EGOV-CeDEM-ePart

The Use of Blockchain Technology in Digital Coproduction: The Case of Barcelona

Evrim Tan*, A. Paula Rodriguez Müller**

*Katholieke Leuven Universiteit, Public Governance Institute, Evrim.tan@kuleuven.be
**Katholieke Leuven Universiteit, Public Governance Institute, anapaula.rodriguezmuller@kuleuven.be

Abstract: By creating an autonomous, transparent, and secure decentralized system, blockchain technology enables the removal of intermediaries as trustees to be replaced by a peer-to-peer based governance system. This feature upholds important implications to redesign the public governance systems and co-production practices in a more transparent, efficient and effective way. As a first use case example of the blockchain technology in a digital co-production process, the city of Barcelona has initiated the Digital Democracy Data Commons (DDDC) project to integrate into the city's participatory democracy platform 'Decidim.Barcelona'. The DDDC pilot uses the blockchain and distributed ledger technology to share a petition with participants, sign it with a mobile app and count the signatures in a cryptographically secure and completely anonymous way. Through an in-depth case study, this paper analyzes how blockchain technology can shape the coproduction processes and what possible roles can be assumed by citizens for the use of these technologies in digital coproduction. In this paper, we created a novel analytical framework to categorize possible roles imposed on coproducers in blockchain technology-based systems. Our preliminary findings suggest that the compatibility with the legal framework, the interoperability with existing institutions in data governance, and previous experiences and established communities for deliberative and participatory processes are important on the design choices and determining citizens' roles in the blockchain technology-based digital coproduction processes.

Keywords: Blockchain, Digital Coproduction, Distributed Ledger Technology

1. Introduction

Disruptive technologies are increasingly influencing the way coproduction provides value to society and how coproduction processes are implemented. Governments around the globe are conceiving of new ways to engage citizens in coproduction and collaborative efforts via disruptive technologies, such as blockchain and distributed ledger technology (DLT). These efforts lie on the promises of such technologies to increase trust in and security of transactions and reduce transactions cost (Foth, 2017; ITU, 2017). However, the existing literature is limited in empirical cases to show how blockchain and DLT can shape the coproduction processes and what possible roles can be assumed by citizens for the use of these technologies in digital coproduction.

This paper aims to address this gap by focusing on the following research question: How can blockchain and DLT shape citizen coproduction processes? A pilot of the Digital Democracy Data Commons (DDDC) project in Barcelona, which applies DLT to engage stakeholders in a participatory process will be studied in order to answer this research question. Through this case study, the paper will outline a theoretical model to study the applications of blockchain and DLT in digital coproduction processes. The remainder of the paper is structured as followed. Section 2 discusses the background of digital coproduction and the way blockchain and DLT can shape digital coproduction processes. Section 3 presents the analytical framework, while Section 4 describes the case and methodology. Section 5 outlines key findings. Finally, Section 6 concludes the paper.

2. Background

2.1. Digital Coproduction

The conception of coproduction fits in the New Public Governance paradigm that recognizes the provision of public services as a model based on networks and inter-organizational relationships (Bovaird & Loeffler, 2012). In this article, we draw on the concept of coproduction by Brandsen and Honingh (2016, p. 431):

> *Coproduction is a relationship between a paid employee of an organization and (groups of) individual citizens that requires a direct and active contribution from these citizens to the work of the organization.*

Citizens can engage in the coproduction of public services in different stages of the delivery process, including the public service design, public service delivery and execution, and public service monitoring. Each stage, therefore, entails different roles both from the public service provider and the citizen (Linders, 2012).

The ability to perform coproduction activities is seen to be increased by the implementation of technological advances in the public sector (Fugini & Teimourikia, 2016; Johnston, 2010; Lember, 2017; Meijer, 2016; William, Webster, & Leleux, 2018). In that regard, digital coproduction often corresponds to the adoption of information and communication technologies (ICT) in coproduction processes. The adoption of ICT can affect coproduction by providing real-time access and exchange of information. ICT can also transform coproduction by scaling up the collection of citizens' data (e.g. FixMyStret's solutions or gamification strategies). Digital technologies can even substitute coproduction processes with fully (or partly) automated processes (e.g. predictive policing). In this vein, different technologies are strongly shaping coproduction processes and our understanding of coproduction.

2.2. How Can Blockchain Shape Digital Coproduction?

Blockchain and DLT are a class of technologies, henceforth blockchain technologies (BCT), that create a transparent, autonomous and decentralized data governance system that gives users confidence that archived information has not been tampered with (Beck & Müller-Bloch, 2018) without the need of trustees to verify the genuineness of stored data.

We expect this feature of the BCT to have important implications for the coproduction processes in public sector, because it allows the service users and stakeholders to directly shape their service provision without a need of intermediary or administrator to validate or channel their input. BCT can also increase the transparency, auditability and accountability of the information provided in the coproduction processes and thereby builds trust in the coproduction processes. For instance, BCT provides new ways of coproduction by allowing cities to create 'voluntary data repositories' of citizens' personal data in order to co-produce new services. Moreover, BCT, as a communication technology, can enable peer-to-peer public service delivery (Lember, et al. 2019) and a new generation of democratic processes (Saldivar, et al. 2019).

However, there are some caveats and different technological features of BCT can have different implications to the coproduction processes. First, choices of the system designers on the design of the digital platform can affect the role of the coproducers and the scope of the coproduction activities. BCT-based platforms can have permissionless/permissioned and public/private forms (Miller, 2019). The choice between permissioned and permissionless systems calls for considerations of several trade-offs and decisions to be made by policymakers and system designers. These trade-off conditions are context-dependent and factors concerning organizational and technological capacities, provider of technology services, area of application, interoperability with other data platforms, and political preferences might determine the choice of decision-makers. Secondly, the underlying consensus protocol and the associated incentive mechanism can alter the role of the actors involved in the coproduction processes. Incentives are important to attract the validators that contribute to the system with their time and resources (e.g. computing power and/or money). The most common form of incentive mechanism is distributing tokens to the validators, which can hold either a monetary value (e.g. Bitcoin) or another form of value for the beneficiary. However, using tokens to motivate users to participate in coproduction processes may undermine the effectiveness of coproduction processes or have negative repercussions (e.g. adverse environmental impact in Proof of Work (PoW)- based systems).

Thirdly, BCT is not a monolithic technology and auxiliary technologies (e.g. tokens, zero-knowledge protocols, smart contracts, etc.) integrated in the blockchain platform can alter the way coproduction takes place. For example, through tokens and smart contracts, coproducers can enable various voting features for coproduction processes and automatically execute ex-ante agreed rules of transactions for service provision. At the same time, with zero-knowledge protocols, co-producers can preserve their anonymity without undermining the validity of transactions in the blockchain network. Depending on the applications (or decentralized applications), the scope and the underlying features of coproduction in a blockchain platform may vary.

Fourth, the way decisions are implemented in the blockchain platform can impact the legitimacy of coproduction. In blockchain governance, there are on-chain and off-chain decision-making mechanisms. On-chain system brings the trade-off between efficient decision-making and transition processes and risking destabilization due to the political dissonance. Off-chain system brings the trade-off between enhancing the political consensus in the decision-making and transition processes and risking the ‘tragedy of commons’ where the maximization of private interests of the miners can undermine the stability of the system (Finck, 2018).

The fifth caveat is related to the definition of the digital coproduction and concerns about to what extent different acts of engagement using BCT can be classified as coproduction or co-creation. Veiko et al. (2019) differentiate on the scope of activities associated with coproduction and cocreation based on the level of engagement where activities concerning the service production correspond to coproduction and the services at a strategic level correspond to cocreation. Moreover, they focus on whether citizens provide direct and active input. Here direct refers to whether the input provided by the citizens affects the services individually provided to them, and active refers to whether citizens take part in the design or delivery of services. Yet, this definition has certain shortcomings when applied to the user roles in a BCT-based system. The functionality of the BCT-based systems rests upon the active engagement of the users in validation of the transactions. Even if the input of the validators (be it random or selected nodes) can be rendered as active and direct according to the aforementioned definition, their involvement is arbitrary and indiscriminate to the service provided by the platform. In a way, they are passive service producers without holding an agency about the scope of the services. Therefore, it is important to identify the different roles of the participants engaging in BCT-based coproduction processes and whether they hold an agency in the services provided by the system.

3. Analytical Framework

The literature of digital coproduction is still at its infancy, and only a few analytical frameworks are focusing on how various factors affect the citizen's role in digital coproduction processes. One framework developed by Veiko et al. (2019) provides some coarse assumptions about the impact of four categories of technology (i.e.sensing, communication, processing, and actuation) on motivation, interaction, resources and decision-making processes and the co-producer's role and involvement in coproduction. However, this coarse categorization has its shortcomings when it comes to the roles of the BCT in coproduction processes. As mentioned earlier, BCT is not a monolith technology, and varying applications and different underlying protocols of blockchain platforms may change the implication of the technology concerning decision-making, motivation and participants' roles in coproduction processes. Furthermore, it is difficult to position BCT only under one category of digital technologies. BCT can be categorized as a processing technology- as rendered by the authors- but BCT can be also treated as a communication technology as it 'mobilizes inputs from citizens on a far larger scale' (Veiko et al, 2019). BCT allows users to control and verify the personal data and thereby it allows an on-chain and off-chain engagement at a larger scale.

A second type of analytical model available in the literature focuses on the use and ownership of data in the coproduction processes (Toots et al, 2017; McBride et al, 2018). For instance, Toots et al. (2017) focus on barriers and drivers in the use of open data in digital co-production processes by categorizing the institutional characteristics of the coproduction processes concerning the technology, organizational structure, perception, attitudes and culture of stakeholders, and regulative framework. This framework is useful to analyze the facilitating and debilitating institutional factors in the use of open data in coproduction. However, in BCT-based systems, data is not the only currency for citizens' engagement in digital coproduction processes. Users contribute to the functioning of the system through their computing power and energy consumption, and

thereby the functionality and stability of the system rely on the continuous engagement of the participants with the mining processes. This technical feature of BCT expands the impact of the institutional framework on digital coproduction processes beyond the use of open data to a more complex techno-social interaction. For instance, PoW-based systems are highly energy-consuming processes[1]. Compatibility of the technology with regulations about CO2 emissions, rights to forgotten or GDPR, and the cost of energy consumption for nodes are some additional institutional factors that may affect the scope and the applications of BCT in coproduction processes. Therefore, we infer that a functional analytical framework for the user roles in BCT-based coproduction processes should align the user roles imposed by the technological features of BCT with the institutional dimensions shaping the application of BCT in co-production processes.

As a first step, we developed an analytical model to assess the user roles in BCT-based co-production (see Figure 1). In the construction of the model, we paid attention to matching three dimensions with each other: (1) possible user roles identified by the BCT-based systems; (2) possible citizen and state roles identified by the digital co-production/co-creation systems; and (3) a versatile and evolutionary view on the role of BCT. Accordingly, we identified three stages in the use of BCT in co-production processes.

Citizen-controlled information management: BCT is used to process personal data of citizens. In this simplest form of BCT-based coproduction, a coproducer can have the role of data provider, verifier and data user (Erhan et al., 2019). Coproducers can control and trace the personal data used in the coproduction processes, verify the transaction as a node either in a permissioned or permissionless system, and use the data for the creation of the public policies. In this mode of digital coproduction, choices of public service organizations about the permission criteria to data infrastructure or ownership of data infrastructure can affect the role of citizens or their representative organizations in the coproduction processes. Nevertheless, citizens preserve the ultimate control of personal data shared for coproduction processes. Therefore, we call this type of coproduction as citizen-controlled information management.

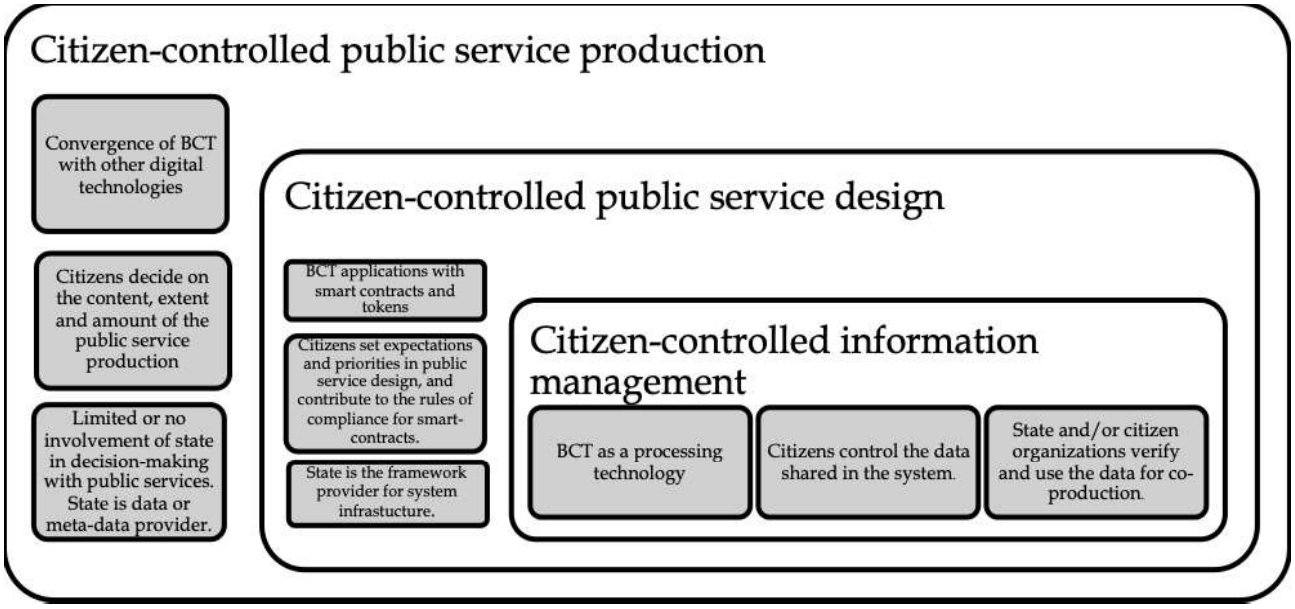
Citizen-controlled public service design: In this mode, applications with smart contracts and digital tokens are used to allow automated, self-enforced service decisions. In digital coproduction, citizens through the use of the tokens can vote on the priority areas and criteria in public service provision and automate the implementation through the use of smart contracts.

Citizen-controlled public service production: In the most advanced form of BCT-based co-production, we expect the convergence of BCT with other digital technologies such as artificial intelligence (AI), internet of things (IoT), or actuation technologies. In this mode, citizens can decide on the content, extent and amount of the public service production. Depending on the combination of technologies, citizens can provide tailor-made services for the specific needs of the communities or groups of people. We expect in this stage, state to have limited or no involvement in public service provision

[1] According to the Digieconomist, PoW-based Bitcoin mining consumes above 70.000 terawatt-hours per year, comparable to the annual carbon footprint of Denmark and energy consumption of Austria. (https://digiconomist.net/bitcoin-energy-consumption)

and instead to provide data or meta-data available in state-sources to contribute to the citizen-controlled production processes.

Figure 7: Modes of BCT-based Coproduction



This framework will help us to categorize the roles imposed on the citizens in a BCT-based system. We will expand our analysis later with the barriers and drivers identified by Toots et al (2017) to understand the impact of institutional conditions on the use of open data on the BCT-based co-production processes. The findings from the case study will allow us to refine and further develop the proposed analytical framework.

4. Methodology

This study is designed as a single exploratory case study to examine how blockchain technologies can shape citizen coproduction processes. A single exploratory case study is a useful design to gain insights about a phenomenon that are thus far understudied or not understood, and to construct new theory or generate propositions about the phenomenon (Yin, 1989). In this study, we will examine the digital government platform of the City of Barcelona 'Decidim', and the unit analysis is the whole process of co-production created by the use of the 'Digital Democracy Data Common (DDDC)'. DDDC is a pilot for a digital participation platform based on DLT that is created as part of the EU funded DECODE project. DDDC uses BCT to share a petition with participants, sign it with a mobile app and count the signatures in a cryptographically secure and completely anonymous way.

We will collect our empirical data from secondary sources and expert interviews. We will gather data from multiple sources of evidence (semi-structured interviews, technical reports and policy reports, government documents) to triangulate conclusions and ensure higher levels of internal validity. Furthermore, triangulation also helps to mitigate against subjectivity in the research and thus strengthens the overall research design.

5. Preliminary Findings

Some preliminary key findings are shared below:

1) The case in Barcelona falls into the category of citizen-controlled public service design. The pilot allows the control of the personal data by the people and creating an immutable and transparent system. Each citizen of Barcelona receives a token for the use of services and functionalities provided by the platform. Through tokens, citizens can vote on the proposals for the municipality agenda on public services. The system operates through smart contracts.
2) Two possible pathways are being discussed on the governance of the DDDC. One option is building a community around the application and creating a self-governance system around the community. The second option is creating an institution for the governance. Whilst the former option refers to a more decentralized system design, where the citizens control the data structure, the second option leads to a more centralized system.
3) Several factors had been influential on the design choices with the platform and integration of the pilot in DECIDIM, the city's e-government platform:
   a) *Need for legal framework*: No personal data in the ledger is being transferred, which gives direct control to citizens, but for further applications with BCT there is a need for a DLT legal framework.
   b) *Interoperability*: Interoperability of the technology with other administrative institutions (e.g. Barcelona Data Office) is important. Further testing of the platform will focus on this dimension.
   c) *Political leverage*: Person in charge should have some political leverage. For this project, Francesca Bria's role in the city council was very critical for its success.
   d) *Building the platform around a communi*ty: Building the technology around an existing community is important for an easier transformation.
   e) *Path dependency*: Previous practices with participative democracy (e.g. 50 men movement) and digital governance (i.e. Decidim) had been influential in the prioritization of citizen-empowering (or more decentralized) systems designs. Furthermore, the emerging business culture in Barcelona in adopting smart city technologies since 2015, allowed the city to cooperate with big corporations on the development of the technology.
4) There are some challenges ahead to scale up the project:
   a) *Technology itself does not create trust*: If people do not understand the technology, it is difficult to create trust only by the technical features of blockchain. Trusted parties/stakeholders can assist in building trust about the technology.
   b) *Compatibility with existing legal/regulative framework:* There are challenges with the current legal framework especially concerning the right to be forgotten and the immutability and transparency of the DLT system. It is possible that some challenges can be solved technically (e.g. zero-knowledge protocol) but some decisions may need to be centralized. Therefore, there may be a need for more complex governance systems (partially centralized, partially through DLT or other decentralized systems). The environmental impact of the PoW technology and its compatibility with the CO2 framework are other concerns and reflect on the decisions with (de)centralization of the platform.

6. Concluding Remarks

DDDC pilot is a unique use case to understand the implications of the BCT in coproduction processes. The case shows that BCT can create a pathway for citizen-controlled coproduction processes where citizens control their own data used in service production, and collectively decide on the policy priorities. However, there are various institutional, technological, social and organizational factors that can affect the design choices of the decision-makers, and thereby the application of BCT in the coproduction processes. In the case of Barcelona, the compatibility with the legal framework, the interoperability with existing institutions in data governance, and previous experiences and established communities for deliberative and participatory processes had been important on the design choices and determining citizens' roles in the governance of the system. Further research is recommended to understand further the underlying factors affecting the choices of decision-makers toward more decentralized systems in BCT-based coproduction.

References

Beck, R., Müller-Bloch, C. & King, J. L. (2018). Governance in the Blockchain Economy: A Framework and Research Agenda. Journal of the Association for Information, 19 (10), Art.1.

Bovaird, T. and Loeffler, E. (2012) 'From Engagement to Co-production: The Contribution of Users and Communities to Outcomes and Public Value', Voluntas, 23(4), pp. 1119–1138.

Bovaird, T., & Loeffler, E. (2012). From Engagement to Co-production: The Contribution of Users and Communities to Outcomes and Public Value. Voluntas, 23(4), 1119–1138.

Brandsen, T. and Honingh, M. (2016) 'Distinguishing Different Types of Coproduction: A Conceptual Analysis Based on the Classical Definitions', Public Administration Review, 76(3), pp. 427–435. doi: 10.1111/puar.12465.Distinguishing.

Brandsen, T., & Honingh, M. (2016). Distinguishing Different Types of Coproduction: A Conceptual Analysis Based on the Classical Definitions. Public Administration Review, 76(3), 427–435. https://doi.org/10.1111/puar.12465.Distinguishing

Chadwick, A. (2006). Internet Politics: States, Citizens, and New Communication Technologies. Oxford: Oxford University Press. (Style ArticleReferences)

Coleman, S. (2000). Parliament in the Information Age: The Case of Westminister and Holyrood. In R. Gibson & S. Ward (Eds.), Reinvigorating democracy? British Politics and the Internet (pp. 67-80). Farnham, Surrey: Ashgate Pub Ltd.

Erhan, M., Tarhan, A., & Ozsoy, A. (2019). A Conceptual Model for Blockchain-Based Software Project Information Sharing. IWSM-Mensura.

Finck, M. (2018). Blockchain Regulation and Governance in Europe. Cambridge University Press.

Foth, M. (2017). Participation, Co-Creation, and Public Space. The Journal of Public Space, 2(4), 21. https://doi.org/10.5204/jps.v2i4.139

Fugini, M., & Teimourikia, M. (2016). The Role of ICT in Co-Production of e-Government Public Services. In M. Fugini, E. Bracci, & M. Sicilia (Eds.), Co-production in the Public Sector (pp. 119–139). Springer, Cham.

Heeks, R. (2006). Implementing and Managing eGovernment. London: Sage Publications.

ITU. (2017). Measuring the Information Society Report 2017 - Volume 1. In International Telecommunication Union (Vol. 1). https://doi.org/10.3359/oz0303157

Johnston, E. (2010). Governance infrastructures in 2020. Public Administration Review, 70(SUPPL. 1), 122–128. https://doi.org/10.1111/j.1540-6210.2009.02116.x

Lember, V., Brandsen, T., & Tõnurist, P. (2019). The potential impacts of digital technologies on co-production and co-creation. Public Management Review, 21 (11), 1665-1686.

Lember, V. (2017). The Increasing Role of Digital Technologies in Co-production. In T. Brandsen, T. Steen, & B. Verschuere (Eds.), Co-Production and Co-Creation: Engaging Citizens in Public Services. London: Routledge.

Linders, D. (2012). From e-government to we-government: Defining a typology for citizen coproduction in the age of social media. Government Information Quarterly, 29(4), 446–454. https://doi.org/10.1016/j.giq.2012.06.003

Macintosh, A., & Whyte, A. (2006). Evaluating how eParitiicipation changes local democracy, eGovernment Workshop 11 September 2006, Brunel University, West London.

McBride, K., et al. (2018). How does open government data driven co-creation occur? Six factors and a 'perfect storm'; insights from Chicago's food inspection forecasting model. Government Information Quarterly, https://doi.org/10.1016/j.giq.2018.11.006.

Meijer, A. J. (2016). Coproduction as a structural transformation of the public sector. International Journal of Public Sector Management, 29(6), 596–611.

Miller, A. (2020). Permissioned and Permissionless Blockchains. In S. Shetty, C. Kamhoua and L. Njilla (Eds.) Blockchain for Distributed Systems Security (pp.193-204). Wiley.

Mingers, J. (1996). A Comparison of Maturana's Autopoietic Social Theory and Giddens' Theory of Structuration. Systems Research, 13(4), 469-482.

Saldivar, J. et al. (2019) 'Civic Technology for Social Innovation A Systematic Literature Review', Computer Supported Cooperative Work. CSCW, 28, pp. 169–207. doi: 10.1007/s10606-018-9311-7.

Toots, M., McBride, K., Kalvet, T., Krimmer, R. (2017). Open Data as Enabler of Public Service Co-creation: Exploring the Drivers and Barriers. In: Proceedings of the 2017 International Conference for E-Democracy and Open Government (pp.102-112). Krems, Austria: IEEE Computer Society

William, C., Webster, R., & Leleux, C. (2018). Smart governance: Opportunities for technologically-mediated citizen co-production. Information Polity, 23, 95–110. https://doi.org/10.3233/IP-170065

Wolfram, D., & Spink, A., & Jansen, B. J., & Saracevic, T. (2001). Vox populi: The public searching of the Web. Journal of the American Society for Information Science and Technology, 52(12), 1073-1074.

About the Authors

Evrim Tan

Evrim Tan is a postdoctoral researcher at KU Leuven Public Governance Institute. His research focuses on decentralization, blockchain governance, and public governance models. He is part of the academic advisory board of INATBA, and member of the Belgian representatives for European Blockchain Service Infrastructure.

A. Paula Rodriguez Müller

A. Paula Rodriguez Müller is a doctoral researcher and teaching assistant at KU Leuven Public Governance Institute. His research focuses on ICT-based coproduction, citizen engagement, channel choice and democratic public values.