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Integration of blockchain technologies into the social security system: transparency and efficiency

Integración de tecnologías blockchain en el sistema de seguridad social: transparencia y eficiencia

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Sumario

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Abstract

Over the past decades and especially in recent years, each of our spheres of life has undergone transformational changes in the use of information technology. From the labour market to the social security system, the world is undergoing a transition from "traditional" models of functioning to more updated and modern ones. We are talking about blockchain technology, which is a unique tool for improving various programmes and areas of activity due to its nature, increased security and speed. This is the reason for the relevance of the study. After all, in many countries of the world, in particular in Estonia, China, Switzerland, the United Arab Emirates and many others, blockchain technology is actively being implemented in various spheres of life of the population. Accordingly, the sphere of social security also falls under this sphere. The purpose of the study is to provide a detailed analysis of the features and characteristics of blockchain technologies, to identify the specifics of integrating blockchain technologies into the social security system based on the principles of transparency and efficiency, as well as to familiarise with the problems of using blockchain in the social security sector and to provide practical recommendations for the effective integration of blockchain technologies. To achieve this goal, we used the following methods of scientific knowledge, such as the general philosophical method, the method of system analysis, synthesis, comparative legal method, dialectical method, deduction and induction. As a result of the scientific research, we have formed general theoretical conclusions about the phenomenon of blockchain technologies, as well as the peculiarities of integrating blockchain technologies into the social security system. Moreover, we have drawn practical conclusions and provided recommendations for improving the process of implementing blockchain technology in the social security system.

Keywords

blockchain technology*;* smart contracts*;* social security system*;* nodes*;* integration

Resumen

En las últimas décadas, y especialmente en los últimos años, cada una de nuestras esferas de vida ha experimentado cambios transformadores en el uso de la tecnología de la información. Desde el mercado laboral hasta el sistema de seguridad social, el mundo está transitando de modelos de funcionamiento "tradicionales" a otros más actualizados y modernos. Nos referimos a la tecnología blockchain, que constituye una herramienta única para mejorar diversos programas y áreas de actividad debido a su naturaleza, mayor seguridad y velocidad. Esta es la razón de la relevancia del estudio. Después de todo, en muchos países del mundo, en particular en Estonia, China, Suiza, los Emiratos Árabes Unidos y muchos otros, la tecnología blockchain se está implementando activamente en diversas esferas de la vida de la población. En consecuencia, el ámbito de la seguridad social también se ve afectado por esta transformación. El objetivo del estudio es proporcionar un análisis detallado de las características y particularidades de las tecnologías blockchain, identificar los aspectos específicos de su integración en el sistema de seguridad social basándose en los principios de transparencia y eficiencia, así como examinar los problemas asociados con su uso en este sector y ofrecer recomendaciones prácticas para una integración efectiva de las tecnologías blockchain. Para lograr este objetivo, hemos utilizado diversos métodos de conocimiento científico, tales como el método filosófico general, el método de análisis de sistemas, síntesis, método jurídico comparado, método dialéctico, deducción e inducción. Como resultado de la investigación científica, hemos formulado conclusiones teóricas generales sobre el fenómeno de las tecnologías blockchain, así como sobre las particularidades de su integración en el sistema de seguridad social. Además, hemos extraído conclusiones prácticas y proporcionado recomendaciones para mejorar el proceso de implementación de la tecnología blockchain en el sistema de seguridad social.

Palabras clave

tecnología blockchain; contratos inteligentes; sistema de seguridad social; nodos; integración

INTRODUCTION

The social security system often suffers from a lack of transparency, inefficiency and significant vulnerability to fraud. Moreover, social security systems in most countries are generally burdened with bureaucracy, but even so, they are designed to provide timely assistance to vulnerable groups of the population. Undoubtedly, in recent years, the world has been rapidly moving towards innovative technologies, with many technological shifts and innovations taking place. Among them are the active automation of administrative services and the solution of inefficiencies in the public sector through active digitalisation (Delgado et al., 2012). At the same time as the latest technologies open up a lot of space for new opportunities, stimulate new technological developments that can be applied in various spheres of society, and contribute to the destruction of the boundaries of exclusion and equity, the digital divide is also growing, i.e., a large part of the population remains without access to the benefits of digital technologies (Rajendran et al., 2023).

This means that we are witnessing a kind of paradox - digital tools designed to optimise and improve the distribution of social assistance remain inaccessible to the very people they are meant to serve. We cannot ignore the fact that the Covid-19 pandemic has become a catalyst for the introduction of digital technologies in various spheres of life, which has highlighted the existence of a significant digital divide between people who have access to and successfully use various digital technologies and those who do not. The quarantine has forced many people around the world to be confined to their homes, and society has been forced to adapt to new realities and actively integrate digital technologies into its normal rhythm of life - from distance learning to basic administrative services (How blockchain could revolutionise social welfare, 2024).

Moreover, the pandemic has clearly demonstrated that the labour market can also transform and exist not only in an offline format, and that is why it has happened - remote forms of work organisation have become increasingly common. Therefore, it is quite logical that this transformation of labour has brought about the dominance of artificial intelligence technologies, innovations, algorithms and automation. However, the social security system also actively needs to be improved in terms of innovation and technology. It is important to note the fact. That today, business data of social security services is quite widespread, while the types of participating institutions are diverse, and the network of business data interaction is certainly complex (Shammar et al., 2021; Razmetaeva et al., 2022). The fact that there is a lack of close communication between different institutions remains a pressing issue, which leads to a deterioration in coordination and coherence of service delivery.

Moreover, this causes the need to re-register personal information when dealing with everyday matters, which means that time is lost for timely response and assistance. Accordingly, this results in a lot of inconvenience at work and a decrease in the efficiency of social protection departments. Therefore, when there is good communication and common platforms, this can be avoided as much as possible. We also note that, in general, different social protection departments and different insurance companies operate separately, which leads to a lack of transparency in approvals for businesses, low efficiency of public services, and risks such as fake applications for unemployment benefits and inconsistencies in the status of participation in different insurance programmes (Shammar et al., 2021). That is why we consider it expedient to improve social security systems by integrating a consortium blockchain to prevent serious problems in the field of social security and empower social security departments. At the same time, it is also important to ensure data security at various stages of blockchain technology implementation in order to build a reliable and high-quality functioning system, while facilitating interagency and cross-border hierarchical information exchange (Rajendran et al., 2023).

In general, the term "blockchain" is a tamper-resistant, immutable, auditable, permanent register of time-stamped blocks used to exchange and store information on a peer-to-peer (P2P) basis. It should be noted that the information stored there is quite different - from personal information about a person to their payment history. Blockchain technology was originally developed to solve the problem of double spending in cryptocurrencies, but later it was actively used in various industries. This was done because blockchain technologies are characterised by data security, auditability and transparency of the system itself, resistance to censorship, etc. (Blockchain in Government…, 2024; Tsypko et al., 2019).

In view of the above, we consider it appropriate to define the purpose of this research, which is as follows: a detailed analysis of the features and characteristics of blockchain technologies, identification of the features of the integration of blockchain technologies into the social security system, which is based on the principles of transparency and efficiency, as well as familiarisation with the problems of using blockchain in the social security sector and providing practical recommendations for the effective integration of blockchain technologies.

1. METHODOLOGICAL FRAMEWORK

In accordance with the purpose of the study, the research was conducted using the following methods of scientific knowledge: the general philosophical method, the method of system analysis, synthesis, dialectical method, comparative legal method, methods of deduction and induction. It should be noted that the general philosophical method was used at all stages of the study to formulate comprehensive theoretical conclusions and practical recommendations for the implementation of blockchain technology in the social security system. The involvement of general philosophical principles made it possible to formulate complex theoretical conclusions about the nature and potential of blockchain technology, as well as to develop practical recommendations for its introduction into the social security system. Philosophical inquiry helped to keep the study aligned with fundamental questions about technology's role in society, the nature of security and trust, and the balance between innovation and regulation.

Using the system analysis method, we identified the features and characteristics of blockchain technologies, noting that blockchain was first used in cryptocurrencies. However, due to the high level of security, safety and efficiency, blockchain is used in various areas of society. Using the method of system analysis, we also identified problematic aspects that arise in connection with the integration of blockchain technologies into the social security system based on the analysed experience of implementing blockchain technologies in different countries, including Estonia, Switzerland, the United Arab Emirates, and China. The use of the comparative legal method, which was used to conduct a comparative analysis of the introduction of blockchain technologies, also helped to identify important issues. The study also used the synthesis method to identify the peculiarities of integrating blockchain technologies into the social security system based on the principles of transparency and efficiency. This method was used to identify the specifics of blockchain integration into social protection systems, emphasizing transparency and efficiency.

The dialectical method reveals the content of the problematic aspects that pose a direct threat to the effective integration of blockchain technologies into the social protection system. This method ensured that the recommendations were based on a variety of legal and regulatory contexts, increasing their relevance and applicability. Deduction is a logical process where conclusions are derived from general premises. Using the method of deduction, we conclude that, despite the characteristics that confirm the effectiveness of effective implementation of blockchain technologies, there are problematic aspects of such implementation. Induction involves deriving general principles from specific

observations. Using the induction method, we formulate practically significant recommendations for improving the situation with the integration of blockchain technologies into the social protection system in combination with other methods.

Taking into account the above methods, we identified the problematic aspects of the implementation of blockchain technologies in the field of social security, and also provided practical recommendations as a response to the identified challenges, as well as recommendations that would be appropriate. The integration of these various methodological approaches made it possible to comprehensively analyze the potential and features of the introduction of blockchain technology into the social security system. Such a multimedia approach made it possible to thoroughly and in detail research the topic, which made it possible to formulate practical and theoretically grounded conclusions.

2. RESULTS AND DISCUSSION

2.1. Blockchain technology: characteristics and features

For further scientific research, we consider it expedient to investigate the characteristics and features of blockchain technologies. In general, a blockchain is a distributed digital ledger or accounting book. Instead of relying on a bank or a lawyer to certify that money has been exchanged or a deal has been concluded, each transaction between participants, or nodes, on a blockchain is securely recorded using strong cryptography as an additional block in the database, a copy of which is available to all full nodes. It is precisely due to this special nature that the blockchain works, and therefore no node can deceive it or interfere with its functioning (Tang et al., 2022). It is also important to check that everyone is using the same version of the blockchain and that there are no conflicting versions - the design also includes a kind of collective consensus and verification system through mining, which is a way to establish proof of work (Mazlan et al., 2020).

It should also be emphasised that blockchain technology stores existing data unchanged, without relying on a central authority. That is, it once again confirms its peculiar integrity, while nullifying any attempts at manipulation. That is why it can be argued that blockchain technologies can easily replace various intermediaries and central authorities, with only one code that can combine the available data into a single whole (Malcolm, 2007).

For example, blockchain was first used in cryptocurrencies, namely bitcoin, but they are identical, because blockchain technology is much broader. Whereas bitcoins and various cryptocurrencies are only manifestations of blockchain applications. The blockchain technology itself is used in various industries - finance, social security, identity verification, etc. A feature of all services based on blockchain technology is its design. And one of the latest innovations of blockchain technology is the so-called “smart contracts” (Nada et al., 2019). Smart contracts are a kind of automated programs that are launched to automatically transfer digital assets within a single blockchain when certain launch conditions are met. Such smart contracts are immutable, as they store their codes in the blockchain, and they allow for many different transactions without any mandatory human intervention (Blockchain: A technology…, 2023; Getman et al., 2023).

Such smart contracts were first introduced by the Ethereum cryptocurrency. After that, there was an increased interest in them from businesses and governments to develop further applications based on such smart contracts (Blockchain: A technology…, 2023). Such applications range from decentralised voting to identity verification, from global money transfers to decentralised fundraising. Certainly, by its very nature, blockchain technology can be applied in many areas of life, as it can

integrate information in a way that provides ample opportunities to improve financial freedom, trade, self-expression, and social welfare (Tang et al., 2022).

It is important to remember that blockchain technology uses cryptography and distributed consensus algorithms to maintain trust and ensure security. In general, blockchain can be described by 3 basic characteristics, such as:

1) It is a distributed database - that is, all existing transactions are manifested in the form of records of several nodes, and each node contains comprehensive information about the transaction. That is why each of these nodes is able to participate in monitoring the legality of a particular transaction and verifying the validity of such a transaction (Blockchain is more…, 2024).

2) P2P (peer-to-peer) network decentralisation - that is, each network node is equal, and P2P communication can help to avoid one person gaining exclusive rights to censor transactions and seize data resources. In general, this concept of decentralised verification of each transaction means that each node individually and collectively verifies each transaction, and the transaction will be completed only when the majority of nodes approve a particular transaction (Alamri et al., 2022).

3) The functioning of smart contracts, i.e. software codes that can be executed automatically in a decentralised blockchain network. Each smart contract is published, verified, stored, and coordinated through each blockchain node (Blockchain is more…, 2024). The main elements of smart contracts are their self-sufficiency, autonomy and decentralisation. Self-sufficiency is manifested in the ability of smart contracts to independently receive data in the blockchain. Autonomy means that the contract is executed automatically after launch without any intervention from its creator. And their decentralisation is manifested in automatic execution through network nodes, while being independent of a single central server (Nada et al., 2019).

2.2. Peculiarities of integrating blockchain technologies into a social security system based on the principles of transparency and efficiency

Social security systems implemented in different parts of the world and actually operating there have faced and are still facing a number of challenges. These challenges include low levels of integration of business data and information in the social security sector, insufficient disclosure of statistics and information, and limited statistical research.At the same time, it is important to note that the significant potential of data to inform service decisions, manage services and serve society has not been unlocked (Vangala et al, 2021).

As the experience of implementing social security systems shows, this area needs to be improved by integrating blockchain systems, sharing data between agencies, and interacting with business processes. Unfortunately, social security departments often do not share important information with most other institutions that also need such information. At the same time, most of this information is personal confidential information, and therefore requires a huge number of necessary actions and procedures, which in turn brings a number of inconveniences and time costs (Bonnah & Shiguang, 2020). Even if the entire procedure is followed, difficulties may arise in another aspect - i.e., personal data leakage. In this case, such procedures often become tools for fraudulent activities.

We would like to recall that it was on the example of social protection and social security that F. Delgado studied the international exchange of e-government information, taking into account the information required to achieve interoperability. This was done to ensure interoperability and interconnectivity between the relevant social security institutions of different countries. It was concluded that the system is centralised, and therefore it is difficult to understand how to ensure the security of authentication of credentials (Blockchain as the future..., 2018). In his turn, Zheng Yang proposed to use blockchain technologies that are decentralised (as we have mentioned above) in order to further assess trust in social networks. However, again, there was a lack of research on the issue of data sharing in heterogeneous networks (Meng et al., 2021). In parallel, Gu Jingjing studied the implementation of blockchain-based e-government data sharing and suggested that blockchain technology can implement a multi-party trust and data sharing mechanism between different government departments, but there is a lack of research on public social welfare services (Crosby et al., 2016; Yaroshenko et al., 2024a).

Thus, we can note that the current information system of the social security service, data standards of different business systems are not unified - when using established means for information exchange, there are generally problematic issues such as not quite consistent interfaces, complicated mechanisms and tools for authentication of credentials. As a result, this situation leads to an incomplete exchange of important information. Moreover, in the absence of blockchain technology and the use of standard information systems in the provision of administrative services, such aspects require manual verification (Bonnah & Shiguang, 2020). It is the delay in verification and the accuracy of data authentication mechanisms that are common difficulties. It is the introduction of blockchain technologies and corresponding smart contracts that will serve to simplify the manual verification procedure.

Therefore, we can confidently say that the integration of blockchain technologies into social security systems should be carried out using distributed sharing, multi-centralisation, enhanced security, protection against tampering, protection against tracking, and trust in consensus. Taken together, this should lead to the construction of a single data platform for social security services and the creation of so-called smart social security services (García-Magariño et al., 2019).

It should be noted that the integration of blockchain technologies into the social security system can bring significant improvements in terms of transparency and efficiency for many states. The principle of transparency can be met by taking the following steps:

— Creating a public unified register - blockchain technology ensures that once the relevant information is entered, it cannot be deleted and changes can be made with the appropriate access codes. In turn, this guarantees the integrity of social security data and transparency of access to it. Accordingly, it simplifies the process of tracking benefits, contributions, and any changes in information over time (García-Magariño et al., 2019).

— Tracking audit trails - as each transaction has its own trace, the authorised bodies can track the relevant transactions and use this data to obtain the necessary information. This, in turn, ensures compliance with the principle of accountability (Li et al., 2021).

— Decentralisation - in this case, we are talking about a network of nodes that reduce the risks of fraud and data forgery. Decentralisation also ensures that no single entity has control over the entire system, which helps to increase trust between participants (Vangala et al, 2021).

— The use of smart contracts - they can improve the situation with automation and ensuring compliance with the rules and security of transactions without human intervention. For example, eligibility criteria for benefits can be programmed into a smart contract, ensuring consistent and transparent application.

Efficiency gains will be achieved by implementing the following steps:

— Streamlining important social security processes - blockchain technology will eliminate the need for numerous intermediaries involved in verifying and processing social security claims. In turn, this reduces administrative costs and processing time (Al-Saqaf & Seidler, 2017).

— Conducting various transactions in real time, which will have positive effects on data processing and speed up payments and contributions (Li et al., 2021).

It is important to note that when using blockchain technologies, all stakeholders, including employers and employees, and various government agencies will have equal access to data that is up-to-date and comprehensive. In turn, this will reduce the number of discrepancies and the need to reconcile data. At the same time, blockchain technology will make all data exchange between different institutions and organisations much more secure and confidential. Therefore, data on social security of certain categories of people will be protected (García-Magariño et al., 2019).

When integrating blockchain technologies, an equally important aspect is the issue of financing operational costs. By automating processes, such financial costs will be significantly reduced. And if all of the above is taken into account, blockchain technologies will help to reduce the number of frauds and unauthorised access situations (Huckle et al., 2016). The integration and adoption of blockchain technologies is a truly effective solution to the problems of social security systems. As such, blockchain technology, known for its decentralisation, transparency and security, offers potential solutions to many of the challenges faced by modern social security systems:

— Linking security and fraud prevention - i.e. blockchain technology can provide a controlled, secure and immutable record of all new transactions and claims. This reduces the risk of fraud and ensures the authenticity of claims.

— Ensuring data confidentiality and improved data management - this can be done through encryption and decentralised storage. Therefore, under such conditions, personal data can be managed much more securely, ensuring confidentiality and protection against breaches (Al-Saqaf & Seidler, 2017).

— Efficient administration - this is achieved through the use of smart contracts on the underlying blockchain, which can automate and streamline administrative processes, reducing the need for manual intervention and minimising errors (Li et al., 2021).

— Addressing informal workers - blockchain technologies can facilitate the creation of portable social security accounts that are not tied to specific employers, allowing informal workers to more easily access benefits (Al-Saqaf & Seidler, 2017).

The integration of blockchain technologies into social security systems is a fairly new issue, but it is already being actively implemented in several countries. We propose to analyse the experience of implementing blockchain technologies in those countries that pay considerable attention to the

latest technologies and try to keep up with the times, improving the provision of public services, including social security.

Estonia is a fairly "new" player in the field of digital public services. However, as of today, it has implemented blockchain technology at the state level to protect data in its e-residency programmes and to update and simplify medical records. The Estonian government is currently studying the prospect of improving social security systems through the use of blockchain. Moreover, the legal framework in Estonia is prepared for the active implementation of blockchain technologies, while ensuring the legitimacy of recognition of digital transactions at the state level. The same applies to smart contracts - their legal status is enshrined at the state level and they are treated with the same seriousness as conventional paper contracts. For example, the Estonian X-Road platform, which integrates various government databases, uses blockchain to ensure data integrity and security (Blockchain and smart…, 2024).

For example, the Swiss government, known for its progressive stance on blockchain technologies, is considering various options for using blockchain to improve the efficiency, security and transparency of public services, including social security. To this end, the legal framework has been adapted to accommodate the introduction of blockchain technologies. The city of Bug has piloted a blockchain-based digital identification that allows residents to access various municipal services. This project is quite promising in terms of its further application in the social security sector. Moreover, the same city has also implemented a blockchain-based e-residency programme. Such government initiatives contribute to the development of a transparent public services sector. At the state level, the development programme includes the use of blockchain in social security through verification of individuals and the active use of smart contracts for the distribution of social benefits. Smart contracts can ensure timely and accurate payment of benefits based on predefined conditions. An immutable blockchain ledger can securely store sensitive personal data related to social security. This ensures data integrity and protects against unauthorised access or tampering (Switzerland has become…, 2023).

The experience of the United Arab Emirates is also worthy of note, where a favourable regulatory climate for crypto and blockchain companies is actively offered at the state level. At the state level, potential investors are protected, the regulatory framework is adapted (laws have been adopted that directly relate to virtual assets and the introduction of blockchain technologies) and standards are approved. Dubai's blockchain development strategy aims to transfer all government documents to the blockchain, which directly includes social security and pensions (Blockchain in the UAE…s, 2023).

China's experience in this area should not be overlooked. Initially, China had a limited attitude to blockchain technology, but today it is a market leader in terms of innovation. The government is showing significant interest in using this technology in various sectors, including social security. For example, China has recently launched RealDID, a blockchain-based digital identification programme to provide "external anonymity". This platform will guarantee the anonymity of registrations and website logins using special private keys and decentralised identifiers. Such applications will guarantee a direct link between personal data and personal financial information. Accordingly, this programme is planned to be used to improve social security systems. At the same time, several cities and provinces in China have launched pilot programmes to study blockchain applications in the social security sector. These pilots aim to test the feasibility and benefits of using blockchain to manage social security data and pay benefits. A positive development has come from Hangzhou, where blockchain technology has been introduced into the social security system to improve data management and optimise benefit distribution (China will implement…, 2023; Yaroshenko et al., 2024b).

2.3. Challenges in the application of blockchain in the social security sector and practical recommendations for the effective integration of blockchain technologies

The integration of blockchain technologies in the countries analyzed above will undoubtedly have a positive impact on social security systems, but this does not exclude the fact that a number of difficulties and problems associated with such integration will arise. The problems of using blockchain in the social security sector include the following:

Lack of standardisation of technologies - this is a rather serious problem, as standardisation of technologies can ensure the desired connection between stakeholders, such as employers and employees, etc. Otherwise, it will prevent the creation of a kind of digital credentials ecosystem. Governments can lead initiatives to create national standards for blockchain technologies. By establishing clear guidelines and regulations, they can promote consistency and interoperability within the country. Collaborating with private sector stakeholders, academia, and international bodies can help in formulating these standards (Wust & Gervais, 2018).

Resource use and complexity - it is important to note that each blockchain node must be stored in the network, which in turn requires significant storage costs. Moreover, the cryptographic process requires more computing power. As a result, this will require more electricity consumption, which will increase the cost and complexity. We ecommend to implement state channels and sidechains, which operate on top of the main blockchain. These solutions reduce the load on the main blockchain by handling transactions off-chain and only recording final states on the main chain. (Shuaib, et al., 2021).

Security issues - of course, blockchain technology is much more secure than other technologies, but we cannot say that it is 100% secure. Still, there are various security issues that need to be taken into account and countermeasures applied to make it safe and reliable, which also applies to the social security sector. That is why it is advisable to apply privacy and security techniques such as zero-knowledge proofs, encrypted data storage, and permissioned blockchains to protect sensitive information. Also, follow data protection regulations such as GDPR to protect user privacy (Shuaib, et al., 2021).

Scalability issues - of course, blockchain technologies are capable of handling and processing large amounts of data and conducting a huge number of transactions. That is why it is not surprising that blockchain technologies can have quite obvious scalability issues due to the limitations of transaction processing speed and bandwidth. That is why we recommend using private blockchains to improve scalability (Hsu et al., 2020). Methods such as sharding, off-chain transactions, and optimised consensus algorithms can also help to efficiently manage large amounts of data and transactions themselves.

Difficulty in fully integrating legacy databases with blockchain technologies - this can be addressed by developing appropriate standardised protocols to facilitate integration with existing systems. Use middleware solutions to connect legacy systems and blockchain networks, ensuring smooth data exchange and communication (Shuaib, et al., 2021). The introduction of blockchain technologies should be carried out in accordance with the current legislation. And the adoption of rapid innovative changes and legislative norms differ significantly in time, as the process of adopting new legal norms takes a long time. That is why we believe it is necessary to work with regulators and policymakers to develop a clear legal framework for the use of blockchain in social security. Create compliance teams to monitor and adapt to regulatory changes proactively (Wust & Gervais, 2018).

The costs of implementing blockchain technologies are significant, which is why it will be advisable to conduct a cost-benefit analysis to determine the long-term savings and efficiency gains from blockchain integration. We also consider it advisable to get acquainted with the basics of public-private partnerships and all possible sources of funding to offset the initial costs of integrating blockchain technologies (Hsu et al., 2020). Gaining the desired level of trust from users and administrators, which is a challenge due to the novelty of blockchain technology, can be difficult. As an example of how to increase the level of trust, we can offer educational campaigns to inform stakeholders about the benefits and security of blockchain. The availability of user-friendly interfaces will be an integral part of the solution.

Governance and control - a problematic aspect in the process of integrating blockchain technologies into the social security system may be the definition of a governance structure. Therefore, it is necessary to establish a clear governance framework that defines roles, responsibilities, and decision-making processes (Wust & Gervais, 2018). Taking into account all of the above and in addition to the recommendations we have made, having analysed the problematic aspects, we consider it necessary to recommend the following to improve the process of integrating blockchain technologies into social security systems:

1) Prior to integration, we recommend assessing the current situation and conducting comprehensive feasibility studies to assess the potential benefits of blockchain implementation. Alternatively, pilot projects and start-ups could be tried to test the effectiveness of the "updated" social security systems.

2) Establish regular mechanisms of communication between stakeholders.

3) Establish clearly defined performance indicators for the implementation of blockchain technologies. These key performance indicators include increased transparency and efficiency, reduced manipulation and fraud.

4) Use smart contracts to automate processes such as eligibility checks, benefit calculations and payments. Smart contracts can reduce administrative costs, minimise errors and ensure consistent application of rules.

5) Modern encryption methods should be used to protect sensitive data stored on the blockchain. It is recommended to use confidentiality techniques such as zero-knowledge proofs to maintain confidentiality while ensuring transparency.

6) Use middleware to connect legacy systems and blockchain networks, ensuring a seamless exchange of data.

7) Continuously monitor the performance of the blockchain system to quickly identify and resolve problems (Alalwany & Mahgoub, 2024).

8) An important step, perhaps the first, is to develop a strategy for integrating blockchain technologies into social security systems. It is important to ensure that the strategy is aligned with broader social security goals and policy frameworks.

9) Implement robust cybersecurity protocols to protect the blockchain network from cyber threats. It is also logical to develop an incident response plan to quickly address current issues.

3. CONCLUSION

Blockchain is a tamper-resistant, immutable, auditable, permanent, time-stamped ledger of blocks that is used to exchange and store information on a peer-to-peer basis. Blockchain technology stores existing data in an unchanged form, while not relying on a central authority. One of the latest innovations of blockchain technology is the so-called "smart contracts". Smart contracts are a kind of automated programs that are launched for the purpose of automatic transfer of digital assets within one blockchain upon fulfillment of certain launch conditions.

Blockchain technology uses cryptography and distributed consensus algorithms to maintain trust and ensure security. In general, the blockchain can be described by 3 basic characteristics, such as: it is a distributed database - that is, all existing transactions are manifested in the form of a record of several nodes, while each node contains comprehensive information about the transaction; decentralization of the P2P (peer-to-peer) network - that is, each network node is equal and with the help of P2P communication, one person can avoid obtaining exclusive rights to censor transactions and capture data resources; the functioning of smart contracts - i.e. such software codes that can be implemented automatically in a decentralized blockchain network.

We can note that the current information system of the social security service, the data standards of various business systems are not unified - when using established means for information exchange, such problematic issues as not entirely consistent interfaces, cumbersome mechanisms and authorization authentication tools arise. As a result, this situation leads to an inferior exchange of important information. Therefore, we can confidently note that the integration of blockchain technologies into social security systems should be carried out using distributed sharing, multi-centralization, increased security, tamper protection, tracking protection, and consensus trust.

We must note that the integration of blockchain technologies into the social security system can bring significant improvements in terms of transparency and efficiency for many states. The principle of transparency can be respected by taking the following steps: creating a public single registry, tracking audit trails, decentralization and using smart contracts. The principle of efficiency will be ensured by implementing the following steps: optimization of important social security processes, conducting various transactions in real time.

It is important to note that when using blockchain technologies, all interested parties, including employers and employees, various government bodies will have equal access to data that will be up-to-date and comprehensive. In turn, this will reduce the number of discrepancies and the need for data reconciliation. With the help of process automation, significant financial costs will be significantly reduced. And provided that all of the above is observed, blockchain technology will help reduce the number of frauds and situations with unauthorized access. Blockchain technology can also facilitate the creation of portable social security accounts that are not tied to specific employers, allowing informal workers to more easily access benefits.

The experience of the analyzed states - Estonia, Switzerland, China and the United Arab Emirates shows that technologies are actively introduced into various spheres of society's life, including social security. However, there are certain difficulties. The problems of blockchain application in the social security sector can be considered the following: lack of standardization of technologies; resource usage and complexity of fully integrating legacy data databases with blockchain technologies; security issues; scalability issues; the introduction of blockchain technologies must be carried out in accordance with the current legislation; the need for significant costs for the implementation of

blockchain technologies; obtaining the desired level of trust of users and administrators; management and control.

We can recommend the following in order to improve the process of integrating blockchain technologies into social security systems: evaluate the current situation and carry out comprehensive technical and economic justifications in order to assess the potential benefits of blockchain implementation; creation of regular communication mechanisms between interested parties; establish clearly prescribed performance indicators from the introduction of blockchain technologies; use smart contracts; use middleware to connect legacy systems and blockchain networks, ensuring seamless data exchange; constant monitoring of the performance of the blockchain system; development of a strategy for integrating blockchain technologies into social security systems; implementation of reliable cyber security protocols to protect the blockchain network from cyber threats.

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