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Research Article

A production and transfer application with Blockchain

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ABSTRACT

In traditional software systems, the user information is kept in databases of the system. These user infomations are critical data for the users and software systems. Theft of data and getting into the hands of malicious people can cause big problems. The most efficient way to get rid of this is to keep the information encrypted, to decrypt the encrypted information with private keys that are not registered in the system, to never access the encrypted information without the private key, and to use it in platform-independent systems. Blockchain technology offers us this system. Blockchain technology, which can be applied very easily in economic fields or systems with transparent data policy of priority, is also the basic structure of cryptocurrencies. Its importance is increasing day by day in the world and it is increasing its weight in banking-finance, voting, asset management and company-specific software systems. Blockchain technology is still evolving. In the academic sense, in recent years, articles have been published with increasing momentum both in different categories and in many different fields. In this study, encryption methods of Blockchain technology, data verification approaches, wallet creation, the roles of public and private keys in wallets in the system, their authorization, the formation of transfers within a certain rule and their verification by a third party after the transfer are discussed theoretically and practically. An application was developed on peer-to-peer transfers of white goods production and products, which were fictionalized as a scenario, and Blockchain technology was applied.

1. Introduction

One of the most important tasks that states are responsible for in the world is ratification. When people get married or graduate from a school, a document is given to them and recorded in databases. This information cannot be changed or deleted. Thus, those records are kept in databases as long as the state exists.

Blockchain, which is a new technology, appears before us with its role in cyber security, transparency and a solid structure due to the fact that historical information is not changed.

Blockchain technology will play a leading role in many sectors in the future, especially in the sectors of all transactions as valuable or transparent information. Blockchain is a new technology that guarantees that confirmed states are stored and cannot be changed.

Blockchain was introduced by Satoshi Nakamoto in 2008 [1]. Blockchain, expressed in Turkish as the Block Chain, is one-way, one-way or more than one size (previous hash address instead of pointer) linked lists connected to each other with certain rules. They are blockchains that verify in reverse of linked lists, which are also designed as the next node, as will be known from their data structures. It ensures that the data inside the chains added to the blocks cannot be changed [2]. Therefore, due to this structure, it is a technology that is suitable for use and design in many different projects in today's world.

Shahnaz et al. developed an application in electronic health records system using blockchain technology. With this application, they aimed to keep the records securely [3].

Gorkhali et al. conducted a review on journal

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publications between 2016-2018. As a result of the review, they revealed that blockchain research has gained momentum recently, requiring more effort to integrate blockchain into new methodologies [4].

Yaga et al. have explained Blockchain technology in detail on a technical level so that people can understand how Blockchain technology works [5].

Prinz et al. explain the working structure and important features of the Blockchain. It sets out the criteria that will determine the projects that will be suitable for the Blockchain technology [6].

Zhang et al. have provided information on basic security features. He has delved deeply into security and privacy issues in the Blockchain [7].

Zheng et al. introduced Blockchain consensus algorithms and applications. It informs about the latest developments in solving the challenges in the Blockchain [8].

Zheng et al. developed a platform that provides Blockchain services over cloud systems. With this platform, operations such as network distribution, system monitoring, smart contract analysis are carried out [9].

Bitcoin is the first cryptocurrency created with Blockchain [10]. It started to prove itself to the communities slowly in 2008, and after 2017, with a logarithmic increase, it has shaken the throne of gold as a virtual currency accepted all over the world as an investment tool for people. In today's technology (2021), the demand for cryptocurrencies in Turkey has exceeded 1 billion dollars. While there are economists who say that these numbers will remain symbolic in the coming stages, there are also economists who say that Bitcoin will disappear in the near future.

The total supply of Bitcoin is 21,000,000. While around 18 million of this coin is floating around the market, around 3 million blocks are still waiting to be mined by miners. Figure 1 shows the increase in the amount of Bitcoin over time.

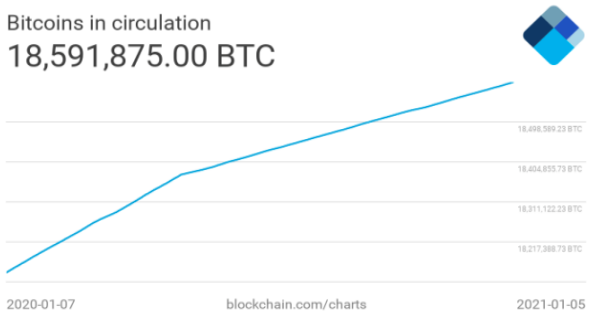

Figure 1. The temporal amount of Bitcoin in circulation.

While the time to obtain blocks by mining was short in the first years of Bitcoin, this situation is reversed, and the mining times and new block opening times are becoming more difficult day by day. Due to the logarithmic increases in costs, the market value of Bitcoin is getting higher day by day. In addition, as seen in Figure 2, the increase in transfers has increased over the years and it is observed that the interest in Bitcoin has increased.

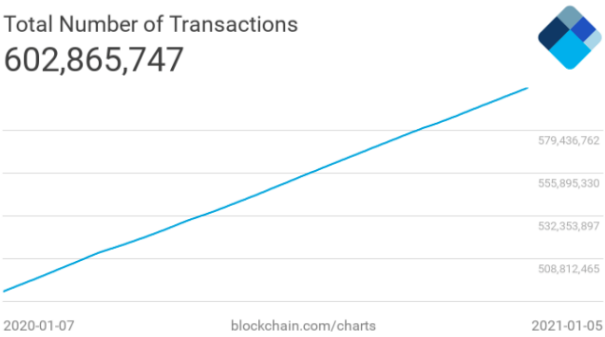

Figure 2. The temporal amount of Bitcoin in circulation.

However, the block size is increasing day by day. Therefore, the total blockchain structure takes up more space physically in direct proportion. It is known that there are around 320 GB of blockchain filing structures today. Figure 3 shows that the increase is logarithmic.

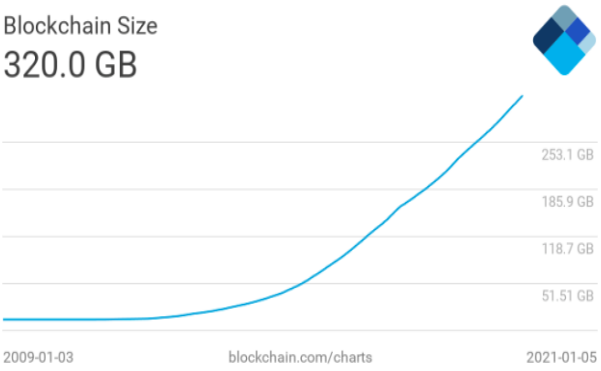

Figure 3. Bitcoin's temporal variation in blockchain size.

Bitcoin, as of its current state;
Average Block Size 1.29 MByte
Daily Transactions, 397,337
Average Number of Transactions Per Block 2.1 KByte
Total Number of Bitcoins in Circulation 18,600,000

The projected end date of the remaining number of blocks is 2140.

In the future, the use of blockchains will be essential for every technological action that requires an approval mechanism. To give an example, the daily volume of the Chinese origin Blockchain technology known as the Tron Foundation is approximately $1,797,035,092. Currently, its potential worldwide value is around $12,956,907,070. The value of the Tron Blockchain is increasing day by day. The contribution of such a high volume and value system to the national economy is very high.

In this study, the white goods product production and transfer scenario was carried out using Blockchain technology. The contribution of this study is to show that Blockchain technology can be easily used in the needs of commercial enterprises by performing the production,

verification, stock status, product transfer between addresses and listing of all transactions with the Blockchain.

2. BlockChain

2.1. Blockchain Structure

Blockchain structure is similar to one-way linked lists. It contains the previous node number (previous hash) instead of the next, and they also carry data in them like linked lists. However, there is a different security issue than with linked lists. The hash number in the previous block must be the same as the previous hash in the next block to be connected. And hash generating functions must consist of globally accepted crypto methods (elliptic curve, secp256k1) [11].

2.2. Genesis Block

The Genesis block is the first link of the Blockchain. It is created by the system that creates the structure and all chains are connected to this block [11]. Figure 4 shows the Genesis block and its structure in the Blockchain.

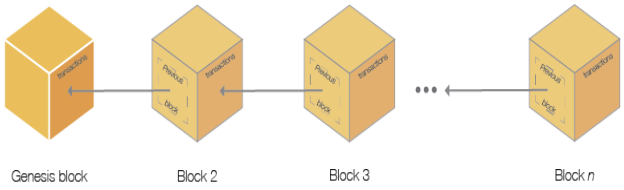

Figure 4. Location of the Genesis Block in the Blockchain.

2.3. Wallets

Every transaction on the blockchain takes place via transaction. And this realization usually happens between 2 addresses. Addresses are also usually created as a key pair using the Elliptic Curve Digital Signature Algorithm, SHA-256 encryption. The first of these is the public key (public key or address), the second is the private key (private key or password).

The user can throw the public key wherever he wants. When there is a request from the other party, the sender must know this public key and send that public key in order for the transaction to take place. If the other is a private key, it must be stored and this key is required during transfer [12].

2.4. Elliptic Curve Algorithm

It is based on the difficulty of factoring the product of two or more very large prime numbers [13]. In elliptic curve protocols, this assumes that it is impossible to find the discrete logarithm of the elliptic curve relative to a known point. This is called the "Discrete Logarithm Problem of the Elliptic Curve".

The security of the elliptic curve is based on the speed at which the dot product is calculated and the inability to calculate the point obtained by looking at the origin and the multiplication point. The size of the elliptic curve also determines the difficulty of the problem.

The points x and y satisfying the equation given in Equation (1) define an elliptic curve.

$$y^2 = x^3 + ax + b \tag{1}$$

For any point P=(xP, yP) on the elliptic curve, the point -P=(xP, -yP) is definitely on the curve as well. The discrete logarithm problem on elliptic curves is to find the number k that provides the P.k=Q equation for the given P, Q points. k is called the discrete logarithm of Q with respect to the base P.

The sum of two points on an elliptic curve, P and Q (Q≠-P), is explained geometrically in Figure 5. To add the P and Q points, first a line is drawn between the two points. This line intersects the elliptic curve at the point -R. The point R, which is symmetric about the -R point with respect to the x-axis, is obtained as the sum of P and Q. Apart from the geometric method, there are also mathematical formulas to perform the addition operations on the elliptic curve [14].

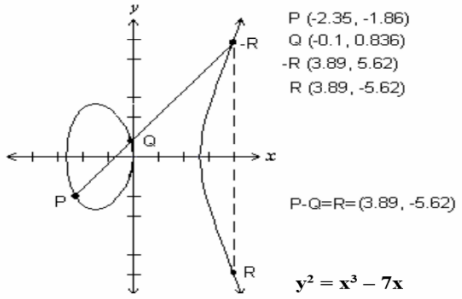

Figure 5. Addition operation on elliptic curves [14].

In the addition of the P point and the –P point, the line drawn between the two points will be perpendicular because the points are symmetrical with respect to the x-axis. As a result, this line does not intersect the curve at a third point and cannot be added as described above. Therefore, the elliptic curve group contains the point at infinity expressed with O and the definition of P+(-P)=O is made (Figure 6).

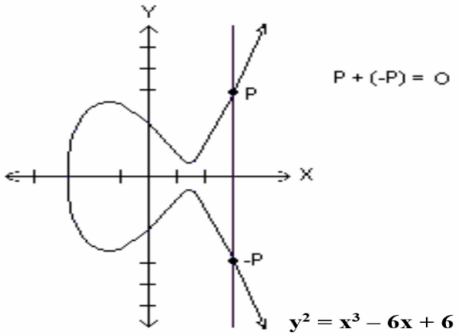

Figure 6. Addition operation on elliptic curves [14].

2.5. Decentralized Structure

One of the most important features of Blockchain technology is that it is decentralized systems. From decentralized systems, Blockchains are not kept on a single server or database, they are kept on many nodes,

which eliminates the disadvantages of a single server and does not create any problems in the Blockchain structure in the technical failure or hacking of any server. Therefore, Blockchain structures are the systems that are minimally affected by cybersecurity threatening situations. In addition, the nodes are always in communication with each other and when a new chain is added that provides the rules set in the Blockchain, this chain is sent to other nodes and works in full synchronization. Figure 7 shows a single-center, multi-center and distributed structure.

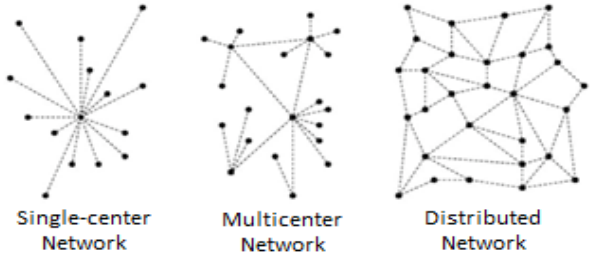

Figure 7. Blockchain Node Types.

2.6. Block

It is mandatory that there are 3 different structures in the block, these are the previous hash address, the current generated hash and the sequence of transactions. The previous hash is the hash data found as a result of the temporal and electrical forcing of the system, the brute-force algorithm approaches, and the effort given until it matches the previous hash [15].

If a hash equal to the previous hash value is found, a new block is considered found and added to the Blockchain and sent to other nodes. A certain number of other nodes are expected to validate this hash. If verified, the time spent here and the electrical consumption constitute the cost of the system, and a certain reward is given to the miner or group of miners who find this block, and they are provided to cover their expenses. Figure 8 shows the hash and other structures resulting from proof of work.

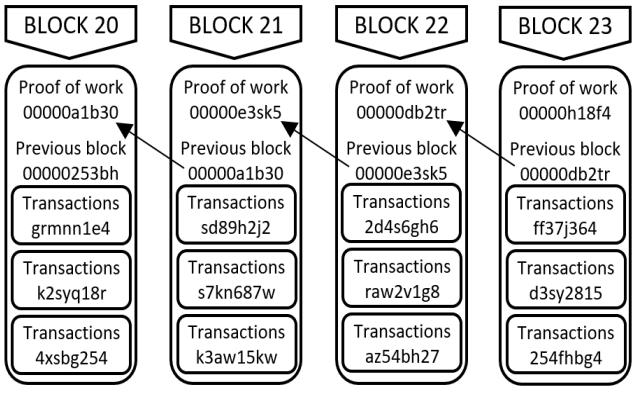

Figure 8. A view from the Block Structure.

2.7. Array of Transactions

There may be more than one transaction in the block, and these transactions are verified and added to the block by the miners, and they receive a commission (fee) for this transaction.

There are 4 important structures in the movements. These are sender address, receiver address, nonce (a counter to measure difficulty), and data [16]. The data structure is designed by the people who designed the blockchain system and varies according to the scenario.

n it, the amount for cryptocurrencies can be kept, the stock code and quantity for keep the stock record, the party number of the voter, or the paperwork number in intranet-based Blockchain systems. The data side completely depends on the structure it will serve. The usage patterns of public and private keys in the transactions are shown in Figure 9.

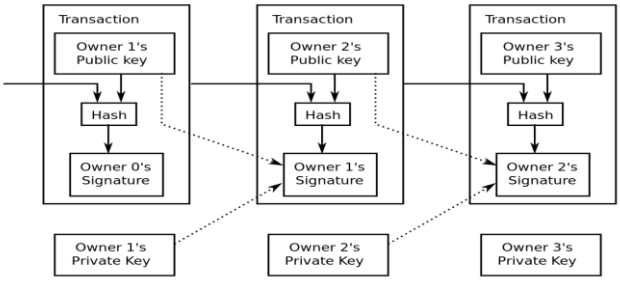

Figure 9. Use of public and private keys in blocks [1].

2.8. Types of Blockchain

Although Blockchain technology has come to the fore with its open structure and distributed consensus feature that can be accessed by everyone, partially-decentralized and private Blockchain structures have been developed in order to meet different needs in the future.

Partially-decentralized shit chain structures, also known as consortium Blockchains, are structures where only a predetermined limited number of peers manage the consensus system, rather than the distributed consensus method. In such structures, Blockchain data can be publicly available, as well as mixed Blockchain structures can be created in which the accessibility of data is restricted in various ways.

In private Blockchains, on the other hand, only a private group/organization has the authority to write (add a new transaction) to the Blockchain. The right to read the data may be open to everyone or may be restricted in various ways.

One of the methods used to classify Blockchain structures is to classify them according to communication preference and consensus preference. In open Blockchains, anyone who wishes can join the network as well as be included in the consensus system (Figure 10) [17].

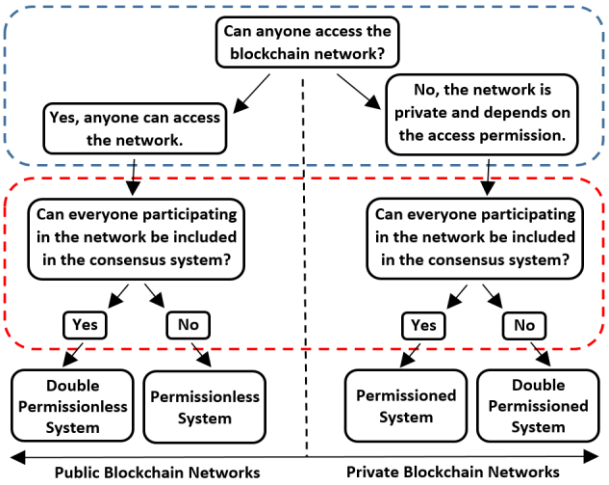

Figure 10. Public and Private Blockchain Structures.

3. BlockChain Advantages and Disadvantages

3.1. Advantages

3.1.1. Distributed

Since blockchain data is stored on thousands of devices in the distributed network of nodes, the system and data are highly resistant to technical failures and malicious attacks. Each network node can make and store a copy of the database. The fact that a node is offline does not affect the security or operation of the network [18].

3.1.2. Immutability and Low Transfer Commission

In most traditional payment systems, transactions rely not only on the two parties involved, but also on an intermediary such as a bank, credit card company, or payment provider. This is not necessary when using blockchain technology because the distributed network of nodes validates transactions using a process called mining. Therefore, blockchain is often referred to as a "non-trust-based" system. Blockchain system eliminates the risk of relying on a single organization and also reduces overhead and transaction fees by not using intermediaries or third parties [18-19].

3.2. Disadvantages

3.2.1. 51% Attacks

The Proof of work consensus algorithm that protects the Bitcoin Blockchain has proven its effectiveness over the years. But there are several potential attacks on Blockchain networks that are likely to be made. The 51% attack is the most discussed among them. Such an attack can be carried out with a unit gaining control of more than 50% of the network hashing power. A 51% attack can result in malicious exclusion of transactions or a change in their ranking of transactions [20].

While theoretically possible, there has never been a successful 51% attack on the Bitcoin blockchain before. As the network grows, so does security, and since the rewards for miners will be higher as long as they work honestly, it is highly unlikely that they will use large amounts of money and resources to attack Bitcoin. Other than that, a successful 51% attack can only change the most recent transactions made recently, because blocks are linked by cryptographic proofs, changing older blocks requires inaccessible computational power. Also, the Bitcoin Blockchain is very resistant and can quickly adapt itself to an attack [18].

3.2.2. Inability to Change the Data

Another downside of Blockchain systems is that once the data is added to the Blockchain, it is very difficult to change it. While immutability is one of the advantages of Blockchain, it is not always good. Changing Blockchain data or code is very difficult. If it has to be changed, the previous chains are invalidated and a new chain structure is passed. An example of this is the Bitcoin Cash crypto currency, which is separated from Bitcoin [18].

3.2.3. Private Keys

Blockchain uses public key (or asymmetric) cryptography to allow its users to own cryptocurrencies (or any other Blockchain data). Each Blockchain account (or address) has two keys, a public key (shareable) and a private key (must be kept secret). If a user loses their private key, they have lost their money and there is nothing that can be done to fix it [18].

3.2.4. Inefficiency

Proof of proof of work in Blockchain systems requires time, effort and electrical power. Here the electrical power generally needs to be of a very high degree. Another situation is inefficiency. In Bitcoin mining, only one miner receives a reward every 10 minutes, while other miners do not have a source of income to cover their expenses for 10 minutes.

3.2.5. Large storage need

Blocks in Blockchain systems can start to take up astronomical space as time progresses. For example, although 320 GB of space is needed to store Bitcoin blocks on node servers, it will require much more space than 320 GB day by day. This will cause more expense for miners [21].

4. Application with Blockchain

4.1. Structure and Parts of the System

In this study, Blockchain based Genesis Block creation, adding stock code and quantity to the block as data, bringing stock amount according to stock code, transfers between suppliers are carried out. Displaying pending transfers and adding pending transactions to the block by the miner are available. Table 1 shows the structure that should exist in the block, and Table 2 shows the transaction structure, which is special data, in detail.

Table 1. Block Structure

Field	Description
PreviousHash	The previous address of the block
Hash	Block hash value
Transactions	Sequence of transactions Array
Nonce	Counter or Random Number Based on Difficulty During Mining
Timestamp	Block production timestamp

Table 2. Transaction Structure

Field	Description
FromAddress	Sender Address
ToAddress	Sent Address
StockCode	Stock Code
Quantity	Number of Product Transfers

The created system consists of 6 parts and is shown in Figure 11.

• Producer: It is the product production department. Producers have the right to add new blocks to the Blockchain here.

• Validator: It is the part of the verification of the transferred products by a third address.

• Quantity and List Transactions: It is the place where the amount of products available in persons (addresses) is displayed and the Blockchains of that address are listed.

• Transfer Between Addresses: This is the section where products are transferred to other people.

• Pending Transactions List: This is the section that contains the list of pending transactions.

• All Transactions: This is the field where all verified transactions are listed.

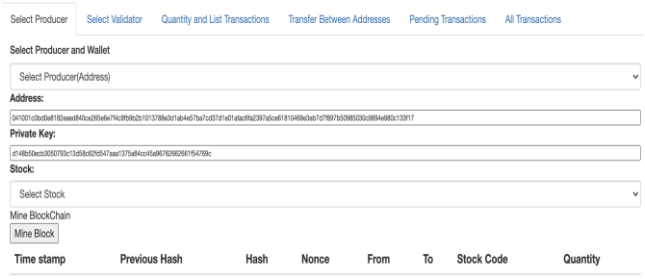

Figure 11. Main Page and Sections of the System.

4.2. Production (Mining) Department

The production part is the inclusion of white goods in the blockchain by adding a new transaction by the manufacturer. As can be seen in Figure 11, there are 2 different inputs in the interface. The first input is the address to produce, the second input is the stock amount to be produced. Figure 12 shows the situation after selecting the address and stock code.

Figure 12. Parameters entering into production.

As a result of the address, private key and stock code parameters entered into the production, the result in Figure 13 is obtained.

Figure 13. The result obtained as a result of the inputs.

4.3. Transfer Section

The process of sending the white goods produced in the system to the wholesalers or suppliers must also be in the nature of a transaction. Therefore, as seen in Figure 14, a sender address (Owner Address), sent address (Receiver Address), stock code (Select Stock) and quantity (Amount) parameters must be obtained from the user. Once these transactions are received, the transfer action is sent. However, the system does not directly add this transaction to the blockchain. For the chain to be added to the block, it must also be verified by a third party.

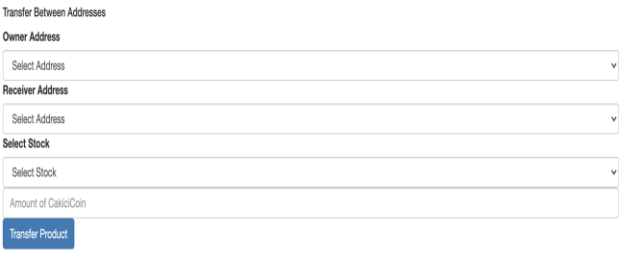

Figure 14. Parameters Used in Transfer Page.

For this operation, first of all, there must be a new block found by the miner. Pending Transactions sequence is added to the new block found.

After the transfer, the transaction is added to the Pending Transfers (pendingTransactions[]) array. And it must be verified by at least a 3rd address (this verification is required by at least 4 or 5 addresses in practice). For this, it needs to be verified (approved) from the Validator Tab by a different address other than the sender and the sent

address. Figure 15 shows the JSON format of the pending transactions.

[
{ "fromAddress":"044119c5ea2077b13cd3cc0cb7222009562bf203fe9fc86044f499aa69b56401a488e43f9586a4c63217b197acaf10e2a17745bee03aa2db40b4cd3f05f0272127",
"toAddress":"041b6f92ea25ddad4bb32bd237a1b71c4d86161624da741b456489feb53b49e69ae79004122dada28cad4b3fc0aecf898e8564122c6d0811f1ed6ee76280c3c784",
"quantity":"1",
"stockCode":"STVESTELBUZ",
"timestamp":1611831035144,
"signature":"3046022100e732066f8ec338e87eb12a38605fff80ad3ea91a6890653263a5b5f45df1caf5022100b70e4d82f19618961d871dc022322a77de07600936af7ae891fcaf55c0d064ff"}]

Figure 15. Pending Transactions.

The brief usage of the SHA256 encryption algorithm used in pending transactions is as follows.

SHA256(fromAddress+toAddress+quantity+StockCode+timestamp).digest('hex');

Sender address, sent address, quantity, stock code and timestamp are entered as parameters to the sha256 function. The SHA256 function generates hash information using these parameters. These parameters are used for signing.

4.4. Validation of Pending Transactions

Pending transactions must be verified by a 3rd address, otherwise no transaction will be provided within the blockchain and no transfer action will take place. Figure 16 shows the new block resulting from the verification of the pending transaction.

Figure 16. New block formed as a result of verification of Pending Transactions.

After the pending transaction is verified, the blockchain turns into the structure in Figure 17.

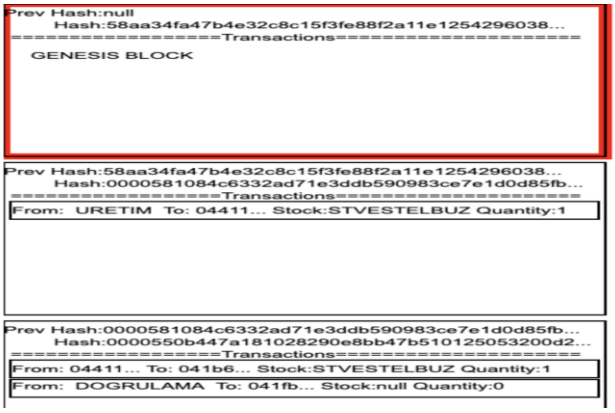

Figure 17. Blockchain structure after transfer.

4.5. Address Balance Query and Address Transactions Section

As shown in Figure 18 in the address query section, the transactions of the corresponding address are seen in the block. Another situation here is that the stock amount appears as 0 (zero) because the address that starts with 044119c is transferred to 041b6.

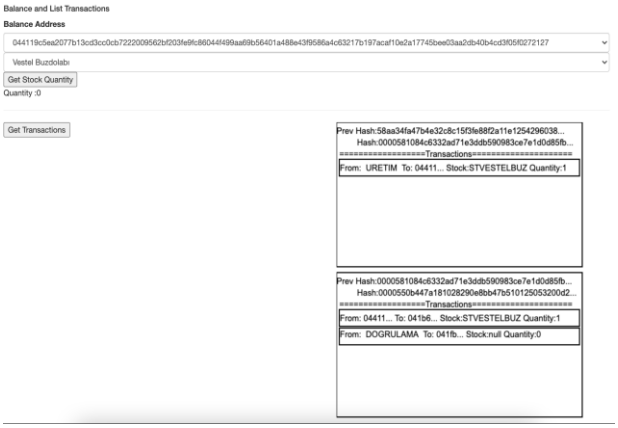

Figure 18. Transactions of the address starting with 044119c.

4.6. Pending Transactions Section

Transfers go through a balance inquiry before the action takes place. If successful, the transfer transaction is added to the pending transaction array (Pending Transactions). Then a new block is expected to be found. When a new block is found, the array of pending transactions is added as private data.

4.7. All Transactions Section

All transactions section is the interface that shows all blocks, including Genesis block, and the move list in the block. All operations performed in this interface are displayed in detail.

5. Conclusions

Blockchain structure has demonstrated its usability by many economic circles, as it is a structure that reveals cyber security and transparency. Although it has disadvantages, it will appear as a software modeling concept that can be used easily in all sectors that require transparency in the future, due to its more advantages.

It is seen that Blockchain systems can be used easily in all systems that require transparency. The biggest advantage is the due to verification by the 3rd person(s). Another important condition is to be protected from 51% attacks. For this purpose, it should be checked who will have the nodes to be included in the system and they should only be given to trusted people/institutions. Otherwise, undesirable situations may arise in the blockchain and big problems may be encountered because the historical data cannot be changed.

Blockchain technology can be easily used in many systems in both the public and private sectors. For example; digital signatures in the public sector, voting, energy use, social security systems, tax systems, title deed transactions, insurance transactions, financial transactions, internet of things, donation transactions, etc. it will make

its name mentioned much more in the coming years due to its stable stance on cyber security and the fact that it guarantees transparency by being easily applied in its fields.

Blockchains can create new business models in all sectors and make changes to existing business models. For this reason, it is important to conduct research on areas where it can be applied in all sectors. This research will be important in determining the direction of future studies.

In this study, a Blockchain system that performs product production, product verification, product transfer between peers, product stock status and listing all transactions has been successfully implemented. In the future, it is planned to develop a Blockchain as a Service (BaaS) platform that provides blockchain services by developing studies on blockchain.

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