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Social and Financial Sustainability of Real Estate Investment: Evaluating Public Perceptions towards Blockchain Technology

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Abstract: Real estate markets play a crucial role in the economy, providing opportunities for investment and housing. However, there are several challenges in both direct and indirect investment mechanisms affecting its social and financial sustainability. These challenges include high costs, lengthy processes, limited transparency, and restricted investor control. Additionally, the dominance of large investors in the market intensifies these issues, creating barriers to smaller investors. This raises concerns around social inequality and sustainability among small investors, that represent, in number, the largest share of investors. Blockchain technology has emerged as a possible solution to address these issues in the real estate sector, with the potential to improve its long term social and financial sustainability. Features such as smart contracts and tokenization can enhance efficiency, transparency, security, and accessibility in property transactions. In the case of smart contracts, these enable self-executing and automated agreements, and tokenization allows for fractional ownership and increased liquidity. To assess the knowledge and perceptions of professionals in the real estate sector and evaluate the possible impact of the technology in the market, a survey-based methodology was followed. It targeted individuals actively involved in the industry, including professionals from real estate investment companies and real estate agencies. The data revealed that most professionals in the Portuguese real estate market have little to no knowledge about blockchain technology. Yet, those who possess knowledge recognize the potential benefits it can bring to the industry. This lack of awareness can be attributed to the relatively recent emergence of blockchain and its limited discussion within the real estate sector.

Keywords: smart contracts; tokenization; real estate market; direct investment; indirect investment

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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.

This study aims to understand the impact of blockchain on the Portuguese real estate market by assessing the knowledge and receptiveness of market participants. The main research questions are the following:

1. What is the level of knowledge of Blockchain technology in the ecosystem of the real estate sector in Portugal?;
2. Does the real estate market have a place for such a technology?;
3. Does Blockchain technology feature capabilities to improve existing systems?;
4. What is the best way to implement Blockchain technology?.

The methodology adopted consisted of a wide survey within the real estate and investment Portuguese community. The literature does not provide significant contributions towards understanding the main barriers and opportunities of blockchain technology in the real estate market, particularly, taking into account specific characteristics of the respondents (e.g., level of knowledge on blockchain).

This paper contributes to the development of the industry 4.0, by providing an overview on the understanding and acceptance of blockchain technology in the real estate sector. Although the survey is country specific, the findings will be relevant for countries with similar real estate investment context, as is the case of European countries. This paper is organized as follows: after this introduction, Section 2 presents the literature review on blockchain and, particularly, its application to real estate investments; Section 3 discusses real estate investment dynamics; Section 4 describes the methodology; Section 5 contains the presentation and discussion of results; and, finally, Section 6 presents the main conclusions, limitations and future developments.

2. Literature Review

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:

1. 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.
2. 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];
3. 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;
4. Recourse to the use of cryptocurrencies in income contracts and purchase and sale, through its ease of programming in acts of payment and redistribution;
5. 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. However, no previous studies were found to provide an in-depth understanding of the Portuguese real estate market perception of blockchain technology. This study intends to address this gap in the literature, contributing to understanding the acceptance of blockchain technology in developed southern-European economies.

3. Methodology

To better understand and quantify this disruptive possibility in the real estate sector, a research methodology using closed-ended questionnaires was chosen. The objective was to obtain the opinions of various professionals involved in the real estate sector and address the following research question: "What is the applicability and receptivity of blockchain technology in the real estate market?".

The questionnaire design (further discussed in Section 4.2 and available in Appendix A) was structured to answer the four research questions previously mentioned in Section 1.

3.1. Questionnaire Distribution

The questionnaire should be representative of the professional real estate sector; however, no rigorous data were found on the total number of professionals in the country. Hence, to determine the size of the sample, the following formula was used:

$$n = \frac{z^2 \times \hat{p}(1-\hat{p})}{\varepsilon^2}$$

where n is the sample size, z is the z-score, $\hat{p}$ is the population proportion, ε is the margin of error. This formula applies to unlimited populations; thus, it should provide a sufficient sample size to achieve reliable results. The goal was to achieve a 95% confidence and a margin of error of 5%. Therefore, the z-score considered was 1.96. The population proportion was assumed to be 0.5. The use of these parameters yields a sample size of 385 respondents.

Among our sample respondents, two groups are considered: Real Estate Investment Trust Management Companies (REITs) employees and Real Estate agents/consultants. The first group deals with indirect real estate investment, while the latter is involved in direct real estate transactions. Due to the distribution format, complete control over participant selection is not possible, leading to potential responses from individuals slightly outside the ideal professional criteria. These respondents are categorized as "Others".

Questionnaires were distributed electronically using Google Forms over a three-month period. Initially, information on REITs was gathered from regulatory and industry association websites, contacting 19 companies for internal distribution. Real estate agencies were also contacted, reaching out to 30 agency headquarters via phone and email, and 533 individual agencies solely via email.

3.2. Questionnaire Structure

The questionnaire was divided into four parts: demographic data, knowledge assessment of blockchain, knowledge assessment of the real estate market, and participants opinions on blockchain implementation in real estate. The demographic section collected information on age, nationality, occupation, and years of experience in the real estate sector. The inclusion of this information aimed to allow for a better understanding of the respondents.

The knowledge assessment sections evaluated participants' understanding of blockchain technology and their experiences with it. They also assessed whether participants considered blockchain a disruptive technology in various sectors. The real estate market knowledge assessment section focused on participants' experiences and knowledge of both direct and indirect real estate investment, as well as the problems they perceive in these areas. This assessment will help in categorizing respondents based on their knowledge level, which can be useful during the cross-analysis phase.

The final section explored the intersection between the real estate market and blockchain technology. It evaluated participants' opinions on the potential disruptive nature of blockchain in real estate, the areas where blockchain could contribute the most and the main obstacles to its implementation.

This structure was followed with the intent to analyze demographics, knowledge of each field and applications both separately and as a cross-analysis. This approach would allow the comparison of possible technology employments in the sector, mentioned in the literature, with the perception of real estate professionals in the country, with the possibility to break down into several demographics and levels of knowledge.

Throughout the questionnaire, it was chosen to use close-ended questions, primarily to ensure data usability for quantitative analysis. Additionally, its use allowed the questionnaire to be completed faster, thus increasing the potential response rate by minimizing the number of dropout respondents.

3.3. Participants Categorization

Participants in this study were categorized into different levels based on their responses to simplify analysis and comprehension. This is similar to other studies on blockchain, where a baseline is established by assessing the respondents' familiarity with the technology (see, for reference, [15]). Hence, it allows the analysis of the responses on applying technology to the sector in light of the respondents' different levels of knowledge. In this regard, two assessments were conducted: the Real Estate Knowledge Assessment (REKA) and the blockchain Knowledge Assessment (BKA).

The REKA evaluated participants' knowledge and involvement in the real estate sector, considering parameters such as professional experience, sector engagement, and knowledge of direct and indirect investments. The BKA assessed participants' familiarity with blockchain technology, including parameters such as technology exposure, understanding, knowledge of smart contracts, and tokenization.

Responses were assigned percentage values ranging from 0% to 100%, with a correspondence established between the numerical ratings (1–5) and percentage ranges. A simple average of the four parameters was calculated for each assessment, resulting in three distinct levels for both REKA and BKA. The level thresholds were determined during result analysis for greater precision and clarity.

4. Results

A total of 120 valid questionnaires were gathered for statistical analysis, providing a margin error of 8.95%. Table 1 shows the demographics results regarding the age, nationality, sector within real estate (indirect investment, direct investment or other) and years of experience in the sector.

Table 1. Base demographics results.

Participant Data							
Age		**Nationality**		**Profession**		**Experience**	
18–29 years	17	Portuguese	112	Indirect	8	<6 years	68
30–44 years	46	Others	8	Direct	78	6–15 years	34
>44 years	57	-	-	Others	34	>15 years	18

The findings indicated that most respondents are Portuguese and over 30 years old. Only 7% of participants worked on the indirect investment segment, mainly due to limited access to Real Estate Investment Trust Management Companies during this study. Additionally, most respondents have less than 15 years of experience in the sector. This section will be divided into four subsections, addressing each part of the questionnaire:

1. Real Estate assessment—the assessment of the respondents' knowledge about the real estate market.
2. Blockchain assessment—the assessment of their knowledge of blockchain technology.
3. Real Estate and Blockchain—their perception of the relation between blockchain and the real estate market.
4. Blockchain implementation in Real Estate—their opinion on the implementation of this technology to the sector.

4.1. Real Estate Assessment

Direct investment constituted the majority (65%) of participants, with a significant portion being real estate consultants (Table 2). The remaining 28% belonged to the "Others" category. In terms of age and experience, participants over 44 years old comprised the largest group (48%), followed by those aged 30–44 (38%) and 18–29 (14%). The majority of participants (57%) had 0–5 years of experience, while 28% had 6–15 years, and 15% had over 15 years of experience.

Table 2. Results on respondents' contact with real estate market (RE Contact), knowledge of direct investment (DI) methods and indirect investment (II) methods. Results are presented as the number of respondents.

	RE Contact	**DI Knowledge**	**II Knowledge**
None	4	0	11
Few	5	7	24
Intermediate	1	8	44
Good	7	63	30
Excellent	103	42	11

Regarding contact with the real estate sector, approximately 92% of respondents reported relevant or total involvement, validating the subsequent data. Similarly, all participants had knowledge of at least one investment method. Direct investment knowledge was well represented, with 105 participants indicating good or excellent knowledge, while only 15 had limited or intermediate knowledge. Indirect investment knowledge exhibited a normal probability distribution, with 41 participants having good or excellent knowledge, 44 having intermediate knowledge, and 35 having little or no knowledge.

The three levels of the REKA were defined based on the distribution of individuals in each level and are the following: Level 1 (45 individuals)—Less than 60%—Intermediate and lower assessment; Level 2 (41 individuals)—Between 60% and 70%—Good assessment; Level 3 (34 individuals)—Greater than 70%—Excellent assessment. The parameters of "Experience" and "Contact" demonstrated limited differentiation across levels, whereas

the most significant variation observed was in the knowledge of both investment methods (Table 3).

Table 3. Parameters' variation in REKA.

Level	Experience	Contact	Knowledge of Direct Inv.	Knowledge of Indirect Inv.
Level 1	Limited to none	Good	Intermediate	Limited
Level 2	Limited	Excellent	Good	Intermediate
Level 3	Intermediate or superior	Excellent	Excellent	Good

4.2. Blockchain Assessment

Participants' knowledge and interaction with blockchain technology were found to be low (Table 4). Only 20 participants had intermediate or higher knowledge, and 22 had intermediate or higher contact with the technology. Many of the participants (100) had little or no knowledge, as well as little or no contact (98) with the technology. Regarding specific functionalities of the technology, such as smart contracts and tokenization, knowledge was limited. Only 13 individuals had intermediate or higher knowledge in tokenization, while 107 had little or no knowledge. In the case of smart contracts, knowledge was more evenly distributed, with 29 individuals having intermediate or higher.

Table 4. Results for the blockchain assessment section regarding respondents' knowledge of blockchain technology, contact with blockchain, and knowledge of smart contracts and tokenization. Results are presented as the number of respondents.

	Knowledge	Contact	Smart Contracts	Tokenization
None	47	48	58	75
Few	53	50	33	32
Intermediate	18	10	23	10
Good	2	7	6	3
Excellent	0	5	0	0

The three different levels in the BKA were defined based on the number of participants in each level. The boundaries for the three levels were as follows: Level 1 (55 participants)—Less than 15%—No Evaluation; Level 2 (48 participants)—Between 15% and 35%—Low Evaluation; Level 3 (17 participants)—Greater than 35%—Intermediate and higher evaluation (Table 5). These values indicate that participants in level 3 will contribute the most to this study, although they have only an intermediate average value for each parameter. Participants in level 1, for the most part, do not have a significant impact on this study. The parameter that shows the most variation between levels 1 and 2 with level 3 is "Knowledge of Tokenization".

Table 5. Parameters' variation in BKA.

Level	Contact	Knowledge	Knowledge of Smart Contracts	Knowledge of Tokenization
Level 1	Limited to none	Limited to none	None	None
Level 2	Limited	Limited	Limited	Limited to none
Level 3	Intermediate	Intermediate	Intermediate	Intermediate

4.3. Real Estate and Blockchain

After evaluating the participants on the real estate sector and blockchain technology, the analysis proceeds to various technical issues related to these topics. The objective of this section is to determine and quantify the role of technology in the real estate industry.

The analysis begins by identifying the most relevant problems in the real estate market. In the direct investment method (Figure 1), many of the respondents (48%) highlighted "High costs" as a relevant issue, followed by "Lengthy processes" (42%). "Lack of liquidity" ranked third with 27.5% of respondents selecting it. It is worth noting that 8% of respondents found no disadvantages in this investment method and a small percentage (5%) did not respond to this question.

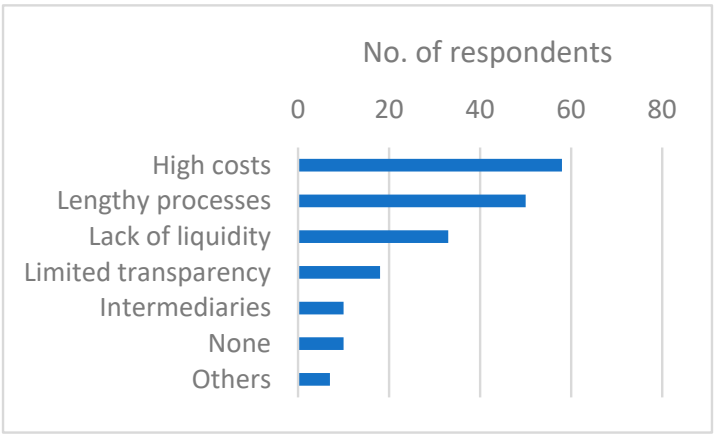

Figure 1. Problems with direct investment.

Analyzing the responses based on the participants' REKA level, several observations were made. "Limited transparency" had greater representation in level 3 (7%—5%—19%) and were less concerned about "High costs" (31%—37%—25%), while "Lack of liquidity" was more relevant in level 1 (24%—14%—15%). Non-response (NR) accounted for 4 responses in level 1 and 2 responses in level 2 (67%—33%—0%).

For the indirect investment method (Figure 2), there was a more balanced distribution of problems, with no option outweighing the others. Approximately 33% of respondents identified "Limited control over invested capital" as a major concern. Other options received significant attention, with response numbers ranging from 18% to 25%. Similarly to the direct investment method, 8% of respondents believed there were no problems with the indirect method "NR" accounted for 17.5%.

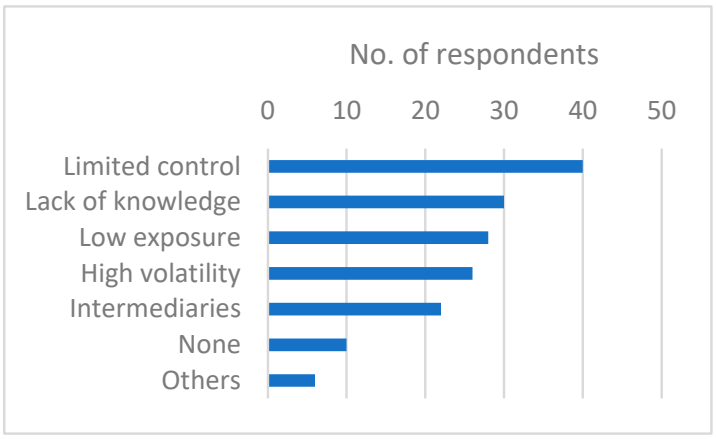

Figure 2. Problems with indirect investment.

Examining the relationship between responses and REKA levels in the indirect investment method, some notable observations were made. "None" had significant representation in level 3 (4%—3%—13%), while "Lack of knowledge" was more relevant in level 1 (28%—16%—13%). Level 2 participants expressed higher concern about "Intermediaries" (8%—19%—13%) and "Limited control over invested capital" (21%—28%—24%). "NR" accounted for most responses in level 1 (81%), followed by level 2 (14%) and level 3 (5%).

When questioning the participants about the disruptive potential of blockchain technology in the real estate sector and other sectors, two important observations arise. A significant percentage of participants, 52.5%, responded with "NR" to both questions, indicating a lack of knowledge about the subject. Among the remaining respondents, 27% agreed that blockchain has disruptive capabilities in various sectors, including real estate. Examining the relationship with the BKA levels, 7% of participants at level 1, 35% at level 2, and 65% at level 3 agreed with both statements, suggesting that greater knowledge about the subject leads to a higher recognition of the potential of this emerging technology.

In the question addressing the various aspects of blockchain technology that could contribute to the real estate sector (Figure 3), no single option stood out as the majority choice. However, the options of "Immutability" and "None" were the least selected, categorized as "Other". This question received a response of "NR" from 48% of participants.

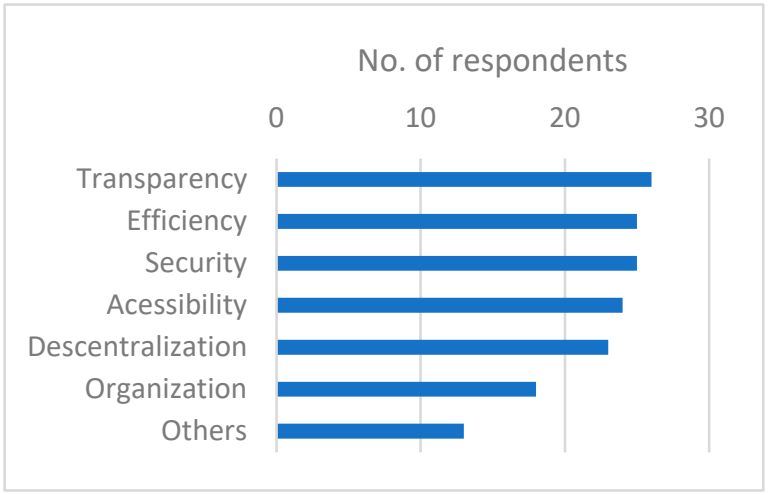

Figure 3. Aspects of the blockchain technology for the real estate market.

Analyzing the relationship between the aspects of blockchain technology and BKA levels, the following observations can be made: "Efficiency" is more important at level 3 (14%—15%—21%), but not "Transparency" (23%—20%—5%). "Organization" is least considered at level 1 (3%—13%—18%), while "Immutability" and "None" are more relevant in this level (17%—6%—5%). The "NR" responses accounted for 69% at level 1, 26% at level 2, and 5% at level 3.

Regarding the obstacles (Figure 4), participants indicated that "Regulation" and "Lack of knowledge" are the most critical in implementing blockchain technology in the real estate sector, 38% and 28%, respectively. This question received an "NR" response from 47.5% of participants.

Analyzing the connection between these data and the BKA levels, the following observations can be made: "Lack of knowledge" is less important at level 3 (31%—32%—18%), while "Digital security" is more noteworthy (10%—11%—25%). Only level 1 selected the option "None" and provided alternative options (10%—0%—0%). The "NR" responses accounted for 67% at level 1, 30% at level 2, and 3% at level 3.

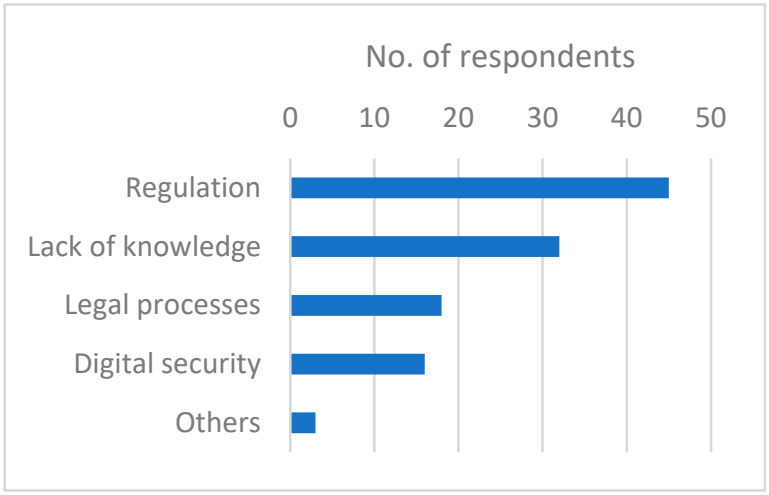

Figure 4. Obstacles for the implementation of the blockchain technology.

4.4. Blockchain Implementation in Real Estate

This section examines the various applications of technology in the real estate market, focusing on direct investment processes such as property buying/selling, rental processes, and property/land registration, as well as mortgage processes. Excluding "NR" responses, most of the respondents (78%, 80%, and 83%, respectively) recognize the potential of blockchain technology to improve and assist these processes. However, for rental processes, the positive majority is only 65% (Table 6).

Table 6. Responses to questions on the implementation of blockchain technology to real estate. Results presented in number of responses.

Question	Yes	No	NR
Can the blockchain improve acquisition contracts?	45	13	62
Can the blockchain improve rental contracts?	32	17	71
Can the blockchain improve property and land registration?	44	11	65
Can the blockchain improve mortgage processes?	38	8	74

In property buying/selling processes, the most important aspect identified by respondents is the "Increase in the speed of information exchange" (27%). Ranging from 19% to 15%, the other options were "Improved accessibility of information to stakeholders", "Real-time transactions", "Increased security of information", "Increased transparency of information among stakeholders" and "Reduction in the presence of intermediaries". Additionally, 46% of participants believe that increased efficiency in these processes can lead to lower costs.

For rental processes, the distribution of responses among the four options is relatively balanced, indicating no standout preference for specific improvements using blockchain technology. The options were "Process automation", "Better security in payment information", "More transparency about the security deposit" and "More transparency about the condition of the property".

Regarding property/land registration systems, participants consider the "Improved accessibility of information" (29%) to be highly important. Surprisingly, options such as "Decentralization of information" (11%) and "Immutable information" (6%) are considered less relevant, despite being frequently mentioned in the literature review of blockchain

technology. The three remaining options were "Increased transparency of information", "Improved data organization" and "Enhanced security in data handling".

On the optimal use of smart contracts in the real estate market, the first question asked whether smart contracts could replace existing contractual systems or act as an additional layer of security. Among participants knowledgeable about the subject, 62% preferred using smart contracts as an additional layer of security, while only 26% considered them a standalone replacement. The others 12% of participants did not see a role for smart contracts in the real estate sector. Regarding the most suitable processes for smart contracts, participants indicated that "Contracts in buying and selling properties" (56%) were more suitable compared to "Rental contracts" (31%). Some participants (10%) believed that neither of these processes was suitable, and an individual mentioned "Inheritance rights and wills".

In terms of the tokenization of properties (Table 7), participants see advantages such as "Creating a more accessible alternative investment method" (15%) and "Increasing liquidity in the real estate market" (13%). However, 69% of participants did not provide a response in this regard.

Table 7. Advantages of properties' tokenization.

Statement	No. of Respondents
Creating a more accessible alternative investment method	18
Increasing liquidity in the real estate market	16
Greater ease in property rights division processes	12
Increased participation of small investors in the sector	12
Greater exposure of the real estate market compared to traditional indirect investment methods	11
Increased attractiveness for foreign investments	9
Others	13

Through the BKA levels, options such as "Creation of a more accessible alternative investment method" is less represented in level 3 (24%—25%—12%), while there's a higher preference for "Increased participation of small investors in the sector" (6%—10%—21%) and "Greater ease in property rights division processes" (0%—13%—21%). Level 1 selects options included in "Others" the most (29%—8%—15%), as well as the option of "Greater exposure of the real estate market compared to traditional indirect investment methods" (18%—13%—9%). The "NR" responses account for 58% in level 1, 38% in level 2, and 4% in level 3.

5. Discussion

This paper was organized around four primary research questions. As a result, the subsequent discussion section will address each of these questions in detail.

The first research question posed was intended to understand the degree of knowledge in the real estate sector about Blockchain technology.

1. *What is the level of knowledge of Blockchain technology in the ecosystem of the real estate sector in Portugal?*

In light of the results, Blockchain technology is still a recent and little-discussed subject in Portugal, especially in the real estate sector. Of the participating individuals, few present relevant knowledge and have had some contact with technology. When *smart contracts* and tokenization topics are addressed, the number of individuals with expertise decreases significantly. This phenomenon may be correlated with the high percentages of non-Response obtained, namely in questions that deepen the technology theme. The categorization of participants in CBA reinforced their high presence without knowledge, getting 46% of

individuals in the lowest category. Although it was not initially considered, these results are somewhat expected because incorporating this recent technology into the real estate market is still debated. This is consistent with existing literature, as previous studies have demonstrated that the application of blockchain to the most traditional business sectors is still in its early stages.

2. *Does the real estate market have a place for such a technology?*

The second question posed for this investigation, the objective of interconnecting a priori the problems of the real estate market with the technical capabilities of Blockchain technology, was held, as well as some barriers that prevent its implementation. Technology's potential for disruption in the real estate market was confirmed at this stage, both in direct and indirect investment. Property and land registration, for instance, was one of the areas where respondents' have considered a good fit for this technology. This is consistent with existing literature, namely with the examples of land registration in Ghana, Georgia and Sweden. Respondents' have also considered that blockchain could improve the accessibility to real estate investment. Similarly, numerous U.S. start-ups are applying blockchain technology to this end. Nevertheless, the results hindered that although we may argue that there is a place for such technology, it is still undefined, will several possibilities of integration. Over the long haul, it is clear that blockchain technology may disrupt or simply improve how the real estate market works. However, the lack of knowledge about this recent technology, the immaturity of the technology itself, and the cultural barriers may delay the opportunity for blockchain technology to find its place in the market.

Based on existing literature, we should note that the place for blockchain technology should be built upon sustainability. ESG criteria are increasingly taken space in the public and business arenas, hence blockchain technologies should focus on reducing its energy consumption Those who comply with these factors may have higher levels of acceptance within the society.

3. *Does Blockchain technology feature capabilities to improve existing systems?*

According to the survey participants, both methods do present several problems. In the direct investment method, great importance is given to high costs and lengthy processes, and in the case of respondents with higher levels of real estate knowledge (ICA level 3), to the lack of transparency that exists. In the indirect investment method, however, no consensus was reached about its problems, presenting a balanced distribution of results. Still, it stood out how little control an investor has when investing his capital. Using the ICA levels, it was found that a part of the highest level understands that there are no problems with this indirect method and that the lowest level is the one that gives more importance to the lack of associated knowledge, which may be related to the very understanding that the individuals of the respective level hold. In addition to admitting the existing problems in real estate investment, the technical capabilities that Blockchain technology brings are also recognized, namely transparency, efficiency, security, accessibility, decentralization and organization. For individuals with higher knowledge of Blockchain (ACB level 3), however, the technology's efficiency is highly valued.

Conversely, the same respondents do not consider transparency a compelling aspect of blockchain's added value to the sector, despite being considered an important problem for individuals with higher levels of real estate knowledge. According to approximately half of the respondents who know about Blockchain, using this technology significantly reduces the existing problems in the real estate market, which could lead to its disruption in the next ten years. However, overcoming some obstacles is necessary before one can successfully implement Blockchain technology in the market. Factors such as regulation and lack of knowledge are the most appropriate to consider, and it is essential to make several efforts in these areas. Digital security is also important but for higher-level ACB individuals only.

The results show that, despite low levels of knowledge about the technology, it is recognized that it has the ability to improve existing systems. This is consistent with the

findings in previous studies, where several applications to real estate have been tested, yielding some positive results.

4. *What is the best way to implement Blockchain technology?*

Despite the high presence of individuals with little or no knowledge regarding the technology, it was possible to deduce the best formats that Blockchain can take in both methods of real estate investment. The conclusions drawn were as follows:

(a) There is a consensus about the capabilities that Blockchain technology presents to improve/assist the four determining processes in the direct investment method, namely the processes of buying and selling real estate, the processes of leasing, the systems of land and land registration and the mortgage processes. There remains, however, some hesitation on the part of the respondents in the lease proceedings.
(b) In the processes of buying and selling real estate, greater importance is given to increasing the speed of information exchanges, involving documents such as identification and proof. Conversely, respondents did not consider it important to reduce the presence of intermediaries such as real estate agents and notaries. This result is in line with many of the respondents occupying these same positions as intermediaries, so they may consider Blockchain technology as a threat to their own profession. With the constant technological evolution, it is, however, expected the disappearance of some professional positions such as these, as well as the emergence of other new ones.
(c) Based on the literature review, leasing processes are indicated to be good candidates for the use of Blockchain technology; however, they are the least preferred by respondents. Consequently, no aspect was obtained that stood out either for the positive or for the negative.
(d) In the land registry systems, it was possible to conclude that technology has a lot of potential, with the ability to improve the accessibility of information being the most chosen by the respondents. Contrary to what is indicated by many investigations inserted in the theme, for the individuals under study not much importance was given to the characteristics of decentralization and immutability, which may indicate a preference of individuals for private or mixed Blockchain networks.
(e) Analyzing the results related to *smart contracts,* it is possible to conclude that the respondents aim at their use in the real estate market with preference to the processes of buying and selling real estate, reinforcing the hesitation in leasing processes. Because this technology is still recent, its use should be restricted to only an additional layer of security to existing systems, however, with the constant evolution of technology, there is the possibility of a complete replacement in the future.
(f) Using tokenization in the indirect investment method, the results obtained indicate that it allows to solve several problems in the market already mentioned, such as accessibility and liquidity. According to the respondents, the main advantages are in the form of creating a more accessible alternative investment method and increasing liquidity in the real estate market. In addition, individuals in the largest category in CBAs point out that tokenization will enable greater participation of small investors, as well as greater ease in property rights division processes.

In sum, there are several ways to incorporate blockchain technology into real estate. However, this transition should be carried out at a pace that allows real estate professionals to realize their advantages without feeling threatened. Additionally, increasing the education on blockchain among real estate professionals and integrating it into existing systems will ease the introduction process to new technology.

6. Conclusions

With the analysis made of the results obtained in the survey, it was possible to draw several conclusions about the perception of the impact that Blockchain technology can have on the real estate market. These allow us to answer the four questions initially posed and to determine the applicability and receptibility of the technology in the market. The

findings of this study suggest that blockchain technology is still a relatively recent and little-discussed topic in the Portuguese real estate sector. Although the potential for disruption that technology holds in the real estate market was confirmed, both in direct and indirect investment, the survey participants revealed a lack of knowledge and contact with the technology. This lack of knowledge may be due to the recent debate surrounding the incorporation of Blockchain technology into the real estate market.

Despite the high presence of individuals with little or no knowledge regarding the technology, this study was able to deduce the best formats that blockchain can take in both methods of real estate investment. There is a consensus about the capabilities that blockchain technology presents to improve or assist the four determining processes in the direct investment method, namely the processes of buying and selling real estate, the processes of leasing, the systems of land and land registration, and the mortgage processes. Respondents, however, showed hesitation in the lease proceedings.

The use of tokenization in the indirect investment method allows for the solution of several problems in the market, such as accessibility and liquidity, and creates a more accessible alternative investment method, according to the respondents. It was also pointed out by individuals in the largest category in CBAs that tokenization will enable greater participation of small investors, as well as greater ease in property rights division processes. However, there is a need to overcome some obstacles before successfully implementing Blockchain technology in the real estate market. Factors such as regulation and lack of knowledge are crucial to consider, and several efforts need to be made in these areas to ensure successful implementation.

To deepen the understanding of the potential impact of the technology on the real estate market, it is recommended to improve the questionnaire already developed, taking into account the lack of knowledge currently existing in the real estate ecosystem regarding Blockchain technology, which was initially not considered. This is one of the main limitations of this research. In addition, the use of a qualitative methodology, such as personal interviews, is recommended in order to obtain deeper perspectives of individuals within the same demographic and socio-economic group. In the future, an analysis may be conducted to determine concrete values of how Blockchain technology can influence costs or durations in processes, such as those of buying and selling real estate. Collaborative efforts are also suggested with real estate professionals who possess relevant knowledge about the technology in order to define possible Blockchain networks that can be implemented in the Portuguese real estate market. Finally, it is important to consider other technologies on the rise, such as artificial intelligence, virtual reality, machine learning or the Internet of Things, which also have great capabilities for disruption in various sectors. Future studies may try to compare these with Blockchain technology, or even see how they would complement each other.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Questionnaire

Part 1—Getting to know the participant

1. What age group do you belong to?
   - ○ 18–29 years
   - ○ 30–44 years
   - ○ Above 44 years old
2. Indicate your nationality
   - ○ Portuguese
   - ○ Other:

   _____
3. Indicate your occupation

   _____
4. How many years of experience do you have in the sector?

   _____

Part 2—Participant's knowledge of Blockchain

1. How do you rate your knowledge of Blockchain technology?
   1- None
   2- Little
   3- Intermediate
   4- Good
   5- Excellent
2. What kind of contact have you had, or do you have, with technology?
   1- No contact
   2- Little contact, through news, articles or surveys
   3- Intermediate contact, through alternative investments such as cryptocurrencies
   4- A lot of contact, through occasional professional work, or individual enthusiasm about the subject
   5- Full contact, through constant professional work
3. Do you consider Blockchain technology as a possible disruptive technology in various sectors for the next 10 years?
   - ○ Yes
   - ○ No
   - ○ I do not have sufficient knowledge to answer

Part 3—Participant's knowledge of the real estate market

1. What kind of contact have you had, or do you have, with the real estate sector?
   1- No contact
   2- Little contact, through news, articles or searches
   3- Intermediate contact, through alternative investments, such as property investment funds.
   4- A lot of contact, through occasional professional work, or individual enthusiasm about the subject.
   5- Full contact, through constant professional work
2. How do you rate your knowledge of direct real estate investment (e.g., buying and selling/managing property)?
   1- None
   2- Little
   3- Intermediate
   4- Good

5- Excellent

2.1. What kind of problems do you consider most relevant in direct real estate investment? Please select a maximum of 2 options.

- ○ High costs
- ○ Long processes
- ○ Lack of liquidity
- ○ Low transparency
- ○ Intermediaries
- ○ None
- ○ I do not have sufficient knowledge to respond
- ○ Other:

---

3. How would you rate your knowledge of indirect real estate investment (e.g., property investment funds)?

1- None
2- Little
3- Intermediate
4- Good
5- Excellent

3.1. What kind of problems do you consider most relevant in indirect real estate investment? Please select a maximum of 2 options.

- ○ High volatility
- ○ Low exposure to the sector
- ○ Little control over invested capital
- ○ Intermediaries
- ○ Reduced knowledge
- ○ None
- ○ I do not have sufficient knowledge to answer
- ○ Other:

Part 4—Participants' views on the implementation of blockchain technology in the real estate sector

1. Do you consider Blockchain technology as a possible disruptive technology in the real estate sector for the next 10 years?

- ○ Yes
- ○ No
- ○ I do not have sufficient knowledge to answer

2. In what aspects will blockchain technology contribute most to the sector? Please select a maximum of 3 options.

- ○ Transparency
- ○ Immutability
- ○ Efficiency
- ○ Security
- ○ Decentralization
- ○ Accessibility
- ○ Organization
- ○ None
- ○ I do not have sufficient knowledge to answer
- ○ Other:

_____

Implementation of the technology in the direct market:

3.1. Do you consider that Blockchain technology has the capacity to increase the efficiency of property buying and selling processes?

- ○ Yes
- ○ No
- ○ I do not have sufficient knowledge to answer

3.1.1. If you answered yes, in what aspects can blockchain technology lead to an increase in the efficiency of the processes of buying and selling property? Please select a maximum of 3 options.

- ○ Decrease in the presence of intermediaries, such as estate agents and notaries.
- ○ Real-time transactions
- ○ Increased speed of information exchange
- ○ Increased information security
- ○ Improved accessibility of information to stakeholders
- ○ Increased transparency of information between stakeholders
- ○ Other:

_____

3.1.2. What is your level of agreement with the following statement? 'Increased efficiency in these buying and selling processes can contribute to lower costs.

1- Strongly disagree
2- .
3- .
4- .
5- Strongly agree

3.2. Do you consider that Blockchain technology has the ability to improve landlord-tenant relations in rental processes?

- ○ Yes
- ○ No
- ○ I do not have sufficient knowledge to answer

3.2.1. If you answered yes, in what aspects can blockchain technology improve landlord-tenant relations? Please select a maximum of 2 options.

- ○ Increased transparency of security deposit information
- ○ Increased transparency of information on the status of the property
- ○ Increased security of information about payments
- ○ Automation of processes
- ○ Other:

_____

3.3. Do you consider Blockchain technology to be an asset for land and property registration systems?

- ○ Yes
- ○ No
- ○ I do not have sufficient knowledge to answer

3.3.1. If you answered yes, in what aspects can blockchain technology be an asset for land and property registration systems? Please select a maximum of 3 options.

- ○ Improved accessibility of information
- ○ Increased transparency of information
- ○ Decentralization of information
- ○ Immutable information
- ○ Increased security in data processing
- ○ Better organization of data
- ○ Other:

_____

3.4. Do you think Blockchain technology can help mortgage processes?

- ○ Yes
- ○ No
- ○ I do not have sufficient knowledge to answer

3.5. How do you rate your smart contracts knowledge?

1- None
2- Little
3- Intermediate
4- Good
5- Excellent

3.5.1. Which way would be the most suitable for the implementation of smart contracts?

- ○ As an additional layer of security to pre-existing systems
- ○ As a single layer replacing pre-existing systems
- ○ None
- ○ I do not have sufficient knowledge to answer
- ○ Other

_____

3.5.2. What would be the best application of smart contracts?

- ○ Property buying and selling contracts
- ○ Rental contracts
- ○ None
- ○ I do not have sufficient knowledge to answer
- ○ Other:

_____

Implementation of technology in the indirect market:

4.1. How do you rate your knowledge regarding tokenization of real estate?

1- None
2- Little
3- Intermediate
4- Good
5- Excellent

4.2. What are the biggest advantages of introducing tokenization processes in the real estate market through the implementation of blockchain technology? Please select a maximum of 3 options.

- ○ Creation of a more accessible alternative investment method
- ○ Increased exposure of the real estate market compared to traditional indirect investment methods
- ○ Greater liquidity in the real estate market
- ○ More participation of small investors in the sector
- ○ Greater attractiveness for foreign investments
- ○ Easier property rights division processes
- ○ Better project financing
- ○ Real-time transactions
- ○ None
- ○ I do not have sufficient knowledge to answer
- ○ Other:

_____

5. Of the following options, which do you consider to be the biggest obstacles to the implementation of blockchain technology in the real estate sector? Please select a maximum of 2 options.

- ○ Digital security
- ○ Regulation
- ○ Legal processes
- ○ Lack of knowledge
- ○ None
- ○ I do not have sufficient knowledge to answer
- ○ Other:

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