of transparency we investigate how blockchain can contribute to generate each type of transparency. Likewise, we verify in what ways blockchain can assist to produce each mechanism of accountability.

Furthermore, we analyze the case to capture socio-technical aspects which must be considered in designing a blockchain-based land registration system. The socio-technical aspects are important to understand how human, social, and organizational factors interact and influence the functionality and usage [3] of the blockchain-based registration system. This understanding will help to increase stakeholders acceptability and will enhance the expected contribution of blockchain to transparency and accountability.

3 TRANSPARENCY AND ACCOUNTABILITY IN PUBLIC SECTOR

Transparency and accountability are interrelated and mutually reinforcing concepts and refer to a broad range of processes, actors, and power relations [19]. Transparency is a necessary, but not a sufficient condition for ensuring greater public accountability [25]. Making information available through transparency initiatives is an important first step toward increasing accountability [38]. In democracy, where citizens delegate authority for decision making to public organizations, transparency and accountability function together to produce the information that citizens need to assess and validate the actions of their governments [34]. Hence, transparency promotes accountability by providing the public with information about what the Government is doing.

There are many definitions and conceptualizations of transparency. Generally, the term of transparency is linked to the notion of openness. Transparency at its simplest is “the ability to look clearly through the windows of an institution” [7, p. 105]. Zhu [63] define transparency as “the degree of visibility and accessibility of information” (p. 670). These views suggest that transparency is most appropriately conceptualized as a perception

of information. Moreover, transparency is generally defined "as the open flow of information amongst stakeholders" [26, p. 47]. In a governmental context, governmental transparency is defined as "the ability to find out what is going on inside government" [47, p. 5].

Transparency can make democracy stronger in several ways. When citizens can observe the workings of government, they can become more involved in what government does [33]. Government transparency empowers citizens as they are more able to express their views about policy decisions that affect them. Transparency makes democracy stronger also by encouraging government officials to perform better, because if the government is more open, they are more likely to be held accountable for their decisions, both good and bad [1]. Similarly, a more open government makes it easier for the media and watchdog groups to expose, and therefore deter improper or otherwise undesirable influences on policymakers [5]. In short, transparency enhances democracy by giving citizens a greater voice in what government does, and promoting government action that advances the interests of all, not just a privileged few.

Bannister and Connolly [1] identify three types of transparency, which are:

- *Data transparency*, related to the facts and figures of government. This type of transparency calls to answer *what* information is needed, *who* are involved, *when* and *where* it happens. Data transparency can be enabled by providing accessible, understandable, versatile and up-to-date information online for the public.
- *Process transparency*, refers to information on the steps, behaviors, and interactions in various processes of government. This type of transparency needs to answer *how*, *when*, and *where* something is performed. Process transparency can be facilitated by presenting information regarding the activities and procedures and providing tracking technology of the process.
- *Decision transparency*, concerns with the intentions and rationale for the decisions, actions and policies of the government. This type of transparency requires to answer *why* and *how* a decision is made. Decision transparency can be delivered by publishing textual explanations related to reasons justifying decisions and/or records created during decision-making processes.

While transparency creates a window into the world of government operations, accountability provides a measure on how government is performing. When a government holds itself accountable to citizens, it shows them how and why decisions are made, offers measures of whether public policy is successful, and presents areas where business and citizens can become involved to help the government to meet goals [52].

Accountability can be defined as "the right of some actors to hold other actors to a set of standards, to judge whether they have fulfilled their responsibilities in light of these standards, and to impose sanctions if they determine that these responsibilities have not been met" [23, p. 29]. This entails that holding someone accountable requires the specification of outputs and outcomes in order to measure results and to link them to goals that have been set, in accordance with the norms of management practice. Being accountable implies a responsibility for one's actions and their consequences [51]. This, of course, suggests a direct causal relationship between actions and results [4], a point of contention for program evaluators.

Furthermore, Vance, Lowry, & Eggett [58] identify three system mechanisms that promote accountability, which are:

- *Identifiability*: refers to a person's knowledge that his outputs could be linked to him. Identifiability is a necessary facilitator of accountability because this mechanism informs a person that his or her actions can be traced back to him or her and that he or she can therefore be made responsible for those actions;
- *Monitoring and evaluation*: related to the process of watching or tracking a person's activities and the belief that another party will assess a person's activity according to some normative ground rules and with some implied consequences:
- *Social presence*: concerns with the effects of increased conforming behavior in the presence of another person in the system.

In summary, transparency determines the availability of information to assess the authorities' performance and to prevent any potential misuse of powers. Thereof, transparency acts as an enabler for achieving accountability, to hold authorities responsible for their actions. In turn, transparency and accountability will increase trust of citizens in the functioning of the government.

The types of transparency and the mechanisms of accountability will be used in the next section as the guidelines to verify the contribution of blockchain technology to improve transparency and accountability in a land registration system in Indonesia.

4 CASE STUDY: LAND REGISTRATION SYSTEM IN INDONESIA

According to the Basic Agrarian Law (BAL) Act No. 10 of 1960 [21], land administration in Indonesia aims to provide legal certainty on the ownership of a specific parcel of land by providing three components: cadastral mapping, written legal instruments and effective land registration. Furthermore, Government Regulations No. 24 of 1997 about Land Registration provides definitions, criteria, and mechanisms of land registration [22]. This regulation also provides the legal protection for right holders of the land parcel. Registration is necessary for evidence of legal validity of land transfer actions for sale and purchase, gift, auction, exchange, inheritance, annulment, and cancellation of rights and encumbrances. The land registration process in Indonesia includes measuring, surveying and mapping of land, the registration of rights, and issuance of certificates of rights, the entire procedure is presented in Figure 2. In the next paragraph, we follow the procedure from the start of application towards the final registration.

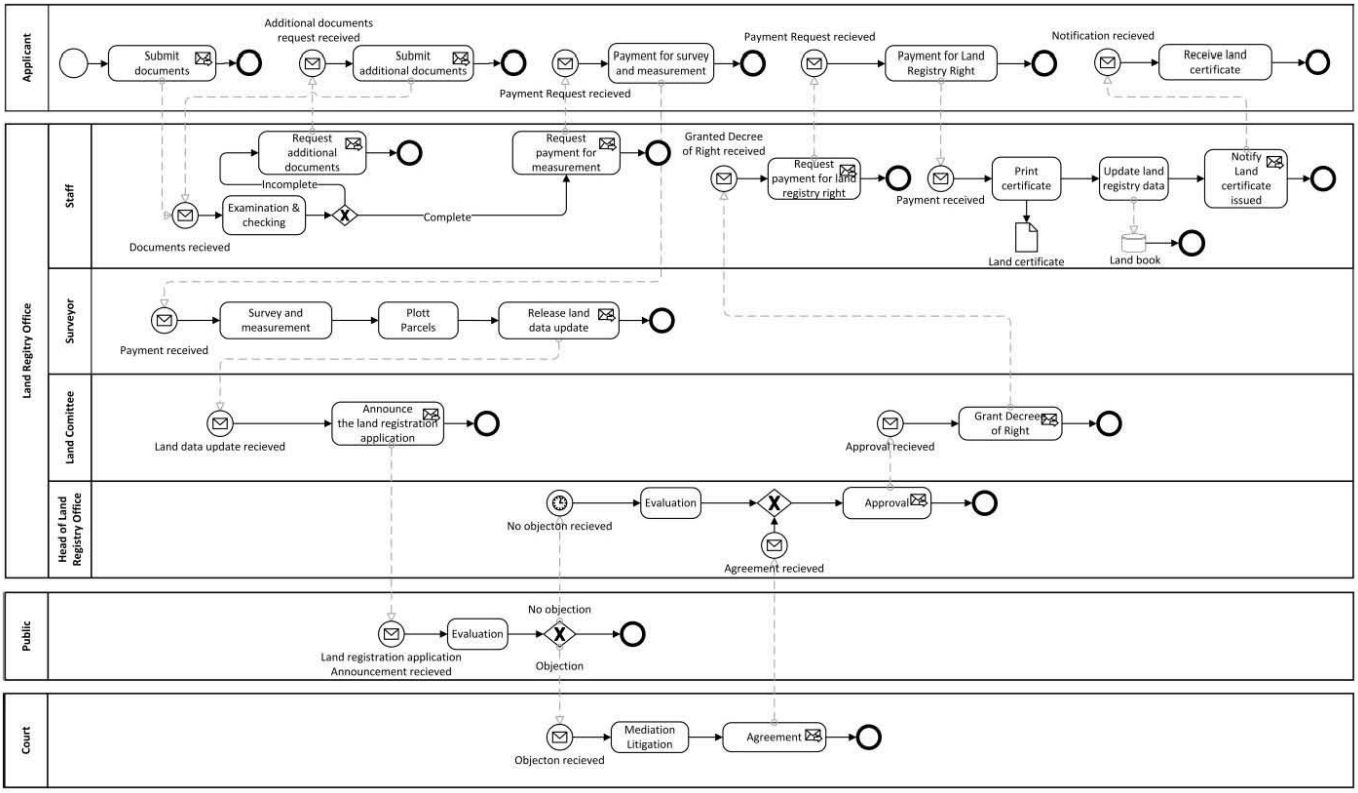

Figure 2: Land Registration Process in Indonesia

The procedure for obtaining a land title is started by submitting application documents to the Land Registry Office (LRO). Staff from the LRO then checks the completeness and validates the documents submitted. Then, the applicant is asked to pay for survey and measurement costs. After the survey and measurement costs are paid, the application is referred to a surveyor for field check and parcel measurement. Based on the field check and parcel measurement, the parcel is plotted. Later, a parcel map and letter of measurement are produced for land registration. In the meantime, a Land Committee, an ad-hoc committee composed of a representative from the LRO, a representative from the village involved, and other individuals from the area who are familiar with the land, announce this land registration request to the public to find out whether there is any conflict to the land tenure. In case there is any conflict, then the process goes to court for mediation or litigation. After agreement, the head of the LRO approves the land status and the Land Committee issues a decree of the right granted and submits it to the land registration system. At this point, a certain amount of money is charged to the applicant for the land registry right. Finally, the parcel is registered to the land book and a land certificate is issued to the new land owner.

From this case, it can be seen that the land registration process in Indonesia is very complex due to the number of organizations involved and the many activities that are required for its fulfillment. Such complex business processes lead to costly and time-consuming processes. Around 70% of the world's population, mostly in developing countries, have difficulties to access the land registration system due to expensive and complex land administration processes [32]. Moreover, the land registration process does not reflect transparency and accountability since the process tends to be closed and no media can be used as a tool to monitor the process of land registration. Lack of transparency and accountability in land registration processes allow several parties (individuals, government officers, or legal entities) to capture and create opportunities for fraud and corruption [39]. Roughly 21% of people around the world report that they paid a bribe for land services [15]. This lack of transparency can make it harder for affected people and governments to hold certain parties accountable for land use decision-making and any sort of violation they commit. In the next section, we explore how this process can be improved by using blockchain technology.

5 PROMOTING TRANSPARENCY AND ACCOUNTABILITY THROUGH BLOCKCHAIN TECHNOLOGY

Whereas digital systems have already improved access to information and increased transparency, blockchain may be able to offer further advantages over existing digital systems. Blockchain is widely announced to be a backbone of the circulation of digital assets, powering any kind of services by

transparency and accountability [26]. There are three main arguments why blockchain is chosen to be a solution with great benefits and maybe no alternatives: records (i.e. certificates, transaction records, digital ID, etc.) in blockchains cannot easily be manipulated, it can prevent double spending/transactions, and rules and requirements can be embedded into a smart contract application which makes it very difficult to manipulate the process.

In the case of the land registration system in Indonesia, a smart-contract-based application could be utilized as the backbone of the system. Predefined rules and requirements of each step in the land registration process could be embedded into the smart-contract-based application. Then, the results of each step in the land registration process as described in Figure 2 will be recorded in the blockchain.

For example, envision two citizens, a buyer and a seller who have negotiated the sale of a parcel and wish to register their sale parcel with the local authorities. They would proceed to the land registration system that is now powered by the blockchain technology. This blockchain-based system then handles the process following the predefined rules. Some steps in the process such as payment and data updating can be done automatically by the smart contract whilst some other activities such as survey and measurement might still have to be done manually due to the lacking or untimely availability and accuracy of the land data in developing countries. The output of each step is then recorded in the blockchain. The process can only move on to the next step if predefined conditions in the previous step are met. After all of the registration steps are fulfilled, the transfer of ownership is automatically completed.

Given the typed of transparency by Bannister & Connolly [1] and accountability by Vance, Lowry, & Eggett [58], we examine the blockchain-based land registration system to reflect the capability of blockchain in enhancing transparency and accountability.

- Data transparency

  Each of the transactions, represented as a block, is broadcasted across the network and validated by the nodes in the network using a specific algorithm. Once validated, the block will be added to the previous block in the ledger and recorded by all nodes in the network [47]. In this way, anyone at any time can verify every transaction data made on the blockchain, which will lead to data transparency.

  By utilizing blockchain technology, parcel data, transaction data, land ownership data, etc. will be secured with a blockchain and broadcasted across the network. The blockchain logs all validated transactions in a sequence. This means the system is fit for checks on ownership, titleholders and so on. It will therefore be easy for authorized parties to verify information. These parties would usually be actors who are part of the process: buyers, sellers, banks, notaries, real estate agents, etc. As an example, involved parties will have easy access to information about the ownership, previous owners history, and parcel data (map, size, etc.).
- Process transparency

  Since all nodes in the transaction can view the ledger, everyone can agree on how the transaction is progressing while it is ongoing, and how it went once it is completed. Moreover, data on the blockchain is "hashed" and linked to the hash of the previous block [44]. Small changes in the data will result in major changes in the hash value. In this way, blockchain will provide good data integrity and traceability due to the ability to maintain the history of all transactions ever made. These mechanisms will lead to process transparency.

  Using smart-contract-based application as the backbone of the land registration process, actors who are part of the process have to confirm what they are doing at various steps in the registration process. Every decision that actors made in the registration process will be recorded and linked to the previous decision. Hence, the system will provide traceability of all transactions ever made in the system. For example, in the land registry process, the process of land title transfer starts with the documents submission step, then followed by documents verification and continues until the new land certificate is received by the new land owner. The process can only move to the next step if only the requirements or conditions in the previous step have been fulfilled. In this way, an applicant will be able to monitor what is the progress of his application, the results of each step, and who made decisions in certain steps.
- Decision transparency

  In a smart contract, a set of predefined rules and requirements for negotiating the terms of an agreement is stored in the blockchain [8]. If and when the pre-defined rules and requirements are met, the agreement is automatically executed and the process will move on to the next step. The smart contract facilitates, verifies, and enforces the negotiation or performance of an agreement. This results in the trustworthiness of the contractual execution and can improve decision transparency.

  In the land registration system, the rules and requirements for each step in the process are stored in the smart contract. In this way, it will be very difficult to change the rules or to bypass the requirements compared if the rules are enforced by the officer.

  As an example, if an applicant submits a set of documents to register a land parcel, after checked and verified by a land registry officer, the smart contract then executes the next step to ask for more documents if the submitted documents have not been completed or to send an invoice to pay the costs for measuring the parcel. Therefore, decisions that are made by the land registry officer will be recorded in the blockchain and parties involved can check why a certain process is halted or continued according to the rules.
- Identifiability

  The use of asymmetric cryptography to validate the authentication of transactions ensures that the source of transactions is legitimate proving that a particular party is authorized to do something [45]. Once a party has performed

a particular action, others can be certain that a particular party indeed performed that action. Therefore, the use of asymmetric cryptography supports the identifiability mechanisms for accountability.

A land registration tells us who has what rights to which parcel, so certainty around the "who" is critical. It is desirable to associate land ownership with a specific person. Moreover, the actors who are going to be involved in the process have to be identified. Although blockchain technology was built not to share identity data with the participants in the network, an external validated identity system can be used to access the land registration system. Hence a digital ID system is required to support the functioning of the blockchain-based land registration system.

- Monitoring and evaluation

Distributed records of transactions provide the possibility of all participants in the network to monitor the progress of ongoing transaction activity and the results of completed transactions. When a new transaction comes into a blockchain, all nodes in the network must execute a specific algorithm to evaluate and verify the transaction data (signatures, rules, and transaction history) proposed [56]. If the majority of the nodes come to a consensus that the transaction data is valid, the new block of transactions is accepted into the ledger and added to the chain of transactions. This consensus protocol reflects the evaluation mechanism of accountability.

Blockchain technology has made it possible to monitor all activities in the land registration process. Each decision made by involved actors will be recorded in the blockchain along with the history of the previous decision. In this way, it will be easy to monitor or to trace decisions that were ever taken in the system. Since every decision can be monitored and traced, it will be easy to hold specific actors responsible for certain decisions. The actors have to take responsibility for the decisions they made throughout the chain of the registration process. As an example, if an officer tried to manipulate land parcel data, it will be easy to find who is responsible for the manipulation and to formulate the consequences that need to be taken, based on the registered data.

- Social presence

The presence of considerable nodes in the network and the consensus mechanism between the nodes to validate the transactions ensure the entire network collectively agrees with the transactions.

Accordingly, every decision in the land registration process needs to be approved by parties involved in the system. Therefore, the parties involved in the process must be aware that their decision will involve other parties in the system, it will be very tough to hide their decision in the system without this being known by others. This condition will effect conforming behavior of parties in the system caused by the presence of other parties.

From the land registration case, it can be seen that a blockchain-based land registration system can support the transparency types by Bannister and Connolly [1] and accountability mechanisms by Vance et al. [58]. Hence, a clear and verifiable record of transactions in blockchain could boost transparency and accountability of the land registration system.

Blockchain is not a set of simple tools that straightforwardly allow solving organizational problems. Blockchain encompasses properties which enable organizations to frame the causal connection of the organizational practices, events, and processes they mediate [56]. Consequently, as long as current processes, people, cultures, and structures remain unchanged, the potential benefits of blockchain technologies cannot be fully realized. Designing complex socio-technical systems such as e-Government systems is not only about a technological aspect, but it also requires coordination of the behavior of stakeholders that are organized through institutional arrangements to regulate the positions and relations between stakeholders [35]. Therefore, in the next section, we analyze some design requirements from technological and institutional aspects that should be considered to make the system able to generate transparency and accountability properly.

6 DESIGN REQUIREMENTS

Based on the case study in the previous section, we briefly review several requirements from the technological and institutional perspective which must be considered in order to support transparency requirements and accountability mechanisms, as presented in Table 1.

Table 1: Transparency and Accountability Design Requirements

Aspects	Design Requirements
Technology	Digital ID
	Privacy
	Interoperability
	Connectivity and a technology-aware population
	Computational efficiency and storage size
Institutional	Acceptability
	Check and control mechanism
	Data validity
	Digital signature
	Algorithm transparency
	Law and regulation support

In general, blockchain technology is still very nascent [2] and comes in many different possible architectural configurations favoring functional and performance aspects in order to meet specific business goals [56]. Therefore, it is essential to consider some technological aspects such as privacy, scalability, and interoperability to support blockchain to achieve its goal in improving transparency and accountability.

In order to provide valid identity in the land registration system, the possession of public and private keys are not sufficient. Verification of identity is indeed a paramount requirement for the system to work, imposing a digital ID requirement on all parties involved in the land registration process. A public permissioned blockchain is needed if registries want to ensure only parties who have validated their real identity to the satisfaction of the authorities that are responsible for the transactions. Therefore, a digital ID is required to do the transaction in the blockchain-based land registration system. In this way, we can ensure the legal status of the parties transacting a land parcel and authorized parties that involved in the transaction while still preserving the transparency since public permissioned blockchain allows anyone to read data in the ledger.

To be able to provide data transparency, the system must be able to disclose relevant data publicly. The data that should be public according to the law can be opened to the public and those which should be confidential will stay. However, data transparency often conflicts with privacy issues [12]. Therefore, data privacy issues and compliance with legal aspects such as, for example, the European GDPR (General Data Protection Regulation) must be considered. One main issue with the blockchain is that it is complicated to exercise people's 'right to be forgotten' since that would require modification or deletion of transactions that include personal data on the blockchain [18]. There may be conflicts between public registries and deleting personal information. In this case, "read/write" and "consensus management" rights can only be granted by a centralized organization, such as a land registry authority. Consequently, a public permissioned blockchain should be used where only authorized institutions or individuals have pre-defined roles to clear transactions per their legally-defined function [23].

The land registration system will also need to be integrated with existing systems and processes, primarily banks, real estate agents, and the tax authority. To allow this, standard protocols for interoperability between multiple blockchain-enabled systems need to be developed to support joint operation.

The social presence in the blockchain technology is supported by a consensus mechanism that attracts more participation from involved parties in decision-making processes. However, in order to be able to participate in such processes, access to a good ICT connectivity such as the internet should be available. Moreover, parties involved need to be able to use the land registration application which requires basic ICT skills. These two boundary conditions are challenging in developing countries [16, 30]. Appropriate approaches are needed to bridge the discrepancy of ICT connectivity and ICT skills in developing countries.

Furthermore, consensus mechanisms vary across different blockchain technologies. Every consensus mechanism brings advantages and disadvantages based on different characteristics such as speed of transactions, energy efficiency, scalability, censorship-resistance and tamper-proof [56]. We need to carefully decide which mechanism fits with our needs by considering the requirements of the land registration system or e-Government systems in general.

Meanwhile, from an institutional perspective, the coordination of the positions, relations, and behavior of the parties that are involved in the system need to be organized through institutional arrangements [35]. Some institutional aspects such as acceptability, data validity, digital signatures, and law and regulation support need to be taken into account when designing the system. These arrangements are necessary for the system to function.

Blockchain technology shifts the balance of control power from institutionalized organizations or institutions to technical systems [42]. There will be fewer checkpoints to guide and assist the flow of data/information. As a result, blockchain could lose the ability of an organization to monitor and control the activities of disparate actors through existing means. Moreover, blockchain technology has the potential to reduce and at least change the role of intermediaries [13] such as notaries in the land registration system. These reasons are the primary concern of organizations to be hesitant to accept blockchain technology due to the loss of control and business opportunities [10]. Organizations assume that their role will be ignored so they will not support the implementation of a technology that will result in them being left behind. In this sense, we should not bypass the role of intermediaries in the system. The intermediary role is still required to provide check and control mechanism in the system but may be different from before due to the built-in trust in the blockchain-based system. A well-functioning land registration system should still consist of check & control mechanisms [59] to prevent fraudulent activity in the transactions. As an example, someone can force others under threat to sell their land at prices far below the market price, then do the transaction using blockchain-based land registration systems. In this case, the notary can check the fairness of the transaction price and report to the respected authority about suspected fraudulent activity.

One of the merits of a blockchain is that it is very difficult to manipulate the data once stored [48], so it is essential to make sure that any input data is accurate before processing into the blockchain to prevent the issue of garbage in – garbage out [40]. Blockchain does nothing to improve the reliability of inputs. Therefore, a data validation mechanism should be established to guarantee the validity of data inputs.

Since blockchain runs in a digital environment, a digital signature to sign transactions or contracts is needed. Digital signatures provide a layer of validation and transmission for public key encryption databases in digital records [31]. In consequence, legal certainty of the digital signature must be supported. Moreover, the legal recognition of a digital signature or e-signature is a crucial aspect to be taken into account should a blockchain solution be envisaged.

Although the algorithm can be stored in the blockchain to keep its integrity [8], complex algorithms can be understood and assessed on its proper execution by only a few people which may reduce user trust. Hence, an illustration of the working, use, and impact of an algorithm which is easy to understand should be made available to the public.

Law and regulatory support are essential to ensure that a user has legal certainty as to the law to determine the rights and obligations of the parties to the agreement and which courts will handle any disputes [61]. However, blockchain-based applications still lack legal and regulatory support [43, 54]. Some of the legal and regulatory issues are: liability (as a result of the lack of intermediaries, regulators could be faced with some level of difficulties), responsibility (each participant should accept the fact that each participant takes their own risks since no authority exists to control or regulate the transactions), dispute resolution (there is no central actor, this requires a reconsideration of current mechanisms for solving disputes), enforcement (difficult to structure all transactional terms by total reliance on blockchain), and cross jurisdictional boundaries (as the nodes on a blockchain can be located anywhere in the world). Therefore, clear legal and regulatory support are required to provide for a legal status for the blockchain-based transactions.

From this case, it can be seen that some aspects related to institutional structure that coordinates the positions, relations, and behavior of stakeholders cannot be solved by blockchain technology alone. It requires institutional arrangements that regulate the coordination of the positions, relations, and behavior of stakeholders necessary to make the system function [35]. Hence, designing e-Government system is not only about a technological aspect, but it also requires institutional arrangements to achieve organizational goals and broader acceptance.

7 CONCLUSION

In this study, we demonstrated the mechanisms and ability of blockchain technology to support transparency and accountability improvement in an e-Government system. The land registration case illustrates how blockchain can contribute to enhance transparency and accountability. Furthermore, we assessed some socio-technical aspects that should be considered in developing transparent and accountable blockchain-based e-Government systems. e-Government systems based on the blockchain technology, implying decentralized architecture, immutability, and auditability, offer a potential solution in improving transparency and accountability in government processes if certain conditions are met.

However, from this study, we found that technology is not a panacea for solving the transparency and accountability problems. Blockchain technology only plays a small role in building transparent and accountable systems. There are considerable institutional aspects which cannot be resolved by the technology such as acceptability, check and control mechanism, data validity, digital signature, algorithm transparency, legal and regulation support, and dispute resolution that need to be introduced in addition to the technology. This suggests the importance of taking into account these aspects for developing blockchain-based e-Government systems to make the system function properly. Without this approach, it is likely the blockchain-based e-Government system will fail to achieve its expected benefits.

Governments should be aware of the typical risks, limitations, and implications of blockchain technologies, and pay particular attention to ensure that the new blockchain-based systems provide sufficient evidence to meet requirements related to those risks, limitations, and implications. Hence we suggest to use a risk-driven approach to develop blockchain-based systems that encourages to pay more attention to high-risk and novel systems such as blockchain technology.

The limitations of this study are linked to the generalizability of the findings and the completeness of the technology and institutional aspects that are important to be considered. The use of one case in this study made it hard to generalize the findings to broader application in e-Government systems. Therefore, more evaluation studies are suggested to study empirical cases from the same domain or a cross-evaluation study into blockchain-based applications in e-Government to assess the contribution of blockchain to transparency and accountability.

REFERENCES

[1] Bannister, F. and Connolly, R. 2011. The Trouble with Transparency: A Critical Review of Openness in e-Government. *Policy & Internet*. 3, 1 (Jan. 2011), 158–187. DOI:https://doi.org/10.2202/1944-2866.1076.

[2] Batubara, F.R. et al. 2018. Challenges of Blockchain Technology Adoption for e-Government : A Systematic Literature Review. *Proceedings of 19th Annual International Conference on Digital Government Research (dg.o'18)* (New York, 2018).

[3] Baxter, G. and Sommerville, I. 2011. Socio-technical systems: From design methods to systems engineering. *Interacting with Computers*. 23, 1 (Jan. 2011), 4–17. DOI:https://doi.org/10.1016/j.intcom.2010.07.003.

[4] Behn, R.D. 2004. Rethinking Accountability in Education: How Should Who Hold Whom Accountable for What? *Research in Public Policy Analysis and Management*. 19–53.

[5] Bertot, J.C. et al. 2010. Using ICTs to create a culture of transparency: E-government and social media as openness and anti-corruption tools for societies. *Government Information Quarterly*. 27, 3 (Jul. 2010), 264–271. DOI:https://doi.org/10.1016/J.GIQ.2010.03.001.

[6] BitFury 2016. *On Blockchain Auditability*.

[7] Den Boer, M.G.W. 1998. Steamy Windows: Transparency and Openness in Justice and Home Affairs. *Openness and Transparency In the European Union*. I.T. V. Deckmyn, ed. European Institute of Public Administration. 91–105.

[8] Buterin, V. 2014. Ethereum White Paper: A next-generation smart contract and decentralized application platform.

[9] Casino, F. et al. 2019. A systematic literature review of blockchain-based applications: Current status, classification and open issues. *Telematics and Informatics*. 36, (Mar. 2019), 55–81. DOI:https://doi.org/10.1016/J.TELE.2018.11.006.

[10] Condos, J. et al. 2016. *Blockchain Technology: Opprtunities ans Risks*.

[11] Cong, L.W. and He, Z. 2018. *Blockchain Disruption and Smart Contracts*.

[12] Conradie, P. and Choenni, S. 2014. On the barriers for local government releasing open data. *Government Information Quarterly*. 31, (Jun. 2014), S10–S17. DOI:https://doi.org/10.1016/J.GIQ.2014.01.003.

[13] Crosby, M. 2016. BlockChain Technology: Beyond Bitcoin. *Applied Innovation Review Issue*. 2 (2016).

[14] Cucciniello, M. et al. 2017. 25 Years of Transparency Research: Evidence and Future Directions. *Public Administration Review*. 77, 1 (Jan. 2017), 32–44. DOI:https://doi.org/10.1111/puar.12685.

[15] Deborah Hardoon and Finn Heinrich 2013. *Global Corruption Barometer 2013*.

[16] e-Government: 2015. *http://www.worldbank.org/en/topic/ict/brief/e-government*. Accessed: 2017-04-14.

[17] EY 2016.14th Global Fraud Survey: Corporate misconduct - individual consequences Global enforcement focuses the spotlight on executive integrity.

[18] Finck, M. 2017. Blockchains and Data Protection in the European Union. *SSRN Electronic Journal*. (Nov. 2017). DOI:https://doi.org/10.2139/ssrn.3080322.

[19] Fox, J. 2011. The Uncertain Relationship between Transparency and Accountability The uncertain transparency Jonathan Fox relationship between and accountability. *Development in Practice*. 17, 4/5 (Aug. 2011), 663–671.

[20] Gaventa, J. and Mcgee, R. 2013. The impact of transparency and accountability initiatives. *Development Policy Review*. 31, S1 (Jul. 2013), s3–s28. DOI:https://doi.org/10.1111/dpr.12017.

[21] Government of Indonesia 1960. *Basic Agrarian Law*.

[22] Government of Indonesia 1997. *Land Registration*.
[23] Graglia, J.M. and Mellon, C. 2018. Blockchain and Property in 2018: At the End of the Beginning. *Innovations: Technology, Governance, Globalization*. 12, 1–2 (Jul. 2018), 90–116. DOI:https://doi.org/10.1162/inov_a_00270.
[24] Grant, R. and Keohane, R.O. 2005. Accountability adn Absuses of Power in World Politics. *American Political Science Review*. 99, 1 (2005), 29–43.
[25] Halachmi, A. and Greiling, D. 2013. Transparency, E-Government, and Accountability. *Public Performance & Management Review*. 36, 4 (Jun. 2013), 572–584. DOI:https://doi.org/10.2753/PMR1530-9576360404.
[26] Herlihy, M. and Moir, M. 2016. Enhancing Accountability and Trust in Distributed Ledgers. *CoRR*. abs/1606.0, (Jun. 2016).
[27] Hileman, G. and Rauchs, M. 2017. 2017 Global Blockchain Benchmarking Study. *SSRN Electronic Journal*. (Sep. 2017). DOI:https://doi.org/10.2139/ssrn.3040224.
[28] Holzner, B. and Holzner, L. 2006. *Transparency in global change : the vanguard of the open society*. University of Pittsburgh Press.
[29] iGov Survey 2016. Transforming Public Sector Service Delivery: Challenges and Opportunities 2016.
[30] ITU 2017. *ICT Facts and Figures 2017*.
[31] Katz, J. 2010. *Digital Signatures*. Springer US.
[32] Kelm, K.M. et al. 2017. Enhancing public sector performance : Malaysia's experience with transforming land administration.
[33] Kim, P.S. et al. 2005. Toward participatory and transparent governance: Report on the Sixth Global Forum on Reinventing Government. *Public Administration Review*. 65, 6 (Nov. 2005), 646–654. DOI:https://doi.org/10.1111/j.1540-6210.2005.00494.x.
[34] Konrad-Adenauer-Stiftung 2011. Concepts and Principles of Democratic Governance and Accountability. Konrad-Adenauer-Stiftung.
[35] Koppenjan, J. and Groenewegen, J. 2005. Institutional design for complex technological systems. 5, 3 (2005). DOI:https://doi.org/10.1504/IJTPM.2005.008406.
[36] Kosack, S. and Fung, A. 2014. Does Transparency Improve Governance? *Annual Review of Political Science*. 17, 1 (May 2014), 65–87. DOI:https://doi.org/10.1146/annurev-polisci-032210-144356.
[37] von Leon, D. et al. 2019. A Lightweight Container Middleware for Edge Cloud Architectures. *Fog and edge computing : principles and paradigms*. R. Buyya and S.N. Srirama, eds. John Wiley & Son, Inc. 145–167.
[38] Mabillard, V. and Zumofen, R. 2017. The complex relationship between transparency and accountability: A synthesis and contribution to existing frameworks. *Public Policy and Administration*. 32, 2 (Apr. 2017), 110–129. DOI:https://doi.org/10.1177/0952076716653651.
[39] Makala, B. and Anand, A. 2018. Blockchain and Land Administration. *The Legal Aspects of Blockchain*. A. Audia et al., eds. UNOPS.
[40] Mans, R.S. et al. 2015. Data Quality Issues. Springer, Cham. 79–88.
[41] Maupin, J.A. 2017. Blockchains and the G20: Building an Inclusive, Transparent and Accountable Digital Economy. *SSRN Electronic Journal*. (Mar. 2017). DOI:https://doi.org/10.2139/ssrn.2935261.
[42] Meijer, D. and Ubacht, J. 2018. The governance of blockchain systems from an institutional perspective, a matter of trust or control? *Proceedings of the 19th Annual International Conference on Digital Government Research Governance in the Data Age - dgo '18* (New York, New York, USA, 2018), 1–9.
[43] Moura, T. and Gomes, A. 2017. Blockchain Voting and its effects on Election Transparency and Voter Confidence. *Proceedings of the 18th Annual International Conference on Digital Government Research - dg.o '17* (New York, New York, USA, 2017), 574–575.
[44] Nakamoto, S. 2008. Bitcoin: A Peer-to-Peer Electronic Cash System. *www.bitcoin.org*.
[45] Nomura Research Institut 2016. *Survey on Blockchain Technologies and Related Services FY2015 Report*.
[46] Ølnes, S. et al. 2017. Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. *Government Information Quarterly*. 34, 3 (Oct. 2017), 355–364. DOI:https://doi.org/10.1016/j.giq.2017.09.007.
[47] Peck, M.E. 2017. Blockchains: How They Work and Why They'll Change the World - IEEE Spectrum. *IEEE Spectrum*.
[48] Pilkington, M. 2015. Blockchain Technology: Principles and Applications. *Research Handbook on Digital Transformations*. F.X. Olleros and M. Zhegu, eds. Edward Elgar. 1–39.
[49] Pina, V. et al. 2007. Are ICTs improving transparency and accountability in the EU regional and local governments? An empirical study. *Public Administration*. 85, 2 (Jun. 2007), 449–472. DOI:https://doi.org/10.1111/j.1467-9299.2007.00654.x.
[50] Piotrowski, S.J. 2007. *Governmental transparency in the path of administrative reform*. State University of New York Press.
[51] Roberts, N.C. 2002. Keeping Public Officials Accountable through Dialogue: Resolving the Accountability Paradox. *Public Administration Review*. 62, 6 (Nov. 2002), 658–669. DOI:https://doi.org/10.1111/1540-6210.00248.
[52] Romzek, B.S. 2000. Dynamics of Public Sector Accountability in an Era of Reform. *International Review of Administrative Sciences*. 66, 1 (Mar. 2000), 21–44. DOI:https://doi.org/10.1177/0020852300661004.
[53] Smart Contracts: 1994. http://www.fon.hum.uva.nl/rob/Courses/InformationInSpeech/CDROM/Literature/LOTwinterschool2006/szabo.best.vwh.net/smart.contracts.html. Accessed: 2018-05-16.
[54] Sullivan, C. and Burger, E. 2017. E-residency and blockchain. *Computer Law and Security Review*. 33, 4 (Aug. 2017), 470–481. DOI:https://doi.org/10.1016/j.clsr.2017.03.016.
[55] Sumanjeet 2015. Institutions, Transparency, and Economic Growth. *Emerging Economy Studies*. 1, 2 (Nov. 2015), 188–210. DOI:https://doi.org/10.1177/2394901515599272.
[56] Tasca, P. et al. 2017. Ontology of Blockchain Technologies. Principles of Identification and Classification. *SSRN Electronic Journal*. (May 2017). DOI:https://doi.org/10.2139/ssrn.2977811.
[57] Upgrading blockchains: Smart contract use cases in industry | Deloitte Insights: 2016. *https://www2.deloitte.com/insights/us/en/focus/signals-for-strategists/using-blockchain-for-smart-contracts.html*. Accessed: 2018-09-03.
[58] Vance, A. et al. 2013. Using Accountability to Reduce Access Policy Violations in Information Systems. *Journal of Management Information Systems*. 29, 4 (Apr. 2013), 263–290. DOI:https://doi.org/10.2753/MIS0742-1222290410.
[59] Vos, J. 2016. Blockchain-based Land Registry: Panacea, Illusion or Something in Between?
[60] Williams, A. 2015. A global index of information transparency and accountability. *Journal of Comparative Economics*. 43, 3 (Aug. 2015), 804–824. DOI:https://doi.org/10.1016/j.jce.2014.10.004.
[61] Yeoh, P. 2017. Regulatory issues in blockchain technology. *Journal of Financial Regulation and Compliance*. 25, 2 (May 2017), 196–208. DOI:https://doi.org/10.1108/JFRC-08-2016-0068.
[62] Zheng, Z. et al. 2017. An Overview of Blockchain Technology: Architecture, Consensus, and Future Trends. *2017 IEEE International Congress on Big Data (BigData Congress)* (Jun. 2017), 557–564.
[63] Zhu, K. 2004. Information Transparency of Business-to-Business Electronic Markets: A Game-Theoretic Analysis. *Management Science*. 50, 5 (May 2004), 670–685. DOI:https://doi.org/10.1287/mnsc.1040.0226.