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A decentralized token economy: How blockchain and cryptocurrency can revolutionize business

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Abstract As the underlying technology of bitcoin, blockchain is expected to create a new economic system by revolutionizing the way we communicate over the internet. Blockchain seeks to improve information security and transparency by sharing encrypted data among peer-to-peer (P2P) networks. Due to its emphasis on security and trust, there is increased demand for blockchain's application in a variety of business sectors. The decentralized nature of blockchain creates the new concept of a token economy in which the community's revenue can be allocated to the actual content producers and service users who create value. This article looks at how blockchain technology and cryptocurrencies are evolving and interconnected, creating a token economy through different business models. Blockchain is expected to be a key technology that enables new protocols for the establishment of a token economy in the future, leading to a new economic paradigm.

1. Blockchain in a mystery novel

Edgar Allan Poe's mystery short story "The Purloined Letter" is considered a masterpiece of classical literature due to its suspenseful plots and twists. The story starts as the noble lady of an imperial family asks for an investigation to find her important missing letter. The suspect is a man named Minister D, who previously visited the lady's home and threatened her with the stolen letter by making an unreasonable request. The Metropolitan Police thoroughly searches Minister D's house but cannot find the letter. The investigation is assigned to the main character, Dupin, who determines that the letter was stuck in the letter holder at the Minister's office. Fortunately, Dupin retrieves the letter by replacing it with a fake letter prepared in advance.

Minister D, the thief in the story, seemed confident managing important information. He intended to generate fundamental confusion in the

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investigation by hiding the letter in plain sight. Although it is not mentioned in the story, the reason Minister D chose the letter holder at his office as a place to keep the stolen letter instead of a more secret hiding place could be ease of care. Keeping the letter in a safe would require additional security devices and extra effort for the safe management, such as a safe password or safe lock keys. If a device is introduced for stronger security but fails to be managed properly, security can be severely compromised paradoxically. Minister D thought that it would be better to bring the stolen letter to his office and verify the existence of the letter from time to time. While the result was disappointing to Minister D, Dupin's investigation was successful. In contrast to the readers' expectation, the idea that the lady's important letter was in a place in which everyone could find it is the beauty of this story.

2. An idea from mystery fiction becomes reality

It is difficult for us as readers to determine whether Poe, who was active during the early 1800s, actually recognized the merits of this information-saving method while writing the novel. More than 200 years later, the idea that the author showed in the novel is currently a hot topic worldwide, but today we refer to it as blockchain. Surprisingly, Poe's fictional setting fits well with the concept of blockchain. Blockchain seeks the value of improving information security and transparency by sharing encrypted data among network members. Sharing information suggests that a particular entity does not monopolize the information. In contrast to the traditional centralized system, it is difficult for any particular blockchain node to falsify information because the same information is distributed and stored across the nodes (Zheng, Xie, Dai, Chen, & Wang, 2017). Due to the absence of a central administrator in the system, this decentralized feature can also hinder external hacking attempts targeted at the central node. Similar to how Minister D confused investigators by keeping the letter mixed with other letters in an open space, blockchain can prepare for external attacks by distributing and sharing information across the network.

2.1. Blockchain: The technology behind cryptocurrencies

Bitcoin, which was first proposed by an anonymous developer named Satoshi Nakamoto, has revolutionized the existing financial system in that it enables reliable transactions to occur through a decentralized system even among anonymous parties (Reyna, Martin, Chen, Soler, & Díaz, 2018). As the underlying technological base of Bitcoin, blockchain is expected to create a new economic system by revolutionizing the way we communicate over the internet (Swan, 2015; Tapscott & Tapscott, 2016). Blockchain is a distributed ledger system in which information on transaction details is shared and verified by P2P network participants (Nakamoto, 2008; Zhao, Fan, & Yan, 2016). The transaction details verified by the network's consensus mechanism can be added to existing blocks and once added into the chain, the block cannot be modified. Because all transactions within a blockchain system are validated and recorded by consensus of the network nodes, the need for a trusted central entity is eliminated (Rennock, Cohn, & Butcher, 2018). Bitcoin is a case of the successful application of blockchain, which is the first global decentralized cryptocurrency. With the progress of blockchain technology, it is expected that blockchain expands its disruptive potential to tokenize and decentralize not only currency but also other business assets (Tapscott & Tapscott, 2016).

Blockchain seeks to improve information security and transparency by sharing encrypted data among network members. Due to its emphasis on security and trust, blockchain is a great fit in the financial sector and, until recently, its widespread popularity was limited. The public's interest in blockchain began when the world's first cryptocurrency, Bitcoin, appeared in January 2009. The blockchain used in Bitcoin is based on a P2P network and validates each transaction through the consensus mechanism whenever a transaction occurs. Transaction information that is approved as legitimate under the network agreement will be stored in the block and a node that creates the block through a process called mining will receive bitcoins as compensation (Vranken, 2017). Transactions between anonymous network participants are still reliable even without the need for a trusted third party or intermediaries.

2.2. The trust machine: The promise of blockchain for business application

The Economist (2015) called blockchain 'The Trust Machine' and predicted that the blockchain system will be performing reliable transactions without human intervention in the future. In human history, the issuance of money has always been controlled and managed by public authorities such as a central government. Bitcoin's significance lies in the fact that it is a new currency system created by an anonymous developer in the private sector. Since there is no centralized issuing entity, a cryptocurrency is quite different from fiat money managed by the government (see Table 1). As we have already seen the extreme price change of bitcoin in the past, cryptocurrencies may have limits in terms of monetary value stability. Thus, it could be premature to replace fiat money completely with cryptocurrencies. Today, there are more than 1,400 cryptocurrencies circulating worldwide, highlighting the flexibility and potential of blockchain-based business models (Zhang, Wang, Li, & Shen, 2018).

Blockchain increases trust between trading parties and reduces costs by allowing direct transactions between participants without intermediaries. Through decentralization, blockchain can reduce transaction costs by directly connecting consumers and suppliers and minimizing conflicts or errors that can occur in contracts through automation (i.e., smart contracts). The U.S. blockchain startup SyncFab helps buyers find manufacturers who can produce their products by directly connecting the two parties. During this process, intellectual property (IP)—including the product idea or manufacturing process—is protected through blockchain and real-time component updates and manufacturing process tracking is possible for use in supply chain management (SCM). The SyncFab platform links buyers and manufacturers directly to reduce the time and marketing costs required for each party to match the other; the platform also guarantees efficient product tracking, quality assurance, and automated payments. The cryptocurrency issued by SyncFab is used as a utility token to operate transactions within the platform.

Another example of a blockchain-based business innovation is Taiwanese startup BioIPSeeds. This company helps researchers in the biomedical field exchange ideas freely via blockchain technology. Some of the researchers' sharable information, such as IP Summary (or a research idea), can be uploaded to the system to obtain other research or funding partners, while individual data or sensitive knowledge can be notarized through blockchain. When research partners are matched, information can be shared between the research parties only through encryption and decryption processes and all transaction processes are recorded in the blockchain. This blockchain-based open innovation can be a way for innovation growth under the current climate in which competition for technology innovation is intense, and uncertainty and risk in technology development are increasing.

Blockchain is not a panacea for industrial development; thus, it is not currently necessary to replace the whole well-operating system completely with blockchain. However, it has great potential in areas for which transaction reliability is important and transaction efficiency can be increased by reducing brokerage costs. Walmart is working with IBM's blockchain technology to track the food distribution process and increase food reliability during the supply process. Maersk is sharing information regarding the transit of cargo in real-time via blockchain and increasing efficiency and transparency in logistics transport. In Sweden, blockchain technology is applied to its national real estate transaction system to expedite efficient and transparent land registration, while preventing counterfeiting and tampering during the process.

Most blockchain studies have focused on how to improve the privacy and security of a blockchain system and its possible applications, yet its potential business models have not been explored actively (Yang, Gavigan, & Wilcox-O'Hearn, 2016). The improved transaction transparency and reliability blockchain affords are of great importance as they enable objective and fair consensus for industrial usage. In this article, I investigate how blockchain technology and cryptocurrencies are evolving, how they are interconnected, and how they create a token economy through different business models.

Table 1. The difference between fiat money and cryptocurrencies

Characteristics	Fiat Money	Cryptocurrencies
Legality (Governments issue and control currencies)	✓	
Tangibility (Have a physical form)	✓	
Supply (Have an unlimited supply)	✓	
Exchange (Exchange is purely digital)		✓
Decentralized (No one can control)		✓

3. Evolution of blockchain technology for industrial applications: From payment system to business platform

According to Melanie Swan, author of *Blockchain: Blueprint for a New Economy* and founder of the Blockchain Science Institute, the development of blockchain technology is divided into three phases (Swan, 2015). In Blockchain 1.0, innovation occurs in the existing currency system as seen in payment and remittance services that use cryptocurrencies. Bitcoin is the 1st generation blockchain paradigm, which is meaningful because it attempted to introduce a single global financial system based on decentralization. In Blockchain 2.0, an autonomous contract can be implemented by Ethereum's Smart Contract, which is called the 2nd generation blockchain. The smart contract sets the content of the contract and execution conditions in advance and automatically executes the contract when those conditions are met (Buterin, 2014). This automation suggests that computer codes can proceed with a legally effective contract without the need for a trusted third party (TTP) that is essential to the current escrow system. The advent of the smart contract demonstrates the applicability of blockchain as an online platform that enables all types of transactions beyond Bitcoin (Buterin, 2014; Reyna et al., 2018). Finally, Blockchain 3.0 is the phase during which blockchain technology is widely disseminated and applied throughout society. As the core infrastructure of the upcoming 4th Industrial Revolution, blockchain is expected to create a new industrial ecosystem as it is applied in various fields beyond financial sectors.

Until now, interest in blockchain has mainly focused on the price volatility of cryptocurrencies and their profit margins. However, cryptotokens are more a way of utilizing blockchain services. Bitcoin can be viewed as a single use case of blockchain because it provides direct value to those who initially used it as an alternative payment method. Other cryptotokens can be considered as a new business model that can substitute for current payment systems (Hileman & Rauchs, 2017). Currently, blockchain is rapidly evolving in terms of scalability and system performance through the development of consensus algorithms in decentralized systems. Moreover, different forms of blockchain models are also emerging across industrial sectors. Diedrich (2016) asserted that in order to apply blockchain to real business models, the advancement of technology should be prioritized. Blockchain is expected to achieve remarkable technological progress in the near future considering the current exponential growth of computing technology.

3.1. How do users reach a consensus in a decentralized system?

As the 1st generation of blockchain, Bitcoin uses a proof of work (PoW) method as the consensus mechanism within the network (Zheng et al., 2017). Whenever a new transaction occurs in the P2P network, it is approved by the network nodes and stored in the block. Thus, the consensus mechanism can be considered a process of validating transaction information. In the case of Bitcoin, this mechanism works through the process of mining and block confirmation. Mining is the process of finding an answer to a type of a cryptographic problem that is difficult to solve and requires a considerable amount of time and computing power (Böhme, Christin, Edelman, & Moore, 2015). Anyone who finds the answer can create a block and other members approve the block so it can be connected to the existing blockchain. Although PoW is an algorithm adopted in many public blockchain platforms, the speed with which it reaches an agreement is slow because the network is open to anyone. It takes an average of 10 minutes to form a Bitcoin block, and only seven transactions can be processed per second (Zheng et al., 2017).

To overcome PoW shortcomings, new consensus mechanisms such as proof of stake (PoS), delegated proof of stake (DPoS) and practical Byzantine fault tolerance (PBFT) have emerged. PoS is a recently developed consensus mechanism that gives nodes with more share (i.e., coins) priority in creating blocks (Reyna et al., 2018). If PoS is a method in which all nodes with certain shares can participate, DPoS is a method of delegating authority to specific nodes in that group (Aras & Kulkarni, 2017). As the word delegated implies, this method aims to reduce the time and cost of the agreement for block generation by delegating the authority to the top nodes selected through the ballot. The top node is usually determined by the total number of coins owned by the members who voted for the node, which is similar to indirect democracy in which people elect a member of parliament by voting.

Finally, PBFT is a method developed to prevent malicious attacks on the network and it is also based on a consensus between nodes. PBFT is unique because one of the network participants becomes a primary participant or leader who

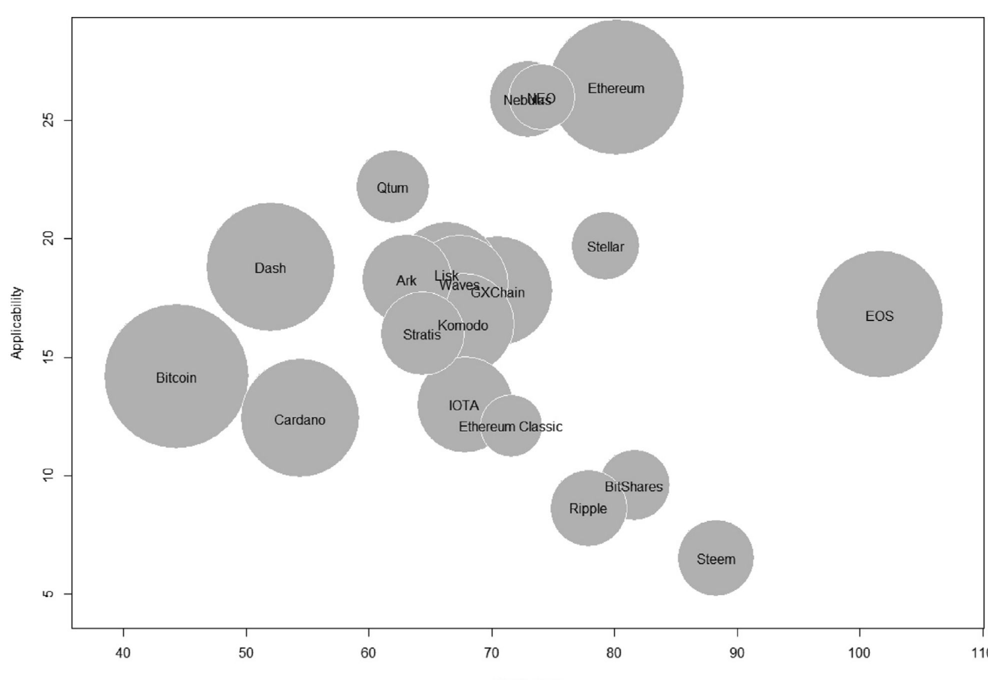
Table 2. Comparison of PoW, PoS, DPoS and PBFT

	PoW	PoS	DPoS	PBFT
Block generation	Anyone	Anyone	Elected representative	Authorized member
Transaction processing speed	Slow	Slow (faster than PoW)	Fast	Fast
Security level	High	High	Relatively low	Relatively low
Rule change	Difficult	Difficult	Normal	Easy
Examples	Bitcoin Ethereum	QTUM	EOS Steem	Hyperledger R3

communicates closely with all other participants (Lemieux, 2017). Because all nodes agree during the block verification process, there is an advantage in that a hard fork (i.e., the blockchain is split into two at a certain point due to network errors) does not occur. However, the processing speed can slow down as the number of network participants increases. Thus, PBFT is mainly applied to private blockchain platforms for businesses, which need a greater degree of control. Table 2 compares these consensus mechanisms and shows their major differences.

Various consensus mechanisms have been developed in the trade-off between decentralization and the processing speed of the network. Cryptocurrencies developed after Bitcoin are adopting these newly developed consensus mechanisms for their public blockchain systems. China's Center for Information and Industry Development (CCID) recently evaluated and ranked public blockchain platforms based on the following three metrics: technology, applicability, and innovation (Wilmoth, 2018). Figure 1 shows a bubble chart of the top 20 public blockchain platforms ranked by overall index scores. The x-axis and y-axis represents technology and applicability scores, respectively, and the radius of each circle stands for an innovation score. As a 1st

Figure 1. Global public blockchain technology assessment index



Source: CCID (http://special.ccidnet.com/pub-bc-eval/index.shtml)
Note: The size of a circle represents an innovation score.

generation blockchain, Bitcoin is evaluated with relatively low technology and applicability scores, but Ethereum, which is regarded as a 2^{nd} generation blockchain, is evaluated as a platform applicable to various industrial areas. Following Ethereum, EOS is expected to become another 3^{rd} generation blockchain platform, offering improved technological capabilities due to its new consensus algorithm (i.e., DPoS).

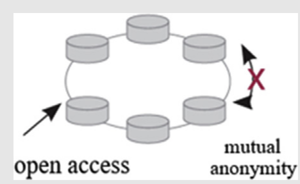
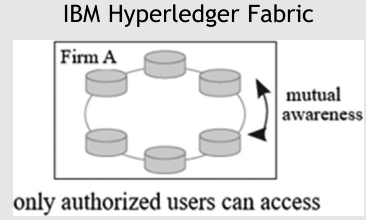
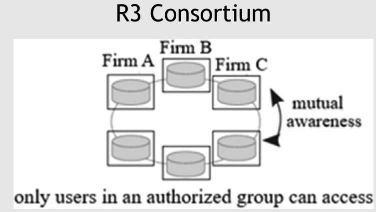
3.2. Different types of blockchain: Public, private, and consortium blockchain

Blockchain exists in many forms and can be applied differently according to its usage purposes (see Table 3). The public blockchain is an open network in which anyone can participate and Bitcoin represents this type (Rennock et al., 2018). Although all participants have free access to the network and its data, a network expansion of public blockchain has a scalability issue due to the large number of unauthorized users involved in the network. Another shortcoming of the public blockchain is the consumptive consensus process that relies solely on computing power, as seen in the PoW mechanism (Pilkington, 2015; Swan, 2015).

Unlike a public blockchain, which has no restrictions on network participation and block generation, a private blockchain restricts network participation and operates mainly on nodes that actually contribute to the network. It allows network participants to customize their own business models as they choose. Many companies, including banks, are paying attention to the potential of private blockchains. Although private blockchain has been criticized as not being truly decentralized because the transaction is approved by a certain central agency, private blockchain still enables companies to build a fast and stable decentralized system by allowing only authorized members to participate in the network (Sankar, Sindhu, & Sethumadhavan, 2017). Private blockchain also maintains the advantage of a blockchain system because it validates network transactions transparently without the need for mining.

Consortium blockchain is an extension of the private blockchain. Unlike private blockchain in

Table 3. Different types of blockchains

Type	Key characteristics	Examples
Public blockchain	• The network is open to any new participants • All participants can be involved in validating the blocks • All participants can read the data contained in the blocks	Bitcoin, Ethereum, and EOS 
Private blockchain	• New nodes are accepted by a central authority • Blocks are validated by an authority and can be subsequently modified • Read rights may be limited by a central authority	IBM Hyperledger Fabric 
Consortium blockchain	• New nodes are accepted based on consensus • Blocks are validated according to predefined rules (approval by a specific number of nodes) • Read rights can be public or limited to certain nodes	R3 Consortium 

Source: PwC (https://www.pwc.com/gx/en/insurance/assets/blockchain-a-catalyst.pdf) which the owner has full authority, consortium blockchain preselects several nodes to which permissions are granted (Sankar et al., 2017). Thus, the consortium blockchain not only enhances network security through limited participation while maintaining a decentralized structure but also solves the problem of slow transaction speed and network scalability issues.

Amid the growing interest in blockchain around the world, international cooperation for utilizing blockchain technology is on the rise. Global financial institutions are attempting to build platform ecosystems such as R3CEV and Hyperledger to standardize blockchain services. R3CEV is the world's largest global blockchain consortium; it was formed in September 2015 to design the right solution and facilitate blockchain technology within financial industries (Prasad, Shankar, Gupta, & Roy, 2018). The consortium is run by a financial IT venture company R3 and approximately 70 financial institutions participate, including Bank of America (BOA), Citigroup, and HSBC. R3 Corda is a new decentralized financial service platform developed by R3CEV specifically for financial service transactions. The Hyperledger project is an open source project under the Linux Foundation. Many companies are participating, including Ripple, IBM, JP Morgan Chase, and Cisco, and all transactions based on the framework are open to network participants and protected through encryption (Cachin, 2016). The project seeks to develop a blockchain platform that enables customized service development based on user needs. It has developed an open source distributed ledger for corporate settlement, product tracking, and project management and it is currently working on completing an open standard blockchain platform. IBM and the Hyperledger consortium recently unveiled the enterprise blockchain network framework, called Fabric, leading the expansion of blockchain technology worldwide with open source-based blockchain software development (Sankar et al., 2017).

As expectations for the industrial applicability of blockchain increase, ensuring interconnectivity between different blockchain platforms is becoming increasingly important. As the number of blockchain-based technologies is expected to surge in the future, there is a need for industrial standards that can enable the blockchain ecosystem. To support the convergence of heterogeneous platforms, blockchain industries are devoting themselves to developing technologies like Sidechain, which enables secure trading of cryptocurrencies of different blockchains (Pilkington, 2015), or Cosmos, which supports the interoperability of various blockchain platforms (Tasca & Tessone, 2018).

4. Beyond bitcoin: Industrial usage of blockchain

In addition to the function of cryptocurrencies such as Bitcoin, demands for the application of blockchain are expanding to include a variety of business sectors. Compared to previous blockchain models that have simple payment and verification functions, the 2nd generation blockchain, Ethereum, offers various applications that can be carried out by it smart contracts and decentralized application (DApp). Over 900 DApps launched in 2018 and various services are being built on the Ethereum platform, including games, asset management, and decentralized exchanges. Due to this scalability, blockchain is considered to be a new economic system because it can improve existing services and propose completely new business models.

In 2016, Ethereum founder Vitalik Buterin presented a decentralized autonomous organization (DAO) as an example of DApp. DAO is a new type of governance system in which a large number of participants jointly decide on aspects of organizational management, such as financing and investment, without the involvement of a CEO or a board of directors (DuPont, 2017). The decisions based on a vote by the members of the organization can be verified and fulfilled in real time through the smart contract function, which can eliminate operational errors and uncertainties. DAO was set to replace crowdfunding or venture capital as it enables transparent and fair revenue distribution to participants. Although the DAO project failed due to external hacking that maliciously used an error in DAO's smart contract coding, it is still significant that the project attempted a new and revolutionary approach to venture capital financing (Chen, 2018). As the DAO example shows, the use of tokens in the blockchain network is not only a new way of raising funds or financing but also a new way of building a company's own ecosystem.

4.1. Types of blockchain tokens

Blockchain tokens are considered new assets globally and they are attracting large numbers of investors around the world. With the birth of Ethereum and the recent initial coin offering (ICO) boom, newly issued tokens are evolving beyond simple coins to become more functional (Catalini

& Gans, 2018). An ICO, which is a means of generating tokens and raising funds, is a critical factor for vitalizing a blockchain ecosystem but the risk of scams or fraud also increases as the number of ICOs increases. According to a recent survey of 1,450 ICOs by the *Wall Street Journal*, 271 ICOs (approximately 18% of the sample) were found to be fraudulent, characterized by such problems as the disappearance of the project team, a falsified plan, or plagiarism of another project's white paper (Shifflett & Jones, 2018). This suggests that active government intervention in the ICO and token market is necessary.

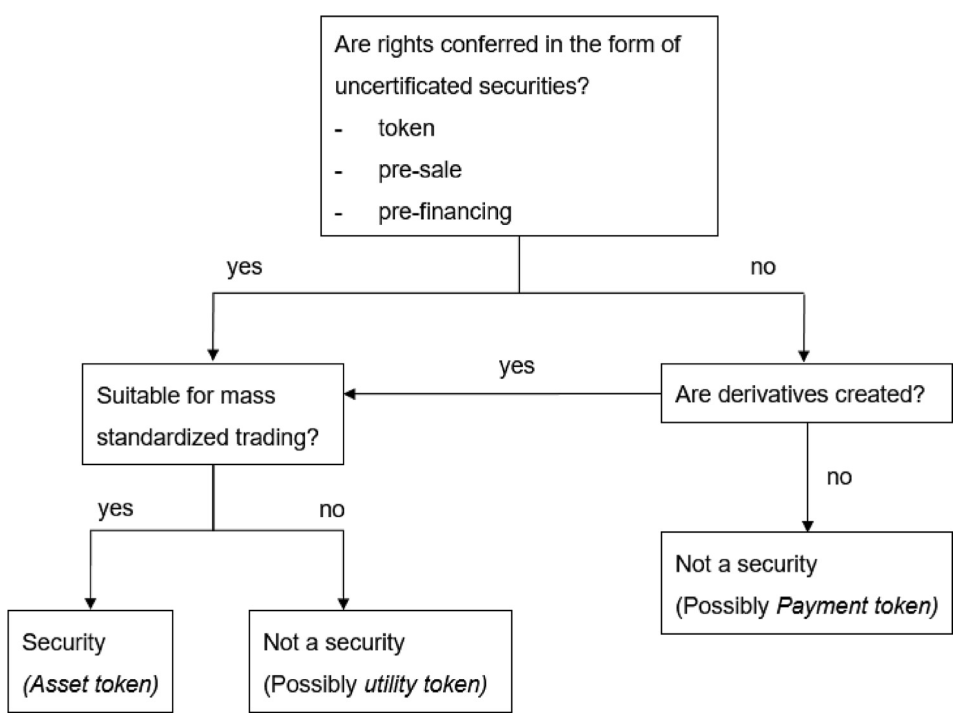
In February 2018, the Swiss Financial Market Supervisory Authority (FINMA) released ICO guidelines and divided the nature of tokens into three categories (FINMA, 2018a). FINMA plans to regulate ICO tokens depending on their nature and will apply different requirements for each. The first type, a payment token, is used to purchase certain goods or services as a payment method or remittance. The payment token is used in combination with other cryptocurrencies. Because a payment token relates to the transfer of money, the Anti-Money Laundering Act can be applied. The second type is a utility token, employed when people use applications or services built on the firm's blockchain platform. The third type is the asset token, which is the form of dividends that depend on the firm's future profits and cash flows. Thus, it is a concept of a user's share that is similar to stocks or securities. Figure 2 shows a FINMA framework that categorizes ICO tokens based on their key features (FINMA, 2018b).

Although blockchain tokens are flexible and easy to trade in the global market, there also exists a high risk due to the uncertainty of token values and information asymmetry in the market (Sehra, Smith, & Gomes, 2017). The Swiss FINMA's ICO guideline is meaningful in that it enhances the predictability of ICO regulations for both token issuers and investors and also sets out the principles of ICO practice for regulatory authorities themselves, thus building a foundation for a stable ICO ecosystem in the future.

4.2. The decentralized token economy and its applications

Unlike a currency, a token operates through a smart contract on top of a blockchain (Massey, Dalal, & Dakshinamoorthy, 2017). The token economy is mentioned in the context of the blockchain ecosystem so it can build a set of

Figure 2. FINMA's token category classification



Source: FINMA (https://cryptovalley.swiss/?mdocs-file=42114, p.14) mechanisms from service implementations to user rewards through program-based economic design in online networks (Tasca, 2019). A properly designed token economy also considers the amount of token issuance, compensation for participants, redistribution of wealth, and users' ongoing service engagement. Thus, if the token economy is implemented ideally, then the participants can optimize their activities to pursue their own interests, leading to overall quality improvement of all services (Pazaitis, Filippi, & Kostakis, 2017). In this regard, one of the most important features for the successful blockchain-based business model is the establishment of a compensation system for participants.

Recently, blockchain-based content services have emerged, allowing consumers to directly reward producers' content. These content services are moving away from the structure of traditional internet portals in which most of the revenues are generated by advertisements (Pärssinen, Kotila, Rumin, Phansalkar, & Manner, 2018). Until now, major portal sites have had access to monopoly profits as network administrators (Cowen, 2018). Because the revenue of a portal site mainly comes from online advertising sales, some platforms concentrated on increasing website traffic rather than the intrinsic value of their content. However, thanks to blockchain and cryptocurrencies, a new token economy model that compensates for the quality of content has recently emerged. For example, SteemIt is a social networking service that utilizes blockchain technology and provides incentives for a user's community contributions such as posting, commenting, or voting. Users can reinvigorate the community by compensating high-quality content with Steem tokens. Another similar example is DTube. Unlike YouTube, DTube compensates video uploaders with cryptotokens. DTube has no advertisements and no video censoring systems but it can self-clear inappropriate content by employing users' voting activities for a video (i.e., upvotes and downvotes, which are similar to YouTube's likes and dislikes, respectively). These cryptotoken-based business models suggest a new way of generating revenue by providing compensation to the content creators directly. This triggers a virtuous cycle in which content creators are more likely to focus on improving their content quality as they are increasingly rewarded with better content.

Meanwhile, the World Economic Forum (WEF) recently predicted that, within a decade, blockchain technology will bring about a dramatic change in our lifestyle (WEF, 2015.). The organization forecasted that blockchain will replace or supplement existing systems as a completely new industrial infrastructure and will create innovative services via integration with other core technologies of the intelligent information society. This shift has already begun as evidenced by the following examples.

- As interest in microgrids for stable renewable energy trade has increased in the 4th Industrial Revolution era, individual energy transactions through a blockchain platform have become more popular (Basden & Cottrell, 2017).

- The Brooklyn Microgrid Project, which is currently underway in New York, is operating a blockchain model that allows more than 50 households in the region to manage energy produced from individual solar panels and to trade with each other through personal mobile apps in real time (Mengelkamp et al., 2017).

- Blockchain can also be used as a platform for charging electric vehicles. A German electric power company, Innogy, is developing a blockchain platform for individuals to charge and pay for electric power for their vehicles (Basden & Cottrell, 2017). Through the decentralized system, the owners of private charging stations are connected to the blockchain network and can sell their power through its payment platforms.

- Swytch Token, which was codeveloped by the MIT Media Lab, is also based on a method that pays tokens to individuals who have solar energy generation systems and compensates these individuals with tokens by calculating energy production and carbon emission reduction measured through personal mobile apps. In this way, blockchain platforms in the energy sector help users reduce power transaction costs, share reliable energy trading information and create new energy markets. Here, the blockchain-based token payment system is enhancing opportunities for small energy producers and consumers (i.e., prosumers) to build their own distributed energy trading systems.

As the Internet of Things (IoT) and artificial intelligence (AI) technologies develop, more stable operation data will become important and blockchain could lead to the spread of big data markets by providing data security for personal information protection and the ability to directly control such data. In particular, the usefulness of the AI services provided by companies depends on how many consumers choose to use these services, which is fundamentally related to trust in the appropriate utilization of personal data and the algorithms applied to the analysis (Kaplan & Haenlein, 2019). Thus, the prevention of data forgery through blockchain can increase the reliability of AI data and ultimately improve the quality of AI services. Furthermore, to maximize the value of the data produced in real time, each individual's data uploaded to a blockchain network can be used as credible learning data by AI developers in the future. At Ocean Protocol, a company providing artificial intelligence data platform services, all members who contribute to the activation of these blockchain service ecosystems can benefit from openly sharing data through token payments. As we already discussed, this is the basic concept of the token economy in which the revenues that have been owned by a few managers are allocated to the actual content producers and service users who create the value of a successful company. In the token economy, a new innovation model can be realized in which both companies and consumers are compensated adequately. Blockchain will be the key technology that enables the new protocols of a token economy to work.

5. Blockchain and cryptocurrencies: Digitally building a new business ecosystem

The digital revolution, which started with the advent of the internet, is now entering a new phase of development with the emergence of blockchain. While the pre-blockchain internet was devoted to its internet of information function, which simply connects providers of information with the consumers who use it, a new blockchain-based internet will open a period of the internet of value, which will reshape existing business models through improved transparency and reliability of information (Tapscott & Tapscott, 2016). In fact, even before blockchain, there was an effort to share objective and reliable information across consumers. In online shopping malls such as Amazon, the reason people post product reviews with 5-star ratings is to help others make a more rational choice by sharing information (Metzger & Flanagin, 2013). Users evaluate the products by sharing information produced by consumers themselves and not just based on the information offered by service providers. The blockchain innovation will help achieve a more objective and fair consensus via a decentralized process that prevents a certain entity from monopolizing information.

It seems clear that blockchain will be one of the key technologies of the upcoming digital age (Deloitte, 2018; WEF, 2015.); it will help users share information more equitably in a more open but safer way than what the existing internet offers. Blockchain is likely to be combined with key technologies that will lead to the 4th Industrial Revolution, including AI and IoT. A connection between IoT devices via blockchain allows new nodes to easily participate in the network without the need for a central system, thereby reducing costs and increasing scalability (Sun, Yan, & Zhang, 2016). Moreover, blockchain can be used as a base technology for reliable and secure data transmission in the upcoming IoT era. For example, in SCM, a blockchain IoT system connects manufacturers, retailers, and consumers through network nodes, providing transparent and reliable information in a series of processes related to product supply and consumption (Saberi, Kouhizadeh, Sarkis, & Shen, 2018). Combined with AI technology, blockchain can also contribute to smoother traffic flow in the intelligent transport system (ITS) as a base technology for data transmission and analysis between vehicles, service providers, and system administrators (Yuan & Wang, 2016). It is expected that more disruptive and innovative services will be created in the near future when blockchain is combined with other core technologies.

The blockchain industry is still in its infancy globally. Thus, there exist many technological and legal issues to overcome. Compared to a centralized system, blockchain systems so far have been constrained by their low transactions per second (TPS) as a result of the consensus mechanism. Technological advancements should by preceded by expanded blockchain services to various industrial fields that require rapid processing of large volumes of data. For example, recently developed cryptocurrencies such as EOS and Cardano are new blockchain projects intended to solve problems related to Bitcoin and Ethereum, such as low processing speed and lack of a governance function (Chatsko, 2018).

To reinvigorate the blockchain business model, it is also necessary to develop a legal and institutional basis for preparing for the future token economy. Unlike crowdfunding, blockchain tokens can be traded flexibly in the global market, providing a huge investment opportunity (Chen, 2018; Massey et al., 2017). Similar to the innovations of social media in communication (Kaplan & Haenlein, 2010; Kietzmann, Hermkens, McCarthy, & Silvestre, 2011), a token-based blockchain business model is revolutionizing existing venture investments in a more transparent and democratic way so that anyone can participate in early investment. In a token economy in which various cryptotokens are traded actively, financial institutions need to consider cryptotokens a complement to existing currencies and, thus, provide sufficient liquidity to the market. It is also necessary for the government to develop a legal framework for consumer protection (Rennock et al., 2018).

It is time to take a step back from the recent controversy over cryptocurrencies and pay attention to the true value of the underlying technology: blockchain. The improvements in transaction transparency and reliability pursued by blockchain are of great importance in that they enable more objective and fair consensus in terms of technology innovation and social perspectives.

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