Social and Financial Sustainability of Real Estate Investment

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Real estate markets play a crucial role in the economy, providing opportunities for investment and housing. Blockchain technology has emerged as a potential solution among other Distributed Ledger Technologies (DLTs), offering secure transactions and transparency through encryption algorithms and reducing dependence on intermediaries. It has the potential to revolutionize real estate by reducing reliance on third-party verification and intermediaries, lowering costs, and increasing transparency to mitigate fraud risk. This entry assess the knowledge and perceptions of professionals in the real estate sector and evaluate the possible impact of the technology in the Portuguese market.

smart contracts   tokenization   real estate market   direct investment

1. Introduction

Real estate markets play a vital role in economic and social development worldwide. However, real estate markets often face crises that can lead to financial and economic collapses [1]. The market's global value in 2021 was approximately 250 trillion euros, representing approximately 60% of the global GDP [2]. In Portugal, it accounted for 13% of the national GDP, with most activity concentrated in Lisbon and Porto [3]. The market offers two investment options: direct and indirect. Direct investment involves property transactions, while indirect investment entails buying shares in real estate companies. However, these investments are not accessible to everyone due to various obstacles. The market is dominated by institutional investors and high-net-worth individuals, making it challenging for average individuals to profit from real estate [4]). The market also lacks innovation and operates with outdated technology, resulting in inefficiency and conflicts among stakeholders [5].

Blockchain technology has emerged as a potential solution among other Distributed Ledger Technologies (DLTs), offering secure transactions and transparency through encryption algorithms and reducing dependence on intermediaries [6][7]. It has the potential to revolutionize real estate by reducing reliance on third-party verification and intermediaries, lowering costs, and increasing transparency to mitigate fraud risk [8]. However, research on blockchain's implementation in the real estate sector is still in its early stages.

2. Social and Financial Sustainability of Real Estate Investment

2.1. Definition

In 2008, Satoshi Nakamoto published a white paper titled "Bitcoin: A Peer-to-Peer Electronic Cash System" [9]. This paper introduced the concept of Bitcoin, a decentralized digital currency, and laid the foundation for blockchain technology. Nakamoto's proposal outlined a payment system that enables peer-to-peer transactions without the need for trusted intermediaries, relying instead on cryptographic proof. The system aimed to address issues such as irreversible transactions and double spending in online transactions [9]. While Nakamoto initially referred to the technology as a "chain of blocks," it became clear that the underlying system supporting Bitcoin had broader applications beyond cryptocurrencies [10][11].

Blockchain technology revolutionizes transactions and data storage by enabling direct peer-to-peer interactions and eliminating the need for a central authority. It introduces key features such as transparency, immutability, and decentralization [7][12]. Blockchain functions as a global digital network that serves as a comprehensive ledger, recording all transactions. It emphasizes transparency, privacy, neutrality, and accessibility. Individuals with a computer and internet connection can access and supervise the network's information, while data insertion and verification are performed by network entities without the involvement of third-party intermediaries [13]. The blockchain network is globally distributed, with nodes storing information and transactions. Absence of a central authority eliminates the need for a centralized database [14]. The existence of a sizable community restricts an entity's ability to manipulate the system's contents by preventing it from controlling the majority of the network [15]. Compromising the network would require altering information in at least 51% of the nodes [16].

A blockchain network can vary between public, private, or hybrid. The choice depends on the desired levels of transparency, trust, and transaction speed [5]. Public blockchains are permissionless and offer anonymity (Using pseudonymous addresses, which are distinctive strings of characters that indicate a user's identity on the blockchain), while private blockchains require permissions and provide access control and data privacy [4]. Hybrid networks combine elements of both. Each network type has its own advantages and considerations.

2.2. Operating Model

A blockchain can be understood as a decentralized ledger. It consists of chains of blocks, which are units of storage containing information such as monetary transactions or other intended data. Blocks can include data from various validated transactions recorded by network nodes. Each block contains transaction-related data and a hash that serves two purposes: identifying the previous block and ensuring the block's content integrity. This process achieves immutability, as changing a block would require altering subsequent blocks [17]. In a blockchain network, transactions occur peer-to-peer without the need for trusted intermediaries. As such, a mechanism has emerged to achieve this decentralization, that addresses an old computer problem designated as the 'Byzantine Generals Problem'. The Bitcoin blockchain introduced the consensus mechanism called Proof-of-Work (PoW) [14]. This process involves nodes, or miners, to compete with each other to solve a complex mathematical puzzle that validates the transactions. The first miner to solve the puzzle adds a new block to the blockchain and is rewarded with cryptocurrency [17]. PoW ensures the network's security and makes it difficult to tamper with past transactions. However, it requires significant computational power and energy consumption. Other consensus mechanisms, such as Proof of Stake (PoS), offer alternatives to address these drawbacks, but introduces others. It is important to note that Bitcoin's and, more broadly, PoW energy consumption has been pointed out as one of the main issues with blockchain technology. Regulators have begun to evaluate their possibilities to limit the power demand of these bitcoin networks in light of the current climate catastrophe and global energy crises [18]. Furthermore, businesses are increasingly focusing on sustainable business practices in compliance with ESG requirements [19][20]. Therefore, one can argue that, from a business side, the development of energy-efficient blockchain solutions may be incentivized.

2.3. Functionalities and Challenges

Smart contracts are a functionality of blockchain technology. These contracts facilitate direct interactions between buyers and sellers without intermediaries. Computational protocols verify transaction legitimacy and ensure compliance with contract terms. If the conditions are met, the contract is automatically executed and recorded on the blockchain. Otherwise, it remains open until fulfilled or undone [4]. Smart contracts function similarly to fixed laws, executing the code only if requirements are met [16]. Another possibility of blockchain technology is tokenization, that enables the digital representation of physical assets through tokens, allowing for easy transfer and shared ownership [14].

Blockchain technology offers desirable characteristics such as decentralization, transparency, and immutability. It can also decrease the costs of producing information while increasing efficiency. One can argue that the gradual integration of businesses and individuals into a blockchain network creates a large community of different stakeholders, including investors, businesses, tax authorities, auditors, and policymakers. All of these stakeholders profit from a setting that is designed with effective and efficient information flow [15]. However, its implementation also presents challenges. Technical issues include scalability, storage, resource usage, security, accessibility, reversibility, key loss, and correlation with external assets [16][21]. Other problems arise such as misinformation and confusion surrounding blockchain technology that leads to misconceptions [14]. Due to its recent emergence, blockchain applications often lack proper regulation by public entities. This enables the potential use of systems such as Bitcoin to bypass international laws and regulations, raising concerns regarding money laundering and terrorist financing in public cryptocurrency networks [21].

2.4. Application to Real Estate

Figueiredo [7] state that blockchain application outside the finance industry is still experimental. However, one could argue that the real estate market will benefit from blockchain since sales information should be made public in the real estate transaction market, and there should not be any incorrect information there [22]. However, blockchain technology has the potential to revolutionize the real estate sector in several ways. This enables digital registration of assets, transforming the transfer process, reducing document authentication time, increasing market transparency, facilitating payment through cryptocurrencies, and the use of smart contracts and tokenization [23][24]. Some authors even argue that it may be implemented as a backbone to solve the missing information process during construction and LCA stages, even without changing the way construction interacts with day-to-day software, with the integration of blockchain with BIM being one such example [7]. Others advocate for its use to avoid hefty middleman fees paid to real estate agents during property transactions while providing a trustless transaction system [22][25]. Developing countries can benefit from the use of the technology due to limited trust in governmental institutions, and it can simplify cross-border transactions in developed countries [4][26]. Examples of blockchain implementation in the real estate sector are observed in countries such as Sweden, Georgia, Ghana, and the United States. These implementations address issues related to land registration, corruption, and efficiency in property transfer processes. Startups in the United States are utilizing smart contracts and property tokenization to streamline property transactions and enhance market liquidity [27].

According to [23], there are five different ways Blockchain technology will be able to influence the real estate industry:

- Possibility of digital registration of real estate assets on the Blockchain network, containing information regarding all aspects of the asset and its history, such as its previous owners, prices and dates of sale, rental and maintenance contracts and materials used in its construction.

- Possible transformation of the asset transfer process, allowing them to be transacted with the same ease as cryptocurrencies and without the need for traditional intermediaries in the sector, using the tokenization of properties previously presented by [14];

- Increased transparency in the markets, which allows a reduction in fraudulent activities and a better knowledge of the risk associated with the real estate market;

- Recourse to the use of cryptocurrencies in income contracts and purchase and sale, through its ease of programming in acts of payment and redistribution;

- Use of *smart contracts* in asset transaction processes, which reinforces the idea of reducing intermediaries in leasing and acquisition processes.

Ref. [5] point to an even greater benefit in the use of Blockchain in the real estate sector in developing countries, whose trust in government institutions is low. In the case of some regions, such as the EU, Ref. [26] exemplifies the possibility of using technology in transactions involving real estate assets beyond national borders, making them less complex compared to current processes. Ref. [7] also reference the application of blockchain as a possible solution for the information over the building life cycle.

The greater use of Blockchain technology in recent years corresponds to cryptocurrency systems such as the Bitcoin and Ethereum Blockchains. However, over time, other areas increasingly turn to Blockchain-based systems, such as in medical records, food supply chains and diverse management [28].

An area also influenced by this technological revolution is the real estate sector, and it is possible to observe some examples of its application in some countries such as Sweden, Georgia, Ghana and the U.S.

In the countries of Georgia and Ghana, Ref. [27] highlights the various problems of organization and corruption pertaining to land and property registration, relating them to the colonialist past carried out by other nations, such as the Soviet Union and the British Empire, respectively.

In the country of Ghana, the Ministry of Land and Natural Resources has partnered with the company IBM, with the aim of exploring Blockchain technology in sectors such as land registration in order to increase transparency and quality of services [29]. According to [30], approximately 80% of the land was not registered and many residents lived in low-quality makeshift settlements. The authors also refer to the high price of land for sale and the lack of documentation on overlapping property claims. Another problem, referred to by [27], lies in the existing information of land and properties, which is dispersed over various local and regional entities, formal and informal. Ref. [31] state that the use of technology in this sector would not only increase transparency in land registration, but also transparency in land valuation and planning processes. The authors indicate that the transparency provided by the Blockchain will allow the passage of records through the system without the intervention of intermediaries, without changing the existing procedures, thus allowing a constant monitoring of information by any interested party. For the system to work it would also be necessary to carry out a total review of the records already made, in order to correct errors and disparities [31]. Despite the efforts made, [27] who indicates that, to date, no considerable results have been reported about this experimental process.

Similar to the previous case, Georgia has also incorporated Blockchain technology into the land registry system in order to combat corruption present in the institutions responsible for them [27]. Some efforts would already be made by the Georgian National Public Registry Agency in digitizing land records, in which cadastral sections and satellite photos of them would be recorded. However, Ref. [32] indicate that, despite the digitization carried out, the records were still vulnerable to possible influences from third parties and did not guarantee full confidence to the population. In 2016 began the process of implementing Blockchain technology that aimed at its incorporation into the existing database system, as an additional layer. The partnership with a private entity called Bitfury, allowed the creation of a private Blockchain for the registration of property rights, implemented in the public Bitcoin Blockchain [33]. By the year 2018 it was possible to register approximately 1.5 million properties on the Blockchain network [32]. Ref. [34] indicates that this system also seeks to deal with property transactions, mortgages, demolitions and notary services. Finally, the use of this technology allows that, in legal proceedings, it is possible to resort to the data recorded in the Blockchain network with full confidence, which would not have been possible previously due to the corruption present in it [27].

In Sweden, contrary to previous cases, the use of Blockchain technology aims at its implementation in a highly digitized and organized land registry system, with the aim of increasing the efficiency of property transfer processes by reducing costs and duration, through the exploitation of the transparency and security features present in the Blockchain. Since 2017, several experimental projects have been carried out with this technology in the country, the most interesting being the project that unites the entity responsible for mapping, cadastre and land registration called Lantmäteriet, the Swedish start-up called ChromaWay, the telecommunications company Telia and the consulting company Kairos Future [27]. Ref. [35] states that the impact of Blockchain technology on the processes of transfer of land or property will allow a better connection between buyers, sellers, lawyers, appraisers and creditors, in which data records about life cycle financing, insuring origination, servicing and would be carried out in real time on the Blockchain. The author also indicates that this register will allow a seamless interaction between various systems, such as land registries, mortgage registries and loan creation. Thus, this recording of information in the Blockchain would eliminate the need for intervention of intermediaries, such as real estate agents, for example, in the verification of data in the processes of purchases and sales of properties and would also enable direct contact with banking systems in order to facilitate the obtaining of loans, says [27]. It is also mentioned by the author that, this implementation of Blockchain in the land registry will make it possible for the duration, from the acquisition contract to the registration of property, to be reduced from several months to a few days. For several interventions of intermediaries to be carried out by the Blockchain, there would be a greater involvement of the Swedish responsible entity Lantmäteriet, which would be responsible for the system. Ref. [36] state that without the implementation of technology, and despite the current digitization in land records, the existence of several documents in physical format, such as acquisition agreements and invoices, still prevails. According to [37], the consulting firm Kairos considers that the elimination of the presence of paper, the reduction in fraud and the increase in the speed of processes using Blockchain technology would imply a saving equivalent to 100 million euros annually to Swedish taxpayers.

In the U.S., you can find numerous *start-ups* that incorporate the use *of smart contracts* and the tokenization of properties in the real estate market. *SMARTRealty*, for example, uses smart *contracts* to facilitate transactions both in the purchase of properties and in income agreements, and enables the use of cryptocurrencies. In another case, such as *RealT*, the process of tokenization in properties is presented with the aim of increasing liquidity in the market, by introducing an alternative investment method to the population [38]. One may argue that this type of funding of real estate deals may even increase the percentage of asset–liability ratio, given the broader number of potential investors, which increases the capital pool available. In its turn, this decrease in the ratio may be beneficial to decrease the risk of real estate companies and funds, preventing an excessive flow of credit [39]. To the broader economy, this decrease in the asset–liability ratio may be a stabilizing factor for the market.

In the example of *SMARTRealty*, company employee Ernie Wong [40] explains the use of smart contracts and how they make it possible to improve the relationship between landlords and tenants in rental contracts, or between sellers and buyers in the acquisition of properties, with the introduction of an extra layer of security and convenience in the process without replacing the existing system. In the case of the interaction between landlord and tenant, as in traditional contracts, a *smart contract* is made that presents all the terms and conditions that must be accepted and signed by both parties. These contracts are carried out on the *SMARTRealty* platform and allow an automation of various processes such as automatic payments at the end of the month by the tenant, or the automatic return of the deposit at the end of the contract by the landlord. Another possibility lies in the automation of notices to the tenant regarding payment terms, immediately presenting the payment or withdrawal options. Wong also points to the transparency regarding the collateral and the soundness of information in the rental contracts, which allows an easy presentation of proof of payment in legal proceedings between landlord and tenant, through the storage of all the information in the Blockchain.

Regarding *RealT,* it is possible to observe an alternative investment in the real estate sector with the use of tokenization of real properties through the Ethereum Blockchain, states [41]. According to the author, this alternative investment process allows to solve three crucial problems of traditional investment in the sector, which cause the lack of liquidity of the assets: (i) high initial investments, (ii) long transactional processes with various costs and intermediaries and (iii) restriction to investment by the level of proximity. The author also highlights indirect investment, stating that it "*does not offer property rights and offers insufficient return on income revenues*". With the use of tokenization, *RealT* acquires properties in the U.S. and converts them into several *tokens* of equal value, with the purpose of their sale. These properties acquired by the company are immediately put up for lease, in which the capital generated by the rents is subsequently divided by the *token holders*, withdrawing a fee for property management services. Individuals who hold *tokens* act as multiple landlords of a property, not requiring any kind of interaction between them or with the property. In the event that some problems occur with tenants, the company responsible for property management services assumes the responsibilities of landlord. Thus, the alternative provided by *RealT* allows any individual in the world with internet access to be able to invest their capital in *tokens* representing a property in the U.S., without assuming any kind of responsibilities typical of a property owner.

Despite the upside of using blockchain technology in the real estate sector, its applications are hampered by technical issues as well as a number of cultural and organizational constraints [7].

2.5. Real Estate Investment

The real estate market is a globally significant industry that moves large volumes of capital annually, being highly dependent of the financial sector [39]. There are two main methods of investment in this market: direct investment through the purchase and direct management of properties, and indirect investment through funds or Real Estate Investment Trusts (REITs). Both methods have their own problems, inefficiencies, advantages, and disadvantages.

According to a report by Deloitte titled "2022 Real Estate M&A Outlook" [42] global property sales reached a record high of USD 2 trillion in 2022. In Portugal, the size of the real estate market can be observed through data from the National Institute of Statistics (INE) on purchase and sale contracts, where it reached almost 32 billion euros in 2019.

Direct investment involves acquiring and managing physical properties, while indirect investment involves buying shares of real estate investment companies that are traded on financial exchanges [43]. Direct investment offers advantages such as lower short-term volatility and better inflation resistance. However, it comes with higher initial investment costs, long periods of inactivity, infrequent valuations, and lengthy and non-transparent processes. On the other hand, indirect investment through REITs offers advantages such as greater liquidity, transparency, and lower initial investment costs, but it is also associated with higher short-term volatility comparable to stock market investments [44].

2.5.1. Direct Investment Process

The process of direct investment in real estate, including property purchase, management, and sale, is often lengthy and complex, making it less accessible to the average individual due to high acquisition costs and various expenses. The acquisition process involves conducting a thorough legal audit of the property, including examining documents such as property registration certificates, property records, usage permits, energy certificates, and other personal documents of both the buyer and seller [45].

Intermediaries play a role in real estate transactions, including real estate agents, notaries, lawyers, property appraisers, and banks. Their involvement varies across different countries, with some requiring the presence of specific intermediaries during property transactions. Real estate agents assist in property search and listing, while notaries verify identities, provide legal advice, and ensure the legality of the transaction. Lawyers may be involved in providing legal advice and handling the entire transaction process in some countries. Property appraisers are required in mortgage-related transactions to assess the maximum financing value to the banks, that also play a role as intermediaries [5].

2.5.2. Indirect Investment Process

Indirect investment in real estate allows individuals to participate in the market without physical ownership. It involves buying shares of real estate investment companies. This method offers advantages such as lower transaction costs, making it attractive to small investors with limited capital [46]. In Portugal, individuals can invest indirectly in the real estate market through four types of investment vehicles: commercial companies (such as limited liability companies and joint-stock companies), real estate investment funds (FII (Fundos de Investimento Imobiliário (Real estate investment funds))), real estate investment companies (SIIMO (Sociedades de Investimento Imobiliário (Real estate investment socities))), and Real Estate Investment Trusts (REITs, or SIGI (Sociedades de Investimento e Gestão Imobiliária (Real estate investment and management societies)), in Portuguese).

2.6. Summary

Previous studies have demonstrated the upsides of implementing blockchain technology in real estate. Additionally, several advantages have been identified in its application to real estate properties' construction and complete life cycle. However, resistance to new technology and cultural barriers are some of the factors that may hamper the process of blockchain innovation in the sector. Understanding these factors is crucial to the successful deployment of blockchain solutions and to understand their applicability. Portugal has been in the spotlight of tech companies in recent years, showing rapid growth in its tech scene [47].

On the other hand, the country's real estate investment has also increased, leading several international real estate investors to take part in its real estate market transformation, especially in its capital city of Lisbon. Hence, the required conditions for the application of blockchain technology in real estate would be gathered.

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