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Abstract

Blockchain has recently become the center of attention as a key technological tool to impact a broad range of organizations and affect the overall economy. Blockchain technology, also referred to as Distributed Ledger Technology (DLT), was initially created as the platform technology that enables Bitcoin that are issued and maintained by anonymous participants around the world. Reacting to the wider acceptance of digital currencies in the private sector, such as Bitcoin, there is a growing interest in the wider use of similar digital currencies in a different context. For example, central banks in countries such as the United Kingdom, Sweden, Cambodia, and Canada are reported to be considering their own digital currencies. There is also a trial to use digital currencies to enable payments for the Internet-of-Things, such as automobiles and solar cells. Some start-up companies use digital currencies to collect investments. Issuance of digital currencies for a variety of contexts and purposes could change how the economy works. This paper provides a conceptual framework and technological implementation of a digital currency for community vitalization and reports the results of a Proof-of-Concept using a new local currency, “Moeka.”

Keyword

Digital Currency, Blockchain, Bitcoin, Distributed Ledger

1. The Overview of Blockchain Technology¹

1.1. Development of Blockchain

Blockchain is a framework for achieving distributed consensus about data, and was initially introduced to provide a distributed and immutable ledger for the crypto-currency, Bitcoin. It was proposed by a pseudonymous author called Satoshi Nakamoto in a paper (Nakamoto, unknown). Because blockchain technology was developed to enable Bitcoin, it is often discussed in the context of financial innovation and *FinTech*. However, blockchain is a technology for data processing and is thus able to be adopted for more general purposes beyond digital currencies. There is a growing expectation that blockchain technology can be applied to a variety of uses, from general record-keeping to the Internet-of-Things.

Observing the potentially disruptive nature of blockchain technology, the government of the United Kingdom (2015) states that, “algorithms that enable the creation of distributed ledgers are powerful, disruptive innovations that could transform the delivery of public and private services and enhance productivity through a wide range of applications” (p.5). The applications of blockchain technology do not apply only to the private sector, but governments can also benefit from the utilization of blockchain technology. Because of the breadth of applications of blockchain technology, the impact can be enormous. For example, a report from METI (2016) states that blockchain can affect industries that have a combined worth of 67 trillion yen, and suggests it can have an impact on industry structures.

Because of ongoing innovation and development in the blockchain space, there is no consensus on the definition of what a blockchain is. Examples of possible definitions are, “a list of validated blocks, each linking to its predecessor all the way to the genesis block” (Antonopoulos 2014), and “the public ledger of all Bitcoin transactions that have ever been executed” (Swan 2015). These definitions mostly reflect the blockchain within the context of Bitcoin. On the other hand, the UK Government (2015) focuses on the general use of blockchain technology and defines it as “a type of database that takes a number of records and puts them in a block (rather like collating them on to a single sheet of paper)” (p.17). Blockchain is still in the initial stage of development, but is expected to be an infrastructural technology that is built on top of the Internet and can provide a general-purpose platform for value-exchange and asset management.

1.2. The Attributes of General Blockchain Technology

Blockchain technology is still rapidly evolving, and has many variations, but there are three common attributes, as follows.

The first attribute is tamper-evidence. Blockchains form data into a structure called a *block*, by collecting a set of transactions (for example, value transfers between accounts) that are generated, and storing them in a block data structure along with meta data (such as a timestamp). This block data structure is then linked to previous blocks by including a pointer in the header to the most recently generated block. An element (hashed data of the previous block’s header) is included in the block, making any changes to past transactions tamper-evident and therefore making it difficult for attackers to manipulate past data. The overall structure of the blockchain is shown in Figure 1.

¹ The introduction to blockchain by the author is also available in Japanese at Takagi (2016).

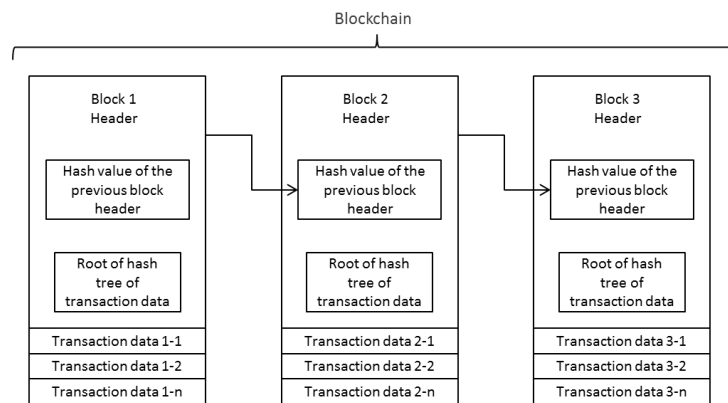


Figure 1. Overview of the typical blockchain structure

The second attribute is connecting entities and values. An entity is the owner of some asset representing a value, and is identified by the owner's public key. The owner of the asset, is usually a person or organization, but it can be expanded to devices, in the context of the Internet-of-Things. The owner can use the value in a transaction only if he or she can prove that they have the corresponding private key. This is done by creating a digital signature on the transaction data, proving the intent to use the value in a transaction; this is the digital analog of signing a check. Blockchains prevent the double spending of values by sharing transaction data (the ledger) with every peer on the network and restricting values to only be used in a single transaction (in the case of Bitcoin).

The third attribute is the use of a peer-to-peer (P2P) network as the medium for data transmission. Instead of storing data in a single, monolithic server, distributed and unspecified computers share the data on the blockchain network. There is no need for an expensive, highly reliable server, as the network can still process transactions even if a server goes down, so long as other servers are still working. This structure has enabled Bitcoin to work for over 8 years with no major down time.

On the other hand, there is the risk of different versions of data coexisting in different parts of the network, if the data are stored in distributed computers that are updated simultaneously in different places. To avoid this disparity, a decentralized consensus mechanism is needed to get the network to agree on a single version of the data. The Bitcoin blockchain adopts the "Proof-of-Work" algorithm. In Proof-of-Work, servers that join the network compete against each other independently, to see who can solve a computational problem first. Whoever solves the problem wins the right to create a new block in the blockchain and transmit it to other peers in the blockchain network. If multiple blocks are broadcast to the network by different peers at approximately the same time, the block that is used as a basis to build the longest blockchain is considered as the correct block; this provides eventual consistency for data on the network.

An important point is that the servers that contribute to the blockchain by creating a new block are run by anonymous participants whose work is rewarded by giving newly issued units of currency (Bitcoins, in the case of the Bitcoin network). Through this system, blockchain enables the management of the system without any centralized control or administrators, forming what is called a DAO (Decentralized Autonomous Organization).

1.3 Digital Currencies

Bitcoin was the first and has been the most popular digital currency using blockchain technology. There are many articles pointing out the volatility of the price of Bitcoin, but recently its price reached a record-high of US \$1,533 on March 5th, 2017². On the other hand, transactions using Bitcoin, are also growing (Figure 2).

The total supply of Bitcoin is designed to have a cap of 21,000,000 BTC. Every time a block is created in Bitcoin—on average once every 10 minutes—a reward of new Bitcoins is created from nothing and given to the block creator (referred to as a miner in the parlance of the Bitcoin network). This reward is halved approximately once every four years, and is currently 12.5 BTC. The fixed monetary policy of Bitcoin is one of the reasons for the fluctuation of the Bitcoin price³.

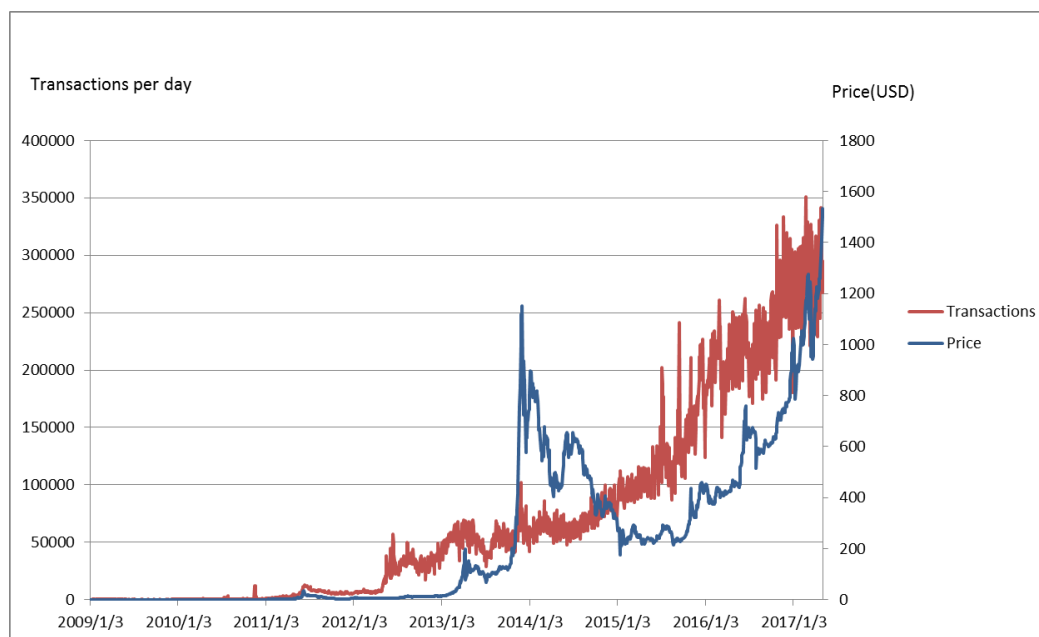


Figure 2. Transaction rates and historical prices of Bitcoin

However, Bitcoin is not the only digital currency using blockchain technology. After the release of Bitcoin, similar currencies with similar technological architectures emerged. These are typically referred to as alternatives to Bitcoin, or *alt-coins*. While some alt-coins have fundamental technological innovations, many are merely copies of Bitcoin or other projects. As of April 7th, 2017, there were 780 digital currencies that were listed on coinmarketcap.com⁴. The top 10 digital currencies based on the market capitalization are shown in Table 1.

² <https://blockchain.info/ja/charts/market-price?timespan=all>

³ Other reason would be the massive transaction based on the speculation around the world.

⁴ <https://coinmarketcap.com/all/views/all/>

Table 1. Top 10 digital currencies in market cap⁵

Rank	Currency	Symbol	Market Cap (USD)	Price
1	Bitcoin	BTC	\$19,011,478,838	\$1169.25
2	Ethereum	ETH	\$3,936,466,670	\$43.51
3	Ripple	XRP	\$1,176,142,960	\$0.03
4	Litecoin	LTC	\$525,791,473	\$10.41
5	Dash	DASH	\$493,185,766	\$68.35
6	Monero	XMR	\$276,084,178	\$19.37
7	Ethereum Classic	ETC	\$239,112,149	\$2.64
8	NEM	XEM	\$154,800,000	\$0.02
9	Augur	REP	\$114,447,300	\$10.40
10	MaidSafeCoin	MAID	\$81,494,733	\$0.18

Source: <https://coinmarketcap.com/all/views/all/>

Given the growing positive perception and acceptance of private digital currencies, central banks have been examining the possibility of issuing their own digital currencies. Digital currencies that are issued by central banks using blockchain technology are generally referred as Central Bank Digital Currencies (CBDC). The interest of central banks is driven partly by the competition between fiat money and private digital currencies, but also by the motivation to improve the efficiency of their own currency systems by taking advantage of new technology. In terms of the competition, the market capitalization of digital currencies is still very small. For example, the global market cap of Bitcoin is 0.1% of the money stock of JPY. However, if the use of digital currencies grow rapidly, the effectiveness of monetary policy by central banks could be largely undermined.

On the other hand, digital currencies have many convenient features, such as ease-of-use for transfer transactions between users and low-cost transfers of money across national borders. For example, the Bank of Canada examined the benefit of issuing CBDC and developed the framework to assess whether CBDC can improve the retail payment system (Fung and Halaburda, 2016). On the other hand, digital currencies have unique functional features that could change the concept of money itself, and forward-looking central banks are gradually examining the impact of employing blockchain technology in their monetary systems.

2. Prior Studies

An increasing number of papers are being published about digital currencies and blockchain technology. One such paper is Cheah and Fry (2015), who explores the fundamental value of digital currencies. Gandal and Halaburda (2016) discuss the competition among currencies and

⁵ <https://coinmarketcap.com/all/views/all/> (Accessed April 7th, 2017)

the network effects of digital currencies. Hayes (2016) explores how the value of digital currencies are determined, and analyzes three elements of digital currencies by regression analysis: “the level of competition in the network of producers, the rate of unit production, and the difficulty of the algorithm used to “mine” the cryptocurrency” (p.1). The legal and political aspects of digital currencies are also one of the topics discussed by Hayes. Iavorschi (2013) discusses governmental intervention in digital currencies, while Kowalski (2015) explores taxation issues.

Several important books have also been written on the general use of blockchain technology. Antonopoulos (2015) provides a detailed description about how Bitcoin and blockchains work, while Swan (2015) focuses on the utilization of blockchain, and how it can be used for various digital assets. Tapscott and Tapscott (2016) discuss the general impact of blockchain. Raval (2016) describes a wide range of aspects of decentralized applications and services using blockchain.

Related to currencies, there are prior studies that discuss the proper geographical or economic areas that use a single currency. For example, Jacobs (1984) illustrates how a single sovereignty and corresponding currency harmed the development of local and rural communities because they generally benefit only central and metropolitan areas by providing substantial import-substitution forces. On the other hand, Stiglitz (2016) points out that the problem with the Euro is that a single currency is being applied to different countries that have wide disparities of economic performance. He argues that if countries have different situations, they would need different interest rates and exchange rates. Based on these arguments, Tanaka (2016) suggests the possibility of a digital, local JPY, which can solve the disparity of the economic performance of local areas in Japan, but still works as integrated JPY.

Regional or community currencies are discussed in the context of local exchange trading systems (LETS) (Seyfang 2001). These kinds of currencies have both economic and social impacts for vitalizing local communities. For example, they recognize and value informal work, improve employability, and promote local economic activity to consider the economic impact, and build social capital, tackle social exclusion, and boost self-confidence to consider the social impact (Michel and Hudon 2015, Nakazato and Lim 2016). Although there have been numerous regional or community currencies all over the world, most of them are used in limited geographical areas and it is difficult to spread beyond geographical borders (Seyfang and Longhurst, 2013). One of the reasons for the geographic limitations is that traditional LETS depend on physical materials such as paper bills and paper ledgers. However, digital currencies based on distributed ledger technology could help transcend geographies and introduce new community currencies that spread beyond geographical borders.

Based on the above-mentioned prior studies, the present research focuses on the potential for digital currencies to vitalize local communities, in particular considering the communication and social interactions of residents and regional economic disparities. This research aims to investigate the possibility of the use of digital currencies for community vitalization and to report the results of a Proof-of-Concept (PoC) that was conducted with a new local currency, “Moeka.”

3. Conceptual Framework

The conceptual framework of the PoC is shown in Figure 3. Issuance of the digital currency was designed to incentivize the participants to communicate with each other and conduct activities to contribute to the local community. These actions were considered to increase the value of the community, which would be measured by the frequency of communication between people, increase of social capital, and overall cleanliness of the place. These additional values for society would be capitalized and support the issuance of the digital currency cyclically.

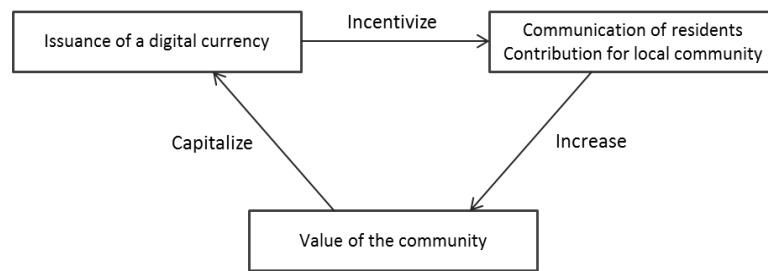


Figure 3. Conceptual Framework of the PoC

The design of the workflow for the PoC is in Figure 4. At first, participants performed some actions for the community, such as communicating with others, contributing to the community by cleaning the venue, and by promoting the event. By doing these actions, participants received a certain amount of Moeka.

Once they received Moeka, they could use the currency in two forms: one was to bet on a raffle to get Moeka goods; the other way was to buy goods such as coffee, popcorn, and cocoa directly. Unfortunately, the Moeka goods and coffee, etc., were not obtainable by the value contributed by the initial action, such as shown in the conceptual framework. Instead, these goods were purchased using Japanese Yen by the event organizers.

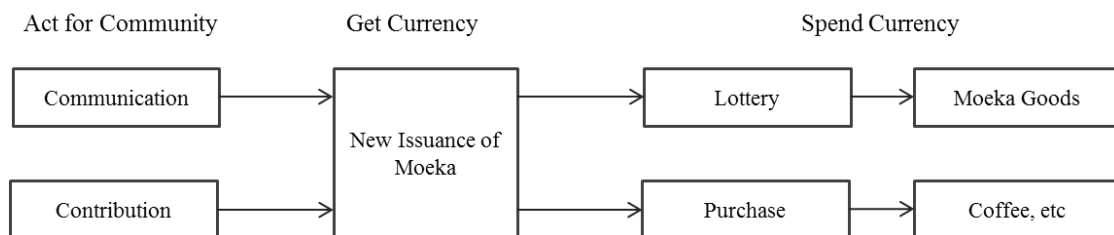


Figure 4. Workflow of the PoC

This research aimed to bootstrap the value-exchange relationship, using a bottom-up approach, rather than a unified money such as the Japanese Yen. As discussed later, Moe-sai was a suitable place to study the value-exchange relationship by observing the visiting anime-lovers and their exchange of values for goods.

The cost of using a conventional (non-blockchain) system architecture to provide the infrastructure for such a currency system as Moeka would be relatively high and require expensive, high-reliability hardware. Therefore, this PoC utilized a new value exchange platform based on Hyperledger Iroha to create Moeka, that was developed to fit the environment of Moe-sai.

4. Description of the Proof of Concept

The field test utilized Hyperledger Iroha, an open source, distributed ledger platform. Hyperledger Iroha is developed in C++ and was originally created and is co-maintained by Soramitsu, a fintech

company located in Tokyo, Japan. Mobile applications were created for Android and iOS, and allowed end users to transfer Moeka between each other.

4.1 Technological implementation

The blockchain platform used for the experiment was Hyperledger Iroha and the development of the prototype and applications, as well as administration of servers, was performed by Soramitsu Co, Ltd. Native smartphone applications were implemented in iOS Swift for the iPhone and Java for the Android platform. These applications utilized the open source libraries that are a part of the Hyperledger Iroha project.

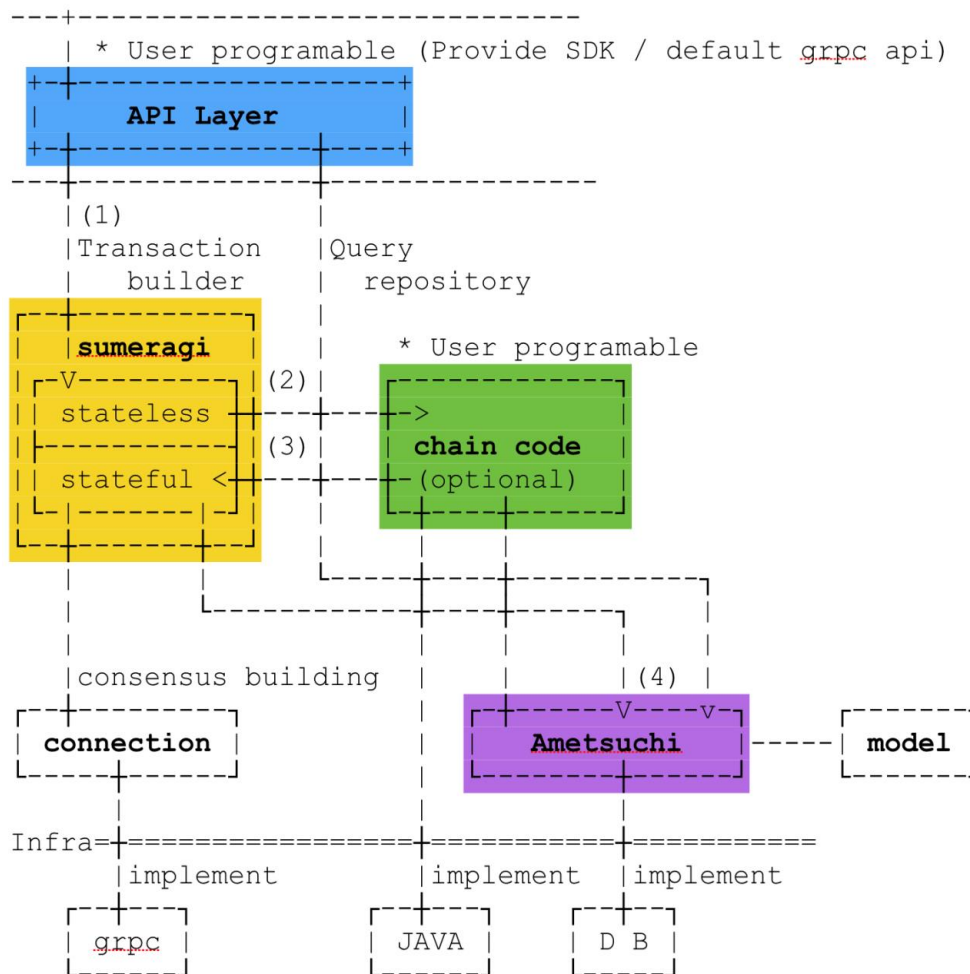


Figure 5. Architecture of Hyperledger Iroha

4.2 Field test environment

For the field test, an API server to communicate with the mobile apps was set up, which then processed transactions from the mobile apps and relayed them to Hyperledger Iroha for

transaction processing. Transactions were processed and finality was achieved, committing the transaction to the ledger within 1s.

4.2.1 Moe-sai

The PoC was conducted at an event called, “Moe-sai.” Moe is a Japanese slang that refers to the affection towards characters in anime, manga, and video games⁶. “Moe-sai” is an event that exhibits the general “otaku”⁷ culture around the Aizu region. It was organized in relation to “Magical Fukushima,” which was conducted by GAINAX, an animation company that is well known for “Evangelion.” The event was composed of attractions such as shows by voice actors, display of Itashas⁸ which decorate animation characters, and cosplays⁹. Moeka, the name of the coin, was taken from this Moe-sai.

Moe-sai was conducted on November 3rd, 2016, between 9 AM and 5 PM, at Aizu-mura, which is located in Aizu-Wakamatsu City, Fukushima Prefecture. Around 800 people attended the event. The PoC of Moeka was conducted in one room at the venue.

4.2.2 Issuing the Moeka Currency

There were three ways to initially create new Moeka: 1) install the app on a phone, 2) communicate with other participants, or 3) by doing some requested task. This issuance was similar to the mining of Bitcoin, as a completely new issuance of money. Installing the app on a user’s phone resulted in the creation of a certain amount of Moeka, as shown in Table 2.

One way that new Moeka was issued was by the communication between participants. One of the participants would shake their smartphone to show a QR code, while the other read the code by his or her smartphone. If the QR code was read within 5s, then approximately 33 (+/- 7% randomness was added to make the action hard to compare with traditional currencies, like the Japanese Yen) new units of the Moeka currency were created and distributed to each of the participants (the participants each received the same amounts). This method for currency issuance thus created a way to quantify the value of communication between two participants. The second method of issuance for the Moeka currency was a reward for work which was desired by the steering committee of the event. When visitors conducted the work, Moeka was transferred from the virtual “job center” to those visitors¹⁰.

Moeka was valid only during the one-day event.

⁶ [https://en.wikipedia.org/wiki/Moe_\(slang\)](https://en.wikipedia.org/wiki/Moe_(slang))

⁷ <https://en.wikipedia.org/wiki/Otaku>

⁸ <https://en.wikipedia.org/wiki/Itasha>

⁹ <https://en.wikipedia.org/wiki/Cosplay>

¹⁰ Initially it was designed that Moeka would be issued as mining, but it was transferred from the job center.

Table 2. Issuance of Moeka

Category	Task	Amount (Unit: Moeka)	Description
Introducing Applications	Introducing Applications	60	Moeka was issued with fixed rate
Communications	Inter-participant communication	33, +/- 7% randomness	Moeka was issued with a random spread
Tasks	Trash collection	60	30 minutes
	Advertisement: Board	120	30 minutes
	Advertisement: Tissue arrangement	50	30 minutes
	Advertisement: Tissue distribution	100	
	Advertisement: SNS	30	

4.2.3 Spending Moeka

There were several ways to spend Moeka at the event. It should be noticed that Moeka could be used only during the event, because of legal requirements and the limited time for preparation. The ways to spend Moeka is shown in Table 3.

Table 3. Spending Moeka

Category	Task	Amount (Unit: Moeka)	Description
Lottery	Goods	30	For one bet
Lazar cutter decoration	Making a key holder	300	Local venture business opened a shop to provide the cutting service with an amount of the fee
Food stand	Popcorn	130	
	Cocoa	500	
	Coffee	150	
	Voting rights for Itasha	70	
	Voting rights for Cosplay	70	
Experiencing Electric Vehicle	Riding in the mobility facility	300	
Drinks at city	One drink (Sake) at restaurants in the city	30	

5. Results

5.1 User profile

The age and sex of registered users is shown in Table 4. A total 160 users registered for Moeka. The number of male users were about 4 times that of female users. In terms of age, the 20s age-range dominated, at around 50% of all users. This reflects the demographics of Moe-sai, which is popular among relatively young hobbyists. The overview of ages and sex is also shown in Figures 6-1 and 6-2.

Table 4. The overview of ages and sex

Sex / Age	N/A	10s	20s	30s	40s	50s	60s	70s	80+	Total
Female	1	8	17	1	0	2	0	0	0	29
Male	2	16	67	19	12	0	0	1	0	117
N/A	10	1	2	1	0	0	0	0	0	14
Total	13	25	86	21	12	2	0	1	0	160

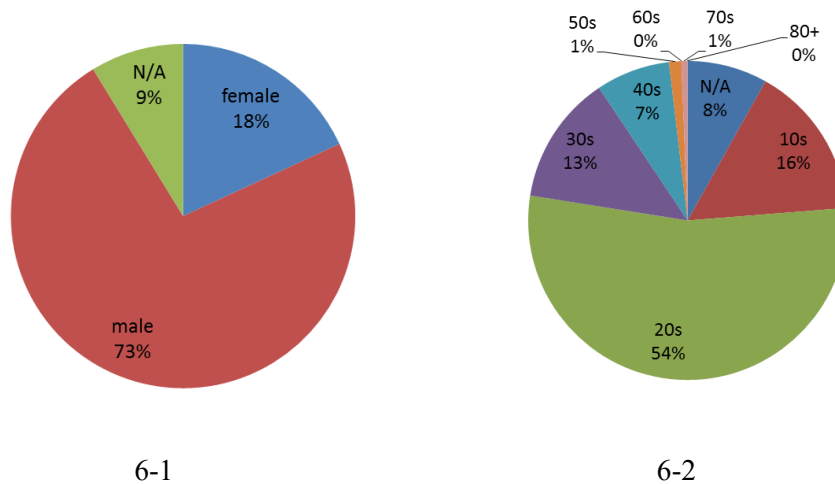


Figure 6. Age and sex of users

5.2 Use by participants

Table 5 shows the number of Moeka transactions at the event. In total, 774 payments were made, with an average of 4.84 payments made per user. For communication events between participants, 1,684 transactions were made. On average, one user participated in a communication event 10.53 times. This means that one user, on average, met about 10 new users to communicate with, being motivated by the prospect of receiving Moeka.

Table 5. Number of Transactions

	Frequency	Percent of total	Average frequency by users
Payments	774	31.49%	4.84/user
Communication events	1,684	68.51%	10.53/user

Table 6 shows the summary of payment transactions. The average amount of Moeka that was spent was 105.38, but was influenced by small number of transactions which sent a large amount of Moeka. The median of amount was 60 Moeka. Figure 7 shows the distribution of the amount spent.

Table 6. Summary of Payments

	N	Mean	Standard Deviation	Min	Max	Median
Amount	774	105.38	164.90	1	1620	60

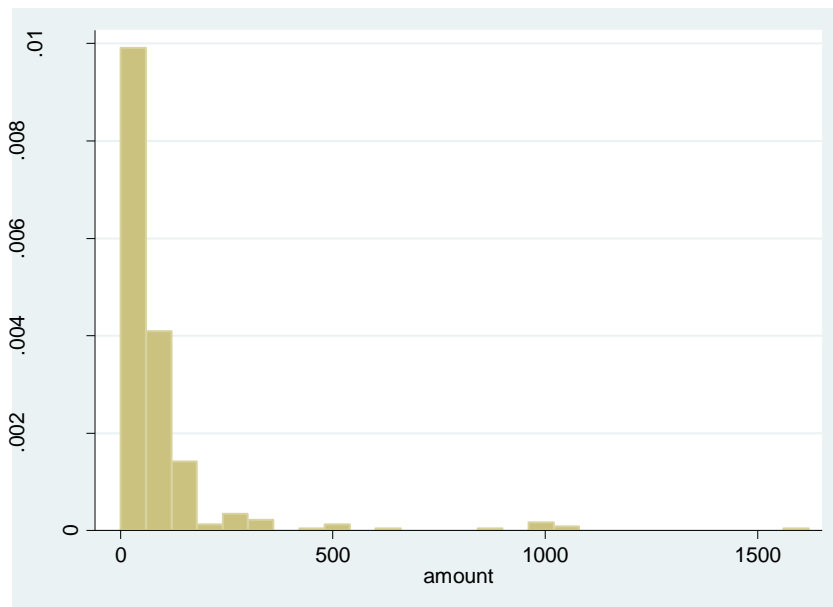


Figure 7. Distribution of spending Moeka

6. Discussion and Conclusions

This research aims to investigate the possibility of using digital currencies for community vitalization, and reports the results of a Proof-of-Concept that was performed in Fukushima Prefecture. This paper provides a conceptual framework and technological implementation, as well as the results of the Proof-of-Concept that was conducted with a new local currency, “Moeka.” In the Proof-of-Concept, the issuance of the digital currency was designed to incentivize people to communicate with other participants, and to conduct activities to contribute to the local community.

A total of 160 users registered for using Moeka, with around 50% of all users being in their 20s. In total, 774 payments were made. On average, every user met someone to communicate with, likely being motivated by the issuance of Moeka. For initiatives to vitalize local communities, it is rare that the young generation is involved in local community activities. It is certain that the issuance of the digital currency in exchange for communication, promoted communication among the younger participants. In terms of payment, 4.84 payments on average were conducted by each user. Given that the fungibility of the Moeka currency was very limited, the attractiveness of the use of the currency was the key for its successful launch. In this study’s case, goods such as badges of Moeka characters worked to bootstrap the value of the currency.

There are many limitations to the present study. Among them, the most important future challenge is the construction of the total value ecosystem using a digital currency. This study used

subsidies from the organizers to obtain Moeka goods and things like coffee and popcorn, which were not fully obtainable using the value contributed to the society by the initial action, as shown in the conceptual framework. Instead, these goods are purchased using Japanese Yen by the event organizers. The design of a comprehensive value ecosystem is a future challenge.

Because of legal considerations, Moeka was designed to be viable only during the one-day Moe-sai event. The consequences of the long-term operation of Moeka is another future challenge. Specifically, whether Moeka can be proliferated as the medium of trade over the long-term is an important question.

Acknowledgement

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