Chapter 17
Blockchain for Decision-Making

Junichi Suzuki

Abstract In Chap. 4, an approach to attracting and engaging new consumers using leading-edge technology was introduced from a user experience (UX) perspective. This chapter delves into the underlying technology, blockchain, that enables such applications. Blockchain is a technology that has the potential to revolutionize society. It builds a distributed ledger on a network and is expected to be used not only in the financial domain but also in a wide range of fields as a new trust protocol to ensure the legitimacy of information that travels across the Internet. In this chapter, the features of blockchain and the context of the background in 2016 that led to the adoption of the Blockchain 2.0 scheme as a decentralized platform during the heyday of Web 2.0 are explained.

Keywords SDGs · Ethical consumption · Summer school program · Web 2.0 · Blockchain · Token economy protocol

17.1 Necessity for Implementation of Blockchains: Realization of a Flat and Open Internet with Web 2.0

With the rapid development of hardware and software, such as smartphones and blogs, in recent years, anyone can create and transmit information on the web today. Consequently, we are at the prime of the so-called "Web 2.0" era, which was initially predicted about 10 years ago. The history of the Internet has been described as witnessing "a big wave once every 10 years," and Web 2.0 is considered one such wave. It is a service driven by user participation, in which each Internet user participates on a level playing field. It is characterized as being an inclusive service in which ordinary users actively share information and evaluate the content shared by other users. Typical examples are Wikipedia, an online encyclopedia, and social

J. Suzuki (✉)
Graduate School of Frontier Sciences, The University of Tokyo, Chiba, Japan

Dentsu Innovation Initiative, Dentsu Group Inc., Tokyo, Japan
e-mail: suzuki-junichi@g.ecc.u-tokyo.ac.jp

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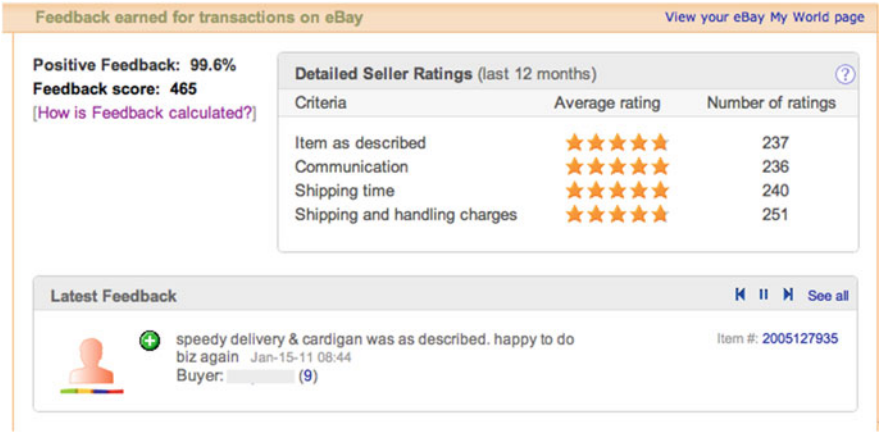

Fig. 17.1 Auction site eBay's seller evaluation (feedback) confirmation screen

bookmarks, which are online bookmarks published by users on the Internet and shared with a specific or general audience.

Umeda Mochio, the author of a book titled *The Theory of Web Evolution* (Mochio 2006), remarked, "Everyone who wants to participate in an act of expression such as writing, photography, narration, music, painting, and video can participate. To select the best among them, we can build a system akin to the preliminary high school baseball games conducted for selection to *Koshien* (the National High School Baseball Championship in Japan), and the information chosen in this way is superior to the information prepared by authorities and experts. The quality of the information obtained in this manner will be of higher quality than the information delivered by authorities such as professors, newspaper reporters, and critics." However, as stated by Umeda, the realization of this objective requires a "preliminary to *Koshien*" system to select the best from the available information of varying quality.

In Web 2.0, schemes whereby parties can evaluate each other after each transaction, which were first implemented in the Internet auction service and then subsequently generalized, enable third parties to recognize the credibility of each party. This process of democratic consensus building, leading to the development of "collective intelligence," has been adopted by many web services since the 2010s and has proliferated into our lives through repeated trial and error. Today, consumers have access to social network services (SNSs) that are naturally rooted in mutual trust, in which they receive and send interactive information. The most important feature of the late stage of Web 2.0, from 2010 onward, is that people acquired the ability to foster trust in others and the information shared by them based on their social graphs, regardless of their authority on a topic conferred by their position in society. This is one of the social impacts of Web 2.0.

Recently, services that use the collective knowledge of people, such as matching services aimed at matching partners, evaluation-sharing services that specialize in restaurant reviews, reviews on auction sites (Fig. 17.1), social lending, and cloud

funding for business and public use, have extended to the private domains of consumers, and the scope of these services is continuing to expand each year. In addition, the fact that anyone can easily disseminate and relay information has led to the formation of an "influencer layer" of users, which influences public opinion beyond the boundaries of SNS. Thus, the mode of information communication has drastically changed over the years: earlier, information was unilaterally communicated by the "authoritative sources," comprising university professors, newspaper reporters, critics, and so on; today, due to the prevalence of the Internet, a vast amount of information is created and communicated through the generation of collective intelligence in an interactive and nonhierarchical environment. Consequently, the influx of SNS into the authoritative layer, whereby authoritative sources also refer to SNS as a source to obtain information, has occurred in recent years. On the other hand, a reversal of this phenomenon can also be observed. For example, a part of the influencer layer that has garnered the trust of a follower base on SNS has partially shifted the axis of information transmission to mass media.

This type of flow can be considered the first step in the "preliminary to Koshien" transition. However, this can also lead to adverse phenomena such as the emergence of information summarization websites that lack credibility and the rapid spread of "fake news" items through SNS. These in turn engender negative outcomes, such as the manipulation of public opinion by fake news. With respect to food safety, problems such as the obfuscation of production conditions and "fake food" are becoming serious social issues, particularly in Asia and Oceania. To address such issues of trust, blockchain can be used to demonstrate to consumers the legitimacy of products and services, as its underlying mechanism ensures that the information recorded cannot be technically altered (the possibility of tampering is extremely low).

17.2 Blockchain Technology and the Internet-Based Real World

17.2.1 Areas that Actively Utilize Blockchains and Their Characteristics

Blockchain is the core technology underlying Bitcoin. It is a data-recording mechanism characterized by anti-tampering properties and a decentralized consensus network that was proposed in 2008 by Bitcoin's inventor, Nakamoto (2008). A simpler definition is that a blockchain is "a mechanism that ensures the reliability of transactions by the intervening eyes of a third party." For modern consumers that are attempting to determine value based on the collective wisdom of people, rather than the unilateral credit recognition by established authorities, blockchains offer a daily decision-making and democratic consensus-building process supported by the technology. Blockchain technology provides an extension to the daily lives of the Web

2.0 generation, which values open, nonhierarchical relationships and interactive trust-building processes.

Regional differences exist in the coverage of blockchain services. However, there are already regions and cultural areas that readily accept services supported by blockchain technology. An overview of relevant global initiatives yields numerous examples, including efforts that are underway to incorporate blockchain technology into Dubai's smart city concepts, the implementation of a tax return system to reduce tax collection costs in Eastern Europe, and the mushrooming of numerous blockchain-based startups and the Bitcoin Embassy (a currency research institution) in Israel. In such countries or regions, there are experts in computer science, mathematics, and cryptography. In addition, they also have flexible and rational national characteristics. Furthermore, a positive attitude toward implementing blockchain services may be related to the regional political situation, history of the country, and stability of the country's financial market.

As an antithesis to the conventional "centralized" technology, which provides users with a single, large service using cloud computing, certain new web services have appeared. They leverage a distributed network technology that is not dependent on a specific service operator. The rapid growth of the new German SNS called "Mastodon" is a good example. There are technical and socio-cultural similarities between the reasons for the popularity of the new web services and the increasing popularity of blockchain. Similar to how Web 2.0 values usurped the then-ideal methods of communication in cyberspace, social change caused by the Internet, which is still considered an amateurish revolution that has not yet been embraced by authorities, is gradually changing consumers' consciousness and beginning to influence their daily behavior.

17.2.2 Technical Characteristics of Blockchain Technology

So far, we have described an outline of the social background that led to the emergence of the blockchain, the differences in approaches and attitudes that were adopted throughout the period corresponding to the modern history of the Internet, and other closely related factors. We now explain the technical characteristics of blockchain by focusing on its differences from the conventional system. First, the two types of blockchains, which may be easily misunderstood, are discussed. Blockchains are broadly divided into public and private types. Public blockchains usually have a completely nonhierarchical relationship, in which it is not possible to grant authority for modifications to some participants and not others. Hence, the process of democratic consensus building in public blockchains is believed to have high affinity, and studies on their utilization are being conducted in line with these characteristics. By contrast, a private blockchain has an administrator. Although it is possible for the administrator in a private blockchain to limit the number of participants and dynamically upgrade the specifications of the computer and network

environment, it is inferior to the public type because of its drawbacks in terms of anonymity and publicity.

Next, a clear understanding of the relevant distributed database system and consensus-building process used in blockchains is essential. Consensus building, also called "mining," is a technical process that identifies information that is to be written to the database. In a centrally managed database, data can be updated consistently unless an administrator commits an error. Furthermore, only one database needs to be updated, which enables high-volume transactions to be processed at high speeds. On the other hand, in a blockchain, transaction information exists in a distributed database; hence, if the transaction information is not appropriately synchronized and updated, only a part of the database will be updated, and the other parts will remain in their earlier states. Therefore, a consensus-building process should be established to consistently update the database.

In particular, since anyone can participate in the maintenance of a distributed database of a public blockchain such as Bitcoin, it typically requires more than 10 min to form a consensus to correctly perform data recording. This avoids a malicious user's attempt to enter falsified data and therefore records only correct and genuine data. By contrast, a private blockchain can reduce the time consumed by the consensus-building process by limiting the number of participants involved in the maintenance of the distributed database, thereby significantly increasing the transaction speed. In addition, because private blockchains can narrow the scope of data reference to the operator, they are better suited for many use cases, such as in consortia led by financial institutions.

One advantage of the private blockchain compared to the conventional centrally managed database is that the former involves less risk of arbitrary change by the operator because data are recorded in the form of a chain that is difficult to change. Another advantage is that services are not disrupted as long as at least one of the distributed computers in a private blockchain is running. Therefore, a private blockchain is suitable in domains where the accuracy of data is required, system downtime is not allowed, and low-cost maintenance operation is required. Examples are medical trial data that require evidence of data integrity and scientific research data that require long-term storage of ongoing records. Another example is that of a private blockchain introduced in agricultural production and distribution in the Aya-cho (a town in Miyazaki prefecture, Japan) demonstration experiment. In this case, soil management history and inspection results for the past 3 years prior to the start of cropping would be continuously recorded as production management information (transaction data) based on the aforementioned characteristics. The local government office was adopted as the manager for this purpose.

17.3 Demonstration Experiments that Leverage the Characteristics of Blockchain

The previous chapter introduced the case of Information Services International Dentsu (ISID) Co., Ltd., which has been engaged in a demonstration experiment to increase added value and boost ethical consumption by visualizing the philosophy of producers using blockchain technology. In this chapter, we introduce the next stage of the *Aya-city* study on ethical consumption.

17.3.1 Demonstration Test for Ethical Consumption in France

In May 2019, ISID's Open Innovation Lab conducted an "ethical consumption" demonstration test in France with the cooperation of Sivira Co., Ltd. and Katsuki Wines (a family-run winery in *Aya-city*) (ISID 2019a). The purpose of the test was to verify how domestic wines with guaranteed production history are evaluated by French consumers and whether visualization of the winery's contributions to sustainable development goals (SDGs) will motivate ethical consumption.

The restaurant "ZEBRA" in Paris collaborated with the team on the experiment. The owner, Mr. Curreck, said, "ZEBRA is actively using organic ingredients, and there are many customers who are willing to try new things. I felt that it would be interesting to be the first store in Paris to handle ethical Japanese wine." Figure 17.2 shows a picture of participants of the experiment at ZEBRA.

In addition to the evaluation of a product from Katsuki Wines, the experiment is also intended to introduce the "Token Economy Protocol" (TEP)[1] jointly developed by ISID and Sivira for the first time to the general public. Mr. Fujii of Sivira explained, "If a token is given to customers for a desired action or contribution to a certain community, and the token has value, a new value system or economic zone can be constructed."

When a visitor consumes Katsuki Wines' bio wine, the SDG token will be given for "ethical behavior." Tokens enable customers to join a consumer community with similar values. Within the consumer community, we envision a future where people who contribute to ethical consumption or adopt desirable actions will be correctly evaluated and therefore conferred with higher trust.

[1] TEP is a general-purpose middleware protocol designed to realize the "token economy," in which all assets and data defined on the blockchain, that is, tokens, are used as a means of exercising rights based on individual values. By providing a general-purpose protocol, various applications will be able to cooperate with each other in the same blockchain environment.

Fig. 17.2 Zebra customers who are comfortable with experimenting with new things

In this case, a hard wallet[2] was used to receive the tokens. The hard wallet incorporates anime elements to reduce psychological barriers for users. The 17 SDGs were anthropomorphized into anime characters (Fig. 17.3).

The SDG token is transferred when the hard wallet is held over the smartphone. This wallet enables visitors to intuitively understand the kind of activity they are participating in, even if they do not fully understand the technical mechanism. Many customers visited, and most of the 50 bottles of wine were consumed by the completion of the demonstration test. Among the participants, the seniors showed a strong interest in wine itself, whereas the younger BOBOs,[3] who prefer "Lifestyles of Health and Sustainability" (LOHAS), were more proactive towards learning about the mechanism of the SDG token and TEP.

Lowering the threshold for introducing blockchain can have a desirable effect on people. First, they would be able to participate in the SNS community using the SDG token, which would motivate them to practice ethical consumption. Second, in an economic area connected by a common set of values, the evaluation can be performed using a unique standard that does not exist in conventional mass

[2] A hard wallet (named so for being hardware based) is one that implements a mechanism to store a user's private key in a contactless IC terminal and read it from an NFC-compatible mobile device to ensure quick transaction signatures. In this demonstration experiment, it is used as a wallet to manage tokens associated with 17 SDGs.

[3] BOBO is an expression used to describe a French bourgeois-bohemian socioeconomic group, meaning "a well-educated person with one foot in the bohemian world of creativity and the other in the bourgeois realm of ambition and worldly success."

Fig. 17.3 Holding the hard wallet personifying the goals of the SDGs over a smartphone

marketing. It is important for people to gain an understanding of these possibilities through their own experience. This experiment was a step towards this.

17.3.2 Application of Token Economy Protocol to the Education Field

In Japan, reforms on entrance examinations have been ongoing in recent years, leading to, for example, the abolition of the National Center Test for University Admissions, in the midst of active discussions on how education should be reconsidered. This may perhaps be an era when the recommendation letter, which can perhaps provide a more accurate reflection of one's ability and interests, is emphasized over the paper test, which is akin to a one-shot game. On the other hand, it is difficult to consistently capture the purpose and the kind of learning that has been acquired by a student, including through extracurricular learning and volunteer activities, in a recommendation. To address this issue, the Open Innovation Lab applied the token economy protocol from the French experiment to the field of education (ISID 2019b). Using blockchain, we verified a mechanism whereby the learning history, the relationship between the instructor and students, and the relationship between students could be proved.

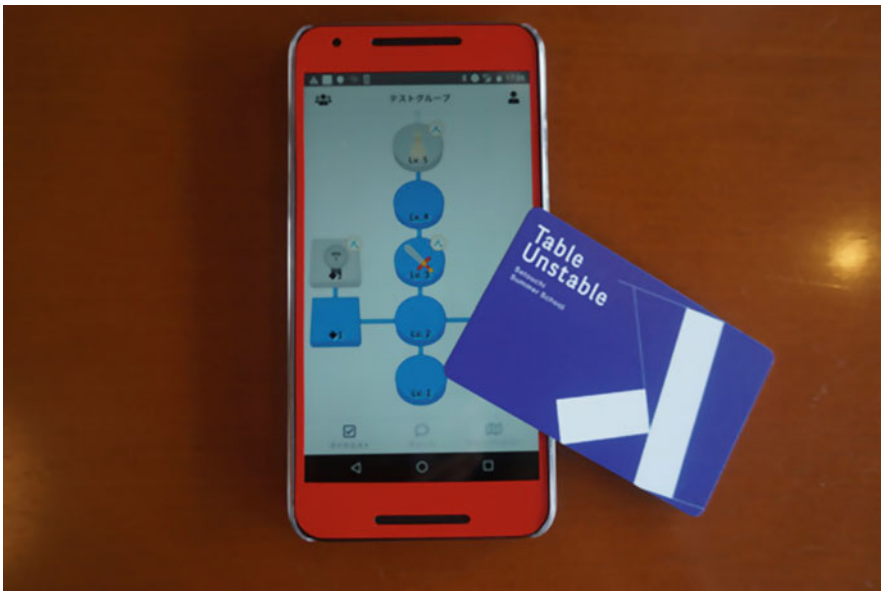

Fig. 17.4 Hard wallet (card) and application screen

This experiment was conducted at a summer school where students learned about SDGs from Yoichi Ochiai, who works as a media artist. The summer school was held for elementary and junior high school students in Hiroshima and Okayama prefectures. The children who participated logged in to the app by holding their hard wallet (NFC card) over their smartphones and recorded their learning. This card also serves as an owner identification card on the blockchain. We set up many squares, similar to a stamp rally, in the app and prepared a "quest" to progress to the next square from each square. By introducing such a game, we aimed to encourage children to learn voluntarily (Fig. 17.4).

Quests are linked to learning and interacting with others, such as "presenting what you have learned in a presentation" and "making friends." When students complete a specific quest, they are given a token to prove it. By obtaining tokens, students gain the right to join the community. Teachers do not force anything in this community, and companies do not provide instructions. It is an autonomous decentralized organization (DAO), which is an organization in which students voluntarily participate without a central administrator. One of the objectives of this experiment was to verify whether a DAO would truly emerge with the proactive participation of the students.

Sivira continued to monitor the summer school to check whether the students are willing to touch the app and operate it intuitively. All students cleared the first quest on the first day. Some students completed all the quests on the first day. Sivira continued to monitor the summer school to check whether the students are willing to touch the app and operate it intuitively. All students cleared the first quest on the first

day. Some students completed all the quests on the first day, so an additional quest was added for them. With the app having a game element, no additional explanation was required, and the students voluntarily progressed through the quests. By completing each quest and obtaining tokens, even if one loses their paper certificate, they can always prove that they learned SDGs from Mr. Ochiai if they have a history on the blockchain.

Mr. Fujii of Sivira remarked, "The DAO protocol, a common rule for creating apps, allows multiple companies, universities, and organizations to create apps that issue tokens based on a common philosophy. The value of the tokens increases as the number of participants increases. It may be possible to imagine a world in which students with many tokens will be exempt from the entrance examination. If you complete a quest, you will be able to reach a certain point. With this point, for example, we developed the application on the assumption that, although it is a dream, direct admission to the University of Geneva would be possible, and we will continue to develop technology toward that goal."

Summer school participants can continue to communicate on the app after the completion of summer school. Instructors can also join the community and build long-term relationships, which may provide an opportunity for them to write recommendations or invite the participants to the lab. Therefore, in the blockchain-based approach, events such as summer schools may become the starting point for SDG activities and career development. This would lead to a long-term engagement involving continuous learning and certification, in contrast to the traditional approach of examinations in which the evaluation is based on a single event.

17.4 Summary

In this chapter, we confirmed the effectiveness of Blockchain 2.0-based systems, through several empirical experiments. The experiments indicate the potential for methods dealing with big data to develop further in the field of artificial intelligence (AI) technology, which is effective with a large amount of learning data, in conjunction with IoT devices that store data without human intervention, as information and communication infrastructure technologies such as 5G communication and quasi-zenith satellite systems become more sophisticated in the future.

Today, changes in the nature of information communication originating in cyberspace have impacted the awareness of consumers and are beginning to affect their daily activities in real space. With respect to food safety and consideration for the ecosystem, using Web 2.0 combined with blockchain technology (as in the example of the decentralized platform technology based on the Blockchain 2.0 scheme from the experiment above) enables an environment in which consumers can evaluate each other's value by sharing materials that are not only endorsed by authorities but also evaluated by consumers themselves. This is akin to the "preliminary to Koshien" mechanism predicted by Umeda.

Through this pilot project, we witnessed the emergence of new markets by connecting rural and urban areas, producers, and consumers. One example is a customer who came to a store with a mother whose child was suffering from allergy symptoms. She understood better than anyone the value of vegetables grown with plant-based compost and saw the irreplaceable value in the vegetables grown in Aya Town and the town's commitment to publicizing its production history. We were reminded that the goal of the Internet of Value by Blockchain (IoVB), a research project that supports regional revitalization through the use of blockchain technology, is to appropriately match the values and needs of individuals. An example of such individuals may be those who are not satisfied with the organic certificate of the Japanese Agricultural Standards (JAS). We intend to continue our research with the aim of creating a society in which producers, consumers, and all stakeholders involved in organic farming are rewarded.

To achieve complete food traceability, the entire food supply chain from production to consumption must be made visible. Food distribution does not always take the form of simple direct sales, such as direct delivery from the producer to the consumer, as was the case with the demonstration experiment. Therefore, it is necessary to involve transportation companies, medium-sized wholesalers and retailers, as well as food service providers when cooking and processing are required. Furthermore, it is important to record the work carried out by each operator at each stage of the food chain and communicate it to the next consumer by recording it on the blockchain, as may be appropriate. Nevertheless, this is a challenging objective to achieve in practice. In addition to the efficient system using the Blockchain 2.0 scheme, which exhibited positive results in this demonstration, we will also continue to explore the approach based on the Blockchain 3.0 scheme in the age of Web 3.0, in which administrators do not exist. In other words, we would like to explore an approach based on a full P2P public blockchain credit approval model in which users and individual consumers can exercise discretion over their data in response to the de-platforming trend.

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