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A conceptual model and case study of blockchain-enabled social media platform

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ABSTRACT

Nowadays, with the emergence of Web 3.0 and the metaverse, we collectively witnessed the explosive development of the decentralised autonomous organisation and the blockchain business model. Particularly, the advancement of technologies has further given birth to a novel form of social platform as blockchain-enabled social media (i.e., SocialFi), which is growing both in size and number of users. Accordingly, the rapid development of these blockchain-enabled social media firms illustrates the requirement to better understand the reasons behind this increase and the innovative practices and strategies of firms in this emerging field. Using the case of Pixie – the world's first fully functional decentralised photo and video sharing social network based on blockchain technology, this insight paper identifies a conceptual model of blockchain-enabled social media that is useful for illustrating the successful business strategy and operations of firms. Particularly, the identified model employs four pillars of innovation as fundamental technologies, governance and operations, incentive mechanism design, and organisational structure and performance. Based on this crypto economy social media model, the study further presents the main challenges, discusses the implications based on agency theory, as well as highlights several directions for future research associated with blockchain-enabled social media.

1. Introduction

'Everything that can be decentralised will be decentralised' - David A. Johnston

While social media platforms such as Facebook, YouTube, WhatsApp, Instagram, and Twitter dominate the market, the social media landscape is probably about to change. Recently, the development of blockchain technology has given birth to a novel form of social platform as Blockchain-enabled Social Media (BSM), which shows a new type of firm that apply blockchain technology to enable the execution of smart contracts and the establishment of applications (Choi et al., 2020; Guidi, 2020; Liu et al., 2022). With increasing social platforms incorporating blockchain, there has been a rapid growth in venture capital funds available to startups. For example, the venture capital firm Paradigm issued a $2.5 billion funding for BSM and decentralised autonomous organisation projects, while in Binance Smart Chain's launched $500 million investment program, BSM has been highlighted as one of the key areas of focus.[1] Although the development in the digital economy over the past decade was mainly driven by the enhancement of information technologies in the operations of conventional businesses, the development in the current century has taken place primarily as the result of more user-facing transactions in innovative and new industries (Apte and Davis, 2019; Keiningham et al., 2020).

Social media has become ubiquitous and most important for communication, networking and content sharing. Nonetheless, the widespread use of social media platforms has brought many challenges to today's business and society. For example, they spread false information on social media because the network lacks the power to effectively validate the content. During the Coronavirus outbreak, it has been reported that social media networks have enabled users to widely spread false information online. The Centers for Disease Control and Prevention (CDC) declares that the spread of misinformation on social media has

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[1] The information is sourced from: https://www.nasdaq.com/articles/social-media-on-the-blockchain-socialfi-could-be-key-to-mass-adoption.

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resulted in a significant negative impact on the conversation regarding COVID-19 globally.[2] Not just in the case of the Coronavirus pandemic but even before that, social media has been criticised by researchers and practitioners for issues with its user control, political neutrality, privacy, censorship and other various activities leading to riots (Siddiqui and Singh, 2016; Dwivedi et al., 2018; Ozcan et al., 2021). According to Dwivedi et al. (2018), social media has accelerated a loss of control and ownership of content as public, private and institutional domains continuously overlap. Also, Oh et al. (2011) point out that social media platforms such as Twitter have been adopted by terrorists for opportunistic decision-making in extreme and volatile conditions.

As a saying goes: social media users aren't paying for social media because they are the product. In other words, it is the users who create the most valuable content on social networks. Thus, it would be interesting to think, will the conventional social media networks still be valuable without their users? For instance, most current social media platforms are designed and managed based on the 'Creator Economy', in which online users create shareable content and participate in social activities. These social platforms typically have centralised revenue structures where the firms earn a fortune at the expense of users' information and personal data (Krombholz et al., 2012). Many of the real social content contributors are never compensated, nor are they even acknowledged. Also, these social media networks usually sell the aggregated user data to offer the highest bidder with more helpful segmentation for their target-oriented advertising and large-scale marketing campaigns. According to Forbes (2018), most social media networks generate and grow their revenue by selling target-oriented advertising based on algorithmically mining every second of their unwitting users' lives. As a result, there is an increasing need to design a fair infrastructure that enables its users to retain relevant rights and ownership of the content and data, as well as make a share of the profits along with the social media network.

While the majority is getting familiar with blockchain-based cryptocurrencies such as Bitcoin and Ethereum, most people tend to be less familiar with blockchain applications in promoting peer-to-peer platforms or their advanced adoptions beyond cryptocurrency transactions. Determined as immutable chains that ensure data transparency, blockchain technology allows pre-programmed protocols and algorithms to track connected inputs automatically, react to modifies, implement rules, and trigger responses (Murray et al., 2021). In particular, blockchain-enabled social media (BSM) has attracted increasing attention and become a critical aspect of Web 3.0, which is believed to be the next Internet revolution. Unlike the Web 2.0 social networks that we are familiar with, blockchain-enabled social media projects offer greater levels of security and privacy for users' personal information, effectively allocate advertising revenues and provide a more valuable user experience. Generally, BSM overcomes the issues of conventional social media models and expects to be a decentralised version of the Internet where users and creators are turned into owners and stakeholders. BSM platforms are usually operated and owned by their users and the entire community. For instance, being decentralised, BSM platforms are not under any corporate central proprietary structures managing all the information. Instead, the generated data is kept decentralised across servers of each node of the network. Users are encouraged to generate quality content and engage proactively with their fellows to effectively keep all the social content circulating inside the platform. This creates a novel 'Creator Crypto Economy' model utterly different from the conventional social media networks, which monetise users' information and infringes upon their privacy. Thus, traditional issues such as data privacy, misinformation, unnecessary content censorship and uninformed algorithm changes can all become a thing of the past.

The rise of BSM startups have further facilitated a fundamental change in organisational structure and created a new type of organisation – the decentralised autonomous organisation (DAO). According to Hsieh et al. (2018), DAOs are "*non-hierarchical organisations that perform and record routine tasks on a peer-to-peer, cryptographically secure, public network, and rely on the voluntary contributions of their internal stakeholders to operate, manage, and evolve the organisation through a democratic consultation process*". Apart from Bitcoin (i.e., the first implementation of a DAO), there have been over 180 DAOs with more than $10 billion assets undermanagement.[3] In a full-fledged DAO, there are no hierarchical organisational structures or centralised authority systems. Rather, all firm management and operational rules are based on cooperation and collective decision-making and encoded on tamper-resistant blockchains (Wang et al., 2019). Although the increasing startups of DAOs have enabled people to gradually identify the benefits of this new organisational structure, the current literature has generally focused on its potential values in different areas (Xu et al., 2017; Choi et al., 2020; Guidi, 2020). Given the increasing number of BSM platforms, there is a lack of a unified framework/model based on empirical evidence to support firms developing infrastructures and harvesting business values from implementing DAO and blockchain technology. This study aims to address this issue.

In summary, there are several reasons why it is important to study this topic: a) most BSM firms are innovative startups that represent a new form of organisation (i.e., DAO) and a thriving element of the economy with relatively low entry costs; b) BSM has aroused great attention and controversy in recent research and business practice (Guidi, 2020; Ryan, 2021); c) BSM tends to have a significant effect on the conventional social media networks with which they compete; and d) BSM firms are believed to represent the next Internet revolution regarding Web 3.0 and can have a positive effect on user engagement as BSM provides a compelling solution, managing the full spectrum of issues associated with conventional centralised social media networks (Xiong and Xia, 2020; Liu et al., 2022). Based on the above reasons, we first conduct a comprehensive review of the relevant literature related to BSM and DAO. Then, we propose a creator crypto economy model based on four pillars of successful innovation identified from a leading UK found BSM startup - Pixie. Finally, we summarise the study by presenting the main challenges, discussing the overall implications based on agency theory, as well as highlighting the directions for future research associated with BSM.

2. Blockchain-enabled social media and decentralised autonomous organisations

Blockchain is one of the latest disruptive innovations for society and business that can facilitate decentralisation, transparency, non-modifiability, security and stability (Mettler, 2016; Murray et al., 2021; Massaro, 2021). While the increase in new business startups is developing completely new business models based on blockchain technologies (e.g., Pixie, Uport, Steemit, Slock. it), many well-established companies are also starting to adopt blockchain-based smart contracts to enhance various areas of their business operations. For instance, IBM recently collaborated with Maersk to create a blockchain-enabled network to enhance the efficiency and transparency of their global supply chains. The network offers digital authenticity and non-modifiability of digital files to all supply chain members while eliminating the requirement for inefficient 3rd party validators across the logistic process (IBM, 2018). Swan (2015) categorises blockchain adoptions into three phases: digital currency, smart contract, and DAO to conceptualise the fast-growing blockchain-enabled applications. Perhaps most interesting for practitioners and researchers, the use of

[2] The Centers for Disease Control and Prevention is the national public health agency of the United States, and the information is sourced from https://www.cdc.gov/vaccines/covid-19/health-departments/addressing-vaccine-misinformation.html.

[3] The data is tracked by deepdao.io: https://deepdao.io/organizations.

blockchain technologies has created a completely new type of organisational structure - DAO. Notably, DAOs operate completely via algorithms enforced and encoded by smart contracts. As a result, firms can run autonomously without having 3rd party interventions or centralised control. Bitcoin is the world's first implementation of a DAO. Compared to the traditional organisational structure, Bitcoin does not have employees, subsidiaries, or headquarters but rather an open network of users and miners who collect, verify, and update transactions on a distributed ledger with public audibility (Hsieh et al., 2018). Any code changes are determined via community-based democratic consultation processes backed by miners' computing power for implementation (Jiang et al., 2021; Liu et al., 2022).

Blockchain-enabled social media (BSM) is not a new concept. Previous studies have documented similar concepts such as blockchain-based decentralised autonomous online communities (DAOCs) (Liu et al., 2022), decentralised online social networks (Greschbach et al., 2012), blockchain social networks (BSNs) and distributed online social networks (DOSNs) (Vu et al., 2009; Guidi et al., 2013; Dutra et al., 2018) which can all be identified as the embryonic form of BSM and build the foundation for its emergence and development. While the definitions are not the same, the conceptual features of these terms are similar, and such BSM platforms can be seen as a new organisational form. The main feature of this new type of blockchain-enabled firm is decentralisation, representing the unique character of its governance and organisational structure. Also, autonomy represents the underlying operation mechanism of the firms, and it is managed automatically through predetermined rules and protocols. The focus of the firms is mainly on content generation, user involvement, as well as organisation development.

The current research on blockchain-enabled social media (BSM) platforms is relatively limited and mostly focused on Steemit – a blockchain-based blogging and social community. As presented in Table 1, these studies can be briefly summarised into two streams based on their research objectives: the impact of different token incentive mechanisms and the influence of this new BSM business model on user behaviour (e.g., engagement and content generation). On the one hand, to investigate the effectiveness of token incentive mechanisms, Kim and Chung (2019) suggest an approach for developing a novel model of the crypto economy via using the case study of Steemit. Bae and Cho (2019) reveal that tokens have more significant stimulation effects on early network adapters. There is no significant difference between token-incentivised and non-incentivised drivers on late adopters. Meanwhile, Kang et al. (2019) suggest that a multi-token economy performs well during the growing phase but not during a recession. Zhang et al. (2019) further investigate the information quality of blockchain-enabled online communities. Using the case of Steemit, the findings show that the stable token (SBD) and the vested token (SP) tend to have a significantly positive impact on information quality, while the liquid digital token (STEEM) does not. On the other hand, through analysing the data collected from Steemit, Liu et al. (2022) investigate the influence of dual roles (e.g., community user and owner) on user active engagement behaviour. The findings suggest that factors such as share capital, social capital, economic feedback and social feedback can positively influence users' dynamic engagement behaviour. Specifically, economic and social feedback further moderates the impacts of the dual capitals. Kapanova et al. (2020) apply a topic modelling analysis and identify that while mundane personal information still presents on Steemit, discussions about blockchain technology, crypto economy and the Steemit community itself show a strong presence on the network. Thelwall (2018) also studies the content of posts on Steemit and finds that the first few participants' posts tend to be more self-introductions, referring that network users generally recognise the significance of their social capital. In short, by reviewing the existing literature, a great amount of research effort has sought to generate a better understanding of BSM, identify its benefits and scope of implementation, and show the technologies that can be used and the elements resulting in the values of BSM. However, it is still unclear about the successful business practices and innovation strategy of these emerging BSM firms for developing infrastructures and harvesting business values from DAO and blockchain technology implementation.

Table 1
Relevant studies on blockchain-enabled social media.

Literature Stream	Reference	Method	Content
The impact of token incentive mechanisms	Kim and Chung (2019)	Case study	Proposing a process for building a desirable model of a token economy.
	Bae and Cho (2019)	difference-in-differences method	Providing the first empirical evidence to validate the practical effectiveness of token incentives.
	Kang et al., 2019	Case study	Addressing the token classification, the reason for adopting multi-token economies and their effectiveness.
	Zhang et al. (2019)	Data mining and regression	Examining how cryptocurrency incentives embedded in blockchain influence the information quality of user-generated content.
The impact on user behaviour	Liu et al. (2022)	Two-way fixed effect negative binomial regression	Investigating the user incentive mechanism when users play the dual roles of social participant and community owner.
	Kapanova et al., 2020	Natural Language Processing and Latent Dirichlet Allocation	Understanding how the emerging online social communities condition the way people create content.
	Thelwall (2018)	Sentiment and content analysis	Exploring new members' first posts for insights into what drives financial success on the site.

Practically, there is neither a central authority nor a hierarchical management structure for BSM firms. As for its governance and operations, BSM can run efficiently based on a set of predetermined algorithms/protocols and implement autonomous development, management, and operation via a democratic validation process among network users. For instance, Steemit has been well studied by researchers as one of the earliest BSM networks and a typical example of DAO (Thelwall, 2018; Kim and Chung, 2019; Kapanova et al., 2020). The use of blockchain technology has created a new incentive method (i.e., token-based incentives) compared to conventional social networks. By providing online users with new roles, studies have shown that the decentralisation of BSM changes the development of users' incentive mechanisms (Bae and Cho, 2019; Liu et al., 2022). Specifically, the token in BSM platforms is a specific amount of assets you can own, assign to others, or redeem. Typically, it is a digital representation of value and rights. The integration of token incentives and a blockchain-enabled social network can govern the authenticity and the uniqueness of resources via encryption protocols and open ledgers circulated by a consensus algorithm. Network users collect tokens through engaging in various social activities, apply tokens to gain corresponding rights and interests, and receive network growth dividends through the value of tokens, therefore framing a two-way value co-creation between online users and BSM (Zhang et al., 2019). For example, Steemit rewards users' contribution behaviours, including new content generations, evaluations, promotions, and diffusions. Besides, the token-based incentive mechanisms are transparent as every user can trace and audit these transactions (Mettler, 2016; Hsieh et al., 2018). The data stored in blockchains tend to be secure, reliable, and authentic,

enabling BSM to publicly make the data available, thus accelerating inspection and verification processes (Murray et al., 2021; Massaro, 2021). As BSM is developed on permanent records, data generated cannot be modified, changed, or removed. We further discuss the innovative features of BSM in the next section.

3. Towards a creator crypto economy model

Apte and Davis (2019) illustrate that business model design refers to developing infrastructure of the value generation, delivery and capture mechanisms. According to Foss and Saebi (2017), "*emerging business model innovation literature lacks theoretical underpinning, and empirical inquiry is not cumulative*". Thus, this study adopts the reference model by Wang et al. (2019) as a starting point and applies Pixie as a successful case to develop a creator crypto economy model with four pillars of successful innovation for BSM firms. Specifically, Pixie is the world's first fully functional BSM. It has grown steadily and achieved over 15, 000 daily active users following a 3-month launch period. It is now one of the largest blockchain-enabled social networks in the UK based on its daily active users. Pixie works with all its members to create and build a decentralised social platform based on blockchain technology where members can contribute to its development and share its profits together.[4] This brand-new model is completely different from the centralised profit models of traditional social networks that monetise users' information and infringe upon their privacy.

Apart from Pixie, several BSM platforms have emerged over the past few years, such as Appics (https://appics.com/index.html), Minds (https://www.minds.com), Sapien (https://www.sapien.network/) and Steemit (https://steemit.com), which is currently the most successful blockchain-enabled social media platform with over 1.2 million registered online users. By comparing these BSM platforms, they are similar and based on Twitter/Reddit like social media models and guarantee social services through the adoption of blockchain technology. Notably, from a technical perspective, the key difference among these platforms involves the blockchains that they apply and the unique features of each blockchain (e.g., block production rate, confirmation time, fees and consensus algorithms). For instance, although Ethereum is one of the most used and well-known blockchains for decentralised applications, its features are not well fitted to social media conditions - this is due to its slow block production rate (i.e., 10–19 s) and the expensive transaction fees. In contrast, Pixie has developed a public blockchain (i.e., Pixie Chain) to serve Pixie. The Pixie Chain is compatible with Ethereum (ERC20) smart contracts, and its PoS consensus mechanism creates a block every 3 s, resulting in faster transaction confirmation and higher chain performance at over 500 transactions per second, etc. It is worth pointing out that the main focus of this study is to identify the common BSM business model based on empirical evidence to support firms harvesting values by implementing blockchain technology, rather than examining the technical features of different blockchains that they apply.

The Pixie company was keen to support our research as their founders were keen to understand how to develop, configure, and optimise their business and service operations, achieving competitiveness through better-applying blockchain technology. The data collected were based on the interview of Pixie founders, participation in internal workshops and meetings, gathering company newsletters and white-papers, and observing different teams' progress on tasks based on their personality preferences to report and interact. As shown in Fig. 1, the proposed creator crypto economy model employs four pillars of innovation: fundamental technologies, governance and operations, incentive mechanism design, and organisational structure and performance.

[4] Pixie can be downloaded from the Apple App Store and Goole Play. For more information about Pixie, please refer to https://pixie.mobi.

3.1. Fundamental technologies

The fundamental technologies refer to all the infrastructures and emerging techniques that support BSM and its applications, such as Blockchain, Artificial intelligence, Internet of Things and Big Data.

BSM firms are typically developed based on the peer-to-peer platform to facilitate the interaction of nodes distributed across the globe. Blockchain is the most important technology for BSM to achieve its roles. Notably, blockchain consensus mechanisms allow all nodes on an open network to be dispersed with great decision-making power to effectively achieve a consensus. Smart contracts integrate predetermined operational rules of BSM into blockchain in the form of computer algorithms and protocols, therefore, to perform the functions as 'law-type of management'. For instance, Pixie has developed a public blockchain (i.e., Pixie Chain) to serve Pixie. The development of its own blockchain is due to the high gas fee of adopting any existing blockchains (e.g., Ethereum), which is not sustainable and feasible for Pixie's business model. Pixie also developed a blockchain-enabled distributed database for effective data storage and management to support the tremendous volume and frequency of social activities. In this way, Pixie can record users' every social activity, including posting, liking, commenting, reposting and sharing. The Pixie consensus mechanisms generate a block every 3 s, leading to extremely quick transaction confirmation and excellent chain performance at more than 500 transactions per second. The completely credible social activity data recorded can be queried and audited at any time. It also enables the development of smart contracts to further create credible value measurements, conduct allocations and transactions.

Recently, with the adoption of AI technology, every single node in a BSM network can be referred to as an autonomous agent. It is expected that the use of technology can further replace human labour in performing functions such as decision-making, reasoning and perception. For example, Pixie is now adopting AI-enabled technologies for user activity, content and recommendation. The firm aims to implement AI and machine learning protocols to avoid reckless and abusive social activities and gradually minimise the centralised intervention of the network. Besides, the implementation of other emerging technologies such as the Internet of Things and big data technologies further enable firms to manage their multisource data (e.g., operational data, state data, and intrachain transactions data) from nodes in real-time and support comprehend the evolution and development strategy of BSM firms.

3.2. Governance and operations

The governance and operations are associated with the encode consensus through smart contracts and achieve network autonomy and continuous iterative development via *digitalisation* and on-chain/off-chain management.

For BSM, there is no centralised or hierarchical organisational structure to take part in managing the firms' business and daily operations. Instead, BSM relies on smart contracts created and enabled by blockchain technology. Normally, smart contracts integrate consensus achieved among stakeholders digitally and can be automatically verified and enforced. Although smart contracts offer the primary trust guarantee for BSM firms' governance and operations, the starting point is to create a successful digital transformation in business. The key steps to achieve digital transformation are through advanced data collection and analysis methods. Then the data is used for innovative business model development, business ecosystem reconstruction, user experience enhancement, etc. For example, Pixie's blockchain-enabled distributed database also involves a multi-structure hierarchical digital transformation process to manage the information generated from the high volume of users and frequency of social activities. As a result, it enables the improvement of data security and facilitates real-time data access, data valuation, and processing.

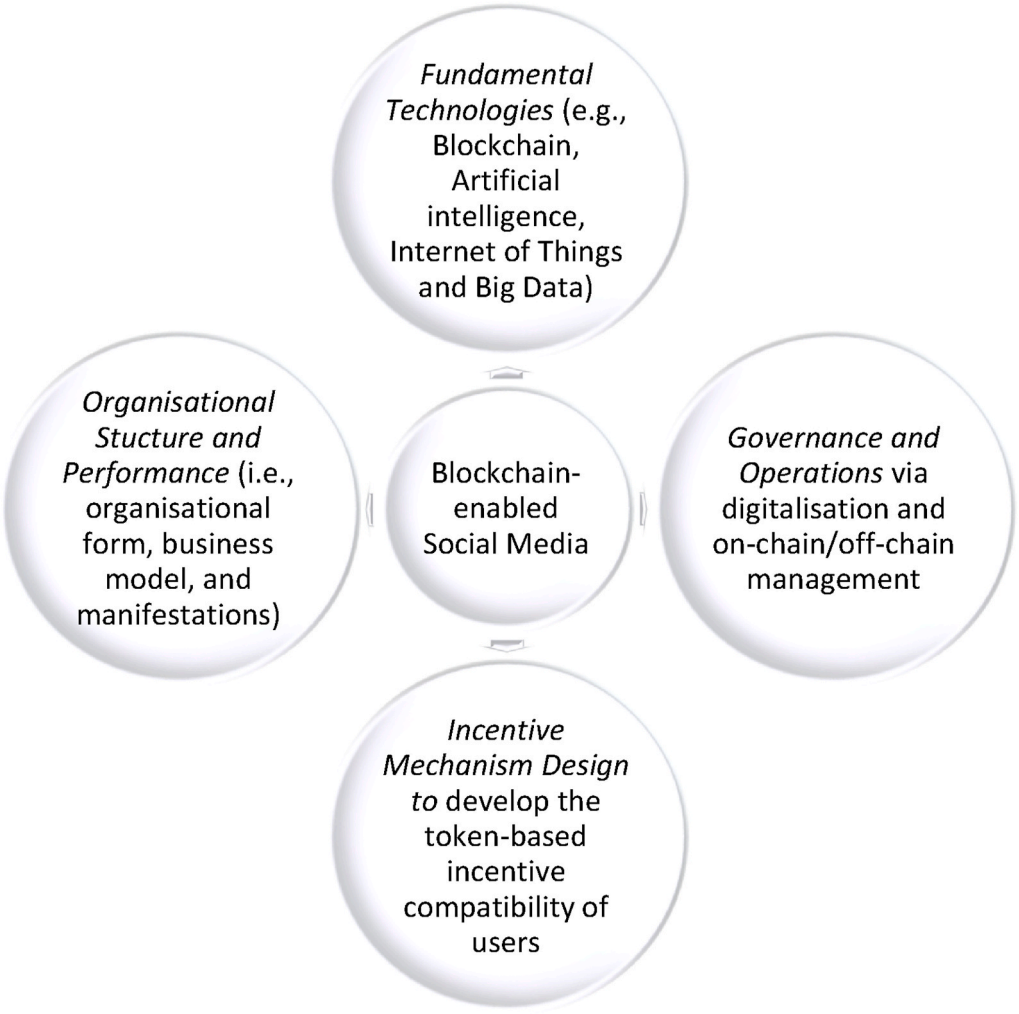

Fig. 1. A conceptual model of BSM.

BSM generally applies an 'on-chain + off-chain' collaborative governance pattern to ensure the smooth flow of operations. As discussed, on-chain governance is about creating, improving, and updating digital agreements via smart contracts. The main objective is to develop a reliable digital infrastructure in a mutual distrust environment and maximise the values of all participants. In contrast, off-chain governance is associated with a range of human governance activities implemented to facilitate the establishment, promotion, recognition, renewal, and diffusion of the consensus. Specifically, to support Pixie chain governance and operations, Pixie management involves four people groups: the users, Pixie founders, Pixie blockchain miners, and the network operation team. Apart from the users, Pixie founders are responsible for developing and maintaining the key implementations such as the application, the distributed database, the Pixie chain, and the AI adoption. Pixie chain miners ensure the smooth operating of the digital consensus of the blockchain, aggregate transactions as blocks, integrate the blocks as chains, and validate a series of on-chain consensus renewals. The Pixie operation team mainly manages daily operations and provides customer services and management of advertisers. Pixie has developed a range of principles to improve the operational efficiency of the network and ensure effective collaboration among the different group members. Due to the limitations of current technologies, BSM firms are more likely to follow the operation mode as a small part of on-chain governance + most of the off-chain governance. However, as BSM firms and relevant technologies are still in their infancy, the firms will shift the focus and pay more attention to on-chain governance and eventually become a decentralised autonomous organisation.

3.3. Incentive mechanism design

The incentive mechanism design is about to develop and promote the token-based incentive compatibility of users and create a win-win situation.

Compared to traditional social media platforms, BSM can issue its unique token and determine the amount in circulation, token lockup period, distribution pattern, as well as other factors of the token incentive mechanism based on the requirements of specific project attributes. Mainly, the token incentive mechanism design plays an extremely important role to BSM in stimulating user content generation and social activities. On the one side, a high-quality token model combines various capitals together (e.g., monetary, human and social). It redefines the relationship between the firm and people, lowers the operating expenses, and supports the fund demand in the early stage of the project. On the other side, as token anchors the project itself, well-managed projects can result in token's market value continuously increasing, which can adversely better serve as an economic stimulus for all stakeholders. For example, to keep the sustainable and healthy development of the Pixie network, users' social activities are rewarded with PIX (i.e., the cryptocurrency of Pixie), and a specific amount of the PIX collected by the users will be received at the time of settlement. According to the Pixie whitepaper, the firm collects 15% of each social activity token reward. The operation team receives 33.33% of the

gathered PIX, while the Pixie founders obtain the other 66.66% of the gathered PIX. The PIX gathered from users' social activities is planned to be applied for the further development and operational costs of the network, according to the different responsibilities of the teams discussed.

To ensure the effective of token incentive mechanism design, it is suggested that token issued should at least involves the features of currency (i.e., circulating within a specific range), property (i.e., referring to the right to own good and services) and equity (i.e., for value-added, long-term income generation). In other words, since the token incentive is the key motivator for BSM, it should work like bonds and stocks in real life, representing a kind of negotiable assets and the proof of interests and rights. Accordingly, all social activities in Pixie, including posting, commenting, liking and sharing, are rewarded with a certain amount of PIX. With the expansion of the social network effect, Pixie's business model will become more and more profitable via targeted advertising. Nonetheless, unlike traditional social media networks that usually monopolise advertising profit, Pixie shares the majority profit with its users via tokens to further encourage them to generate, collect, and promote high-quality content. This will be a positive reinforcement cycle that benefits all participants involved with Pixie.

3.4. Organisational structure and performance

The organisational structure and performance refer to BSM firms' unique organisational form, business model, and manifestations.

Unlike a conventional organisational form, BSM firms' organisational structure can be categorised as open, flat, and collaborative intelligence. Specifically, the open refers to the external and internal organisational boundaries becoming less obvious. In other words, BSM can make justifications according to different projects, needs, and targets through network consensus, and then perishes or dismissed when its objectives are achieved; The flat means that the hierarchical management system in the organisation does no longer exist. As a result, users' flexibility is given full play, while effective and transparent management can be obtained; The collaborative intelligence characteristic indicates that with the development of technologies, the BSM is evolving into a new model as human-machine engagement in work. Thus, the intelligent agents in BSM networks can be validated by humans to conduct a range of business activities. Specifically, Pixie is an open and decentralised platform that ensures platform security and digital assets. Stakeholders in Pixie receive all rights to their resources, including ownership, transaction, profit sharing and control rights via the use of non-fungible token (NFT) technology. Pixie's high-security blockchain-enabled distributed database system is developed using C/C++, enabling efficient management of users' personal information and social data generated in Pixie. The smart contract of Pixie automatically implements settlements and rewards for users' social activities performed in the database as long as there are no rejections received from validators.

Moreover, according to the extent of the decentralisation level, BSM's self-organisation model can be either fully decentralised (i.e., like public blockchains such as Bitcoin and Uniswap) or partially decentralised (i.e., like consortium blockchains such as Quorum, Hyperledger and Corda). Most BSM depends on the 'Nonprofit Foundation + Commissioned firms' model. Specifically, the nonprofit foundation is usually responsible for initial token offering, management, supervision, and distribution as the critical body of the token issuance. The commissioned firms are associated with technology implementation, legal services, promotion and marking. In this way, BSM is often introduced in an open-source social network to facilitate on-chain/off-chain collaborative management.

4. Challenges, implications and future directions

It is undeniable that BSM is still in its early infancy and has several issues regarding its implementation. Notably, we find BSM introduces two new challenges for organisations to contend with when deciding whether to transact by smart contracts. On the one hand, inflexibility issues may arise from a lack of discretion in adopting smart contracts' predetermined regulations, which can generate new contracting charges for organisations. As the smart contract is operated completely based on encoded 'if-then' rules that are pre-programmed at the very initial consensus among transacting members, therefore, changes in smart contracts' enforcement are strict, inflexible and rigid (Hsieh et al., 2018). For example, the DAO was a digital decentralised autonomous organisation and a type of investor-directed venture capital fund. However, the hack in June 2016 utilised a bug in the DAO's smart contracts to steal around $50 million from its fund. Given that the DAO used an autonomous and fully decentralised governance structure, no managers were able to take immediate actions to avoid the hack or even fix the loophole in its smart contract after the hack had taken place.[5] Apart from pointing out the inflexibility issue of smart contracts, The DAO's example also indicates the important relationship between humans and machines in making an adaptive and real-time response in the emergencies like the occurrence of hacks or data breaches through setting up systems and procedures in place to avoid similar problems from happening subsequently.

On the other hand, security and technical issues related to maintaining blockchain reliability and data records can lead to significant extra expenses. As BSM implements the temporal processing and encoding of transactions over time, it is critical to acknowledge that this blockchain-enabled process is highly computationally intensive, and therefore, extremely inefficient considering its resources consumption as well as carbon emission generated when compared to conventional centralised information systems (Jiang et al., 2021). Nonetheless, it can be argued that using a centralised information system is only as safe as the servers on which they locate. Firms need to cope with additional costs such as labour, software, and hardware to ensure a centralised information system's reliability. Due to the increase of recent data breaches by numbers,[6] it is believed that most traditional social media infrastructures are not paying enough attention to ensure the safety of their databases. Hence, caution is urged for researchers and practitioners when comparing the expenses of BSM reliability against the safety and technical costs of conventional social media infrastructures.

Apart from the challenges, we further discuss the implications of BSM based on agency theory. According to agency theory, agent managers tend to not perform in the best interest of firms' boards and shareholders (Bosse and Phillips, 2016; Murray et al., 2021). Compared to traditional social media networks, we propose BSM firms can reduce agency costs in three ways. First of all, while much research on corporate governance has paid particular attention to studying a series of factors of the directors that can influence the effectiveness of agent managers (Cyert et al., 2002; Arosa et al., 2010; Terjesen et al., 2016), BSM opens a new opportunity for the directors to substitute smart contracts for monitoring managers via a DAO organisational structure. Although an ideal DAO suggests an entire business autonomous management through smart contracts, it is practical to think of how firms can repeatedly operate complex routines using blockchain technologies. The tendency for BSM to reduce firms' requirement for controlling monitoring managers' incentives also lead to several new issues for scholars to investigate. As organisations can benefit from professional managers with considerable expertise and knowledge (Chang et al., 2010; Chang and Shim, 2015). Therefore, future studies should explore the critical junctures at which these professional individuals are necessary and whether

[5] More information about the history and consequences of the DAO: https://medium.com/swlh/the-story-of-the-dao-its-history-and-consequences-71e6a8a551ee.

[6] The Information is sourced from the Information Commissioner's Office (ICO) https://ico.org.uk/action-weve-taken/data-security-incident-trends/.

the wisdom of crowds based on decentralised chains, together with secure encryption algorithms, can influence the values generated by these managers.

Secondly, the adoption of BSM offers an efficient way for the board of directors to manage various areas of firms' daily operations over specific business decisions. For instance, a private blockchain can be developed to offer security, transparency and timeliness to all its participants with various applications to effectively deal with tasks in daily operations and supply chain management (Cole et al., 2019; Lohmer and Lasch, 2020; Choi et al., 2020). This way allows firms' managers to react more effectively and efficiently to emergencies. The amount of available information mitigates managers' discretion in making a course of decision and thus reduces the potential loss of shareholders' value due to agent managers' misinformed actions. While BSM offers an effective way to manage firms' day-to-day operations by mitigating information asymmetries and lowering the requirement for third-party intermediaries to verify agent managers' decisions, it cannot change the role of agent managers in determining an organisation's strategy. Hence, it leads to an exciting direction as to whether social media companies can apply BSM to autonomously/semi-autonomously perform strategic decision-making through digital protocols that consider external factors to trigger actions under specific situations.

Thirdly, studies show that there are different ways how agent managers can go after a self-interest driven suboptimal business strategy for the organisation instead of the profit-maximising objective favoured by shareholders (Cyert et al., 2002; Nevo et al., 2016; Bosse and Phillips, 2016; Murray et al., 2021). For example, executives tend to prefer business strategies to quickly expand the size of a company to receive more significant compensation rather than greater profits. This issue can be avoided according to the company's degree to which blockchain technologies are adopted. Specifically, BSM can eliminate the agency issue completely and thus get rid of agency costs, as the board of directors takes all actions through a democratic validation process among network users. However, future studies can further investigate whether and how organisations eliminate monitoring costs and perform strategic decision-making via developing smart contracts. So as the organisational performance and implications regarding the automated strategy decision-making process.

In summary, this study is among the earliest attempts to develop a creator crypto economy model based on empirical evidence to support firms developing mechanisms and harvesting business values from implementing blockchain technology and DAO. It provides significant implications through illustrating the development approach of the model with four pillars of successful innovation for BSM firms, applying a case study. While much literature on the crypto economy model is based on the perspectives of computer science or economics (Böhme et al., 2015; Kim and Chung, 2019), this research is from an operations and innovation management perspective, paying particular attention to sustainable business model innovation with an incentivised user base. Compared with traditional social media networks, the business model of BSM can offer better value co-creation and provide incentive compatibility with participants. The model can better obtain social sustainability by sharing profits with its online users, in contrast to well-developed social media firms that grow revenues with their shareholders. Although previous research has extensively examined the incentive mechanism and social media engagement behaviour of participants in traditional social media (Ashley and Tuten, 2015; Dolan et al., 2016; Lobel et al., 2017), the study of BSM leads to different social media engagement behaviours and has enriched the incentive mechanism by endowing online users with dual roles: social participant and community owner. This study explains the mechanisms and identifies four specific pillars of successful innovation for firms.

Besides, most existing discussions on social media today are still in the initial stage and often focus on traditional centralised social media platforms (Oh et al., 2011; Siddiqui and Singh, 2016; Dwivedi et al., 2018; Ozcan et al., 2021). This research extends our understanding of the successful business operations of decentralised BSM platforms. The findings can enrich the relevant literature on the business model of traditional social media platforms (Xiong and Xia, 2020), offering practical guidance for the operation and governance of BSM and developing incentive mechanisms in traditional social media networks. Given crypto economy model is still in its early stages, it is anticipated that the innovation pillars identified in this study will stimulate further research in this area. Considering that more and more firms worldwide are implementing blockchain technology and initiating ICOs. Therefore, it can offer practical guidance for firms to use token incentive mechanisms in their operations for innovation.

However, this paper has some limitations. Particularly, this study relies on one single case of Pixie, a young developer of decentralised photo and video sharing social network based on blockchain technology. While the focus on a single company could be regarded as a limitation, it also allows a deeper understanding of the factors of competitive heterogeneity with different contextual situations remaining similar, which would be challenging in a multi-company study. So far, there is limited literature focusing on the emerging crypto economy model for BSM. Thus, the development of high-level innovation pillars for such a complex context may not be able to capture all elements and relationships (Xiong and Xia, 2020). We are hopeful that the developed crypto economy model with four innovation pillars will offer new directions to help integrate the wealth of research on BSM to advance both practice and research.

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