Blockchain Applications in Geographical Information Systems

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NTRODUCTION

Blockchain technology is one of today's most popular technologies. Blockchain, which we can define as a decentralized distributed database system, technically combines all records in the block structure and unites them as an integral chain that stores them from the first block. The main advantage of Blockchain technology is that the information obtained is precise and cannot be changed.

Blockchain technology enables clients and providers to operate directly with each other without the need for authentication by a third party. All transactions are held in a distributed database using cryptography to ensure that the transaction between the client and the provider can be done safely. To make changes to this distribution structure, the corresponding change must be saved on all computers in the system. In order for a cyberattack to be successful, the corrupted data must be verified by at least 50% of the users within the whole network, which makes the success of an attack almost impossible. Advantages such as more security, agentless processing, and transparency in data tracking make Blockchain technology attractive for geographical information systems.

Today we see the popularity of Blockchain technology in financial transactions such as Bitcoin. However, Blockchain is a system that can be programmed to record the value of almost everything, not just financial transactions. Blockchain technology is an emerging technology that meets the need of buyers and sellers to exchange data in a digital environment resistant to cyberattacks without the need of any third-party intermediaries.

Since 2015, applications have been developed in many areas using Blockchain technology including geographical information systems. Yli-Huumo argues that Blockchain applications are not limited to cryptocurrency applications and Blockchain will provide diversity and knowledge to work in various areas of smart ownership (Yli-Huumo, Ko, Choi, Park, & Smolander, 2016). This arena is one of the significant areas that can use Blockchain technology. There are valuable applications of GIS-Blockchain usage in land registration (currently used in Brazil, Honduras and Sweden), detection of border violations, and food tracking systems. In this paper, the use of Blockchain infrastructure in geographical information systems will be examined.

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SMART CONTRACTS

Bitcoin crypto currency has obscured Blockchain technology due to its popularity in the financial field. However, Bitcoin is actually an application developed using Blockchain technology and has gained much more stature than Blockchain technology Many people who do not know Blockchain technology are quite knowledgeable about Bitcoin. However, Blockchain technology can also be applied to many other areas. For example, in a cloud service using Blockchain technology, an environment can be created for smart contracts and peer-to-peer data sharing (Swan, 2015). Data integrity, which is the strong point of Blockchain technology, is the reason its use has spread to other services and applications.

Blockchain technology enables the participants in the network to execute transactions without third-party validation, even if the parties do not have mutual interests. Therefore, an agreement between a buyer and a seller can be achieved faster by eliminating intermediaries. When the data on the chains are encrypted, there is no need for central authority. Blockchain smart contracts automatically execute files or named scripts that are integrated with each other evenly in a smooth manner (Christidis & Devetsikiotis, 2016). Within the framework of the agreement made with the application of the Blockchain smart contracts, payment terms, conditions and processing steps are determined, then all these steps are implemented without additional third-party verification.

The idea of smart contracts was first proposed by Nick Szabo in 1997 (Nick Szabo, 2018). However, the idea of using Blockchain to track ownership status and transfer of ownership was first described by Mike Hearn in the article "Smart Property" (Mike Hearn, 2018). After Blockchain technology became increasingly widespread, Blockchain smart contracts gained popularity and many applications emerged. Ethereum and Hyperledger are the most popular applications of smart contracts and numerous applications can be developed using these platforms.

Ethereum

When we look at the popular applications that offer smart contract infrastructure, Ethereum is the most notable example. Ethereum is crypto money like Bitcoin and is based on a decentralized structure using Blockchain technology. The main difference between Ethereum and Bitcoin is that Ethereum allows a number of smart contracts (Founder & Gavin, 2017). Ethereum, designed and coded by Vitalik Buterin and his team, was first launched at the Bitcoin Conference on July 30, 2015. Ethereum offers the most widely used smart contract infrastructure. Various studies have been done with this useful application and experts have emphasized that Ethereum can be transformed into a platform for smart contracts (Huh et al., 2017).

Hyperledger

One of the main problems of implementing Blockchain technology is that standardization does not occur. A standard has not been established because many different software groups construct the systems differently. In order to solve this problem, an open source community called Hyperledger was established. Large technology companies like IBM, Cisco, Fujitsu as well as financial institutions such as Morgan and Accenture were involved in this community ("Hyperledger," 2018). In July 2017, Hyperledger Fabric 1.0 was released. In February 2018, Hyperledger Sawtooth 1.0 was released. The Hyperledger community aims to create a mature version after receiving users' feedback on these different versions.

REPRESENTATIVE EXAMPLES

The advantages of Blockchain such as enhanced security, speed, transparency, and agentless processing are attractive for application developers. Companies can use their own platforms for the applications they want or use platforms such as Ethereum and Hyperledger. Blockchain applications are preferred in many areas in order to obtain more transparent and highly secured processes at reduced cost by the removal of intermediaries. Geographic information system applications are one of these areas. Ylii-Huumo points out that it is possible to work on smart property blockchains, and emphasizes that they have identified prototype applications (Yli-Huumo et al., 2016). Land registration information, boundary violation detection, and food tracking applications are examples.

Land Registry

A land registration system is one of the areas where Blockchain can be considered as a potential star candidate. Ylii Huumo emphasizes the impact of increasing Blockchain research on the development of the system and uses a decentralized database to illustrate the idea that companies can sell their properties in a virtual environment, which may represent a revolutionary solution (Yli-Huumo et al., 2016). Carrying out land registration procedures through a Blockchain will help to reduce or eliminate the intermediaries and provide a safe and transparent way of conducting transactions.

In a similar approach, Lamieux argues that Blockchain is a new technology with the potential to radically change the registration of land and real property transactions. The author emphasized applications using Blockchain technology in Brazil, Georgia, Ghana, India, Japan, and Sweden (Lemieux, 2017). The application is being implemented as a pilot but it is envisaged that the number of full-time transitions will increase.

Spielman argues that the Blockchain land registration system is the future of land registration, and its advantages will be evident over the current land registry system. Land registration through Blockchain can increase processing efficiency, prevent fraud in property exchange, add security levels, accountability and transparency, and lower sensitivity to natural or man-made disasters (Spielman, 2016). The basic workflow of Blockchain based land registry systems is shown on Fig 1.

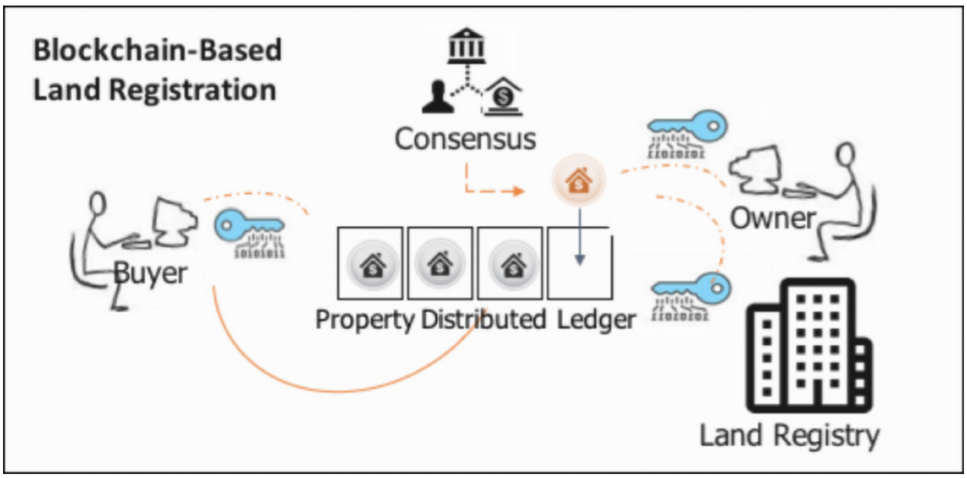

Figure 1. Basic Work Flow of Blockchain Land Registry Systems (eSatya, 2019).

Even with these advantages, some issues need to be clarified before a land registration system is built using Blockchain. Documents provided through the system should contain legal evidence in the case of dispute, ensuring that the system is accurate. . At this point, issues such as how to transfer old records into the system and how to manage legislation through the system should also be clarified. Otherwise, the applicability of the system will be low (Lemieux, 2017).

When we look at examples of land registry, we see that applications in Brazil, Honduras, and Sweden come to the forefront. Factom, a US-based Blockchain technology company, has developed a Blockchain based land registration solution for Honduras. Honduras' application was the first one using Blockchain technology for land registration. Much of the data collected between November 2015 and January 2016 was found in whitepapers. Honduras wanted to switch to a Blockchain-based system was due to the irregularities in the land registration process. The Honduran government aimed at reforming the system by enacting a number of laws to prevent irregularities during land registration, but these new regulations were also vulnerable to manipulation, including de facto counterfeiting. For this reason, they have agreed with Factom to implement a Blockchain-based system (Lemieux, 2017).

Another Blockchain land registration project was implemented in the Rio Grande do Sul Province of Brazil, Pelotas Municipalities, and Morro Redondo between May and July 2017 by Ubitquity. The aim of the project was to create a pilot program for official land registration in the region, to reduce costs, and to increase the accuracy, security and transparency of land records. Before this system was implemented, the transfer of ownership was carried out in 13 steps. In explaining the pilot, Ubitquity CEO Nathan Wosnack said they would carry out the Blockchain solution in a fair and transparent manner to address property and land disputes, with the intention that the system will prevent fraud in land registration. (Lemieux, 2017). After evaluating the data obtained through the Blockchain application, errors in the registration system were reduced and there has been a significant ease in archiving (Allison, 2018).

Sweden is another country that has moved its land registration processes into a Blockchain-based system. In the "World Bank Business Index" data, Sweden is among the most accurate in the world for property registration, so its move toward Blockchain technology was not due to fraud or irregularity in its processes as in Brazil and Honduras. The cadastral operations are done separately but integrated with each other. The transfer process is completed in seven steps, and a notary lawyer does not participate in the project. The pilot project data was collected between July and October 2017. And the application developed by Chromaway is still in use (Lemieux, 2017). The user interface of the application is seen in Figure 2.

With the success of the practice in Sweden, Ukraine announced in October 2017 that it will transport the country's land registration system to Blockchain in order to provide transparency in the processes ("Ukrainian Blockchain Land Registry," 2018). In a similar fashion Andre Pradesh, a state in India, announced in October 2017 that the land registration system of Chromaway will also be used for a pilot ("Indian Blockchain Land Registry," 2018).

Considering that the technology is relatively new and the application includes many different stakeholders, the specific uses require time to reach maturity. Even with the advantages of the application, clarifying any risks such as the fact that the data may be used as legal evidence after a lengthy period, is of great importance to ensure the continuity of the system. . These issues are mostly subject to regional regulations and their implementation architecture, and a single solution in the international market is not realistic. The local laws of all countries differ; and, as a result, there is a need to make local specialization. When the projects completed so far are examined, we expect to say that the application offered

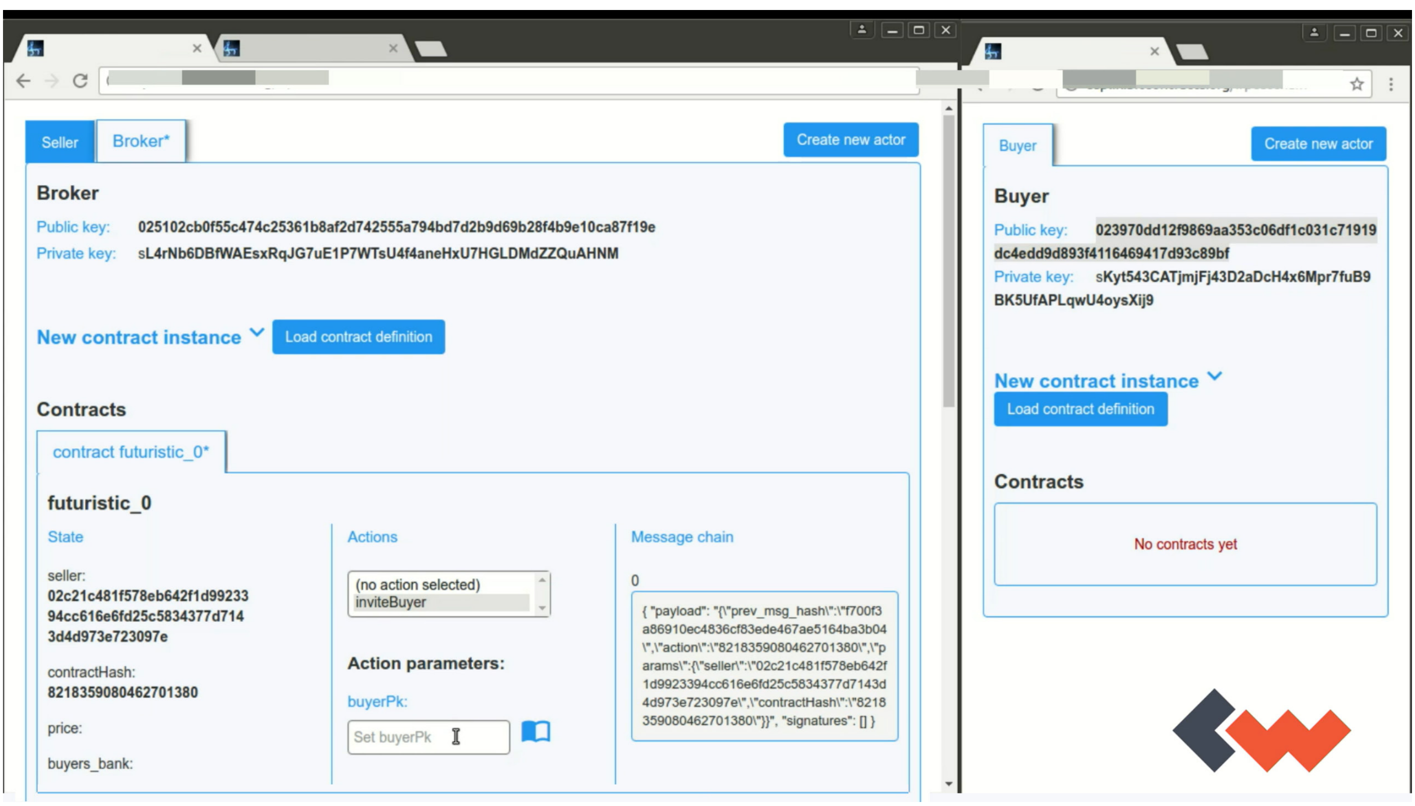

Figure 2. A Screenshot of Chromaway Land Registry Application ("ChromaWay Land Registry," 2018).

by Chromaway has gained the most popularity with its user interfaces and system design. With this success, the number of regions that are using the application has grown and the number of uses may increase with greater speed as the advantages of Blockchain land registration systems are publicized.

Border Violation Detection

Another Blockchain GIS application is for boundary detection violations. This cadastral Blockchain work, which was developed in Turkey/Kirsehir, was presented by Abdulvahit Torun. The problem of inconsistent demarcation between successful cadastral surveys emerged in that country and a method based on a hierarchical Blockchain model has been proposed to prevent such situations. After presenting two separate physical boundary overlap studies represented as accurate, an effective Computer-aided design (CAD) GIS method based on Blockchain technology was proposed to prevent such incidents in Kirsehir. In the proposed method, there is no border change operation in the land registry unless the joint approval of all stakeholders is received (Torun, 2018). Torun stated in his study that the main purpose of using the Blockchain in the cadastre is to manage the process of determining any boundaries that cause conflicts. The author proposed that with Blockchain technology, land registration procedures will be decentralized, transparent, and open to everyone. In addition, with the common participation of all stakeholders and supervision of the official authorities, property transactions could be managed safely (Torun, 2018). The purpose of digitization of the processes is similar to Blockchain land registration applications in Brazil, Honduras, and Sweden. In addition, considering that the purpose for the transition of Honduras and Brazil to Blockchain includes the elimination of the irregularities in the existing systems throughout the countries, the objective of more efficient land registration is achieved.

Food Tracking Systems

In October 2018, IBM announced the commercial availability of a Blockchain-based electronic distributed ledger that can track and trace food supply chain data from farm to store (IBM, 2018). IBM's Food Trust ledger, which was created using Hyperledger Fabric infrastructure, will allow food retailers, suppliers and growers to see supply chain data in near real time, enabling a more transparent and efficient method of determining the origin and safety of products.

In September 2018, retail giant Walmart announced that it would begin requiring its suppliers to implement the system to track bags of spinach and heads of lettuce. Walmart says it now has a better system for pinpointing which batches of leafy green vegetables may be contaminated. After a two-year pilot project, the retailer announced that it would be using a Blockchain to keep track of the produce (Corkery & Popper, 2018).

In similar manner, Carrefour, one of the leaders in food traceability, through the gradual application of Blockchain technology to its quality line products, has joined other participants involved in building the IBM Food Trust platform. The companies stated that the objective of this collaboration is to implement a global food traceability standard from producers through to market (Carrefour Group, 2018).

CONCLUSION

Advantages such as enhanced security, agentless processing and transparency in data tracking make Blockchain technology attractive. The GIS-Blockchain applications will mature through increased usage, and updating the applications once any feedback is received from long-term use. After the elimination of risks arising mostly from the diversity of local laws, the advantages of GIS-Blockchain applications will begin to emerge and the number of uses will increase. With the expectation that land registration applications will stand out among Blockchain-based applications, then the boundary violation detection systems can be implemented easily.

In addition, the advantages of traceability and increased security may appeal to big companies and lead them to invest in developing food-tracking applications through Blockchain. As successful results increase, there will be more diversity in the number of GIS applications of Blockchain technology.

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