UNLOCKIT FIELD LAB ON INCENTIVIZING REAL ESTATE PARTICIPANTS – HOW BLOCKCHAIN IS RESHAPING DATA SHARING

ALEXANDRE FALCONNIER

Student ID: 53984

Work project carried out under the supervision of:

Prof. Zejnilovic, Leid

João Santos - Blockchain Developer at Unlockit

Tiago Dias – Founder at Unlockit

20/12/2023

ABSTRACT

To present a comprehensive analysis of the potential impact of Unlockit, a blockchain-based platform, on the Portuguese real estate market, our thesis delves into the intricacies of the market, highlighting the need for digital transformation to enhance transaction efficiency, transparency, and compliance. The study explores the application of blockchain and distributed ledger technologies (DLTs), examining models like EBSS and CoSC, and discusses their implications in real estate. A proposed business model for Unlockit suggests a subscription-based service with transactional fees, tailored to the sector's needs. Ultimately, we conclude that Unlockit could create true long-term impact on the real estate transactions in Portugal, despite challenges in scalability and regulatory compliance, offering a model for global market innovation with a phased approach.

Acknowledgements

Gratitude goes out to Leid Zejnilovic (Nova School of Business and Economics), Unlockit, João Santos (Unlockit), Nate Sousa Uva (IAD), Bruno Lemo (IRN), Sandra Garrett (SG Real Estate Advisors) and all interviewees for their insights and perspectives during consultation. We also acknowledge the use of AI technology in streamlining processes.

Keywords: *Blockchain, Real Estate, Web3, Distributed Ledger Technology (DLT), innovation, Smart Contracts, Rental Market, Data Aggregation*

This work used infrastructure and resources funded by Fundação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/00124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

1. **INTRODUCTION** 1

2. LITERATURE REVIEW
2.1. Introduction 2
2.2. Data Aggregation and Its Importance in Real Estate 3
2.3. Data Sharing Models and Theories 4
2.4. Behavioral Economics and Strategies to Incentivize 5
2.5. Trust and Data Security 6
2.6. Regulatory Considerations 7
2.7. Case Studies and Precedents 10

3. **RESEARCH METHODOLOGY** 12

4. **STAKEHOLDER ANALYSIS** 13
4.1. Landlords 13
4.2. Tenants 13
4.3. Realtors 14
4.4. Lawyers/Notaries 15
4.5. Rental Platforms 16
4.6. Instituto dos Registos e do Notariado (IRN) 16

5. **GAME THEORY & BEHAVIORAL ECONOMICS; HOW TO INCENTIVIZE STAKEHOLDERS** 18
5.1. Introduction to Game Theory in Real Estate 18
5.1.1. Overview of game theory concepts 18
5.1.2. Relevance to real estate data sharing 18
5.2. Stakeholder Dynamics Analysis 19
5.2.1. Detailed examination of motivations and strategies of participants 19
5.3. Nash Equilibrium in Data Sharing 20
5.3.1. Nash equilibrium in data sharing 20
5.3.2. Examining stakeholder strategies: landlords, citizens, and brokers & agents 20
5.3.3. Scenario analysis for each group 20
5.3.4. Overcoming equilibrium barriers 22
5.3.5. Sustaining nash equilibrium with landlords 22
5.4. Behavioral Economics in Stakeholder Decision-Making 23
5.4.1. Exploration of cognitive biases affecting stakeholder choices 23
5.4.2. Discussion of loss aversion, reciprocity, and social proof 23
5.5. Conclusion 24

6. **USE OF BLOCKCHAIN/DISTRIBUTED LEDGER TECHNOLOGIES (DLTS) IN THE CONTEXT OF UNLOCKIT** 25
6.1.Introduction to blockchain and DLTs in real estate 25

6.2. Blockchain technology: Concept and application 25
6.3. Advantages of blockchain in real estate 26
6.4. Challenges in real estate 28
6.5. EBSS: Enhanced blockchain-based secure sharing for real estate credentials 29
6.6. Implications for real estate industry 32
6.6.1. Hyperledger Fabric 32
6.6.2. R3 Corda 33
6.6.3. Quorum 33
6.6.4. DAML 34
6.7. Collaborative smart Contracts (CoSC) in real estate transactions 34
6.7.1. Concept and application 34
6.7.2. Operational mechanism 36
6.7.3. Impact on real estate processes 36
6.7.4. Application in Unlockit's transaction management software 36
6.7.5. Compliance and paperwork simplification 37
6.7.6. Communication and collaboration benefits 37
6.7.7. Future prospects and development for CoSC 37
6.8. Future directions and potential developments for DLTs/Blockchain in real estate 38
6.9. Conclusion 38

7. **INCENTIVES AND BUSINESS MODEL FOR UNLOCKIT** 39
7.1. Digital Real Estate Workspace 39
7.1.1. Blockchain-based Rental System 40
7.1.2. Regulatory Compliance Tools 42
7.2. Initial Business Model Proposal 44
7.3. Additional Considerations 46

8. **CONCLUSION** 48

REFERENCES

1. Introduction

The Portuguese rental market, vigorous and dynamic, presents unique opportunities for digital transformation through blockchain technology. This thesis explores Unlockit, a Web3 PropTech and GovTech Portuguese Startup, that aims to provide a platform that streamlines real estate transactions and simplifies compliance, paperwork, communications, enabling collaboration through the home buying/rental journey. Unlockit, is currently developing a key piece of Web3 technology that can challenge and change many of the current real estate operations. Their ambition extends beyond being a simple tool, having the long term goal of becoming a force for transparent and efficient transactions envisioning themselves as becoming a vital digital tool for realtors while offering valuable data insights for consumers. For this, understanding the intricacies of Portugal's rental market is crucial. This includes examining the roles of stakeholders, the steps involved, necessary documents, and the real changes that could be implemented from the platform itself to the business model.

This thesis is dedicated to conducting a comprehensive analysis of various elements that are pivotal in setting the groundwork for the adoption of Unlockit's blockchain-based platform in the real estate sector. We commence our exploration with an exhaustive review of the current literature, providing a foundation for understanding the various elements associated with such an innovative platform within the real estate market. Through extensive research, in-depth interviews, and the application of various analytical frameworks our methodology enables us to closely dissect and identify the key elements that are essential for Unlockit to incorporate and consider in their strategic development. By integrating insights collected from seasoned professionals and synthesizing data collected from our research, we aim to synthesize a holistic and comprehensive overview of the situation confronting Unlockit.

2. Literature Review

2.1. Introduction

Unlockit's first focus will be the rental real estate market. This market has its own set of difficulties with regard to data management, data aggregation and making data more transparent. In today's world of centralisation and opacity for the real estate market, the need for better data transparency and seamless transaction and administrative processes between different participants such as buyers, sellers, real estate agencies, realtors, online platforms etc has never been greater. This literature review aims to explore and summarize existing literature around the key question: how participants in the rental real estate market can be incentivized to share their data with Unlockit centralized platform and use it for their transactional processes.

2.2. Data Aggregation and Its Importance in Real Estate

In order to change the industry's current and opaque processes and bring more transparency, data aggregation has a role to play and brings some challenges. Currently, the real estate market consists of fragmented data sources, including government records, multiple online rental platforms, and individual real estate agencies. Being able to aggregate this data into a centralized platform can provide a more accurate and less biased view of the market, thereby aiding in better decision-making for both buyers and real estate professionals. Portugal, especially Lisbon, currently experiences a significant rental real estate problem with high price inflation and a decorrelation between offer and demand. The spread between listed price and actual buying price is relatively high. For instance, Dhar and Stein (1997) argue that data aggregation can significantly improve the efficiency and transparency of real estate transactions by providing a "single source of truth." According to Wiesweg et al. (2022), strong changes in the flow of information can lead to performance issues during real estate operations and could prevent improvements in the efficiency of processes. Hence, there is a

need for more efficient processes, and this can happen through for instance, the aggregation of data within a single platform in order to prevent any changes of the information or any other issues.

In addition to the points already mentioned, we want to emphasize that data aggregation can impact market analysis and predictive modelling. As Zillow and Redfin have shown, data aggregation with enough good data could allow for better analysis of market trends and enhance predictive pricing models, which are helpful tools for buyers, sellers, and realtors (Rigdon, 2018). Those models rely heavily on large datasets, hence the importance of a platform like Unlockit that would gather and aggregate rental real estate data. The question of incentives and how to gather the data remains and will be further explored.
Moreover, Distributed Ledger Technologies (DLTs) could be the key to offer a secure and transparent method for data aggregation. Tapscott and Tapscott (2016) suggest that DLTs can revolutionize the way data is aggregated and shared, ensuring data has been verified and reducing the risk of fraud. Such technology would be a possible answer to the issues highlighted above as well to the benefits of data aggregation in real estate.

2.3. Data Sharing Models and Theories

Since there is limited literature focusing specifically on data sharing models in real estate as data aggregation between parties and cooperation is a relatively novel idea, we decided to use and apply general data sharing theories as we believe the concepts can be applied in the context of real estate. The "Tragedy of the Commons" theory, which was by Hardin (1968), suggests that individuals are less likely to share data when they believe it will be used incorrectly. Indeed, sharing data costs time and effort, and the benefits of sharing data are not always clear for both parties, especially for the one that provides the data.

Although both parties could benefit from sharing data, there could still be miscomprehensions and biased that hinder the collaboration and would lead to a state where parties do not trust each enough to share their data. Therefore, creating a secure and transparent platform is essential to encourage data sharing and promote trust between the two parties.

Trust is important, but so is value. For that matter, we want to use another relevant theory called the "Network Effects" model, which assumes that the value of a service or product increases as more people use it (Katz and Shapiro, 1985). In the context of a centralized real estate platform, as more participants contribute data, the platform becomes more valuable to all participants. Indeed, as more people share data, other participants that could potentially share data could feel that the platform is secure and would be more inclined to trust it. In Unlockit's case, the toughest challenge will be to get enough people to share data to create this network effect. For that regard, finding appropriate incentives for each participant will be key.

In order to create a secure platform for participants to share their data, Wu et al. (2022) proposed an enhanced blockchain-based secure sharing scheme known as EBSS specifically for real estate financial credentials. Their work focuses on multiple important issues related to data sharing, such as confidentiality, anonymity, and traceability. The EBSS scheme utilizes hierarchical encryption and access control approaches to ensure the confidentiality of shared credentials. It also uses a combined group signature-based and commitment-based scheme to achieve anonymous authentication. Furthermore, the scheme supports the tracking of identity and the auditing of transactions through a distributed ledger mechanism. Implementing such features on Unlockit could provide strong incentives for participants in the rental real estate market to share their data in a secure and most trustworthy way.

Indeed, data-sharing is an issue, and incentives matter, but there are other important aspects to consider. Security and privacy issues must also be addressed in order to make the Unlockit platform attractive to participants. The study of the aforementioned model shows that it is effective and feasible. This suggests that blockchain-based solutions could be a potential way of incentivizing data sharing in the rental market (Wu et al., 2022). Although the study focuses on real estate financial credentials and not on real estate data such as transactional data or legal documents, we believe that the proposed scheme still applies in order to reflect on how to create a secure platform.

When exploring the different data sharing models, it's vital to explore the concept of "Information Asymmetry" in real estate. Akerlof's (1970) work on information asymmetry tells us that unequal access to information can lead to market inefficiencies. In real estate, this asymmetry often leads to imbalances of power between different participants. By aggregating data on a single platform, Unlockit could create a level playing field, therefore providing a better reason for participants to share their data with Unlockit.

2.4. Behavioral Economics and Strategies to Incentivize

Using behavioral economics concepts we are able to get insights into how individuals make decisions, including the sharing of data. These concepts and studies will be helpful in understanding needs, behaviors and will be very important to design the incentives and business model of Unlockit. Indeed, as indicated previously, incentives will play a central role in driving adoption of the platform. We must then study and understand what would make the participants share their data. Different strategies would have different results, therefore it is needed to go through a thorough analysis. Thaler and Sunstein (2008) in their book "Nudge" discuss how small incentives can lead to important changes of behavior. If we relate this to Unlockit, offering financial or non-financial incentives could potentially encourage stakeholders to share data.

Moreover, the concept of "Social Proof," that was explained by Cialdini (1984), can be used. Indeed, reciprocity is a powerful motivator in human behavior. By creating an environment where both parties benefit from data sharing, participants might be more inclined to contribute. This could be supported by highlighting case studies or testimonials where data sharing has led to positive results for all parties involved (Cialdini, 1984).
Lastly, we want to emphasize and highlight the role of transparency in building trust in the context of sharing real estate data. By making the data usage and sharing process transparent, in addition to showing how this data benefits all participants, Unlockit could promote trust and bolster cooperation (Ostrom, 1990). This would greatly play a role in furthering the network effect mentioned in the beginning of the literature review.

Furthermore, implementing a system of rewards with different levels would be an efficient way to target and adapt to different types of participants. For instance, regular data contributors could be recognized with advanced analytics tools or market insights from Unlockit, providing them with services that are beneficial for them. Such services would be perceived as valuable and would foster the sense of cooperation as the participants gave something, but also got something valuable in return. This goes with the concept of reciprocity mentioned above and would be a good motivator. In order to receive something, there needs to be a benefit for the other party to give, therefore incentivizing is key, whether it comes with direct financial rewards or other types of rewards.

2.5. Trust and Data Security

The rental real estate sector is increasingly confronted with the intricate challenges of data management, aggregation, and ensuring transparency in its operations. The dynamic interplay between various stakeholders – including buyers, sellers, real estate agencies, realtors, lawyers, and online platforms – underscores the necessity for a more transparent, reliable, and efficient flow of information. This complexity is magnified when considering the variety of

transactions and administrative processes inherent in the real estate market (Finck, 2019). In this context, this review aims to delve into the crucial question: How can participants in the rental real estate market be incentivized to trust and utilize a centralized platform like Unlockit for their data sharing and transactional processes? In addressing this, it becomes especially important to explore the multifaceted aspects of trust and data security in the world of real estate. Trust, in this sector, transcends the mere safeguarding of sensitive information; it encompasses the reliability and accuracy of data, the assurance of privacy for all parties, and the guarantee of beneficial usage of the data shared. In particular through the use of blockchain it is important for all users to have control over what data is necessary to share and what should remain private (Karamitsos, 2018). For Unlockit, building this trust necessitates an intricate balance between implementing rigorous data security measures and demonstrating the practical advantages of data sharing in real estate transactions. As will be explored further in the paper this is a major point of sensitivity for most parties especially with current business models of various real estate agencies.

These security measures should not only align with European law and standards in cybersecurity/blockchain but also be agile enough to adapt to the evolving nature of cyber threats. Compliance with international data protection regulations, such as the General Data Protection Regulation (GDPR), becomes a cornerstone in establishing this trust. In addition, the platform must transparently communicate its data handling practices while having a clear distinction between what information is public and private. This would serve to ensure that all stakeholders are aware of how their data is being used, stored, and protected (Finck, 2019). When prototyping the platform, it is also extremely important to articulate the value proposition of data sharing. In particular for government institutions and real estate agencies who may see this as a threat. This includes illustrating how advanced data analytics can empower stakeholders with insights for more informed decision-making, or how automation

and data-driven processes can streamline and expedite transactional workflows. The platform and its development should also demonstrate the tangible benefits it offers, such as enhancing market accessibility, reducing administrative burdens, and potentially lowering transaction costs (Karamitsos, 2018). However, the complexity does not end here. Unlockit must also navigate the diverse and sometimes conflicting interests of various market participants. After preliminary talks with IRN and several members of real estate brokers it became clear that different goals complicate cooperation. Furthermore, it should facilitate an environment where data sharing is not perceived as a relinquishing of competitive advantage but as a contribution to a more efficient and transparent market ecosystem. In order to Incentivize stakeholders in this context, a nuanced understanding of their unique needs and concerns is required along with the ability to tailor solutions that address these effectively.

2.6. Regulatory Considerations

The rental real estate market, while navigating the complexities of data management and transparency, must also contend with a labyrinth of regulatory considerations. Especially considering the intended use of blockchain given all its advantages, the currently evolving regulations surrounding it are important to consider. These regulations encompass a wide spectrum of laws, ranging from data privacy, real estate transaction regulations, compliance with anti-money laundering directives (KYC and AML) and even potentially cross-border data sharing norms (Karamitsos, 2018). It is extremely important to understand how Unlockit can develop its platform that adheres to stakeholders needs while simultaneously navigating these regulatory frameworks. At the forefront of these considerations is the adherence to data protection regulations, a particularly important aspect given the scope of the project, such as the General Data Protection Regulation (GDPR) in the European Union, which mandates tight controls over the handling of personal data (European Parliament and Council, 2023). For a platform like Unlockit, this entails not only securing data against unauthorized access

but also ensuring that data collection, processing, and storage practices are transparent, and consent based. The platform must demonstrate a robust compliance framework that is up to date with European standards, instilling confidence among stakeholders that their engagement with the platform aligns with legal requirements.

The real estate market is also subject to specific regulations that govern property transactions. These may include disclosure requirements, anti-discrimination laws, and regulations related to property financing (particularly through guarantors and loans). Unlockit must ensure that transactional processes are designed to comply with these regulations, offering an improved yet compliant and seamless experience for renters, landlords, lawyers and realtors. This compliance must extend itself to the accuracy and authenticity of the data provided on the platform, which is critical in property valuation, financing decisions, and legal verifications. eIDAS (Electronic Identification, Authentication and Trust Services) is also important to consider as a regulation on electronic identification and trust services in the European Single Market (European Parliament and the Council 2014). The eIDAS regulation creates a predictable regulatory environment to enable secure and seamless electronic interactions between businesses, citizens and public authorities. It provides a framework for digital trust services, including electronic signatures, seals, time stamps, registered delivery services and certificates for website authentication. Real estate transactions are also often scrutinized under anti-money laundering and know your consumer (AML and KYC) laws. These laws mandate thorough checks to prevent illegal activities like money laundering and terrorist financing (LeewayHertz). Unlockit must incorporate robust checks into its platform, ensuring that each transaction and set of documents are monitored and vetted in accordance with these laws. This is a vital component in maintaining the integrity of the platform and safeguarding it against misuse. There is added complexity that is introduced by the global nature of the real estate market, where cross-border transactions bring into play different legal jurisdictions.

This may include foreign documents being used when setting up a rental contract. This aspect requires Unlockit to be adept at handling diverse regulatory requirements across different regions, encompassing everything from cross-border data transfer protocols and payments (European Parliament and Council, 2023). Navigating this multi-jurisdictional environment requires not only legal expertise but also a flexible platform architecture that can adapt to various legal requirements. While this paper is focussed on the rental market which is far simpler in terms of documentation the eventual goal of encompassing all forms of real estate transaction are an important factor to consider the development of this platform. For Unlockit, navigating this landscape is not just a matter of compliance, but a strategic imperative that can set it apart in the market and be the first of its type in Portugal (Garcia-Teruel, 2020). By effectively managing these regulatory considerations and demonstrating a commitment to legal compliance and integrity, Unlockit can further incentivize market participants to engage with its platform, confident in the knowledge that their transactions are secure, legal, and efficient.

2.7. Case Studies and Precedents

The exploration of case studies and precedents is instrumental in understanding the operational and strategic nuances of the rental real estate market, particularly in the context of integrating a centralized platform like Unlockit. These cases offer important insights into the practicalities of data management, regulatory adherence, and the cultivation of stakeholder trust and engagement.

The first example observed is Zillow, a well-known online real estate marketplace in the United States. Zillow works to aggregate real estate listings from various sources, providing comprehensive data on properties both for sale and rent. A critical aspect of their success lies in their robust data verification process, ensuring the accuracy and reliability of listings. For instance, Zillow uses complex algorithms to cross-reference data from multiple sources and

employs a team dedicated to data quality control (Zillow). Additionally, Zillow's user interface caters to a wide range of users, with tools like Zestimate providing estimated market values for homes using proprietary calculation methods. However, Zillow must constantly navigate evolving data privacy laws, such as the California Consumer Privacy Act (CCPA), to protect user data.

In Europe an example of a platform that is also innovating in the sector is Badi, a Barcelona-based rental platform focusing on shared housing. Badi employs advanced analytics to match tenants with suitable shared housing options. The platform's algorithm considers numerous factors such as personal interests, living habits, and preferred location to make these matches. Badi's success also hinges on its ability to provide market insights, like average rent prices in different neighborhoods. However, Badi has to comply with the EU's GDPR, ensuring tenant data is handled securely and transparently. They also need to be mindful of varying tenant rights across European countries, tailoring their services accordingly (Badi, 2019).

It was also important to consider any precedents that include adoption of blockchain in real estate transactions. Propy, a real estate transaction platform utilizing blockchain leverages blockchain technology to streamline real estate transactions. The use of blockchain allows for a decentralized and secure ledger of property ownership, reducing the risk of fraud and making the transaction process more transparent (Propy, 2021). For example, Propy completed the first-ever blockchain-based real estate sale in Vermont, USA. The transaction process was recorded on a blockchain ledger, enhancing security and transparency while reducing the need for intermediaries.

An additional case study we considered was the use of blockchain for land registry and the implication this could have on the industry. Sweden's land registry authority, Lantmäteriet, experimented with blockchain technology to record property transactions. This initiative

aimed to increase transparency, reduce fraud, and expedite the property transfer process. By creating a blockchain-based registry, Sweden demonstrated how emerging technologies could enhance the security and efficiency of traditional government services related to real estate, an element that can be considered if Portugal's institutions become involved or If Unlockit expands to markets that have these technologies (Lantmäteriet, 2016).

3. Research Methodology

In order to assess the relevance of Unlockit's platform and to work on the incentives part, we decided to focus on landlords. We interviewed landlords in order to understand their problems, how they manage their current processes such as rent and contracts and tried to see if the Unlockit platform could be of any use for them. Our goal is to provide Unlockit with added value, and for that matter we must be objective and not biased. The interviews were conducted in order to truly comprehend to what extend Unlockit's initial idea would be interested to landlord, which are potential future users. These interviews also help to see how the Unlockit platform could be improved or modified to cater the needs of the landlords throughout the whole transactional processes. Interviews with real estate brokers were also conducted in order to gauge sentiments towards such large fundamental changes and to understand their perspectives on current challenges. Furthermore, we also discussed with the Instituto dos Registos e do Notariado (IRN). Indeed, Unlockit wants to be able to gather data from all participants in order to aggregate everything and render it public. For that matter, it is important to not miss out on any important data. The Portuguese government holds data that can only be accessed through it. In order to assess if a potential collaboration between Unlockit and the IRN could bring benefits, we talked with Bruno, an employee in charge of the technological part. To evaluate the relevance of blockchain and how to use it in the context of Unlockit, we examined two different blockchain-based models that were applied in

the context of real estate, namely, EBSS and Collaborative Smart Contract (CoSC). In the equilibrium part we used game theory and behavioral economics.

4. Stakeholder Analysis

4.1 Landlords

For citizens, particularly landlords, Unlockit would simplify the rental process through the implementation of user-friendly interfaces. This approach significantly eases the complexity often associated with rental transactions, making the process more accessible and less time-consuming. Additionally, the platform would ideally provide transparent access to property history and contractual terms, ensuring that all parties involved in a rental agreement are well-informed and that their transactions are based on trust and transparency. After speaking to a wide variety of landlords throughout both the Lisbon area and Porto we found that the main concerns lie around additional costs that could be incurred as generally there is no lack of demand. Many landlords and property managers use various listing platforms along with private brokers having described no significant issues on their ends and with fears of higher costs. The use of an additional platform would have to compensate costs appropriately or speed up the process significantly for mass adoption.

4.2 Tenants

For the tenants the primary concern once again in addressing higher costs while the key way to incentivize adoption is by providing a significantly better service. It is important for the platform to be easy to use, clear and better than current systems especially given the wide range of technological literacy throughout various demographics in the country. Ultimately, this reflects quite closely with what was heard from landlords but given that fees for the platform are not likely to be absorbed by tenants, there is more focus on how processes could be faster. The emphasis should therefore be on streamlining the rental application process,

ensuring timely communication between tenants and landlords, and offering a comprehensive, yet intuitive interface that simplifies the search and application process. Features such as real-time property updates, custom search filters, and automated document handling could enhance the tenant experience, thereby increasing the attractiveness of the platform. By addressing these specific needs and concerns, UnlockIt can potentially carve a unique position in the market, offering value that resonates with both landlords and tenants.

4.3 Realtors

For realtors and brokers, a central appeal lies in enhanced data security measures for documentation and confidentiality, which are crucial in addressing the prevalent concerns about data safety in the real estate industry. This feature could be complemented by the provision of sophisticated market analytics tools, ensuring that realtors and brokers maintain their competitive edge in a rapidly evolving market landscape. This is achieved through automated document verification and contract management, significantly enhancing the efficiency of legal operations in real estate transactions. It is especially important to stress tangible benefits that realtors will see in their work when developing and pitching the platform due to strong resistance to any form of data sharing. Initially it may be best to consider an approach that highlights the increase in efficiency for transactions, facilitation of operations and potential features that could be used in the future such as market analytics tools and AI. These are the areas that can and should be targeted in an initial minimum viable product (MVP) given the difficulty in entering the market. Currently most real estate agents work with similar models taking a commission of one or two rents (depending on value) when completing a deal and keeping a portion of this. At IAD for example they work independently paying a monthly fee to the company and as a result keep 69% of the cut while at other more integrated firms this number can vary with JLL for example being 25%. With this in mind Unlockit can also consider the various sectors as some companies that have

larger teams and/or different models such as IAD tend to have a stronger resistance. Nate Sousa Uva, a tenured real estate broker for IAD shared her personal views about her role as an intermediary and described her personal connection to clients as her greatest asset, something she would not give up. Her view was also quite set in the fact that she enjoys the current model with real estate agents being pure intermediaries, any idea of a different model such as one that includes payment based on a monthly percentage of agreed upon rent was met with fierce scepticism. While other companies such as Remax showed more openness to Unlockit's vision of more transparent data in the market, too much disruption could lead to a lack of adoption across the industry. As described by Saari, Vimpari, & Junnila; "The recent blockchain literature on real estate transactions has highlighted how implementing blockchain concepts to reduce information asymmetries in real estate transactions would require updated policies or reward mechanisms for the parties to share information. Not all parties would likely benefit from the reduced information asymmetries." Particularly in the Portuguese market as seen from various conversations with tenured realtors, this seems to ultimately be a phase that cannot be overcome in the industry as things stand.

4.4 Lawyers/Notaries

For legal professionals, including lawyers and notaries, there could be a significant benefit from the platform's ability to streamline legal processes. Allowing for a faster processing of documents could make the experience smoother for all parties involved but while Unlockit has floated the idea of having its own team of legal experts on the platform that may be beyond the scope of an initial offering. This is because we also found that many of the biggest real estate agencies currently possess vast legal operations teams that set up and register contracts/transactions brokered by the company. This process was explained to us by Nate Sousa Uva who explored the process behind a deal where once there is an agreement, she directly contacts the legal team at IAD and much of the work is done immediately.

Having this be replaced would cause too much demand, add an additional layer of complexity and potential friction with the company. While an initial small team could be valuable, the platform would rather serve the various companies' legal teams instead of changing the dynamic too much initially.

4.5 Rental Platforms

Rental platforms such as Idealista could potentially also benefit from a platform such as Unlockit but many of the similar concerns that are seen in other stakeholders remain constant. Their role as intermediaries is currently highly profitable and would require a strong proof of concept before integrating a platform into their services. Similarly, to real estate agent's information if one of their most valuable assets and any threats to this, as presented in Unlockit's vision, cause strong friction. Devising an initial strategy to allow for more use is critical in the development of a first launch.

4.6 Instituto dos Registos e do Notariado (IRN)

One potentially important stakeholder that could facilitate and collaborate with Unlockit in the project is the Instituto dos Registos e do Notariado (IRN) which plays a significant role in real estate transactions by managing the public registries related to property and land. They maintain the Property Registry, which is a central repository of information about property ownership and related rights. When a real estate transaction occurs, such as buying or selling property, the transfer of ownership is typically recorded in the Property Registry. This recording provides legal certainty about property ownership. However, this can also apply to rental contracts in particular those with a longer duration (over four years). Other functions include land registration, authentication of real estate documents, issuance of the national tax identification number (NIF), data verification and the protection of property rights. The IRN's registries help verify the accuracy of information related to properties and real estate transactions. Prospective buyers can access these registries to confirm the property's

ownership status, any existing encumbrances, and legal restrictions before finalizing a transaction. In order to explore options from Unlockit's point of view we also spoke with Bruno Lemo, currently working with IRN in the IT and technical side with regards to potential collaboration. Currently IRN uses five different systems that are approximately 20 years old and poorly interconnected with other public institutions, a major problem for efficiency and for collaboration with other entities. With this in mind there is an ongoing project of digital transformation that aims to have a central system that encompasses all of IRN's operations. Given this process there could then be a promotion of further interoperability with other agencies such as tax authority. Inefficient processes and communication in this area lead to slow progress and repetitive information and with updated systems they could also document a far larger number of deals brokered by real estate companies (including most rental contracts as opposed to the current model) and store the respective records. This long-term objective is composed of a three-year plan where everything can eventually be digitized and data can be tiered (with a proposed end date of Q4, 2025). Some major benefits include greater advantage for citizens through the benefits of interoperability, easier processes and greater conveniences but there is still a digital literacy issue especially among an aging demographic which also makes this project of digitalisation especially difficult. Other ideas were also floated such as allocation of ID's to land components and data access subscription service. However, in the short term, Bruno currently believes that UnlockIt's vision is not compatible with IRN given the focus on digital transformation but in the future presents an opportunity for both. That all parties and citizens could benefit from collaboration but currently many challenges make it difficult at this point in time.

Given the various and wide set of challenges presented by current market stakeholders we will narrow the scope and refine focus on real estate agencies, landlords and online rental

platforms. These key stakeholders form a substantial part of the currently realistic and accessible part of the market that must be the key target points.

5. Game Theory & Behavioral Economics; How to incentivize stakeholders

5.1. Introduction to Game Theory in Real Estate

5.1.1. Overview of game theory concepts

Game theory, a branch of mathematics and economics, provides a useful framework for analyzing strategic interactions in multiple and diverse fields, including real estate. Its application in real estate is particularly relevant if we consider in our case the data sharing among different stakeholders such as landlords, tenants, real estate agents, and legal professionals (Holder, 2021). These stakeholders often have conflicting interests, making real estate transactions complex.

At its heart, game theory explores how individuals make decisions in situations where the outcome depends not only on their actions but also on the actions of others. In the context of real estate, this translates to understanding how each stakeholder's decision to share or keep the data affects the overall state of the market. For instance, a landlord's choice to share property data could influence a tenant's decision to rent or a realtor's ability to sell the property.

5.1.2. Relevance to real estate data sharing

The relevance of game theory in real estate becomes clear given how competitive this market is. Stakeholders are constantly making decisions that impact their financial returns and market position. For Unlockit, a platform aimed at improving and simplifying real estate transactions through the use of blockchain and a collaborative platform where data is shared,

understanding these interactions between stakeholders is key. The platform needs to navigate the motivations and behaviors of different players to create an environment that can foster data sharing.

One of the key concepts in game theory is the Nash Equilibrium, named after mathematician John Nash. This concept is useful in real estate market analysis. It represents a situation where, given the strategies of others, no player has anything to gain by changing their own strategy. In Unlockit's scenario, achieving a Nash Equilibrium would mean creating a balance where all parties involved see the maximum benefit in sharing their data, with no incentive to deviate from this strategy.

Understanding the Nash Equilibrium in the context of Unlockit involves analyzing how landlords, for instance, weigh the benefits of sharing data against potential risks like loss of privacy or competitive disadvantage. The equilibrium is achieved when these stakeholders perceive that sharing data contributes positively to their goals, such as attracting better tenants or maximizing property values, without compromising their market position.

In summary, game theory offers useful tools for Unlockit to have a strategy in order to approach data sharing in the real estate market. By applying game theory principles, Unlockit can identify the most effective ways to incentivize stakeholders, anticipate their responses, and create a platform that aligns with their interests (MIT, 2013). This strategic alignment is key to fostering a transparent, efficient, and cooperative real estate market.

5.2. Stakeholder Dynamics Analysis

5.2.1. Detailed examination of motivations and strategies of participants

In the real estate sector, understanding the complex interactions among various stakeholders such as landlords, tenants, real estate agents, and legal professionals is essential for effective

data sharing, particularly for platforms like Unlockit. Each group possesses unique motivations and considerations that influence their approach to data sharing, creating a complex landscape of interdependent decisions. (Atlas Global Advisors, 2023)

Landlords, who are crucial in this ecosystem, often prioritize maximizing property value and ensuring the best occupancy rate possible. Their willingness to share data can be influenced by the perceived impact on these goals. For instance, sharing detailed property data might attract more tenants due to increased transparency, but it could also potentially expose sensitive information that might affect their bargaining position.

Tenants, on the other hand, want transparency with regards to the condition of the property and also want a fair rent. Their participation in data sharing on platforms like Unlockit is often driven by the fact that they want to make better decisions when renting a flat or house. They might be more inclined to share feedback and preferences if they believe it leads to a better property search experience and that it will guarantee them better living conditions.

Real estate agents and brokers navigate a competitive landscape where access to comprehensive market data can provide a significant edge. Their decision to share or keep the data can be a strategic one, balancing the benefits of enhanced market insights against the risk of losing competitive advantage. Legal professionals, while not directly involved in these transactions, play a crucial role in ensuring compliance and facilitating transactions. Their engagement in data sharing is often guided by the need for streamlined legal processes and access to updated legal precedents and regulations.

Understanding all of this is crucial for Unlockit to tailor its platform to effectively encourage data sharing. It needs to align its features and incentives with the specific needs and motivations of each stakeholder group, ensuring that the perceived benefits of participation outweigh any potential concerns. This deep understanding of stakeholders will enable

Unlockit to create a more efficient, transparent, and cooperative real estate market, where data sharing is mutually beneficial for all the participants.

5.3. Nash Equilibrium in Data Sharing

For Unlockit, it will be key to understand the relation between its primary users (citizens, brokers & agents, and lawyers). Each group has unique motivations and considerations. Game theory offers a framework to analyze and predict the strategic interactions among these stakeholders, particularly focusing on their willingness to share data. (Grenadier, 2003)

5.3.1. Nash equilibrium in data sharing

When we apply Nash Equilibrium to the Unlockit case, it will be crucial to consider the different motivations and behaviors of landlords, as well as those of the citizens and real estate brokers and agents. The equilibrium here represents a state where landlords, understanding the collective behavior of other stakeholders, find optimal benefit in sharing their data, with no incentive to change their mind given the strategies of others. (Cornell University Blog, 2021)

5.3.2. Examining stakeholder strategies: landlords, citizens, and brokers & agents

For landlords, the decision to share data on Unlockit could be influenced by multiple factors: the potential to attract more tenants, streamline property management processes, or gain access to valuable market insights. Citizens might be interested in data sharing to have better access to property listings and market trends, while brokers and agents could be motivated by the possibility to access comprehensive market data, which could give them a competitive edge, or at least benefit them.

5.3.3. Scenario analysis for each group

Landlords: If we could consider a scenario where landlords recognize that sharing property details such as initial price, actual buying price, rental trends, and tenant feedback leads to

more efficient property management and higher occupancy rates, they are more likely to share data. The equilibrium is achieved when landlords see that not sharing data does not give them a significant advantage, especially if brokers, agents, and citizens are actively participating in data sharing.

Citizens: For citizens, equilibrium might be realized when they see that their data sharing (preferences, feedback) contributes to a more tailored property search experience. Observing landlords and brokers actively participating in data sharing emphasize the perception of mutual benefit.

Brokers & agents: For brokers and agents, the equilibrium could be when they acknowledge that the data landlords and citizens shared could enhance their ability to serve clients better, thereby benefiting their business.

5.3.4. Overcoming equilibrium barriers

In the first place, landlords might be hesitant to share data, thinking that it could lead to loss of control and they could also be concerned with privacy issues. Unlockit needs to address these fears by demonstrating the direct benefits of data sharing, such as enhanced visibility, better tenant matching, and access to market analytics. Highlighting success stories of other landlords who have benefited from the platform can foster participation.

5.3.5. Sustaining nash equilibrium with landlords

To maintain this state of equilibrium, Unlockit must ensure that the benefits perceived by landlords, citizens, and brokers & agents continue to outweigh any perceived disadvantages of data sharing. This could involve continuously updating and improving the platform's features based on user feedback, ensuring data security, and keeping the participants informed about how their data contributes to the overall efficiency of the real estate market, which should benefit all of them.

Integrating Nash Equilibrium into Unlockit's strategy, especially with landlords as a key stakeholder group, involves understanding and aligning the platform's incentives with their unique needs and motivations. By creating an environment where data sharing is seen as mutually beneficial for landlords, citizens, and brokers & agents, Unlockit can establish a collaborative ecosystem. This equilibrium is critical for the platform's success in fostering a transparent, efficient, and responsive real estate market. Indeed, the platform's data sharing aspect can only work if all participants are incentivized to do it and that the participants see mutual benefits with this. It is going to be a difficult process to convince and onboard all the participants. In the last part of the thesis we will expand on how Unlockit could incentivize the participants and will give some insights on what business model could be suitable.

5.4. Behavioral Economics in Stakeholder Decision-Making

5.4.1. Exploration of cognitive biases affecting stakeholder choices

Integrating behavioral economics into the analysis of real estate data sharing adds a layer of depth to understanding stakeholder decisions in Unlockit's ecosystem. Behavioral economics is different from the assumption of rational decision-making, typical in traditional economic theories, by considering the psychological, cognitive, and emotional factors that influence human behavior.

5.4.2. Discussion of loss aversion, reciprocity, and social proof

One crucial aspect is loss aversion, where stakeholders tend to weigh potential losses more heavily than gains. Landlords might fear losing control over their property information, while tenants could be concerned about privacy. Real estate agents may perceive data sharing as a threat to their competitive advantage. Unlockit must address these fears by clearly communicating the benefits of data sharing, such as increased market efficiency, better tenant-landlord matches, and enhanced market insights for agents.

Reciprocity and social proof are other powerful concepts from behavioral economics. Reciprocity can be leveraged by offering stakeholders tangible benefits in return for their data. For instance, landlords could receive analytics on market trends, while tenants might get personalized property recommendations. Social proof, demonstrated through testimonials or case studies, can influence stakeholders by showing them the benefits others have gained from using Unlockit.

Another key concept is the Fear Of Missing Out (FOMO). Stakeholders are more likely to engage in data sharing if they perceive that others in their community are doing so and benefiting from it. This is particularly effective in a digitally connected world, where trends and behaviors can be quickly observed and adopted.

Moreover, behavioral biases like anchoring and framing can influence how information is perceived and decisions are made (Humanities and Social Sciences Communications, 2023). For instance, how data sharing benefits are framed (emphasizing gains or mitigating losses) can significantly impact stakeholder responses.

Unlockit can apply these insights to design its platform and communication strategies. This could involve creating user interfaces that are intuitive and reassuring, offering features that clearly demonstrate the value of data sharing, and crafting messages that resonate with the intrinsic motivations of each stakeholder group.

In summary, applying behavioral economics principles helps Unlockit to understand and influence the complex decision-making processes of its users (Hillier & Waltham, 2015). By addressing their inherent biases and emotional drivers, Unlockit can encourage more active and beneficial participation in its data-sharing ecosystem.

5.5. Conclusion

In concluding the game theory and behavioral economics segment for Unlockit's data-sharing strategy, it's essential to emphasize the significance of these theoretical frameworks in understanding and aligning with the varied motivations of stakeholders in the real estate market. This approach is crucial for fostering a cooperative, efficient, and transparent platform. The effective application of these theories enables Unlockit to operate complex market dynamics, ensuring it remains responsive to the needs and behaviors of its users. Looking ahead, Unlockit stands poised to transform the real estate market, leveraging these insights for strategic and practical applications that benefit all stakeholders involved. This forward-thinking strategy signifies Unlockit's potential to revolutionize real estate transactions, promoting a more informed, interconnected, and equitable market environment.

6. Use of Blockchain/Distributed ledger technologies (DLTs) in the context of Unlockit

6.1 Introduction to blockchain and DLTs in real estate

Blockchain and Distributed Ledger Technologies (DLTs) have emerged as transformative tools across various industries, with significant implications for the real estate sector. In real estate, particularly concerning financial credentials, with these technologies promising enhanced security, transparency, and efficiency (Wu et al., 2023). Unlockit’s goal is to ultimately simplify real estate transactional processes and engage all participants in a simple, practical, smooth and secure platform. As real estate involves different types of confidential documents, blockchain and distributed ledgers technologies offer a potential solution that should be explored.

6.2. Blockchain technology: Concept and application

Blockchain is a distributed ledger technology that records transactions securely, immutably, and transparently through different mechanisms such as Proof-of-Work/Proof-of-Stake, cryptography and consensus rules. In real estate, this technology can create a system for managing financial credentials, property titles, and transaction histories, establishing trust and efficiency in the process (Wu et al., 2023).

Blockchain can be private and permissioned or public and permissionless. These different methods of functioning have different goals and have to be carefully assessed. For a decentralized finance application, it is going to be necessary to opt for a public blockchain as it requires full transparency and no limitations on people who can use it. However, in the context of enterprise blockchain use cases, public blockchain might not always be the best choice. Indeed, companies usually need more privacy and more control. Although they might benefit from blockchain advantages for some use cases, they still need to retain some control and privacy. That is where private blockchain comes in place. According to (Mougayar, 2016), a private blockchain, also known as a permissioned blockchain, is a type of blockchain where access is restricted and controlled by a single organization or a consortium. Unlike public blockchains where anyone can join and participate in the network, a private blockchain requires an invitation and must be validated by either the network starter or by a set of rules put in place by the network starter. This type of blockchain is often used by private enterprises and organizations for business solutions where the control over the network is necessary for compliance, security, or other operational reasons.

6.3. Advantages of blockchain in real estate

Blockchain technology introduces a shift to handling real estate transactions, especially by improving transparency and trust. Blockchain technology possesses different core characteristics, of which immutability of the ledger, providing a transparent record where the

data cannot be altered or tampered with. In the real estate sector, where the history of a property is crucial, such as previous buyers and buying price, blockchain's ability to maintain an accurate and unalterable history of property ownership and transaction would be a game-changer. This transparency fosters a new level of confidence among buyers, sellers, and other stakeholders, ensuring the authenticity of information linked to the property. Such a system significantly reduces the potential for manipulation or alteration of records, a practice frequent in real estate processes.

The security and immutability aspect of blockchain is another key advantage. Once an information is entered into the blockchain, it cannot be altered or tampered with without the majority agreeing on this change. It is called “network consensus” (Knudsen, Notland, Haro, Ræder, & Li, 2021). This aspect is particularly important in real estate given that the integrity of real estate data such as property titles, transaction histories, and contractual agreements must be preserved. To protect against fraud, it is necessary to have a platform with enhanced security and immutability. This will help make real estate processes more reliable.

Moreover, blockchain technology can streamline real estate processes by fostering efficiency and speed, particularly through the use of smart contracts. These digital contracts automatically execute when predefined conditions are met, reducing the need for intermediaries such as brokers, legal representatives, and banks. This automation can greatly reduce processing times, reduce the need for lengthy paperwork, and accelerate sales and rental agreements. This results in a more efficient real estate market and easier transactions.

Another major advantage of blockchain in real estate is the possible reduction in transaction costs. By reducing the use of multiple intermediaries usually involved in real estate transactions, blockchain can reduce the commissions and fees that are included in traditional properties sales. This is more cost-effective and can render real estate transactions more

accessible and interesting and could potentially lead to increased market activity and more liquidity.

Blockchain's immutability is a great fit for property title management, ensuring a permanent, unalterable record of property transactions. For that matter, blockchain will be beneficial to effectively mitigate common fraud types, including false listings and title fraud. By providing a transparent and secure ledger, blockchain can significantly reduce these fraud risks, fostering a safer real estate environment for both buyers and sellers.

6.4. Challenges in real estate

Despite these advantages, the use of blockchain in real estate comes with challenges. One major problem is scalability. When a network faces too many transactions, it can struggle to process all of them efficiently. This can lead to delays and also more expensive transactions. This is especially the case of public blockchains, which are usually used by a lot of participants. Blockchains like Ethereum, when greatly used, can take a long time to process a transaction, and when a peak of transaction is achieved, they can cost tens of dollars. Per se, waiting a few minutes for a transaction would not be a dealbreaker for real estate processes, but it would not be optimal. Transactions with near-instant finality would be the most favourable to make processes as efficient as possible. The scalability issue must be considered, because as we mentioned previously, slower transactions and higher costs would be a barrier to promote blockchain to be used in real estate. If Unlockit wants to provide a centralized platform for transacting, this platform must be able to handle large amounts of transactions, in a quick and cheap way.

Scalability remains a significant challenge for blockchain in real estate. In cases where blockchain networks have faced performance barriers, it becomes clear that addressing these scalability issues is crucial for real estate applications that require high transaction volumes.

Additionally, aligning blockchain with GDPR compliance creates unique challenges, as blockchain's immutability aspect can conflict with GDPR's data deletion requirements. Existing blockchain projects addressing similar challenges offer valuable insights into potential solutions for these compliance issues.

GDPR and regulatory compliance is an additional challenge. The real estate industry is heavily regulated, and the use of blockchain technology will also have to be subject to that regulation. Unlockit aims to gather data from many different stakeholders, including governments. However, during our interview with the IRN, we have been told that the government could not use external software and would have to build and use their own. Collaboration could be conceivable, but this would surely not be a very simple process due to privacy reasons. The document "Blockchain and the General Data Protection Regulation" by (European Parliamentary Research Service, 2019) highlights that private and permissioned blockchains are usually more compatible with the EU data protection law and that public permissionless blockchains are less compatible due to their tendency to be more decentralized and more transparent. Unlockit will have to take this into consideration with regards to the types of blockchain it will use to build its platform and ensure GDPR and regulatory compliance.

In definitive, although blockchain is a promising technology that can be used to enhance the processes of the rental market by making them more transparent and efficient, it also poses some challenges that need to be addressed. These challenges mainly reside in building the infrastructure of the platform and complying with regulations.

6.5. EBSS: Enhanced blockchain-based secure sharing for real estate financial credentials

This part will focus on presenting and discussing a framework called “The EBSS scheme” which was introduced by Wu et al. (2023). It describes an application of blockchain technology within the real estate industry but focusing on the management of real estate financial credentials. However, these ideas can be applicable in the context of Unlockit. Our goal with this part is to present the research that has been done to provide Unlockit with practical examples and insights.

This scheme has the objective to address several key problems regarding how sensitive real estate information is being handled, by presenting a versatile approach that combines advanced cryptographic techniques with the intrinsic benefits of blockchain such as immutability, traceability and transparency.

As just mentioned, EBSS utilizes advanced cryptographic techniques to enhance data security and privacy in real estate financial transactions. Hierarchical encryption and access control ensure the confidentiality and integrity of shared credentials, while group signature-based and commitment-based approaches offer anonymous authentication, addressing privacy and transaction confidentiality. Although it has numerous security benefits, implementing EBSS in the real estate sector may face adoption barriers, such as resistance to change and integration challenges with existing systems.

The EBSS scheme places an emphasis on ensuring the confidentiality of real estate credentials. It accomplishes this through a combination of encryption and access control methods which are vital in an industry where the protection of financial credentials is of utmost importance. By employing encryption, sensitive data is appropriately secured at levels

of sensitivity. Access control mechanisms then govern who can access data, thereby maintaining strict data privacy and security protocols.

Another notable aspect of the EBSS scheme is its ability to authenticate parties involved in real estate transactions while preserving their anonymity. This feature addresses the concern for privacy in transactions. By allowing authentication without revealing identities, it not only enhances user privacy but also adds an extra layer of security by preventing malicious actors from easily identifying and targeting users based on their transaction history or financial credentials.

Moreover, the EBSS scheme acknowledges the importance of identity tracking and transaction auditing in real estate transactions. Leveraging blockchain capabilities it ensures the maintenance of a detailed and unalterable record of transactions and credential changes. This feature proves advantageous for auditing purposes as well as for maintaining transparent transaction records while ensuring the credibility and verifiability of credential content. A system such as the EBSS one plays an important role in preventing fraud and errors, which are common issues in real estate processes.

In the EBSS paper, Wu et al. (2023) also underlines the importance of resisting data tempering. Being able to ensure that real estate credentials cannot be altered without having to verify it is vital for building and sustaining trust in the system. The blockchain's immutable aspect plays a crucial role here, as it provides a secure and tamper-evident environment where each transaction and credential change is permanently recorded and can be easily verified.

They also mention the integration of Role-Based Access Control (RBAC) within the EBSS scheme to further strengthen its capability to manage and preserve real estate financial credentials in an effective way. By assigning roles and corresponding access privileges,

EBSS ensures that users only access the data they need, and not other data that would not be relevant or useful for them. This is commonly referred to as the principle of least privilege. This not only enhances security but also streamlines the workflow by ensuring that users are not overwhelmed with unnecessary information.

Overall, Wu et al. (2023)'s EBSS scheme shows a practical application of blockchain technology in the context of securing data and information in the real estate industry, with an emphasis on security, privacy, confidentiality and integrity of the data. EBSS could be an inspiration for Unlockit. Unlockit has broader goals as it aims to be a single source of truth regarding data aggregation and a secure platform for transacting and signing documents. Therefore, the EBSS scheme does not fully apply, but can be very helpful for designing Unlockit's infrastructure. In the context of Unlockit, the use of blockchain really needs to be tailored to their specific goals and aspects such as decentralization and transparency will not be a priority. The focus will then be on privacy, security, confidentiality, immutability and traceability. With regards to these considerations, a private blockchain structure might be more relevant. Examples of such private blockchains include Hyperledger, Daml, Quorum or R3 Corda.

6.6. Implications for real estate industry

The EBSS model shows the potential of blockchain and DLTs in enhancing the security, efficiency, and transparency of real estate transactions. This model serves as a blueprint for developing similar systems in the real estate industry.

A focus on private blockchain networks; how could they benefit Unlockit?

Previously we mentioned the names of some of the most used private blockchain networks. In this part, we will focus on three of them.

6.6.1. Hyperledger Fabric

Hyperledger is a permissioned distributed ledger framework for developing applications. It is an open-source project created by the Linux Foundation. Hyperledger is a project that contains various tools and frameworks designed to support the development of blockchain-based applications for enterprises. One of the key advantages of Hyperledger is that it offers a modular and configurable architecture, which is very well-suited for enterprise projects. In the context of Unlockit, Hyperledger would be a good fit to create a robust, secure, scalable platform that can achieve privacy when needed. Indeed, Unlockit will disclose aggregated data for free, but some data have to remain private (legal documents and personal data of buyers and sellers). Moreover, its flexibility in permissions can allow different access levels for various stakeholders like citizens, brokers, and landlords, ensuring that data is shared securely and efficiently. From the mining industry to supply chain and global trade, a multitude of multinationals are using Hyperledger to create innovative solutions that traditional systems cannot resolve. (Hyperledger, 2023)

6.6.2. R3 Corda

Corda is a blockchain platform developed by R3 and is designed for enterprise. It puts a special emphasis on privacy, security and scalability. These are key elements for Unlockit.

Corda is open and permissioned, meaning that information is only shared among parties that have a legitimate need to know specific data. This is very interesting and relevant for Unlockit. Indeed, in real estate transactions confidentiality is paramount. The platform is also able to integrate with existing legal and regulatory frameworks, which makes it even more suitable for Unlockit since it requires it to be compliant with laws such as property laws and with regulations. (Corda, 2023)

6.6.3. Quorum

Quorum is an open-source enterprise-focused version of Ethereum that was developed by Consensys. It leverages the Ethereum blockchain to develop enterprise use cases. Indeed, public blockchain like Ethereum are currently not suitable for enterprise blockchain projects due to scalability issues and lack of control. Quorum's main features include increased transaction speed, privacy options, and the ability to work in a permissioned network environment. Quorum is able to handle high-speed private transactions, so it makes it an interesting choice for Unlockit to build their platform on it. Quorum can be utilized to build a secure and efficient platform for real estate transactions, offering benefits such as faster processing times and enhanced privacy controls. Quorum's main advantage is its focus on flexibility. As indicated on the website, "*ConsenSys' product modules on top of Quorum can be deployed to address a variety of industries and institutional use cases.*"

Consensys' side products include rollups (layer 2 solution that permits high-speed and extremely low fees on transactions), an Enterprise Key Management, which would allow Unlockit to build with enterprise-grade security and be able to have a secure space to manage security aspects such as key management and private key signing.

Quorum can be used to design a solution that activates smart property management to facilitate data sharing, streamline rental collections and payment to property owners. Another example is about land registries. Analog paper-based processes can lead to loss, fraud and mismanagement. Property transfers can be very expensive and lengthy. Through Quorum, Unlockit could build an immutable digital registry to help facilitate transactions and provide a single source of truth. (Quorum, 2023)

6.6.4. DAML

DAML (a short for (Digital Asset Modeling Language), is a smart contract language and framework designed for creating enterprise use cases. DAML is perfect for creating interconnected solutions. DAML is used mainly to build efficient platforms that automate workflow with very high-speed and low cost. For Unlockit, DAML can enable the creation of legally appropriate smart contracts that can automate various aspects of real estate transactions, such as escrow services, property transfers, and compliance checks. Its emphasis on creating clear and enforceable digital agreements can drastically reduce the legal complexities and paperwork traditionally involved in real estate, making the process more efficient and user-friendly for all stakeholders involved. (DAML, 2023)

6.7. Collaborative smart Contracts (CoSC) in real estate transactions

6.7.1. Concept and application

In this part I will give a second example of blockchain applied to real estate to give insights to Unlockit. This model is called 'The Collaborative Smart Contracts (CoSC)' model. As the name says, the goal of this approach is to think of a way to create a collaborative platform to process real estate transactions with all participants. This is very relevant in the case of Unlockit, and we believe this paper provides a strong foundation for Unlockit's platform. Indeed, earlier we mentioned smart contracts. These digital contracts running on a blockchain are the perfect way to allow for automation and immutability within Unlockit's application. Let's dive into this model and how it is relevant for Unlockit to create a collaborative platform and incentivize participants to share their data but also to use the platform. (Timuçin & Biroğul, 2023).

This model is designed taking into consideration the complexities of real estate deals, which involve various participants like real estate brokers, lawyers, buyers and sellers. In the CoSC

model, a consortium blockchain is considered. CoSC facilitates a collaborative environment where all parties can engage in the contract execution process, particularly effective in complex, multi-party transactions, which are common in real estate. It ensures that each party's role and responsibilities are clearly defined and executed within the smart contract framework, leading to more efficient and transparent transactions.

CoSC offers a novel approach that combines smart contracts with collaborative decision-making in real estate transactions. It operates on a consortium blockchain network, emphasizing transparency, fairness, and efficiency, particularly in real estate purchase and sale processes. CoSC focuses on multi-party collaboration and its performance in terms of execution time, benefits, and security, makes it a promising solution for improving the efficiency, transparency, and trustworthiness of complex real estate transactions. Integration with other technologies like IoT could further enhance its capabilities for smarter property management.

6.7.2. Operational mechanism

CoSC uses a shared, secure blockchain network, enabling a transparent and collaborative space for all participants involved in a real estate transaction. The platform is designed in a way where smart contracts are executed, which automate the terms agreed and defined. That way, there is no, or less need for middlemen, which is cheaper and faster. This automation is particularly beneficial in managing various stages of real estate transactions, including initial agreements, compliance checks, and finalizing deals. By streamlining these processes, CoSC not only promotes more efficiency, but also minimizes the potential for human error and miscommunication, which are common mistakes in real estate deals.

6.7.3. Impact on real estate processes

The use of CosC in real estate deals will revolutionize traditional processes which are still relying heavily on paper-based processes and manual actions, on top of outdated IT systems. CoSC will render these analog processes more streamlined and transparent. The model's ability to manage property titles, transaction histories, and contractual agreements suits perfectly with Unlockit's objective to simplify real estate transactions. By integrating CoSC, Unlockit can offer a more efficient platform for real estate transactions through automation, which is really important to reduce the time and effort required to complete property deals.

6.7.4. Application in Unlockit's transaction management software

Unlockit's goal is to create a digital workspace that facilitates effortless collaboration among various stakeholders through simplified compliance, paperwork and communications. CoSC could be used or studied to help design Unlockit's platform and revolutionize how real estate transactions are managed and conducted. Its application can lead to a more synchronized process, where real-time updates and automated contract execution enhance the overall efficiency and reliability of real estate transactions.

6.7.5. compliance and paperwork simplification

One of the most significant challenges in real estate transactions is ensuring compliance with legal requirements and managing paperwork. CoSC addresses these challenges by digitizing and automating the legal and contractual aspects of real estate transactions. The smart contract technology inherent in CoSC can automatically verify compliance with laws and regulations, reducing the heavy reliance on lawyers and notaries which can end up being costly, and usually lengthen the overall process. This simplification of paperwork not only speeds up the process but also reduces the potential for errors, ensuring that all transactional documents are accurate, up-to-date, and comply with laws and regulations.

6.7.6. Communication and collaboration benefits

Unlockit wants to create a collaborative environment, which would be used by all participants involved in the deal to transact, sign documents through the platform. The more these participants are incentivized to use the platform, the better it will be. The platform must allow for seamless and smooth interaction between all participants and bring to each benefit so that they have an interest in using it. We believe that the CoSC could help enhance communication and collaboration among all parties involved. Its consortium blockchain structure allows stakeholders to access a common platform where information is transparent, and participants can easily access real-time updates. This is particularly beneficial for agents and their clients, who require constant communication and access to accurate information. CoSC fosters a trust-based environment where each party is assured of the authenticity and timeliness of the information shared, leading to more informed decisions and smoother transactions.

6.7.7. Future prospects and development for CoSC

We believe that the CoSC model has a lot of potential to be further developed. This could be by further studying the model and enhancing it with other features, functionalities or using other types of networks, or by integrating other technologies such as AI or IoT.

In conclusion, the Collaborative Smart Contracts model offers an innovative and efficient solution for managing real estate transactions, in line with Unlockit's goal of simplifying the home buying and selling process. By adopting or adapting the CoSC model, Unlockit can offer a platform that is efficient, transparent, and conducive to seamless collaboration among all stakeholders in the real estate sector.

6.8. Future directions and potential developments for DLTs/Blockchain in real estate

The evolution of blockchain and DLTs will likely enhance their capabilities and applicability in the real estate industry, with innovations in scalability, integration with technologies like IoT, and advancements in cryptographic methods.

6.9. Conclusion

Blockchain and DLTs, as demonstrated by the EBSS or CoSC models, offer solutions for Unlockit, and more broadly for the real estate industry's needs for secure, transparent, and efficient transaction processes. The choice and design of the underlying infrastructure will depend on Unlockit’s goals, objectives and the aspects that matter most for their platform, such as confidentiality and security. The platform infrastructure will serve as the basis for developing incentives that will bring participants to share their data with Unlockit, and ultimately use the platform for all their real estate deals. The extent to which the platform is legally compliant, allows for transparency, immutability, security and confidentiality will be key in driving adoption of the platform.

7. Incentives and Business Model for Unlockit

7.1 Digital Real Estate Workspace

Unlockit's Minimum Viable Product (MVP), the Digital Real Estate Workspace, must be a meticulously designed platform that offers a suite of functionalities and incentives tailored to revolutionize the way real estate professionals operate. At its core, this comprehensive portal facilitates efficient management of client interactions, document handling, and transaction processing, catering specifically to realtors, brokers, lawyers, solicitors, and notaries. The workspace's robust functionality must be underscored by several concrete incentives aimed at enhancing user experience and operational efficiency. Key features must include

customizable dashboards that allow various entities to properly tailor the platform to their needs.

The incentives for adopting the Digital Real Estate Workspace must be manifold, promising for efficient technology through blockchain and interoperability between different parties that ultimately speeds up the process in a way to justify the cost. Through increased efficiency and productivity by automating routine tasks, agents and brokers are allowed to focus more on client service and closing deals. The platform must enhance the client experience by offering modern, engaging features potentially incorporating new features and consistent updates are user friendly. The workspace also addresses the critical aspects of risk and compliance. Automated checks and secure document management minimize the risk of errors and non-compliance in transactions, ensuring adherence to evolving legal and regulatory standards. Furthermore, the platform offers significant cost savings by reducing operational costs through automation in the long term with efficient resource management, and by diminishing the need for physical document storage and manual processing (Kalyuzhnova, 2018). This process must be proven through metrics and fine testing of the platform prior making it accessible.

The implementation strategy should include comprehensive user training and support to ensure smooth onboarding and usage. Feedback-driven iterations are integral to the platform's evolution, ensuring it continuously aligns with user needs. Marketing and awareness campaigns are crucial in showcasing the benefits and features of the workspace to potential users. Pilot programs with key clients are instrumental in demonstrating the platform's effectiveness and gathering testimonials for broader marketing. A digital real estate workspace from Unlockit is poised to provide a transformative solution for the real estate industry. By aligning with the evolving needs of its stakeholders, it sets a new standard for

efficiency, compliance, and client service, heralding a new era in real estate transaction management (Kalyuzhnova, 2018).

7.1.1 Blockchain-based Rental System

The Blockchain-based Rental System, a pivotal component of Unlockit's MVP, introduces a paradigm shift in managing rental agreements through the use of blockchain technology. This innovative system is designed to bring transparency and efficiency to the forefront of rental processes. At its core, the functionality of the system revolves around the utilization of blockchain for crafting rental agreements that are not only transparent and immutable but also automatically executable. This is achieved through the deployment of smart contracts, a cornerstone feature of blockchain technology. These smart contracts are programmed to automatically execute rental agreements, thereby minimizing the potential for human error or misinterpretation of contract terms. This automation extends to various aspects of the rental process, including the critical task of rent collection. By automating rent payments through smart contracts, the system significantly reduces the administrative overhead for landlords, streamlining what has traditionally been a time-consuming and often complex process.

In addition to automated rent collection, the system incorporates built-in smart contract features for dispute resolution. This functionality is crucial in enhancing trust and reliability between tenants and landlords. By offering swift and fair dispute resolution mechanisms, the system ensures that any disagreements or issues that arise during the rental period can be resolved efficiently and equitably, fostering a harmonious tenant-landlord relationship (Timuçin & Biroğul, 2023).

A key incentive for early adopters of the system is the offering of reduced transaction fees or a period of fee waivers. This strategic move is designed to encourage initial usage of the system, demonstrating Unlockit's commitment to user acquisition and market penetration.

Beyond the functionality of smart contracts for rental agreements, the Blockchain-based Rental System also emphasizes the importance of decentralized identity verification. This feature integrates advanced identity verification methods to ensure the security and trust in tenant-landlord relationships. In an industry where the verification of identities is paramount, this decentralized approach offers a more secure and reliable means of confirming the identities of all parties involved in a rental agreement (Wouda, 2019). The incentives for adopting this blockchain-based system are manifold. Automated processes inherent in the system streamline rental transactions, significantly reducing the time and effort typically required in traditional rental methods. Enhanced security and trust are key benefits, as the system provides a more secure and transparent rental experience. This transparency is not just beneficial for tenants and landlords but also adds a layer of accountability to the rental process. Additionally, the system promises reduced costs by lowering administrative and legal costs associated with rental agreements through automation (Wouda, 2019).

The implementation strategy for the Blockchain-based Rental System includes several key initiatives. Educational initiatives are paramount to ensure that stakeholders fully understand blockchain technology and its benefits in the rental process. A focus on education helps in alleviating any apprehensions or misconceptions about blockchain technology, facilitating smoother adoption. The development of a user-friendly interface is crucial in ensuring that the transition to digital rental agreements is as seamless as possible. This approach is especially important in attracting users who may be less tech-savvy or resistant to change (Spielman 2016). Pilot projects with early adopters are also an integral part of the strategy, allowing Unlockit to showcase the system's effectiveness and refine its features based on real-world feedback.

Ultimately however, companies and real estate companies do not care about the underlying technology and are purely focussed on the more tangible effects. It is important to focus on

what the benefits are rather than how it truly works (Saari, 2022). The implementation strategy, with its emphasis on education, user-friendliness, and pilot projects, ensures that the system is not only innovative but also accessible and practical for its intended users. Through this system, Unlockit is poised to set new standards in the rental market, showcasing the transformative potential of blockchain technology in real estate.

7.1.2 Regulatory Compliance Tools

The Regulatory Compliance Tools, as an integral part of Unlockit's platform, are meticulously engineered to address the critical need for compliance monitoring and legal adherence in the real estate market. These tools are not merely functional; they are transformative, providing a robust framework for regulators to ensure that real estate transactions comply with the prevailing laws and regulations. The functionality of these tools is multifaceted. Firstly, they are designed to create automated audit trails for real estate transactions. These trails are immutable, enhancing the transparency and accountability of transactions. This feature is crucial in a sector where the accuracy and veracity of transaction records are paramount. By ensuring that each transaction is accurately logged and immutable, the platform significantly enhances the trust in and reliability of real estate transactions (European Parliament and the Council 2014).

Additionally, the tools offer capabilities for real-time monitoring and reporting of compliance with real estate laws and regulations. This aspect of the tools is particularly important in an industry that is often subject to complex and evolving legal frameworks. Real-time monitoring allows for prompt identification and resolution of compliance issues, thereby maintaining the integrity of the real estate market. The concrete incentives for adopting these regulatory compliance tools are significant (European Parliament and the Council, 2016). They bring efficiency in compliance monitoring, highlighting how the tool can streamline and automate regulatory processes, thus saving time and resources for regulatory bodies. This

efficiency is a critical benefit, as regulatory compliance is often seen as a time-consuming and resource-intensive task. By automating these processes, Unlockit's tools allow regulatory bodies to focus on more strategic tasks, enhancing their overall effectiveness (Garcia-Teruel, 2020). Providing regulators with real-time access to transaction data is another key incentive. This access enhances the ability of regulators to monitor market activities effectively, ensuring that they are always up to date with the latest transactions and market trends. This feature is instrumental in proactive regulatory oversight, allowing regulators to swiftly respond to market anomalies or potential regulatory breaches (Saari, 2022).

The establishment of a collaborative compliance framework marks a paradigm shift in how regulatory compliance is managed. By fostering a sense of partnership between regulators and industry stakeholders, these tools enhance communication and compliance. This collaborative approach is beneficial not only in ensuring compliance but also in building a cooperative relationship between regulators and the real estate industry. Unlockit's implementation strategy for these tools is as comprehensive as their functionality. A key component of this strategy is the formation of regulatory partnerships. These partnerships ensure that the tools are not only aligned with current legal requirements but are also adaptable to future changes in the regulatory landscape. Collaboration with regulatory bodies is crucial in ensuring that the tools are effective and relevant. Customization and scalability are at the heart of the development of these tools. Recognizing that the regulatory landscape is diverse and ever-changing, Unlockit has focused on developing solutions that can be customized to meet the specific needs of different regulatory bodies and can be scaled to adapt to evolving regulatory requirements (Wouda, 2019).

Demonstrations and training sessions for regulatory authorities are a crucial part of the implementation strategy. These sessions are designed to illustrate the benefits and functionality of the tools, ensuring that regulatory authorities are well-equipped to utilize

them effectively. Training sessions also serve as a platform for feedback, allowing Unlockit to refine and enhance the tools based on real-world usage and requirements. Unlockit's Regulatory Compliance Tools represent a ground-breaking development in the real estate sector. By focusing on transparency, efficiency, and collaboration, these tools offer a range of benefits that appeal to regulators and industry stakeholders alike. The implementation strategy, with its focus on partnerships, customization, and training, ensures that the tools are not only innovative but also practical and adaptable to the needs of the regulatory community. Through these tools, Unlockit is poised to set new standards in regulatory compliance in the real estate market, showcasing the transformative potential of technology in enhancing legal adherence and market integrity.

7.2 Initial Business Model Proposal

Unlockit's platform represents a potentially ground-breaking advancement in efficiency for the real estate market but will require substantial time to reach its ultimate goal. In its initial iteration focussing on what is possible and realistic in the current climate is the best course of action. A platform that can streamline transactions, given the idea for an initial set of features the best model we suggest is a subscription-based model complemented by transactional processing fees, tailored for the real estate industry's nuanced needs. Designed to cater to realtors, brokers, lawyers, solicitors, and notaries, this Minimum Viable Product (MVP) embodies a meticulously crafted platform that streamlines client interactions, document handling, and transaction processing. At its core, it offers a suite of functionalities that revolutionize operational efficiency and user experience. The platform's robust functionality, underscored by customizable dashboards, enables diverse real estate entities to tailor the workspace to their specific requirements. This customization aligns with the core promise of Unlockit: to provide a solution that is not just efficient but also adaptable to varied professional needs. The subscription model is strategically tiered, offering different levels of

access and features to accommodate the varying scales and scopes of real estate practices. This approach ensures affordability for smaller practices while providing comprehensive solutions for larger firms. In addition to the subscription fees, Unlockit leverages a transactional fee structure for specific services. These services include the processing of digital contracts and transactions that utilize the platform's advanced blockchain capabilities. The fee structure is carefully calibrated to ensure that it aligns with the value delivered, particularly in automating and securing transactional processes.

Unlockit's blockchain based platform, introduces an innovative approach to managing rental agreements. Utilizing blockchain technology, the system offers transparent, immutable, and automatically executable rental agreements through smart contracts (Timuçin & Biroğul, 2023). This automation extends to rent collection and dispute resolution, significantly reducing administrative overhead and enhancing reliability in tenant-landlord interactions. The system's incentivization strategy for early adopters includes reduced transaction fees or fee waivers, encouraging initial usage and demonstrating Unlockit's commitment to market penetration. Additionally, the platform emphasizes decentralized identity verification, enhancing security and trust in rental transactions.

Training and certification can play a crucial role in fostering widespread use of the program. Recognizing the importance of professional development in the rapidly evolving real estate sector, Unlockit offers courses and workshops focused on blockchain technology and digital real estate processes. These educational programs are designed to enhance the professional skills of users, keeping them abreast of the latest developments in the industry. Beyond skill enhancement, the platform provides official certification for completed courses. This accreditation adds credibility and recognition for professionals, bolstering their portfolio and career prospects. The training and certification model not only benefit the users but also reinforces Unlockit's position as a leader and innovator in the real estate tech sector.

The implementation strategy is multifaceted, focusing on comprehensive user training, support for smooth onboarding, and feedback-driven iterations. Marketing campaigns and pilot programs with key clients are instrumental in demonstrating the platform's effectiveness and gathering testimonials for broader marketing efforts. One key element to remember is the scalability aspect since as the platform grows, it could develop new features such as providing users with real-time market data, trends, and predictive analytics crucial for property valuation and market positioning. As these value-added features get rolled out broader changes to both the industry and business of Unlockit can be considered but at the current initial stage are too intricate. Along with further collaboration amongst stakeholders this presents many opportunities for future developments.

7.3 Additional Considerations

Unlockit's multifaceted approach towards developing its Minimum Viable Product (MVP) is a testament to its commitment to addressing the current challenges within the real estate market while also fostering widespread adoption and long-term growth. The platform's innovative design will be tailored to meet the diverse needs of stakeholders in the real estate sector. Critical to the success of Unlockit's MVP is the emphasis on additional considerations such as partnership development, user-friendly design, and regular feedback and updates. By forming strategic partnerships with real estate associations, regulatory bodies, and technology firms, Unlockit positions itself to gain credibility and wider acceptance in the market. The focus on creating an intuitive and accessible platform significantly reduces the learning curve for new users, ensuring that the platform is user-friendly and inclusive. Moreover, maintaining an ongoing dialogue with users and incorporating their feedback into regular updates and feature enhancements ensures that the platform remains relevant, efficient, and aligned with the evolving needs of its users.

The conclusion that rental processes in real estate can utilize blockchain technology without the need for tokenization was also apparent especially when focusing instead on operational improvements like increased trust and efficiency, reduced corruption and fraud, and cost reduction (Wouda, 2019). Described in the research paper as not requiring tokenization; "real estate management includes blockchain proposals for concepts such as rental platforms, real estate data storage solutions, and multiple listing services." Unlockit's implementation strategy further reinforces its commitment to creating a robust and scalable platform. A phased rollout, beginning with core functionalities like the digital workspace and basic blockchain rental system, allows for a controlled and effective introduction of the platform to the market (Karamitsos, 2018). Gradual introduction of more advanced features like AI auditing and a fully decentralized database ensures that the platform evolves in line with technological advancements and market demands. Stakeholder engagement and feedback sessions is crucial in understanding and addressing the needs and resistance points of realtors, lawyers, and citizens. Compliance and security are paramount, with adherence to regulatory standards like GDPR and robust data security measures forming the backbone of the platform's trustworthiness. Furthermore, a thorough cost-benefit analysis ensures that the platform's offerings are cost-effective and provide substantial value to different stakeholders (Garcia-Teruel, 2020). Finally, scalability is a key consideration, allowing Unlockit to expand and integrate more complex features over time. This scalability is essential for the platform's ability to adapt to the growing and changing needs of the real estate market. In essence, Unlockit's strategic approach in developing its MVP – encompassing innovative features, thoughtful considerations, and a robust implementation strategy – positions the platform to effectively solve current market challenges. Its commitment to innovation, security, and user-centricity paves the way for Unlockit to become a leading force in the digital transformation of the real estate market, building trust and expanding its reach over time.

8. Conclusion

Our research encompassed an extensive review of the current market dynamics, stakeholder analysis, and the exploration of blockchain and Distributed Ledger Technologies (DLTs), culminating in the proposition of a viable business model for Unlockit. At the core of our study was the realization that the Portuguese real estate market, is ripe for digital innovation. Unlockit emerges as a beacon of this transformation, proposing a blockchain-based solution aimed at streamlining real estate transactions, enhancing transparency, and simplifying compliance. The analysis of the rental real estate market revealed the critical need for a unified platform that can streamline processes and foster true trust among stakeholders.

Our exploration of blockchain and DLTs provided valuable insights into the potential benefits and challenges of implementing these technologies in real estate. The discussion on EBSS (Enhanced Blockchain-Based Secure Sharing) and CoSC (Collaborative Smart Contracts) models highlighted how blockchain could revolutionize real estate processes by ensuring data security, transparency, and efficiency. The proposed business model for Unlockit, a subscription-based service complemented by transactional fees, is designed to cater to the nuanced needs of the real estate market. The emphasis on regulatory compliance tools within the platform underscores Unlockit's commitment to adhering to legal standards while providing a secure and efficient transactional environment. Our study underscored the importance of a phased implementation strategy, beginning with core functionalities and gradually introducing more advanced features. This approach is crucial for ensuring the platform's adaptability and scalability, enabling it to evolve in tandem with technological advancements and market needs. While challenges remain, particularly in terms of technology adoption and regulatory compliance, the potential benefits are clear. As the market continues to evolve, Unlockit's role in shaping the future of real estate transactions in Portugal is both pivotal and promising.

References

Akerlof, G. A. (1970). The Market for "Lemons": Quality Uncertainty and the Market Mechanism. The Quarterly Journal of Economics.

AlShamsi, Mohammed, Mostafa Al-Emran, and Khaled Shaalan. 2022. “A Systematic Review on Blockchain Adoption.” Applied Sciences 12 (9): 4245. https://doi.org/10.3390/app12094245.

Atlas Global Advisors. (2023). How Master Data Management Transforms the Real Estate Sector. Retrieved from https://atlasglobaladvisors.com/blog/master-data-management/.

Badi. (2019). Building trust in room renting platforms. Retrieved December 17, 2023, from https://medium.com/badiapp/building-trust-in-room-renting-platforms-3b65d450d0ee

Cialdini, R. B. (1984). Influence: The Psychology of Persuasion. Harper Business.

Consensys Quorum | Consensys. Consensys Quorum. Retrieved from https://consensys.net/quorum/.

Corda | The open permissioned distributed application platform. R3 Corda. Retrieved from https://corda.net/.

Cornell University. (2021). Real Estate and Game Theory. Retrieved from https://blogs.cornell.edu/info2040/2021/09/19/real-estate-and-game-theory/

Dhar, V., & Stein, R. (1997). Seven Methods for Transforming Corporate Data Into Business Intelligence. https://www.researchgate.net/publication/234817663_Seven_Methods_for_Transforming_Corporate_Data_into_Business_Intelligence

European Parliament and Council. 2023. “Is a QTSP Listed in the Trusted List Browser Recognized as a QTSP in All Member States - ESignature Knowledge Base -.” Accessed December 17, 2023. https://ec.europa.eu/digital-building-blocks/wikis/display/ESIGKB/Is+a+QTSP+listed+in+the+Trusted+List+Browser+recognized+as+a+QTSP+in+all+Member+States.

European Parliamentary Research Service (EPRS). (2019). Blockchain and the General Data Protection Regulation: Can distributed ledgers be squared with European data protection law? European Union.

Finck, Michèle. 2019. Blockchain and the General Data Protection Regulation: Can Distributed Ledgers Be Squared with European Data Protection Law? : Study. Brussels: European Parliament.

Grenadier, S. R. (2003). An Equilibrium Analysis of Real Estate. National Bureau of Economic Research. https://www.nber.org/papers/w9475``【oaicite:1】``.

Grenadier, S. R. (2003). An Equilibrium Analysis of Real Estate. SSRN Electronic Journal. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=375327

Hillier, D., & Waltham, M. (2015). Real Estate Investment Decision Making in Behavioral Finance. In ResearchGate. Retrieved from https://www.researchgate.net/publication/277697839_Real_Estate_Investment_Decision_Making_in_Behavioral_Finance

Holder, M. (2021). Real estate and game theory. Networks Course Blog for INFO 2040/CS 2850/Econ 2040/SOC 2090, Cornell University. Available at: Cornell University Blog.

https://www.researchgate.net/publication/374266007_Data-Sharing_Markets_Model_Protocol_and_Algorithms_to_Incentivize_the_Formation_of_Data-Sharing_Consortia/references

Humanities and Social Sciences Communications. (2023). Behavioural biases in real estate investment: a literature review and future research agenda. Nature. Retrieved from https://www.nature.com/articles/s41599-023-02366-7

Hyperledger - The Open Global Ecosystem for Enterprise Blockchain. Hyperledger. Retrieved from https://www.hyperledger.org/.

Karamitsos, I. , Papadaki, M. and Barghuthi, N. (2018) Design of the Blockchain Smart Contract: A Use Case for Real Estate. *Journal of Information Security*, **9**, 177-190. doi: 10.4236/jis.2018.93013.

Knudsen, H., Notland, J. S., Haro, P. H., Ræder, T. B., & Li, J. (2021). Consensus in Blockchain Systems with Low Network Throughput: A Systematic Mapping Study. Retrieved from ar5iv.org.

Lantmäteriet, Telia Company, ChromaWay, & Kairos Future. (2016, July). The Land Registry in the blockchain: A development project with Lantmäteriet (The Swedish Mapping Cadastre and Land Registration Authority), Telia Company, ChromaWay, and Kairos Future.

LeewayHertz. (n.d.). Blockchain in AML. Retrieved December 17, 2023, from https://www.leewayhertz.com/blockchain-in-aml/

Massachusetts Institute of Technology. (2013). Game theory and real options: Analysis of land value and strategic decisions in real estate development [S.M. Thesis, Massachusetts Institute of

Technology, Program in Real Estate Development in Conjunction with the Center for Real Estate]. MIT DSpace Repository. https://dspace.mit.edu/

Mougayar, W. (2016). The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology. John Wiley & Sons.

Multi-Party Applications for Global Business | Digital Asset | Creators of Daml. Digital Asset. Retrieved from https://www.digitalasset.com/.

Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press.

Propy. (2021). Propy Whitepaper 2.0: Real estate NFTs, DeFi & Crypto Title Insurance Fund. Propy.

Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the Protection of Natural Persons with Regard to the Processing of Personal Data and on the Free Movement of Such Data, and Repealing Directive 95/46/EC (General Data Protection Regulation). GDPR. European Parliament and of the Council. April 27, 2016. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R0679.

Regulation (EU) No 910/2014 of the European Parliament and of the Council of 23 July 2014 on Electronic Identification and Trust Services for Electronic Transactions in the Internal Market. eIDAS. European Parliament and the Council. July 23, 2014. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2014.257.01.0073.01.ENG.

Rigdon, J. (2018). Big Data's Impact on Real Estate Market Analysis. Journal of Property Management.

Tapscott, D., & Tapscott, A. (2018). How Blockchain Will Change Organizations. https://www.researchgate.net/publication/371007710_How_Blockchain_Will_Change_Organizations

Thaler, R. H., & Sunstein, C. R. (2008). Nudge: Improving decisions about health, wealth, and happiness

Timuçin, T., & Biroğul, S. (2023). Collaborative Smart Contracts (CoSC): Example of Real Estate Purchase and Sale(s). The Journal of Supercomputing, 79, 13442-13461. https://doi.org/10.1007/s11227-023-05196-1

Wiesweg, N., Schäpers, P., Bernhold, T., & Hartmann, T. (2022). On the challenges of inter-organisational data in real estate: The role of knowledge sharing. Engineering, Construction and Architectural Management. https://doi.org/10.1108/ECAM-12-2021-1081

Wu, Y., Tie, G., Yu, Y., Li, J., & Song, J. (2022). EBSS: A secure blockchain-based sharing scheme for real estate financial credentials. World Wide Web, 26, 1599–1624.

Wu, Y., Tie, G., Yu, Y., Li, J., & Song, J. (2023). EBSS: A secure blockchain-based sharing scheme for real estate financial credentials. World Wide Web, 26(1599–1624).

Zillow. (n.d.). Home. Retrieved December 17, 2023, from https://www.zillow.com/