

Blockchain technology and real estate: a viable combination?

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ABSTRACT

This paper is written as response to the financial difficulties recognized in the real estate and housing industry due to the impact of the Covid-19 crisis. The current problem is that it is yet unknown if the relatively traditional real estate and housing industry can be transformed with the use of blockchain technology to decrease the financial impact of future crisis on the industry. Information is gathered on the industry itself implementation of blockchain technology in other industries to determine its viability in the real estate and housing industry, using one of the central players in the industry as a case study.

We concluded that blockchain technology is indeed a viable technology for the real estate and housing industry. However, it has an impact on the industry structure due to disintermediation and an emphasis on IT in the parties involved. This will increase the importance of cybersecurity.

Keywords

Blockchain technology, real estate and housing, crisis management, digitalisation

INTRODUCTION

The Covid-19 crisis has already had a profound impact on various sectors. The real estate and housing sector has been affected as well. This is mainly due to the financial implications of the crisis, similar to the financial crisis in 2008-2009. While the industry was still recovering from that crisis, the Covid-19 crisis hit. Real estate prices were already exceeding before the crisis, causing various implications during and in the immediate aftermath of it. Hence, it is very relevant and important to assess the industry and a possible change in technology to decrease the impact of a future crisis, both for the industry itself and for the homeowners involved. This decreases its societal (financial) impact.

This report will focus on the real estate and

housing industry in The Netherlands. This focus on one particular country was made due to the different impacts the Covid-19 had on different countries, since each country enforced its own rules and regulations against the spread of the virus. This has had an impact on the way the real estate industry was affected in different countries. For instance, in Sweden, where the government did not enforce any strict regulations on Covid-19, the real estate industry was hardly affected, while this is not the case in The Netherlands.

While we have already elaborated on the importance of this research, we want to highlight academic importance as well. Crisis management is an emerging field, so we can further elaborate on it to provide a platform to future researchers on the implications of the Covid-19 crisis.

RESEARCH

Objective

The objective of this research is to generate knowledge about the use of a specific technology on the real estate market as a reaction to the Covid-19 crisis. We decided to choose blockchain as the focal point of this research, since it has had meaningful impacts in other sectors already. Overall, it is unknown if the use of blockchain technology offers a viable solution for the experienced difficulties during and after a (financial) crisis.

The industry is foremost focused on participants with high liquidity. However, as the peer-to-peer market is rising the individuals with “low” liquidity also want to join the housing market. Therefore, the sector could move to a lower entry barrier with the use of blockchain technology for its participants.

Currently, the knowledge is missing as to how the real estate industry can react during and in the immediate aftermath of the Covid-19 crisis. While the industry is managing the current crisis, there is a need to assess the possible technological evolutions that can decrease the impact of a future (financial) crisis. In order to assess this thoroughly, we ought to

look at the implications of blockchain technology on IT governance, the business processes, and the cybersecurity within the sector. Overall, the objective is to determine if blockchain technology in its proposed form can indeed decrease the impact of a future crisis.

Approach

In order to investigate the use of blockchain technology in the real estate market, a research design is created beforehand, which will be discussed in this section.

After an initial assessment of the real estate industry to get a thorough understanding of its workings, a literature review is conducted on the available literature on blockchain technology and tokenization. Specifically, information is gathered on the use of blockchain and tokenization in other industries, to see if parts of this could be generalized to the real estate industry. Secondly, a digitally mature organization within the real estate industry is chosen as a representative of the industry. This is done by creating an overview of the industry and a collective final selection of the major digital players. Finally, the chosen organization is investigated thoroughly based on their publicly available strategy documents, annual figures, and other publicly available information on both the organization's website, news articles, and published documents.

This paper is structured as follows: after the introduction and research outline, an introduction is offered on the real estate industry, to get an understanding of its workings. Then, the analysis introduces the results of this research, capturing the effects of blockchain technology on the industry. Finally, a discussion and conclusion will summarize the main findings and answer the research objective.

THE REAL ESTATE INDUSTRY

The COVID-19 crisis was expected to bring chaos to the real estate industry. The effect it had varies depending on the country or city, as some got more affected than others. There was quite some guessing how the industry will change since people who can work from home could potentially move out from cities, lose jobs or stop paying rent. That might lead to empty office spaces, people changing their minds about selling or buying their house, and general panic in the market. If people are supposed to stay at home and shops were to close, that would indicate more web-based shops opened while brick and mortar shops and restaurants are out of work. In addition, people often have lower financial credibility during a crisis, since a significant amount of jobs are disappearing. This is a development the sector has to respond to, and one of the possible solutions being the tokenization of real estate. This

lowers the entry barrier for investors to invest in real estate objects, while it enables real estate owners to sell fragments of it, rather than the whole object. Since this solution was not implemented before the Covid-19 crisis, countries were forced to take different measures to deal with the situation, such as suspending eviction, providing temporary mortgage relief, or rent holidays. Furthermore, some countries suspended construction which can be seen in a downturn in the construction sector, supply chain, and GDP (GPG, <https://www.globalpropertyguide.com/news-covid-19-effects-on-the-european-real-estate-market-4097>). The real estate sector had to adapt and take action to continue with business as uninterruptedly as possible. Our research shows that COVID-19 was not that disruptive for the sector in the Netherlands and Germany where the situation is similar, while countries like Spain and the UK were hit more.

Funda.nl led a survey through turbulent times, to get the input from people, while also using their statistics to depict the up-to-date picture in the real estate market. At first, people didn't know what to expect, so they were uncertain, cautious, and hesitant. The viewings which were supposed to happen probably did, but no one knew the future of the market. Some real estate agencies had to adapt and innovate, for example by enabling 3D virtual viewings, enabling electronic document signing, and more (EY, https://www.ey.com/en_gl/real-estate-hospitality-construction/seven-likely-implications-of-covid-19-for-real-estate). These are just minor and initial innovations towards better service, but because demand is still relatively higher than supply, big changes in the sector cannot be seen. A few trends are emerging such as looking for a house with a garden and dislike of large office spaces as people look for something with more flexible conditions. Now the future of the trends and changes in the long term depends completely on how the situation of Coronavirus develops. However one of the most important implications in the future will be how developers and architects decide to implement people's preferences and "safety standards" (touchless technology, designing spaces where we move and how we interact...) in their new construction projects (Forbes, <https://www.forbes.com/sites/petertaylor/2020/04/23/real-estate-development-will-never-look-the-same-post-covid-19-realtors-and-architects-should-pay-attention/#15f5c7be6f2a>)

The timeline with article titles acquired from Funda gives an overview of people's behavior in the time of COVID crisis is seen in figure 1.

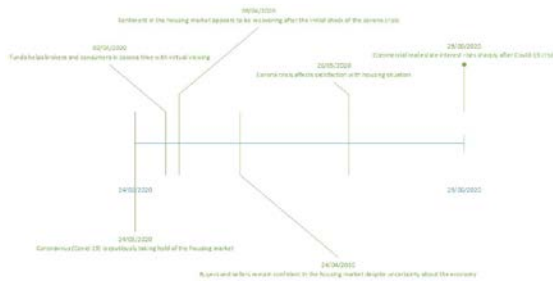


Figure 1. Timeline of Covid-19 crisis

ANALYSIS

In this section, all evidence will be gathered according to the proposed research approach in order to fulfill the objective of this research. Tokenization of the real estate industry will be assessed on its effects on Business Process Integration, IT Governance and Strategic Sourcing, and Cyber Security. Before the individual analysis of the intertwined subjects, the decision was made to first offer a brief introduction into tokenization and the chosen definition of it.

First off, an explanation will be offered into tokenization. In asset tokenization, physical assets are virtually turned into digital assets that can be subdivided into subunits, which can then be represented by a digital token (Sazandrishvili, 2019). This allows people to both purchase a small portion of an asset when they do not have enough capital yet to buy the complete asset and to sell part of owned assets to increase your current credit without having to take on extra loans. Overall, tokenization is expected to have a profound impact on the real estate market as a whole. The coming paragraphs will discuss its impact on the three subjects mentioned above, which are the focus of this research.

IT Governance and Strategic Sourcing

IT Governance is about determining who has decision rights, input rights, and how these people or groups are held accountable. It also differs from company to company because it depends on its goals, structure, experience, industry & regional differences, and size (Weill, P., 2004).

We chose Funda.nl to depict the changes in ITG for a company in the real estate & housing sector during COVID-19. Funda has already created a large digital platform for real estate & housing, which would ease the implementation of our solution. Its key decision-makers are the Supervisory board, Executive team with multiple C suite roles, and shareholders, of which NVM Holding B.V. (hereafter NVM) is the majority shareholder with 90% voting rights (Funda, 2020;

Funda, n.d.). Although NVM has a veto, there is not enough information regarding NVM's governance structure and their involvement in Funda.nl's IT decision making. The analysis is therefore limited to Funda.nl's internal ITG.

To determine the impact of tokenization on ITG, we first analyse the ITG of Funda.nl as-is. The findings could not be verified, so they are solely based on publicly available material on Funda.nl. A summary of the analysis is also available in a table below the analysis.

IT Principles

The facilitating role of IT applications and systems is decided upon by the CFO. However, each business unit creates its own applications, jointly led by the Chief Product Officer and Chief Technology Officer (Funda, 2020). This points towards a Business Monarchy archetype regarding decision making. Because the CFO is the single delegate for the IT applications and systems, the input rights are Federal.

IT Architecture

IT Architecture is approved by the CEO and CFO, as part of the business strategy. This is assumed based on the example of the containerization of IT in order to reduce cost (Funda, 2018). Therefore the decisions for IT Architecture follow the Business Monarchy archetype. Since the CFO is responsible for applications and systems (Funda, 2020), we assume the CFO and CTO are responsible for the input of IT Architecture. This aligns with the IT Duopoly archetype.

IT Infrastructure strategies

The strategy for IT infrastructure is determined by the business strategy, which is created by the Strategy & Business Development team (Funda, 2020). Therefore the input of IT Infrastructure Strategies follows a Feudal archetype. The decisions are made by the CEO, who has a technical background (Funda, 2020). This is typical for a Business Monarchy.

Business application Needs

The Chief Product Officer and Chief Technology officer are responsible for the application development (Funda, 2020), thus the decision rights follow a Business Monarchy archetype.

Multidisciplinary customer teams are set up to represent the needs of different customers (Funda, 2020). Thus, input rights follow a Federal archetype.

IT Investment

IT Investments are primarily a result of the business strategy. For example, in 2017 the investments in hardware and software were increased to improve website performance and internal office automation, with the goal of decreasing the required product development time (Funda, 2018). The CFO is responsible for the budgeting, while the Strategy & Business development team determines the strategy and the required investments. In the end, the strategy is to be accepted by the CEO (Funda, 2020). The decision rights therefore follow a Business Monarchy archetype, since the CFO and CEO approve the strategy and the required investments. The input is similar to the Federal archetype since the Strategy & Business development team delivers input, as well as the CFO and possibly the CTO.

Overall, these results are incorporated in the as-is IT Governance matrix of Funda is shown in figure 2.

IT Activities (Input/Decision) Archetype	IT Principles		IT Architecture		IT Infrastructure Strategies		Business Application Needs		IT Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy		X		X		X		X		X
IT Monarchy										
Feudal					X					
Federal	X						X		X	
IT Duopoly			X							
Anarchy										

Figure 2: As-is IT Governance Funda

Funda's strategy for the future is to create value for its customers and to maintain and earn a strong market position. As they are already an established organization that aims for growth, enabling blockchain technology (tokenization of ownership) would potentially improve their market position by attracting more real estate investors while interest rates are low in times of crisis.

The biggest influencing factor to change the governance would be the desire to achieve their new strategic and performance-related goals with the help of IT. The success of new governance would depend on how well they designed it, the transparency of mechanisms and education and awareness level in the company.

The to-be IT Governance matrix is shown in

figure 3.

IT Activities (Input/Decision) Archetype	IT Principles		IT Architecture		IT Infrastructure Strategies		Business Application Needs		IT Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy										
IT Monarchy				X		X				
Feudal										
Federal	X						X		X	
IT Duopoly		X	X		X			X		X
Anarchy										

Figure 3: To-be IT Governance Funda

The input rights are usually broad-based therefore, the TO-BE matrix uses federal input everywhere, but for architecture and infrastructure. Duopolies are the ones who provide input there, because these decisions are of more technical complexity. Because of the same reason, individuals or groups of IT executives have decision rights (p 8).

The most strategic decisions that a firm makes are on IT principles and IT investment. In the matrix we show that IT duopoly should have decision rights on IT principles, because they state how IT is used in the business. If they are implementing new technology, IT has to take these decisions, but also work with business units to make sure it will be in line with their strategic and performance goals. When it comes to decisions on IT investment, the rights should go to IT duopolies if Funda wants to grow and innovate, or to business monarchy, to make sure all stakeholders are happy and to double-check the perceived value of innovation (p14).

When it comes to specifying the business needs for applications, and whether it should be developed in-house or purchased, that is the decision of duopoly that includes business unit leaders, IT professionals from the business units, IT shared services and the new role of the blockchain specialist (p12). Giving a lot of decisions in the hands of IT duopoly may not lead to the perfect synergy between business, IT, and enterprise-wide perspectives but it will enable decisive implementation of the new technology.

In addition to the change in IT, governance conveyed in the ITG matrix, we want to emphasize the impact of the proposed solution on the IT governance of Funda. Blockchain technology influences governance mechanisms, such as decision rights and accountability (Hsieh et al., 2017, p. 51). The role of blockchain specialists should be considered in the decision-making process since it is unclear whether funda currently possesses

the technical knowledge to operate a blockchain application. Furthermore, decision rights over the blockchain application may need to be shifted to the IT department (duopoly) in order to centrally manage the blockchain.

BUSINESS PROCESS INTEGRATION

The current system in the real estate industry will undergo changes on different aspects. To highlight these changes, two activity flow diagrams are created, one for the current situation, one for the new situation (with the use of blockchain technology). The structural difference between the two diagrams will be discussed in more detail by text.

Current system

The current situation in the real estate industry is quite traditional, with a lot of intermediaries within the process. The process starts with a registering home seller and ends with the transfer of ownership of the asset. Between these points, three intermediaries mediate the relationship between the home seller and the home buyer, being the real estate agent, the bank, and the notary. Each of these intermediaries requests a certain commission for their service and complicates the process. The activity diagram of the current situation is shown in figure 4.

New system

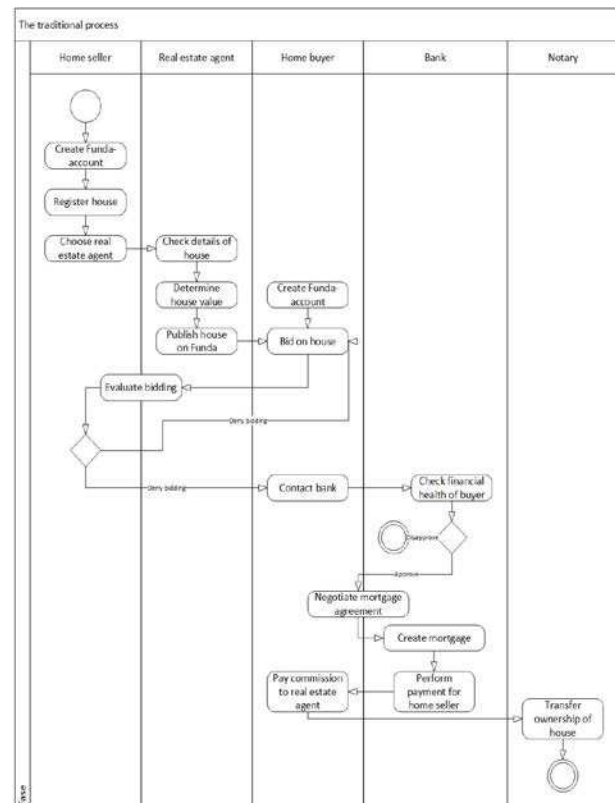
The new situation is characterized by a fundamental decrease in the number of intermediaries within the process. As a trust mechanism, the smart contract has taken over a lot of functions from the real estate agent, the bank, and the notary. The activity flow diagram of the new system is shown in figure 5.

Changes in the process

The changes in the two processes overall have two causes: a change in regulation and a change in the technologies used. Both essential aspects will be assessed below.

Changes in the processes due to the adoption of new technologies

Blockchain technology has the potential to revolutionize the real estate industry by tokenizing assets. Using tokenization in combination with smart contracts will lead to disintermediation. Smart contracts are programmable contracts (in code) that



can automate processes by “if this, then that” statements. By using oracles they have access to

Figure 4: As-is Activity diagram

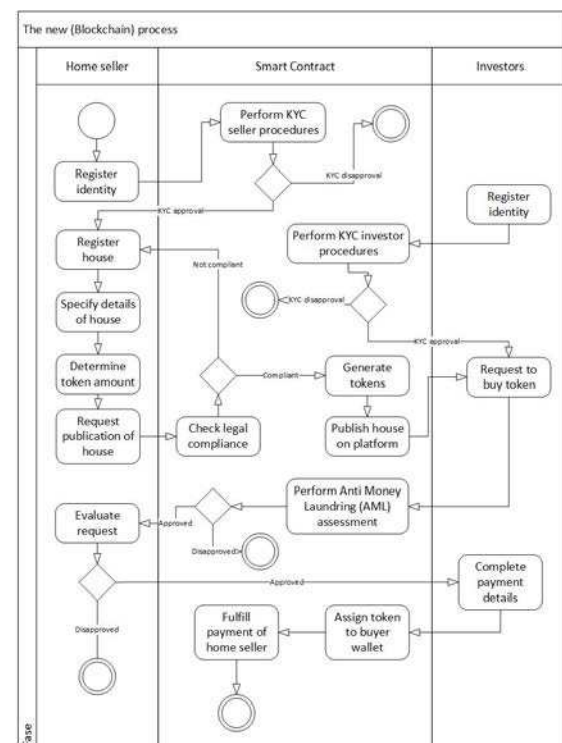


Figure 5: To-be Activity diagram

real-world data, like person identities and house values based on zip codes. Therefore, the following

changes in the process can be made based on disintermediation, efficiency, and liquidity.

For the complete process, real estate agents become obsolete by automatically home value identification of oracles. Therefore, smart contracts automatically validate if the house price is compliant with the minimum asking price. Secondly, banks are no longer required, because payments can be automatically executed via the smart contract. In addition, notaries don't have to exchange the ownership manually, since ownership is represented by tokens and can be exchanged between wallets via the smart contract, cutting the third parties making it more efficient and cheaper for investors to buy and sell real estate.

Smart contracts and tokenization also add liquidity and transparency into the real estate sector, because tokenizing an asset will divide it into smaller shares. Therefore, the entry barrier into real estate is significantly lower, since participants can buy now a part of an asset. This technology also facilitates the selling of the tokens, instead of using a bidding mechanism.

Changes in the processes due to regulation

The disintermediation within the process has the most profound impact on regulatory requirements. To comply with these requirements, three primary changes are identified:

In the traditional model, the KYC process is performed by intermediaries: the real estate agent, the bank, and the notary. These parties require official identity documentation by law to perform their services. In the new model, this is completely automated by the blockchain, since this has proven to be possible in existing literature (Doughty, 2005, p. 250). With regard to regulation, this means that the system needs to have a thorough KYC process that complies with both the national and European regulatory requirements. Both buyers and sellers should be identified by uploading official documents and a strong authentication method. This differs from other platforms, such as social media networks, where customers can apply with just an email address and name, without sophisticated authentication.

AML guidelines are set up to detect and report any suspicious activity with regard to money laundering and terrorist financing. Organizations should be 'reasonably designed' to ensure the detection and reporting of suspicious activity (Anti-Money Laundering (AML) | FINRA.org, 2020). In the traditional process, these guidelines are enforced by intermediaries, primarily by the banks. Although the bank is still involved in the processing of the transaction (and thereby has an AML-process itself in the background), our blockchain should

incorporate it as well. Early in the process, this is done by the KYC-procedures, which assesses both the identity and the source of funding. With the additional use of algorithms later in the process, the smart contract can detect and disapprove any suspicious transactions based on the information gathered during the process, such as in the payment details.

The tokenization process should comply with the current AFM guidelines to provide adequate information to authorities. Currently, this process is executed within the information systems of the real estate agents involved but gets automated with the use of a smart contract. Due to the AFM guidelines, the blockchain application should be designed to output quality financial information in the right output to directly send to the authorities interested, to prevent the need for manual interventions.

In the current situation, the intermediaries in the market are audited on their compliance with (industry) standards. By disintermediating, this audit will change fundamentally. In the new situation, regulatory requirements oblige us to audit the blockchain application and the smart contracts, so that the complete process complies with the (industry) standards. This technical audit is required by law to ensure that the controls of the application are well-implemented and managed.

Cyber Security

In this section, implementing tokenization in the housing market will be discussed by analyzing the likelihood and impact of the risks that can occur after implementation. The risks will be identified according to the CIA+A triangle with the top 4 Information Security Concerns: Confidentiality, Integrity, Availability, and Auditability which is also in line with the ISO 27001 Implementation. After that, a risk analysis will be conducted and appropriate security measures for the prevention of these risks will be proposed.

Implementing tokenization will create a new business model, which stimulates innovation even more and from which the industry can gain a lot. While tokenization has a lot of future possibilities to innovate, or you can even say disrupt, the sector, it also brings business- and cybersecurity risks with it.

Real estate cycle

In this paper, we have chosen to use Funda for our case study. Funda aims to grow their organization. They already have a Monopoly so growing in their current situation is difficult (Eigenraam, 2018). By implementing a tokenization platform, they can add new target groups to the market of real estate enabling them to grow. On top of that, blockchain and smart contracts provide trust

that can otherwise only be assured by a notary. A notary increases costs to a degree that our model is not feasible.

First, it has to be explained why tokenization can give opportunities for Funda, therefore we will introduce the “real estate cycle” (Fisher & Brueggeman, 2010, pp. 341). Some of the characteristics of the real estate cycle are:

- The real estate market is relatively large, in terms of both the number of properties and square footage.
- It is a highly competitive market.
- Ownership is highly fragmented, no owner/developer controls a significant share of the real estate market.
- There is a large information asymmetry, real estate agents often have more information about a property than the investors.

Determining the amount of space needed for new house development is still vague because it is hard to determine the depth and extent of demand. The real estate market itself is a highly competitive industry by its nature; there are certain times when excess supply is unintentionally produced, whereby other market conditions have a large shortage. See figure 4 for a hypothetical Real Estate Cycle.

Tokenization can bring a lot of profits to this industry, among others the real estate process can become quicker, and as a result of that, the imbalance in market conditions can become more stabilized.

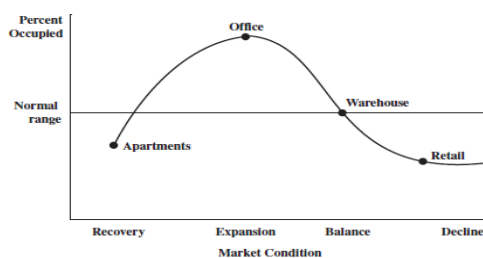


Figure 6: The Real Estate Cycle (Fisher & Brueggeman, 2010, pp. 341)

Although these benefits sound promising, we still live in an uncertain time, there is a distortion in the real estate market due to COVID-19 (Rabobank, 2020). Funda is experiencing the consequences of COVID-19. They had a significant drop in visitations to houses of more than 25% (Funda, 2020).

We really need a stakeholder analysis; analyze the advantages and disadvantages per stakeholder

Tokenization can be one of the solutions to start reversing this trend and bring innovation and new opportunities to the market. Currently, most of

the tokenization has been done in the big cities, Funda will be considered as an early adopter if they implement this in the Netherlands. There are a few examples where tokenization in the housing market already succeeded, such as in Tokyo, Sweden, and NY. A Dutch company called MijnVastgoedICO also tried to implement tokenization in the dutch real estate market. They started the process to develop a solid blockchain platform, but the project was canceled because of liquidity problems (Suiker, 2018).

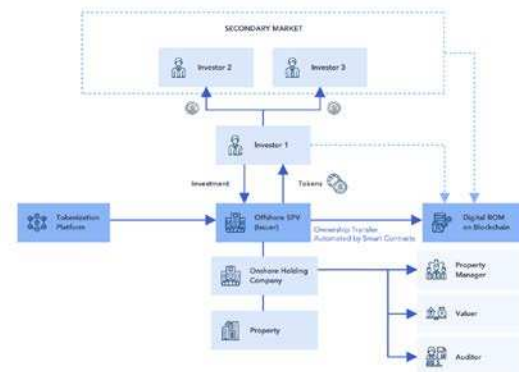


Figure 7: MijnVastgoedICO

Possible cyber-security risks of implementing tokenization in the Real Estate market

The earlier stated benefits of tokenization sound well promising, but there are some serious risks to consider. These risks with tokenization will partly be explained by referring to figure 5, this figure illustrates a compact overview of the actors involved in the tokenization process (Liquefy et al., 2020). The following risks are determined by researching several papers.

1. Funda must make regulations to monitor data and provide data reliability. Tokenization is highly resilient compared to the old system, considering it's a decentralized and distributed platform. It, therefore, introduces a new operational risk to the current industry. Thus, meeting compliance is important because there is a lower financial barrier for new users to enter than in the old system, and a lot of (sensitive) data will be shared. Funda must make sure that they have the necessary resources to monitor this and assure security.

2. Although Funda has regulations in their current system, adhering to the ‘middle-man’ actors in the system such as auditors, valuers, and a property manager; tokenization itself is a new technology and therefore there is not yet a good regulatory framework established (Liquefy et al., 2020).

“The legal and regulatory requirements and restrictions for the offer, distribution, holding,

trading and management of security token may change in the future”(Liquefy et al., 2020). Therefore, there is a lot of uncertainty while developing a regulatory framework. Even when a regulatory framework is established, it needs to be kept updated and changed. This can bring skepticism to using tokenization because nobody knows how harmful actions in the system will be punished.

A future tokenization platform for Funda needs for that reason, to follow the General Data Protection Regulation and consist of law and regulations needed to make a deviation between what's wrong and what's right in using the system.

3. The highest risk while using blockchain, is the risk of an attack on the system of the platform (Otterspeer & Aman, 2020); two types of common attacks are the eclipse attack and the 51% attack. An eclipse attack makes use of communications in a network of nodes. The attacker selects a victim and intervenes unknowingly by the victim with his communications. The attacker then spreads or accepts false information for the attacker's objectives, which may compromise the network. An eclipse attack can eventually deviate in a 51% attack (Nakamoto, 2008). Despite the fact that tokenization will make use of a private blockchain system, a 51% attack is a common problem in blockchain with severe consequences. In a 51% attack, a greater part of the nodes is compromised by validators, they have then more than 50% of the network's computing power. As a result, the whole network can be compromised and data can be falsified, the whole system isn't reliable anymore.

4. An important risk lies in the inappropriate use of the system by end-users. Tokenization can be a difficult concept for possible investors who lack IT knowledge. Although, figure 5 is a simplification of the tokenization process, to fully profit from the previously indicated benefits, an end-user should be able to have a substantial understanding of the tokenization process. In this context, it means that the end-user has a moral judgment and sufficient information about how the system works and the possible consequences of using it, so they can give full consent while using the platform (Schermer et al., 2014). A lot of end-users don't have a full understanding of the process, and therefore the benefits of tokenization are substantially less than expected in the beginning. This results in a vulnerability in the private blockchain, the end-users can make the system more susceptible to outside interference, resulting in disclosing their transactions. It is a common fact that the most successful cyberattacks on the blockchain are not because of the design of the system but because of the end-users who use the system.

End-users' private keys can get stolen because

of not having a (sufficient) firewall, phishing, and malware attacks, which result in stealing their tokens. When end-users don't have sufficient security an attacker can hack into their domain and impersonalize the end-user of his key, and consequently enter the private blockchain. When tokens get stolen it has a big impact on the system because it is an interconnected private blockchain, and therefore will have a significant impact on the whole system.

5. The tokenization system should be up and running 24/7, the platform needs to be available when you need it. When the uptime of the platform is too low, the CIA triad will be compromised.

Also, how can it be assured that the written code for tokenization is good enough, and there are no coding errors? Perfect security does not exist, there will always be a trade-off between security and other components such as usability of the platform (Anderson pp 147, 2020). The platform needs to ensure a 'level of security appropriate to the risk' (art. 32). Funda must find out what a reasonable state of compromise is.

Another downfall is that codes are written by humans and this makes the probability of defaults higher. A little software coding error can develop in bigger cyber risks, making hacking more feasible. Nonetheless, hackers' skills become more advanced, making their chance of succeeding in hacking a system bigger.

Risk-analysis of potential cybersecurity risks by implementing tokenization

To acknowledge the previous overview of potential security risks, the CIA + A triad will be used to make a good analysis (Parker, 2002). Pursued by conducting a risk analysis, where the likelihood and severity of these risks are determined. In the end, the goal is to develop a universal standard for tokenization in the housing market, to ensure that other companies than Funda, can support this technology, without having a negative influence on the end-users. Currently, blockchain isn't adopted quickly in the real estate industry, while it has been praised as being revolutionary (M., McAuley, 2020).

To make a good risk analysis, a market analysis to evaluate the supply and demand for the type of properties that people are evaluating as an investment should be conducted. Unfortunately, this can't be done with the current resources available to us in the Netherlands. Therefore, we want to give a disclaimer about the possibility of having a subjective view of the determination and impact of the stated risks. Table 3 below shows which parts of the CIA + A triad are afflicted for each potential cyber risk for tokenization (Parker, 2002).

	Confidentiality	Integrity	Availability	Auditability
Bad monitoring of the data	X			
Not established regulatory framework				X
Cyber-attacks	X	X	X	
Inappropriate use of the system by end-users	X	X	X	
Bad coding		X	X	

Table 1: CIA Triad potential cyber risks for tokenization

The second analysis applies to the current COVID-19 situation but will most likely also be applicable in the nearby future. Most of the determination of the impact in the risk matrix is determined by using the guest lecture of PwC, and the paper by KPMG over tokenization. But as long as tokenization is not widely implemented, and (especially) not implemented in the Netherlands, the previous disclaimer of having a subjective view still applies for this analysis.

First, an explanation of the degree of impact will be given:

Impact 1: It won't have a significant impact on the system or its end-users.

Impact 2: It will have some impact on the system or its end-users but no intervention is needed.

Impact 3: Both the system and its end-users are affected, intervention is preferred

Impact 4: It will have a significant impact on the system and its end-users, intervention is needed.

Impact 5: The whole system and end-users are compromised, the tokenization process can be considered as invalid. A new design of the system is needed.

		Impact				
		Very low	Low	Middle	High	Very High
Likelihood	Very high			2		
	High					3
	Middle			1		4 & 5
	Low					
	Very low					

Table 2: Cyber risk matrix

Proposed security measures and controls to mitigate these risks

As described earlier, there are five main potential risks. All of these risks are from level 3 or higher, therefore, they cannot be taken lightly and specific measures to (at least) reduce the risk is preferred.

To conclude, an earlier attempt to invest tokenization in the dutch real estate market has proven that there is a demand among Dutch citizens (Suiker,2018). Although Funda is an incumbent player, they aim to grow their organization. They already have a monopoly, growing is therefore difficult. By implementing our model, new target groups become available, this will enable the dutch market of real estate to grow. This growth is not feasible in the old model, because the trust provided by blockchain and smart contract provides trust that can otherwise only be assured by a notary. A notary increases costs to a degree that our model is not feasible.

Risk	Possible Measures
Bad monitoring of data reliability	<p>When internal control by having an internal audit is necessary, having an external auditor is advisable. Although 100% security is not possible, emphasis must lie on the detection of possible breaks which can lead to data not being reliable (Otterspeer & Aman, 2020). By having a good external auditor, it can be more assured that the data running through the platform is reliable.</p> <p>Another possible measure of how there can be focused on quality control is by implementing the Plan-do-check-act (PDCA) cycle. This means that the system is built on a feedback-control loop (PDCA; Deming; Toyota). By continuously improving itself, more data reliability can be guaranteed.</p>
New technology, not established regulation	<p>Funda is an incumbent player in the real estate market in the Netherlands. They have therefore the fire-power to go lobbying at the government, demanding good regulation of tokenization compliant with the GDPR principles.</p> <p>An optional measure is to hire advocates who design these laws for them, to give the government a head start in designing a good regulatory framework.</p>
Attacks	<p>Segment the internal network of the platform. By making it more distributed, the platform becomes less dependent on one node (Anderson, 2020, pp. 125-148).</p> <p>Apply corrective measures by assigning IT specialists to the platform. They need to check the platform and identify vulnerabilities & respond appropriately (Power, 2009).</p>
Inappropriate use of the system by end-users	<p>“Employees are often the weakest link in information security”(Marinussen, 2020). Often the biggest risk on a platform does not lie in the design but in the way the users use it (GISS, 2019).</p> <p>By implementing a two-factor authentication before users of the tokenization platform are logged in, it lowers the likelihood of resulting in a cyber risk (Anderson, 2020, pp. 133–134). you create a multiple-step access process.</p> <p>Another important part is to raise awareness among end-users, by explaining what the possible risks of lacking personal security are. By giving them an overview of the possible (financial) losses, they will be more aware of their actions.</p>
Bad coding	<p>Funda must calculate a “margin of safety” while designing their tokenization platform. They must recognize that with enough computing power and time, it is possible to break any algorithm, but if they continue to work together and stay on top of computational performance, they can find new algorithms to replace old ones (Schneier, 1999)</p> <p>Redundancy should be built into the infrastructure of the platform. By having a resilient system design, it can prevent the system from failing because of one single point of failure. This can be certified by having an increase in the up-time of the platform.</p> <p>A new platform such as tokenization used for real estate is not immediately safe, they should try to realize the hardening of the platform. Frequently used encryption techniques are scrutinized all over the world and keep developing. By examining if unused possibilities and options of the platform can be switched off, so this cannot be used as a backdoor. anymore.</p>

Table 3: Possible measures

Funda has the financial resources to develop a tokenization platform. Further internal research has to be conducted if they are also able to implement this in the current platform or that they need to develop a niche company.

At last, appropriate cybersecurity measures need to be implemented before tokenization can be introduced in the Dutch real estate market. The current impact of the stated risk is too high, with an impact of at least 3 or higher on our cyber risk matrix. Intervention and looking at the possible

measures for these cyber risks before starting to develop a tokenization platform are therefore obligated.

DISCUSSION

The research objective of this paper is to determine if the use of blockchain technology can offer a solution in the real estate industry to the financial difficulties experienced during and after a crisis. Research has shown that blockchain technology does impact the industry on three different, interlinked dimensions.

Blockchain technology will disintermediate the industry. With a smart contract, the interaction between multiple parties can be facilitated in an automated environment. This will disintermediate the real estate agent, the notary, and the bank, which has consequences for all three domains. The smart contracts will lead to processes integration, and cause technology to take over multiple critical functions from intermediaries, such as the KYC requirements.

Also, due to this disintermediation, a lot of trust shifts from institution to technology. This is reflected in the IT governance matrix, where a shift from a business perspective to a more IT-related perspective is observed. In the traditional governance matrix, decisions were primarily made by the business side due to the nature of the industry, such as a lot of manual processes, intermediaries, and the little role of IT in the process. The new governance model will focus on IT as the central enabler of the inter-company coordination between the parties involved. Therefore, the increased involvement of IT in both decisions and input fits with the required degree of business process integration. Cybersecurity is affected by the critical functions it takes over, but also by these two aspects. Cybersecurity gets a more important role because a new system will be implemented which doesn't have a good regulatory framework yet. A good regulatory framework is needed to reduce the risks while implementing this system and keeping it up and running. Also, the cybersecurity requirements will change, since the critical functions of intermediaries will now move from the physical to the digital space.

Blockchain technology offers a solution for both the short- and long-term effects of a crisis. Since these effects have been found to differ, we will discuss both terms.

There are several implications regarding the short and long-term effects of digital transformation. If Funda decides to implement blockchain technology (tokenization), it would be one of the analysis of a case study. This enables further research to gather actual data on the impact of

first companies to do so. If successful, That would improve their market position and attract new customers, which is in line with the company's strategy and beneficial for the long run. Being a first-mover also has disadvantages, such as not being able to properly execute the project, as it is not proven to work yet. That would hurt the company the most in the short term, because the investment in the transformation could lead to a bad financial situation and inter-company disputes.

Nevertheless, there are also some barriers to identify. We distinguish several barriers to the effective implementation of blockchain technology within the real estate industry. The first revolves around the huge change in industry structure. There are several authorities involved in the current process, forming a challenge to disintermediate these parties due to regulatory requirements. Since smart contract technology has not matured yet, it is not yet able to take over the regulatory role of the notary, the real estate agent, and the bank. However, natural language smart contracts will stimulate maturity. Secondly, the demand for real estate tokens is extremely difficult to predict. At the same time, the costs for the development and fulfilling the required regulatory compliance are high, while there is no assurance that a critical mass will be reached any time soon. A shift has to be made in the industry to trust blockchain technology as home sellers and buyers would trust authorities.

CONCLUSION

Looking back on this paper, we are able to reflect on the knowledge gained, as well as the shortcomings and future work that might flow from it. Although we fulfilled the research objective in a short period of time, it is always valuable to evaluate both the process and the findings.

The short timeframe in which we had to fulfill the research objective has been the main challenge for us. Within six weeks, a literature study was conducted on the real estate industry, tokenization and blockchain technology, IT governance and strategic sourcing, business process integration, and cybersecurity. This led to a decrease in the amount of time spent on the literature study regarding tokenization and blockchain technology. As this research focused on the effects of the Covid-19 crisis, we prioritized a thorough industry analysis. By doing so, we could identify the disruptions in the industry. Although we do not regret this choice, we realize that it has shifted the academic value of this work towards a design science approach. We recognize a high potential for blockchain technology in the real estate industry. Research to further explore this topic is encouraged, especially the

blockchain technology implementations within an organization and its impact on society as a whole.

Regardless of the time constraints, we have learned a lot about the different aspects of digital transformation during crisis management by ‘taking a step back’. By analyzing the impact of a disruptive change on an organization and industry, we

collectively realized how invasive technology can be for a given industry. Digital transformation is not just about the changing technology, but even more about the organizational and industry changes it triggers.

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