Transparency in Digital-Citizens Interfaces Through Blockchain Technology: BBBlockchain for Participation Processes in Urban Planning

Beatrice Ietto[1] , Kerstin Eisenhut[2] , Robert Muth[2] , Jochen Rabe[2] , Florian Tschorsch[2]
[1] Marche Polytechnic University, Ancona, Italy, b.ietto@univpm.it
[2] Einstein Center Digital Future, Berlin, Germany, kerstin.eisenhut@tu-berlin.de, muth@tu-berlin.de, rabe@tu-berlin.de, florian.tschorsch@tu-berlin.de

***Abstract* — Despite the new opportunities created by digital technologies, today's participation processes in urban planning face major problems mainly regarding transparency, trust, and accountability. Therefore, the aim of the paper is to investigate how the implementation of blockchain technologies can impact the transparency of urban planning processes. Specifically, the study adopts an empirical approach through a case study analysis of an App *BBBlockchain* for citizen participation in urban planning decisions based on blockchain technology. From a preliminary investigation on the use cases called timestamping and document management, both addressing the first layer of participation which is information, the study draws some important conclusions on the positive and negative effects that blockchain has on transparency of urban development processes and repercussions on stakeholders' engagement. In particular, the findings suggest that blockchain alone cannot support transparency as conceived in this study as, there are some transparency dimensions which are beyond blockchain's influence.**

Keywords* — *blockchain, blockchain-based systems, citizen participation, open government, transparency

I. Introduction

Citizen participation has recently become one of the most important topics in public government and it relates to citizen engagement in decision making and public affairs [1]. Digital technologies have allowed citizens to demand a new type of relationships with public administration, founded on greater transparency, and more participatory systems [2]. Despite the new participation opportunities created by digital technologies, a steadily growing stream of research on participation initiatives has been reporting citizens' low level of engagement caused by several factors including little trust on public institutions [3], [4]. In the context of urban development, governments have often been held responsible for limited transparency, little trust amongst different stakeholder groups, and reduced co-creation initiatives, which have led to the need of more transparency to improve their functioning, accountability and civic participation in the decision-making process [5]–[8]. When government procedures, policies and plans are made transparent, citizens can detect improper behaviors more easily and government officials can be held accountable for their actions [8].

Historically, transparency has been difficult to achieve because of indecisions of public officials, lack of clear mechanisms to establish transparency, and associated costs [9], [10]. Accordingly, urban planning decisions have suffered from an underlying mistrust and a negative image of corruption [11]. More recently, an increasing body of research has been arguing that blockchain, due to its unique and attractive features, can be adopted to improve government transparency and, accordingly, increase accountability, especially in lengthy, and often controversial, urban development processes, so citizens can better understand and monitor governments' decisions [12]–[14].

Nonetheless, although much hope is projected on blockchain as a new technology for more transparent urban planning decisions, so far, there have been very few attempts to examine how and in what ways blockchain can enhance transparency [15]. Most studies focus on potential benefits and uses [15], but it remains still unclear how blockchain can practically improve transparency in governmental processes and decisions.

Based on such premises, this study investigates how the implementation of blockchain technologies can impact on the transparency of urban planning processes.

The study adopts an empirical approach through a case study analysis of an DApp *BBBlockchain* for citizens participation in urban planning decisions based on blockchain technology [16]. BBBlockchain was developed in the 2nd half of 2019 with the purpose of improving citizens participation in urban development. Specifically, BBBlockchain provides an ongoing overview of the development process through the management and secured storage of various documents such as land-use plans, approval processes, contracts and general buildings information. As the study is currently on its second development and testing phase, the analysis will provide preliminary insights based on 4 experts interviews and a content analysis of the information published on BBBlockchain during a first pilot phase.

II. Theoretical Context of Reference

Transparency is nowadays considered as a key tool of good governance as supposed to produce increased trust and reduced corruption [17]. Transparency can be broadly defined as the availability of information about government organisation and their accessibility from citizens, so that they can monitor their functioning [6], [7], [17], [18]. In terms of e-government literature, transparency is recognized as a public value associated to. We therefore conceptualize transparency, as shown in Fig. 1, as follows:

- Information availability: information should be comprehensive, meaning that citizens should not only have access to the information on how the project unfolds but also on the actual decision-making processes, i.e., what decisions are made, how they are made, why, by whom and what are the outcomes of the decision. The interests of all the involved stakeholders should also be disclosed [19].
- Information accessibility: information are usually shared on e-platform which should be easy to use by all the involved actors. Specifically, information should be found easily and, most importantly, they should be presented in ways and language which are easy to understand by all the users, including non-experts [19].
- Information quality: Information quality refers to the accuracy, completeness, timeliness and reliability of information [19].

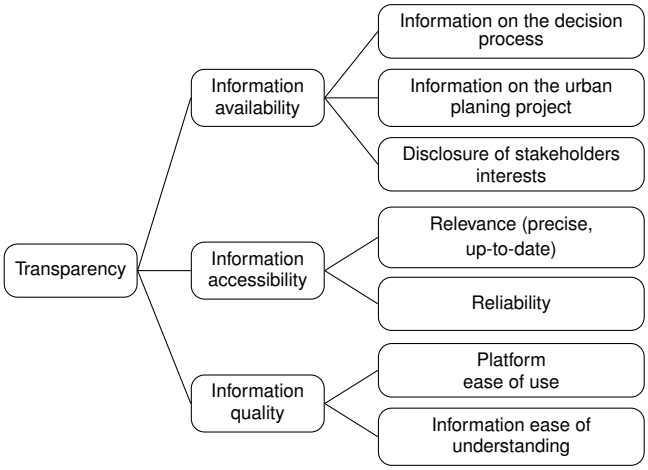

Figure 1. Theoretical conceptualization of transparency.

Table I. Interviewees information

Experts	Organisation	Position of Interviewee
E1	Developer of digital tools for spatial planning	Co-founder
E2	Funding program to develop open-source applications in the areas of Civic Tech	CEO
E3	No-profit organization developing innovative solutions for more democratic decision making	Founder
E4	Open-source software firm developing solutions for agile administration	Founder

A. Blockchain and Transparency

From a technical perspective, blockchain unique characteristics potentially yield new opportunities to make government more transparent, especially in those situations where governments' decisions are likely to be lengthier and more controversial [14], [20]. Drawing on the extant literature, it can be argued that blockchain builds transparency upon its three most important intrinsic characteristics of traceability, decentralization, and immutability.

In terms of traceability, blockchain build on a distributed ledger for data storage and a consensus algorithm for appending new data in form of transactions. As all transactions remain permanently visible to anyone, at any point of time, all data can be traced back [21], [22]. Blockchain traceability becomes, then, an important feature to enhance information availability. Furthermore, as such records cannot be altered, they become extremely relevant for tracking development processes when conflicts arise, thus, providing a transparent basis for conflict management [16].

In terms of blockchain immutability, all new transactions must be approved by the consensus algorithm to ensure data integrity; hence all participants can monitor and verify the information in the network. As all the data in the blockchain are *hashed* and linked to the hash of the previous block, even minimal changes in the data will result in major changes in the hash value. Therefore, as data are unlikely to be manipulated, blockchain can provide good data integrity which positively impacts on information quality by ensuring information reliability [21]–[23].

In terms of decentralization, blockchain keeps the historical record of all the completed transactions in a distributed ledger which is not controlled by a central authority [24]. Therefore, as a decentralized network, blockchain allows secure exchange of data in a decentralised manner, eliminating the need for trust among relevant parties [22].

In terms of information accessibility, blockchain is considered as a complex and hard-to-understand technology and only people with adequate technical knowledge might be able to understand all relevant details [25]. For example, [26] argues how existing blockchain-based systems have shown significant obstacles, limiting its widespread use, such as a lack of digital (blockchain) literacy and technical know-how among citizens, public officials and civil society.

III. Methodology

A. Research Design

As the investigation of how blockchain can practically improve transparency in urban planning decisions has not been sufficiently studied yet, the paper employed a case study approach as a qualitative methodology to perform an exploratory analysis. Case studies are particularly useful because they provide in-depth information to answer the ”how” and ”why” research questions and enable a holistic, comprehensive, and realistic understanding of the studied phenomenon [27]. In our context, the case study methodology was particularly suitable since, as the findings are deeply grounded in the empirical evidence collected from the case, it helped to better uncover stakeholders' practical experience with BBBlockchain as well as what issues they might face in relation to transparency (see [28]). The primary source of empirical data collected from the case consisted of semi-structured interviews with experts, considered as key indirect stakeholders of BBBlockchain. As this study is still into its preliminary phase, experts were chosen based on their role as a complementary source of information about the target group of direct stakeholders of BBBlockchain. In other words, experts were considered as guides who possess contextual, and more specialised knowledge, as they inform researchers with valid information which are unknown to them [29]. In particular, as blockchain is still an emerging technology, with a high degree of technical complexity, experts could provide an informed opinion on how blockchain can improve the transparency of e-participation platforms. Experts were selected based on their involvement on e-government start-ups, their knowledge on blockchain technologies and the provision of different viewpoints from different e-participation contexts which could benefit of blockchain technologies [30]. Table I summarizes experts' details.

The decision to rely on semi-structured interviews suited the exploratory approach of the study as they keep a structured approach but also enable some openness and the investigator must ensure sufficient space for the interviewees to disclose their experiences, opinions and knowledge [29]. The interview script was carefully designed considering the literature previously analysed. Specifically, based on the three central dimensions of the concept of transparency as emerged in the literature, a semi-structured interview guideline was developed to obtain explorative insights. Although keeping a common set of questions, the interviewees were able to elaborate and expand on their answers, allowing the researcher to ask additional probing questions [31]. Interviews lasted between 45-60 mins and participants were asked to test BBBlockchain before the interview so that their impressions could be recorded.

Interviews data were supplemented with data extracted from the official content published on the platform.

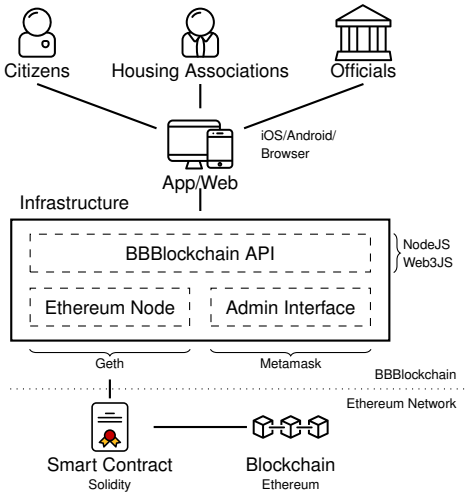

Figure 2. Current technical infrastructure of BBBlockchain, based on [16].

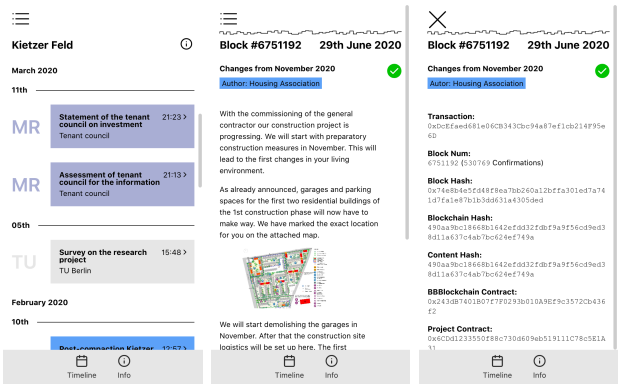

Figure 3. Screenshots of BBBlockchain interface.

Since transparency has been associated to information availability and quality, the analysis of the information already published on BBBlockchain helped us to gain a more in-depth understanding of the level of information comprehensiveness and accuracy achieved so far on the platform. Such variety of data sources is recommended for theory building, as it can provide greater reliability, less dependency on a particular context, and better generalizability of the findings [27].

B. Research Context: BBBlockchain

BBBlockchain was developed with the purpose of improving citizens participation in urban planning processes. The use cases analyzed in the paper are called timestamping and document management, both addressing the first layer of participation which is information [32]. Specifically, BBBlockchain provides an ongoing overview of the urban development process through the management and secured storage of various documents such as land-use plans, approval processes, contracts and general buildings

Table II. CONTENTS ON BBBLOCKCHAIN IN PILOT PHASE 1

	Direct Stakeholders		
Type of Content	**Housing Associations**	**Municipalities**	**Tenant Council**
Administr. info.	11 entries	1 entry	
Future planning	5 entries		
Accomplishments	9 entries		
Tenants FAQ	1 entry	1 entry	
General opinion	1 entry		2 entries
Tenants voting	2 entries		
Tenants survey	4 entries		

information. Technically speaking, BBBlockchain is a decentralized application which verifies the integrity of the blockchain-secured contents on the users' devices through a simple user interface, which conveys complex blockchain concepts on a visual level [16]. Fig. 2 shows the current technical infrastructure of BBBlockchain and underlying technologies.

The App interface, as shown in Fig. 3, revolves around a timeline and ensures that users are confronted with blockchain details as little as possible. Nonetheless, users can access blockchain details for each entry and utilize cryptographic hash values to verify data integrity. Accordingly, by incorporating verification in the user interface, can ensure information reliability. As urban planning processes are likely to change as they develop, such changes will need to be communicated as new information due to blockchain's immutability.

C. Data Collection and Analysis

During the introduction of BBBlockchain and after the first pilot phase, the following preliminary were collected:

- 4 semi-structured expert interviews.
- Published contents on BBBlockchain during pilot phase 1 (30 September 2019 – 28 July 2021): 31 entries from two official building projects KF (inform use case) and 6 entries from BU (consultation use case).

Following [33] grounded approach, the interviews[1] were eventually inductively coded from empirical to conceptual so that related concepts could be merged into more abstract themes following the subjective interpretation of the researcher.

D. Content Analysis of BBBlockchain

Interviews were complemented with a content analysis of BBBlockchain. The scope was to have an initial understanding on the amount and type of information that stakeholders published on the platform. From September 2019 - September 2021 a total of 37 entries were made by three main stakeholders: two housing associations (33 entries), the involved municipalities (2 entries) and the tenant council (2 entries). Table II summarizes the type of content of the entries, divided by categories. From a preliminary content analysis, it emerges that most of the entries (12) concerned administrative information like time and location of physical events, invitations, welcomes, etc.

Five entries discussed the future development steps of the project, including a timeline from the beginning till completion and maps of the construction plan. Nine entries were about decisions already made such as the appointment of a new contractor, trees cutting, permits, etc. As for information on the decision-making process, like, for example, how decisions were made and by whom, were absent. Finally, six entries involved citizens by asking their opinions or votes for the potential establishment of facilities such as a roof garden or a laundry room. Nonetheless, it was not made clear how their contribution would have been used.

IV. PRELIMINARY FINDINGS

Overall, the findings revealed that BC was recognized by experts as a key asset for transparency and, although the interviewees associated transparency with all the previously identified dimensions, they believed that BC did not have an equal impact on all of them. Broadly speaking, experts seemed positive on BC impact on transparency but, because of the significance of energy and development costs, they emphasized that, before the value of BC can be confirmed, the real beneficial effect of BC must be properly assessed and evaluated on each individual context of application.

In particular, the coding process and content analysis led to the identification of three main themes which represent the key findings of the preliminary analysis and are discussed here below.

A. Blockchain for Information Availability

Experts agreed that BC, because of the provision of an open and immutable record of all the decisions ever made, can have a positive impact on information availability. Interestingly, though, they did not associate such impact to information comprehensiveness, in terms of types and depth, but to the availability of the entire historical record of the information published on BBBlockchain since its conception:

"*If all the decisions are stored and they are also verified, plus the blockchain has a small circle of stakeholders, bindingness can be established, and decisions can be tracked in retrospect as you can look up exactly what the actual decision was.*" (E3)

In this case BC was considered particularly relevant to increase government accountability during potential conflict management.

In practice, though, such increase in accountability might result to produce undesirable effects on the very

[1] All the collected data was entered into NVivo12 software for manual coding and analysed through a thematic content analysis.

same information availability which is supposed to enhance. Because BC makes published information traceable and immutable, experts believed that key stakeholders might be reluctant to publish enough information as they could be held accountable for it.

Therefore, in relation to information availability, on one hand BC might improve transparency but, on the other, it can reduce information comprehensiveness, as stakeholders might abstain to publish more information for fear of increased accountability. This was also partially confirmed by the low level of engagement on BBBlockchain from government and housing associations which, during pilot phase 1, did post a total of 35 entries out of which only 14 regarded the actual development plan.

Interestingly, the findings seemed to suggest that BC, in fact, has a neutral impact on information comprehensiveness as it entirely relies upon the willingness and commitment of the involved actors. Nonetheless, in some circumstances it might even hinder stakeholders to participate and, accordingly, have a negative impact on transparency. In terms of information availability experts also emphasized the importance of including information on the actual decision-making process such as what decisions need to be made, why they are made and who makes them. Ideally, the interests of all the involved parties should also be disclosed:

"*Transparency to me means communicating content but also processes in an understandable way.*" (E4)

Experts believed that the more comprehensive are the information provided, the more citizens would feel motivate in participating as they would have a better understanding on how their contribution might impact on the project:

"*If I have received the context information then I would be able to find my way around completely. What is still unclear to me at the moment is where is it going? What is the timeline in the future? What is the resolution or what is at the end of the process? If I am not given the information, then I cannot make a qualified decision. That's why it's always a prerequisite for participation processes that I have access to information.*" (E4)

E4 suggests that providing citizens with context, can assist them in making more informed decisions and, accordingly, make their contribution more meaningful. In fact, when citizens do not understand how their contribution will be used, or they perceive that it has not been valuable, they might feel a sense of frustration and lose motivation to participate, especially if they were also required to put effort by informing themselves beforehand.

"*I don't want to be permanently in the situation where I have to say and have the feeling that nothing comes out.*" (E2)

Therefore, in this instance, transparency in terms of information availability is important to improve citizens engagement but BC does not have any influence on this aspect.

B. Blockchain for Information Accessibility and Quality

In terms of information accessibility, the findings emphasized the importance of making the information openly accessible and easy to understand by all the users, including non-experts.

In this case, BC can have a positive impact on accessibility as its permissionless and open-source features allow anyone to access information. Nonetheless, BC complexity might constitute a barrier to accessibility for non-expert users as they might not understand or value its added benefits. In fact, E1 argued that the lack of understanding of both the content and the platform use, might generate distrust:

"*The complexities of the planning processes need to be presented in a simpler way as I think distrust does not come from not trusting others but more from the fear of not understanding the information.*" (E1)

The fact that BC could have a negative impact on information accessibility was also confirmed by the low level of citizens participation during pilot phase 1 and by the documentation of the 1st tenant information event on the construction project which states that "*most of the tenants' contributions to these stands were questions of understanding and questions about the details of the construction project*".

Nonetheless BBBlockchain interface design keeps BC hidden through an API so that users are confronted with technical detail as little as possible.

In relation to information quality, one of the merits of BC is that it can improve information reliability by ensuring information integrity but, interestingly, it is essential that any input data is accurate before processing into the BC. BC cannot, in fact, assess the quality of the data which are inserted by stakeholders in terms of how relevant and exhaustive they might be [34]. Interestingly, BC systems are particularly exposed to the problem garbage in –garbage out (similar to [35]) since, if the inserted data are of poor quality, their assessment cannot be automated and BC immutability is going to extend their longevity. In fact, as previously discussed, BC not only cannot assist for the reliability of the data but, because of its immutability, it might even constitute a hindering factor for stakeholders as they could be held accountable for wrong entries.

C. Establishing an Adequate Level of Transparency

This theme discusses experts' opinions on how the conflict between information availability and stakeholders' accountability, caused by the implementation of BC, could be overcome.

Stakeholders' hesitation to publish information on BBBlockchain was seen by experts as a need to protect more

sensitive and confidential information. In fact, experts supported the idea that an optimal level of transparency could also be achieved without reaching maximum levels of disclosure:

"*I don't think that 100% transparency is important or even right in every step and that a certain level of secrecy in some points is not wrong and is also important to protect the stakeholders*" (E2)

Experts suggested that if all the actors involved would decide and agree upon on what information to publish on BBBlockchain, this problem might be overcome:

"*Communication of the limits of transparency is important; what do I publish and what not.*" (E3)

According to the E3, an optimal level of transparency can indeed be achieved without reaching maximum levels of disclosure but by establishing an "adequate level of transparency", which takes into account the need of government confidentiality, public officials fear of over-exposure and citizens need of open access. The point was also confirmed by the other experts which stressed the importance of keeping private information on costs, calculations, and tender documents. For example, copyrighted material, personal data, licensed material, communication logs and recordings, should not be included for legal reasons or without the permission of the involved parties.

V. Discussion

Based on the above preliminary analysis it can be concluded that BC has some important positive and negative effects, on the levels of transparency of urban development processes and repercussions on stakeholders' engagement. Nonetheless, BC alone cannot support transparency as conceived in this study as, there are some transparency dimensions which are beyond BC influence.

First, this study has associated transparency with information availability, relevant to increase stakeholders' accountability and manage potential conflicts. Information availability, in terms of comprehensiveness, can be achieved through the content published on BBBlockchain, so it's beyond the influence of BC underlying infrastructure and it relies on stakeholders' commitment to make information available to citizens. Nonetheless, information availability also depends on BC characteristics of traceability and immutability as they enable the access to historical records. As previously discussed, this might cause an institutional resistance which can hinder the adoption of BBBlockchain by those stakeholders whose accountability increases. The analysis suggested that such resistance cannot be managed through BC infrastructure but, instead, it can be solved at an informational level by establishing in advance an "adequate level of transparency", meant as information comprehensiveness, to which stakeholders should agree upon in advance. For example, "rules of games" could be established for a clear communication on what information should be shared, how often and by whom. Nonetheless, as the publication of information on the platform usually goes beyond both stakeholders' usual communication protocol and their legal compliance, it remains the issue of how such agreed levels of transparency will be respected by the relevant parties. Besides, the limited availability of information on BBBlockchain, especially on the decision-making processes and on how citizens contribution would have been used for the project development, further confirm such point.

Information accessibility can be fostered with a public BC design and with information understandability. Besides, the findings have shown that BC technological complexity might constitute a hindering factor for non-expert users which, however, could be addressed with an interface design which hides BC content through an API. Therefore, although BC can have a beneficial impact on transparency, it can also have a counter-intuitive impact of deterring key stakeholders to publish information. In this last instance, BC can result in higher degrees of interferences in the development process as preserving a given level of transparency requires a substantial commitment which might not be sustainable in the long term, especially if the affected stakeholders are not legally bound to its compliance.

To sum up, it can be argued that BC infrastructure alone might not be sufficient to achieve the desirable levels of transparency as information quality and comprehensiveness are also important, but they cannot be proved by the BC itself and need to be addressed at an informational level. While these results are to be further researched in the next phase of the pilot, the advantages of the underlying blockchain integration would primarily become visible when conflicts arise between the involved stakeholders. In this case, past statements could be traced back through the blockchain integration, thus, providing a transparent basis for conflict management. Obviously, this only applies to conflicting parties committed to reason and cannot avoid discussions deliberately deploying misinformation beyond the BBBlockchain. So far, the current first stages of the urban development project did not face significant cases of mistrust.

To conclude, it is important to emphasize the importance of adopting a more socio-technical implementation of blockchain solutions for citizens participation which takes into consideration the often-contrasting perspectives of all the involved stakeholders, their technological expertise, required effort and best interests. Although the analysis is at a very early stage, it clearly emerges that transparency can be addressed at both an infrastructural and informational level. In fact, a pure technocentric BC implementation which fails to consider the above issues, might lead to unsuccessful results.

VI. Relevance for Practice

Both scholars and practitioners need more guidance on how BC-based platforms should be designed and how the design should incorporate values that will motivate users to engage with the platform and make a responsible use of it.

For example, approaches to overcome some stakeholders institutional resistance should be identified. The establishment of a priori levels of transparency and their acknowledgment by all the involved parties might minimize such potential drawback. In case of low levels of engagement, the increase of the levels of transparency through the improvement of information accessibility and availability should motivate stakeholders to engage more. In this case a clear communication protocol should also be decided in advance. Nonetheless, as ultimately stakeholders' compliance to a priori protocols is entirely discretionary, strategies, like tokens implementation, to make them commit to what decided, might need to be identified.

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