Global Scientific and Academic Research Journal of Economics, Business and Management
ISSN: 2583-5645 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journals-gsarjebm-home/

RWA-TOKENIZATION AS A TOOL FOR ATTRACTING INVESTMENTS AND DEVELOPING POST-WAR UKRAINE

BY

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Article History

Received: 21/11/2024
Accepted: 28/11/2024
Published: 30/11/2024

Vol –3 Issue – 11

PP: -64-77

Abstract

RWA tokenization is of particular interest to the Ukrainian economy, as the transformation of traditional assets into digital tokens on the blockchain allows for lowering the barriers to entry for potential investors and increasing the liquidity of these assets. Given the presence of a significant amount of real assets with a low level of economic efficiency of use, the introduction of RWA tokenization can become a powerful catalyst for the creation of new investment instruments and the modernization of the country's financial infrastructure, especially in the conditions of ensuring post-war recovery. The purpose of the article is a comprehensive analysis of the essence and mechanism of RWA tokenization as an innovative financial instrument, a study of modern market trends in the field of tokenization of real assets, as well as an assessment of the prospects for its implementation to attract investments into the Ukrainian economy, taking into account the needs of post-war reconstruction and the need to transform the financial sector. The article examines RWA- tokenization as an innovative financial instrument that opens up new investment opportunities through portfolio diversification and access to previously inaccessible assets. It has been determined that blockchain technology and RWA tokenization facilitate the emergence of new markets and products, creating more efficient and inclusive financial ecosystems. The key challenges of implementing RWA tokenization are analyzed, including regulatory requirements, technological security, and the need for investor education. RWA tokenization has been found to form a bridge between the physical and digital worlds, opening up new avenues for investment and ownership. The perspective of introducing RWA tokenization in Ukraine as a tool for attracting capital for post-war reconstruction and digital transformation of the economy is substantiated.

Keywords: *RWA-tokenization, digitalization, investment, blockchain, assets, digital transformation, innovation, financial instrument.*

INTRODUCTION

Tokenization of real assets (RWA tokenization) has been developing rapidly in recent years, and according to Outlier Ventures, the market for tokenized assets is estimated at trillions of dollars (Outlier Ventures, 2024). This rapid growth is explained by the benefits of the digital transformation of the world economy and, as a result, the increased interest of financial institutions and governments in the integration of financial instruments into blockchain systems.

Tokenization significantly transforms the ways of financing, trading, and asset management. Technology can radically rethink the traditional framework of investment and ownership, significantly reducing transaction costs, which ensures transparency and greater liquidity. By expanding access to investment, tokenization not only changes the way we look at property, goods, and values but also the way we interact with these key elements of the economic system. Tokenization of real assets is not a thing of the future, it is happening now and is laying the groundwork for a financial ecosystem where digital tokens symbolize the real world of assets, making them more accessible than ever before – not just to privileged or institutional investors, but to the general public the public

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Tokenization technology, together with blockchain, allows for the creation of digital counterparts of physical assets such as real estate, artwork, jewelry, or luxury items such as watches and jewelry. This process, known as asset tokenization or digitization, involves converting the rights to these assets into digital tokens. Using the blockchain, these tokens can be securely bought, sold, and exchanged, increasing liquidity and reducing transaction costs and time across markets.

PROBLEM STATEMENT

Modern scientific work contains a number of studies on the application of tokenization of assets. This issue is highlighted in the works of such scientists as A. Andreeva, D. Rudenko (2022), A. Martynov (2023), I. Makaliuk (2023), Ya. Belinska, S. Onishko and R. Dyuk (2023).

The analysis of scientific literature shows the multifaceted application of tokenization. In particular, this technology is considered as an effective tool for protecting confidential data by replacing real values with virtual equivalents (Paschini, M., & Agarwal, N. 2021). The researchers describe complex systems for the issuance, management, and transfer of asset-backed tokens that include minting and customer interaction components. In the context of cryptocurrencies, scholars propose methods of using tokenization to create stable cryptocurrencies backed by government debt using digital wallets and blockchain technology. This allows for safe and efficient transactions (Tian, Y., Lu, Z., Adriaens, P., Minchin, RE, Caithness, A., & Woo, J., 2022). Tokenization is seen as a potential solution to the problem of financing infrastructure projects. Researchers cite the example of energy security token Ziyen-Coin, which meets the requirements of the SEC and demonstrates increased liquidity, transaction efficiency and transparency between intermediaries (Wandmacher, R., & Wegmann, N., 2020).

In the field of real estate, tokenization can contribute to increasing market liquidity and transparency by enabling fractional ownership and reducing transaction costs through the use of smart contracts and blockchain technology (Benedetti, HE, & Rodríguez-Garnica, G., 2021), (Joshi, S., 2024). The methodology of tokenization, as defined by the researchers, involves the registration of assets in a distributed ledger, the assignment of replaceable or irreplaceable tokens to them, and the verification of ownership using cryptographic keys (Pestovska, ZS, 2022). It is important to note that the legal and regulatory framework for tokenization is still in its nascent stages. Some countries, notably Ukraine, Liechtenstein and Switzerland, are already taking steps to provide legal certainty and protection for virtual assets and related transactions. (Pestovska, ZS, 2022), (De Jong, BW, Goldstein, FD, & Grinalds, SH, 2020)/

Existing scientific studies do not sufficiently cover the tokenization of real assets and the benefits it can provide, especially in the context of the intensification of investment activities and the digital transformation of the economy as a whole.

PURPOSE AND TASK

In this article, we will consider in detail the mechanisms of tokenization of real assets, explore market trends and examples of its application, advantages and challenges. In addition, we will consider the prospects of investing in such a new class of assets as RWA tokens to attract investments for the reconstruction of Ukraine in the post-war period.

The realization of the set goal necessitated the following tasks:

- to investigate the essence and features of RWA tokenization;
- systematize the categories of real assets that can be tokenized;
- identify trends in the development of the market of real assets in the world and outline the potential of tokenization of these assets;
- identify the main advantages of RWA tokenization and the challenges it may cause for participants in the process of investing in RWA tokens;
- describe how RWA-tokenization can change the financial landscape and approaches to asset management and activate the attraction of investments for the reconstruction of Ukraine in the post-war period.

METHODS

To conduct the research, general scientific research methods were used: analysis, synthesis, induction, system approach, comparison, structuring, dynamic approach, logical assumptions, and generalization. This article also uses the following special methods and methodological techniques: review and constructive-critical analysis of scientific and official sources; collection, processing, and interpretation of analytical and statistical data on RWA tokenization.

RESULTS

With the expansion of the digital asset market, the need to tokenize various forms of value and assets on the blockchain has grown. Today, this asset class includes not only pure crypto-assets such as Bitcoin and Ethereum but also tokenized representations of tangible and intangible assets - from fiat currencies such as the US dollar (stablecoins) to a variety of traditional financial assets such as government securities, private credit, real estate, commodities, money market funds and other real assets (RWA).

Tokenization is the process of representing valuable assets or rights on the blockchain through the creation of digital tokens. Attention to it has increased significantly since leading financial institutions have implemented basic infrastructure for digital assets. This infrastructure enables financial institutions and web3 companies to leverage key benefits of tokenization such as instant global asset transfer, sharding, faster settlements, elimination of counterparty risk, secondary liquidity and many others. RWA (Real World Assets - from English “real assets”, “real world assets”) are transforming the blockchain landscape, bridging the gap between the physical and digital worlds.

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RWA are tangible or intangible assets that have real economic value in the traditional financial world. Each RWA has two dimensions. These dimensions are also related to two structural trends occurring today with RWA: digitalization, which applies to tangible and intangible assets, and financialization, which applies to real and financial assets. Tokenization accelerates two existing trends of structural assets (Fig. 1):

- Digitization of assets - transforming physical assets into digital forms or moving digital assets to new infrastructure to gain even more benefits.
- Financialization of assets - the process of transforming any asset into a financial instrument by reengineering cash flows, investment opportunities and capital formation.

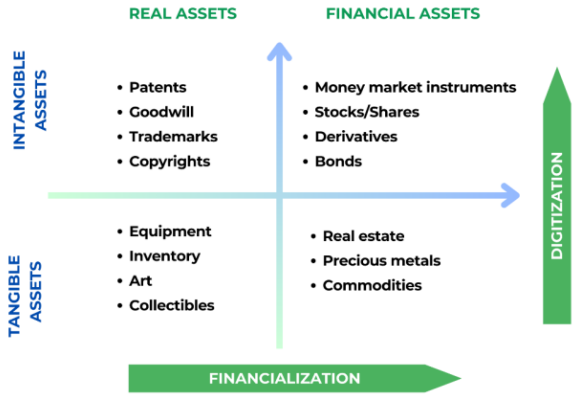

Figure 1. Structural relationship between digitalization and financialization

Source: drawn by the authors based on data (De Maere, J., 2024)

RWA- tokenization accelerates both financialization and digitalization of real assets. As more and more assets are tokenized, we expect to see an increase in the number of assets becoming intangible and transformed into pseudo-financial instruments. Next, we take a closer look at the digitalization and financialization of RWA. Below is a brief explanation of how RWA tokenization and blockchain are accelerating these trends.

Digitization – In search of greater efficiency, assets are becoming digital and intangible, as the tokenization process reveals more benefits that come with their tokenized representation on the blockchain. Intangible assets can also benefit from digitization when moving to a different database or infrastructure, opening up new opportunities. With 75% of all the data stored in the world being created in the last 5 years, we believe that the value in the digital world will soon exceed the value in the physical world (eg inventory, supply chain assets, financial products, etc.).

Financialization – the token that represents the RWA asset is highly programmable and contains automatically performed actions built into the token's smart contract code. This allows for easy and minimal cost transformation of cash flows, investment opportunities and capital formation related to real assets that were not previously considered financial instruments (eg data, intellectual property, gaming assets, etc.).

It is important to emphasize that digitalization and financialization are not mutually exclusive. There are assets that, being tokenized, can cover both trends at the same time. We categorize some assets below to show what types of assets tend to fall under a particular trend.

Without RWA tokenization, the computing power of smart contracts on the blockchain is limited only to the "on-chain" world. That is, smart contracts on the blockchain can work only with those assets that are located and function in the digital environment of the blockchain itself (on-chain), such as cryptocurrencies or tokens created inside the blockchain. RWA tokenization allows you to connect the blockchain with the real world by digitizing physical assets (real estate, goods, financial instruments). Establishing such a connection makes it possible for smart contracts to manage real assets through the blockchain, expanding the limits of their application and opening up new opportunities for asset management.

Assets that can be tokenized cover a wide range of different categories - both tangible and intangible assets. These can be both physical assets that have a real market value, and financial instruments that are used to invest and preserve capital. Assets characterized by high liquidity or potential for diversification also often become objects of tokenization. Table 1 lists the main categories of assets that can be tokenized.

Table 1.
Categories of assets that can be the object of tokenization
(Source: compiled by the authors)

Financial assets	state capital; private capital; arrears; investment funds; goods
Real estate	commercial; residential; Earth
Precious metals and raw materials	gold; silver; platinum; oil
Infrastructure	energy infrastructure; renewable energy sources; transport infrastructure
Collectibles	fine arts; rare books; coins/stamps; cars; watches; jewelry; branded bags
Fun and games	in-game assets and virtual goods; gaming platforms and infrastructure; eSports; NFT
Data	personal; financial; energy; IoT; weather data
Scientific assets	intellectual property; results of scientific research; scientific innovations (prototypes, formulas); educational products and educational materials; laboratory equipment and infrastructure; royalties from scientific discoveries; scientific journals and publishing

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	platforms

As can be seen from Table 1, the spectrum of assets that can be tokenized is extremely broad and covers both physical objects and financial instruments. Especially interesting is the question of analyzing the market of tokenization of real assets, which usually have a high value and less liquidity.

Understanding RWA Tokenization.

Tokenization of real assets (RWA-tokenization) refers to the process of converting ownership rights to tangible or intangible assets into digital tokens on the blockchain platform. This innovative approach enables a wide range of assets such as real estate, artwork, commodities, and financial instruments to be represented in a digital form that can be traded and partially owned.

At its core, RWA tokenization involves the creation of digital tokens that represent a share, or fraction, of ownership of real assets. These tokens are typically issued on a blockchain that provides a secure and transparent ledger for recording ownership and token transfers. Blockchain technology not only makes it easier to prove ownership but also ensures the immutability of transaction records, increasing trust between participants. A schematic representation of the essence of RWA tokenization is shown in Fig.2.

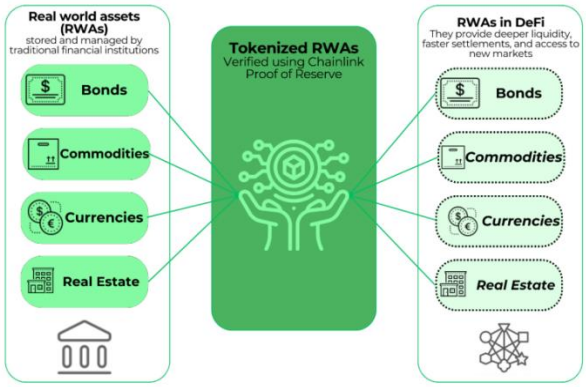

Figure 2. Schematic presentation of the essence of RWA tokenization

Source: constructed by the authors based on data (BlackRock, 2024)

One of the most important advantages of asset tokenization is the ability to divide ownership into parts. In traditional asset markets, owning valuable assets, such as real estate or artwork, usually requires a significant investment, which severely limits the pool of potential investors. However, with the help of tokenization, these assets can be divided into smaller, more accessible units, which significantly lowers the entry barrier for potential investors. For example, a property worth $1 million could be tokenized into 1 million tokens, each worth $1, allowing investors to invest just a few dollars.

The fractional ownership model not only democratizes access to valuable assets but also increases liquidity. Traditional assets such as real estate and art are known for their low liquidity, meaning they are difficult to quickly sell or exchange for cash without significant delays or costs. Tokenization changes this dynamic by allowing parts of an asset to be traded on digital exchanges, just as stocks are. Increased liquidity allows investors to enter and exit positions more easily, providing greater flexibility and opportunities for portfolio diversification. Another key component of asset tokenization is the use of smart contracts — self-executing contracts in which the terms of the deal are written directly into the code. Smart contracts automate the execution of transactions, ensuring that all conditions are met before ownership is transferred. This automation reduces the need for intermediaries such as brokers or lawyers, which in turn reduces transaction costs and speeds up the process. In addition, smart contracts can be programmed to perform complex scenarios, such as automatically distributing rental income from tokenized real estate to token holders, further simplifying asset management. The transparency and security provided by blockchain technology are also important benefits of asset tokenization. Every transaction related to a tokenized asset is recorded on the blockchain, creating a permanent and immutable record. This transparency ensures that all parties have access to the same information, reducing the likelihood of disputes and increasing confidence in the market. In addition, the decentralized nature of the blockchain means that no single entity has control over the data, making the system more resistant to hacking and fraud. There are three main components to implementing tokenized RWAs. Each component has different elements and participants that perform certain functions, according to the needs of tokenization (Fig. 3).

Figure 3. The structure of tokenized RWA

Source: built by the authors based on data (Ryan, C., & Centieiro, H., 2023)

1. The real world where the participants are the originator of the asset, the custodian, and the asset broker.
2. Information "bridge", where the elements are: an oracle (a service or mechanism that provides communication between the blockchain and the outside world), a legal structure, a token standard, information disclosure, third-party audit, deposit payment, and withdrawal channels.
3. On-chain - when transactions, data or processes take place directly on the blockchain and are recorded in its distributed register. The elements of this component include: RWA token issuer, issuing platform, and smart contract.

In Fig.4. shows the RWA tokenization scheme, which allows you to get an idea of how real assets are transformed into

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digital tokens, opening new horizons for investment and financial innovation.

A schematic representation of the process of tokenization of real assets demonstrates how this transformation takes place, which helps to understand the complex relationships between the various stages and participants of the process:

The process begins with the selection of the real asset to be tokenized. This asset is divided into smaller units, each of which is represented by a digital token. Tokens are issued on the blockchain, a decentralized digital ledger that records all transactions and ownership details through smart contracts. Features of creating a token depend on the type of asset being tokenized: real assets are linked to digital tokens, creating a digital "double" that represents the value of the asset; purely digital assets are linked to digital tokens through an issue event.

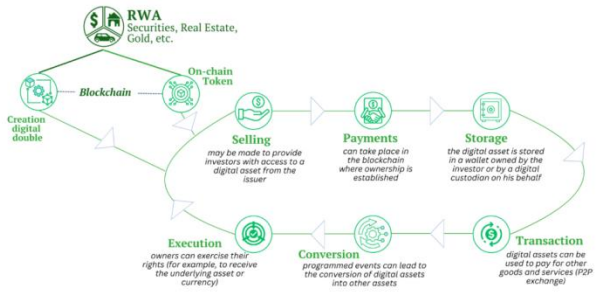

Figure 4. Schematic presentation of the RWA tokenization process

Source: constructed by the authors based on data (Ryan, C., & Centieiro, H., 2023)

Then there is a sale of tokens to give investors access to a digital asset from the issuer. Settlements for tokens can take place on the blockchain, where ownership is established. The digital asset is held in a wallet owned by the investor or by a digital custodian on his behalf. RWA tokens can be traded or used to pay for other goods and services (P2P transactions).

It is worth noting that programmed events can lead to the conversion of digital tokens into other assets. This concept is one of the key elements of flexibility and innovation tokenized assets. It opens up wide opportunities for creating complex financial instruments and automated investment strategies. Smart contracts can automatically trigger a conversion based on predefined conditions, without the need for manual intervention. It can involve the conversion of one type of token to another, for example, when a token representing shares of a company is converted into a dividend token, or when a tokenized asset is exchanged for cryptocurrency or even rights to real physical assets. These conversion processes can be initiated by various triggers built into smart contracts. Such triggers can be triggered when certain price indicators of the asset are reached, which is especially relevant for dynamic market conditions. A time frame can also act as a trigger, such as when a tokenized bond matures. In addition, external events, such as significant changes in market conditions or the achievement of certain business indicators, can automatically trigger the conversion process.

Enforcing the rights of holders of tokenized assets is a key aspect that provides a link between the digital and real worlds of finance. This process allows token holders to exercise their rights enshrined in smart contracts by converting digital representations into specific material or financial benefits.

When it comes to receiving the underlying asset, it can mean the physical delivery of goods, the transfer of ownership rights to real estate, or the issuance of securities ownership certificates. For example, the holder of a token representing a share in a gold bullion can demand physical delivery of the corresponding amount of gold. In the case of real estate, enforcement may include legal registration of ownership of a specific object.

Exercising rights to receive currency often involves converting tokens into fiat money or cryptocurrencies. This may be especially true for tokenized bonds or shares where holders are entitled to receive interest or dividends. The process may include automatic payments through smart contracts or interaction with traditional banking systems.

The implementation of the rights of owners is closely related to regulatory aspects. Depending on the type of asset and jurisdiction, different rules and requirements regarding identification of owners, taxation, and reporting may apply. This creates the need to develop complex systems that combine blockchain technologies with traditional financial and legal structures.

The ability to effectively enforce the rights of owners is critical for trust in tokenized assets and their widespread adoption. It demonstrates that digital tokens do represent real value and can be converted into tangible assets or financial benefits, creating a strong bridge between innovative blockchain technologies and the traditional world of finance and investment.

Overall, this process demonstrates the lifecycle of a tokenized asset, from its creation to possible transactions and conversions, providing flexibility and efficiency in managing and trading digital representations of real assets.

After considering the theoretical aspects of tokenization of real assets, the logical continuation of our research is the transition to the analysis of the state of the market. Market analysis will allow us to assess how theoretical concepts are reflected in real economic conditions, how market participants perceive and implement RWA tokenization technology, and what trends are forming in this segment of the economic space.

Deloitte experts claim that about 10% of the world's GDP can be stored and transferred through the blockchain, introducing new levels of efficiency and security in financial systems. (Deloitte, 2024). By 2030, the market for tokenized assets is expected to be over $11 trillion, which is almost equal to the current GDP of the EU. Although stablecoins remain the main driver of tokenization growth, tokenization of real assets

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whose value exists outside the blockchain is gaining more and more popularity. The total value of non-stablecoin tokenized assets has reached approximately $3 billion, more than doubling since the start of 2023. This figure only takes into account publicly tracked assets, while the Hong Kong Monetary Authority estimates another $3.9 billion of bonds have been tokenized.

Government securities drive the tokenization of real assets and are the only asset class where US companies, led by BlackRock and Franklin, are prominent Templeton, are actively engaged in tokenization. Recent high interest rates have fueled demand for safe, high-yielding Treasury bills on the blockchain, driving the value of tokenized US Treasury products up over 1,000% since January 2023 to $1.29 billion as of May 31, 2024. The yield on these securities reached the highest level in 30 years.

Prior to the advent of tokenized T-bills, the focus was on commodities, and while their tokenized value lags behind the explosive growth of government securities, more users on the blockchain own tokenized commodities than any other type of tokenized asset (except stablecoins). Gold is the undisputed leader among commodities, accounting for nearly all of the $1 billion in tokenized commodities.

The total value of tokenized loans on public blockchains has grown from almost zero in October 2020 to over $400 million as of April 2024. Loan types have become more diverse and include trade finance, income-based financing, and real estate financing, among other categories, reflecting the expansion of tokenized lending space for different types of borrowers and use cases in recent years. (The Fortune 500 Moving Onchain, 2024)

BlackRock, the global leader in asset management, has made a big splash with the launch of its first tokenized fund, BlackRock USD Institutional Digital Liquidity Fund (USDIDLF) on the Ethereum platform on March 20, 2024. Together with the well-known digital asset firm Securitize, the USDIDLF fund provides qualified investors with the opportunity to profit from the yield of US Treasuries. The fund is aimed at maintaining a stable value of $1 per token, and the dividends accumulated daily are automatically deposited into investors' wallets in the form of new tokens every month.

Among the first participants of the BUIDL ecosystem are such well-known crypto industry companies as Anchorage Digital Bank NA, BitGo, Coinbase, and Fireblocks. BlackRock acts as the investment manager of the fund, and Bank of New York Mellon acts as administrator and custodian of the assets. The auditor of the fund until the end of 2024 is PriceWaterhouseCoopers.

The USDIDLF fund has seen significant growth since its launch in March, surpassing Franklin's FOBXX in terms of assets under management Templeton, capturing almost 30% of the tokenized US Treasury bond market, the value of which is estimated at $1.3 billion.

In general, according to experts' forecasts, the global RWA market in the period until 2030 will have a stable trend of moderate growth by approximately 7% every year (Fig. 5)

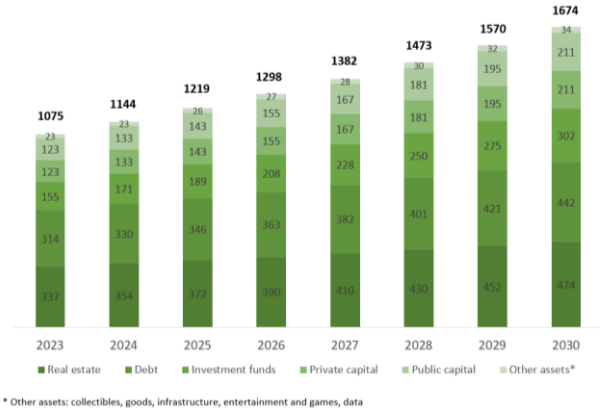

Figure 5. The size of the real assets market, tln. US dollars

Source: built by the authors based on data (Roland Berger, 2024)

The forecast of the size of the market of tokenized assets shows its significant growth by more than 50% every year, and compared to 2023 to 2030, it will increase almost 30 times.

According to experts, the tokenization of assets will grow rapidly, to at least 10.9 trillion US dollars by 2030, which represents a 40-fold increase in the value of tokenized assets from 2022 to 2030 (Fig. 6). This would be a significant increase from the current value of approximately US$300 billion.

Real estate and financial assets will dominate the tokenized market due to the size of the underlying markets and the high prevalence of use cases.

The mass adoption of tokenized assets is fast approaching, and asset management companies around the world are showing increasing optimism about the timing of implementation and their internal capabilities to make new decisions. According to a November 2023 survey by Calastone, the largest global fund network, companies in Asia Pacific (APAC) and the US are setting the pace in developing commercially viable tokenized offerings.

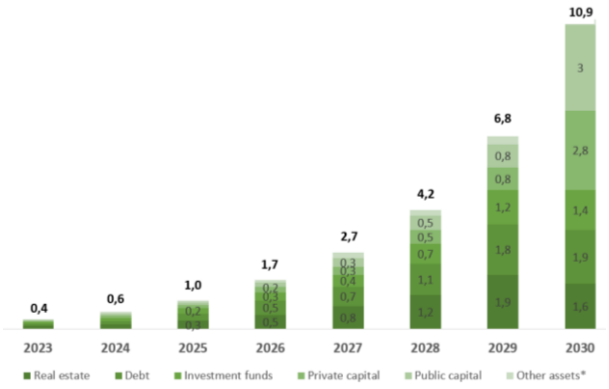

Figure 6. Market size of tokenized assets, tln US dollars

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Source: built by the authors based on data (Roland Berger, 2024)

It's clear from the survey results that adding tokenized funds to product lines is a priority for asset managers in all regions as competition heats up. Most participants indicated that they expected this to be a commercial reality within three years or less.

Companies from the USA and Asia are the most optimistic about bringing tokenized offers to the market for their customers: 67% and 61% of respondents, respectively, believe that it can be implemented in less than a year (Fig. 7). In Asia, almost 96% of companies said they would be able to achieve this within three years.

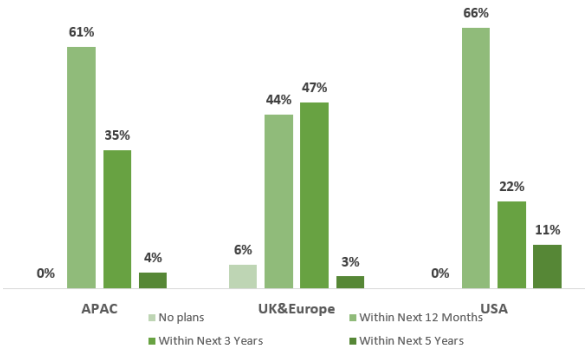

Figure 7. Intentions regarding the tokenization of assets
Source: built by the authors based on data (Calastone, 2024)
When asked about attitudes toward tokenization and the likely impact of this technology on day-to-day operations, only a small minority of respondents (about 10%) said that they currently do not see a role for this technology in their company. More impressively, over 50% of participants indicated that they are exploring the use of tokenization in specific areas.

As for the actual implementation of projects tokenization - the USA and Asia again emerged as leaders at the regional level (Fig. 8). About 40% of companies in these regions reported that they are actively implementing projects tokenization in their businesses.

While many participants have offerings across multiple asset classes, data suggests that while tokenization projects are being applied to a variety of investment opportunities, bond and private equity companies are making the most progress.

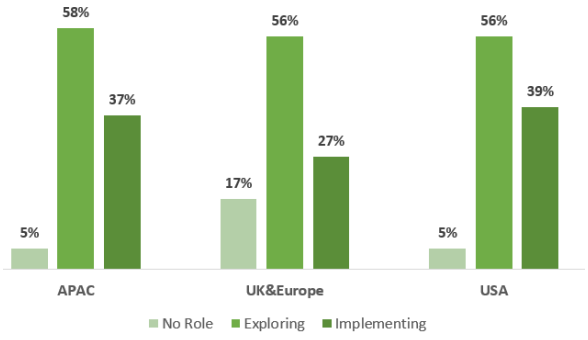

Figure 8. The current state of tokenization

Source: built by the authors based on data (Calastone, 2023)

According to analysts, RWA tokenization is one of the fastest-growing segments of the tokenization market. Research shows that the market for tokenized assets could reach trillions of dollars in the coming years, and a significant portion of this market will be real assets such as real estate, bonds, art, and precious metals.

CoinGecko study, which was conducted from January 1 to September 16, 2024, the country most interested in RWA tokens is the USA, which accounts for 14.8% of global interest in 2024 (Fig. 9). RWA token retail attention are Indonesia and Turkey, which account for 10.1% and 8.0% of global interest, respectively.

In addition to Indonesia, 3 other Southeast Asian countries are also among the most interested in RWA tokens, namely Vietnam (2.9% share of global interest), the Philippines (2.2%), and Singapore (1, 2%).

Neighboring India ranked 4th with 6.3% of global interest in RWA tokens, as the only South Asian country to make the top 20. Thus, Brazil leads South America's interest in RWA tokens with a share of 3.3%, which puts the country in 9th place in the world. Nigeria ranked highest among African countries at 16th place in the world with a share of 1.5%.

On the European continent, the UK has the most attention for RWA tokens, accounting for 5.6% of global interest. Separately, 6 of the 27 countries of the European Union are among the top 20 in the world, that are most interested in RWA tokens, and France leads the way with a share of 3.9%. In total, the 20 countries most interested in RWA tokens account for 81.8% of global interest.

Discussions about the potential of real assets in the context of tokenization are gaining momentum, and such influential companies as BlackRock signal a growing interest in such financial innovations. In early 2024, BlackRock launched the BlackRock USD Institutional Digital Liquidity Fund (BUIDL) (Bloomberg, 2024) - a tokenized fund that works on the blockchain Ethereum and offers USD earnings through the tokenization of US government bonds.

The fact that RWA tokenization is of interest to big players in the financial sector, such as BlackRock, is significant for several reasons. First, it shows the serious acceptance of this technology in the market, because BlackRock is one of the largest and most influential investment companies in the world. Their interest in RWA tokenization confirms the potential of this segment to transform traditional financial models and create new opportunities for investors.

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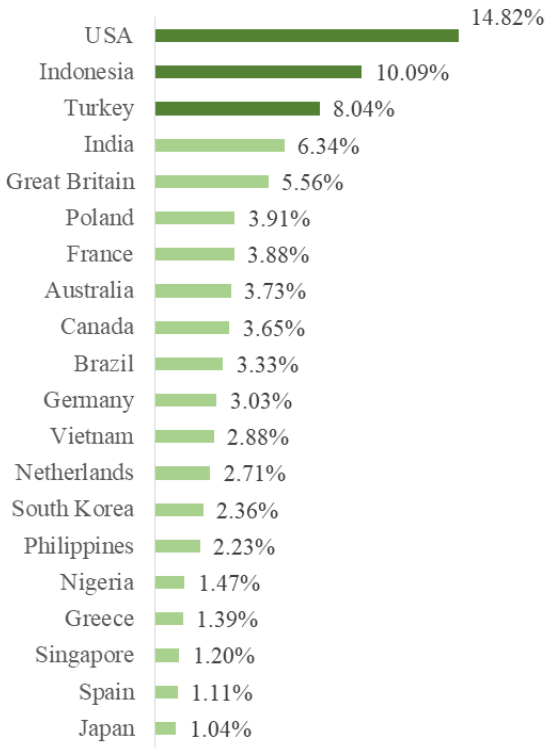

Figure 9. Share of global interest in RWA tokens
Source: constructed by the authors based on data (Lim, YQ, 2024)

Second, BlackRock and similar institutional investors manage large portfolios of assets, including real estate, infrastructure, and other real assets, that can be tokenized to increase liquidity and reduce transaction costs. Tokenization allows such players to divide large assets into smaller shares, opening up the opportunity for a wider range of investors to participate in the market.

After the analysis of the RWA tokenization market, which shows significant potential and growing interest from investors and financial institutions, the logical next step was the implementation of pilot projects. These experimental initiatives are designed to test theoretical concepts in practice and explore the real opportunities and challenges of tokenization in various sectors of the economy.

Tokenization pilot projects conducted by Euroclear, Digital Asset, and the World Gold Council, as well as Digital Asset and DTCC, represent significant experiments in the field of tokenization and financial technologies. These initiatives were aimed at exploring the potential of blockchain technology to transform traditional financial operations and asset management.

The first pilot project involving the tokenization of gold, gilts, and Eurobonds was conducted in June-July 2024 with the participation of 27 market participants (Securitiesfinancetime, 2024). As part of this experiment, more than 500 transactions were carried out, which demonstrates the scale and intensity of testing. A key aspect of the project was the creation of digital duplicates of real assets, in particular gold, whose average daily trading volume reached $162 billion.

A second pilot project focused on the US Treasury collateral network was also conducted in June-July 2024 (Securitiesfinancetime, 2024). It was attended by 14 market entities, including investors, banks, central counterparties, custodians, and the central depository. 100 transactions were completed, confirming the viability of the concept of using tokenized assets to optimize collateral and margin management.

Both projects demonstrated the following key benefits of tokenizing real assets:

1. Increasing the mobility and liquidity of collateral. Tokenization overcomes the physical limitations associated with the movement and storage of assets, especially gold.
2. Optimization of collateral management processes. The use of tokenized assets allows for real-time transactions, which significantly accelerates the fulfillment of intraday margin requirements.
3. Increasing market transparency and strengthening regulatory oversight. The ability to track the movement of tokenized assets in real-time provides a deeper understanding of market dynamics and risks.
4. Improvement of legal certainty. The projects have demonstrated the potential to improve legal certainty regarding the ownership rights of tokenized assets, especially in the context of default or position-closing scenarios.
5. Potential for atomicity in transactions. The use of blockchain technology allows for atomic transactions between different programs and parties, which increases efficiency and reduces risks.

The results of such pilot projects not only form the basis for future larger implementations but also help identify potential challenges and opportunities for innovation, paving the way for a more mature and developed tokenized asset market.

Based on empirical data and practical results of pilot projects, we can now consider the benefits of RWA tokenization in a more in-depth and valid manner. Analyzing these benefits will allow us to better understand how RWA tokenization can transform traditional financial markets, improve asset management efficiency, and create new opportunities for investors and issuers. Let's take a closer look at the key benefits that stand out based on the results of pilot projects and theoretical studies to assess the true potential of RWA tokenization in transforming real asset management.

One of the most transformative aspects of RWA tokenization is its ability to significantly lower the barriers to entry that have traditionally limited access to high-value asset investments. Historically, owning and investing in assets such as real estate, artwork, and commodities has been reserved for wealthy individuals and institutional investors due to the significant amount of capital required and the complexity of managing these assets. However, RWA tokenization is changing this dynamic by democratizing access and allowing

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a wider range of investors to participate in markets that were previously out of reach.

In traditional markets, investing in high-value assets usually requires significant financial resources, which can be an insurmountable barrier for most potential investors. For example, buying real estate or a valuable piece of art usually requires a large initial investment. In addition, the process of acquiring and managing these assets is complex as it involves various intermediaries such as brokers, legal advisors and financial institutions, which increases the cost and complexity of such transactions. As a result, these assets have largely remained the domain of the wealthy, leaving average investors with little opportunity to participate.

RWA tokenization solves these problems by allowing assets to be divided into smaller, more affordable parts. This process, known as fractional ownership, allows investors to purchase a portion of an asset rather than the entire asset. For example, a commercial property worth $10 million can be tokenized into 1 million tokens, each representing a small portion of the property. An investor who doesn't have the resources to buy an entire home can now invest just a few dollars to own a share. This fractionalization lowers the financial barrier to entry, making it possible for more people to invest in high-value assets.

In addition, RWA tokenization reduces the complexity of ownership and management through the use of blockchain technology. In the case of tokenized assets, ownership is recorded on a decentralized ledger, eliminating the need for the many intermediaries typically involved in asset transactions. This simplified process not only reduces costs, but also simplifies asset management. Investors can easily buy, sell or transfer their tokens on blockchain platforms without the need for complex legal procedures or a lot of paperwork. This ease of transaction further lowers barriers to entry, making it easier for people to access high-value assets. (Gulei, AI, Kotukh, Ye. V., & Riabokin, MV., 2024)

The affordability provided by RWA tokenization goes beyond financial aspects. In traditional markets, geographic barriers may limit access to certain types of investments. For example, investing in real estate abroad can be complicated due to differences in legal systems, currency risks and logistical challenges. However, tokenization allows investors to participate in global markets regardless of their location. An investor from Europe can easily invest in tokenized real estate in the US or Asia without having to understand the specifics of international real estate transactions. This global access not only expands investment opportunities for people, but also increases the potential to diversify their portfolios.

In addition, RWA tokenization promotes financial inclusion by allowing people in developing regions who may have limited access to traditional financial markets to invest in high-value assets. For many potential investors in such regions, barriers to entry into traditional asset markets are not only financial, but also infrastructural and regulatory. RWA tokenization, due to its digital and decentralized nature, can overcome some of these barriers, providing a path for more people to participate in wealth creation opportunities. This can help reduce economic gaps and provide more opportunities for people in under-banked or under-served areas.

However, while RWA tokenization lowers many barriers to entry, it is important to recognize that it does not eliminate all challenges. For example, investors still need to navigate the technological aspects of blockchain, including understanding how to use digital wallets and how to keep their tokens secure. In addition, the regulatory environment related to tokenized assets is still evolving, and investors should be aware of the legal implications of their investments. Despite these circumstances, the overall lowering of barriers to entry through tokenization is a significant step towards a more inclusive and accessible financial system.

One of the most attractive benefits of RWA tokenization is its ability to unlock liquidity in traditionally illiquid markets. In many cases, high-value assets such as real estate, artwork, and commodities are considered illiquid because they cannot be easily sold or exchanged for cash in the short term. This lack of liquidity has historically created significant barriers for investors, limiting their ability to access capital and effectively manage risk. RWA tokenization offers a solution to this problem by making these traditionally illiquid assets more liquid, accessible and tradable.

In traditional markets, the process of buying or selling a large asset, such as real estate or a rare painting, is often complex, time-consuming and expensive. It involves multiple intermediaries, including brokers, legal advisers and financial institutions, which increases bureaucracy and fees. In addition, finding a buyer willing to purchase the entire asset at market value can be difficult, especially in markets with low demand or economic uncertainty. This can lead to significant delays and forced discounts, making it difficult for asset owners to access cash when needed.

RWA tokenization solves these problems by dividing the asset into smaller, fractional units, each of which is represented by a digital token. These tokens can be traded on blockchain exchanges, providing a platform for seamless buying and selling. For example, instead of trying to sell a property worth $10 million, the owner could tokenize it into 10 million tokens, each worth $1, and sell those tokens to multiple buyers. Such fractionation significantly increases the circle of potential investors, thereby increasing liquidity.

In addition, the ability to trade tokenized assets on digital exchanges allows for faster and lower-cost transactions compared to traditional markets. Investors can buy and sell tokens representing shares of the asset in real time, just like they trade stocks or cryptocurrencies. This instant liquidity allows investors to react more quickly to market changes, manage their portfolios more dynamically and access their capital at any time. It also opens up opportunities for more sophisticated financial strategies, such as using tokenized assets as collateral for loans or participating in peer-to-peer lending.

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Another important aspect of unlocking liquidity through RWA tokenization is the reduction of market inefficiencies. In traditional markets, large assets often remain underutilized due to the difficulty of selling or leasing them in full. For example, a commercial building may have vacant spaces that do not generate income, or an art collector may have valuable exhibits sitting idle in a gallery. By tokenizing these assets, owners can sell or lease parts of them to generate income, even if the entire asset is not fully utilized. This creates new revenue generation opportunities and improves overall asset utilization efficiency.

Moreover, RWA tokenization can facilitate the creation of secondary markets for assets previously considered too illiquid for frequent trading. For example, once a property is tokenized, its tokens can be traded among investors on the secondary market, providing constant liquidity and price determination. Such constant trading activity helps to establish the fair market value of the asset, reduces the risk of its holding and increases transparency for all participants. Over time, these secondary markets can evolve into developed ecosystems offering a wide range of financial products and services around tokenized assets.

However, it is important to recognize that the liquidity benefits of RWA tokenization are closely related to the development of a healthy market infrastructure. In order for tokenized assets to be truly liquid, active exchanges, sufficient market demand and regulatory clarity are necessary. Without these elements, tokenized assets may still face liquidity problems despite technological advances. As the tokenization ecosystem continues to develop, the infrastructure supporting these assets will likely improve, further increasing their liquidity and making them an attractive option for a wider range of investors.

Another opportunity that RWA tokenization opens up is the ability to easily create highly diversified investment portfolios. Traditionally, achieving diversification across different asset classes—such as real estate, art, commodities, and even collectibles—required significant capital investment, knowledge, and access to different markets. Tokenization breaks down these barriers, making it possible to invest in shares of different assets while using a single digital platform.

For example, an investor can hold tokens representing shares in a luxury condominium in New York, a Picasso painting, a barrel of oil, and a rare collectible car. This level of diversification allows investors to spread risk among different types of assets and markets, increasing the stability and potential income of portfolios. In addition, due to the ease with which tokens can be traded on blockchain platforms, investors can dynamically rebalance your portfolios, quickly responding to market changes or your own financial needs.

In addition to traditional assets, RWA tokenization paves the way for the creation of completely new financial products. One such innovation is the development of tokenized funds, where investors can buy tokens representing a stake in a diversified portfolio of assets. These tokenized funds can include a mix of real estate, commodities, art, and even digital assets like cryptocurrencies. The transparency and efficiency of blockchain technology allow such funds to operate with lower fees and greater accessibility compared to traditional mutual funds or exchange-traded funds (ETFs).

In addition, programmability blockchain and smart contracts open up the possibility of creating highly customized financial products adapted to the needs of specific investors. For example, a tokenized real estate investment can be structured to automatically distribute rental income to token holders each month. Alternatively, a commodity-backed token can be designed to track the price of gold with physical redemption. Such customized products offer a new level of flexibility and precision in investment strategies, catering to diverse investor preferences.

Having considered the main advantages of RWA tokenization, we can state that the transformation of real assets into digital tokens on the blockchain (the process of RWA tokenization itself) allows using the unique properties of blockchain technology to manage these assets and obtain new benefits. The main functions of the blockchain, which are opened during RWA tokenization, are as follows (Fig. 10):

- Transparency – Blockchain is a transparent ledger where all participants can verify transactions, increasing trust and accountability.
- Tradability – Blockchain enables the creation and exchange of digital assets that can be easily bought, sold or exchanged across platforms.
- Immutability – data stored on the blockchain is nearly impossible to change or delete, ensuring the permanence and security of the recorded information.
- Fractionality – Blockchain allows assets to be divided into smaller, tradable shares, making it possible for more people to invest and own shares of valuable assets.
- Programmability – blockchain smart contracts provide for automated and self-executing agreements, making it possible to embed predefined rules into the blockchain for different applications and processes.

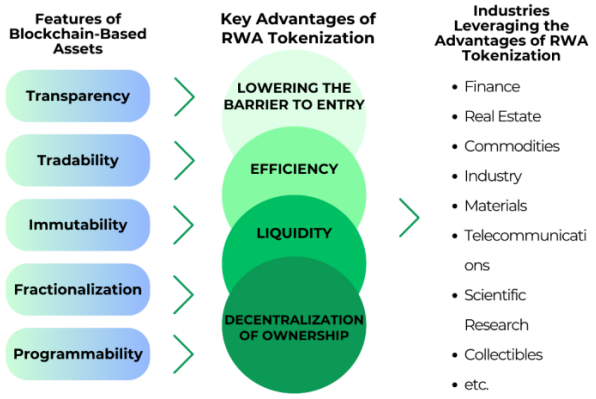

Figure 10. Key benefits of RWA tokenization

Source: built by the authors

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Despite the significant potential benefits of RWA asset tokenization, it is important to be aware of the challenges and aspects that accompany this new technology. As with any groundbreaking innovation, tokenization faces a number of hurdles that must be overcome for its successful adoption and widespread adoption. These challenges include regulatory uncertainty, technology risks, market maturity and investor education. Understanding these challenges is essential for market participants to navigate the complexities of tokenization and exploit its full potential.

One of the biggest challenges facing asset tokenization is the lack of a clear and consistent regulatory framework across jurisdictions. The regulatory environment for blockchain technology and digital assets is still in its infancy, with many countries taking different approaches to how they define, tax and regulate tokenized assets. Such regulatory heterogeneity creates uncertainty for issuers, investors and market participants who have to navigate complex legal environments that can change rapidly.

For example, in some regions, tokenized assets may be classified as securities, making them subject to strict regulation and compliance requirements. In other countries, they may be treated as goods or property, each with its own rules and tax implications. This lack of harmonization can create significant legal and operational difficulties for businesses seeking to tokenize assets, as they must comply with multiple regulatory regimes, which is often a costly and complex process.

In addition, the evolution of the regulatory framework means that tokenized assets may be subject to new or changed laws that may affect their validity, transferability, or taxation. This regulatory uncertainty may deter potential investors who may fear the legal risks associated with owning or trading tokenized assets. Addressing this challenge requires greater clarity and coherence in the regulation of digital assets, as well as active collaboration between regulators, industry participants, and legal experts to develop frameworks that support innovation and protect investors. (Liveplex, 2024)

Another challenge standing in the way of the development of RWA tokenization is technological risk because the technology underlying RWA tokenization — blockchain — is relatively new and is accompanied by a number of risks and challenges. Although blockchain is characterized by its transparency, security and decentralization, it is not completely immune to vulnerabilities. One of the main threats is the risk of errors or vulnerabilities in smart contracts that can be exploited by attackers. Smart contracts can automate and optimize transactions, however, any errors in the code can lead to unpredictable consequences such as loss of tokens or unauthorized transfer of assets.

The security of digital wallets and exchanges where tokens are stored and traded is also a critical issue. Known cases of hacker attacks and security breaches have shown that even the most reliable platforms can be vulnerable to cybercrimes. Investors holding tokenized assets should take steps to secure their digital wallets and understand the risks associated with storing and transacting in digital tokens. Losing the private keys used to access and transfer tokens can lead to an irreversible loss of assets, underscoring the importance of security measures.

Another technological challenge is the scalability of blockchain networks. As the adoption of tokenization grows, so will the demand for blockchain infrastructure. Many current blockchain networks face limitations on the number of transactions and speed, which can reduce the efficiency and usability of tokenized assets. Solutions such as second-layer scaling, which involves building additional protocols on top of existing blockchains, and developing more advanced consensus algorithms are being explored to address these issues. However, until these solutions are widely implemented, scalability remains a significant issue for the future of tokenization.

Another challenge is the maturity level of the RWA tokenization market and its liquidity. While RWA tokenization will help increase liquidity in traditionally illiquid markets, in reality, the market for tokenized real assets is still nascent. Liquidity depends on the presence of active buyers and sellers, as well as the availability of reliable and efficient trading platforms. In many cases, the market for certain tokenized assets may be limited, meaning there are few participants and low trading activity. This may lead to price volatility and difficulties in buying or selling tokens at desired prices.

The immaturity of tokenized asset markets also means that there is limited historical information about how these assets have performed over time, making it difficult for investors to accurately assess risks and returns. Unlike traditional assets, which have established valuation models and indicators, tokenized assets are still developing these indicators, which leads to uncertainty in pricing and investment decisions.

In addition, the lack of standardized protocols and platforms for tokenized assets can lead to market fragmentation. Different projects and platforms may use different standards for issuing and managing tokens, which creates interoperability issues. Investors may find it difficult to move assets between platforms or consolidate their holdings of different tokenized assets, reducing the overall efficiency and attractiveness of the market.

Another important challenge is the need to increase the level of education of investors. RWA tokenization introduces a new paradigm in the field of finance, requiring investors to understand not only the underlying asset but also the technology and mechanics of blockchain and tokenization. For many traditional investors, the concepts of digital tokens, smart contracts, and decentralized ledgers can be confusing and intimidating. This lack of knowledge can be a barrier to adoption and limit the potential investor base for tokenized assets.

Educational measures are needed to dispel the myths surrounding tokenization and explain its benefits and risks in an understandable and accessible way. This includes

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providing resources to help investors understand how to safely manage digital wallets, navigate tokenized asset markets, and assess their value. Additionally, financial institutions and advisors must be prepared to help their clients navigate the complexities of RWA tokenization by providing insights and support as the market evolves.

Trust in the technology and platforms that support tokenization also affects adoption. To overcome skepticism from traditional investors, it is important to demonstrate the security, transparency, and reliability of blockchain-based systems. This is especially important for overcoming doubts about new and unproven technologies. Successful pilot projects, case studies, and recommendations from authoritative institutions can play a significant role in building trust and stimulating wider adoption of tokenized real assets.

Also, RWA tokenization creates complex legal and ownership issues that require careful handling. For example, the RWA tokenization process requires a clear legal basis to define what exactly the token represents—is it a share of ownership, a right to income, or something else? These differences are critical in determining how tokens will be treated under the law, including their classification for tax purposes, the rights of token holders, and the legal consequences in the event of disputes or default.

In addition, the process of connecting digital tokens to physical assets requires reliable mechanisms to ensure proper management and support of the underlying asset. For example, in the case of tokenized real estate, it is necessary to ensure the availability of systems for object management, rent collection and income distribution among token owners. These operational aspects are critical to the success of tokenized assets, but their implementation and control can be complex, especially in a decentralized environment.

Although the potential of RWA tokenization of assets is huge, all challenges and risks must be carefully considered in order to realize its full potential. Addressing regulatory uncertainty, improving technological security, driving market maturity, and educating investors will create a solid foundation for the future of tokenized real assets. As the ecosystem evolves, it will be important to balance innovation with responsible governance, delivering on the promise of a more inclusive, efficient and transparent financial system.

DISCUSSION

The breadth of information presented on RWA tokenization, its essence, market trends, and investment prospects characterizes a significant selection of versatile materials that take into account global trends in the development of the real assets market and the intentions of key asset managers regarding investments in tokenized RWAs.

The current state of functioning and the development of financial markets under the significant influence of technological innovations, in particular blockchain and smart contracts, actualize the need for new approaches to the formation of classification and evaluation of RWA tokens, which not only takes into account positive experience, but also relies on the comprehensive potential of the individual characteristics of various classes assets, uses the close interaction of all components of traditional and decentralized finance in order to make effective investment decisions for further effective development and functioning of the digital economy.

The introduction of RWA tokenization in Ukraine is a promising mechanism for attracting capital for post-war reconstruction and development of the economy. Based on the stable experience of implementing IT technologies in the field of public finance, Ukraine has favorable prerequisites for the implementation of this initiative as a state program. Tokenization of real state assets of Ukraine can provide a number of strategic advantages, namely: expanding the access of international capital, especially in the context of post-war development, increasing the liquidity of state assets, reducing transaction costs, and ensuring the transparency of investment projects. Particularly promising directions for the implementation of RWA tokenization are infrastructure reconstruction projects, modernization of industrial assets and development of the agro-industrial sector. At the same time, it is critically important to create a complex regulatory framework that will ensure legal certainty and protect the rights of investors. It is also necessary to take into account the potential risks associated with cyber security, market volatility and the complexity of valuation of real assets. For successful implementation, it is recommended to use a phased approach, starting with pilot projects in the most prepared sectors of the economy. Special attention should be paid to the development of technical infrastructure, including the creation of reliable platforms for tokenization and smart contract systems. Integration with international financial markets and ensuring compliance with global transparency and security standards is also an important aspect. In the long term, the successful implementation of RWA tokenization can not only provide a significant influx of investments for the reconstruction of Ukraine, but also create a basis for the formation of a regional fintech hub. The key success factor remains the active participation of the state in creating a favorable regulatory environment and stimulating the development of the ecosystem of professional market participants. At the same time, special attention should be paid to issues of transparency, protection of investors' rights and compliance with international standards of financial regulation. Given the current global trends and the growing interest in tokenization of real assets, the timely implementation of this technology can provide Ukraine with competitive advantages and accelerate the process of economic recovery in the post-war period.

The analysis of RWA-tokenization proposed in the study is based on the study of the practice of implementing pilot projects of tokenization of real assets, literary sources of domestic and foreign scientists, including author's studies, regarding the prospects of RWA-tokenization.

CONCLUSIONS

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Thus, a comprehensive analysis of the essence and capabilities of the RWA- tokenization technology demonstrated high potential and investment opportunities that allow easy diversification of portfolios, provide access to previously inaccessible assets and contribute to the development of innovative financial products. Blockchain technologies and RWA tokenization facilitate the emergence of new markets and products, giving investors more opportunities for effective capital management and wealth creation.

The future of asset tokenization is promising, with the potential to profoundly transform the global financial landscape. As the technology matures and the regulatory framework evolves, we can expect increased adoption across industries, the emergence of new asset classes, and the creation of more efficient and inclusive markets. By lowering barriers to entry, increasing liquidity and fostering innovation, asset tokenization will play a key role in shaping the future of finance, making it more accessible, transparent, and dynamic for all participants.

Moving forward, it will be important for stakeholders to address issues and consider aspects related to RWA tokenization, including regulatory compliance, technological security, and investor education. By taking appropriate measures, it is possible to ensure that the benefits of RWA tokenization are realized and that this innovative technology fulfills the expectations of creating a fairer and more prosperous global economy. RWA tokenization bridges the physical and digital worlds, opening new avenues for investment and ownership. By turning physical assets into digital tokens, tokenization creates a more inclusive and efficient financial ecosystem. Realizing the potential of RWA tokenization is key for all economic actors as we move towards a digital future and transformation of the economy. With this innovative financial technology, conflict-affected territories can access new sources of capital, increase transparency, ensure greater investor participation, and accelerate the digital transformation needed for sustainable reconstruction and development. The strategic implementation of RWA tokenization can become a key tool for overcoming the challenges of Ukraine's post-war period.

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