DOI https://doi.org/10.30525/2592-8813-2024-spec-16

TOKENIZED ASSETS: DISPELLING THE MYTH OF THEIR ESSENCE FOR THE NEEDS OF REAL ECONOMY

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Abstract. The paper offers a generalized author's view on the new phenomenon of the digital world, backed tokenized assets, as a tool for asset accounting in digital accounting systems. This view is new and currently unpopular in the literature since the main aspect of tokenized asset presentation is related to speculation on financial markets, widespread creation of unbacked assets around objects of human life, graphics, etc.

The aim of the paper is to determine the essence, generic features and technological basis of the use of tokenized assets for their implementation in the digital and platform-based economy.

In accordance with this aim, the author logically presents the material from the general to the specific, analyzing the essential features of 7 main related concepts: distributed ledger, distributed ledger technologies, blockchain technology, tokens and consensus algorithm, tokenized asset, decentralized information platform and blockchain-based ecosystem of services.

The author persists in the opinion that a tokenized asset is a type of virtual asset. It is a tool for certifying sufficient and confirmed legal rights: rights of access to products and services, rights to a certain product or service, rights to receive a fixed income or percentage of profits, management rights, rights to purchase a certain asset at a certain price in the future, etc. The paper offers the original definition of a tokenized asset: tokenized asset is a type of virtual asset that exists in a digital data accounting system based on the distributed ledger technology in the form of a record with an identifier of information derived from the original asset. A tokenized asset can be used as a tool for implementing a method of recording, accounting and managing property rights to assets. Moreover, a tokenized asset can be used as a tool for certifying any rights; providing services; recording events; generating, processing and submitting statistical and analytical information; ensuring logistics, etc. Depending on the purpose of creating a specific tokenized asset and, as a result, certain inherent properties envisaged by the creator, this tokenized asset can be classified as a separate type.

Key words: tokenized assets; virtual assets; distributed ledger token; blockchain; accounting system; information; property rights management; digital accounting.

Introduction. Backed tokenized assets are a relatively new phenomenon in our digital age. They are surrounded by a lot of conceptual confusion, biased and erroneous judgments as well as public speculations and even fakes on a global scale. In accordance with the aim of this paper, we will consider and define the essence, advantages and disadvantages as well as the terms of use of tokenized assets below.

Today, there is a lot of evidence that digital technologies make the traditional world more convenient, simple and accessible: distances can be covered with no time wasted, time is understood differently, objects can be copied and duplicated without additional effort. However, intellectual property rights can be widely violated, and the lines between real and fictional images are becoming blurred as well. Due to highly enhanced capabilities of modern computing equipment (described by Moore's law and confirmed by numerous studies before the rapid development of artificial intelligence and neural networks), the digital world may surpass the physical one in the coming years. This applies at least to the number of identified objects and processes, cause-and-effect relationships, and together it all means that the speed, growth and complexity of digital transformations will increase signifi-

cantly. The blockchain technology plays a fundamental role in these digital transformations, ensuring the data accounting and storage in electronic registers without the possibility of traceless changing, copying or deleting records. As a digital protocol or "book" of trust, distributed ledger technologies (in particular, blockchain) can be considered a technical "bridge" between the physical and digital worlds. Due to the distributed ledger technology properties, trust and transparency in the digital space take on a new meaning. It is possible to keep records of objects or rights to objects of the physical world by assigning them unique identifiers through tokenization, thereby endowing such objects with new properties that can be used in economic relations.

Considering that trust will play a key role for society in our digital age, the important elements to ensure trust in the digital environment are and will be trust in content, trust in identity, trust in ownership, trust in authenticity and trust in truth. Therefore, tokens will be essential in the digital environment since they represent physical assets in the digital world and enhance their functionalities. Tokens will represent the identity and value aspect in a protocol.

Literature review. Understanding the term "tokenized assets" still faces terminological challenges, largely due to its novelty and interdisciplinary nature. There's confusion between "tokenization" in the context of digital assets versus broader financial instruments. The distinction between tokenized assets and cryptocurrencies often blurs, complicating regulatory discussions. Moreover, the term encompasses a wide range of assets, from tangible real estate to intangible intellectual property, leading to debates over the scope and application of tokenization. These terminological issues underscore the need for a standardized lexicon that clearly delineates the varied facets of tokenized assets within the blockchain and financial discourse.

In the current scientific literature [5, 11, 20, 25], there is a consensus that the combination of tokenization and blockchain takes the main advantages of blockchain, such as transparency, traceability, accuracy and immutability. Being registered in blockchain, tokenized assets allow anyone to view all transactions related to their asset. This allows building trust on the market since the history of an asset can be verified. The blockchain immutability ensures that no transaction can be changed, which strengthens trust even further. For example, a seller cannot manipulate the history of an asset to inflate its price or get more money than it is actually worth. In general, tokenization together with blockchain brings significant changes in various areas, providing greater accessibility, efficiency and security. It promotes the democratization of financial services [25], lowers barriers to investment, and creates new opportunities for asset ownership and trading.

For a better understanding of the basics of tokenized assets and the terminological framework of their legal essence, it is necessary to consider approaches to the definition of tokenized assets and tokens underlying this modern type of assets. To do this, one should start with the essence of the blockchain technology itself and a number of related definitions: blockchain technology, virtual asset, token, cryptoasset, identifier [34], as well as the definition of the parties involved in relations arising from the use of distributed ledger virtual assets. These components are special concepts minimally sufficient to formulate the term "tokenized asset".

Thus, blockchain is a technological solution in the digital space that provides a modern way of digital data accounting. In fact, blockchain is an accounting system based on accounting objects in the form of tokens, records in a digital data accounting system based on the distributed ledger technology, which is an identifier of information that can be (but not exclusively) derived from the original asset. Blockchain differs from well-known so-called "classical accounting systems" in the object of its accounting and the technological solution for its implementation. We are talking about a high level of encryption, an open protocol, distributed storage of information, the ability to transfer digital data between accounting addresses without intermediaries, which ensures the reliability and transparency of transactions involving tokens [31]. Indeed, it is difficult to even imagine that an entry in a classic register (for example, in a transaction accounting book or in an Excel file of home bookkeeping), that

is, an entry not based on blockchain, can be a separate object of the transaction. On the contrary, this entry can rather be considered the result of some legal fact that affected the emergence, change or termination of legal relations. As it can be seen, blockchain is essentially one of the types of the distributed ledger technology implementation, which is based on a token as an accounting object that can be accounted for exclusively in decentralized information platforms, or simply in blockchain-based data accounting systems.

The aim of the paper is to determine the essence, generic features and technological basis of the use of tokenized assets for their implementation in the digital and platform-based economy.

Stages of development. Keeping in mind the aim of this paper, the author presents the material using a certain logic – according to a chain of concepts. The first initial concept is the distributed ledger technology. Speaking about it, first of all, it is necessary to consider the relationship between the concepts of "distributed ledger", "distributed ledger technologies", "blockchain technology", "consensus" and "token", which logically ensure the emergence of such a relatively new phenomenon as "tokenized asset" (Fig. 1).

Blockchain-based ecosystem of services	As an environment for market-driven circulation (exchange, purchase, sale) of tokenized assets
↑	
Decentralized information platform	As an infrastructure environment for registration and accounting of all data on tokenized assets, at the core of which is a distributed ledger token accounting system in the form of a hardware and software complex
↑	
Tokenized asset	As the most numerous and widespread type of virtual asset and the main blockchain-based digital service and product
↑	
Tokens, distributed ledger nodes, consensus algorithm	As mandatory tools of the blockchain technology
↑	
Blockchain technology	As the technology selected for well-ordered maintenance of a decentralized digital data register
↑	
Distributed ledger technologies	As basic technologies for the emergence of tokenized assets
↑	
Distributed ledger	As an example of a well-ordered decentralized space arrangement, where the functions of recording and maintaining distributed transactions are performed automatically

Fig. 1. The morphology of the emergence of tokenized assets through the explanation of their basic technological conditions and components

** Source: author's development based on [33, 34, 35].*

We will begin the presentation of basic material with a brief overview of the main essence of the concepts. As you know, a distributed ledger is a set of technical and software devices operating together, but decentralized and independent of each other for recording events with the data of a distributed ledger token using distributed ledger token transactions synchronized by means of a certain consensus algorithm. In other words, a distributed ledger is:

1) from a technological point of view, a decentralized database distributed among several network nodes, each of which receives data from other nodes and stores a full copy of the ledger. At the same

time, such nodes are updated independently of each other. The key feature of the distributed ledger is decentralization, that is, the absence of a single data storage and registration center. In addition, the information in all distributed ledger nodes must be valid and up-to-date, which is possible only by reaching agreement between all nodes of this ledger. Each node compiles and records the ledger updates independently of other nodes. Nodes then algorithmically "vote" on the update to algorithmically "make sure" that the majority of nodes "agree" with the final version. Achieving agreement on one of the ledger copies is called consensus, a process performed automatically using a consensus algorithm. Once consensus is reached, the distributed ledger is updated, and the latest agreed version of the ledger is stored in each node that can be very numerous [35];

2) in terms of the accounting management function, a technological solution in the digital space that provides a modern way of distributed ledger token accounting. In fact, a distributed ledger is an accounting system based on accounting objects in the form of distributed ledger tokens, objects of the distributed ledger token accounting system, which are identifiers of specifically structured information that can be (but not exclusively) derived from the original asset.

Therefore, it is obvious that the technologies using which distributed ledgers are created and maintained in space and time (and these are just a few of the existing distributed ledger technologies – blockchain technology, asynchronous graph technology, etc.) are an unconditional technological basis for creating systems for technologically secure and impartial storage of information at any time. In particular, in blockchain technology, such storage is ensured due to the accounting of distributed ledger tokens, which expand the possibilities of using virtual assets and their integration in various areas. Virtual assets that are created in distributed ledger token accounting systems and are distributed ledger tokens by their technological nature can be an analogy and example of this.

Distributed ledger technologies are multifunctional and multilevel information technologies intended for reliable storage, accounting and transfer of various information [35]. Among the few other distributed ledger technologies, the blockchain technology is the most well-known and widespread type of distributed ledger, where a sequence of blocks (block chain or blockchain) is used to achieve consensus (agreement) between network nodes. Blocks are arranged chronologically, connected to each other and protected by cryptographic methods. According to the logic of its construction, blockchain is a theoretically infinite sequence of blocks with various encoded information that is stored in a database with a very high security level. These blocks can be continuously generated algorithmically and linked to each other in a decentralized manner. This approach to information storage and the principle of interconnection between blockchain elements resemble the principles inherent in nature. For example, DNA chains as well as the atomic and molecular structure demonstrate the similarity and repeatability of their elementary forms of construction – fractals and, accordingly, the very principle of factuality. This indicates a structured and decentralized way of organizing space and, in particular, storing information and its constant repetition in various forms of the universe, from the smallest to the largest.

At its core, the blockchain technology provides information encoding using elliptic curve functions, which ensure its authenticity and protection against duplication, and the algebra of finite fields. The technology builds sequences of blocks that are connected to each other using hash functions, where the end of one block is the beginning of another. Blockchain data is recorded using cryptographic methods similar to those used in banking data transfer systems. Each new block is created based on a "digital mold" (hash) of the previous block, which ensures the connectivity of all blocks in the chain. In order for a block to be added to the chain, its data must be valid, which is ensured by a consensus mechanism that automatically verifies blocks before adding. In this way, a chain of blocks is created, where it is impossible to imperceptibly make changes or delete one of the blocks.

The process of joining new blocks to the chain goes through validation, where the compliance of a block with all blocks in the chain or blocks selected according to certain criteria is checked. Each

new block is completed with an electronic signature created by a private key. For this purpose, the digital signature algorithm with elliptic curves in finite fields is used, which works in a certain range of positive numbers. The authenticity of a digital signature can be easily verified using a public key, but the signing party remains the exclusive owner of the signature.

Such methods as cryptography are used in registers of information requiring protection from possible fraud. Cryptography quickly became widespread in the financial area due to the possibility of reliable verification of each banknote and its protocol (in fact, its exact identification) and gained a clear advantage over fiat (ordinary) money.

Modern and most common areas of the blockchain technology application are:

1) financial area (all cryptocurrencies or cryptoassets as the first known types of virtual assets since 2009);

2) management of traffic flows. For example, logistics algorithms for the movement of various goods or services as well as algorithms for regulating (e.g. traffic lights) traffic flows. The blockchain-based traffic light mode highly optimizes traffic and thus significantly increases the throughput of transport arteries. Traffic flow management of entire districts or even large metropolises is optimized with increased traffic safety and short-term predictability of the availability of the best logistics routes;

3) corporate operational management (for instant notification and processing of requests for the supply of various components and finished goods or services);

4) accounting of emissions from fossil fuels and transition to new "carbon currencies", which is actively used, for example, by Maersk, the largest Danish shipping company [24];

5) instant accounting and tracking of any registered objects and entities during international transportation;

6) trade in agricultural products with confirmation, for example, of their origin, storage or transit route;

7) services of bank lending, verification and check of customer trustworthiness;

8) registration and accounting of circulation of digital currencies issued by central banks;

9) queue management for users of public (state) medical, tourist, cultural institutions, for example, as it is used in the Louvre Museum in Paris;

10) confirmation and protection of copyright on musical works and works of art, etc.

Modern literature [1, 30, 31, 20, 27] mentions many areas and examples where blockchain-based digital solutions are being tested or implemented for optimizing the operation of public and private registers:

- registers of ownership rights to assets, leases and their exchanges;
- registers of contracts and agreements;
- election lists and registers of election campaigns;
- civil and social status registers;
- sociological and public opinion surveys;
- registers of judicial and law enforcement actions;
- databases and registers of private information systems, for example, a class of ERP systems related to the artificial intelligence training;
- court proceedings and commercial arbitration;
- registers of production of goods, products and their consumption;
- private insurance, energy and medical registers of accidents and emergency situations with an indication of the reasons;
- registers of tickets for various types of transport, logistics and postal transfers;
- registers of treatment protocols;
- student academic progress registers;

- registers of conducted research, experiments and engineering solutions;
- population census with grouping according to various characteristics, etc.

It is important that the main in these practical applications is the expected effect of the blockchain technology – to ensure the preservation of data, authorized access to it or its immutability. This is technologically ensured by algorithmic, legal, medical and other types of analysis of data in the blockchain format, which is practically impossible to distort without a trace. This can put an end to various frauds and manipulations with digitized data and information resources wherever they are digitized and entered into a digital data accounting system, that is, into a distributed ledger operated by one selected decentralized information platform every second (see Fig. 1).

Coming back to the blockchain technology and new meaningful derivatives based on it, it is important to note that blockchain is inherently one of the distributed ledger technology implementations, which is based on a distributed ledger token as the only possible (in the blockchain technology) identifier and type of accounting object. This means that the essence and meaning of a token should be determined.

As a term, this is a relatively new concept, but, in fact, this is not at all: its first analogs have been used since the 1960s in the coding of the computing machines of that time, but information circulation systems using a token (or its first analogs) are incomparable today.

In the digital world, the world of virtual assets, a digital token is a form of a unique identifier, a unique digital certificate confirming the obligations of a company (e.g. the issuer) to its holder. The uniqueness of a token is ensured by an exclusive entry in a distributed ledger (blockchain), which is technically almost impossible to forge.

A distributed ledger token is the main tool of a distributed ledger (see Fig. 1). By their technological nature, virtual assets created in distributed ledger token accounting systems are unique distributed ledger tokens [28, 6, 34], which can contain a lot of valuable information about the conditions of their emergence, owners, past circulation, divisibility, etc. In particular, the distributed ledger token data, which is a combination of attributes and properties of the distributed ledger token, includes: a) distributed ledger token hash; b) hashes of transactions; c) number of distributed ledger token accounting units; d) storage addresses of accounting units of this distributed ledger token; e) other attributes and properties that may be specified by the creator of this distributed ledger token [34]. This means that the distributed ledger token attributes can contain all fundamentally important legal information about the basic object of legal relations, which actually exists in the physical world and has its owner. This is crucial for revealing the economic and social potential of tokenized distributed ledger assets, in particular in the context of, for example, a new solution to the global problem of economic inequality.

A token (or, more terminologically, a distributed ledger token [28, 6, 34] can also be compared to shares traded on stock exchanges, but is only used in the field of virtual assets [29]. Accordingly, the main purpose of all tokens is to identify the object to which they are assigned (linked) at the time of their creation: tokens can be applied to any persons or phenomena for their accounting in a digital accounting system (i.e. a decentralized information platform) (see Fig. 1). Therefore, the distributed ledger token as an accounting object of blockchain-based systems can be an independent object of property relations that has its own accounting units in a blockchain-based digital data accounting system [34] (Fig. 2).

It is worth noting that the attributes of a distributed ledger token are necessary, permanent features of it, while the properties of a distributed ledger token are features making up its peculiarity, but at the same time are not mandatory.

In the context of the paper subject, it is important to understand that tokens (i.e. unique digital identifiers in blockchain-based registers) used for a kind of "marking" and designation of rights to actually existing physical or intangible assets (i.e. non-tokenized assets) can add sufficient legal grounds for tokenized assets to be the subject of legal economic and civil relations. This is based on

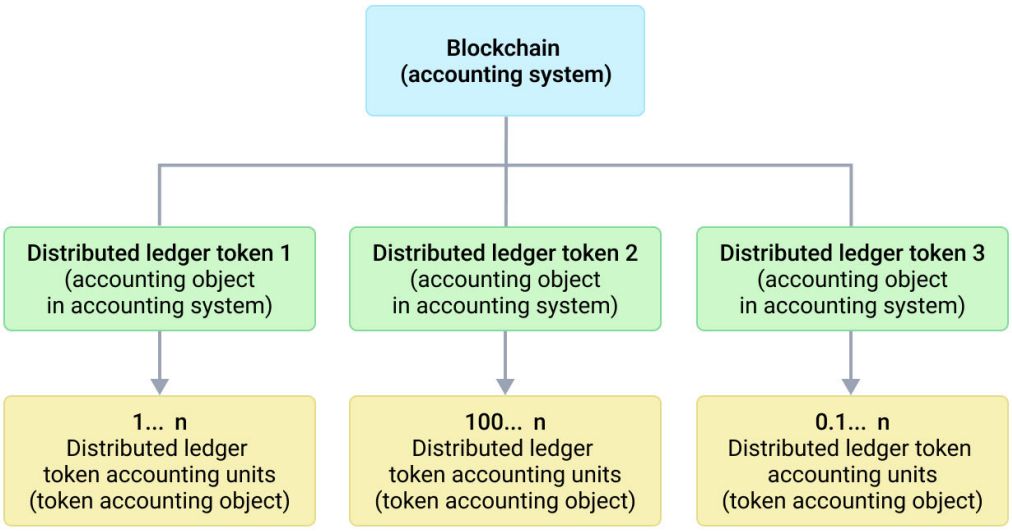

Fig. 2. Blockchain-based digital data object accounting system

** Source: author's development.*

a number of features that together confirm that a token (distributed ledger token) can be an object of legal relations:

1) users of an accounting system (blockchain) can independently create tokens;

2) a token exists as an identifier and has its own accounting units in an accounting system;

3) a user of an accounting system, taking into account their goals, at the time of token creation, can independently indicate the number of accounting units of this token to be issued;

4) between users of an accounting system, not a token itself is transferred, but its accounting units;

5) essence duality of a token: token accounting units can act as a measurement unit for the scope of rights to this token, while the token can be an object of accounting of any property existing outside an accounting system (outside blockchain);

6) users of blockchain as an environment for token circulation keep records collectively, as a result of which it is impossible to change or delete data individually and without a trace [34].

A distributed ledger token accounting system is an information system for registering, storing and exchanging data of distributed ledger tokens, which is based on the distributed ledger technology [34]. Defining a distributed ledger as a distributed ledger token accounting system allows considering a distributed ledger token as an object accounted for in this system.

It should be noted that technically, all objects that are disputed and discussed continuously (we are talking about virtual currencies, virtual assets, digital financial assets, etc.) are essentially tokens. This technological diversity of tokens in the digital world led to the fact that today there are different standpoints of national regulators with regard to the classification of distributed ledger tokens. One of the most well-known approaches is contained in the Guidelines for Enquiries Regarding the Regulatory Framework for Initial Coin Offerings (ICOs) developed by the Swiss Financial Market Supervisory Authority (FINMA). This Swiss regulator took its economic function as the main criterion for the classification of tokens. FINMA distinguishes four types of distributed ledger tokens:

1) payment tokens intended for use either today or in the future as means of payment for goods or services, or as means of transferring money or any value;

2) utility tokens intended for providing digital access to an application or a service using infrastructure based on a distributed ledger;

3) asset tokens that constitute assets, such as debt obligations or claims on the issuer's shares. For example, asset tokens may be promises of a share in a company's future revenues or future capital flows [35, 18];

4) hybrid tokens [34].

The British Cryptoassets Taskforce distinguishes between exchange tokens, security tokens and utility tokens [7]. For its part, the Financial Conduct Authority in the UK, along with these three types, also mentions e-money tokens [17].

Moreover, to understand the types of tokens, it is worth using a generalized explanation of the essence of several types of tokens for original (underlying) assets made by the Blockchain Council [5]:

1) fungible and non-fungible assets. Fungible assets are not unique, so they can be replaced with a similar item, for example, a one-hryvnia coin that cannot be distinguished from any other coin. Examples of fungible assets include gold and money, which in most cases can be easily divided into smaller units. In contrast, non-fungible assets are unique and non-interchangeable assets that cannot be divided into units in the analog world. One of the most common examples of non-fungible assets is the Mona Lisa painting [9]. In addition to fungible and non-fungible assets, we should also consider intangible assets (i.e. assets not represented in a physical object), such as patents and copyrights that can be tokenized as well;

2) security tokens and utility tokens. On the one hand, security tokens provide a holder with the same rights as traditional securities, for example, the right to a share. However, the definition of security tokens depends on the respective jurisdiction: they may differ slightly from country to country. Nevertheless, the classic Howey test is most commonly used internationally to determine whether a token is considered a U.S. security. This criterion was set forth in a decision of the U.S. Supreme Court and defines securities as "an investment of money in an ordinary enterprise with a reasonable expectation of profit derived from the efforts of others". This definition is also used by the main U.S. regulator, the U.S. Securities and Exchange Commission (SEC). In April 2022, the Chairman of this Commission, Gary Gensler, stated that "most cryptotokens are likely to meet the features of investment contracts, which means that they should be registered with the SEC" [19], that is, the head of the main U.S. stock regulator indicated the similarity of cryptotokens to securities.

On the other hand, utility tokens provide a token holder with access to an existing or potential product or service [9]. They are usually limited to a single network (i.e. the issuer) or a closed network associated with the issuer. For example, a tokenized discount card from your favorite store nearby, Disney Dollars, or game tokens in computer games can be considered examples of utility tokens.

It is important to note that objects that are more complex in nature and can also be created based on distributed ledger tokens, i.e. virtual assets, are of significant interest for the use in the economy and, as a result, for the establishment of a correct legal regime.

It is clear that various tools can be created based on the blockchain technology, and not only numerous types of tokens. Some of them have gained enormous popularity nowadays, in particular cryptocurrency or cryptoasset as a type of virtual assets. A review of the specialized literature dedicated to the first world experience of the circulation and regulation of various types of virtual assets [2, 26, 8, 13] assures that over the past decade, the issue of not so much consolidating the legal regime of virtual assets but rather establishing the terminology in this area has been open. Today, there is no consensus on this issue even in developed countries, although there is a trend towards further unification.

The definition of a virtual asset proposed by the FATF [16] is "a digital expression of value that can be digitally traded or transferred as well as used for payment and investment purposes". Taking into account this definition, the following key features of a virtual asset can be distinguished: a) is a digital expression of value; b) can be digitally traded or transferred; c) can be used for payment or investment purposes.

By the way, in the current field-specific regulation of the European Union on cryptoassets (MiCA) [14], a direct terminological link was made between the content of "virtual asset" and "cryptoasset" as understood by the FATF [16]. This logically became a new basis for the Ukrainian legislator, which was embodied in the new version of the Draft Law "On Virtual Assets" dated 2023. For comparison, updated Law of Ukraine "On Virtual Assets" No. 2074-IX dated February 17, 2022, defines a virtual asset as "an intangible benefit that is an object of civil rights, has value and is expressed by a set of electronic data. The existence and circulability of a virtual asset are ensured by the system for maintaining the circulation of virtual assets. A virtual asset can certify property rights, in particular the right to claim other objects of civil rights" [38]. However, the fundamentally new Draft Law of Ukraine "On Virtual Assets" (its working version was proposed for the Advisory Board of the National Securities and Stock Market Commission in June 2023) provided the following definition: "a virtual asset is a digital representation of the value of an object of civil rights or a right that can be transferred and stored electronically using the distributed ledger technology or similar technology". Moreover, no relevant and field-specific current legislative act of the EU and Ukraine contains a definition of a tokenized asset [34].

As you can see, the definition of "virtual asset" covers a wide range of regulated objects, in particular, it can cover not only virtual assets based on the distributed ledger technology but also those based on other (classical) accounting systems (e.g. non-documentary securities, electronic money). This greatly complicates the task of determining the legal regime for this object [34]. The following scientific results will greatly contribute to solving this task:

1) justification of the essence and components of a tokenized asset as one of the main types of a virtual asset. This issue will be outlined below;

2) determination of the subject and object composition of relations regarding the circulation of tokenized assets, which will result in defining the types of tokenized assets;

3) substantiation of the correlation between a real object of the physical world and a virtual object through the procedure of digitizing property and creating a tokenized asset.

As for distinguishing the essence of a tokenized asset, the attention of authoritative international organizations, governments of influential countries, and large banks is focused on tokenized assets having a certain legal link (legal connection) to the original (underlying) asset. The author believes that attention should be directed to virtual assets, the environment for circulation of which is a distributed ledger. The original asset can be any property that a user of a digital data accounting system based on the distributed ledger technology uses to create a distributed ledger virtual asset for conducting transactions involving such property, in particular for economic use. Therefore, given the objective features of a large number of distributed ledger virtual assets known to us, it is enough to consider such a criterion as "derivation from the original asset". This criterion is sufficient for the widest possible coverage of known types of virtual assets, however, taking into account the objective properties of each type of virtual asset and ways of their use in real life.

Accordingly, the following original definition of a tokenized asset is proposed: tokenized asset is a type of virtual asset that exists exclusively in a digital data accounting system based on the distributed ledger technology in the form of a record with an identifier of information derived from the original asset.

This concept is based on the economic category "asset". According to paragraph 2 of Part 1 of Article 1 of the Law of Ukraine "On Prevention and Counteraction to Legalisation (Laundering) of Criminal Proceeds, Terrorist Financing and Financing of Proliferation of Weapons of Mass Destruction" dated December 6, 2019, "assets are funds, including electronic money, other property, property and non-property rights" [39]. Thus, the etymology of the term "tokenized asset" indicates that it is property. Since a tokenized asset is an object of property relations, it exists (i.e. it is registered, accounted for and stored with the entire history of changes in accordance with the divisibility

of tokens) only in a digital data accounting system based on the distributed ledger technology in the form of a record with an identifier of information derived from the original asset.

The adjective "tokenized" indicates the key feature of the term – that a tokenized asset itself is not only property but also an identifier (token) of digital information derived from the original asset (right to ownership and/or use and/or disposal). "Tokenized asset" is a type of virtual asset, a tool for certifying sufficient and confirmed legal rights: rights of access to products and services, rights to a certain product or service, rights to receive a fixed income or percentage of profits, management rights, rights to purchase a certain asset at a certain price in the future, etc. Introducing a new concept of "tokenized asset" at the legislative level will contribute to reaching a new level of digital transformations. The first attempt to do this in Ukraine was made in November 2020, when a team of Ukrainian scientists, on the initiative of the Kharkiv non-governmental organization "Research Center of Economic and Legal Solutions in the Area of Application of Distributed Ledger Technologies" [36], prepared Draft Law "On Tokenized Assets and Crypto-Assets" No. 4328 and registered it in the Verkhovna Rada of Ukraine [37].

Having clarified the essence of a relatively new and modern type of assets existing in the digital environment only, tokenized assets, it should finally be revealed how the connection between a real asset and a tokenized asset is established and tracked.

Only virtual assets that have undergone a particular tokenization procedure (there are already several of them from private providers in the world), that is, digitization with mandatory registration of the object itself and the underlying asset in the distributed ledger, can be useful and, most importantly, legal for achieving socially significant (and not speculative) economic goals, in particular with regard to the market infrastructure development. Accordingly, the procedure for creating such assets is called tokenization.

In fact, tokenization is the transfer of all key features of a physical object to distributed ledgers for storage and accounting, that is, the creation of a unique digital representation of an asset, adding to the underlying (initial) asset "an additional dimension – a protected digital dimension" [15]. In layman's terms, "tokenization of an asset is the creation of an information code providing the asset with key features while revealing some functions that allow a user to interact with the asset digital representation" [15]. For example, based on the popular Ethereum blockchain, this information code is developed in Solidity.

The well-known international expert organization Blockchain Council [5] defines tokenization as "a process of transforming property and rights to certain assets into a digital form" and at the same time indicates that by means of tokenization, it is possible to transform ordinary indivisible assets into the forms of tokens and make them divisible using a unique property of tokens – divisibility into literally any number of token parts, provided that they are registered and accounted for on a blockchain platform. Hence, used tokens represent or prove a share or ownership of assets. Tokenization of backed assets makes it easier and faster for investors to buy and sell shares of assets since they can be divided into smaller units.

From a technical point of view, the process of asset tokenization can be divided into four main stages:

1) selection of a model for submitting assets;
2) asset modeling;
3) technical and security verification of the information code;
4) information code deployment [15]. After security verification, the code can simply be deployed in a blockchain-based ledger, either public or private, depending on the purpose of further use and the conditions for the outside distribution of these tokenized assets.

In 2022-2023, significant efforts were made to address the terminological and regulatory challenges surrounding tokenized assets. Regulatory bodies and industry groups [4, 21, 40] worked towards

standardizing definitions and creating frameworks to govern their use. Collaborative efforts, such as international forums and working groups, aimed at harmonizing regulations across jurisdictions. These endeavors resulted in preliminary guidelines and best practices for tokenization, though comprehensive global standards remain in development. The future likely holds continued collaborative efforts, with a focus on establishing clear, universally accepted definitions and regulatory frameworks to facilitate the broader adoption of tokenized assets. As an output, the gradual disappearance of myths around tokenized assets can be attributed to several key developments:

- increased regulatory clarity: regulatory bodies worldwide have begun issuing guidelines and frameworks for tokenized assets, providing legal legitimacy and reducing uncertainty;
- successful use cases: the growing number of successful implementations in various sectors, such as real estate and art, demonstrates the practical benefits and feasibility of tokenization;
- enhanced security measures: advances in blockchain technology have improved the security of tokenized transactions, addressing concerns over potential fraud and hacking;
- educational efforts: industry stakeholders have invested in educational campaigns to dispel myths and inform the public and investors about the true nature and potential of tokenized assets.

At least, we think, these 4 factors contribute to a more informed and receptive environment for the adoption of tokenized assets. So, the field of tokenized assets saw significant trends across government, analytical, and business organizations. Key developments included regulatory advancements, with several countries beginning to establish clear frameworks for tokenization, enhancing legal certainty for investors and issuers. Innovations in blockchain technology further facilitated the tokenization of a wider range of assets, including real estate and commodities, promoting greater liquidity and market accessibility. Business adoption surged as firms recognized tokenization's potential to streamline operations and unlock new financing avenues [4, 21, 40]. However, discussions on ethical implications and the need for robust cybersecurity measures also gained traction, highlighting the complexity of integrating tokenized assets into mainstream finance.

Moreover, in 2023, an international regulatory environment for tokenized assets underwent significant transformation. Governments across the globe initiated efforts to refine their regulatory frameworks, aiming to create a balance that fosters innovation while ensuring investor protection. This strategic move towards the integration of tokenized assets into formal financial systems marks a crucial step in their legitimization. It demonstrates a global acknowledgment of the potential that blockchain technology holds for revolutionizing asset management and ownership. This regulatory evolution underscores a commitment to nurturing technological advancements in the financial sector, while also establishing robust safeguards against the inherent risks associated with digital assets. The focus on developing clear, comprehensive legal guidelines reflects an understanding of the need to build trust among investors and stakeholders in the burgeoning tokenized asset market.

Finally, there are few of our arguments about debunking the myths that were stated in the title of this article. As we see, the relatively new phenomenon of “tokenized assets” introduces novel dimensions to microeconomics, finance, and GovTech by enabling fractional ownership, enhancing liquidity, and ensuring transparent transactions through blockchain technology. This innovation allows for broader participation in asset markets, potentially stabilizing prices and democratizing investment. In finance, it facilitates real-time, secure transactions, reducing costs and improving efficiency. GovTech benefits from increased transparency and accountability in asset management. Previously, the technology and regulatory frameworks necessary for implementing and recognizing tokenized assets were not sufficiently developed, limiting their conceptualization and integration into mainstream economic and financial systems.

Next, we will try to look at the debunking of myths about tokenized assets through the prism of the GovTech sphere. Why GovTech? Because this is the field that causes further irreversible changes to society, is a kind of “locomotive” of change, although it should be recognized that GovTech is not, and has never been a pioneer of change, a breakthrough innovator and a "fast molecule” in dig-

ital innovation. So, tokenized assets seem to almost revolutionizes microeconomics, finance, and GovTech in 21st century by enabling fractional ownership of assets, which democratizes access to investments previously available only to wealthy individuals or institutional investors. In finance, it streamlines transactions, reduces costs through blockchain efficiency, and enhances liquidity, making it easier to buy and sell assets. For instance, for GovTech, tokenization offers a transparent, secure method for managing public assets and records [12, 3]. Previously, the absence of advanced blockchain technology and regulatory frameworks limited the feasibility and recognition of tokenized assets, rendering the term and its application largely conceptual rather than practical. What does it mean here? As believed for GovTech, tokenized assets represent a transformative approach to managing public assets and records with unparalleled transparency and security. By leveraging blockchain technology, tokenization ensures that each asset or record is uniquely identifiable and traceable, eliminating the risks of duplication or tampering. This enables government entities to streamline their asset management processes, from real estate to intellectual property, enhancing efficiency and reducing bureaucratic overhead. Furthermore, the inherent transparency of blockchain provides a clear audit trail, fostering trust among citizens and improving accountability in public administration. Such advancements could significantly modernize government operations, paving the way for more responsive and citizen-centric services.

So, if it's really true, as the concept of "tokenized assets" becomes more integrated into GovTech and broader financial systems, scholars and policymakers will gain a deeper and more nuanced understanding of its implications. We think this increased familiarity will dispel several myths, such as the inaccessibility and complexity of blockchain technology, and concerns over security and fraud. The clarity brought by widespread implementation will highlight tokenization's benefits in enhancing transparency, security, and efficiency in asset management [10]. Misconceptions about the scalability and regulatory viability of tokenized assets will also be addressed, fostering a more informed and confident approach to leveraging this technology for public good. So, the main beneficiaries of these mentioned GovTech innovations through tokenized assets will include government and regional authorities, citizens, private investors, and software developers. For instance, public-owned agencies gain from increased efficiency and transparency in asset management. Citizens benefit from enhanced access to public records and services, fostering trust in government operations. Investors enjoy improved market accessibility and liquidity, opening up new opportunities in public assets [22]. Lastly, developers find new avenues for creating solutions that integrate public services with blockchain technology, driving innovation and collaboration in the public sector.

In GovTech, tokenized assets could be applied through various mechanisms such as digital registries for land and property, tokenized voting systems to enhance electoral transparency, and blockchain-based identity management for secure citizen data handling. These implementations promise to revolutionize public sector efficiency by ensuring traceability, reducing fraud, and improving service delivery. The irreversible impact on society includes heightened trust in public institutions, democratized access to government services, and a foundation for innovative civic engagement models, fundamentally transforming the relationship between governments and citizens.

In this matter, state-owned centralized platforms and private-owned decentralized blockchain-based platforms really offer new possibilities for GovTech by ensuring enhanced security, transparency, and efficiency in public services [11]. Decentralized platforms, in particular, allow for secure, transparent transactions and records management without a central point of failure, reducing risks of corruption and increasing trust in government operations. The tokenization of assets on these platforms can streamline asset management, facilitate secure voting mechanisms, and improve public record keeping. This represents a significant step forward by harnessing technology to foster more accountable, efficient, and citizen-focused governance.

As we see, digital platforms play a crucial role in debunking myths about the criminality associated with virtual and particularly tokenized assets. By leveraging the inherent transparency and immutability of blockchain technology, these platforms ensure that all transactions involving tokenized assets are recorded in a tamper-proof manner. This not only facilitates the traceability of assets, making it easier to track and report suspicious activities but also enhances the overall security of digital transactions. The use of smart contracts on these platforms further automates compliance with regulatory standards, reducing the risk of fraud and illegal activities. Moreover, blockchain's decentralized nature diminishes centralized points of vulnerability, making it harder for malicious actors to manipulate the system. As regulatory bodies continue to understand and integrate blockchain technology into their frameworks, the perception of tokenized assets is shifting from being seen as a tool for illicit activities to a legitimate and valuable innovation in financial and governmental sectors. This transformation is a significant step forward in the adoption of tokenized assets, promising a future where digital assets are both secure and trusted by the public and authorities alike.

Conclusions

1. All currently known modern virtual assets can be implemented in classic digital accounting systems (digital ecosystems based on a distributed ledger) or only in a distributed ledger. In particular, tokenized assets, which are virtual assets backed by real property, can be easily adapted to the existing civil law system with possible minor legislative amendments. At the same time, the second type of virtual assets, cryptoassets, needs closer attention from legislators, in particular through the adoption of special regulations and consolidation of their legal regime.

2. Two main types of distributed ledger virtual assets can be distinguished: tokenized assets and cryptoassets. In turn, depending on the original asset, based on the International Financial Reporting Standards, tokenized assets can be divided into derivatives of a current or non-current asset. Due to the different nature of their origin from original property (backing), tokenized assets and cryptoassets should be subject to a different legal regime. It also opens up new prospects for further scientific research in economics and law.

3. The purpose of tokenization of backed assets is to create a more accessible and liquid way of investing in these assets. Due to tokenization, assets are divided into small shares represented by digital tokens, allowing investors to buy these shares at a lower cost. Tokens associated with valuable assets are usually backed by real assets, which gives them stability and value. Tokenized assets pave the way for a much easier process of trading and transferring ownership since tokens can be easily transferred and traded on digital platforms.

4. A tokenized asset can be used as a tool for implementing a method of recording, accounting and managing property rights to assets. Moreover, a tokenized asset can be used as a tool for certifying any rights; providing services; recording events; generating, processing and submitting statistical and analytical information; ensuring logistics, etc. Depending on the purpose of creating a specific tokenized asset and, as a result, certain inherent properties envisaged by the creator, this tokenized asset can be classified as a separate type.

5. Parties to relations in the field of application of virtual assets are primarily users of digital data accounting systems based on the distributed ledger technology, who provide or consume services implemented in such systems. It is they who set the demand and supply for virtual assets, initiate transactions and are responsible for the use of distributed ledger virtual assets. Consolidation of the parties' legal status is a prerequisite for a comprehensive approach to the regulation of this area.

6. In 2023, the landscape of tokenized assets witnessed evolution, marked by a convergence of governmental, analytical, and business insights. Governments globally have started to refine regulatory frameworks, aiming to balance innovation with investor protection, highlighting a shift towards legitimizing tokenized assets within formal financial systems. Analytical organizations have focused on assessing the impact of tokenization on market dynamics, emphasizing enhanced liquidity, and the

democratization of investment. Business entities, particularly in the fintech sector, have pioneered the application of tokenized assets, exploring new models for asset management and capital raising. This period also saw an emphasis on sustainability and ethical considerations, with tokenized assets being evaluated for their potential to support green finance initiatives. Despite the enthusiasm, challenges around cybersecurity, market volatility, and the need for international regulatory harmonization were prominently discussed. Overall, 2023 was a year of strategic groundwork and cautious optimism in the realm of tokenized assets, setting a precedent for future innovation and integration into the global financial ecosystem.

7. The strategic implications of tokenized assets for the average person involve broader access to previously inaccessible markets, transforming personal finance management and investment strategies. This democratization of investments could lead to a more financially informed public, with direct participation in markets that were once exclusive to high-net-worth individuals or institutional investors. However, as the concept becomes mainstream, new misconceptions may arise, possibly around the overestimation of technology's ability to eliminate all financial risks or misunderstandings about the nature of digital ownership and its legal implications. Overcoming these challenges will require comprehensive public education efforts and the development of intuitive platforms that simplify the complexities of blockchain and tokenization for everyday users.

References:

1. Afaq, Y., Manocha, A. (2023). Blockchain and Deep Learning Integration for Various Application: A Review, Journal of Computer Information Systems.
2. Aksoy, P. C. (2023). The applicability of property law rules for crypto assets: considerations from civil law and common law perspectives. *Law, Innovation and Technology.* Vol. 15. p. 185–221.
3. Basiuk, O. (2023). Recommendations for implementing distributed ledger technology (blockchain) in the public sector of Ukraine based on global experience. *Pressing Problems of Public Administration*, 1(62), 131–154. Retrieved from: https://doi.org/10.26565/1684-8489-2023-1-08 (original in Ukrainian)
4. BIS (2022). Application of the Principles for Financial Market Infrastructures to stablecoin arrangements (13 July 2022) / BIS. Geneva : BIS, 2022. 24 c. URL: Retrieved from: https://www.bis.org/cpmi/publ/d206.htm
5. Blockchain Council (2021). What Is Tokenization? A Complete Guide. URL: Retrieved from: https://www.blockchain-council.org/blockchain/what-is-tokenization/.
6. Bokolo, A. (2023). Distributed ledger and decentralised technology adoption for smart digital transition in collaborative enterprise.
7. Braddick, K., Bailey, A., Ramsden, D. (2018). Cryptoassets taskforce: final report. URL: Retrieved from: https://assets.publishing.service.gov.uk/government/-uploads/system/uploads/attachment_data/file/752070/cryptoassets_taskforce_final_report_final_web.pdf.
8. Buttigieg, C., Efthymiopoulos, C., Attard, A., Cuyle, S. (2019). Anti-money laundering regulation of crypto assets in Europe's smallest member state. *Law and Financial Markets Review.* No. 13:4. p. 211–227.
9. Dahlborn, A., de la Roche, M., Kajtazi, L., Daykin, R. (2020). Tokenization of Assets and Blockchain. Retrieved from: https://www.eublockchainforum.eu/sites/default/files/research-paper/Tokenization%20of%20Assets%20%26%20Blockchain_0.pdf.
10. Dunayev, I., Orlov , O. (2023). National legal regulation of the digital economy and information platforms. *Pressing Problems of Public Administration*, 1(62), 6–21. Retrieved from: https://doi.org/10.26565/1684-8489-2023-1-01 (original in Ukrainian)
11. Dunayev I., Byelova L., Kud A., Rodchenko V. (2023). Implementing the "government as a platform" concept: the assessment method and an optimal human-centered structure to address technological challenge. *Eastern-European Journal of Enterprise Technologies*. № 2 (13 (122)), 6–16. Retrieved from: http://journals.uran.ua/eejet/article/view/275613

12. Dziundziuk, V., & Dziundziuk, B. (2022). Public administration using blockchain technology and platforms: new opportunities. *Pressing Problems of Public Administration*, 2(61), 104–115. Retrieved from: https://doi.org/10.26565/1684-8489-2022-2-07 (original in Ukrainian)
13. Edwards, F., Hanley, K., Litan, R., Weil, R. (2019). Crypto Assets Require Better Regulation: Statement of the Financial Economists Roundtable on Crypto Assets. *Financial Analysts Journal.* No. 75:2. p. 14–19.
14. European Parliament (2019). Regulation of the European Parliament and of the Council on Markets in Crypto-Assets, and Amending Directive (EU) 2019/1937. Retrieved from: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020PC0593.
15. EY (2021). Tokenization of Assets: Decentralized Finance (DeFi). Vol. 1. Spot on: Fundraising & StableCoins in Switzerland. Retrieved from: https://assets.ey.com/content/dam/ey-sites/ey-com/en_ch/topics/blockchain/ey-tokenization-of-assets-broschure-final.pdf.
16. FATF (2019). Public statement on virtual assets and related providers. Orlando: FATF. Retrieved from: https://www.fatf-gafi.org/publications/fatfrecommendations/documents/public-statement-virtual-assets.html.
17. FCA (2019). Guidance on cryptoassets / Financial Conduct Authority (FCA) website. Retrieved from: https://www.fca.org.uk/publication/consultation/cp19-03.pdf.
18. FINMA (2018). Guidelines for enquiries regarding the regulatory framework for initial coin offerings (ICOs) / Swiss Financial Market Supervisory Authority (FINMA). Retrieved from: https://www.finma.ch/en/news/2018/02/20180216-mm-ico-wegleitung.
19. Gensler, G. (2022). Speech. Prepared Remarks of Gary Gensler on Crypto Markets: Penn Law Capital Markets Association Annual Conference. Retrieved from: https://www.sec.gov/news/speech/gensler-remarks-crypto-markets-040422.
20. Hort, J., Vališ, M., Zhang, B., Kuča, K., Angelucci, F. (2021). An Overview of Existing Publications and Most Relevant Projects/Platforms on the Use of Blockchain in Medicine and Neurology. Frontiers in Blockchain. p. 4.
21. IMF (2023). IMF policy paper "Elements of effective policies for crypto assets" №2023/004 (February 23, 2023). Retrieved from: https://www.imf.org/en/Publications/Policy-Papers/Issues/2023/02/23/Elements-of-Effective-Policies-for-Crypto-Assets-530092
22. Kud, A. (2023). Modern approaches to global and governmental regulation of virtual assets: what to choose to support digital innovations?. *Pressing Problems of Public Administration*, 1(62), 59–82.
23. Kud, A. (2022). Modernization of the Public Governance System in the Age of Information Platforms: Monograph / V. N. Karazin Kharkiv National University, Educational and Research Institute "Institute of Public Administration"; NGO "Research Center of Economic and Legal Solutions in the Area of Application of Distributed Ledger Technologies". Kharkiv: Pravo. 408 p. Retrieved from: https://www.blockchainukraine.org/wp-content/uploads/2022/10/a-kud-modernization-of-the-public-governance-system-in-the-age-of-information-platforms-en.pdf.
24. Maersk (2021). How blockchain technology is beefing up supply chain visibility. Retrieved from: https://www.maersk.com/news/articles/2021/07/27/how-blockchain-technology-is-beefing-up.
25. Markey-Towler, B. (2018). Anarchy, Blockchain and Utopia: A Theory of Political-Socioeconomic Systems Organised Using Blockchain.
26. Pavlidis, G. (2021). Europe in the digital age: regulating digital finance without suffocating innovation, *Law, Innovation and Technology.* No. 13:2. p. 464–477.
27. Pestunov, A. (2020). Cryptocurrencies and Blockchain: Potential Applications in Government and Business. *Problems of Economic Transition.* Vol. 62. Issue 4–6: Financial Policy. p. 286–297.
28. Saramago, C. (2023). Using distributed ledger technologies for bond issues – a primer.
29. Sepp, A. (2021). Blockchain and Distributed Ledgers: Mathematics, Technology, and Economics, by Alexander Lipton and Adrien Treccani, World Scientific Publishing. E-book.
30. Sparrow, R., Howard, M., Degeling, C. (2021). Managing the risks of artificial intelligence in agriculture. *NJAS: Impact in Agricultural and Life Sciences.* No. 93(1). p. 172–196.

31. Wünsche, J. F., Fernqvist, F. (2022). The Potential of Blockchain Technology in the Transition towards Sustainable Food Systems. *Sustainability.* No. 14(13). p. 7739.
32. Dunayev, I., Kovalenko, M. (2022). New traces of regulation of information platforms and a platform-based economy for the new public good. *Pressing problems of public administration.* No. 2(61). p. 6–24.
33. Kud, A. (2021). Comprehensive Classification of Virtual Assets. *International Journal of Education and Science.* Vol. 4. No. 3–4. p. 64–91. Retrieved from https://ijes.world/files/paper-files/2021-volume-4-no-3-64/ijes-2021-3-6.pdf.
34. Kud, A. (2020). The phenomenon of virtual assets: economic and legal aspect. *International Journal of Education and Science.* Vol. 3. No. 3. p. 30–42.
35. Kud, A., Kucheryavenko, N., Smychok, E. (2019). Digital assets and their economic and legal regulation in the light of the blockchain technology development: monograph. Kharkiv: Pravo. 384 p. [in Ukrainian].
36. Research Center of Blockchain Solutions (2020). Work on development of the Draft Law "On Tokenized Assets and Crypto-Assets" was completed. Retrieved from https://www.blockchainukraine.org/work-on-development-of-the-draft-law-on-tokenized-assets-and-crypto-assets-was-completed/ [in Ukrainian].
37. Verkhovna Rada of Ukraine (2020). Draft Law "On Tokenized Assets and Crypto-Assets" No. 4328 dated 05.11.2020. Retrieved from https://itd.rada.gov.ua/billInfo/Bills/Card/4570 [in Ukrainian].
38. Verkhovna Rada of Ukraine (2022). On virtual assets: Law of Ukraine No. 2074-IX dated 17.02.2022. Retrieved from https://zakon.rada.gov.ua/laws/show/2074-20#Text [in Ukrainian].
39. Verkhovna Rada of Ukraine (2019). On prevention and counteraction to legalization (laundering) of criminal proceeds, terrorist financing and financing of proliferation of weapons of mass destruction: Law of Ukraine No. 361-IX dated 06.12.2019. Retrieved from https://zakon.rada.gov.ua/laws/show/361-20#Text [in Ukrainian].
40. WEF (2023). Pathways to the Regulation of Crypto-Assets: A Global Approach. Geneva – Davos. WEF, 2023. 34p. Retrieved from: https://www3.weforum.org/docs/WEF_Pathways_to_the_Regulation_of_Crypto_Assets_2023.pdf