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POSSIBILITIES OF APPLICATION OF BLOCKCHAIN TECHNOLOGY IN MODERN CONDITIONS

Abstract. The article discusses the possibilities of using blockchain technology in modern conditions, since blockchain is considered one of the most breakthrough technologies in the digital economy in terms of transparency, trust and security. The digital integration of all processes in modern society puts the countries of the world in front of the need to quickly respond to these transformations and confront global digital challenges and threats of the future. Blockchain technology can be a possible solution to these problems. The essence of the blockchain and its role in the developing digital economy are considered. A number of problems and priority places for the application of the blockchain are identified, and the prospects for the development of technology are considered. Given the Russian aggression against Ukraine, the possibilities of using blockchain technology in the defense industry were considered. Therefore, it is very important to determine the prospects for the development of blockchain technology, its capabilities in minimizing digital and military risks and the feasibility of promotion and implementation in the industry of Ukraine.

Keywords: blockchain technology, transaction register, digital risks, industry, supply chains

Introduction

The digital integration of all processes in modern society, the merging of technologies, and their mass introduction put the countries of the world in front of the need to respond quickly to these changes, which makes it possible to withstand the global challenges of the future. The development of Industry 4.0 is based on the creation of new technologies and cyber-physical systems capable of decentralized management of production, sales, self--learning, and development. The functioning and maintenance of such systems require intelligent technologies to ensure this decentralization and cyber security. A possible solution to this problem was considered blockchain technology, which provided security and trust in cryptocurrencies and created "smart" contracts. The mass mutual distrust of partners primarily facilitated this technology spread. Blockchain has become a tool that can support trust between parties and eliminate corruption or human error. A severe challenge for blockchain

technology has been the shift in focus from the narrow field of cryptocurrencies to use in industry and the public sector. At the same time, blockchain technology has become a challenge for the industry on the way to the digital transformation of enterprises as part of the development of Industry 4.0 technologies. Given the current situation and the military threat from the Russian Federation that Ukraine has faced since 2014 and which has escalated significantly after February 24, 2022, the possibilities of using blockchain technology in the defense industry and, in general, in the military environment are being considered. Therefore, it is crucial to determine the prospects for the development of blockchain technology, its capabilities in minimizing digital and military risks, and the feasibility of promotion and implementation in the industry of Ukraine.

1. The essence of the blockchain and its place in the developing digital economy

Blockchain is the latest technology for processing and storing information (digital data) and identifying counterparties due to transparency, stability, and independence. This tool has a high probability in the future not only to maintain trust between the parties but also to eliminate corruption or the human factor. Due to its distributed nature, blockchain brings new opportunities to the markets. Blockchain technology provides storage in a distributed database of information about transactions, packed into blocks, which, in turn, are inseparably linked into chains thanks to cryptographic algorithms. In addition, each block contains a timestamp and a link to previous transactions. Any changes are not possible since the system will reject such an operation; only adding new blocks to the chains is possible.

The essence of the technology on the basis of which the blockchain arose is described in the works of Stuart Haber, V. Scott Stornett, and Dave Bayer [12,2]. The possibilities of the practical application of blockchain technology are described in the research of Satoshi Nakamoto (the concept of a decentralized electronic payment system for Bitcoin) [9]. Analysts and research companies are making significant contributions to blockchain research, with Gartner and IDC being the most notable. Domestic research on the blockchain and its practical application, particularly in industry, is somewhat limited today. Still, it is worth highlighting the work of Lipnitsky D.V. and Yushchenko N.L. 15,17] and a review from the Ukrainian Blockchain Association [16]. Questions about the possibilities and feasibility of using blockchain technology in the industry to minimize digital risks remain relevant today.

According to the annual analytical findings of the world's leading research and consulting company Gartner, blockchain has been included in the Top 10 promising technological trends for four years (from 2017 to 2020). This testifies to the expectations of

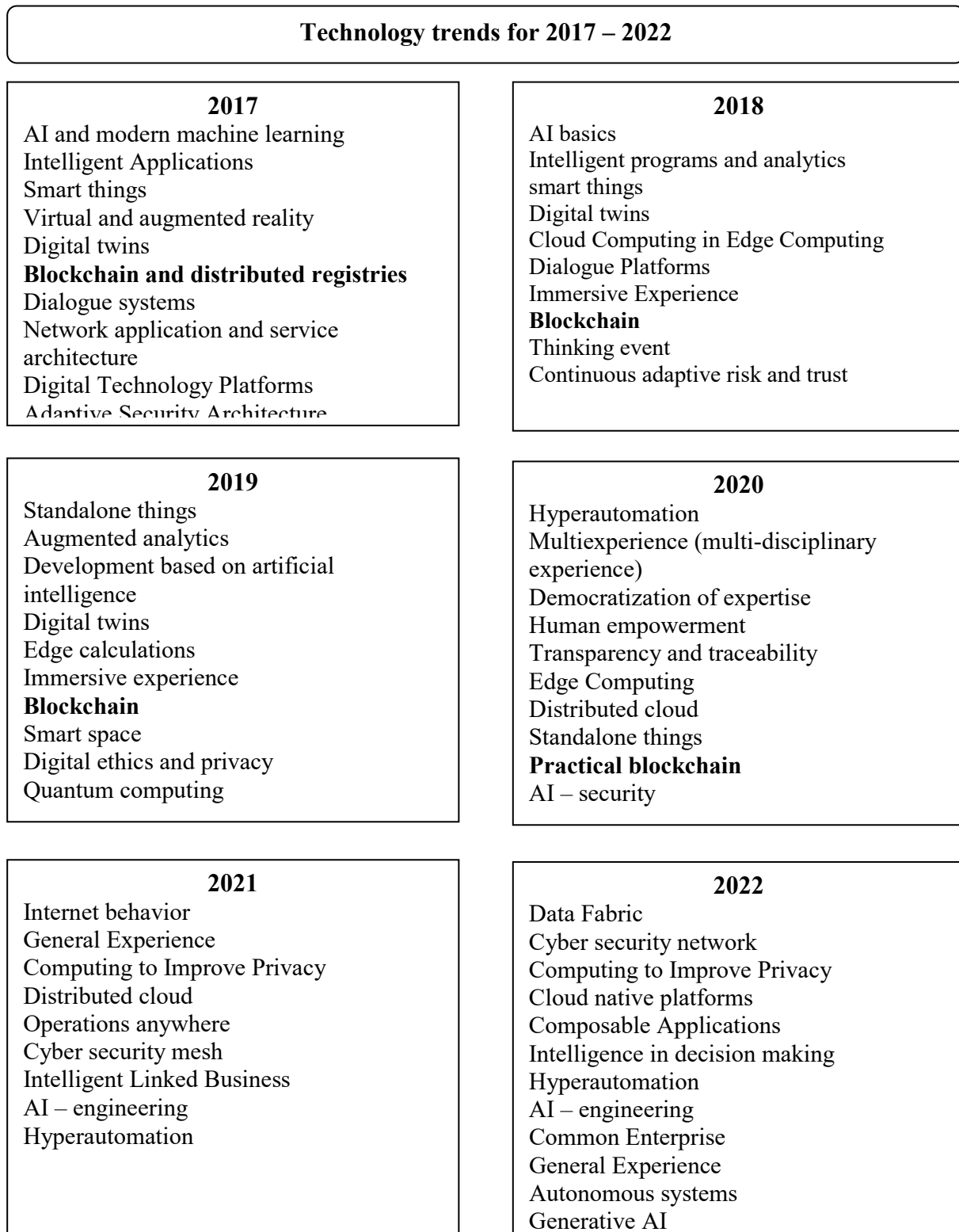its growing role in developing future technologies and developing a new industry – Industry 4.0 [Fig. 1].

Technology trends for 2017 – 2022

2017
AI and modern machine learning
Intelligent Applications
Smart things
Virtual and augmented reality
Digital twins
Blockchain and distributed registries
Dialogue systems
Network application and service architecture
Digital Technology Platforms
Adaptive Security Architecture

2018
AI basics
Intelligent programs and analytics
smart things
Digital twins
Cloud Computing in Edge Computing
Dialogue Platforms
Immersive Experience
Blockchain
Thinking event
Continuous adaptive risk and trust

2019
Standalone things
Augmented analytics
Development based on artificial intelligence
Digital twins
Edge calculations
Immersive experience
Blockchain
Smart space
Digital ethics and privacy
Quantum computing

2020
Hyperautomation
Multiexperience (multi-disciplinary experience)
Democratization of expertise
Human empowerment
Transparency and traceability
Edge Computing
Distributed cloud
Standalone things
Practical blockchain
AI – security

2021
Internet behavior
General Experience
Computing to Improve Privacy
Distributed cloud
Operations anywhere
Cyber security mesh
Intelligent Linked Business
AI – engineering
Hyperautomation

2022
Data Fabric
Cyber security network
Computing to Improve Privacy
Cloud native platforms
Composable Applications
Intelligence in decision making
Hyperautomation
AI – engineering
Common Enterprise
General Experience
Autonomous systems
Generative AI

Figure 1. Top strategic technology trends according to information technology research and consulting company Gartner for 2017-2022

Source: compiled by the author based on data from Gartner [7]

Studies point to the vast possibilities of using blockchain technology, which in the future is able to minimize the digital risks that arise in the process of carrying out entrepreneurial activities of enterprises. In particular, the following main and promising areas of blockchain use can be distinguished:

- tracking physical assets in the supply chain to accurately determine location and ownership (chasing cars through lending processes, spare parts, art aftersales, shipping locations, etc.);

- implementation of automatic processing of claims and product recalls in the field of car sales, agriculture, transportation, life, and health insurance;

- implementation of personal identification – thanks to the blockchain, records are immutable and securely linked to a specific person (can be used in managing forms of educational achievements, the health of patients, identification in elections, etc.);

- organization of internal accounting – data that must be protected remains within a separate organization using a private blockchain (master data management, internal documents, order records, invoices, and treasury operations);

- in education, retail, and tourism to track loyalty points and provide internal rewards to employees or students;

- use for payment and settlement between the parties in settlement of an agreement, such as royalty payments, share settlements, interbank payments, commercial lending, purchase-to-payment processing, and money transfer processing;

- tracking the origin of assets – accounting for the movement of assets without tracking location, reproduction of the full history of asset ownership;

- joint storage of records of a certain number of participants for reliable distribution between them (corporate announcements, booking management, flight recording, regulatory reporting);

- data tracking and function management of smart spaces or IoT solutions (peer-to-peer energy trading, electric vehicle charging administration, smart grid management, wastewater system control);

- rationalization of the trade finance process (management of letters of credit, simplification of trade finance, facilitation of cross-border trade);

Given the potential of the technology and broad business interest in the opportunities it can provide, spending on blockchain technology has skyrocketed since 2017, reaching $4.5 billion. USA in 2020. It is predicted that by 2024, global spending on blockchain solutions will reach $19 billion. United States (Fig. 2) [10].
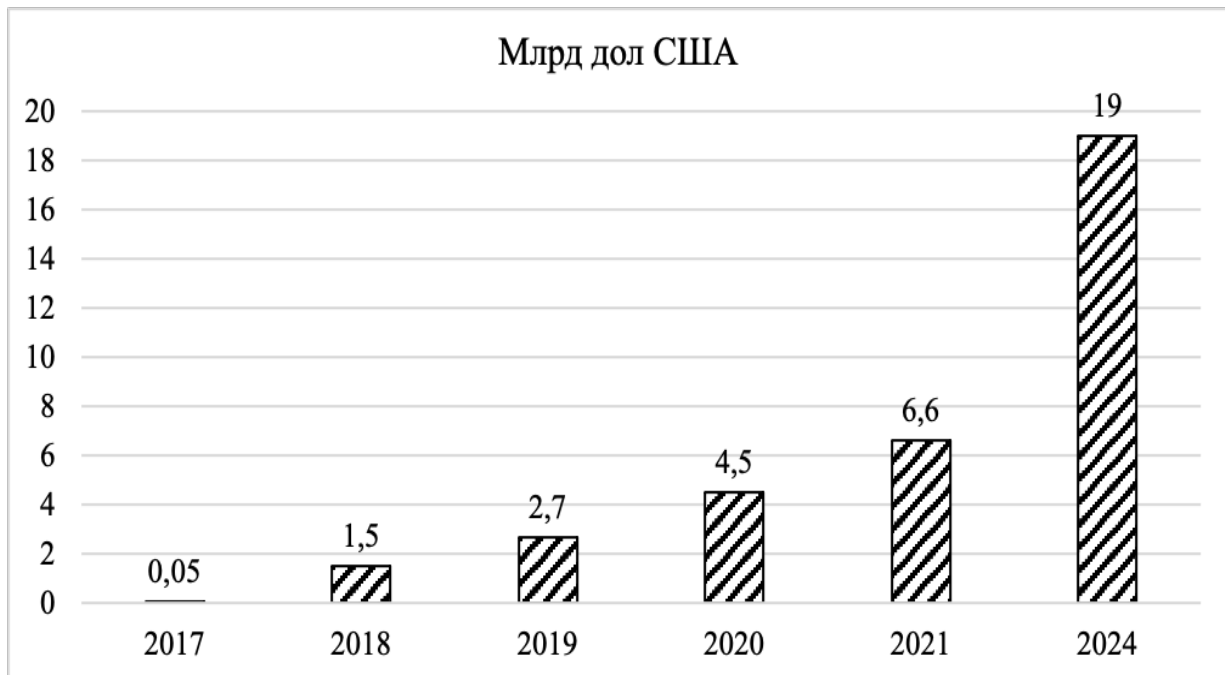
Figure 2. Global spending on blockchain solutions for 2017-2024
Source: Statista Inc. Global blockchain solutions spending 2017-2024.

2. Problems of application and prospects for the development of blockchain technology

Even though the blockchain is considered one of the most disruptive technologies in the digital economy, at the same time, there are specific warnings regarding its use. In particular, the question arises of the advisability of using blockchain technology to solve problems that a conventional database usually handles. Also, this technology should not be perceived as mature enough for full-scale implementation and application. Blockchain is misunderstood as a "business solution" when it is a base-level technology that requires the creation of additional programs to meet specific business needs. The scale of use must also be considered, as this technology does not yet scale well and is not suitable for database or storage applications. Expectations regarding technology compatibility are not justified since most platforms, and their underlying protocols are still under development and do not guarantee complete interoperability.

To date, some problems and bottlenecks have been identified that impede the widespread implementation of blockchain technology, in particular: reputational, technological, organizational, energy, and environmental issues [6].

Reputational problems: image problem (blockchain is associated with cryptocurrencies, which negatively affects the image due to the actions of scammers and hackers); the destructive nature of the blockchain technology implementation process

negatively affects the blockchain technology system as a whole; regulatory opposition from the state (the rigidity with which regulators approached the control of blockchain technology hinders innovation and growth).

Technological problems: lack of scalability and immaturity of technology; lack of standardization (the blockchain space is in a "state of disarray" without universal standards); integration with legacy systems is quite problematic due to the lack of blockchain specialists; lack of blockchain developers; cumbersome and slow blockchain – with an increase in the number of users, the time for processing transactions increases. As a result, the transaction cost is higher than "traditional" payment systems.

Organizational problems: lack of understanding of technology; productivity paradox (speed and efficiency are associated with high total costs); lack of cooperation; the issue of security and privacy; lack of clarity of regulation and proper management.

Energy and environmental problems: Blockchain technology uses Proof-of-Work (PoW) protocols as a consensus mechanism to validate transactions. These protocols require a lot of computing power to validate transactions and secure the network. The amount of energy consumed by computers has reached an all-time high. According to the Cambridge Electricity Consumption Index, their production requires almost as much energy as Ukraine consume [5].

However, this does not mean that the technology has lost its appeal. Confirms the growing importance of blockchain research LinkedInLearning, in which blockchain takes the lead in the top 10 hard skills among the most in-demand essential skills in 2020 [13]. The Covid-19 pandemic is also changing the way we prioritize technology development. So, for 2022, an increased demand for the use of blockchain technology is expected in the following areas [14]:

To distribute and control vaccines. Blockchain can be used to track and manage the delivery of medicines to patients directly from the manufacturer. This problem is very relevant as companies increase the turnover of drugs, resulting in a need for control. Blockchain technology helps to create records of the vaccine's movement and change of location and guarantees their authenticity and the absence of falsification at any stage. The launch of such a project requires additional developments: determining and forecasting the demand for the vaccine, and managing the main processes. Today, the leader in this area is the IBM organization, whose representatives actively collaborate with popular pharmaceutical companies to launch a pilot project.

Private or corporate blockchain, which means the control of processes by one, "master" user. These can be companies that provide a platform for doing work. It is predicted

that the system will be used in healthcare, service, defense, as well as industrial enterprises. A study by the international company Gartner showed that by the end of 2020, the introduction of blockchain projects into the industry amounted to about 14% of their total number. It should be mentioned that a few years ago, in 2019, the figure did not exceed five percent, which indicates the rapid popularization of technology and its development.

Introduction to the system of digital archives – "NFT" (non-fungible token). Assets that have value due to their uniqueness – music, various files, images, codes – digital files that cannot be copied or duplicated uncontrollably. They ensure the protection of creative heritage and contain information on the ownership of land, real estate, and vehicles. This facilitates tracking information about the previous owner and data that can directly affect pricing. Today, this is interesting and relevant for many people since the standard methods of obtaining knowledge can take a long time due to the need to send requests to registries, wait for a response, or do the search yourself.

Services. Large companies such as Amazon, Microsoft, and others create and develop unique platforms. These platforms are designed for entrepreneurs who want to learn how to control blockchain technology and use it as a service. With its help, it will be possible to create objects and architectures that are entirely independent and decentralized.

Military use of the blockchain. The technology has several advantages for the defense industry due to its decentralized nature. First, the distributed structure of the blockchain ensures its availability. It also makes this technology less expensive to imitate. Secondly, its fault tolerance, security, and immutability are beneficial for data storage and are vital assets for many military applications. Representatives of the aerospace and defense industry consider blockchain one of the best new technologies they would like to promote to increase the industry's growth and efficiency. Defense departments around the world are increasingly attracted to the possibilities of blockchain. In the coming years, the defense research community is expected to look for new applications for the military based on blockchain technology, with predominant candidate areas such as cyber defense, secure messaging, resilient communications, logistics, and the defense IoT network.

3. Development of blockchain technologies in the military industry

Blockchain technology can have many applications in the defense sector as it can be used in military operations and ancillary purposes. In this regard, blockchain has three uses: cyber security and data integrity, supply chain management, and sustainable communications [3].

Technically, in the defense industry, it is believed that a private blockchain would be the most useful. With a public blockchain, access to the chain will not be controlled, which can be dangerous for protecting sensitive information. Since private blockchains are characterized by barriers to entry, with one administration responsible for accepting participants and defining chain rules (read and write permissions), they are most suitable for defensive use. One person could control access and system rules: the army commander. In the context of inter-service governance, a hybrid blockchain is also possible.

Cyber security and data integrity. The numerous advantages of blockchain make it a powerful tool for preventing cyber attacks and explain why this technology is helpful in some areas related to cyber defense. In 2017, the DPRK stole 235 GB of classified information belonging to the South Korean and American intelligence agencies. At the same time, the European Commission stated that "there were more than 4,000 ransomware attacks per day, and 80% of European companies experienced at least one cybersecurity incident. The economic consequences of cybercrime have increased fivefold in the last four years alone," and their share continues to increase [11]. The US federal government has been the target of more than 60,000 cyberattacks, especially in the energy sector, which has become vulnerable due to its connectivity and dependence on computing technologies [8]. Storing large amounts of confidential information in one place becomes especially risky. This can lead to a "terabyte of death," an expression used to describe the theft of massive classified information by foreign entities. Given this, the resilience provided by the blockchain, with its distributed nature and ability to detect and block any intrusion attempt, can be pretty valuable. While a centralized organization responsible for digital communication is more vulnerable to attacks that can lead to interception or communication change, blockchain, through horizontal data exchange, creates a secure environment in which the failure of one node will not lead to the negligence of others. In upgrading obsolete weapons, the blockchain is used to more effectively protect the centralized command and control system that links sensors to firearms within the system and allows weapons to detect targets and strike faster [1].

A decentralized decision-making approach protects transaction processes from cyberattacks. Blockchains are immutable thanks to advanced cryptographic techniques and are genuinely secure. Since blocks cannot be changed without the consent of all participants or the chain's administration, the data transfer must come from legitimate subjects. Moreover, the security guaranteed by the blockchain is not based on secrets or trust, and there is no need to protect passwords or cryptographic keys. Finally, the blockchain uses the entire network's combined power to resist attackers actively.

Supply chain management. Currently, military logistics and supply chains connect hundreds of different actors in the military and private sectors. This environment is becoming increasingly complex due to partnerships with developers, startups, and industry players, resulting in unnecessary costs, inaccuracies, or non-delivery. However, blockchain can solve these problems and offers various benefits: faster delivery speed, traceability, security, and lower costs. One of the most important applications of blockchain in supply chains is to make them more transparent, secure, and efficient.

Tracking parts and materials used in the defense industry is critical. Blockchain technology can help determine the origin of weapons from production to delivery and prevent counterfeiting. A date-stamped blockchain allows users to track past transactions easily. Defense companies can combine blockchain technology with other technologies, such as artificial intelligence, quantum computing, and augmented reality, to speed up data sharing and analysis.

As security systems increasingly use commercial off-the-shelf components for their software systems, there is growing concern that these components may contain deliberate vulnerabilities that attackers could exploit at any time. Blockchain can be a solution that establishes the origin of each processor, circuit board, and software component. Blockchain technologies bring greater transparency to the food supply chain and can improve food security. Food supply chain tracing can prevent food shipment incidents and infectious disease outbreaks and help solve the severe problem of tracing critical commodities such as pharmaceuticals.

Sustainable communications and other uses. Reliable communications are essential in the military, especially during operations requiring access to networks. In the context of multi-level conflict, blockchain can provide resilient communication. In this type of conflict, defense agencies must be prepared for the enemy to attack the electromagnetic spectrum and, in particular, critical communications systems such as satellites, submarine cables, or tactical data links. Also, the enemy will try to manipulate the data to break the "chain of destruction" (a method of preventive actions to repel an attack). To counter this threat, armies will need the ability to securely generate, secure, and share data, which is possible thanks to blockchains, as explained above.

In addition, blockchain can be helpful for securing messaging systems. Blockchain cryptographic encryption techniques will enable automation measures that can reduce costs and improve interagency and field communications. For example, due to the geographic

location of NATO members on both sides of the Atlantic, secure communications are vital for both annual and ongoing meetings.

The UN has used blockchain to help Syrian refugees buy food [4] (WFP, 2020), which can be especially useful in defense to create combat trackers. These trackers will be distributed among units and searchable by all participants, allowing instant verification of the location of soldiers on the battlefield in real-time.

As 3D printing is increasingly being used to construct buildings and produce drones, grenade launchers, bulletproof vests, and other equipment, blockchain can serve as a more secure data transfer tool due to its distributed nature.

Findings and conclusions

Due to its capabilities, blockchain creates an environment for attracting investments and optimizing working capital. Supply chain financing is accelerating lending to manufacturing and trade transactions. The use of blockchain as an information platform for electronic invoices (e-Invoicing) allows, due to the improvement in the quality of information (openness and mutual audit), to minimize the risks of the parties, respectively, to reduce the cost of attracting loans in factoring schemes. The combination of electronic invoices and blockchain is believed to create the prerequisites for a further transition to digital taxation.

The future combination of blockchain with IoT technologies can solve the security problem that exists due to low trust in IoT devices. Suppose new generations of blockchain can offer reasonable trade-offs that combine security, high performance, and scalability. In that case, the combination of IoT, artificial intelligence, and blockchain will usher in a new direction of disruptive industrial innovation.

Blockchain plays an essential role in the defense industry and military affairs. Firstly, thanks to this technology, the confidentiality of personal data is ensured since the digital identity stored in the blockchain cannot be falsified. Secondly, the blockchain provides more significant order accuracy thanks to smart contracts. Using them, partners can automatically allocate funds to agreed initiatives and shared infrastructure, strengthening national defense projects.

Technological progress takes a long time to mature and reach a stable form that can be brought to market. Like any technological innovation, blockchain is following the same steady adoption trajectory in the coming years. Although there are already many opportunities today, it will still take some time to get rid of the existing blockchain problems and use it to get all the benefits.

In Ukraine, the distribution and application of blockchain technology in the industry face the following main problems:

- low level of demand by Ukrainian producers;

- lack of qualified personnel;

- energy problems (the amount of energy computers consume when implementing blockchain solutions reaches a high level).

The priority measures for the dissemination and application of blockchain technology in the industry in the context of the increasing digitalization of the economy include the following:

- Consolidation in the priority programs of the state strategic management of the energy aspect of the use of blockchain in Ukraine;

- Development of more efficient protocols, with less energy consumption, which will lead to more efficient and economical application and mass implementation of blockchain technologies in the industry of Ukraine;

- distribution of educational events, establishing cooperation with blockchain technology developers and popularizing blockchain technologies in the Ukrainian business environment.

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