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PROSPECTS OF IMPLEMENTING BLOCKCHAIN TECHNOLOGIES FOR OPTIMIZING BUSINESS PROCESSES IN CONDITIONS OF UNCERTAINTY

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ПЕРСПЕКТИВИ ВПРОВАДЖЕННЯ БЛОКЧЕЙН ТЕХНОЛОГІЙ ДЛЯ ОПТИМІЗАЦІЇ БІЗНЕС-ПРОЦЕСІВ В УМОВАХ НЕВИЗНАЧЕНОСТІ

Технологія блокчейн, з моменту свого створення у 2008 році разом із появою Bitcoin, зазнала значного розвитку, трансформуючись з інструменту для криптовалют у потужний механізм оптимізації бізнес-процесів. Її децентралізована та незмінна природа забезпечує прозорість, безпеку та довіру, що є ключовими аспектами для сучасного бізнесу. На відміну від традиційних баз даних, де інформація зберігається централізовано та може бути змінена адміністратором, блокчейн розподіляє дані між усіма учасниками мережі, що робить його стійким до цензури та шахрайства. Кожна транзакція, записана в блокчейні, є незворотною та доступною для перегляду всіма учасниками мережі, що зменшує кількість суперечок і витрати на їх вирішення. Наприклад, у логістиці блокчейн дозволяє відстежувати кожен етап постачання товарів – від виробника до споживача – усуваючи можливість підробок або втрати даних.

У фінансовому секторі технологія дозволяє здійснювати міжнародні платежі без посередників, знижуючи комісії та прискорюючи транзакції. Ця технологія особливо ефективна в ненадійних середовищах, де традиційні механізми часто виявляються вразливими. Так, у країнах з нестабільною економікою або слабкою правовою системою блокчейн може стати основою для створення чесних виборчих систем, реєстрації прав власності або захисту інтелектуальної власності. Блокчейн сприяє зміцненню партнерських відносин, надаючи надійну платформу для обміну інформацією та здійснення транзакцій.

У сучасному світі, де глобалізація та цифровізація ускладнюють бізнес-процеси, блокчейн стає інструментом для підвищення ефективності та прозорості. Наприклад, у міжнародній торгівлі смарт-контракти (розумні контракти) автоматизують виконання угод, якщо виконуються попередньо задані умови. Це усуває необхідність у дорогих посередниках, таких як банки чи юристи, та зменшує ризики невиконання зобов'язань. З розвитком Інтернету речей (IoT) та інших технологій, блокчейн ідеально підходить для підтримки динамічних та децентралізованих моделей

управління, забезпечуючи гнучкість та адаптивність. Наприклад, у сфері енергетики блокчейн дозволяє створювати децентралізовані мережі обміну електроенергією, де споживачі можуть купувати та продавати надлишки енергії без участі великих постачальників. Однак існують проблеми, які потребують вирішення: міжмережева взаємодія – різні блокчейн-платформи (наприклад, Ethereum, Hyperledger, Polkadot) часто несумісні між собою, що ускладнює масштабне впровадження технології; ідентифікація довірених об'єктів – у публічних блокчейнах залишається питання, як перевірити достовірність учасників мережі без централізованого регулювання; незворотність транзакцій – хоча це перевага з точки зору безпеки, помилкові операції неможливо скасувати, що може призводити до втрат. Вирішення цих питань відкриє нові перспективи для використання блокчейну, роблячи бізнес-процеси ще ефективнішими, безпечнішими та прозорішими.

Вже зараз компанії експериментують з гібридними моделями, поєднуючи приватні та публічні блокчейни, а також інтегруючи штучний інтелект для аналізу даних. Блокчейн стає ключовим фактором успіху для компаній у цифрову епоху. Він не лише зменшує витрати та підвищує довіру між партнерами, але й створює нові бізнес-моделі, такі як децентралізовані фінанси (DeFi), NFT-ринки та автономні організації (DAO). У майбутньому ця технологія може стати основою для повністю автоматизованих економічних систем, де людський фактор буде зведений до мінімуму.

Таким чином, блокчейн – це не просто інновація, а фундаментальна зміна у підході до обробки даних, управління активами та побудови довіри в цифровому світі.

Blockchain technology, since its creation in 2008 with the advent of Bitcoin, has seen significant development, transforming from a tool for cryptocurrency into a powerful mechanism for optimizing business processes. Its decentralized and immutable nature provides transparency, security and trust, which are key aspects for modern business. When choosing from traditional databases, where

information is stored centrally and can be changed by an administrator, blockchain distributes data among all network participants, making it resistant to censorship and fraud. Each transaction recorded in the blockchain is irreversible and viewable by all network participants, which reduces the number and cost of their execution. For example, in logistics, blockchain allows you to track every stage of the supply of goods - from the manufacturer to the consumer - taking advantage of the possibility of forgery or data loss. In the financial sector, the technology allows you to make international payments without intermediaries, reducing fees and speeding up transactions. This technology is particularly effective in untrustworthy environments where traditional mechanisms often prove vulnerable. For example, in countries with unstable economies or weak legal systems, blockchain can become the basis for creating fair electoral systems, registering property rights, and protecting intellectual property. Blockchain helps strengthen partnerships by providing a reliable platform for exchanging information and conducting transactions. In today's world, where globalization and digitalization are improving business processes, blockchain is becoming a tool for increasing efficiency and transparency. For example, in international trade, smart contracts automate the execution of terms if predetermined conditions are met. This eliminates the need for expensive intermediaries such as banks or lawyers and reduces the risks of non-fulfillment of obligations. With the development of the Internet of Things (IoT) and other technologies, blockchain is ideally suited to support dynamic and decentralized governance models, providing flexibility and adaptability. For example, in the energy sector, blockchain enables decentralized electricity exchange networks where consumers can buy and sell surplus energy without the involvement of large suppliers. Other issues that need to be addressed include: interoperability – different blockchain platforms (e.g. Ethereum, Hyperledger, Polkadot) are often incompatible with each other, making it difficult to implement the technology on a large scale; identification of trusted entities – in public blockchains, the question remains how to verify the authenticity of network participants without centralized regulation; transaction irreversibility –

while this is an advantage from a security perspective, erroneous transactions cannot be reversed, which can lead to losses. Addressing these issues opens up new perspectives for using blockchain, making business processes more efficient, secure, and transparent.

Companies are already experimenting with hybrid models, combining private and public blockchains, as well as integrating artificial intelligence for data analysis. Blockchain is becoming a key success factor for companies in the digital age. It not only reduces costs and builds trust between partners, but also creates new business models such as decentralized finance (DeFi), NFT markets and autonomous organizations (DAOs). In the future, this technology can become the basis for fully automated economic systems, where the human factor will be minimized.

Thus, blockchain is not just an innovation, but a fundamental change in the approach to data processing, asset management and building trust in the digital world.

Keywords: *blockchain technology, business processes, smart contracts, tokenization, digitalization.*

Ключові слова: *блокчейн технології, бізнес-процеси, смарт-контракти, токенизація, цифровізація.*

Problem statement. The current stage of development of the digital economy is characterized by the increasing influence of uncertainty factors, which is due to dynamic changes in global markets, technological transformations and geopolitical instability. In these conditions, traditional business process management mechanisms demonstrate a decrease in efficiency, which is manifested in the growth of operational risks, insufficient transparency of business transactions and a decrease in the level of trust between market participants. These problems highlight the need to find innovative tools for optimizing business processes, among which blockchain technologies, based on the principles of decentralization, cryptographic protection and distributed consensus, are of particular interest.

Analysis of recent research indicates the presence of significant scientific interest in the potential of blockchain technologies in the context of increasing the efficiency of business processes. However, a comprehensive study of the possibilities of their practical application in conditions of increased uncertainty requires further scientific understanding, in particular, regarding the solution of key problems: the technological complexity of integration with existing corporate systems, the need to overcome regulatory barriers, ensuring the economic feasibility of implementation and adaptation of organizational structures of enterprises to new operating conditions. The issue of developing methodological approaches to assessing the effectiveness of the use of blockchain solutions in specific sectors of the economy, taking into account the level of their cyber security and economic sustainability, is of particular relevance.

The practical significance of the study lies in the possibility of developing scientifically based recommendations for the implementation of blockchain technologies to optimize key business processes of enterprises operating in conditions of instability. The expected results are: the formation of a methodology for assessing the effectiveness of blockchain solutions, determining optimal scenarios for their application in supply chain management, financial transactions and accounting systems, as well as the development of practical tools for overcoming organizational and economic barriers during their implementation. The implementation of these research areas will contribute to increasing the adaptive potential of enterprises in modern business conditions, reducing transaction costs, and creating new competitive advantages in the digital economy.

Formulation of the article's objectives. To explore the possibilities of implementing blockchain technologies to optimize business processes in volatile environments, identify key benefits, challenges, and practical recommendations for their use.

Analysis of recent research and publications. An organization is considered functionally stable and competitive if it has a proven system of

effective technologically active business processes that ensure high productivity, product quality, low costs, and meeting the needs of the target audience.

Based on the above definitions, we can conclude that the structure of any business process reveals the values of the enterprise. Since business processes describe the entire coordination of the organization's activities, which directly affects the achievement and successful implementation of the business goal.

Business processes have always existed in the activities of the enterprise, but they have become objects of analysis and, accordingly, management quite recently. This is explained by the ambiguity of their interpretation as an economic category, the complexity of formalized description and modeling. The ideas of structuring an enterprise into processes were initiated by the works of A. Fayol and were further developed in the publications of B. Andersen, A. Scheer, M. Porter, M. Hammer and D. Champi, D. Baiura, V. Repin, V. Vinogradova, etc. The study of literary sources on the problems of the process approach to management gives grounds to assert that within the framework of this approach two terms are used: process and business process.

Formulation of the article's objectives. To explore the possibilities of implementing blockchain technologies to optimize business processes in volatile environments, identify key benefits, challenges, and practical recommendations for their use.

Presentation of the main research material. In the national standard ISO 9001 series, a process is understood as a work or set of works for which resources are used and which are managed to transform inputs into outputs.

The category "business process" has not received a normative explanation at all, although it is often used in the special literature by both scientists and practitioners. They perceive these categories as identical concepts. At the same time, the definitions take into account that any business process has an internal and external consumer, although some scientists believe that the criterion for distinguishing business processes is the presence of only an external consumer, which allows the enterprise to receive economic benefits in the form of profit, added or consumer value.

Having conducted a theoretical analysis of known definitions, it should be stated that the process, as the objective essence of changing the state of anything, can relate to various systems, not necessarily economic ones, and business processes acquire a clearly expressed economic content. Therefore, it is advisable to use this category when applying the process approach to management.

Thus, a business process is a set of sequential related business operations managed by the so-called "owner" - (an official responsible for its progress and results), using inputs (raw materials, materials, information, etc.), with the help of resources at his disposal (personnel, equipment, technology, infrastructure, etc.) he transforms them into outputs (finished products, information, documentation, etc.) - the results of the business process that are used by consumers.

To manage a business process, the “owner” must receive feedback on the progress of its execution and information from consumers (clients) of the business process. In addition, the top management of the enterprise must regularly receive reports on the progress of the business process. A business process has suppliers and consumers with whom it interacts. These can be other business processes of the enterprise, individuals and legal entities.

Summarizing the above It is worth noting that business processes by their nature are aimed at implementing the functions of the enterprise, which have both direct and indirect impact on the production process. To identify areas for improving business processes at the enterprise, it is worth systematizing them according to certain classification criteria (see Table 1) [1] .

Table 1. Business process classification

Classification feature	Business process type
By functional component	Main, supporting, provisioning and servicing
Regarding the consumer	External, internal
By time	Continuous, cyclical, temporary
By hierarchical affiliation	Top-level processes, subprocesses, operational
By interaction with respect to structure	Vertical, horizontal, individual
By level of efficiency	Economic, social, managerial
By importance	Meta-, macro-, and micro-processes

Source: [1]

In domestic practice, the most widespread division of business processes into basic, supporting and management processes has become. Basic business processes are related to the movement of funds, cover the sphere of production, sales, marketing. Supporting processes are aimed at supporting the basic processes and infrastructure of the enterprise (auxiliary shops, canteens, warehouses, repair shop, etc.). Management business processes cover the areas of managing the financial stability of the enterprise, assets, solvency, rational distribution of financial resources to ensure the continuity of the production process[4].

External and internal business processes focus on minimizing factors that affect the production process or market conditions. In the internal environment, such factors include:

- imperfect production technologies;
- lack of motivation of the company's personnel;
- imperfect management policy (ineffective management at all levels of the enterprise's activities);
- imperfect sales or marketing policy.

External business processes are aimed at adapting the enterprise to changes in the environment, which the enterprise has no means of influencing. These include: changes in the legislative field, state tax policy, market fluctuations, epidemic situation, interaction with suppliers and creditors. According to the time criterion, business processes are divided into continuous, cyclical and temporary, taking into account the needs and specifics of production. Continuous business processes are related to management and the technological process (production of products). Cyclic business processes are those that repeat in time with equal time intervals. Such a process is typical for enterprises of the agricultural complex, or enterprises with a long production cycle.

To improve business processes, a necessary condition is to assess their effectiveness. For this purpose, they are divided into:

- economic business processes are focused on the constant search for financial resources capable of satisfying the production needs of the enterprise, constant

monitoring of the efficiency indicators of the enterprise's operational, financial and investment activities, etc.;

- social business processes are aimed at creating a favorable environment for the professional development of personnel and ensuring effective personnel policy;
- management business processes cover all stages of production and further distribution of products, taking into account the economic efficiency of the enterprise.

It is precisely management processes that became the prerequisite for dividing them into business processes - meta-, macro-, and micro-levels.

Meta-level processes focus on the processes of planning and financial support of the production process, the formation of managerial responsibility to the owners and shareholders of the enterprise. Macro-processes involve the purchase and organization of processes for transporting raw materials to the processing base, direct production of products and the development of a marketing strategy for promoting goods in foreign and domestic markets. Micro-processes focus on the strategy of distributing goods and finding alternative sales channels.

The division of business processes into vertical, horizontal and individual provides effective interaction of all structural divisions of the enterprise. Vertical processes arise in connection with the delegation of powers and responsibilities from the management of the enterprise to lower levels, which are interconnected by functional ties (production and non-production spheres). Horizontal business processes involve the interaction of structural units of the same level, which simplifies the exchange of information and minimizes the time spent on performing assigned tasks. Individual business processes involve the performance of duties, the responsibility for which lies with one person according to job descriptions[1].

Blockchain technology is rapidly gaining popularity as one of the leading tools for automating business processes in enterprises. Its importance lies in its ability to guarantee a high level of data security and transparency. Due to its decentralized nature, blockchain significantly reduces the likelihood of fraud and

external interference in information processing. This is especially important for financial transactions, where accuracy and reliability are extremely important. Blockchain technology allows you to optimize various routine processes, which saves time and money during their implementation.

The potential of this technology goes beyond its own capabilities, as it can be effectively integrated with other advanced solutions, such as smart contracts and the Internet of Things (IoT). Using blockchain technology, businesses can optimize supply chain management, allowing them to control the movement of goods from the point of origin to the end consumer. Blockchain is an innovative technology that promises to change the decision-making process and can provide innovative organizational practices for the development of digitalization in enterprises.

Initially, blockchain was defined as a distributed public ledger . It consisted of blocks, and each block was a place to store transactions recorded as data. A new block had a special header that pointed to the previous block, which formed a chain to it , built by combining relevant technologies . For example, it uses a cryptographic hash as a pointer so that any change in previous blocks has a cascading effect on subsequent blocks, leading to inconsistency. index values (hash). This will detect fraud or unauthorized modifications. Immutability is preserved .

When new transactions are entered into the blockchain, they must be verified by nodes. Depending on the types of business processes , nodes are recognized as miners or validators. The verification operation is called consensus, which maintains the integrity of the shared ledgers. The consensus algorithm can be configured so that the relevant business process can tolerate faulty or malicious nodes to a certain extent . Type of blockchain classified into private, permitted and publicly available, which are determined based on registry sharing schemes and consensus execution methods.

Private blockchain has the highest degree of centralization. It is transparent when all are under the sovereignty of a single enterprise. Public , fully decentralized; this allowed any interested party participate in all processes and

keep the books of account. He had the highest degree of openness with costs of ensuring confidentiality and performance. A permissioned blockchain balanced between private and public types by taking the advantages of both.

Permissioned is not fully decentralized, it involves more trust than public. Nodes that called validators, are selected from predefined conditions to form a consortium. Internal properties Blockchains create trust and provide natural resilience to a single point of failure. When an attacker attempts to alter past transactions, most nodes that have the same view of the shared ledger will detect and nullify such actions.

It is worth noting that to achieve its properties, blockchain combines the advantages of other technologies, such as cryptography, database and distributed control tools. The potential of blockchain for business process management stems from its deep properties in establishing trust between unreliable cooperating parties without intermediaries.

Traditional business process management methodology, which was originally designed for centralized trust-based settings, must adequately address the robustness and tamper-proofing characteristics that are vital to blockchain transactions. A significant hurdle arises when incorporating critical components unique to blockchain technology, including decentralized consensus mechanisms, the complexity of smart contracts, and asset tokenization. [2]

Despite their effectiveness in traditional settings, these models face limitations when applied to blockchain scenarios. These issues include the following:

- Decentralized consensus . Traditional models need help, to introduce the decentralized consensus mechanisms that are fundamental to blockchain, where multiple parties collectively validate transactions.
- Smart contracts . The complex logic of smart contracts, an integral part of blockchain processes, is not easily accommodated in traditional business process notations .

- Tokenization . The implementation of asset tokenization and their decentralized management is a challenge in the traditional business process structure .

Traditional business process management models designed for centralized, trust-based environments. The trustless and tamper-proof attributes of blockchain transactions, which are an integral part of the technology's value proposition, may need to be properly embraced.

Blockchain-centric modeling represents a fundamental transformation in the traditional field of business process management. This methodology seamlessly incorporates the complexities and distinctive attributes of blockchain technology into the modeling procedure. The main focus is on integrating the trust, tamper-resistant, and decentralized characteristics of blockchain technology into operational procedures.

Blockchain-centric modeling goes beyond the conventional linear and centralized structures seen in business processes by developing process models. Conversely, it embraces the distributed and decentralized characteristics inherent in blockchain networks. This includes the representation of nodes, smart contracts, and cryptographic mechanisms that maintain the integrity and immutability of the ledger.[2]

When applying this modeling approach, several distinct factors become apparent. Visual representations are needed to illustrate the function of decentralized consensus mechanisms in transaction verification, such as proof-of-work or proof-of-stake. Smart contracts, which are characterized by autonomous execution on the blockchain, are seamlessly integrated into the models, thus demonstrating their triggers and outcomes. In addition, explicit representation is necessary to convey information about the administration and flow of digital assets in business processes, as tokenization of assets is a defining characteristic of many blockchain applications.

While blockchain-centric modeling has the potential to improve efficiency, security, and transparency, it is fraught with obstacles. It can be difficult to

communicate the complexity of decentralized systems to stakeholders accustomed to centralized models. The delicate task of reconciling the need for transparency with the criticality of data privacy is an additional hurdle that requires careful consideration. Despite these obstacles, the prospects offered by blockchain-centric modeling are significant, enabling enterprises to optimize operations in a trustless environment.

Data flow and interaction, data validation, security, audit trail, reporting, and analytics are some of the business process steps . Key blockchain elements such as configuration, smart contracts, consensus processes, and asset tokenization are seamlessly integrated at the same time. The closed-loop structure illustrates how data moves through the interaction, undergoes blockchain validation and consensus, is added to a secure audit trail, and is finally used for reporting and analytics. This structure represents the iterative nature of business processes, as shown in Figure 1.

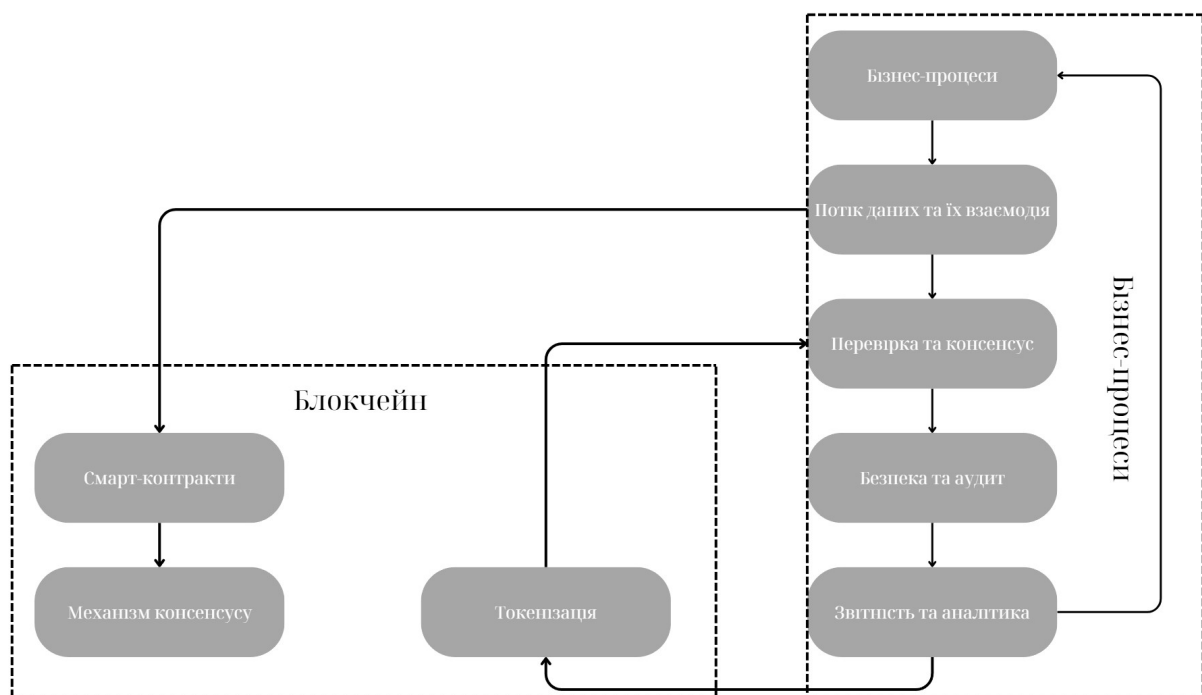


Fig.1 The process of implementing blockchain into business processes

Source: compiled by the author based on [5]

Regarding hybrid models. The goal is to combine the organization and precision that a traditional business process provides with the decentralized and tamper-resistant characteristics of blockchain. Hybrid methodologies that integrate blockchain components with a traditional business process represent a solution that adapts to the demands of modern businesses. One of the important advantages is their ability to effectively integrate the simplified traditional business processes with the decentralized, transparent and tamper-resistant attributes of blockchain technology. This framework offers organizations a comprehensive and inclusive approach to modeling, ensuring adaptability across different operational structures[6].

Additionally, by incorporating the fundamental characteristics of blockchain, hybrid models enhance transparency and trust. These systems enable organizations to leverage blockchain-specific features, including smart contracts and decentralized consensus mechanisms, while maintaining the transparency offered by traditional business processes. Additionally, blockchain's tamper resistance enhances the security of hybrid approaches, minimizing susceptibility to data manipulation and unauthorized modifications. By leveraging this increased security and adaptability, organizations can strengthen their operational procedures against an ever-changing technological environment.[7]

Conversely, implementing hybrid methodologies that effectively combine conventional business processes with blockchain-specific components is a challenging but rewarding endeavor. One significant hurdle is ensuring interoperability and seamless integration between blockchain technology and conventional business process tools. These domains often use different technical infrastructures and data structures, requiring careful strategy development to avoid integration complications. Careful consideration is needed to ensure seamless data and transaction exchange when centralized and decentralized components coexist. At the same time, implementing blockchain-specific components adds complexity, requiring extensive user guidance and training. Given the increased complexity, it

is vital to provide user support to make it easier for stakeholders to understand and navigate hybrid models.

In addition, hybrid methodologies face the challenge of ensuring data integrity and security. The decentralized and tamper-resistant characteristics of blockchain technology pose new challenges, including protecting data integrity during transitions and establishing secure communication channels between conventional and blockchain systems. An additional obstacle is that hybrid models need to adapt to a wide range of business processes while maintaining adherence to standardized practices to ensure interoperability. Lifecycle management and maintenance pose ongoing obstacles, forcing organizations to create robust procedures for updating models, addressing emerging issues, and ensuring that modifications do not hinder overall process efficiency.[5]

To overcome these obstacles, collaboration between IT and business stakeholders is required, and continuous research and development should prioritize the creation of protocols, optimal methodologies, and tools that optimize integration, promote user adoption, and ensure secure and consistent implementation of business operations at the intersection of blockchain and business process management.

optimization in the digital age is an important aspect of managing a modern enterprise. This process involves the use of digital technologies to improve, optimize and simplify operational processes, which allows enterprises to increase efficiency and reduce costs. Business process optimization involves a combination of different technologies, including resource management software, customer relationship management systems and business process automation platforms. It allows automated tasks that were previously performed manually to be performed automatically, which helps minimize errors and speed up data processing.

In the era of digitalization, companies have a chance to introduce innovative business models adapt to evolving market dynamics and increase customer engagement.

The use of innovative technologies and processes, the development and implementation of innovative products allows the company to occupy leading positions. market position. This will ensure that the products have a high degree of scientific content and novelty, making them competitive in the global market.

This also minimizes administrative costs and allows for efficient allocation of resources for important strategic activities. Implementation of advanced analytical tools that help make informed decisions based on Big data is a key component of automation. Overall, optimizing business processes in the digital age offers businesses a competitive advantage and plays a crucial role in long-term sustainability[6].

Blockchain operates on a decentralized network computers where each participant has a copy of the entire registry, making it impossible to change data without the consent of the majority network participants.

Blockchain provides high resistance to hacking and fraud thanks to cryptographic security methods. Its main advantages are increased security, transparency, reduced costs for intermediaries and automation of processes through the use of smart contracts. Blockchain technology is widely used in various industries, including finance, logistics, healthcare, real estate and many others. Due to its properties, blockchain becomes the basis for developing new business models and increasing efficiency existing processes.

The process of optimizing business processes using blockchain technology is an innovative approach to improving the efficiency and security of modern enterprises. Blockchain, as a decentralized database, provides transparency and immutability of records, which are key to establishing trust between participants in business processes[7].

The evolution of blockchain and its connection to business is extremely important. Different blockchains have been developed that can be used for business purposes depending on social needs and goals. Blockchains are divided into versions 1.0, 2.0 and 3.0. Each blockchain has its own unique development history.

For example, Blockchain 1.0 made financial transactions such as cryptocurrencies possible by allowing transactions between individuals without the need for an administrator. Since it allows anonymous money transfers and payments, active trading occurs. Individuals involved in the project have created an environment where they can easily trade cryptocurrencies without complicated procedures. Blockchain 1.0 is used by hundreds of cryptocurrencies.

Blockchain 2.0 has solved the problems that arose with Blockchain 1.0, such as the time it took to transfer and settle virtual currencies. If transfers and payments inevitably take a long time, the market as a whole will lose its elegance. Blockchain 2.0 not only facilitates transactions, but also supports smart contracts.

Blockchain 3.0 is an update to the blockchain, which was previously used mainly for virtual currencies, allowing it to be used in other areas as well. It is said that the general awareness of Blockchain 3.0 has spread as it has been applied to intellectual property, education, healthcare, and other fields. In addition, the basic functions have been improved compared to Blockchain 2.0, making it possible to send information quickly, securely, and efficiently. This version has significantly improved basic functions and expanded application areas [8] .

But it is worth noting that the successful application of blockchain in business process management requires stakeholders to understand the intrinsic values, challenges and impact of blockchain on business process management. Blockchain has been used to accelerate the implementation of new technologies. However, a prerequisite is a good understanding of blockchain-specific configurations that differ from traditional systems in terms of properties and behavior.

Many researchers suggest using Ethereum for business process management due to its advanced, high popularity and reliability compared to other blockchain platforms with smart contract support. The adoption of Ethereum increases the additional costs of business process execution. Cost analysis from a monetary and operational perspective shows that the cost of blockchain-based business process

management is almost three times compared to conventional solutions with cloud technology or traditional database[7].

One of the most striking examples of the state's use of a decentralized system is ProZorro. Thanks to this platform, taxpayers can find out what the state spends their money on. Anyone interested is given the opportunity to learn about the details of government procurement, as well as study the tenders that appear in the system. The main thing is that none of the parties can delete data from the platform. This is precisely the opportunity provided by blockchain technology, and the transparency of procurement has already saved about \$1.5 billion in budget funds.

In addition to ProZorro, there are other platforms in our country based on a decentralized system. Among them, it is worth noting the project for trading in seized property. It was opened in 2017 and allows the state to replenish the budget through the sale of confiscated property [9] .

Companies in China have begun to test blockchain technology in their industries. Many blockchain infrastructure providers have also emerged, such as BCOS, Onchain, and Ontology Zero. These providers offer companies services to develop various blockchain applications based on their infrastructure using various programming languages. Recently, BAT (Baidu, Alibaba, Tencent) announced cloud services that will facilitate the development and deployment of blockchain applications.

Also, Alibaba and JD.com have begun to address the problem of counterfeit goods in China using blockchain, providing luxury items, from hard liquor to Louis bags . Vuitton , an electronic passport, a unique QR code to record product lifecycles from source to destination.

Leading Chinese automaker Wanxiang Group, based in Shanghai, is now managing its supply chain using blockchain technology. Automakers are integrated with suppliers, ensuring fast, reliable and transparent transactions. Wanxiang is committed to working with financial institutions to provide financing solutions for

small and medium-sized suppliers. And the use of blockchain is not limited to manufacturing.

Recently, Tsinghua University teamed up with Walmart and IBM to digitally track the movement of Chinese pork from source to consumer[10].

Both BM and MAERSK are building corporate partnerships to use blockchain technology to manage and track transactions in the shipping supply chain. The companies said they are working with suppliers, freight forwarders, trading agents, ports and other supply chain enforcers to create blockchain tools for cross-border operations.

The project was launched at the end of 2017. The companies have already launched several pilot versions of the platforms together with the Port of Rotterdam, the Port of Newark (New Jersey), and the Netherlands Customs Administration. The project is implemented on the basis of the open Hyperledger platforms.

The application of blockchain technology of the open Hyperledger platform in the field of transport supply chain will increase the transparency of all operations and replace “tons of paper processes” managed manually, reduce fraud, monitor inventory management and help save time and money[11].

To fully explore the potential of blockchain, existing applications must be enhanced based on best practices to reduce ongoing costs. Blockchain-enabled business process management should automate the processes of creating, updating, and executing business processes regardless of the types of blockchains equipped with smart contracts. However, when developing, developers must be well-educated to understand the impact of blockchain on business processes, especially the transaction confirmation delay caused by consensus algorithms.

Blockchain is not the only technology option for business processes , the decision to implement it must be aligned with business strategies. In many cases, blockchain must be integrated with advanced technologies such as machine learning, IoT, big data analytics, cloud computing, artificial intelligence , and

robotic process automation to improve business processes . Numerous opportunities arise in the application of blockchain .

Conclusions

The implementation of blockchain technologies in uncertain times opens up significant prospects for optimizing business processes. Despite the challenges associated with uncertainty, blockchain offers a number of advantages that can help companies become more agile, efficient and competitive. Blockchain provides transparency and immutability of data, which helps to increase trust between participants in business processes. In uncertain times, when trust is critical, it can be a decisive factor for success. Using smart contracts, blockchain allows you to automate and optimize business processes, reducing costs and increasing efficiency. In uncertain times, when companies are forced to quickly adapt to change, it can provide them with a competitive advantage. Blockchain provides a high level of security and data protection, which is critical in the face of growing cyber threats. In uncertain times, when companies can become targets for attackers, it can provide them with peace of mind and confidence in the safety of their data. Blockchain is a decentralized technology, which makes it more resilient to external influences and changes. In times of uncertainty, when companies need to be prepared for unforeseen situations, this can provide them with greater flexibility and adaptability.

However, implementing blockchain technologies can be complex and require significant technical resources and expertise. The legal framework for blockchain technologies is not yet fully developed, which can create certain risks and uncertainties for companies. Blockchain technologies can have scalability issues when processing large amounts of data and transactions. Integrating blockchain technologies with existing company systems can be complex and require significant effort.

To successfully implement blockchain technologies in an environment of uncertainty, it is necessary to conduct thorough research and planning, define specific goals and objectives. It is important to choose an appropriate blockchain

solution that meets the needs and requirements of the company. Successful implementation of blockchain technologies requires the support of the company's management and the involvement of all stakeholders. It is necessary to provide training and development of personnel for the successful use of blockchain technologies.

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