Use of Blockchain Technology as a Prospect Element of Management in Product Traceability Systems

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Abstract: Blockchain technology in recent years becomes more and more popular and up-to-date theme in the world. The main issues on the functioning of the blockchain technology and the importance of introducing of products traceability systems on its basis are investigated. Blockchain is a distributed database whose essence is a constantly increased amount of counterfeiting with appropriate digital data encryption systems. The deployment and use of blockchain technology allows the final consumer of any food product to be convinced of the safety of the product, have information on the place of origin of the product, information about the passage of goods through all stages of the expanded reproduction cycle, preventing the forgery of products. For interested persons, in particular stakeholders and regulators, the deployment of this technology will allow to find weak links in logistics processes, to improve funding, to constantly improve the quality control system, monitor the highlights on compliance with legislative and certification requirements. Thus, this will improve the work of agricultural producers, as it will exclude from the supply chain of false and unnecessary intermediaries and will promote better sales of products. From the positions of investors, blockchain technology are also interesting, because it helps to provide transparency of all stages of business processes, as well as to have a perspective vision of export opportunities for individual participants and the agrarian industry in general. The main attention of the research is emphasized on the need to use agricultural and other products traceability systems in the supply chain, which should be based on the use of blockchain technology. The tracking of food products, in case of its deployment, will increase the effectiveness of transactions, reducing their bureaucratization and increase the margin of production within the entire supply chain. The importance of the influence of digital transformation processes into the agrarian sector of the economy as an important stage of the new innovation development of our country is emphasized.

Keywords: Blockchain, Distributed ledger technology, Traceability, Supply chain management, Digital economy.

INTRODUCTION

The rapid development of the modern world leads to the constant improvement and introduction of the latest technologies based on the use of mainly digital technologies. Issues related to the regulation of digital financial assets, which can act as a means of payment, are of considerable interest among the scientific community. The use of blockchain technologies in general in the economy, and especially in agriculture, deserves special attention. These technologies save a lot of money and prevent any manifestations of fraud. Despite the fact that progressive changes in agriculture have a very low adaptive speed, the issue of tracking products in the chain "producer – end consumer" is currently quite relevant, because today to check products for safety and declared quality is a difficult process.

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LITERATURE REVIEW

Theoretical aspects of blockchain technology have been studied in the works of foreign scientists, in particular in the team of authors K. Demestichas, N. Peppes, T. Aleksakis and E. Adamopoulou, who in their study consider definitions, levels of application, tools for tracking agricultural products and provide a brief overview of the functionality and benefits and prospects of using blockchain technology in the supply chain of agricultural products (Demestichas, 2020).

A study by a team of Italian scientists M. Caro, M. Ali, M. Vecchio and R. Giaffreda presented AgriBlockIoT technology as a fully decentralized, blockchain-based system to improve agri-food supply chain management, capable of uninterrupted operation of integrated Io receiving and accumulating digital data throughout the supply chain. In this paper, the classical scheme within the vertical domain is studied and tested, as well as developed and applied, using two different blockchain technologies, product tracking system,

which is tested from the standpoint of performance and other technical aspects related to the Internet (Caro, 2018).

Among domestic scientists, the research of blockchain technologies in agriculture is devoted to the works of scientists Moroz T.O., Hrybyniuk O.M., Dukhnytsky B.V., Sheremeta O.O., who in their research consider the mechanism of functioning and features Internet technologies that can be used in agriculture. The main emphasis in their research is based on the importance of using blockchain technology in domestic agriculture, which will radically change the current practice of settlement relations between counterparties (Moroz, 2019; Hrybinyuk, 2018).

METHODOLOGY

The task of our research is to investigate the peculiarities of the functioning of blockchain technology and the prospects of its use in agriculture of Ukraine.

Blockchain technology is currently in its infancy and its commercial use is sometimes faced with certain technical problems and limitations, mainly related to the speed of transaction confirmation. Among the research methods we used general and special methods. Among them, the bibliographic method should be singled out as part of the methodological tools of this study. It was used to screen scientific publications and analyze their content regarding the use of blockchain technology in various sectors of the economy.

In addition, the research used methods of structural analysis and synthesis, which were used to select scientific information. Also, the formal-logical method was used to define the main concepts and definitions. The application of the method of analytical work made it possible to determine the extent to which all stages of conducting business processes when using blockchain technology are transparent and allow to exclude unnecessary intermediaries from a number of counterparties. The use of cause-and-effect analysis provided an opportunity to identify the advantages and disadvantages of using blockchain technology in agricultural product traceability systems. Using the forecasting method, it is proposed to apply blockchain technology in agriculture as one of the elements of food product safety for the end consumer. Conclusions from the conducted research were made using dialectical and logical methods.

RESULTS AND DISCUSSION

In today's world, consumers pay a lot of attention to the origin and quality of food, which in turn leads to a tendency to spend more money on those products whose origin is certified. Despite the technologies already in use, in many cases the vast majority of tracking systems are centralized, asymmetric, and outdated in terms of data exchange and compatibility. Existing systems are not transparent and do not trust consumers due to the lack of a fast and reliable way to obtain information about the origin of the product.

In view of the above, along with the rapid technological developments in the value chain, there is a significant increase in new innovations leading to new digital tracking systems and taking advantage of information and communication technologies (ICT), radio frequency identification (RFID) sensors, Internet of Things (IoT), blockchain, etc. In such circumstances, distributed registry technologies (DLT), such as blockchain, offer solutions to many existing problems, but also create new challenges.

In recent years, the rapid growth of the practical and efficient use of distributed ledger technologies (DLT) in the agricultural supply chain of European countries has been the focus of the scientific community and the food industry. At the same time, the formation of the paradigm of the Fourth Industrial Revolution makes distributed registry technology a promising direction for further research in the future. Agriculture is a complex and complex industry, as the agri-food sector is constantly facing changes in processes and operations taking place in the world. As more and more requirements and restrictions are imposed on the agricultural sector every year, this necessitates the search for new, innovative solutions.

Improving the efficiency of decision-making in the value chain in the agri-food sector is closely related to the presence of the following problems:

- lack of necessary infrastructure and lack of human resources;

- the need to harmonize the proven technologies used with innovations to ensure optimal costs;

- reduction of time costs for the introduction of technologies, taking into account the needs and problems of small agricultural producers;

- optimization of the share of funding for the introduction of information technology in agriculture between stakeholders, including public-private partnership mechanisms;

- Insufficient exchange of information on the progress of successful projects, including opportunities for agri-food business and the benefits of new technologies (Mahant, 2012).

One of the important areas of using blockchain technology is to improve the organization of supply chains in the agricultural market. From an economic point of view, the use of blockchain technology reduces transaction costs, as it eliminates the link between intermediaries, which are known to always be between agricultural producers and their end users.The positive side of this technology can be considered the expected effect of improving counterparty relations between market participants, improving the efficiency of the movement of goods along the product chain, more rational planning and use of movement schemes of the product itself. Thus, the formation of an effective supply chain will contribute to better efficiency of agreements between the parties, a more rational attitude to the current solution of operational tasks, increase margins at all stages of the chain, improve the traceability of the final product. In parallel, online blockchain technology will provide all counterparties with a single, unbiased and non-falsified source of true information about a particular product at any stage of its movement along the logistics chain (Fig. **1**).

An important element in the process of forming the value chain is the traceability element. Thus, the study of a group of authors (K. Demestichas, N. Peppes, T. Aleksakis and E. Adamopoulou) shows the current scientific and technical

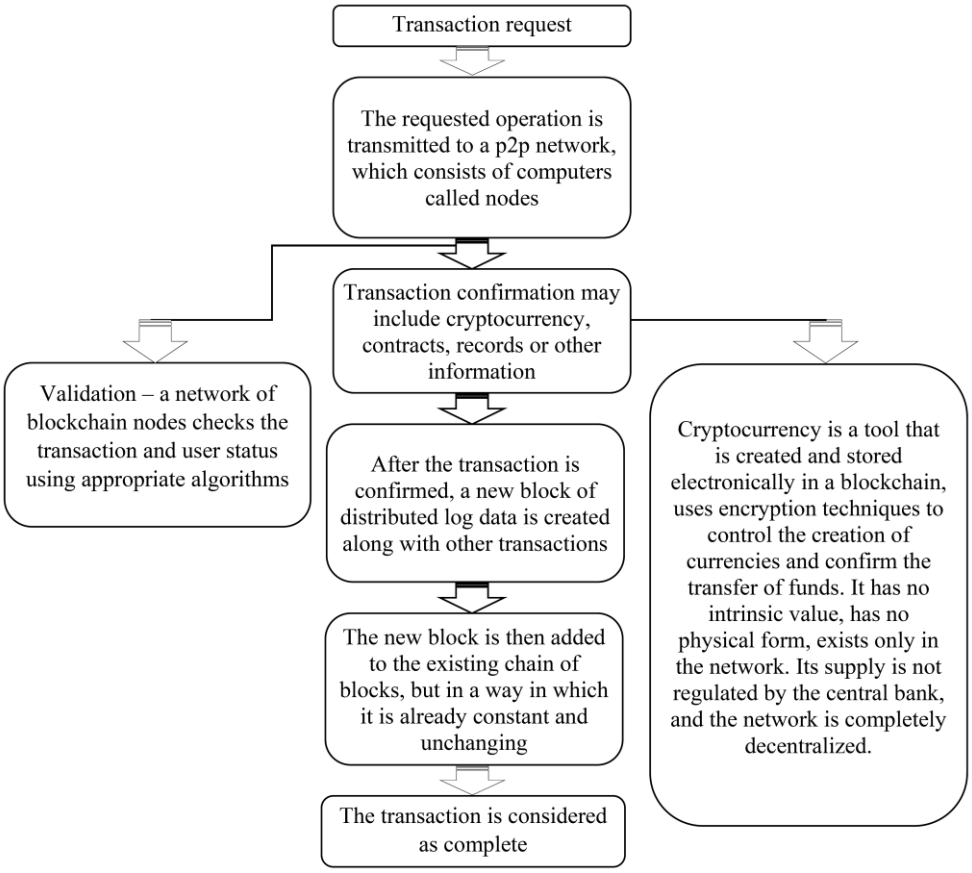

Fig. (1). The principle of blockchain technology.

Source: formed by the authors on the basis of (Daneev, 2018, p. 71).

publications on the use of blockchain to track products in the supply chain in agriculture. In particular, traceability is known for the principle of "one step back one step forward", ie - is the ability to reproduce all the information about the origin of a product (Traceability, 2015). According to the definition given by the International Organization for Standardization (ISO) in its standard ISO 22005: 2007, traceability is "the ability to track the movement of feed or food products through certain stages of production, processing and marketing" (ISO, 2016).

Thus, the traceability of the food product contains information about the ingredients, sources of origin of the product, processing, as well as conditions of transportation and storage. The ideal tracking system in agriculture will also contain information on each component of the final product. Thus, to be considered effective, the traceability system must contain both quantitative and qualitative information about the final food and its origin.

Tracking processes in agriculture require a large amount of data to be collected throughout the supply chain. In recent decades, there has been a rapid development of automated processes and products, as well as communication technologies, leading to the so-called Internet of Things (IoT) paradigm. The rapid development of IoT and sensor technologies facilitates the data collection process by offering fast and reliable methods. These methods include product identification technology, component analysis, transportation, storage, and information gathering within the overall system integration. Methods such as barcodes, QR codes, radio frequency identification (RFID), and wireless sensor networks (WSNs) are the most common and well-known in supply chains.

One way to address product tracking issues could be to introduce blockchain technology in the general supply chain in agriculture. In general, a blockchain can be described as a distributed ledger that maintains an ever-growing list of data records validated by all participating nodes. A block is a record that includes data inside it, as well as the hash value of the previous block and a value that represents its own hash. A hash means a digital imprint of the amount of data in a block. The relationship between the hash of the current block and the hash of the previous block explains the value of the cryptographically linked chain of blocks through these hashes. If someone wants to forge certain data, this digital fingerprint will be changed, and thus the chain will become invalid. In the report of the World Economic Forum, blockchain technology, or as it is also called - distributed ledger technology - is a technological protocol that allows data to be exchanged directly between different parties to the contract (contractors) on the Internet without the involvement of intermediaries. Thus, network participants interact with encrypted identifiers (ie, anonymously), and each transaction is subsequently added to a fixed chain of transactions and distributed to all network nodes (Seffia, 2017).

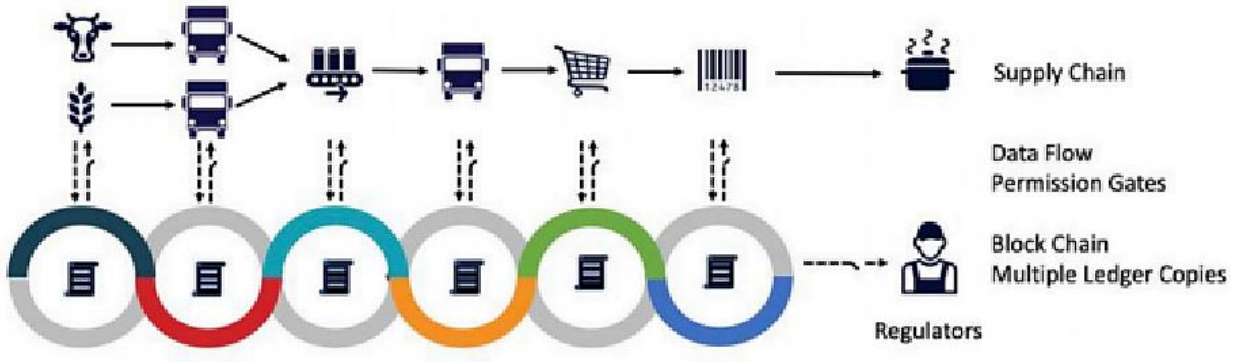

Fig. (2). Scheme of tracking the flow of data in the food supply chain in the interaction of blockchain technology (distributed registry technology).
Source: formed by authors based on (S. Pearson et al, 2019).

The significant potential of blockchain technology is due to the fact that two complementary approaches are used to confirm the authenticity of journal entries, namely:

1. Proof-of-Work (PoW) - participants in the transformation solve cryptographic problems of variable complexity. Accordingly, the more information resources in the network, the more complex the task. This approach has led to a general fascination with mining in the world of cryptocurrencies.

2. Proof-of-Stake (PoS) - participants do not solve cryptographic problems, but validate (confirm) transactions by "freezing" as a mechanism for confirming ownership of the benefit. Upon reaching an agreement in the network, transactions are added to the blockchain, when "thawing" the miner receives back the amount with the commission for recording the transaction in the blockchain.

The differences between PoW and PoS are quite significant. The PoS approach is more decentralized than PoW, it does not allow each user to extract new blocks, ie the costs are much lower than the requirements for mining equipment in the PoW approach, and finally encourages more people to install their own blockchain nodes, which makes the network more decentralized and also more secure.

Effective tracking systems that can minimize risks are considered a necessary tool to ensure food safety (Aung and Chang, 2014).It should also be noted that international food traceability standards are based on the joint work of the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), which have developed a Food Standards Program called the Codex Alimentarius Commission.). The basic principles of food traceability are set out in CAC / GL 60-2006: "The food traceability tool must be able to identify at any specific stage of the food chain (from production to distribution) where the food came from (one step back) and where it has gone (one step forward) in line with the objectives of the food inspection and certification system "(CAC, 2006).

Thus, such a pragmatic procedure (ie, step up - step down) connects all related members of the supply chain, because all participants know who their suppliers are and where their products are sold. However, this approach can still be considered somewhat inaccurate, as many foods have complex multi-component vertical and horizontal branched chains (eg, multi-ingredient products). In addition, such traceability can be easily lost in raw materials that are mixed (eg milk from several dairy farms) or separated and mixed in the supply chain (eg meat animals). Due to this complexity, it will soon be impossible to verify the origin and quality of specific products. Accordingly, the loss of such clarity in the multiple supply chain will contribute to or hide the moments of fraud.

Blockchain technologies, in which data is reflected in transaction logs and cryptographically linked in blockchains, are offered as an additional solution to the above problems and allow regulators, consumers and businesses to instantly access information throughout the supply chain of any food product. Thus, the registers are reproduced (distributed) by a number of identical copies among all users of the system.

Data with new information is added to the register only by consensus, when all users agree that this data is accurate and true. Any attempt to change the information by one user will be visible to all users, and therefore theoretically impossible. In addition, twelve of the world's largest food companies use blockchain technology to support food tracking in the world. Among them are well-known companies Walmart, Nestle, Unilever, Tyson Food, Driscoll's and Dole Food (Pearson et al, 2019).

Consider the scheme of tracking the flow of data in the food supply chain using blockchain technology (Fig. **2**).

Fig. (**2**) shows the scheme of operation of blockchain technology in the food supply chain from the farm to the final use of products by the consumer. Thus, each member of this chain (farmer, food producer, carrier, retailer and consumer) can have access to a complete copy of the register. In this case, the information data is sent to the distributed register by all participants in the supply chain, but access to this data is possible for all others only with permission. Next, the information data is collected into interconnected integral "blocks", which are combined into one whole using fixed cryptographically encrypted keys.

With permission, any member of the chain can see the full picture of the origin of the product within that supply chain. Instead, regulators only have access to the registry, which gives them instant access to all information about the origin of any particular product, at any stage and in any participant.

This aggregation of datasets allows regulators to track any changes in the supply chain and even track the formation of multicomponent products.

CONCLUSIONS

Technological innovations such as robotics, artificial intelligence, cloud technology, and the mobile economy have evolved rapidly over the past few years through the development of social media and digital IDs, and are now a key element of the commercial and social economy (eg, sharing, crowdfunding). Therefore, the ability to change and adapt today is vital for enterprises, as such a rapid response allows you to timely protect and expand their existing competitive advantages and market share.

Summing up our research, it should be noted that the use of blockchain technology in agriculture significantly improves the traceability of any element of the final product due to the consistency and integrity of the stored data that characterize it. With the help of blockchain technology, it is possible to build a much higher level of trust in the agricultural sector as a whole. However, to date, this system is not yet fully understood and implemented. Issues of a legal nature and the relationship between the participants in the supply chain remain unresolved. Therefore, in the long run, the evaluation model of this technology should be improved. If the developed model saves time, reduces costs and risks, increases the level of traceability of the final product, will increase productivity and bring added value and, consequently, profit, stakeholders will be ready to apply it in their activities.

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