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Value drivers of blockchain technology: A case study of blockchain-enabled online community

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ABSTRACT

There is growing recognition that blockchain technology has significant potential to alter how organizations and people work and communicate. However, theoretical guidance concerning how organizations leverage blockchain technology to enhance value creation for users is still limited. Grounded in the socio-technical perspective and leveraging the rich data obtained from case analyses of blockchain-enabled online communities, this paper develops a theoretical model to identify the core value drivers that blockchain enables for online communities. The core value drivers include: a reputation-value system, data ownership mechanisms, and verification & tracking mechanisms. Our findings suggest that these three value drivers enhance value creation of online communities by motivating participation and protecting contributions.

1. Introduction

Blockchain has gained increased visibility in the past few years, with its inclusion in the World Economic Forum's list of emerging technologies powering the fourth industrial revolution.[1] As the world heads towards a new era where information and communications technologies (ICT) are driving the next industrial revolution, organizations and governments worldwide are paying increased attention to technologies that have significant potential to transform businesses. Blockchain is a technology that can provide a platform for decentralized transactions and data management, and has the promise to improve the security and transparency of business processes, creating new business scenarios that were not previously possible (Dula and Chuen, 2018). The most widely known implementation of blockchain as of now is the Bitcoin.

With the explosion of Bitcoin since 2008, a growing number of start-ups and organizations are attempting to take advantage of blockchain technology, applying it to different industries (Park and Yang, 2018). Despite the increasing interest from both academia and industry, however, only 1% of surveyed companies actually use blockchain technology in their business according to research by Gartner.[2] As blockchain technology is nascent, many organizations are still exploring how they can effectively make use of blockchain to create value for users. To date, most blockchain-related studies discuss the features and performance of cryptocurrencies, such as Bitcoin (Li and Wang, 2017). Recently, more studies have discussed the opportunities and challenges of utilizing blockchain technology in various domains, such as finance, accounting, supply chain management and governance (Coyne and McMickle, 2017; Kokina et al., 2017; Ølnes et al., 2017; Rozario and Vasarhelyi, 2018; Saberi et al., 2019). However, blockchain is not necessarily

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[1] https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

[2] https://www.gartner.com/en/newsroom/press-releases/2018–05-03-gartner-survey-reveals-the-scarcity-of-current-blockchain-developments

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beneficial for all businesses (Lo et al., 2017), for example, blockchain is not suitable for systems that require centralized operations. Hence, it is important for organizations and businesses to understand why and when blockchain technology provides value. Extant research, however, has mainly discussed this question from the perspective of blockchain design. For instance, Bonsón and Bednárová (2019) discussed when private or public blockchain architecture is suitable for businesses, Macrinici et al. (2018) discussed the impact of different smart contract design on business, and Kokina et al. (2017) discussed the challenges to be solved for the adoption of blockchain in accounting. Limited research has examined blockchain with a focus on the social perspective (Zhao et al., 2016a). While Chong et al. (2019) examined different business models of blockchain companies, and Ølnes et al. (2017) discussed the value that blockchain technology can bring to organizations, these studies have mainly focused on how companies can create value from blockchain technology. Little attention has been paid to how applications using blockchain can create value for customers or users. Hence, this study fills this research gap by examining the value drivers of blockchain technology.

This study adopts a socio-technical approach to understand the value drivers of blockchain technology, and to provide insights into how blockchain technology is adopted and used. The socio-technical perspective states that a successful system is the result of mutual effects of both technical and social aspects of the system (Chai and Kim, 2012). We choose online communities as our research context, for the following reasons. First, with the global reach of Internet, more people are using online communities to seek information and to communicate with others (Iriberri and Leroy, 2009). Community members' participation and contributions are critical to the success of an online community. Extant research highlights that the extent of member engagement with online communities is dependent on the extent to which the latter creates value for its members (Bateman et al., 2011). Hence, it is important to understand how blockchain technology can enhance the value online communities create for their members. Second, despite the importance of member participation, online communities largely have a voluntary structure—in that the quantity and quality of community members' contributions and participation largely depends on their own willingness (Moon and Sproull, 2008). The voluntary structure of online communities makes it a desirable context to discuss the value drivers of blockchain technology (Kang et al., 2007a), as it eliminates the need to consider the potential influence of organization-specific factors, like leadership and management strategies.

This study contributes to extant literature by identifying value drivers of blockchain technology with a special focus on blockchain-enabled online community (BCOC). To do so, we present findings that emerged from our analysis of 30 BCOC projects. Although we do not go into detail on each of the projects studied, we use three representative cases to illustrate the concepts that emerge. Our analysis reveals three primary and interrelated value drivers of BCOC: reputation-value system, data ownership mechanism, and verification & tracking mechanism. We observe that value creation in BCOC goes beyond the value that can be realized in traditional online communities through motivating participation and protecting contributions. Throughout the discussion of the value drivers of BCOC, we also enrich our findings with observations regarding the interrelationships among the three value drivers.

This paper is organized as follows. First, we review the socio-technical perspective and the technical features of blockchain technology. Then, we show the results of our qualitative analyses with three representative cases. Next, we present our findings on the value drivers of blockchain technology, which emerge from the cases and we discuss how these value drivers enhance value creation for online communities. Finally, we discuss the challenges online communities face in leveraging blockchain technology.

2. Theoretical background

An online community represents a virtual space that aggregates people with common interest and enables people to communicate with one another through computer-mediated mechanisms (Hagel, 1999; Iriberri and Leroy, 2009; Kim et al., 2008). To date, diverse types of online communities and social networking sites have emerged to satisfy people's needs for information seeking and communication (Iriberri and Leroy, 2009; Preece et al., 2003). Prior research has classified online communities based on four major dimensions: *functions*, *attributes*, *governance approaches*, and *boundedness* (Iriberri and Leroy, 2009; Kim, 2006; Lazar and Preece, 1998). Function refers to the purpose served by the online community. For example, online Q&A communities (e.g. Yaoo!Answers) are ideal outlets for members to seek advice and to share experience or knowledge; and brand (or review) communities like Yelp and Tripadvisor are formed on the basis of consumers' attachment to products or services and the shared content mostly focuses on user reviews (Khansa et al., 2015). Attributes refer to the characteristics of online communities. For example, online communities can be classified by geographic characteristics (e.g. formed by members in close proximity), by demographic characteristics (e.g. formed by people of specific age, gender, etc), or by interests and goals (e.g. formed by member with shared interests and goals) (Kim, 2006). **Governance** refers to the mechanism of managing the content. For instance, in online communities like Wikipedia or GitHub, community members collaboratively manage the content (Xu and Zhang, 2013), whereas in online communities managed by Twitter or Facebook, the platform owner will be in charge of censoring the content. **Boundedness** refers to whether only predefined populations can join the online community. For example, online communities developed in organizations only allow employees to participate, whereas most communities in the Internet are loosely bounded communities where anyone around the world is free to join (Lazar and Preece, 1998). Hence, each online community can be classified according to these four dimensions (Lazar and Preece, 1998). Despite the variety of online communities, they share the common purpose of satisfying individuals' needs for information seeking and communicating. In this study, we define an online community as a publicly accessible computer-mediated space which centers upon integration of content and interaction of participants with an emphasis on member-generated content. Hence, those online communities that are operated within an organizational intranet, and those that do not emphasize member-generated content are not the focus of this study.

2.1. Value creation of online communities

The concept of value dates back at least to Aristotle (4th century BCE), who introduced the notion of value and defined value as a

subjective concept that reflects the usefulness of the item concerned. Specifically, Aristotle identified two kinds of value: use value and exchange value. Use value refers to the extent to which a product or service can satisfy users' needs, whereas exchange value refers to the monetary payment users are willing to pay in exchange for the product or service (Aristotle, 1959). While there have been controversies over a commensurable metric of exchange value amidst the development of economic thoughts, largely by Smith's (1776) early distinction of real value, labor, and nominal value, the concept of use value has been widely accepted among early medieval schoolmen and philosophers, and has been widely studied since then (Dixon, 1990; Grönroos and Voima, 2013; Priem, 2007; Smith, 1776; Vargo and Lusch, 2004). For example, Heinonen and Strandvik (2009) analyzed the use value of e-services and Boyd and Koles (2019) discussed the impact of virtual reality on B2B marketing from a use value perspective.

As noted by Kang et al. (2007b), business success rests on its ability to offer new and superior value to users. Prior research shows that use value is particularly important for an online community (Hagel, 1999; Iriberri and Leroy, 2009; Kim et al., 2008). Specifically, online communities create value for their members by engaging them in a variety of activities (Nordin et al., 2011; Vargo et al., 2008), such as interacting with the content as well as with other community members, producing and contributing their own content, and consuming content for information collection and entertainment (Liu and Bakici, 2019). Studies have shown that online communities can fulfil members' social interaction needs, decrease their loneliness, increase their self-acceptance, and widen their social circles (Dolan et al., 2016; McKenna et al., 2002; Walther, 1997). In this regard, online communities can create value for members by satisfying their social needs (e.g. develop social relationships) and functional needs (e.g. express themselves and seek information) (Bechmann and Lomborg, 2013). Hence, we further define value creation of an online community as the extent to which the online community can satisfy members' needs.

2.2. A Socio-technical approach

In this study, we adopt a socio-technical approach to understand how blockchain technology helps to better satisfy members' needs and enhance value creation by online communities. The concept of "socio-technical" emphasizes the importance of considering the interrelationship between social factors and technological factors in understanding a technological system. Specifically, the social factors highlight the need to consider the attributes or attitudes of individuals, whereas the technological factors focus on the features of technology (Bostrom and Heinen, 1977). The socio-technical perspective highlights that both people and technology are two major subsystems of organizations that affect each other as organizations use and apply technologies (Tatnall, 2005). As such, to build a healthy and successful socio-technical system, an organization needs to leverage technological capabilities and consider relevant social factors affecting the organizational system. As noted by McIvor et al. (2002), the most significant problem facing organizations is their lack of ability to align the role of people with technological innovations. Essentially, technology is embedded in the social context, and the value of technology can only be realized if users interact effectively with technology. For instance, Gao (2005) examined China's strategy for the telecommunications market transformation from a socio-technical perspective. They examine how actors' interests are influenced by the technological innovation as the telecommunications industry reforms. Similarly, Davenport and Prusak (2000) showed that implementation of information technology without considering social factors will result in a grave failure. In this regard, the socio-technical perspective highlights that researchers should not only examine how technology generates value for organizations, but should also incorporate social attributes to examine how the use of technology influences organizational outcomes.

2.2.1. Social factors of online community

Social considerations for online communities refer to the requirements and needs of members in the online community (Chai and Kim, 2012; Tatnall, 2005). As members act as both content producers and recipients, a successful online community thus requires high quality inputs from its members and active interactions between members to enhance member stickiness to the platform (Bechmann and Lomborg, 2013). In this respect, we identify the sense of belonging and trust as the two key social factors that reflect members' needs and requirements for online communities and are critical for member engagement in online communities.

2.2.1.1. Sense of belonging. Sense of belonging refers to members' desire to build and maintain social bonds with others in the community (Baumeister and Leary, 1995; Damsio et al., 2012). Online communities represent a major channel for people to build such social bonds on the Internet (Blanchard, 2007), as they enable individuals to connect and interact with one another regardless of geographical distance, thus satisfying people's basic needs for social connectedness (Damsio et al., 2012). By sharing experiences and information, members enhance their feelings of social belonging and social advantage (Heinonen, 2011). As noted by Smith and Colgate (2007), people have psychological needs for group membership and social belonging. A sense of social belonging can help decrease the feeling of loneliness and make people less prone to low self-esteem or depression by connecting with others who share similar interests and goals (Lee and Robbins, 1998; Liu et al., 2020; Liu and Bakici, 2019; McKenna et al., 2002). As such, online communities need to create a sense of belonging amongst their members to increase their participation and contributions.

2.2.1.2. Trust. One important reason for the popularity of online communities is the informational value it provides to members (Bechmann and Lomborg, 2013). Members often regard online communities as a major source of information (Wagman, 2010). Hence, trust in the information quality of member contributions is a critical factor impacting the engagement of members and the success of online communities (Cheng et al., 2017). Specifically, increasing the verifiability of the information source enhances the trustworthiness of the information and provides indications of how authoritative the information source is (Chai and Kim, 2012). But ensuring information quality has been a major challenge for most online communities, for several reasons. First, few online communities have

clear governance rules to verify content, and most online community platforms do not verify the information provided by members on a timely basis. This is especially so for opaque platforms that prioritize profit-driven motives to manipulate member attention for clicks, which could potentially lead to the prevalence of fake news in online communities (Chai and Kim, 2012). Second, members are often anonymous or pseudo-anonymous and often bear no responsibility for the information posted. The anonymity feature of online communities reduces the motivation for content creators to verify information sources before posting (Chen et al., 2011). As a result, members may not have much trust in the information obtained from online communities due to the potential risk of false information, which may ultimately affect their engagement in online communities.

Additionally, trust in the platform is required to encourage contributions from members (Shin, 2019). Members' incentive to post content can be negatively affected if operators of online communities do not adopt good practices to ensure that user-generated data is well governed with little risk of being sold or used for the benefits of for-profit organizations (Choi and Sung, 2018; Tang et al., 2012). In this regard, an untrustworthy platform operator can pose threats to member privacy (Jetzek et al., 2014). As highlighted by Chen and Chen (2015), concerns about personal information security are negatively associated with members' self-expression behaviors in online community. Hence, members' trust in the data governance processes affects their engagement in an online community.

2.2.2. *Technical factors of blockchain*

In addition to social factors, technical factors of the blockchain technology may also impact members' attitudes and activities in online communities. There are two basic types of blockchain platforms: public and private blockchain. Public blockchains, which are more widely used by online communities, have no access controls for reading or writing to the blockchain. Private blockchains, on the other hand, only allow those members with read and write permissions to gain access to the blockchain, so they are more suitable for enterprise scenarios (Coyne and McMickle, 2017). The hybrid blockchain, also referred to as the consortium blockchain, is a mix of private and public blockchains, as the blockchain is publicly visible to all nodes in the network, but only preapproved nodes can write to the blockchain. In this study, we focus on public blockchains, which is widely adopted by BCOCs, as online communities are usually openly accessible to all members. We review three major features of public blockchain technology in this section, namely: (1) the token economy, (2) accountability and (3) security & immutability.

2.2.2.1. Token economy. Tokens represent a tradable asset that is closely tied to blockchain technology and fuels various blockchain use cases (Massey et al., 2017). Tokens serve several functions. First, tokens provide financial incentives for miners to contribute computing powers to verify and record transactions and to run smart contracts in the blockchain. This ensures that the ecosystem runs smoothly, and computer nodes behave in a non-malicious manner to create a secure and trusted system.

Second, blockchain tokens are often created and sold by blockchain start-ups (in exchange for fiat currencies (e.g. USD) or cryptocurrencies (e.g. Bitcoin)) to fund their development of products or services (Bourveau et al., 2018). In return, investors holding the tokens can enjoy a set of rights afforded by the tokens, such as the ability to exchange the token for certain digital products or services (Adhami et al., 2018).

As there is usually a limited supply of tokens issued for a platform, the token value will theoretically increase with the growth of the blockchain platform (Drasch et al., 2020). Hence, it will create a token network effect (Dixon, 2017; Drasch et al., 2020), where platform users or miners have strong incentives to earn more tokens and to ensure the growth of the platform, such that the tokens they possess can be more valuable. Consequently, the token has become one of the most critical elements in motivating engagement in the BCOC.

2.2.2.2. Accountability. Accountability refers to "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" (Graglia and Mellon, 2018). The transparent and decentralized nature of blockchain enables the achievement of accountability, with multiple computer nodes making verifications at the same time. This enables all users of the network to work together in a decentralized manner, not only supervising others' activities, but also taking responsibility for their own actions (Beck et al., 2018; Rizal Batubara et al., 2019).

Transparency refers to the degree of visibility and accessibility of information (Zhu, 2004). Each block of transactions is broadcasted and validated in the peer-to-peer network on the blockchain (Peck, 2017). This way, anyone in the network can view and verify the transaction data recorded on the blockchain, which leads to data transparency. Moreover, smart contracts are widely used in blockchains to achieve process transparency. A smart contract is essentially a piece of software code that codifies rules and agreed terms, verifies the fulfillment of requirements and automatically executes the predefined rules (Buterin, 2014). In addition, smart contracts are publicly visible to everyone in the network unless they are encrypted, such as in the case of private blockchain. This way, it will be almost impossible to change the rules or to bypass the requirements specified in a smart contract, thus helping the blockchain to achieve process transparency. The resulting data and process transparency enables blockchain technology to achieve greater accountability.

Identifiability, on the other hand, refers to the ability to recognize a member and to link a member to the activities that s/he engages in. Blockchain enables identifiability using digital signatures, which is based on the asymmetric cryptographic mechanism. Specifically, a digital signature constitutes of a pair of public and private keys to validate the authenticity of the transaction (Rizal Batubara et al., 2019). The private key, used to sign the transaction, is confidential to users. Only the paired public key is shown publicly to others (Nakamoto, 2019). The unique public key for each member ensures that all their activities in the network are identifiable without disclosing their real identity. Therefore, the use of digital signatures in blockchains supports the identifiability of

contributors with pseudo-anonymity, thus increasing accountability for their actions.

2.2.2.3. Security & immutability. Blockchain is a distributed ledger system in which all the information recorded on a blockchain is shared and verified by a peer-to-peer network of computer nodes (Nakamoto, 2019; Zhao et al., 2016a). Once a newly verified block is added to the chain, it can no longer be modified. Blocks are connected through the cryptographic hash header of the previous block (Nakamoto, 2019). The cryptographic hash header of each block is generated through a hash function using both the content, timestamps on the specific block and the connection information of the prior block. Any tiny changes on any block will change the hash dramatically (Rizal Batubara et al., 2019), enabling the detection of any data change on the blockchain, thus ensuring data immutability.

Additionally, the decentralized and distributed nature of blockchain makes it robust to attacks, as all nodes in the network have a copy of the data (Lee, 2019). Hence there is no single point of fallibility, unlike the case of a centralized database. More importantly, it is difficult to corrupt and hack the data existing in a large number of nodes. Even if one node is attacked, the distributed consensus verification mechanism still ensures that the entire system will operate with authenticity.

Fig. 1 shows our conceptual model. The model illustrates how the social aspects of online community and technical aspects of blockchain jointly play a critical role in enhancing value creation of online communities.

3. Methodology

Due to a lack of theory guiding research on blockchain, we use an inductive case study approach, as it is most appropriate to develop insights for an emerging domain (Eisenhardt, 1989). Specifically, we employ a multiple-cases and multiple-investigators approach. We searched for token-based blockchain projects that (1) operate online community platforms; (2) are active in crypto exchanges[3]; and (3) have an average market capitalization[4] larger than USD100,000 since listed in crypto exchanges. We refer to these online communities who use blockchain as a critical element in its design as Blockchain-enabled Online Communities (BCOC). These case selection criteria mean that we focus on those market-oriented BCOC cases that are active and popular in the crypto market.

We identified 30 BCOC projects that satisfy all three criteria. We collected detailed data on these BCOC projects mainly from publicly available sources: whitepaper (our major source), experts' review reports, and the project community site. The project whitepaper provided the most information showing how the blockchain is used to add value to the BCOC. Like an initial public offering prospectus published by traditional companies, a whitepaper is the main channel for blockchain projects to disclose details of their projects and to solicit the interest of investors (Feng et al., 2019). It explains in detail what problem the focal project is solving, and describes the proposed product or service as well as the underlying technology used. Further, we monitored the projects' online community site and social media sources and collected online experts' reviews related to these projects. These sources enable us to triangulate our findings from whitepapers to generate a more complete understanding about these projects (Yin, 1994; Zott and Huy, 2007).

We recruited two research assistants who are familiar with blockchain technology to collect and code the data. To ensure that all crucial aspects of the BCOC projects are captured in the coding process, we provided a list of 30 guiding questions (See Appendix) as a systematic guiding framework to aid the research assistants in their coding task. The guiding questions are mostly open-ended. Each research assistant independently answered the 30 guiding questions for each BCOC project by integrating and triangulating facts from various data sources that are relevant for the question. After that, they compared their answers and discussed any disagreements. The guiding questions include: (a) the BCOC project information (e.g., funding date, country, project status, and some financial data); (b) the types of activities or services the project enables (e.g., 'What activities users can engage in'; 'What benefits users can enjoy'); (c) roles of blockchain technology (e.g., 'How blockchain helps the operations of the online community'; 'How blockchain enables users' activities'). Using the information collated, we develop a conceptual framework, which we present below (Amit and Zott, 2001).

3.1. Within-case analysis

A multiple case study approach examining three BCOC projects is adopted to increase the methodological rigor and robustness of our findings (Yin, 1994). The three cases are compared based on their approaches of applying blockchain technology to online communities. Table 1 shows brief descriptions of the three focal cases in our data analysis. We followed two case selection strategies proposed by prior research: *typical case selection* and *maximum variation* (Miles and Huberman, 1994; Patton, 1990; Shakir, 2002). First, as this study is exploratory, it is suitable to "describe and illustrate what is typical" (Patton, 1990, p.173) in the process of understanding how blockchain technology creates value for online communities. Hence, we select these three cases that are popular and widely discussed projects that showcase the most common types of online communities developed by the 30 BCOC cases. Specifically, Steemit is a popular social networking site that allows members to post thoughts and interact with others. Sensay, on the other hand, is a blockchain-based online Q&A community allowing members' to seek advice and share knowledge or experience. And Typerium allows for trading of digital content. Second, we used the case selection strategy of maximum variation for the purpose of enriching our findings. As noted by Patton (1990, p.172), "any common patterns that emerge from great variation are of particular interest and value

[3] Crypto exchange platforms are marketplaces for digital cryptocurrencies trading

[4] Market cap measures how much a company is worth on the digital market, as well as the market's perception of its future prospects.

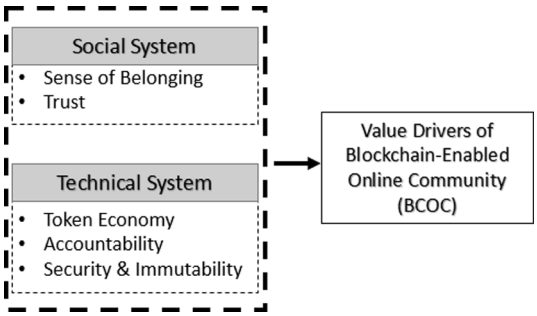

Fig. 1. The Conceptual Model.

Table 1
Brief Description of Selected Cases.

Case	Business description	Country	Project Status	Market Cap	Blockchain
Steemit	A blockchain-based social media platform where anyone can earn token rewards by posting or curating quality content.	UK	In operation	Above $10,000 k	Steem
Sensay	A cross-platform messaging application and bot network that supports knowledge repositories and allows users to seek information from unknown others.	USA	In operation	$1,000 k–$10,000 k	EOS
Typerium	A decentralized content creation platform that enables the purchase and sales of creative contents, as well as the protection of the intellectual property.	UK	In testing stage	$100 k–$1,000 k	Ethereum

in capturing the core experiences and central, shared aspects" of a case. Hence, the three cases are selected based on their differences as well. As shown in Table 1, they are different in development stages, in their market capitalization, and they are developed on different blockchain platforms. Hence, a detailed analysis of these three focal cases can provide us a comprehensive understanding of the value drivers of BCOCs.

Table 2 illustrates, in summary form, the results of our in-depth, case-based analyses of the value drivers of the three selected BCOC projects. The table depicts the specific ways in which blockchain-enabled business practices are manifested in these projects and how the blockchain features support these practices. Next, we introduce the three selected cases to further elaborate the role of blockchain technology in BCOCs.

3.1.1. Case 1: STEEMIT

Steemit is a blockchain-based social media platform, which rewards its members with the platform token for posting and curating content. To date, Steemit already has 1.39 million registered members.[5]

In Steemit, a member acts as both a content curator and a content creator. Steemit adopts a reputation voting mechanism to identify high quality content, by giving token rewards to content creators that commensurate with the quality of the content and to content curators who help discover quality content through upvoting or commenting. The Steemit blockchain constantly mints new tokens used for rewarding content creators and curators. The tokens supply is designed to take on an inflation rate of 8.16% for year 2019 and the rate of supply will decrease by 0.5% every year until the overall inflation rate reaches 0.95%.[6] The design is to ensure a regular but decreasing supply of Steem tokens to facilitate the business model.

Different from traditional online communities that reward high quality contributions by giving points or badges to members, which rarely have any economic value, the blockchain technology enables Steemit to make the reward system more effective by providing concrete economic value for the tokens. There are three types of native tokens available in Steemit:

- STEEM: The STEEM token is a liquid cryptocurrency that is transferable across STEEM members as a form of payment. STEEM can be traded for other cryptocurrencies or fiat currency on external exchanges. STEEM can also be converted to STEEM Power and STEEM Dollar.
- STEEM Power (SP): SP is an access token that grants its holders voting power within Steemit. The more SP one member holds, the more influential the member's vote will be and the more token rewards the member can get for each vote s/he makes. SP is non-transferable, but the voting power will be decreased when SP is converted to STEEM. Members can delegate their SP to others, allowing the receiving member to use the voting power tied to the SP, while the owner continues to keep the SP in their own account.

[5] https://steemblockexplorer.com/
[6] https://steem.com/SteemWhitePaper.pdf

Table 2
Value Drivers of Selected BCOC Projects.

Case	Blockchain-enabled business practices	Blockchain features
Steemit	• Reputation voting mechanism that gives token rewards to content creators and curators; • New tokens can be constantly minted at a predetermined inflation rate; • Tokens have economic value that can be exchanged for other cryptocurrencies or fiat money; • Quality contributions can be incentivized: The economic value of the tokens can be increased with the recognition and popularity of the whole Steemit community; • Voting abuse is unlikely to happen: they will have more to lose if the economic value of tokens falls due to abuse than they might gain by voting for themselves; • No central entity controls and manages the data; • The reputation ranking system is automatically operated with smart contracts, and the content of smart contracts are publicly available for all users to see; • Transparent reputation and reward system: all user actions are publicly recorded and time-stamped on blockchain; • Proof of content origin with immutable public record and timestamp on blockchain; • No censorship on content • Unable to edit or delete content;	Token economy Accountability • Transparency • Identifiability Security & Immutability
Sensay	• Users can get token rewards from their knowledge contributions; • The amount of token rewards depend on content ratings; • Sense token has economic value and can be exchanged for other cryptocurrencies; • Token is used to incentivize engagement and quality contributions; • Economic value of token depends on the vibrancy of the community; • Cross-platform knowledge repository: data is owned and controlled by users; • All the data is hash encrypted, and the data's hash value along with the user's wallet address will also be recorded on the blockchain, ensuring accountability and immutability; • All activity data is recorded on blockchain, making the reputation and rewarding system transparent;	Token economy Accountability • Transparency • Identifiability Security & Immutability
Typerium	• Creators sell their content on Typerium for TYPE tokens – the platform's cryptocurrency. TYPE tokens can be used to buy intellectual products (e.g. font packs, image packs, filter packs etc.) on Typerium, and they are also exchangeable for other cryptocurrencies or fiat currencies; • Protect intellectual property (IP) of content creators; • Users can anonymously timestamp their creations; • The concept of Proof of Existence allows users to store the hash of a file on the Blockchain that is linked to both the file submission and file creation time. • Enforce sales contracts: The smart contract will be executed based on pre-defined agreements between sellers and buyers; • Conflict situations between sellers and buyers can be effectively solved through smart contract; • No intentional manipulation of ratings: All data will be recorded on blockchain and visible to all;	Token economy Accountability • Transparency • Identifiability Security & Immutability

- STEEM Dollar (SBD): The SBD is used to provide STEEM tokens with stable value and it is designed to be pegged to USD1. SBD can be converted to a STEEM token at a rate determined by the fluctuations of the STEEM to maintain the stable value of SBD.

To protect content creator or curator against the fluctuations of the Steem cryptocurrency, the token rewards are given to members in the form of 50% SBD and 50% SP. The SP gives the member increased voting power while the SBD gives the member a stable exchange rate to fiat currency. While there are increasing examples of online platforms encouraging content consumers to financially tip contributors of quality content, such platforms require members to pay content creators directly from their own e-wallets, which potentially increases their cognitive and financial costs. With tokens minted and distributed from Steem blockchain, the online community provides more incentives for members to contribute and curate quality content.

As the reputation ranking of the content will determine the amount of tokens content creators and curators can receive, it is of great importance to implement a transparent and fair reputation system. Traditional online communities centrally control and manage the reputation system. It is not always transparent to members how their reputation scores or rankings are calculated. For example, YouTube has a trending list that ranks videos based on the popularity and reputation of the video among members. But the underlying algorithm and data that determines the rank is unknown to members. Hence, the non-transparency of the reputation mechanism will create a trust gap, with members questioning the fairness of the reputation and reward system.

In Steemit, however, there is no central entity controlling and managing the data. Instead, the reputation ranking system is automatically operated with smart contracts on the blockchain. This ensures transparency in how the reputation scores are calculated. In addition, to reduce undue influence of voting results by content creators, each member is only allowed to vote for a limited number of posts/articles each day, and the member receives less token rewards for each vote s/he makes with more posts/articles the member votes for each day. Moreover, members have different voting power measured by the SP the member is holding—the higher the SP balance, the more influence over how contributions are scored. This way, it prevents Sybil attacks where attackers subvert the voting by creating a large number of pseudonymous identities and use them to increase reputation scores. Meanwhile, the token economy enabled by blockchain also guarantees that members with high SP balance will not abuse the voting system because the reputation of the whole community is closely tied to the economic value of the tokens they hold. They may have more to lose if the economic value of tokens falls due to abuse than what they might gain by voting for themselves. As such, using blockchain technology as the basis for the reputation system enables online communities to ensure fairness and transparency.

Moreover, all member actions are publicly recorded and time-stamped on the blockchain, enhancing the transparency of the reputation and reward system. Due to the immutability of blockchain, all content is stored permanently once posted on Steemit. Therefore, members can also use the immutable public record and timestamp on the blockchain to prove their content origin, although they lose the freedom to edit or delete content at a later point in time.

Further, with the transparent and decentralized nature of blockchain technology, there is no single entity that can censor content published on Steemit. Despite the censorship-free environment, the inability to censor and delete content also presents the risk that malicious actors may contribute problematic content (e.g. hate speech or content that is untrue). To this end, Steemit involves community members in the process of bringing down inappropriate content through downvotes. This way, Steemit not only ensures a censorship-free environment, but also eliminates the influence of abusive content.

3.1.2. Case 2: SENSAY

Sensay is an online Q&A community that allows members to seek answers and share knowledge. With an AI-powered chat bot, a Sensay member can ask Sensay anything that s/he wants to know and Sensay will find the right person based on a search on cross-platform knowledge repositories shared by all the members and connect the focal member directly to the expert. Thereafter, the member can rate the conversation and decide whether s/he wants to tip the conversation party with SENSE token, Sensay's platform token.

Sensay also provides support for decentralized messaging and the protection of data ownership. Many of today's centralized online communities (e.g. Facebook, WeChat) have the platform operators owning their members' data and analyzing the data for targeted marketing or the platform may monetize the data in other ways. However, members are rarely compensated for their contributions, and have little say in how their data is used by the platform. With blockchain technology, Sensay provides members with a cross-platform knowledge repository where the data is owned and controlled by contributors, and members are rewarded for their knowledge contributions. Essentially, Sensay extracts members' profile data and activity data from various messaging apps (e.g. Line, Reddit) through OAuth[7], and records the extracted data on the blockchain. The immutability of blockchain enables Sensay members to show they are the authors of the data. Moreover, to encourage members' knowledge contributions, Sensay also gives token rewards to members, depending on the rating of content. For example, each post and comment will be rated on traditional online communities such as Reddit. This reputation score will be converted into SENSE token, rewarding Sensay members for their contributions of valuable knowledge. Like STEEM tokens, SENSE tokens also have economic value and can be exchanged for other cryptocurrencies. This way, the use of blockchain technology provides Sensay with the ability to allow members clear ownership of their data and to provide economic rewards to members for their valuable knowledge contributions.

Besides these benefits, storing data from various messaging platforms to Sensay's blockchain also allows members and communities to chat and transact freely across centralized messaging applications. Specifically, when a member asks a question to Sensay's chat bot,

[7] **OAuth** is a widely used approach for access delegation that users can grant websites or applications access to their data on other websites without giving the passwords.

Sensay can quickly figure out who is the right person to answer the question based on the cross-platform data shared by members. People do not need to switch between different online communities to find the right person to chat with. As such, the cross-platform chat bot connects people together seamlessly. In essence, the distributed and immutable nature of blockchain provides an important basis for the realization of the cross-platform chat bot by enabling individuals' trust in Sensay and willingness to use Sensay as a knowledge repository that stores their data from different online communities.

Additionally, to encourage members to engage with the chat bot either as an inquirer or advisor, Sensay gives token rewards for members' timely activities in the chat bot and for members' agreement to share information or knowledge with inquirers. Reward amounts are weighted based on members' reputations reflected in the ratings from each chat. This kind of token rewards enabled by blockchain technology provides members with more incentives to contribute and to maintain a high reputation. Like Steemit, the creation of a token economy not only provides incentives to maintain a personal reputation, but also provides the incentives to maintain a lively community, as the value of the tokens possessed depend on the vibrancy of the community.

3.1.3. Case 3: TYPERIUM

Typerium is a BCOC that protects the intellectual property (IP) of content creators and creates a decentralized marketplace for buying and selling digital content. The Typerium platform includes a marketplace where creators can distribute their content, and sell them for TYPE tokens – the platform's cryptocurrency. TYPE tokens can be used to buy digital content (e.g. font packs, image packs, filter packs, etc.) on Typerium, and they are also exchangeable for other cryptocurrencies or fiat currencies. Blockchain technology enables Typerium members to timestamp their creations and IP securely and anonymously. Unlike traditional IP protection agencies that require applicants to provide their personal identity to register their IP, the use of digital signatures in blockchain enables the identifiable of data ownership without disclosing private identity data to the community. Moreover, the concept of Proof of Existence allows members to store the hash of a file on the blockchain that is linked to both the file submission and file creation time. By taking advantage of the accountability and immutability features of blockchain technology, Typerium provides an efficient way to track and protect members' IP.

In addition, Typerium can be used to enforce sales contracts such as return policies for products. The smart contract will be executed based on pre-defined agreements between sellers and buyers, helping to reduce conflicts. The use of smart contracts makes the whole business process transparent, ensuring that both sellers and buyers respect their commitments to each other and that all conflict issues are dealt with fairly.

At the end of each transaction, both content sellers and buyers can rate each other. The rating is recorded on the blockchain and is publicly visible to all. Hence, the decentralization and immutability feature of blockchain technology prevents intentional manipulation of ratings.

3.2. Cross-case analysis

The final model was derived through intensive cross-case analysis. It began after all within-case analyses were completed. We went through the project details of each BCOC project coded by research assistants, and classified the blockchain-enabled evidence across cases to gain insights about the value drivers of blockchain technology. Based on this analysis, we identified three predominant value drivers in BCOC projects, namely reputation-value system, data ownership and verification & tracking mechanisms. We tabulate the evidence underlying the value drivers of blockchain technology, as suggested by Miles and Huberman (1984) (See Table 3). We find that these three value drivers are common across almost all the cases. In the next section, we discuss the three value drivers and the interdependencies among them.

4. Emergent Theory: Sources of value creation in BCOC

Our data reveals three primary value drivers (see Fig. 2). Specifically, they are: (1) reputation-value system, (2) data ownership, and (3) verification & tracking. In this section, we discuss the three value drivers, the linkages among them, and how these value drivers are generated due to a combination of various technical and social factors. Moreover, we develop insights into members' sense of belongings and trust towards BCOCs by analyzing a series of radio interviews with Steemit members.[8] Finally, we discuss how these value drivers can enhance value creation of online communities.

4.1. Reputation-value system

To create sustained value for its members, online communities need to increase and sustain a high level of contributions from and engagement amongst its members. Prior research has shown that members of online communities are incentivized to contribute and share quality content to gain and maintain their reputation in the community (Tang et al., 2012). Accordingly, many online communities carefully design their reputation systems to facilitate member participation and contribution (Rice, 2012). However, there are two potential issues commonly associated with the reputation systems of online communities. One challenge is to ensure the

[8] We were only able to find the public resources of user interviews from Steemit because of the maturity and the large user group of the Steemit platform, whereas Typerium is still at testing stage and Sensay is still inviting new members to get early access to the online community. The series of radio interviews on Steemit can be found on https://www.youtube.com/channel/UCWM5iBpQa4Ir-T9HidDtPJA/videos

Table 3
Evidence underlying the value drivers of blockchain technology.

Reputation-Value System	Data Ownership	Verification & Tracking
• Members can get token rewards from their contributions to the online community; • The amount of token rewards depends on the content ratings / reputation; • Tokens have economic value that can be exchanged for other cryptocurrencies or fiat money; • The economic value of the tokens increases with the recognition and popularity of the whole community; • The reputation ranking system is operated automatically with smart contracts;	• No censorship of content; • Unable to edit or delete published content; • Data is immutable, using the hash function of blockchain; • Members decide whether they want to share or monetize their data; • Advertising revenue goes directly to contributing members;	• All member actions are publicly recorded and time-stamped on blockchain, and all records are recorded in decentralized network. • Members can anonymously timestamp their creations with the use of public and private keys; • The smart contract will be executed based on pre-defined agreements and the content of smart contracts is publicly available for all members to see;

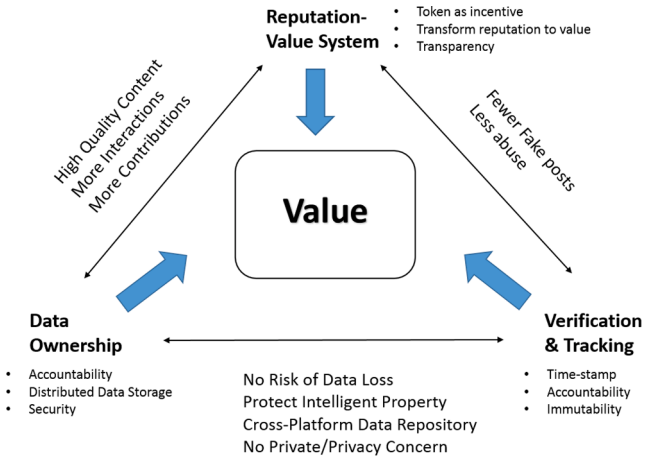

Fig. 2. Value Drivers in BCOC.

authenticity of the reputation ranking system. Since the data is owned and operated by platforms, without enough transparency, members do not have the assurance that reputation scores they see have not been manipulated by the platforms to the latter's advantage (Chen et al., 2011). Another challenge is in creating a reputation system to provide strong enough incentives to motivate high-quality contributions from community members (Tang et al., 2012).

Our case analyses show that BCOCs make significant use of blockchain token designs to overcome the challenges highlighted above. For example, most cases provide explicit value for reputation/votes accumulated by members, by tying members' reputation to tokens offered by the BCOC. Specifically, members can be paid with platform tokens, which have economic value, in return for their efforts in publishing or curating quality content. Members' reputation and the economic value of the token reinforce each other—members with higher reputation/upvotes can gain more token rewards from their contributions. Meanwhile, the value of tokens depends on the reputation of the whole community. As such, members are well incentivized to maintain a high reputation for themselves and to foster the development of the whole online community. As noted by Eren and Vardarlıer (2013), members' sense of belonging can also be derived from the identification of mutual values and goals. Leveraging on a token economy, community members are incentivized to work together to maintain the reputation of the whole community. The shared goal cultivates a greater sense of belonging to the community (Shao, 2009). As commented by a Steemit member during a radio interview: "Members are now incentivized to do [publicity] or to do the marketing for our platform. I feel that this is our platform, no one [is] going to take care of us, there's no one going to do it for us, we are [one] team and essentially all of us are part of a start-up right now. It's better for all of us if we can have more people on the platform, so it's really in our best interest." As articulated by this member, the token provides the incentives for the community to act as a united whole and increases members' sense of belonging. Similarly, another Steemit member commented: "How the platform attracted me is that it is possible to earn a living like this. I do try my hardest to make [my posts] interesting to read. I believe my role here is to make content and hopefully pick up enough followers or supporters." The use of blockchain tokens effectively transforms the time and effort spent by members on the online community into tangible and intangible assets in the form of their own reputation and cryptocurrencies. The reputation-value system thus provides extrinsic motivation for members to contribute quality content, maintain connectivity and interact with others. Engaging in such activities also help to forge social connections that facilitate a feeling of belonging and bonding to a community (Heinonen, 2011).

More importantly, with the use of blockchain technology, no central entity (e.g. platform owner) is responsible for managing the

reputation system for the online community. All reputation ratings are publicly recorded on the blockchain and automatically operated by smart contracts, making the rating process more transparent As such, members have greater trust in the operations of the community and are more willing to engage in the online community. Additionally, the token is specific to the online community, and is used as a monetary payout to members in return for quality contributions. The value of the token would thus depend on the recognition and popularity of the whole community. If the tokens indeed become more valuable, participants will have greater incentives to curate and contribute more quality content to the online community, to increase their reputation and to gain more tokens. This will potentially form a virtuous cycle— whereby each participant is incentivized to contribute to the community and to maintain the level of trust so that the tokens they hold can be more valuable.

To sum up, the use of well-design tokens can provide the basis for a robust reputation system, constituting a primary value driver of BCOC. With a higher level of engagement and interactions in the online community, members increase their sense of belonging. In addition, the transparency enabled by blockchain assures members of the authenticity of the reputation system, and the token economy encourages quality postings. Hence, with the use of a robust reputation-value system, members interact more actively in the online community and can find more quality content, increasing their utility from participating in the online community.

4.2. Data ownership

With the growing number of people actively participating in online communities, an enormous amount of data is created every second. Current online communities, however, do not have clear data ownership guidelines. In many cases, the data is owned by the platform, and can be leveraged by the platform for profits (e.g. in the form of targeted advertising) (Bechmann and Lomborg, 2013). Members have little or no control over their own data, and they have limited influence over decisions relating to the use of their data. As content contribution incentives are diminished by the absence of data ownership, it will also negatively influence the engagement level and contributions of online community members. Our case analyses suggest that blockchain technology enhances value creation by giving members control over their own data. By storing all data in a distributed database, no central authority decides how the data would be used. Rather, the data belongs to the content creators themselves. Members are compensated for sharing their data (as in the case of Sensay and Typerium). This helps members to develop greater trust in the community and reduce their concern for data ownership, which may prevent them from posting content.

Moreover, online community members often complain about censorship from centralized platforms. One Steemit member mentioned during a radio interview: “Some of my friends are doing YouTube videos, they were complaining that they were being censored, so they felt that they could come over to Steemit, to at least write about their content freely.” Indeed, blockchain eliminates the risk of data loss due to censorship, as the immutability of blockchain technology makes it impossible for any party to edit or delete the data.

Our case analyses further suggest that blockchain technology offers better accountability for the data, without revealing personal private information. The use of public–private encryption keys ensures that all posts can be traced to unique accounts. As noted by a Steemit member: “A lot of platforms you chat on are with people you know or your family, I find it limits or restricts some of the content you could potentially put up just from the fear of being judged [by others out there]; whereas in Steemit, you can hide behind a name but you don’t have that automatic judgement laid towards you about different things that you post. I find you have more freedom to do and post about anything.” The accountability of blockchain increases members’ trust in online communities as both their data ownership and private identity information will be protected.

Our cases also highlight the interdependency between reputation-value system and data ownership. While members are incentivized to contribute more due to the token-based reputation system, having no control over their published data is a concern for members. Hence, coupling the value drivers of reputation-value system with data ownership, BCOCs increase the likelihood that members would engage in the online community and contribute more quality content.

4.3. Verification & tracking mechanism

Unlike traditional media, the content on online communities is considered user-generated content (UGC). There is little quality control or vetting of the information source before the UGC is published. As noted by a Steemit member: “Steemit to me should be about originality. I don’t worry about earning money on this platform, I worry about quality over quantity.” The quote shows that community members have concerns about the originality and quality of the posts. Quality issues are pervasive for UGC, as information seekers find it difficult to validate the reliability and quality of the content. This in turn affects the ability of the online community to build a trustworthy environment for its members. It is thus of paramount importance for online communities to create trust in the UGC so that information seekers can trust the information gathered from the online community with less concerns about the reliability of the information (Wu et al., 2012).

To create a high level of trust, the verification & tracking feature is an important value driver that relies on the increased accountability and security of blockchain technology. Data on blockchain is time-stamped and immutable, making it ideal for tracking members’ activities and ensuring the accountability for all data posted. Additionally, the use of digital signatures ensures immediate verification of identity for each post. Hence, it will be difficult for members to hide themselves behind fake posts, which assures members of the integrity and authenticity of the information posted. This way, members’ functional needs can be better satisfied with a higher trust on the originality and authenticity of the content.

Additionally, the sharing of content in online communities may be inappropriate, undesirable, or done without permission from the content creator, which may result in violations of laws, or intellectual property (IP) rights associated with the content. This is a

challenge increasingly faced by platform owners as countries around the world update and beef up their Internet laws, and as IP laws get increasingly complex and varied around the world. Due to the voluminous amount of content created online every day, it is difficult for any central registry to keep track of and authenticate contents published online. Our case analyses show that the verification and tracking mechanism provides protection for members' IP rights. For example, Typerium protects members' IP through "proof of existence", by storing both the hashed content and its time stamp on the blockchain. Blockchain ensures that all the records are immutable, and every member can trace the origin of the content.

To sum up, the reputation-value system and data ownership enabled by blockchain technology can work together with the verification & tracking feature to foster more interactions and encourage more quality contributions to enhance the value creation of BCOCs. The more credible the information found in online communities, the greater the level of trust and the greater the utility that members derive from participating in the online community. Hence, the data ownership and the verification & tracking mechanisms work jointly with the reputation-value system to protect members' contributions, reduce fraud, increase trust, and to incentivize the contributions and curation of high-quality content.

4.4. Value drivers of BCOC from a Socio-technical perspective

Members' participation and contributions are crucial for online communities to flourish, and in turn, create value for their members. The sense of belonging to the community is a core social factor encouraging members' contributions to online communities. However, lack of trust can discourage members from participating and contributing due to the concerns about data ownership and protection, and the quality of UGC.

With the use of a socio-technical lens, our case analyses surface three key value drivers, namely mechanisms for a reputation-value system, for data ownership, and for verification & tracking. As noted by Garcia-Castro and Aguilera (2015), community members capture more value when their willingness to participate increases or when the potential risk of participating decreases. As shown in Fig. 3, the use of well-designed tokens enables the reputation-value system to be a value driver that enhances members' incentives to contribute quality content, driving a sense of social belonging amongst members from enhanced interactions with others. Meanwhile, quality content increases members' utility derived from participating in the online community. In contrast, the data ownership and the verification & tracking mechanisms, enabled by the accountability and immutability features of blockchain technology, are value drivers that offer protection to members' contributions. To the extent that members can better control and protect their content, members will have greater trust in the online community, be more responsible for their content, and are more willing to express themselves in online communities due to fewer concerns about security of their IP.

5. Discussion

There is a positive loop between value creation and member benefits—value creation requires members' engagement and contributions, which in turn, enable members to enjoy the benefits of enhanced value creation. Our analyses show that the features of blockchain technology can bring new value drivers to online communities. Specifically, we identify sense of belonging and trust as two key social factors that reflect members' needs and requirements in online community and impact members' engagement with the online community. In BCOCs, the reputation-value system enabled by blockchain technology incentivizes members' participation and contributions, thus enhancing their sense of belonging to the community. Meanwhile, the data ownership and verification & tracking mechanisms enabled by blockchain technology can protect members' contributions such that members have greater trust in the online community's information quality and data governance process. This way, the three value drivers of BCOC support the social factors of online community, jointly enhancing value creation in BCOC.

Moreover, the value drivers of BCOC identified in this study could also help facilitate the governance process of online communities based on principles of commons governance, where members cooperate with each other to produce shared resources without a traditional hierarchical organization (Rozas et al., 2018). As noted by Elinor Ostrom (1990), communities can effectively manage commons assets and resources in a sustainable way by following a specified set of principles for self-governance by communities. The principles include clear definitions of members' rights, collective decision-making mechanisms, accountable monitoring systems, conflict resolution mechanisms, etc. Along this vein, the reputation-value system clearly defines participation rights and motivates quality contributions, whereas the data ownership and verification & tracking mechanisms ensure an accountable and trustworthy online community for sharing content and resolving conflicts. The connections between the value drivers of BCOC and Ostrom's principles provide further insights into how and why BCOCs operate effectively with the use of blockchain to support commons-based governance. There is thus scope for future studies to adopt this perspective to further discuss the implications and performance of commons-based governance using blockchain.

5.1. Challenges faced by BCOC

Despite the potential value blockchain technology can bring for online communities, our data reveals that there are also challenges for online communities adopting blockchain technology.

First, while censorship-free content is a core advantage of BCOCs, it also brings with it the spam problem. For instance, malicious members may take up precious network capacity with worthless contributions, which can ultimately destroy the network by preventing members from making regular contributions. Traditional centralized platforms can monitor the network and block the malicious member. However, it is more complicated for BCOCs to solve this problem due to the emphasis on a democratic community

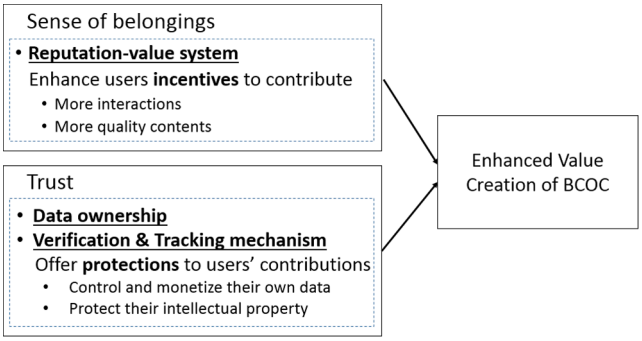

Fig. 3. Value Drivers of BCOC from A Socio-Technical Perspective.

without a central platform owner. One common solution adopted by blockchains so far is to charge a minimum transaction fee to prevent spam behavior, however, it may pose a barrier to entry for new members. Considering online communities have a large amount of information or transactions to be recorded on the blockchain every day, it is particularly important for BCOCs to find an effective solution to prevent spam behavior from wasting limited computing power.

Second, token rewards enabled by the reputation-value system in BCOCs create extrinsic motivation for members to engage with and contribute to the online community. As shown in prior studies, extrinsic motivation driven by financial incentives may undermine intrinsic motivations, and may even negatively affect members' long-term contributing intentions in the online community (Garnefeld et al., 2012; Wang and Hou, 2015; Zhao et al., 2016b). Members may attribute their contribution behaviors to extrinsic financial rewards instead of their own interests, thus reducing their feelings of involvement in the community (Frey and Jegen, 2001; Qiao et al., 2020). Hence, BCOCs need to consider how they should optimize the reputation-value system, such that they can incentivize members by increasing both their intrinsic motivation (e.g. enjoyment of contribution or prosocial behavior) and extrinsic motivation to contribute to the online community.

In addition, the economic value of tokens could also attract greed driven hackers to attack the platform by exploiting potential vulnerabilities. For example, by exploiting the way smart contracts were coded on the blockchain, a hacker repeatedly executed a transaction and withdrew USD60 million from the DAO[9] in June 2016 (DuPont, 2017; Morrison et al., 2020). Hence, BCOC projects need to constantly upgrade their protocols to defend against various forms of attacks.

Third, the growth of an online community will bring scalability challenges with the use of blockchain. Some attempts have been made to solve the scalability problem, but most of the solutions are achieved by compromising on decentralization or security (Zheng et al., 2017). For instance, Steemit achieves scalability by introducing the witness consensus mechanism—witness nodes are selected by the Steemit community through votes and the selected witness nodes are delegated the authority to create blocks. Although this mechanism creates better scalability, it sacrifices decentralization to some extent. There are other approaches to resolve the issue of scalability – such as increasing blocksize, but the higher blocksize will increase the vulnerability of the blockchain to attacks and may ultimately compromise the security of the network. As compromises among scalability, decentralization and security are often required, it is important for BCOC projects to design proper protocols to meet the growing demands and maximize benefits.

Fourth, the huge energy consumption is another common blockchain adoption challenge, especially for those BCOC projects using proof-of-work (POW) as the consensus mechanism for validating transactions. The POW protocols require miners to solve complex mathematical puzzles to create blocks, which consumes tremendous computing power and electricity (Cao et al., 2020). The high levels of computing power needed for mining also create entry barriers for miners, making the blockchain system less decentralized by including only miners who can satisfy the high computational requirements. Many BCOC projects have adopted proof-of-stake (POS) protocol to replace POW by randomly assigning the block creation task to participants, with the probability of being selected based on their stake in the network. However, POS allows miners to stake their coins on competing chains, which can potentially make the blockchain vulnerable to double-spend attacks (Saleh, 2020).

Further, a "51% attack" on a POW blockchain is also possible if a miner or a group of miners controls more than 51% of the mining power of the blockchain network. With the majority of computing power on a blockchain, attackers can intentionally manipulate the records/transactions as they are faster in creating new blocks than other miners (Sayeed and Marco-Gisbert, 2019). However, the cost of conducting majority attack is high and once the attack occurs, the transparent nature of blockchain could also allow the blockchain community to discover the attack and potentially agree on a change/fork to reverse the attack or block the attacker.

Finally, our analyses show that the three value drivers of BCOC are common across all the cases. Yet, the resource-based view (RBV) of firms highlights that value will slip away unless firms possess unique resources versus potential competitors (Lepak et al., 2007). It is important to heighten customer awareness and offer differentiation in their business propositions to gain competitive advantage. Similarly, prior research shows that community member's sense of being locked-in to a certain community results from their belief that

[9] The DAO is an investment company that uses smart contracts on the Ethereum blockchain

the net benefits from this community are not easily available elsewhere (Bateman et al., 2011). As such, while BCOCs take advantage of blockchain technology, they also need to differentiate their offerings and value propositions from other competitors to facilitate value appropriation. We find that different BCOCs present different value propositions to their members. For example, Sensay differentiates its business offerings with the combined use of AI and blockchain. Through "smart chat", members can find relevant information by intelligently matching the information repository on blockchain. Hence, online communities need to consider the differentiating offerings and value propositions they offer, and whether Blockchain plays a critical role in helping them to offer these unique value propositions.

6. Conclusion

In this study, we propose three value drivers of BCOC: reputation-value system, data ownership, and verification & tracking. We emphasize that these three value drivers can enhance value creation of online communities by encouraging quality engagement and protecting contributions. We also suggest that blockchain is not always a desired technology for online communities to adopt. It is important for online communities to think of ways to minimize the potential risks of adopting blockchain technology. We further propose the importance of considering the fit between the key value propositions of the online community, and the technological characteristics afforded by blockchain. Online communities must be able to differentiate their offerings from that of competitors. In particular, the three value drivers enabled by blockchain technology emerged across almost all BCOCs. Hence, it is important to identify different value propositions, beyond the ones enabled by blockchain, to gain competitive advantage.

6.1. Theoretical contributions

While blockchain technology has significant promise to propel the Fourth Industrial Revolution and to change our lives, there is still a lack of theory-driven research on business applications of blockchain technology (Beck et al., 2018; Rossi et al., 2019). Indeed, a comprehensive analysis of the intertwining effects of social factors and technology factors is of great importance to understand how businesses can leverage blockchain technology to create value for their customers and stakeholders. Yet, to the best of our knowledge, extant research tends to discuss the effects of blockchain technology with limited considerations of social factors (Bonsón and Bednárová, 2019; Chong et al., 2019; Ciriello et al., 2018; Lo et al., 2017). In this regard, our study contributes to extant literature by adopting a socio-technical perspective to identify three value drivers of blockchain technology for BCOCs. The core value drivers include: a reputation-value system, data ownership, and verification & tracking. Our findings suggest that these three value drivers enhance value creation of online communities by motivating participation and protecting contributions.

Our study also contributes to extant research by identifying how the three value drivers are interdependent. Our case analyses show that all three value drivers reinforce each other to enhance the value creation of BCOCs. In this regard, our findings highlight the necessity to develop a more comprehensive picture of the functioning of BCOCs and capture the various sources of value creation.

Further, while there are many blockchain startups operating online communities, prior research has mainly focused on the role of blockchain in the financial, accounting, supply chain management and governance field (Coyne and McMickle, 2017; Kokina et al., 2017; Ølnes et al., 2017; Rozario and Vasarhelyi, 2018; Saberi et al., 2019). The discussion of value creation is particular important for online communities as they need to show sufficient value to attract and retain members amid the many alternative online communities members can choose to engage in. In this regard, our study provides new insights for those online communities to enhance their value creation from the role of blockchain technology.

6.2. Limitations

As many of the BCOC projects have just started with their implementation or are only in the testing stage, our current analysis is mainly based on whitepapers, with information supplemented from the online community sites and other information sources where possible. Whereas a deep analysis of whitepapers offers the opportunity to improve our understanding of how businesses can leverage blockchain technology to create value for their users, they only offer initial clues about the value drivers of BCOCs. Future research may need to look at longer-term outcomes of such BCOCs and to conduct more member interviews from different platforms.

It should also be acknowledged that our case selection criteria suggest that our study mainly focuses on market-oriented BCOC projects, or those projects whose tokens have higher market value. However, it is possible that some BCOC projects do not emphasize creating a high market value for their tokens, as they may aim to engage members based on direct prosocial motivation or social benefits. Future research should also consider different types of crypto-economic design and compare the value drivers enabled by different designs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Basic information

1. Role of token (Whether the token is a utility token)
2. Type of Project Platform (Private or Public or Permissioned Blockchain)
3. Project platform name
4. Project location
5. Whether there was an ICO event? (If yes, indicate how much money has been raised from ICO)
6. The date that the project is first listed in crypto exchanges
7. The date the online community platform is first launched?
8. Average amount of market capitalization since listed in crypto exchanges
9. The current status of the project (whether the project platform is available, whether there are active users, the amount of active users)
10. What is the consensus algorithm used in this online community

Product or services details

11. What's the product type (e.g. whether it is a mobile application? A website?)
12. A brief introduction of this online community.
13. What's the aim/purpose of establishing this online community?
14. How does this online community operate?
15. Who is the target user/member of this online community? (Characteristics of members in this online community)
16. List the activities that can be done in the online community platform?
17. What are the benefits members can enjoy in this online community?
18. Are there any other incentive mechanisms being adopted? If yes, please specify.
19. What kinds of roles exist in this community? (E.g. user, miner, developer, adviser)
20. Describe the activities/responsibilities of each role in this community.
21. What are the role/responsibility of project founders?

Role of blockchain technology

22. How activities in this online community are supported by technology?
23. How tokens can be obtained in this online community?
24. How tokens can be used in this online community?
25. How benefits in this online community are achieved with the use of technology?
26. How blockchain technology is used in this online community?
27. How other technologies (except blockchain technology) are used in this online community?
28. What is the distribution plan of tokens?
29. Whether token amount is limited?
30. How are tokens created?

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