Housing associations and blockchain : a positive match?

an exploratory research to the implementation of blockchain in the tenant mutation process at housing associations

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Housing Associations and Blockchain – A Positive Match?

An exploratory research to the implementation of blockchain in the tenant mutation process at housing associations

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II. Preface

Before you lies the master thesis "Housing Associations and Blockchain – A Positive Match?". This master thesis is written as the finalization of my Master Construction Management and Engineering at the Department of Built Environment at the Eindhoven University of Technology. I was engaged in researching and writing this thesis from September 2017 to January 2018.

There is little to no research on the relationship among blockchain and the housing association sector. This gives me the opportunity to be one of the first student exploring this interesting topic. With this research I want to contribute to the creation of knowledge on the topic only a few people are familiar with. However, due to the explorative nature of my study it might raise more question than it answers. Nevertheless, my goals are to contribute to the current discussion around blockchain and the efficiency of housing associations and to motivate fellow students to continue studying ways how to implement blockchain.

I would like to thank my supervisor Ruud Boots for his support, time and cooperation in order to complete my thesis in a pleasant way. I believe you are one of the best supervisors a student can wish for. Furthermore, I want to thank Martijn Witvoet for working together on trying to make this project a success and making this graduation process so much more fun. Your knowledge and experience gave me some new views on the topic and directed me in the right way. Furthermore, I would like to thank Frank Kerstens for his motivation and friendly support even when you were very busy with your regular work. Thanks to everyone at ABN Amro Innovation Centre for giving me this opportunity, and being genuinely interested and always willing to take time for a brainstorm or finding new contacts within the bank. In addition, I would like to thank my mentors Bauke de Vries, Qi Han, and Alexander Koutamanis for giving their support and guidance.

Last but not least, I would like to thank my family, friends, and girlfriend for supporting me throughout my study. I especially owe a big thank you to my mom, dad, and brother. Thank you all for the distractions when I needed them, and for the endless support and believe in me.

But now, I want to wish you much fun reading this thesis and I hope to inspire you.

Michel Vonk
January 2018

III. Summary

There are approximately 350 Dutch housing associations. They are dominant players in the rental market with a 70% dominance in the rental market. Housing associations are private parties with a public task, which is ensuring that people with low income can live well and affordable. The Dutch government has firmly retaken control over the social rental sector after the start of the credit crunch. This is mainly done by means of the revised Housing Act in 2015 and 2016-2019 targets. The housing act and targets imposed that focus should be on achieving an affordable and energy-efficient housing stock that is available for urgent target groups and elderly. This caused organizational issues for housing associations. Reason for this is because social housing is not a profitable core business. In the earlier days, housing associations invested a lot in commercial housing, which was a good source of income. Thus, housing associations are focusing on the reduction of operational expenses in order to realize a healthy solvency level to conduct sustainability and improvement investments and to enhance the organization and service to social tenants. When the current rental and management activities are evaluated, it can be concluded that there is still a lot to be gained in terms of cost reductions and a better service. Namely, these activities are responsible for 51,7% of the personnel costs. Therefore, this thesis is focusing on the core business (*hereafter: tenant mutation process*) of housing associations and to introduce an innovative solution in order to make it more efficient.

The characteristics of blockchain technology seems to supply a solution to the housing association sector. A blockchain network can ensure that different parties are able to transfer assets or documents. Every transferred asset or document is registered on the blockchain ledger, which will result in a complete audit trail. This is preferable for housing associations and regulators for all kind of checks or assessments. Furthermore, every party that is connected to permissioned blockchain network environments should be obliged to identify himself, which is desirable whenever a blockchain application for housing associations is developed. Also, disintermediation because of smart contracts and peer-to-peer transactions will ensure that the current way of working is more efficient. It speeds up the process by means of digitization and automatization and this could lead to a decrease in manual actions, cost reduction, and an increase in service towards tenants. However, organizational and technical changes for housing associations could result in adoption problems. It is hard to decide whether blockchain technology is suitable for housing associations because blockchain is still a nascent technology and currently does not have any other pilot projects. Therefore, research to the link of blockchain and housing associations is interesting.

An explorative research is conducted to investigate where optimizations in the tenant mutation process are mostly desired. Therefore, many housing associations employees are interviewed to correctly model the tenant mutation process and to determine the major impediments and pains in this process. Housing associations all argue that the tenant mutation process is an inefficient process that involve many actors. The average process takes 50-70 days, of which the vacancy rate is 20-40 days. Unfortunately, this not only leads to an increase in costs but also lowers the customer satisfaction because tenants will have to wait a longer period before they can move in. Therefore, the involved actors will need to take care that the tenant mutation process is run through without any delays. Housing associations are mainly experiencing impediments and pains in activities that are sensitive to errors. The strict regulations require housing associations to work with a low margin of error. This ensures that housing association check every step in the process over and over again. It is noticed that this is especially the case when the housing association have to check the documents of the tenant and everything involved in signing the rental agreement.

When in a fact, a blockchain database is implemented with API's between databases it ensures that tenants are not responsible for obtaining the data, but the database request the data automatically. Housing associations are ensured of validated data because the documents originate from the oracles (*tax authority, the municipality, and the chamber of commerce*). Also, an audit trail is realized because everything is registered in the blockchain ledger. A solution like this could lead to an enhancement in terms of its usability, efficiency, transparency, and could be beneficial to the relationship between tenants and housing associations. Furthermore, signing the rental agreement is a time-consuming activity that requires many manual actions, which could lead to human errors. Many checks on agreements are executed to minimize the errors. A smart contract ensures that the information of tenants, dwellings, and housing associations is inserted automatically. Also, checks and reminders can be automated. Ensuring a digital and automated agreement could reduce the paper-driven and time-consuming signing activity. The outcomes of implementing smart contracts could lead to instant settlements and management of certain cash flows, simplified property management, faster agreements of rent increases and an enormous decrease in manual actions. Thus, a solution that supports both the collection of the documents by means of a permissioned blockchain and the activity of signing the rental agreement by means of smart contracts is useful. The blockchain database with smart contracts offers enhancements for the tenant and the housing associations, namely: Disintermediation and trust less exchange, a high quality of data, a high level of transparency and immutability, a simplification of the ecosystem, faster and cheaper transactions, and empowered users in the network.

Implementing the solution will also reduce the operational expenses. This is important because housing associations are focusing on reducing the operational costs in order to realize a healthy solvency level to conduct investments in the housing stock and to focus on the social tenants. The proposed solution could lead in a reduction of 140 minutes per rental agreement. This is enormous because interviewees indicated the entire tenant mutation process takes approximately 12-14hours. If the solution is plotted on every rental agreement in The Netherlands then it can reduce the operational expenses by 22mio – 24.7mio. This is a gross estimation, without taking into account the costs to use the proposed solution.

However, besides the strengths and opportunities, one should also bear in mind that there are weaknesses and threats to this solution. Because blockchain is a disruptor in the current process it could lead to organizational issues. Furthermore, there are regulation and compliance conflicts. No party could be held responsible for the functioning of the distributed ledger and the exchange of the information. Finally, blockchain solutions are accompanied by huge investment costs, which should be taken into consideration for the service provider.

The final question that is answered in this thesis is whether a bank should be platform provider. The provider of a blockchain solution provider should be an independent party. A bank could be blockchain solution provider to housing associations because the bank has extensive experience in KYC processes, blockchain technology, and is a trusted advisor. However, it is important to bear in mind that integrity and reputation is very important for the bank. Therefore, risk will have to be minimized. This can be done by in cooperating third parties, such as the tax authority, housing associations, municipalities, Aedes, Social House-Building Guarantee Fund (*Dutch: WSW*), and The Dutch Authority of Housing Associations (*Dutch: AW*). Along with these parties knowledge can be shared and risks can be minimized.

IV. Samenvatting

Er zijn ongeveer 350 Nederlandse woningcorporaties. Ze zijn dominante spelers op de huurmarkt met een bezit van 70%. Woningcorporaties zijn private partijen met een publieke taak, want ze moeten ervoor zorgen dat mensen met een laag inkomen fatsoenlijk en betaalbaar kunnen leven. De Nederlandse overheid heeft de controle over de sociale huursector heroverd na het begin van de kredietcrisis in 2008. Dit gebeurde voornamelijk door de herziene huisvestingswet in 2015 en door nieuwe opgelegde doelen voor woningcorporaties. De huisvestingswet en de opgelegde doelen leggen de nadruk op het realiseren van een betaalbare en energie-efficiënte woningvoorraad die beschikbaar is voor urgente doelgroepen en ouderen. Dit veroorzaakte organisatorische problemen voor woningcorporaties. Reden hiervoor is dat sociale huisvesting geen winstgevende kernactiviteit is. Dit zorgde ervoor dat woningcorporaties zich focussen op het terugdringen van operationele kosten om een gezond solvabiliteitsniveau te realiseren. Hierna kunnen duurzaamheid- en verbeteringsinvesteringen gerealiseerd worden en kan de dienstverlening richting sociale huurders verhoogd worden. Zodra de huidige verhuur- en beheersactiviteiten worden geëvalueerd, kan worden geconcludeerd dat er nog veel te winnen valt op het gebied van kostenbesparingen en een betere dienstverlening. De verhuur- en beheeractiviteiten zijn verantwoordelijk voor 51,7% van de personeelskosten. Daarom richt dit rapport zich op de kernactiviteiten (*hierna: verhuurmutatieproces*) van woningcorporaties en introduceert het een innovatieve oplossing om dit proces efficiënter te maken.

De kenmerken van blockchain technologie lijken een oplossing te bieden voor de corporatiesector. Een blockchain netwerk kan ervoor zorgen dat verschillende partijen in staat zijn om goederen of documenten uit te wisselen. Elk overgedragen goed of document wordt geregistreerd in het blockchain-grootboek, wat resulteert in een volledig controletraject. Bovendien moet elke partij die verbonden is met het blockchain netwerk zich identificeren, wat wenselijk is wanneer een blockchain-toepassing voor woningcorporaties wordt ontwikkeld. Disintermediatie vanwege geautomatiseerde en zelf executerende contracten zal er ook voor zorgen dat de huidige manier van werken efficiënter is. Het versnelt het proces door middel van digitalisering en automatisering en dit kan leiden tot een afname van handmatige acties, wat resulteert in kostenbesparingen en een toename van de dienstverlening aan huurders. Door implementatie van een blockchain oplossing kunnen organisatorische en technische veranderingen ontstaan wat kan leiden tot adoptieproblemen. Het is moeilijk om te beslissen of blockchain-technologie geschikt is voor woningcorporaties, omdat blockchain een nieuwe technologie is en momenteel geen andere referentieprojecten heeft in de corporatiesector. Daarom is in dit onderzoek geprobeerd een link te leggen tussen blockchain en woningcorporaties.

Een verkennend onderzoek is uitgevoerd om te onderzoeken waar optimalisaties in het verhuurmutatieproces gewenst is. Daarom zijn medewerkers van woningcorporaties geïnterviewd om het proces te modelleren en zijn de belangrijkste belemmeringen en pijnen in dit proces bepaald. Woningcorporaties stellen dat het verhuurmutatieproces inefficiënt is, omdat er veel verschillende actoren zijn betrokken. Het gemiddelde proces duurt 50-70 dagen, waarvan de leegstand 20-40 dagen is. Helaas leidt dit niet alleen tot een verhoging van de kosten, maar ook tot een lagere klanttevredenheid, omdat huurders een langere periode moeten wachten voordat ze in een nieuwe woning kunnen intrekken. Daarom moeten de betrokken actoren ervoor zorgen dat het mutatieproces zonder enige vertraging wordt doorlopen. Woningcorporaties ervaren vooral belemmeringen en pijnen in activiteiten die gevoelig zijn voor fouten. De strenge regels vereisen dat woningcorporaties met een lage foutenmarge werken. Dit zorgt ervoor dat woningcorporaties elke stap in het proces steeds opnieuw controleren. Het is opgevallen dat dit met name het geval is wanneer de woningcorporatie de documenten van de huurder controleren en bij het ondertekenen van de huurovereenkomst.

Een blockchain database kan worden geïmplementeerd door API's te realiseren tussen databases. Dit zorgt ervoor dat huurders niet verantwoordelijk zijn voor het verkrijgen van de gegevens, maar de database vraagt de gegevens automatisch aan. Woningcorporaties zijn verzekerd van gevalideerde data, omdat de documenten afkomstig zijn van de bronbestanden (*belastingdienst, gemeente en kamer van koophandel*). Alle transacties, in de vorm van goederen of documenten worden opgeslagen in het blockchain grootboek. Een dergelijke oplossing kan leiden tot een verbetering van de bruikbaarheid, efficiëntie, transparantie en kan gunstig zijn voor de relatie tussen huurders en woningcorporaties. Bovendien is het ondertekenen van de huurovereenkomst een tijdrovende bezigheid die veel handmatige acties vereist, die tot menselijke fouten kunnen leiden. Veel controles op overeenkomsten worden uitgevoerd om de fouten te minimaliseren. Een geautomatiseerde en zelf executerend contract zorgt ervoor dat de informatie van huurders, woningen en woningcorporaties automatisch wordt ingeladen. Ook kunnen betalingen en herinneringen worden geautomatiseerd. Het garanderen van een digitale en geautomatiseerde overeenkomst kan de tijd voor het tekenen van een contract enorm verminderen. De uitkomsten van het implementeren van een geautomatiseerde en zelf executerend contract kan leiden tot onmiddellijke afrekeningen en beter beheer van bepaalde kasstromen, vereenvoudigd beheer van de woningvoorraad, snellere afspraken over huurverhogingen en een enorme afname van handmatige acties. De blockchain database met geautomatiseerde en zelf executerende contracten een verbeteringen voor de huurder en de woningcorporaties, namelijk: disintermediatie en geautomatiseerde uitwisseling van documenten, een hoge kwaliteit van data, een hoge mate van transparantie, een vereenvoudiging van het huidige proces, snellere en goedkopere transacties.

Het implementeren van bovenstaande oplossing zal tevens resulteren in een vermindering van operationele kosten. Dit is van groot belang omdat woningcorporaties zich richten op het verlagen van de operationele kosten om een gezond solvabiliteitsniveau te realiseren om investeringen in de woningvoorraad uit te voeren. De voorgestelde oplossing kan leiden tot een verkorting van 140 minuten per huurovereenkomst. Dit is aanzienlijk, omdat de geïnterviewden aangaven dat het mutatieproces van de huurder ongeveer 12-14 uur duurt. Als de oplossing wordt geplot op elke huurovereenkomst in Nederland, dan kan het de operationele kosten met 22 miljoen - 24,7 miljoen verminderen. Dit is een bruto schatting, zonder rekening te houden met de kosten om de voorgestelde oplossing te gebruiken.

Maar naast de sterke punten en kansen, moet men ook bedenken dat deze oplossing tekortkomingen en problemen met zich mee kunnen brengen. Omdat blockchain een enorme verstoorder in het huidige proces is, kan dat leiden tot organisatorische problemen. Verder zijn er conflicten over regelgeving. Geen enkele partij kan verantwoordelijk zijn voor het functioneren van het gedistribueerde grootboek en de uitwisseling van informatie. Ten slotte zijn blockchain oplossingen gerelateerd aan de organisatie die het platform beheerd.

De laatste vraag die in dit rapport wordt beantwoord, is of een bank platform provider zou moeten zijn. De organisatie die het platform beheerd moet een onafhankelijke partij zijn. Een bank kan een platform beheerder zijn, omdat de bank uitgebreide ervaring heeft met KYC-processen, blockchain-technologie en een vertrouwde adviseur is. Het is echter belangrijk om in gedachten te houden dat integriteit en reputatie erg belangrijk zijn voor de bank. Daarom moet het risico worden geminimaliseerd. Dit kan door samenwerkende derde partijen aan te gaan, zoals de belastingdienst, woningcorporaties, gemeenten, Aedes, Waarborgfonds Sociale Woningbouw en de Autoriteit Woningcorporaties. Samen met deze partijen kan kennis worden gedeeld en risico's worden geminimaliseerd.

V. Abstract

The defined Housing Act in 2015 represented a shift for housing associations in terms of redefining their traditional way of working. Housing associations have to focus on their core business again. This means they have to build, rent, and manage social housing for people with low incomes or who, for other reasons, find it difficult to find a suitable accommodation. The characteristics of blockchain technology seems to supply a solution to the housing association sector. To support the practical implementation of blockchain technology, this study aims for the development of a solution for the tenant mutation process of housing associations. An explorative research is conducted to investigate where optimizations in the tenant mutation process are mostly desired. Therefore, many housing associations employees are interviewed to correctly model the tenant mutation process and to determine the major impediments and pains in this process. These interviews are evaluated based on the grounded theory approach and the results are modelled by means Business Process Model and Notation. Based on this analysis it is clear that housing associations are mainly experiencing impediments and pains in activities that are sensitive to errors. It is noticed that this is especially the case when the housing association have to check the documents of the tenant and everything involved in signing the rental agreement. Therefore, a blockchain database with API's between databases it ensures that tenants are not responsible for obtaining the data, but the database request the data automatically. Furthermore, signing the rental agreement is a time-consuming activity that requires many manual actions, which could lead to human errors. A smart contract ensures that the information of tenants, dwellings, and housing associations is inserted automatically. Also, checks and reminders can be automated. Ensuring a digital and automated agreement could reduce the paper-driven and time-consuming signing activity. Based on this solution several UML models are created to technically show how the system works. Implementing the solution will also reduce the operational expenses by approximately 22mio – 24.7mio. This research provides the first approach of presenting a detailed process model and a blockchain solution to this process.

VI. List of abbreviations and glossary

API	Application Programming Interface.
AW	Autoriteit Woningcorporaties.
BPD	Business Process Diagram.
BPMN	Business Process Model and Notation.
CDD	Customer Due Diligence.
CJM	Customer Journey Map.
***(Non)* DAEB**	Dienst Algemeen Economisch Belang.
EVM	Ethereum Virtual Machine.
KYC	Know-Your-Customer.
OMG	Object Management Group.
PoS	Proof-of-Stake.
PoW	Proof-of-Work.
***(Non)* SGEI**	Services of General Economic Interest.
TTP	Trusted Third Party.
UML	Unified Modeling Language.
WSW	Waarborgfonds Sociale Woningbouw.

Blockchain technology	Underlying technology of blockchain applications.
Blocks	Bundled record of transaction information.
Cryptographic protocol	Protocol that uses a security-related function and applies cryptography.
Cryptocurrency	Digital currency.
Forging	Process on how new blocks are created and added to the blockchain, by means of a Proof-of-Stake mechanism.
Hash	Certain type of cryptography that transforms all the blocks raw data into a code.
Ledger	Database of all the information in the blockchain network.
Miner	Refers to the computational process performed on each block of data in the blockchain in order to verify the block.
Node	Nodes in the blockchain network.
Nonce	Arbitrary number, which is a part of a block.
Permissioned blockchain	Also called a private blockchain, which is only accessible by participants with certain permission.
Permission less blockchain	Also called a public blockchain, which is accessible by everyone.
Proof-of-Stake	Proof-of-Stake is a mechanism where the creator of a new block is chosen in a deterministic way, depending on its wealth, also defined as stake.
Proof-of-Work	Proof-of-Work is a requirement to define an expensive computer calculation, also called mining.
Smart contract	A computer protocol intended to facilitate, verify, or enforce the negotiation or performance of a contract.
Token	Also called a cryptocurrency coin (asset of a certain cryptocurrency).

VII. List of figures and tables

Part 1 - Introduction

1. Introduction

This first chapter introduces the topic by starting off with the background, certain trends, and developments of housing associations. Based on this overview a literature study is presented in the problem definition and objective section, which is followed by a description why this research is of practical and scientific relevance. Section 1.3 will provide an overview of the questions that will be examined and answered in this thesis. This first chapter will end with a description of the graduation company and research outline.

1.1 Background

"The model for the Dutch social rental sector is often seen as a good practice for other European countries. This is due to the fact that the Dutch social rental sector has a large size, offers dwellings of a relatively good quality, and functions without receiving substantial subsidies. However, current policies, both at the European and the national level, are threatening its unique characteristics." (Hoekstra J. , 2013)

One of these policies, which Hoekstra (2013) is referring to, is the new Dutch Housing Act that is introduced in July 2015. This newly defined Housing Act represented a shift for housing associations in terms of redefining their traditional way of working. Housing associations have to focus on their core business again. This means they have to build, rent, and manage social housing for people with low incomes or who, for other reasons, find it difficult to find a suitable accommodation (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). The redefining shift in the way of working does have a major impact in the way how associations are managed.

In addition to the redefined Housing Act, other priorities have imposed that state targets for housing associations between 2016-2019 (Aedes, 2017; Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). These priorities are as follows:

1. Make rental housing available and affordable for specific target groups;
2. Focus on an energy-efficient housing stock, with at least an energy label B in 2021;
3. Focus on making social housing available for urgent target groups;
4. Realize housing, combined with healthcare, for the elderly to make sure they are able to live independently for a longer period.

There are several reasons for the redefinition of the Housing Act and the creation of the 2016-2019 targets (Boelhouwer & Priemus, 2014). First, housing associations earned a lot of money over the years because they were important players in the (re)development of the social and commercial housing market. Consequently, the Dutch government decided to announce huge budget costs 2012 and 2012. The rental sector already faced drastic reforms and huge budget cuts by the start of the Rutte I Cabinet in 2010. The increased unpopularity of housing associations explains that these social housing providers were extremely hit by additional budget cuts (Boelhouwer & Priemus, 2014). Second, associations lost their focus on the core business. Namely, housing associations were highly involved in commercial housing projects (Hoekstra J. , 2017). These projects are more often accompanied with a higher risk if you compare these project with social housing projects. Unfortunately this had led to occasions where associations were involved in several scandals. Examples are the Vestia affair, the WSG scandal and the mistake Woonbron made with the investment in the cruise ship SS Rotterdam (Dohmen & Konig, 2014).

As mentioned, several targets were imposed. The first priority states that housing associations should focus more on the availability and affordability of rental housing for specific target groups. This reflected in stricter laws on appropriate allocation (*Dutch: passend toewijzen*) and the split between Services of general economic interest (*SGEI / Dutch: DAEB*) and non-SGEI activities (*Dutch: Non-*

DAEB) (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). First, stricter rules on appropriate allocation norms forced nearly all associations to adapt their rent-, allocation-, and stock policies (Aedes, 2017). It caused that nearly two third of the associations had to lower their rental prices. Furthermore, people with low incomes (*income levels explained later on*) cannot register for social houses above the capping limit (*around €600,-*) and people with a high income can no longer live in social houses above the capping limit. From that day on, associations have to focus on the realization of cheap dwellings in case of new construction (Aedes, 2017). The split between SGEI and non-SGEI states that housing associations should only focus on households with an income below €36.165,- (*price level as of 2017*). At least 80% of the social dwellings should be allocated to these households. In addition, there is room to allocate 10% of dwellings to households with an income between €36.165,- and €40.349,- (price level as of 2017). The remaining 10% may be freely allocated, but should be prioritized to people who find it hard to find suitable housing accommodations (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). Housing associations are continuously checked if they meet these targets. An example is an extensive approval process that housing associations have to go through if they want to carry out non-SGEI activities, such as the development of commercial housing or more expensive rental dwellings (Aedes, 2017). This approval process consists of a market test and a financial test (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). It is more difficult for housing associations to construct new dwellings for the commercial market because they can only receive financial aid for social housing. Furthermore, to get clear insights for the regulator whether associations meet these targets, they have to split the SGEI and non-SGEI administration (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). Unfortunately for housing associations, this has led to a complete reorganization of the administration.

The second priority states that housing associations should focus more on energy-efficiency and sustainability (Aedes, 2017; Blok, 2015). This priority originates from Minister Spies, Aedes (*association for Dutch housing associations*), Woonbond (*association for interests of tenants*), and Vastgoed Belang (*association for private investors in real estate*). In June 2012 these parties signed an agreement for energy savings in the built environment. Additionally, Aedes signed agreements on energy savings in the housing corporation sector and the Spring Agreement Energy-Efficiency For New Developments. These agreements note that the average energy label of the entire housing stock of housing associations should at least be level B in 2021.

To achieve these sustainability goals enormous investments are required. Obviously, the government encourages such investments by offering financial aid, fiscal bottlenecks and barriers (Blok, 2015). However, housing associations data reveals that nearly 45% of the housing associations do not meet the energy and sustainability commitments for the reason that these 2021 targets are accompanied with enormous investments, which are difficult to bring up (Autoriteit woningcorporaties - Inspectie Leefomgeving en Transport, 2017). Consequently, housing associations have difficulties with the redefined scope. Due to the fact that social housing is not as profitable as the commercial housing market and, therefore, will not be a sufficient income to generate solvency for the investments. This ensures that housing associations are changing their current processes in order to reduce the operational expenses (Aedes, 2017). Furthermore, Aedes (2017) shows that since 2014, the operating expenses are already reduced with 23%, which ensures that housing associations have more possibilities to investment in sustainability.

In summary, housing associations face changes caused by the redefined Housing Act and imposed priorities. To meet these targets, housing associations are focusing to a greater extent on reducing operating expenses in order to meet the enormous investment costs.

1.2 Problem definition and objective

The Housing Act of 2015 and imposed targets intent housing associations to focus more on their core business, which is ensuring that people with low incomes can live well and affordable. To do this, they should focus on improving the current housing stock, service towards their tenants, and reduce operating expenses. For the simple reason that the focus on social housing is expensive and not profitable.

Annually, associations sign approximately 220.000 new rental agreements (Aedes, 2017). It can be assumed that an efficiency improvement in the rental and management process could lead to both enormous reductions in costs and an increase in service towards tenants. In order to make this process more efficient, one could think of implementing a technological innovation that causes digitalization and automation.

One example of an innovative technology that causes digitalization and automation is blockchain. In the very beginning, blockchain technology was thought to be the next generation of the fintech infrastructure. The technology is becoming a symbol of the fourth industrial revolution very quickly. It is heralded as the next big disruptor, it got geeks and banks in excitement, but as of yet, there are just a few examples of blockchain applications in the real estate industry. Blockchain technology makes it possible for individuals to transfer information quickly, cheap and paperless without intermediaries that have to validate the information (Antonopoulos, 2014; Bharadwaj, 2016). Besides the fact that blockchain technology can function as a database, it also features smart contracts, which are self-executing digital contracts. Blockchain claims to be a solution for processes where sensitive data is shared and where automatization would lead to the enhancement of efficiency, correctness, and transparency (Mansfield-Devine, 2017). One could imagine, by analyzing these characteristics, that this technology could mean a lot for the tenant mutation process. This is because process currently involves many different parties, which all need up-to-date information in order to serve the tenants. Not only could blockchain support the processing of data, but also supports digitalizing contracts by means of smart contracts.

Due to the characteristics and inefficiencies in the core business of housing associations, blockchain might improve the tenant mutation process. This research aims to propose a blockchain solution to this process, by taking into account the following research objective:

The objective of this research is to propose a blockchain solution to improve the tenant mutation process of housing associations. A thorough proposition can be offered to involved stakeholders by means of conducting research how blockchain can improve the current way of working by housing associations.

1.3 Research questions

The corresponding main research question is as follows:

What are the different opportunities and constraints for the implementation of blockchain technology in the tenant mutation process at housing associations?

To answer the main research question, the following sub-questions are established (*note: several terminologies and methods will be explained later on*):

Q1: How does the current housing association sector look like and why should housing associations focus on reducing operating expenses?

In order to explore the current way of working it is important to first determine characteristics of the social housing sector and why housing associations are focusing on reducing operating expenses.

Q2: What is the status quo in regard to the blockchain technology?
To explore the potential of blockchain technology features in the current way of working by housing associations, a clear understanding of the general functioning and possibilities is needed.

Q3: How does the current tenant mutation process at housing associations look like, and what are the impediments or pains for housing associations in this process?
It is of high importance to understand the current way of working in order to determine what activities could be improved. Hence, actors that are involved in this process will have to be analyzed. This way, a knowledge base will be created before conducting interviews. This question will be answered by means of developing a customer journey and a BPMN model. A customer journey is used to visualize the process, the involved actors and the impediments and pains. The BPMN model will be used to show the process in a level of detail, what actors are involved and how they work together.

Q4: What blockchain technology features could be used to improve the current way of working and how can these features be implemented?
Once an explorative research regarding blockchain technology and the tenant mutation process at housing associations is finished, it is necessary to conduct research to possible implementation of blockchain features. What features of blockchain could be used to change the tenant mutation process? After understanding what features of blockchain can be used in the process, it is necessary to model these features and present the optimized process.

Q5: What could the potential role of a bank be in a tenant mutation process at housing associations, which is supported by blockchain technology?
The potential role of the bank in the optimized process must be answered because this research is conducted at a Dutch bank.

The method how these sub-questions and main question are approached is explained in the next section as well as in the research methodology section (*Part 3 - chapter 4*)

1.4 Research design

This research will be carried out in seven different phases. After creating a proper problem statement and research question, an explorative in-depth literature review will be conducted regarding housing associations and blockchain. The theoretical framework will operate as fundament in order to conduct research to the current way of working for housing associations and possible blockchain features that can optimize this process.

Thus, the intent of this research looks the following (*figure 1)*:

- **Step 1:** In-depth literature review regarding housing associations;
- **Step 2:** In-depth literature review regarding the status quo of blockchain technology;
- **Step 3:** Conduct interviews with employees from housing associations to determine their current way of working;
- **Step 4:** Analyzation of the collected data and model this data into a customer journey and a BPMN model, which both visualize the current way of working;
- **Step 5:** Based on a literature review, the interviews, and the developed BPMN model a solution will be determined for the current way of working. What blockchain features can be used to enhance the current way of working?;
- **Step 6:** The proposed solution will be modelled in UML language and will be presented in a new BPMN model to show what steps are eliminated or improved;
- **Step 7:** Conclusions and recommendations;

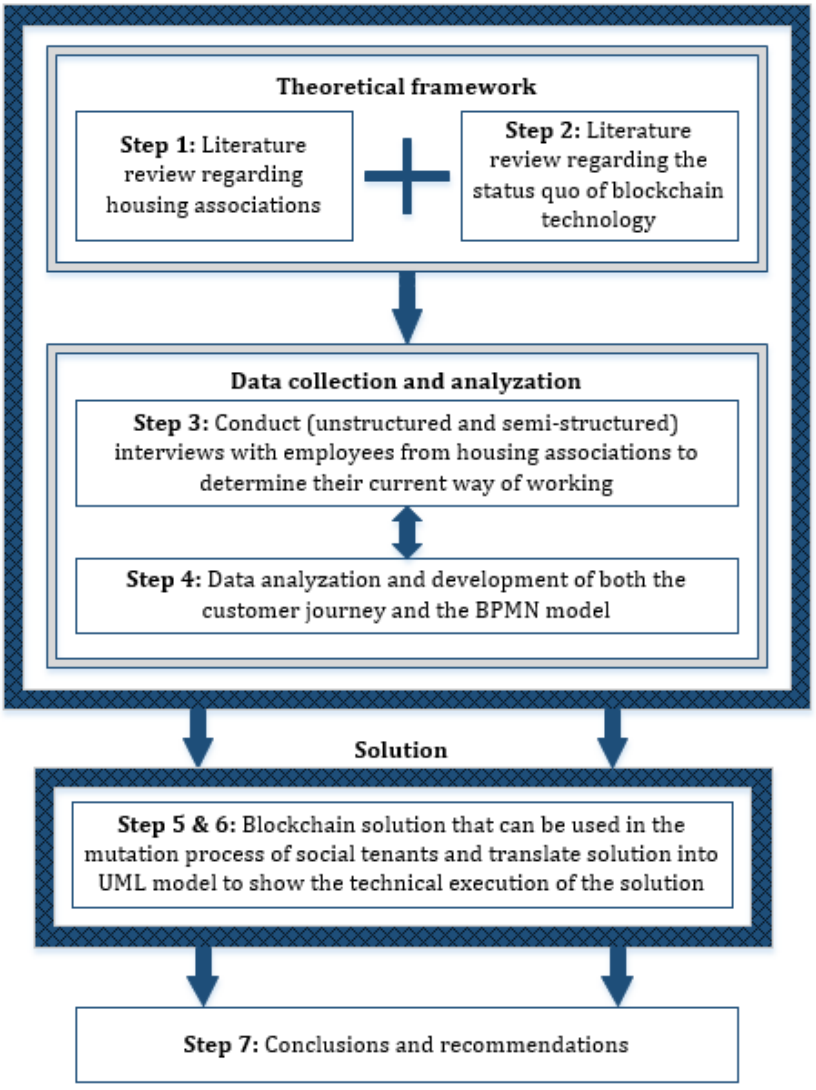


Figure 1: Research model (own ill.).

1.5 Scientific and practical relevance

This research contributes to the scientific literature by adding a literature review of blockchain and its implications on the real estate sector. Despite the growing attention to blockchain, there is still little knowledge on the effects of blockchain technology on real estate processes. Therefore, one can imagine that there is a need to investigate opportunities in the real estate.

Besides scientific relevance, this research will have practical relevance as well. Particularly, by making the way of working by housing associations more efficient by means of a proposed solution that should result in a reduction of operating expenses. Reducing these costs will have enormous benefits for the solvency of associations.

Furthermore, this research will reveal opportunities and limitations of using a blockchain feature in the tenant mutation process. Extensive processes are caused by the involvement of exchanging paperwork, many transactions and the involvement of numerous middleman. Eventually, once blockchain technology is proposed as a solution regarding the exchange of information among housing associations and tenants, these actors will benefit from an efficient, transparent system.

1.6 External organization

This research is conducted in collaboration with ABN AMRO, which is the third-largest bank in the Netherlands with its headquarters in Amsterdam. ABN AMRO serves retail, private and corporate banking clients with a primary focus on the Netherlands and with selective operations internationally.

The department that focuses itself on commercial real estate is called Real Estate Clients. This department focuses on the financing on of single properties as well as property portfolios, whether it concerns small or large property projects. In addition to property finance, the department also offers services in the areas of cash & liquidity management, treasury and capital market transactions (ABN Amro, 2016).

Next to the more financial related services and products, the departments is also focusing on several innovations including investigating new business models. Recently they have finished an experiment on a real estate blockchain application, called Torch (*Torch is explained in chapter 3.3 – other blockchain applications*). Real Estate Clients works closely with other departments within ABN AMRO, namely the Innovation Center, Public Sector Clients (for instance Housing Associations and care institutions) and Financial Restructuring and Recovery. By means of working closely together, these departments can share knowledge and address innovations together. This research will address this main question, by means of combining the knowledge of the described departments.

1.7 Research outline

This research is structured by means of different parts and each part represents a specific subject. First, *part 1* represents the introduction that embodies the background of this study, the problem definition and research questions. In this part the exact scope of this research is elaborated.

Part 2 represents the theoretical framework. This part embodies two chapters, which are: '*Chapter 2 – Dutch social rented sector*' and '*Chapter 3 – Blockchain domain*'. These two chapters will describe a detailed understanding of the two domains. This research will try to link these two domains.

Part 3 comprehensively describes the empirical findings to this research. First, this part will explain what research methodologies are used in order to collect and process data. This is done in *chapter 4 – research methodology*. Furthermore, *chapter 5 – empirical findings* will discuss the results of the data collection.

Based on the theoretical framework and the empirical findings, a solution is provided in part 4. This part will show a solution to the problem definition and presents the value proposition in *chapter 6 – model* and *chapter 7 – next steps: how to implement?* Finally, *chapter 8 – conclusion* will answer all the sub-questions and main research question and shows possible ideas for future research .

Part 2 - Theoretical framework

2. Dutch social rented sector

This chapter will make it clear why this study is relevant, by providing a detailed understanding of main characteristics of housing associations and the urge to improve the current way of working. This is done in order to answer the following sub-question: "How does the current housing association sector look like and why should housing associations focus on reducing operating expenses?"

First, *section 2.1* will start with a general description regarding Dutch housing associations in order to get a broad understanding of the business sector. Secondly, *section 2.2* will provide a detailed understanding on why housing associations need to reduce their operating expenses. Finally, the sub-question related to this chapter will be answered in the conclusion, which is represented in *section 2.3*.

2.1 Main characteristics of the Dutch housing associations

This section will provide a general description of Dutch housing associations and will make clear why optimizing the process is desirable. The Dutch government annually published statistics of the public housing stock (Rijksoverheid, 2017). The Dutch housing stock is divided in a rental market and a commercial market, which together are responsible for approximately 7.64 million dwellings. The Rijksoverheid (2017) states that Dutch housing associations are dominant players in the rental market with approximately 2.3 million rental properties in ownership, which is a 70% dominance in the rental market and a 30% dominance in the entire Dutch housing stock (*Figure 2*).

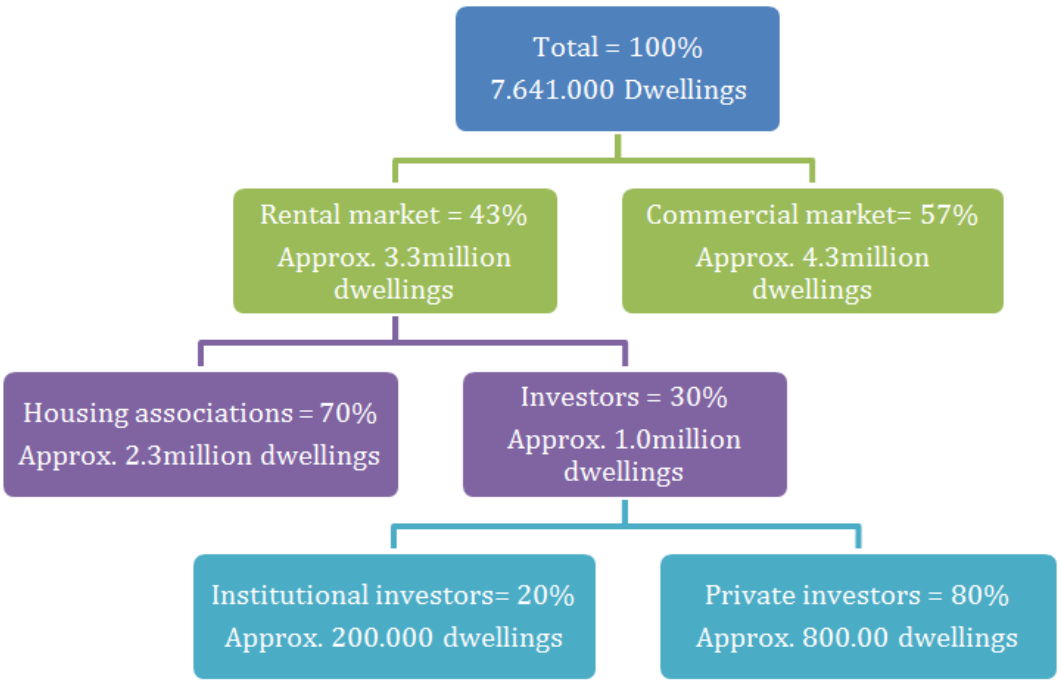


Figure 2: Overview of the Dutch housing market (Rijksoverheid, 2017).

Housing associations are private parties with a public task. This public task is to ensure that people with low income (*income levels are discussed later on*) can live well and affordable. In order to make sure that the associations adhere to this public task, they have been imposed several guidelines by the Dutch government (Hoekstra J. , 2013):

- Accommodate target groups by means of social housing;
- Maintain the quality of the social housing at all times;
- Involve tenants in policies and management matters;

- Ensure financial continuity;
- Promote the quality of life in districts and neighborhoods;
- Not only contribute to the social housing but to care homes as well;

Nowadays, there are approximately 350 Dutch housing associations (Autoriteit woningcorporaties - Inspectie Leefomgeving en Transport, 2017). They originate from a social initiative at the end of the 19th century and have played a decisive role after the Second World War. Due the fact that, after the World War II, The Netherlands had to deal with serious housing shortages (Boelhouwer & Priemus, 2014). The share in social housing grew incredibly fast, from a 12% share in 1945 to a 41% share in 1975. In the mid-nineties, the associations became privatized and financially independent of the government. Despite their focus on building and managing social housing, their focus expanded to the commercial housing market as well. However, in 2011, the European Commission summoned the Netherlands to gradually pushing back their involvement in the commercial housing market (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015; Visscher, 2011). As a result, the European Commission argued that the Dutch housing associations should adapt their back to social housing activities. The consequences of this focus shift are discussed later on.

Boelhouwer & Priemus (2014) argued that the housing production remained at a high level until 2010, partly because the Dutch government stimulated financial aid for new construction, for both commercial projects as well as social construction projects. Unfortunately, in 2010 the Housing market tumbled down because of the credit crunch. The credit crunch hit The Netherlands in 2008 and the Dutch government responded by means of changing several guidelines for parties that serve the commercial market. These temporary alterations included changes in maximum mortgage loans for dwellings, modest subsidies for new market sector housing units and temporary decrease in transfer tax from 6% to 2% (Boelhouwer & Priemus, 2014). Unfortunately, these interventions were not sufficient enough to push back the credit crunch. Therefore, other interventions were necessary to put public finances back together.

One of these other interventions is a heavy budget cut for housing associations because the Dutch government was in need of extra income (Hoekstra J. , 2017). Therefore, the Dutch government announced to tax housing associations heavily. They aimed to claw back the extra rent income that housing associations collect. Associations collect the extra rent income by introducing new rent increases for households with a higher income in the social rented sector (Boelhouwer & Priemus, 2014). The reason that the Dutch government targeted housing associations with heavy budget cuts is mainly due to the fact that associations were involved in several cases of fraud and mismanagement. These cases ensured that the government decided that housing associations should be controlled better.

The Dutch government has firmly retaken control over the social rental sector after the start of the credit crunch (Hoekstra J. , 2017). As mentioned before, the major change for housing associations started in 2011, when a change in target groups was introduced. Before 2011, only 75% of the social rental dwellings were allocated to socially disadvantaged or less advantaged groups (Hoekstra J. , 2017). From 2011 and onwards, it was imposed that minimally 90% of the social rental dwellings should be allocated to the target group with an income below €40.349,- (*price level as of 2017*). At least 80% of the social rental dwellings should be allocated to the target group that have an income below €36.165,-. The height of the rent paid for a dwelling at housing associations is dependent on income classes (*figure 3)*. The maximum rent a housing association can ask is capped to a rental price of €710,68, which is called the liberalization limit (Rijksoverheid, 2017). If the rental price is below the liberalization limit, the dwelling qualifies for rent allowance.

How the rental classes and income groups are categorized is determined each year based on the appropriate allocation regulations. The deviation in rental classes, income groups, and appropriate allocation is represented in *figure 3*.

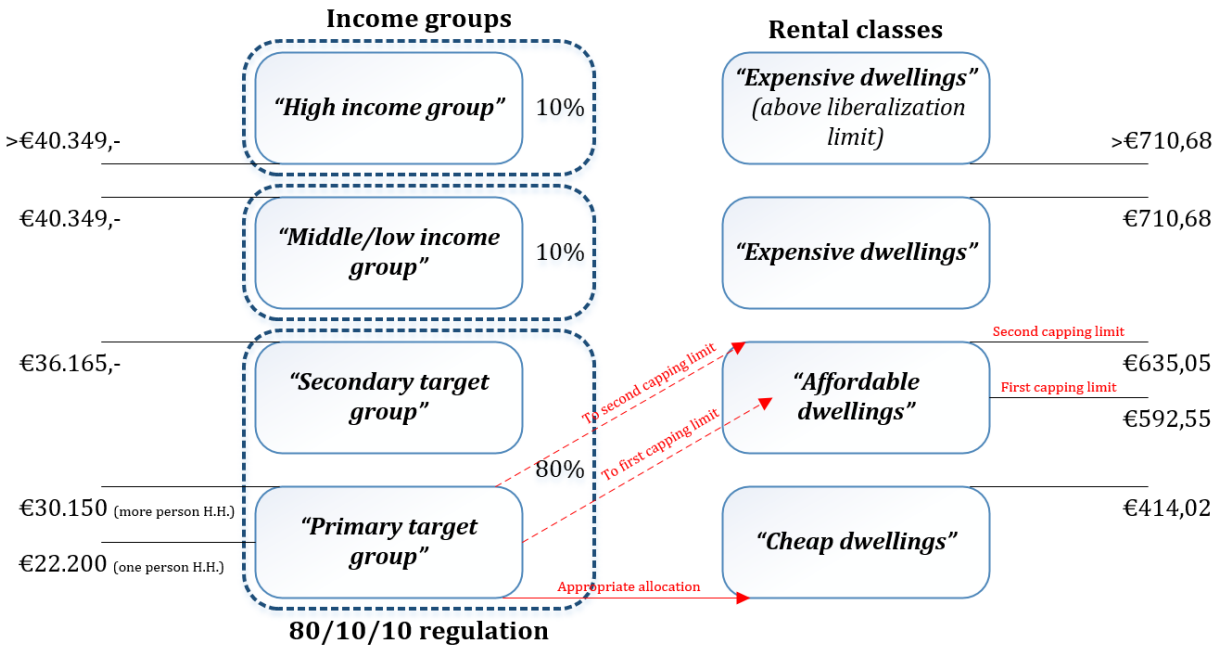


Figure 3: Income groups versus rental classes of housing associations (own ill.).

Additionally, a few years later in 2013, the government decided that income dependent rent increases should be introduced. The government decided that social housing should be targeted on lower income groups and people with higher incomes should move out of the social housing market. Therefore, people with a higher income, which do not belong in the target group that housing associations serve, could face a yearly rent increase up to 4,3% (Hoekstra J. , 2017).

The revised Housing Act, which clearly stated what housing association can and cannot do, came into force in July 2015 (Hoekstra J. , 2017). As mentioned in the introduction, it stated that housing associations should focus more on SGEI activities. All other activities that are categorized as non-SGEI should be transferred to commercial parties or should be separated administratively from the SGEI activities. This is because non-SGEI activities are no longer core activities for housing associations. Despite this, associations are still able to conduct non-SGEI activities, but only under very strict conditions (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2015). One example of these strict conditions is the fact that associations cannot receive financial aid for non-SGEI activities anymore.

Housing associations faced a lot of shifts in restrictions and regulations. Not only the mentioned policies, but the priorities of housing associations have changed as well, which is represented in the introduction of this thesis. Two public associations continuously monitor housing associations on whether they meet the imposed targets. Firstly, The Dutch Authority of Housing Associations (*Dutch: Autoriteit Woningcorporaties – AW*) ensures that housing associations concentrate on their core activities. This is done annually by means of collecting data of every housing association. Furthermore, the Social House-Building Guarantee Fund (*Dutch: Waarborgfonds Sociale Woningbouw – WSW*) ensures that associations can obtain financial aid at favorable interest rates. As a result that housing associations can construct new social housing projects at a low-interest rate and with a minimum level of risk for the financier (Hoekstra J. , 2013). Unfortunately for the housing associations, these loans are only applicable on social housing projects and not on commercial projects.

The addition of several policies and the shift in focus areas for housing associations caused a reconsideration of the current way of working. Reason for this is because social housing is not a profitable core business. In the earlier days, housing associations invested a lot in commercial housing, which was a good source of income. This is because associations were able to request financial aid for the construction of commercial projects and eventually they were able to sell these

dwellings on the commercial market. The shift in focus for housing associations does have consequences for the revenue model, which is now under severe pressure (Aedes, 2017). Reason for this is that housing associations that do not have sufficient cheap social dwellings have to consider whether to make expensive commercial rental dwellings cheaper or let social tenants wait a longer period of time. By making commercial rental dwellings cheaper they will swift from the non-SGEI portfolio to the SGEI portfolio, which means that the association will also need to pay a Landlord Levy.

How the revenue model is affected will be explained in the following section, which will comprehensively explain why housing associations should focus on the reduction of operating expenses.

2.2 Operating expenses

Housing associations have been working on reducing operational expenses already for a number of years. This is annually monitored by Dutch Authority of Housing Associations by ensuring that associations hand in their annual report. This part will present a detailed overview of the Aedes benchmark of 2017, which represents a summary of the year 2016 annual reports of 263 Dutch housing associations. These housing associations are responsible for 92.8% of the entire social rental sector. This benchmark report reveals statistics on how these housing associations score on customer satisfaction, operating expenses, sustainability, maintenance & improvement of the housing stock, and availability & affordability of the housing stock (Aedes, 2017). This section will only focus on the operating expenses of housing associations because this topic corresponds to the scope of this research.

The total operating expense for every rentable unit increased with €58,- (+3,0%) in 2016, in comparison with the year before (*figure 4*). This is in particular explainable by the increase of the Landlord Levy. Despite the increase in total operating expenses it is remarkable that the net controllable operating expenses are reduced by €63,- (-7,4%) per rentable unit.

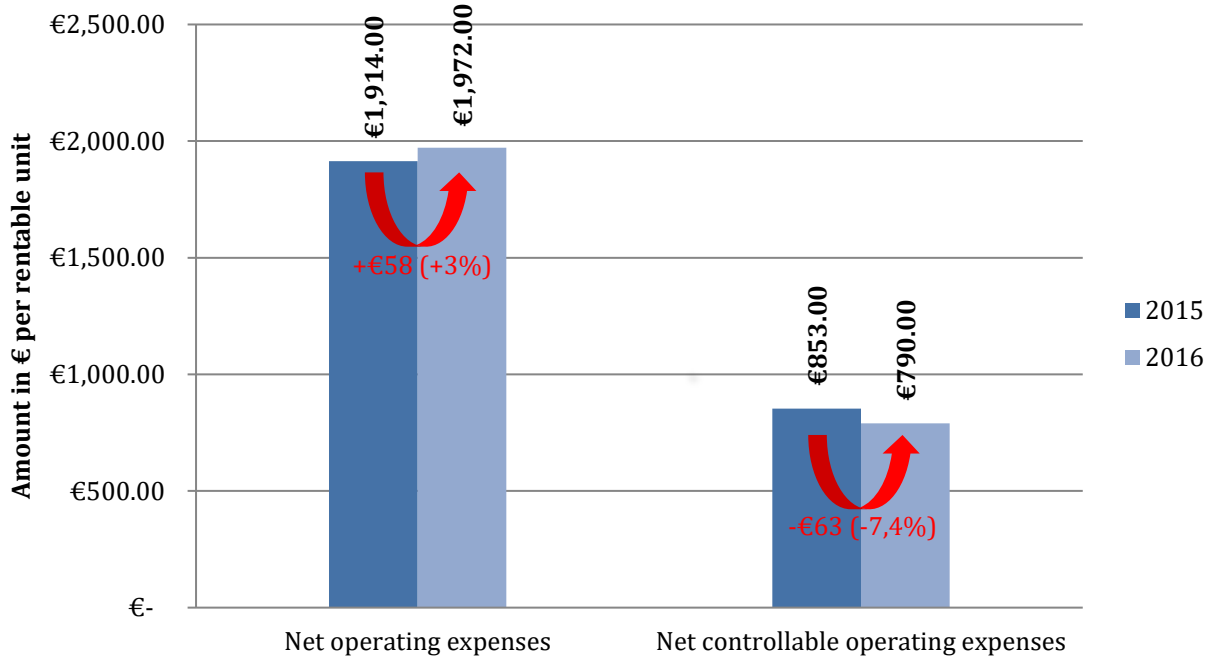


Figure 4: Net (controllable) operating expenses of 263 housing associations (Aedes, 2017).

As mentioned, the reduction of operating expenses is a hot topic among housing associations caused by the redefinition of the Housing Act. In 2013, when the first policies on income dependent rent was established the net controllable operating expenses were €1.025,- per rentable unit. In three years housing associations were able to reduce this amount with €235,- (-22,9%) (*figure 5*).

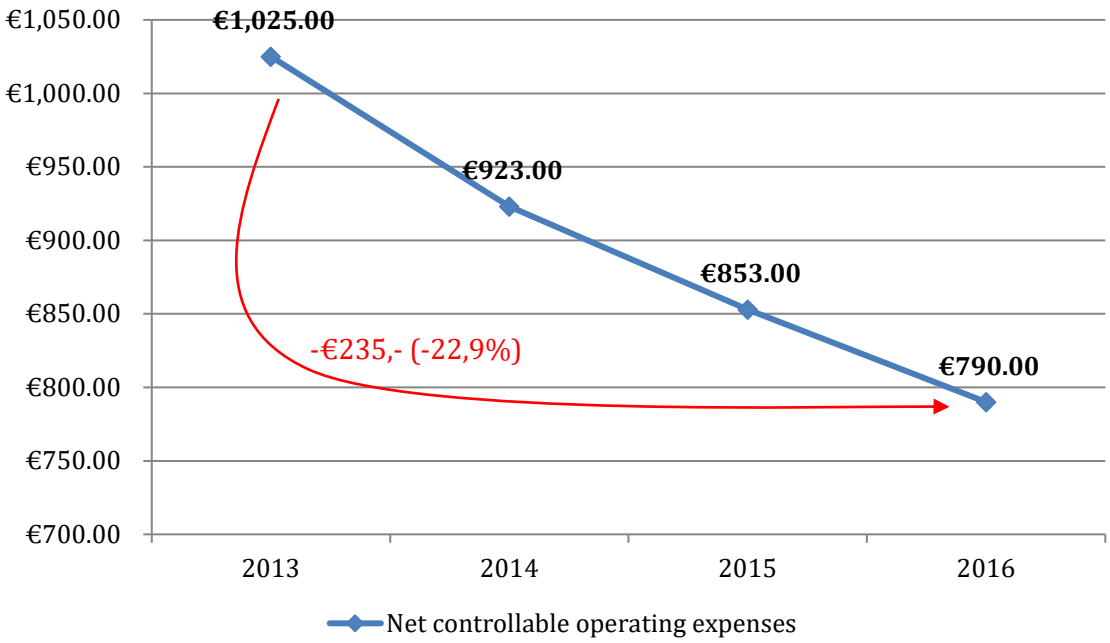


Figure 5: Net controllable operating expenses per rentable unit (Aedes, 2017).

These operating expenses are divided into several categories. *Table 1* provides an overview of these categories and the reduction in cost, in comparison with the year before.

Table 1: Operating expenses per rentable unit (Aedes, 2017).

Category	**2015**	**2016**	**Difference (€)**	**Difference (%)**
Personnel expenses	€358,-	€333,-	-€25,-	-6,98%
Other operating expenses	€463,-	€409,-	-€54,-	-11,6%
Livability	€101,-	€102,-	€1,-	+0,99%
Other operating income	-€73,-	-€53,-	€20,-	+27,4%
Balance of service contracts	€4,-	-€1,-	-€5,-	+25,0%
Cost per rentable unit	€853,-	€790,-	-€63,-	-7,4%

Personnel expenses are reduced by €25,- (-6,98%), which is due to an increased focus on maintenance and improvement activities. This increased focus resulted in a shift of personnel from the rental and management department to the maintenance and improvement department. Therefore, fewer employees are engaged in rental and management processes, which explains the difference. Furthermore, other operating expenses are reduced by €54,- (-11,6%). This is partly due to a decrease in the number of reorganizations and associated costs (*buying out contracts, use of consultancy firms*). In 2015, associations have recovered VAT. In 2016, the recovering of VAT did not take place and, therefore, the other operating income have dropped, which causes the increase in costs by €20,- (+27.4%) The expenses for livability by associations remained more or less the same (+€1,-), which also applies for the balance of service contracts (-€5,-) (Aedes, 2017).

This year Aedes (2017) included an overview that presents the deviation of personnel costs by housing associations (*figure 6*). It shows that the rental and management activities of housing associations are responsible for the biggest share in personnel costs.

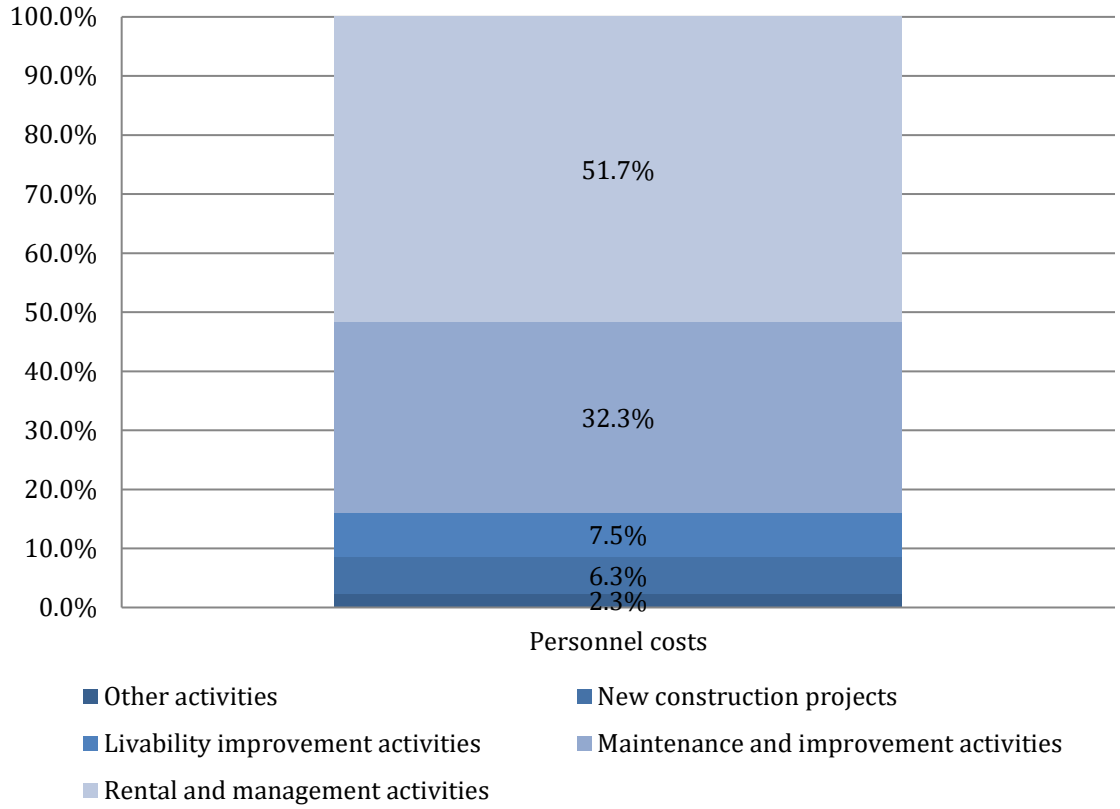


Figure 6: Personnel costs for the main activities by housing associations (Aedes, 2017).

In 2016, housing associations managed to reduce the total operating expenses by 150million euros (~7,0%) in comparison with 2015 (Aedes, 2017). The reason that housing associations focus on the reduction of operating expense is caused due to the redefined Housing Act and the shift to the focus on social housing. It causes housing associations to make strategic choices in short term. In the end, these strategic choices relate to the way in which housing associations will manage to combine their functioning as a real estate company with social objectives.

This section comprehensively presented the focus on reducing operating expenses by housing associations. It can be concluded that housing associations are already performing well on reducing operating expenses, considering the reduction of €235,- (-22,9%) within three years for each rentable unit. This is mainly achieved by reorganizing branches and departments in order to lower personnel costs and to reach a higher level of efficiency. Personnel expenses (€333,-/42%) and other operating expenses (€409,-/47,9%) are still the biggest costs per rentable unit. Considering these numbers and the deviation of personnel costs it can be concluded that an efficiency improvement in rental and management activities could lead to the biggest reduction in operation expenses. Also taking in consideration that rental and management activities are the core business of housing associations. Therefore, before developing a solution, it is interesting to conduct research on how housing associations address their current core business: rental and management activities.

2.3 Summary

This chapter comprehensively discussed the main characteristics of Dutch housing associations and the current operating expenses. Finally, this section will summarize this chapter, in order to answer the sub-question: "How does the current housing association sector look like and why should housing associations focus on reducing operating expenses?"

To start with, there are approximately 350 Dutch housing associations. They are dominant players in the rental market with approximately 2.3 million rental properties in ownership, which is a 70% dominance in the rental market and a 30% dominance in the entire Dutch housing stock. The associations are private parties with a public task, which is ensuring that people with low income can live well and affordable. To ensure this task they have been given several guidelines by the government (Hoekstra J. , 2013):

- Accommodate specific target groups by means of social housing;
- Maintain the quality of the social housing at all times;
- Involve tenants in policies and management matters;
- Ensure financial continuity;
- Promote the quality of life in districts and neighborhoods;
- Not only contribute to the social housing but to care homes as well;

After the credit crunch of 2008, the Dutch government has decided to firmly take control of the social rental sector. As mentioned before, the major change for housing associations started in 2011, when a change in target groups was introduced. The government decided that social housing should be targeted better on lower income groups and people with higher incomes should move out of the social housing market. This was mainly decided by the revised Housing Act in 2015. Under such circumstances, this caused housing associations to make strategic choices in short term. For the simple reason that social housing is not a profitable core business. In the earlier days, housing associations invested a lot in commercial housing, which was a good source of income. In other words, nowadays the revenue model of associations is under severe pressure because housing associations do not have sufficient cheap social dwellings and they have to consider whether to make the expensive commercial rental dwellings cheaper, or let social tenants wait a longer period of time before they are allocated a dwelling. By making commercial rental dwellings cheaper they will swift from the non-SGEI portfolio to the SGEI portfolio, which means that the association will also need to pay a Landlord Levy and redesign the administration.

To summarize, housing associations are focusing on reducing the operational costs in order to realize a healthy solvency level to conduct investments in the housing stock and to focus on the social tenants. The biggest reduction in operational costs can be accomplished in making the core business more efficient, which are the rental and management activities. Reason for this is that rental and management activities are responsible for 51.7% of the total personnel costs. In 2013, when the first policies on income dependent rent was established the net controllable operating expenses were €1.025,- per rentable unit. In three years housing associations were able to reduce this amount with €235,- (-23%) to €790,-. This amount could be reduced even more and that is where associations are currently focusing on (Aedes, 2017). Therefore, before developing a solution, it is interesting to conduct research on how housing associations address their current core business: rental and management activities.

Before moving on to the current way of working by housing associations an innovative technology will have to be analyzed that could reduce the operational expenses even more. Therefore, the following chapter will show an in-depth literature study on blockchain technology.

3. Blockchain domain

The previous chapter presented an introduction to Dutch housing associations and the need for reductions in operating expenses. In order to answer the main research question, it is necessary to have a detailed understanding of the blockchain domain as well. This technology ought to be suitable to enhance the current way of working by housing associations. Therefore, this section will give a comprehensive review of blockchain technology to provide an answer to the following sub-question: "What is the status quo in regard to blockchain technology?"

Every day more and more news posts, (*scientific*) articles, blogs, and conferences appear regarding blockchain technology. It seems that blockchain technology has developed an almost unchallenged reputation as the next big thing in finance and technology (Bharadwaj, 2016). Not to mention, many people talk about it, but only a few people do really understand the implications of the technology. As a consequence, all the attention is mostly misunderstood, mostly oversimplified, and biased by many businesses. Therefore, this chapter will give an in-depth overview of blockchain technology, which is done as follows. Firstly, *section 3.1* will start with a general description regarding blockchain technology, followed by a more detailed description how a typical blockchain works and the three different types of blockchain features are explained. Secondly, *section 3.2* describes the general challenges and risks that blockchain currently faces. Additionally, *section 3.3* provides an overview of blockchain applications in real estate. Finally, this chapter will end with a summary on blockchain technology in *section 3.4*.

3.1 What is blockchain technology?

Blockchain technology is proposed by Satoshi Nakamoto (2008) by means of publishing a scientific article with the following title: "Bitcoin: A Peer-to-Peer Electronic Cash System". The idea of Nakamoto (2008) is proposed as a solution to the double-spending problem, by using a decentralized peer-to-peer blockchain network. This network generates computational proof of the chronological order of transactions (Nakamoto, 2008). Nakamoto (2008) translated this idea into a virtual currency called "Bitcoin", which can be used for peer-to-peer transactions without the need of a trusted third party.

The majority of people know blockchain as the technology underlying the Bitcoin, but the technology is much wider applicable. In the most basic explanation, blockchain technology is an application to hold, track, and verify any kind of information. Hence, not only virtual currencies can be exchanged but, for example, documents including (*sensitive*) information as well. Once you try to explain blockchain technology, it is difficult to figure out the starting point. The Goldman Sachs Group (2016) released an equity research report on blockchain technology. They described blockchain in short as (Schneider, et al., 2016):

*"**Blockchain is: a database** (with copies of the database replicated across multiple locations or nodes) **of transactions** (between two or more parties) **split into blocks** (with each block containing details of the transaction such as the seller, the buyer, the price, the contract terms, and other relevant details), **which are validated by the entire network** via encryption by combining the common transaction details with the unique signatures of two or more parties. The transaction is valid if the result of the encoding is the same for all nodes **and added to the chain of prior transactions** (as long as the block is validated). If the block is invalid, a "consensus" of nodes will correct the result in the non-conforming node"* (Schneider, et al., 2016).

Swan (2015) states that blockchain is a technology with tiered technical levels. Besides, Yermack (2017) describes the technology as a novel application of cryptography and information technology to age-old problems of financial record-keeping. Thus, blockchain technology is based on a

cryptographic protocol, allowing any two willing parties to transact directly with each other without the need for a trusted third party (Nakamoto, 2008). This brings advantages to the consumer because the fate of the entire system does not depend on an intermediary that checks every transaction for proving ownership. Many people are conducting research to the technology's suitability for different kind of applications, such as exchanging assets, from stocks and bonds to real estate titles, works of art, but also for storing (*public*) records.

To get back to the point, the transactions on a blockchain network will be stored in the database, also referred to as a ledger. The database of a blockchain network is different in comparison to centralized databases, such as clouds. Namely, blockchain technology is a decentralized transparent ledger, which is managed by a network of computers (*figure 7*) (Swan, 2015; Nakamoto, 2008; Bharadwaj, 2016). The ledger with all transaction records is shared by all the network nodes and is continuously being updated by miners, it is monitored by everyone, and owned and controlled by no one (Swan, 2015). Also, the ledger is built with a large number of nodes that all possess an own copy of the entire ledger (Bharadwaj, 2016). Thus, blockchain networks can be seen as enormous interactive spreadsheets that are accessible by everyone, which is connected to the network and is continuously being synchronized, meaning that everyone in the network does have access to the same up-to-date information.

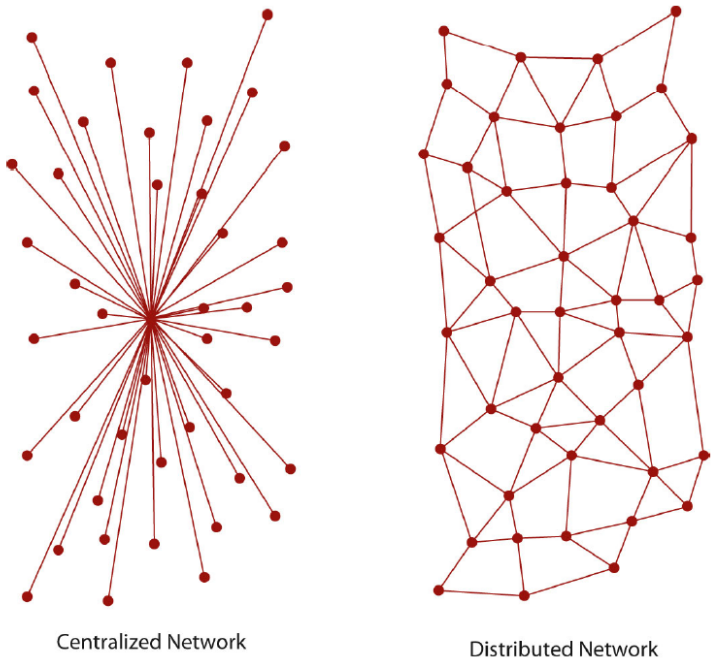


Figure 7: Visualization of different networks (Bharadwaj, 2016).

3.1.1 How does it work?

First, to easily explain the functioning of blockchain technology an example of the double-spending problem will be presented. Subsequently, an example will show how blockchain technology solves the double-spending problem (Custodio, 2013).

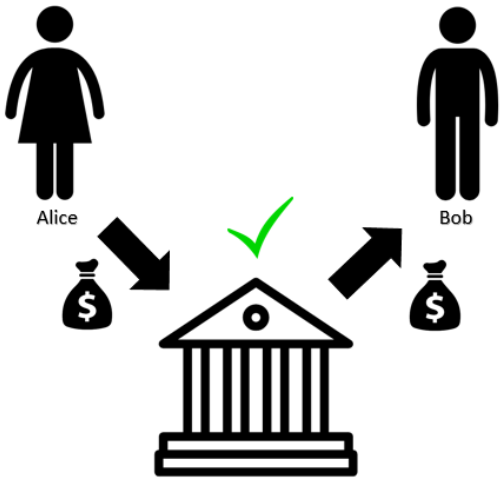


Figure 8: Exchange of an asset between Alice and Bob (own ill.)

The exchange of an asset, like money, between two people is simple: Person 1 (*Alice*) gives the asset to person 2 (*Bob*), which means that Bob is now in the possession of the asset. However, only Alice and Bob were physically there, so they are the only two people that know the asset is exchanged. The described situation will be different once you are talking about digital assets: how can you be sure that the other person did not spend or use the digital asset before? Before the existence of blockchain, this double spending problem was eliminated by means of a trusted third party that uses a centralized ledger (*figure 8*). In this scenario, the bank (*trusted third party*) will verify whether Alice is in possession of the asset and checks if this digital asset can be sent to Bob. The transaction will be executed by the bank once all the verifications are confirmed. Finally, the transaction will be registered on a centralized ledger

within the bank, which is not accessible by others. Blockchain is a technology that eliminates the use of a trusted third party, by means of using a decentralized ledger instead of a centralized ledger. As a result, everyone does have the ability to check whether Alice is in possession of the asset before she conducts the transaction.

Now, imagine that Alice wants to send the asset to Bob by means of a blockchain network. This will operate as follows (*figure 9*) (Antonopoulos, 2014; Bharadwaj, 2016; Custodio, 2013; Eyal & Sirer, 2013; Nakamoto, 2008; PwC, 2016; Swan, 2015):

1. Alice assigns the transaction to the blockchain network;
2. Different nodes in the blockchain network will check whether the digital asset is in possession of Alice. Thus, the network will check whether Alice has double-spend her asset. The transaction can only be validated once there is consensus in the network;
3. This is achieved by state of the art mathematical principles of transactions that are verified by the so- called "miners", whom that maintain the ledger. The mathematical principles also ensure that these nodes automatically and continuously agree about the current state of the ledger and any transaction in it. Thus, if anyone attempts to corrupt a transaction the nodes will not arrive at a consensus. And hence will refuse to incorporate the transaction in the blockchain. Once a miner solves the cryptographic puzzle as first, that miner will be rewarded by receiving both a particular cryptocurrency and the transaction fee;
4. Once the node approved the transaction, the transaction will be added to the blockchain network as a "block". A block is a permanent record of the transaction, which cannot be altered or removed;
5. Finally, after approval, the transaction will be executed and Bob will receive the digital assets that Alice sent him.

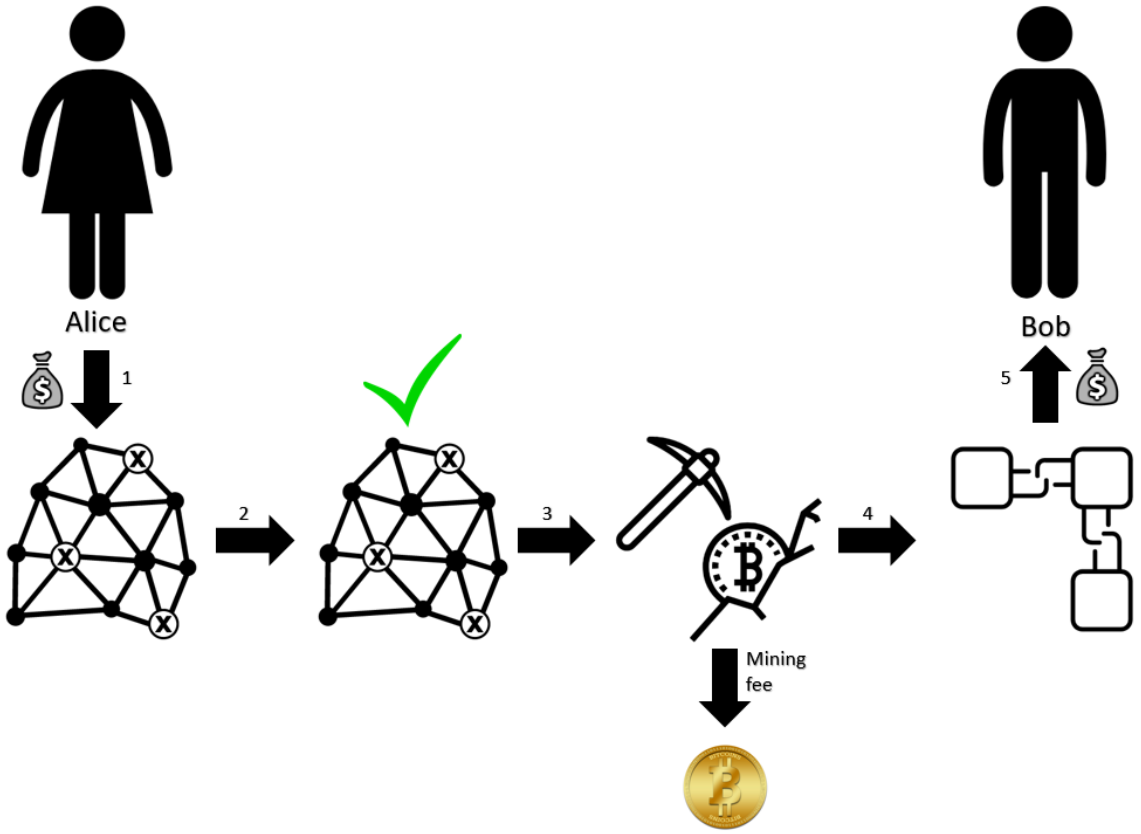


Figure 9: Functioning of a transaction on a blockchain network (own ill.)

The described mining process to verify and add blocks to the blockchain is called a Proof-of-Work (PoW) method, which is a consensus mechanism that requires huge computational power in order to solve the mathematical puzzles (Bharadwaj, 2016; BitFury Group, 2015; Meijer, 2017; Nakamoto, 2008; Swan, 2015). The miner, who is able to solve the mathematical puzzle, will be rewarded with a fee and his solved block with transactions will be added to the blockchain network. As mentioned, PoW requires enormous computational power because the difficulty changes periodically, based on recent processing times. As mentioned, the highest level of computational power may lead to solving blocks faster than others. But on the other hand, a higher level of computational power leads to higher costs in electricity. Therefore, it is not profitable to install the highest level of computational power. Nowadays, the vast majority of tokens make use of the PoW mechanism (BitFury Group, 2015). Several examples of tokens that make use of the PoW mechanism are Bitcoin, Ethereum, Dash, Dogecoin, SiaCoin, Monero, and Zcash (Swan, 2015).

Besides PoW, there is another consensus mechanism that is called Proof-of-Stake (PoS), which is a mechanism that requires the stake of ownership in order to determine the validation of blocks before adding them to the network (BitFury Group, 2015). In a PoS network, the blocks are usually said to be forged, rather than mined. Proof-of-Stake mechanism does not require huge computational power, but only a private wallet that is connected to the blockchain by means of an application programming interface (*API*), which is an interface that is connected to the blockchain network. For example, in this case, the API is the link between the wallet and the blockchain network. People holding a stake of ownership do not get rewarded for forging blocks, which is in contrast to the proof-of-work method but will get the transaction fees for each validated block.

The blocks that are mined or forged cannot be altered or removed because they are added to the chain of blocks that are all interconnected (BitFury Group, 2015; Swan, 2015). *Figure 10* explains this principle, by means of decomposing blocks. A block includes a hash function, which is a type of cryptography that transforms all the blocks raw data into a code. So, the hash code of block 10 consists all the raw data of block 10 and the generated hash of block 9 (Yermack, 2017). Additionally, a block includes a timestamp, which is a rough indicator of when the block was formed by the miner (Swan, 2015). A nonce is a random number with the property that, when added to the other information in a block, it generates a hash with a certain number of leading zeroes (Yermack, 2017). Tx_Root, also referred as Merkle root, is a cryptographic proof of which transactions are in the block, and which order they are in (BitFury Group, 2015).

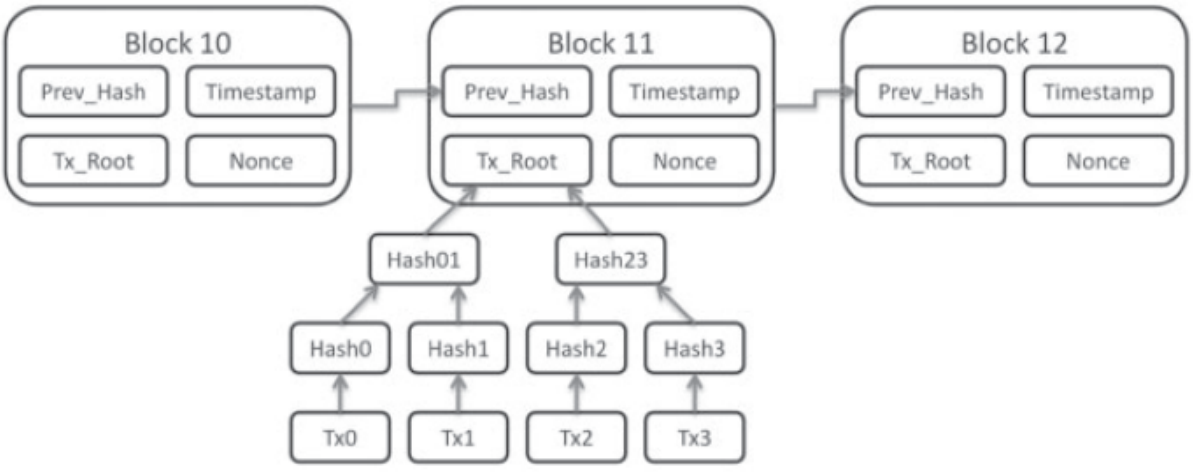


Figure 10: Decomposition of a block (Yermack, 2017).

All these described block features are included to prevent fraud, like removal or alteration of blocks. Yermack (2017) visualized the fact that you cannot remove or alter Bitcoin blocks. This visualization is added in *figure 11*.

There are many different applications that can be built on blockchain technology. These applications are called Blockchain 1.0, Blockchain 2.0 and Blockchain 3.0. The following chapter will provide a description of the most common application, which is the cryptocurrency application, also called Blockchain 1.0.

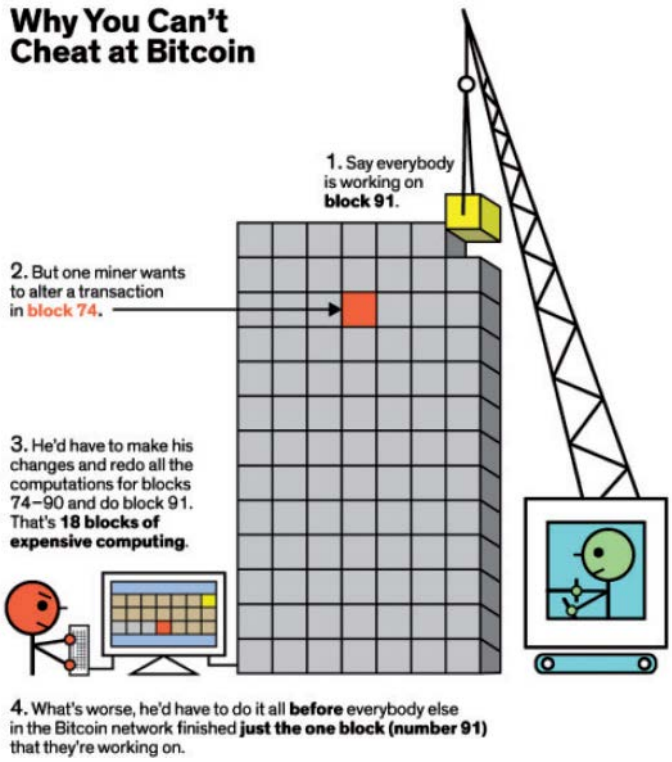


Figure 11: Reason why alteration of a blockchain network is impossible (Yermack, 2017)

3.1.2 Blockchain 1.0 – Cryptocurrency

Cryptocurrencies are virtual currencies that can be used for buying and selling things over the internet. All different cryptocurrencies do have different underlying uses, values, and developments (Swan, 2015). For example, they differ in structuring exchanges, software developers, miners, web wallet companies, and users/consumers (Bharadwaj, 2016).

The digital currencies can be used once an individual has generated a private wallet to store his/her cryptocurrencies. A private wallet includes a public address, a private key, and wallet software (Lemieux, 2016). The public address is the address that others need to use in order to transfer the cryptocurrency and the private key is a login key. The advantage of a own wallet is that the specific cryptocurrency is not stored in a centralized place, which could be a centralized exchange. The use of private wallets is in contradiction with the current financial system where people use banks to store their currencies. Another advantage is that private wallets are accessible by any internet-connected computer or smartphone. However, there is a downside to the management of an offline wallet as well. For example, imagine losing the private key, which leads to the inability of logging into the wallet. Under such circumstances, people are unable to contact customer service because there is no trusted third party in a blockchain network that handles such problems. Besides having a private wallet, an individual can exchange tokens with other individuals by means of an cryptocurrency exchange.

Once you compare cryptocurrencies with fiat money (*Dollars, Euros, etc.)*, there are several differences. First, transaction fees of cryptocurrencies are different in than transaction fees of fiat money. Miners of the cryptocurrency receive the transaction fees in comparison to the banks that receive the transaction fee for fiat currencies. With Bitcoin, you can send any amount to someone his Bitcoin wallet and pay around 0.001BTC *(~€3,50 as of September 2017*). This fee is fixed, despite the amount or where you send the money to (Bharadwaj, 2016). Also, transaction speed differs per cryptocurrency, because transactions need to be verified by miners by means of the PoW or PoS mechanism. On the day of writing, the average time to confirm any transaction is 14 minutes (*figure 12*). The transaction time of Bitcoin is dependent on the miners in the network. Thus, the transaction speed of cryptocurrencies is excessively faster than, for example, transacting fiat money. An international transaction in fiat money can take anywhere from one to five days, depending on the amount.

Figure 12: Transaction speed of Bitcoin (www.blockchain.info)

Secondly, the volatility of the cryptocurrency (*figure 13*), which is the fluctuation in value that is driven by many factors. To begin with, cryptocurrencies are still in its nascent stages what leads to positive or negative news events that influence investors enormously. The early adopters of cryptocurrencies are mostly feared by regulatory news events because it may result in a ban of the currency or lead to shutting down exchanges (e.g. the bankruptcy of Mt. Gox in 2014 and China banning Initial Coin Offerings in 2017). Also, large holders of the currency can control the market by liquidating large positions in order to move the market. Furthermore, the volatility is driven by varying perceptions of the intrinsic value of the cryptocurrency. This makes cryptocurrencies risky for businesses because it is uncertain what the tomorrows price of the coin will be.

Figure 13: Value chart of Bitcoin until September 2017 (www.coinmarketcap.com)

Also, chargebacks are not possible in a blockchain network. For the simple reason that you cannot alter, reverse, or remove a transaction once it is verified and added to the blockchain network. Finally, inflation is not possible in cryptocurrencies. Inflation means that the amount of any currency in circulation continues to increase. This can be a problem when inflation can be very high because it results in economic instability. Cryptocurrencies, on the other hand, are deflationary currencies, which means they have a capped maximum amount of supply (Nakamoto, 2008).

Government regulation is one of the most significant factors as to whether the blockchain industry will develop into a full-fledged financial-services industry (Swan, 2015). As a matter of fact, many countries have completely banned Bitcoin: Bangladesh, Bolivia, Ecuador, Iceland, Vietnam. Also, in December 2013 China already banned financial institutions from dealing in cryptocurrencies. Not to mention, many countries in Europe are unfavorably on Bitcoin (Swan, 2015), whereas other countries, like the UK, have already classified Bitcoin as a currency.

There is a lot of fear, uncertainty, and doubt regarding the implementation and use of cryptocurrencies, which will lead to people being uncertain whether the implementation of digital currencies will be successful. This is mostly a result because of countries banning digital currencies and media is not convinced of the technology and they continuously are warning people of a 'bubble'.

Therefore, applying cryptocurrencies in new business models will firstly lead to a long regulative process because a few countries accept cryptocurrencies and many people are not convinced by the application.

3.1.3 Blockchain 2.0 – Smart contracts

"Whereas Blockchain 1.0 is for the decentralization of money and payments, Blockchain 2.0 is for the decentralization of markets more generally, and contemplates the transfer of many other kinds of assets beyond currency using the blockchain, from the creation of a unit of value through every time it is transferred or divided" (Swan, 2015).

Smart contracts are referred to as "Blockchain 2.0" because it is the next stage of development after Bitcoin, which is called Blockchain 1.0. Basically, a smart contract is a digital contract that can automatically be conducted without the involvement of a trusted third party (PwC, 2016). In order words, it is a computer program that stores rules for negotiating the terms of a contract, automatically verifies the contract and then automatically executes the agreed terms. This means, untrusted parties can transact directly with each other using smart contracts. According to Swan (2015) a smart contract can also be used to register, confirm, and transfer all manner of contracts and properties. These characteristics have led to an unsurprising enthusiasm regarding smart contracts because they offer a more efficient and cost-effective way of conducting transactions (Giancaspro, 2017).

There are already several applications for smart contracting (Bharadwaj, 2016; Schneider, et al., 2016; Mansfield-Devine, 2017):

- Public records (e.g. land holdings, vehicle registrations, and other licenses);
- Private records (e.g. bets, contracts, loans, and wills);
- Identification (e.g. licenses, passports, and identity cards);
- Intangible assets (e.g. patents, trademarks, and copyrights);
- Financial transactions (e.g. private equity, mutual funds, and derivatives).

There are certain blockchain networks that have the ability to run smart contracts. Nowadays, the largest blockchain that features smart contracts is called Ethereum, which is a cryptocurrency project developed by the 22-year old Russian developer Vitalik Buterin (Kirkman & Newman, 2017). Ethereum is different than Bitcoin because it supports an Ethereum Virtual Machine (EVM). An EVM is an extra feature that is used to run the "smart contracts" (Kirkman & Newman, 2017; PwC, 2016). Secondly, Ethereum is a ledger technology that enables developers to build decentralized applications, by means of existing coding languages like Solidity, JavaScript, and Python (Araoz, 2016; Delmolino, Arnett, Kosba, Miller, & Shi, 2016). Decentralized applications will be explained shortly in *chapter 3.1.4 Blockchain 3.0 – DAOs*. Thus, Bitcoin is nothing more than just a currency, whereas Ethereum is a cryptocurrency that allows more technical applications.

The Chamber of Digital Commerce (2016) provided a simplified example that shows how a smart contract network functions when a mortgage swap is executed by means of a smart contract (*figure 14*). In this case, smart contracts are used to automatically connect involved actors with mortgage transactions in order to realize a less error-sensitive process (Chamber of Digital Commerce, 2016). A visualization (*figure 14*) presents how mortgages are currently provided, in comparison how mortgages can be provided by means of a smart contract application. In this case, the current state represents a procedure where a possible new homeowner appeals on a new home and does this by means of contacting the bank for a mortgage. In turn, the bank works along with insurers, mortgage holders, and internal revenue services. This may leads to, for example, process friction, dependency,

and privacy concerns. Smart contracts could eliminate many of these challenges because the property rights can automatically be released once the mortgage is paid off. Namely, smart contracts are contracts that are triggered by specific events. Once an event is successfully completed, the next event will be put in motion.

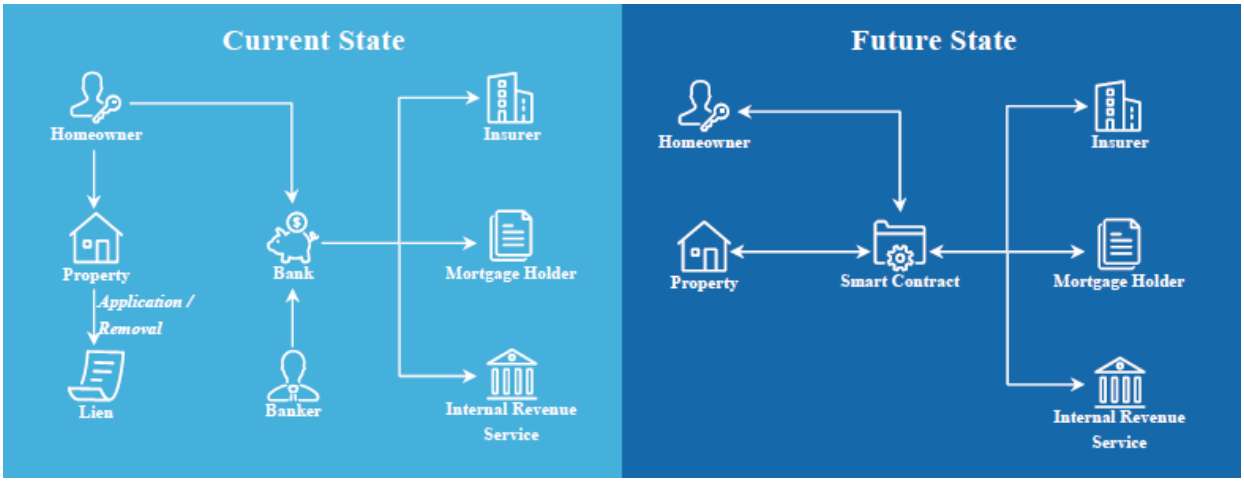


Figure 14: Smart contracts for mortgages (Chamber of Digital Commerce, 2016)

Also, Delmolino, et al. (2016) provides a simplified example that shows how a smart contract is coded by means of using the Ethereum network (*figure 15*). In this case, Alice and Bob use a smart contract for a financial swap. This is done as follows: Firstly, this contract allows Alice and Bob to set up an agreement on a future of a physical commodity or financial instrument. The example explains that Alice assumes that the price of the asset will be higher and Bob believes that, at the time of the deadline, the price of the asset will be lower.

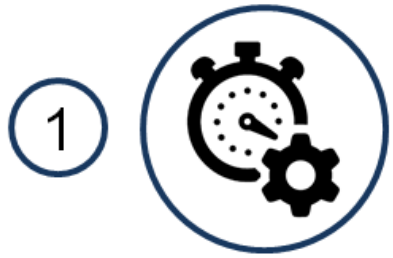
```
1  data Alice, Bob
2  data deadline, threshold
3
4  # Not shown: collect equal deposits from Alice and Bob
5  # We assume StockPriceAuthority is a trusted third party contract that can give us the price
   ↪  of the stock
6
7  def determine_outcome():
8    if block.timestamp > deadline:
9      price = StockPriceAuthority.price()
10     if price > threshold:
11       send(Alice, self.balance)
12     else:
13       send(Bob, self.balance)
```

Figure 15: Programming a smart contract for a financial swap (Delmolino, Arnett, Kosba, Miller, & Shi, 2016).

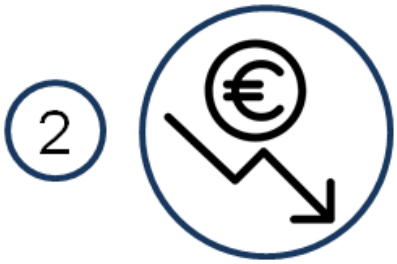
To enter the agreement, Alice and Bob both deposit an equal amount of money in terms of Ethereum tokens. After the agreed deadline has passed, the stock price will be determined by means of some external pricing authority. In the smart contract this is referred to "price = StockPriceAuthority.price()". Thus, depending on the stock price at the determined date, either Alice or Bob automatically receives the entire sum of the money that is jointly wagered (Giancaspro, 2017).

It can be concluded that the example of Alice and Bob illustrates that smart contracts can be used to identify the two parties that engaged a contract, refer to the deadline the smart contract will need to be activated, include preconditions, and include the logic for execution of the contract and how the outcome is determined.

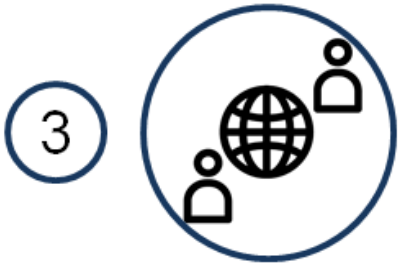
There are advantages regarding the use of smart contracts. The major advantages are as follows:



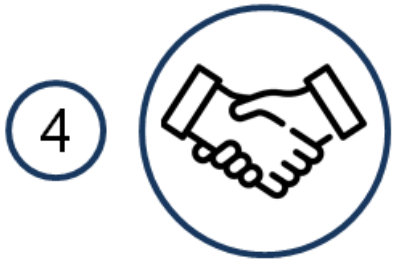
Increased efficiency: Smart contracts are validated by consensus in the network and are not validated by a trusted intermediary, due to the fact that transfers on the blockchain are instant and peer-to-peer. Thus, settlements can take place quicker because of disintermediation and trustless exchange.



Reduced transaction and legal costs: The absence of trusted third parties and legal parties will result in cost reductions. The lowering of overhead costs might lead to an increase in transactions, because the entry level will be lower.



Greater transparency and anonymity: A greater transparency will occur, because all the transactions executed in a blockchain network are accessible to the people connected to the blockchain. Also, your personal data is not stored on the network, which will lead to a high level of anonymity.



Greater trust among two parties: In a traditional contract the two parties will have to trust each other in order to fulfil its side of the obligation. The advantage of a smart contract is that an autonomous check will consider whether the parties fulfilled its side of the obligation, but remove the need for trust because the transaction will be executed automatically.

It can be concluded that smart contracts can be adopted in many businesses and processes by means of translating current contracts into coding with legal certainty. For the reason assets can be exchanged trustless by means of the rules by which they will be exchanged. However, this is only the case if the code is clearly programmable and readable because everyone should be able to read the code.

3.1.4 Blockchain 3.0 – DAOs

The next generation of blockchain are DAOs, referred to as decentralized autonomous organization. In this stage, smart contracts are further developed, so that they rely on their own laws and operate autonomously (Wojdyło & Czarnecki, 2016). DAOs can operate like traditional companies, foundations, or associations. The first example of a DAO was an organization called “The DAO”. This DAO was supposed to function as a decentralized venture capital fund. Everyone was able to pay funds into the DAO and receive tokens in return. The token holders were allowed to vote on investments by the fund (Swan, 2015; Wojdyło & Czarnecki, 2016).

Ethereum is a blockchain platform that enables anyone to construct DAOs, without launching their own blockchain, because it keeps operating on the Ethereum blockchain. This causes a lower level of entry and promotes the Ethereum technology.

3.1.5 Public, private and hybrid blockchain networks

One of the main advantages of blockchain technology is that many networks are accessible for everyone. However, not all blockchain networks are public because developers do have the choice to build their applications on either a public, private, or hybrid blockchain (PwC, 2016). This section will explain differences between public, private and hybrid blockchain networks.

Nowadays, the majority of the blockchain networks are public, also referred to as permission less. This means that anyone is able to participate and interact in the network. Thus, anyone does have identical privileges to check transactions, conduct new transactions and participate in the validating process (Glaser, 2017). On the other hand, private networks, also referred to as permissioned blockchain networks, are only accessible by users that have certain credentials to have access to the network in order to interact. A private blockchain network (*for example R3*) is in contrast to a public blockchain, like Bitcoin or Ethereum (*figure 16*). For financial institutions or regulated companies, this type of network is the primary choice because they have to comply with Know Your Customer (*KYC*) norms (Glaser, 2017; PwC, 2016). Thus, anonymity is not acceptable. Not to mention, a public network will expose all the transactions conducted by financial institutions, which is in conflict with data privacy and confidentiality obligations. Nevertheless, the characteristics of public- and private blockchain networks can be combined in order to form a hybrid blockchain network. A hybrid network is a network where only one user or organization owns the blockchain and can determine which transactions can remain public, and which must be restricted to particular users. Private blockchain networks do have several advantages over public networks. First, KYC norms will be met because a private blockchain is not an anonymous network, which leads to reducing risks for particular businesses. Additionally, unwanted users cannot access the network without certain permissions, which enhances the level of privacy.

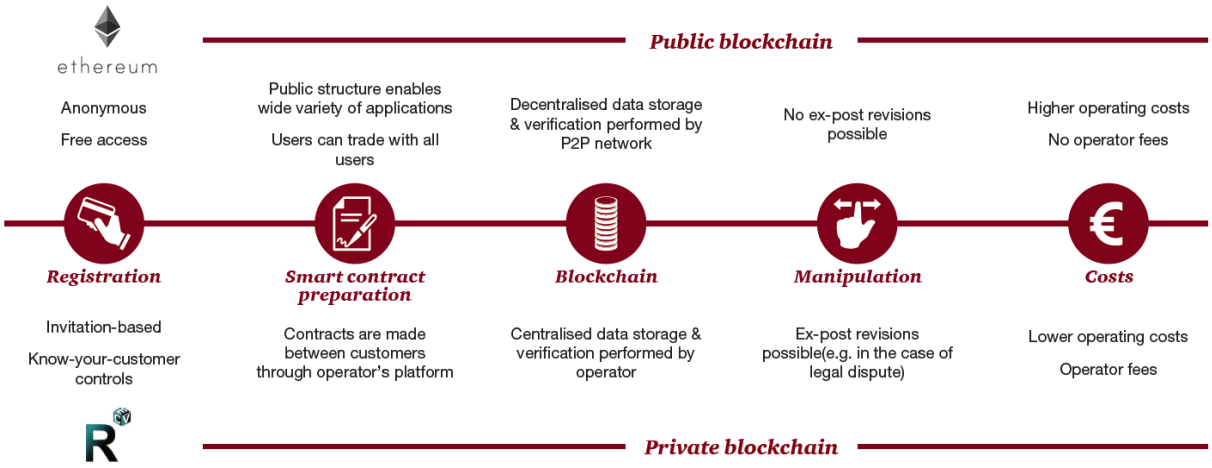


Figure 16: Difference between a public blockchain (e.g. Ethereum) and a Private blockchain (e.g. R3) (PwC, 2016).

Secondly, in a private blockchain certain nodes and transactions can be modified, which is nearly impossible in a public blockchain. This can be done, because one organization controls the blockchain (PwC, 2016). Thirdly, transactions are cheaper because there are only a few nodes necessary in order to verify transactions. Once there is a fault in the nodes, it can be fixed quickly because the nodes are well connected and, not to mention, trusted by the controlling organization.

As a result, one could argue that a private blockchain does no longer operate to the core principle of blockchain technology. Private blockchain networks are not fully decentralized, because it is owned and controlled by one organization. Also, a private blockchain is open for adjustments or interventions. Only if the organization is a trusted advisor, this will be an advantage because this organization can control the network and advice participants.

3.2 Challenges and risks

Blockchain technology is a nascent technology that is resolving many challenges in order to gain worldwide adoption. This section will describe the challenges and risks, which blockchain technology is currently facing and what makes it vulnerable for adoption.

To start with, the technology requires need more applications in different businesses and sectors in order to gain broad adoption (Spielman, 2016). In order to do this, technical standards will have to be developed to have a seamless blockchain cooperation amongst different industries. Different applications are necessary in order to gain trust because of its usability (Swan, 2015). However, businesses might have to change their current way of working in order to adopt blockchain or cryptocurrencies. Therefore, this challenge will take some time in order to be achieved.

Furthermore, the regulatory status of the technology is still uncertain. On the one hand, cryptocurrencies are facing heavy regulatory challenges because it is in contrast to the current economic system (Barrdear & Kumhof, 2016). Also, cryptocurrencies were used for money-laundering and cyber fraud, which led to regulations regarding anti-money laundering systems for exchanges. (Seppälä, 2016). On the other hand, smart contracting is facing challenges because it is unknown whether this technology should be considered under the terms of "Contract Law". If the answer is yes, everyone should have the ability to read and understand the smart contract coding and the automatization of smart contracting is conflicting with the current Contract Law. This is because contracts in public blockchain networks cannot be altered, cancelled or invalidated (Swan, 2015). Nevertheless, in a private blockchain revisions of transactions or contracts are possible.

For Bitcoin, every ten minutes a new block will be added to the blockchain. The first miner that solves the algorithm receives a fee for adding the block to the network. In order to do this, one must be in possession of huge computational power and a high level of connectivity (Barrdear & Kumhof, 2016). Many mining farms arose in geographical areas with either low energy costs (*e.g. Eastern China*) or good connectivity (*e.g. Iceland*). This leads to a high level of energy usage in order to keep the network running. One of the key features to blockchain technology is that it is said to be unhackable, due to the complex cryptography and decentralized nature of the ledger (McKinlay, Pithouse, & Sanders, 2017). However, an attack on the network is still possible whenever attackers have more than 50% of the network's mining hash rate. If the attackers succeed, they will have the ability to interfere with the process of recording new blocks and prevent other miners from completing blocks. Hence, this will give the attackers a monopoly position.

Fourth, the scalability of blockchain protocols are limiting widespread use (Spielman, 2016). For example, Bitcoin is a blockchain network that is currently facing scalability challenges because blocks in the network are limited to one megabyte in size. Once the network is being used by more and more people it will have to process more and more blocks. Eventually, the network is not able to handle more and bigger transactions. Therefore, forking is necessary. This is a process of 'forking' the blockchain network in separate chains.

Blockchain technology is aiming to function as a fully decentralized platform, being independent from intermediaries to control every transaction. Last couple of years it already has proven its value by increasing the total market cap of cryptocurrencies from 1.5 billion to 145 billion in just four years (*September 2013 – September 2017*). The increase in cryptocurrency value is just one example that shows that the technology is being adopted by more and more people and organizations. For it to be fully functional, it will have to overcome the mentioned limitations and risks.

The following section will describe blockchain possibilities and current applications in the real estate sector.

3.3 Blockchain in real estate

A distributed database technology company, called R3, is leading a consortium of more than 80 of the world's largest financial institution in research and the development of blockchain technology in the banking industry. Furthermore, real estate companies are focusing on the topic as well, which can be concluded by different reports regarding proof-of-concepts and there are several applications in real estate already. This section will describe blockchain opportunities and applications in the real estate sector (ABN Amro, 2016; Chamber of Digital Commerce, 2016; Cushman & Wakefield, 2017; Deloitte, 2017; Donkers, 2016; PwC, 2016; Spielman, 2016; Swan, 2015):

1. **Smart contracts:**
   Key terms of the current agreements can be recorded in the blockchain and this contract is automatized. Therefore, it can contain payment rules, reminders, a fully-secure verifiable system, without the need of a third party. Because the history is audited, all parties have confidence in the data being shared, and the time needed to close a transaction is much shorter (Cushman & Wakefield, 2017; Deloitte, 2017). Implicating smart contracts within real estate transactions will ensure a transparent, efficient and flawless process. Smart contracts can also be used to collect documents from source files (*Databases that function as source are called 'oracles'*);
2. **Re-design real estate processes:**
   Real estate processes can be changed by means of applying a blockchain database (ABN Amro, 2016). Real estate assets can be stored digitally and transactions can be executed by means of cryptocurrencies. The transactions are recorded on the blockchain, which results in an audit trail that can be used for due diligence (Deloitte, 2017). Currently, transactions in real estate are time consuming and expensive due to due diligence and the involvement of intermediaries. These parties are expensive because they own information, which is not publically accessible. If this type of information would be easier accessible it would improve the current processes incrementally.
3. **Payment systems using tokens:**
   Cryptocurrencies could be used as payment system in real estate by means of conducting peer-to-peer transactions. One can think of transactions for the purpose of rent.

Besides described opportunities, there are several applications in real estate as well. The following section will describe these blockchain applications.

3.3.1 Examples of blockchain applications in real estate

As mentioned, blockchain technology is new to many organizations and people in real estate. Therefore, there are only a few examples where organizations use blockchain in order to support the core business. This section will explain some blockchain applications.

Currently, ABN Amro is working on a private blockchain experiment, called Torch, that is approaching the commercial real estate sector in a different way (ABN Amro, 2016). Torch is a blockchain application on which parties can transparently, trustfully, efficiently, and verifiably exchange building related data

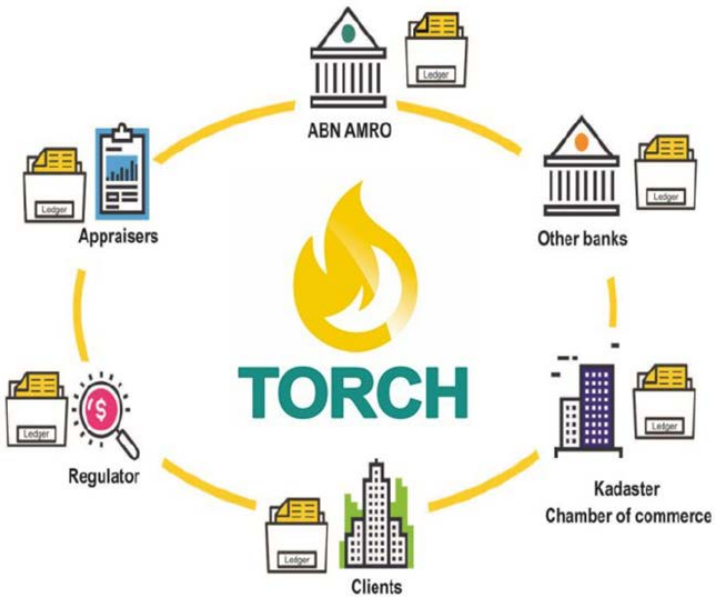


Figure 17: Parties connected to the Torch platform (ABN Amro, 2016)

by means of using blockchain technology and smart contracting. The parties that are involved on this platform are real estate investors, appraisers, other banks, and the Dutch Central Bank (*figure 17*).

Having many parties connected to the Torch application offer advantages. Every authorized party does have direct access to up-to-date data. For example, the Dutch Central Bank can carry out their audits whenever they want, without triggering an extended reporting process first (ABN Amro, 2016). Even more, the client is in control of the data in terms of who may access it. The result of this blockchain application is an enhancement in transparency a higher level of data quality, and a more efficient business process.

Another example is REAL (Real Estate Asset Ledger), which is an Ethereum Smart Contract governed blockchain that focusses on creating the best conditions for real estate investment opportunities, by cutting costs due eliminating unnecessary intermediaries, providing transparency and liquidity, alleviating tax inefficiencies and easing cross-border transactions by means of a crowdfunding platform (REAL, 2017).

REAL (2017) argues that crowdfunding blockchain applications are highly suitable for the real estate market because it will lower entry barriers for many people that want to invest in real estate.

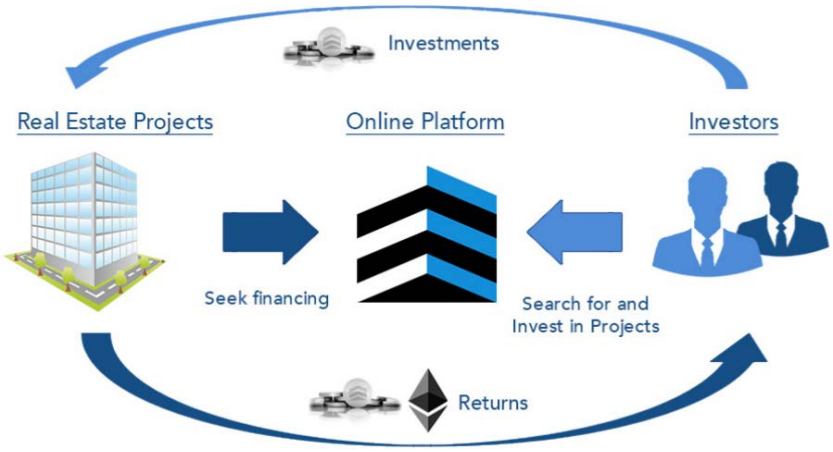


Figure 18: Comprehensive overview of the REAL crowdfunding platform (REAL, 2017).

On the crowdfunding platform of REAL, users will be able to exchange REAL tokens for economic rights of a property (REAL, 2017). The properties presented on the platform are located all over the world, which causes that people can easily diversify their real estate portfolio. The latter example is a typical example of combining cryptocurrencies and smart contracts by means of EVM.

These are just two examples to show the different opportunities in real estate. Obviously, there are other applications in real estate as well, which are not included in this research. It can be concluded that many companies conduct research regarding blockchain technology and its features. Blockchain features are useful for many different sectors as well. It seems that several sectors are only interested in the commissioning of smart contracts or cryptocurrencies, where others are aiming to use a combination of both.

3.4 Summary

This chapter described blockchain regarding its key features, challenges and risks, and other implementations. Finally, this section will summarize the technology of blockchain, in order to answer the sub-question: "What is the status quo in regard to blockchain technology?"

Blockchain is an online ledger that records executed transactions parties. The database is different in comparison to centralized databases, such as clouds. Namely, blockchain technology is a decentralized transparent ledger, which is managed by a network of computers. As a result, the ledger contains blocks that contain details of the transaction, which are chained to each other by means of the hashes. As mentioned, the blocks in the network contain mathematical principles that are validated by the miners and nodes in the network. Eventually, the transaction is approved if the result of the encoding is corresponding, according to the nodes in the network.

Developers do have the choice to build their applications on either a public, private, or hybrid blockchain. Nowadays, the majority of the blockchain networks are public, also referred to as permission less. This means that anyone is able to participate and interact in the network. On the other hand, private networks, also referred to as permissioned blockchain networks, are only accessible by users that have certain credentials, which grants access to the network. A hybrid network is a network where only one user or organization owns the blockchain and can determine which transactions can remain public, and which should be restricted to particular users.

The technology is emerging, which causes start-ups and corporations to explore the possibilities. On the one hand, blockchain technology can be used to transfer value by means of cryptocurrencies. On the other hand, blockchain features the implementation of smart contracts. Smart contracts can be further developed into a decentralized autonomous organization (DAO). These three blockchain features can be used individually or jointly to support the businesses of corporations.

Blockchain technology still faces major challenges and risks. Firstly, more and more blockchain applications need to be developed in order to gain more popularity and adoption. In order to do this, businesses will have to change their current way of working to imbed the technology. Secondly, regulatory status regarding the technology is still uncertain. Furthermore, the usage of the network is still expensive due to the fact that it requires huge computational power, a high level of connectivity, and a lot of energy. Also, the scalability of the networks are still too small for widespread adoption. The current networks are not able to process more and bigger transactions. Therefore, forking the network happens regularly.

Blockchain is a technology that enables the enhancement of current processes in every sector. However, it is important to bear in mind that it can only be useful whenever the current process requires the same characteristics as the blockchain technology:

- The requirement of a database;
- The users do not have a unified interest;
- The users do not want, or do not want to trust a third party to maintain the data;

Whenever a current process meets the mentioned requirements and a blockchain application is possible, then this process can benefit from the following advantages: disintermediation and trustless exchange, a high quality of data, a high level of transparency and immutability, the simplification of the ecosystem, faster and cheaper transactions, and empowered users in the network. The tenant mutation process at housing associations is a process that could benefit from these characteristics.

3.5 Blockchain and housing associations

In the previous chapters two topics are researched separately. Both the topics are input for the theoretical framework. This sector aims to align blockchain technology to the Dutch housing association sector. This alignment will form the assumption for the development of a blockchain based solution.

To align the two topics, it is important to investigate the demand of housing associations to optimizations and how blockchain technology can supply these demands. This is done by means of analyzing the theoretical framework. If the supply and demand match it could be assumed that a blockchain solution fits for housing associations (Turk & Klinc, 2017; Wüst & Gervais, 2017).

Supply by blockchain technology

- Digital currency: cryptocurrencies can used to buy and sell goods and services;
- Inter-organizational data management: Blockchain offers the exchange of data by means of a peer-to-peer decentralized network that functions as a database;
- Transparency / Auditable: A valid transaction is added to the chain of blocks. This means that the block cannot be altered. The result is a complete audit trail of all the transactions. Every party, that is connected to the network, has insight into all the blocks and transactions;
- Digital identity: Every user of a permissioned blockchain network will have to digitize his identity;
- Disintermediation: Smart contracts removes mediators and speeds up the process;

Demand of housing associations:

- Database: Housing associations are in need of a database that continuously offers up-to-date information regarding the housing stock, information of tenants, and the administration;
- Easy cooperation with other parties: Housing associations need a lot of data from other parties, such as tenant information that should be derived at the tax authority or municipality. Easy cooperation with all these parties and trustless exchange of information is desired;
- Audit trail: Because every housing association is monitored by regulators, it is necessary to have a complete audit trail of all the exchanged information. This will also enhance administrative work because everything is recorded;
- Efficiency / cost reduction: According to the theoretical framework, it is needed for housing associations to speed up the current way of working. This will lead to cost reduction and an increase in service towards tenants;

The supply characteristics of blockchain and demand characteristics of housing associations can be matched. A blockchain network can ensure that different parties are able to transfer assets or documents. However, this is only the case whenever the systems are interoperable. Every transferred asset or document is registered on the blockchain ledger, which will result in a complete audit trail. This is preferable for housing associations and regulators for all kind of checks or assessments. Furthermore, every party that is connected to permissioned blockchain network environments should be obliged to identify himself, which is desirable whenever a blockchain application for housing associations is developed. Also, disintermediation because of smart contracts and peer-to-peer transactions will ensure that the current way of working is more efficient. It speeds up the process by means of digitization and automatization and this could lead to a decrease in manual actions, cost reduction, and an increase in service towards tenants. However, organizational and technical changes for housing associations could result in adoption problems.

It is hard to decide whether blockchain technology is suitable for housing associations because blockchain is still a nascent technology and currently does not have any other pilot projects. Therefore, the decision tree will be used, which is developed by Wüst & Gervais (2017) (*figure 19*). They determined whether a blockchain is the appropriate technical solution to solve a problem (Wüst & Gervais, 2017).

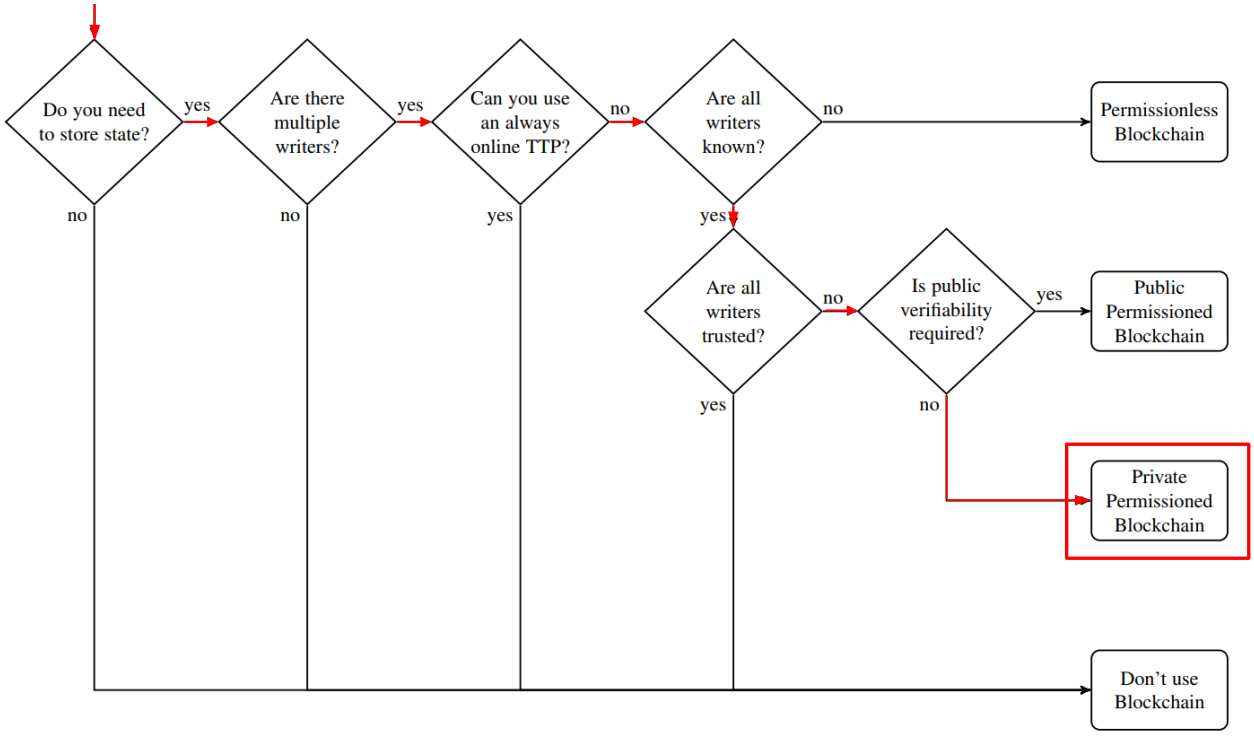


Figure 19: Flow chart to determine whether blockchain is a solution to a problem (Wüst & Gervais, 2017)

Due to the requirements of housing associations it could be assumed that a blockchain application fit. To conclude this assumption, the flowchart will be evaluated:

- Housing associations need a database to store information of the housing stock, information of tenants, and the administration;
- Shared access is required to involve other parties (*tenants, trusted third parties - TTP*);
- Housing associations and tenants are not able to always use an online trusted third party (*TTP*);
- All writers are known because housing associations desire to know who they work with and who they assign a dwelling to;
- Not all these writers are trusted because they do not have a unified interest;
- A public verifiability is not required.

Both the requirements and flowchart conclude that a private permissioned blockchain could be possible for housing associations. Therefore, the next chapter will investigate what activities of housing associations are in need for optimization. Afterwards a solution will be developed.

Part 3 – Empirical findings

4. Research methodology

The previous part presented the theoretical framework. In order to conduct research to the implementation of blockchain technology in the current way of working by housing associations, it is necessary to reveal the research approach on how these two topics will be examined in detail. Therefore, this chapter shows the research approach and research tools that will be used in this study.

Firstly, *section 4.1* will start with an explanation on how this research is approached, which is an extension to the research design. S*ection 4.2* to *section 4.7* will show the different research tools and methods that are used in this research.

4.1 Approach

This research is of an explorative nature, due to the fact that blockchain is still an undeveloped technology. Besides, there is no scientific knowledge to the way of working by housing associations. Therefore, an explorative nature is preferred because it is considered as a relatively unstructured approach to the research process (Bryman, 2012). Qualitative research explores the reality as constructed by individuals, which results in a textual account of the individual's life, instead of the concrete realities of objects (Erlingsson & Brysiewicz, 2012).

Conducting a qualitative research ensures that the researcher is part of the study, and is in fact, the research instrument (Bryman, 2012; Erlingsson & Brysiewicz, 2012). This research approach will require the participation of different field experts, who have experience of the phenomenon under investigation. These field experts will be interviewed individually. The results of these interviews will be reported in a literary style, based on transcribed narratives (Bryman, 2012). The results of a qualitative research approach are textual reports of the employees at housing associations. As a researcher, it is important to understand patterns and similarities in way of working by different housing associations. This will be accomplished by conducting the interviews in an unstructured- and semi-structured style. Consequently, these interviews will be transcribed by means of the grounded theory approach.

As mentioned, the tenant mutation process is not a process which is described in scientific literature. Therefore, the knowledge of field experts will function as input for this domain. How this domain will be elaborated will be explained in the following sections. The nascent stage of blockchain technology offers many opportunities because many new pathways can be discovered. However, the nascent character brings difficulties considering not many applications exist and not many references can be consulted. With this in mind, blockchain experts will support this research in order to find an appropriate blockchain solution to the tenant mutation process.

4.2 Data collection

On the one hand, the data for this study originates from desk research by means of informing scientific knowledge. On the other hand, expert interviews are necessary in order to do research to the process at housing associations. This section comprehensively describes the two data collection methods.

4.2.1 Desk research

First, a literature review is necessary to understand the research field and to gather a better understanding of possible solutions. A well-executed literature study will bring better focus to the research problem and contextualize the possible findings (Bryman, 2012).

Desk research regarding general information of housing associations and their operating expenses is available due to Aedes, which is an association for Dutch housing associations. Aedes annually publishes benchmark reports of all Dutch housing associations. Unfortunately, no data or scientific papers are available that address the current way of working by housing associations. This might be due market circumstances and changes in their core business.

Literature will also be reviewed in order to understand the functioning of blockchain technology in a detailed way. The scope of the scientific reports is limited to different business models and explanations of the technology. Literature regarding the way on how blockchain is programmed is excluded because it is outside the scope of this research. The empirical findings along with the desk research will function as a fundament to provide an answer to the main research question.

4.2.2 Expert interviews

As mentioned earlier, expert interviews are necessary in order to collect data regarding the current way of working. First, unstructured interviews will be conducted to understand the general process, since this approach offers a broad approach to the subject. These interviews are somewhat regarded as a discovery interviews. The interview protocol to these interviews is presented in *Appendix A*. Open questions are used in these interviews that generate qualitative data. This helps to better understand the general way of working of housing associations.

The interviewees are professionals from the same area of expertise, namely working as housing officer or process manager. A selection is made based on housing associations with different rentable units. Therefore, size of the housing associations that are interviewed range between 1.100 and 85.000 rentable units. Consequently, it can be determined whether every housing association experiences the same process, impediments, and pains. Additionally, semi-structured interviews are conducted to determine the current way of working in high detail. As a result, the impediments and pains could be defined. The interview protocol for semi-structured interviews is added in *Appendix B*. The interviewees work at the rental- and management department and their job is to rent- and let social housing. Thus, they could easily point out the impediments and pains in the current way of working.

The interviews and coding schemes reveal sensitive information regarding the particular housing associations and are confidential. These interviews are defined in an external report. For the full version, please contact the author (*Appendix C*).

4.3 Grounded Theory Approach

The interviews will generate a lot data. Therefore, the grounded theory approach will be used to direct, manage, and streamline the data collection. More importantly, this method will be used to construct an original analysis based on the collected data (Charmaz, 2006).

The grounded theory method emerged from two sociologists, namely Barney G. Glaser and Anselm L. Strauss (Charmaz, 2006). Charmaz (2006) argues that Glaser and Strauss aimed to move qualitative inquiry beyond descriptive studies into the realm of explanatory theoretical frameworks, thereby providing abstract, conceptual understandings of the studied phenomena. This is done by means of analyzing and coding the data. Coding the data means that labels are attached to different segments of data that depict what each segment is about (Charmaz, 2006).

There are different kinds of coding methods. The main coding methods are open coding, axial coding, and selective coding (Bryman, 2012; Khan, 2014). Open coding is a method that concerns with reading the entire text and continuously ask yourself a question “what is this part about? what is being referenced here?” This type of coding refers to general steps in the tenant mutation process. Axial coding is relating various categories to each other (Charmaz, 2006). This method helps to find

relationships among different interviews. Selective coding is a method of choosing one category and relate all different kind of paragraphs to this category (Bryman, 2012). For this research, open coding and axial coding, are the most relevant and effective methods because the interviews are being analyzed to determine relationships. Selective coding is undesired because it is impossible to know in advance what statements are related to various categories. The coding schemes are confidential and presented in *Appendix C*. The interviews are relevant to collect data and the grounded theory approach is relevant to analyze the data to define a formal theory. What steps are being undertaken to define this formal theory regarding the tenant mutation process is shown in *figure 20*.

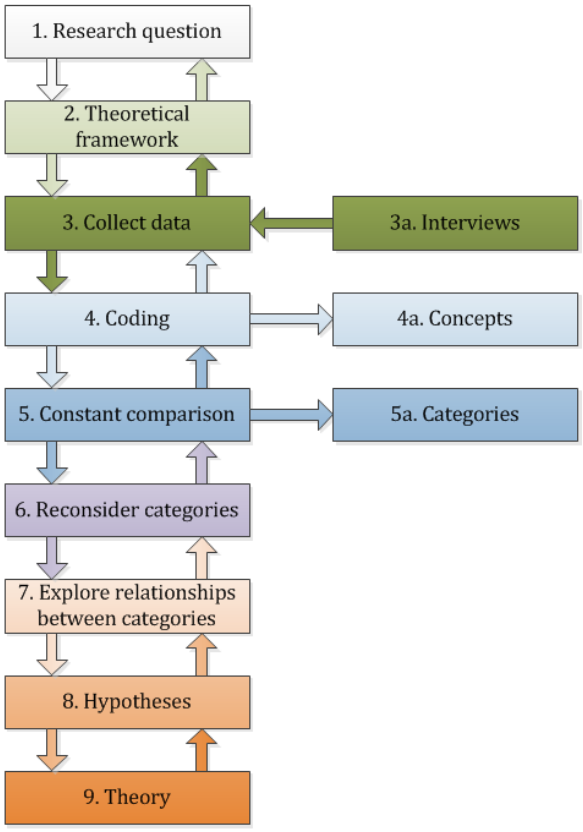


Figure 20: Process how theory is constructed (own ill.)

First, the problem statement and research question gives direction to what is needed to be investigated. Based on this question a theoretical framework is elaborated in order to understand the topics. Afterwards, data collection takes place. The data will be generated by means of interviews. The data is coded by means of open coding and axial coding in order to understand relationships among the interviews and to reveal recurring impediments and pains in this process. This will help to find a proper solution to the process. Finally, a theory can be defined. This theory, which is the current way of working is explained in *chapter 5*.

4.4 Business Process Model and Notation

Based on the data analysis a process model is constructed that visualizes the current way of working by housing associations. The research method Business Process Model and Notation (*BPMN*) is chosen to visually present the tenant mutation process. Thus, the data derived from the interviews are translated to a process model. BPMN modeling is a standard to identify three different application domains (Chinosi & Trombetta, 2012):

- Pure description of a process;
- Process simulation;
- Execution of a process.

The major goal of using a BPMN model in this study is to purely describe the current way of working by housing associations. The method is based on a Business Process Diagram (*BPD*), which is a traditional way of flowcharting techniques (Rosing, White, Cummins, & Man, 2015). BPMN serves as a common language, bridging the commination gap that frequently occurs between business process design and implementation (Rosing, White, Cummins, & Man, 2015). As mentioned, the input for this model is derived from the explorative interviews. By means of visualizing the current way of working, it can easily be understood how a proposed solution can fit in.

The model, is presented in Appendix E. Additional information regarding the elements' summary is presented in Appendix D. This overview will explain what the elements in a BPMN model stand for.

4.4.1 Customer Journey

Customer Journey Mapping (*CJM*) is an increasingly popular strategic management tool praised by both academics and practitioners for its usefulness in understanding an organization's customer experience (Rosenbaum, Otalora, & Ramírez, 2017). The idea of a CJM is to visualize the sequence how a customer interacts. Every step in the sequence is called a touchpoint and each touchpoint includes the experience of the customer. This research includes a customer journey as well because customer journeys are templates, which can be used to visualize the major impediments and pains. In this research, the CJM is a supportive tool to the BPD.

4.5 UML Modeling

To express the software model in this research a graphical modeling language will be used, called Unified Modeling Language (UML). UML allows to build models, a reflection of something in the real world or a reflection of something in a planned world (Chonoles, 2018). UML modeling is developed by Grady Booch, Ivar Jacobson and James Rumbaugh in 1994-1995 and in 1997 the Object Management Group (OMG) adopted UML as a standard (Chonoles, 2018). Also, in 2005 UML was accepted by the International Organization for Standardization (ISO) as an approved industry standard (Greefhorst & Maat, 1997). UML modeling consist of constructing different diagrams (*figure 21*). The diagrams are divided into two different categories. Some types represent structural information and the others represent behavior. UML modeling is supportive to the BPMN model because an UML model is object-oriented, while BPMN is a process-oriented approach. The constructed models in this research will be used to determine how systems behave and they are structured.

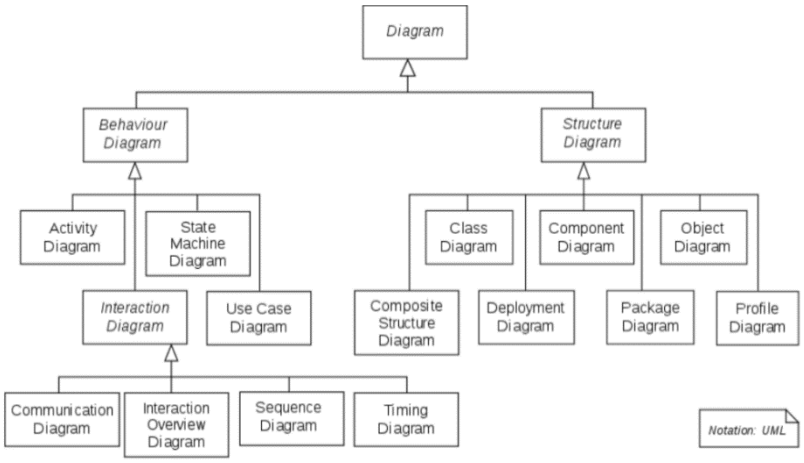


Figure 21: Categorization of UML diagrams (Chonoles, 2018)

4.6 Research methodology Summary

This research is of an explorative nature due to the fact that blockchain is still an undeveloped technology. The results of a qualitative research approach are textual reports of the employees at housing associations. As a researcher, it is important to understand patterns and similarities in the way of working by different housing associations. This will be accomplished by conducting the interviews in an unstructured- and semi-structured style, which are transcribed by means of the grounded theory approach.

The results of the interviews is input for the housing association domain that will be investigated in *chapter 5*. Based on the collected data a process model is constructed that visualizes the current way of working. Thus, the data derived from the interviews are translated to a process model, which will support the understanding of the current way of working in order to determine a proper solution. Once the solution is figured out a solution will be modelled in UML modeling. The constructed models will be used to determine how systems behave and how they are structured.

5. Empirical findings

The theoretical framework described two domains. First, housing associations and why they are focusing on reducing operational expenses and, secondly, blockchain technology. The previous chapter described research methods that support this research to link these two domains. This section will present the results of the empirical research, which is the current way of working by housing associations. These results derived from the conducted interviews. These results will function as a fundament for developing a blockchain solution.

First, *section 5.1* will start with analysis of the collected data. Thus, the current way of working by housing associations will be explained. The collected data is translated in a BPMN model and a customer journey. Major impediments and pains are described in *section 5.2*. The major pains and impediments and, obviously, the most interesting to address for a solution. This is shortly described in the discussion in *section 5.3*. Finally, this chapter will end with a summary in *section 5.4*.

Section 4.3 described how the collection of data is addressed to develop a theory. The developed theory is the current way of working by housing associations. As mentioned, *figure 22* is a visual presentation on how the data is collected and processed.

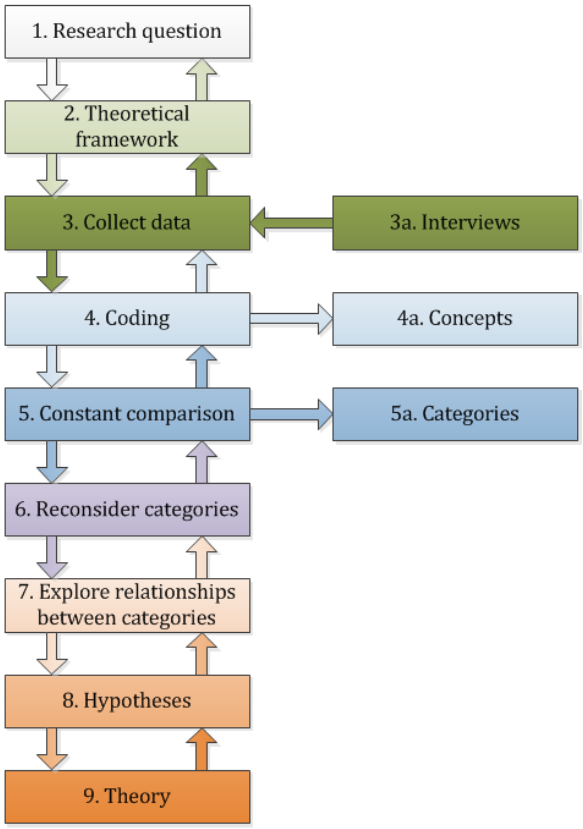


Figure 22: Process how theory is constructed (own ill.)

The first chapter of this report states the research question. Based on the research question a theoretical framework is constructed. This theoretical framework only described general characteristics of housing associations, such as the historical development of associations and the urge to reduce operating expenses. Unfortunately, no scientific papers are written that describe the current way of working. Thus, in order to develop a blockchain technology solution that enhances the current way of working in terms of efficiency, it is needed to collect data regarding the current way of working. As mentioned in chapter 4, this research is of qualitative nature and, therefore, interviews will provide the required data.

The collected data is structured by means of the grounded theory approach. This helps to find out whether every housing association is using the same current way of working and whether they experience the same impediments and pains. The coding schemes are built up as follow (*Appendix C*):

- 1st order: Quotes from the interviews.
- 2nd order: The quotes of the 1st order will be categorized. The chosen categories are: general quotes/ impediments and pains/ goals.
- 3rd order: The 2nd order categories relate to a certain topic. In this case the topics relate to specific steps in the process.

Every interview is coded this way, which makes it easy to constantly compare entire interviews, categories, and quotes. An example coding scheme is presented in *table 2*:

Table 2: Example of used coding scheme (*Appendix C*)

3rd order	2nd order	1st order
Step 1: Termination of rent	*General quotes*	
	Impediments and pains	
	Goals	
Step 2.1: Pre-inspection	*General quotes*	
	Impediments and pains	
	Goals	
Step 2.2: Selecting new candidates and offering of dwelling	*General quotes*	
	Impediments and pains	
	Goals	
Step 3: Final inspection	*General quotes*	
	Impediments and pains	
	Goals	
Step 4: Acceptation of dwelling by new tenant	*General quotes*	
	Impediments and pains	
	Goals	
Step 5: Mutation maintenance	*General quotes*	
	Impediments and pains	
	Goals	
Step 6: After Sales	*General quotes*	
	Impediments and pains	
	Goals	

The coding schemes helps to structure the collected data. Based on the coding schemes and interviews a comprehensive theory is developed. The following section will describe this theory, which is a representation of the tenant mutation process.

5.1 Data analysis

The tenant mutation process is a time-consuming and manual process that has to be addressed efficiently. Otherwise it could result in an increase of operating expenses and vacancy rates, which is undesired because housing associations will have to lower their operating costs in order to stay financially healthy. Employees of housing associations are dependent on each other's work. As a consequence delays in a certain activities may result in delays for other activities.

The tenant mutation process is divided into different steps (*visually represented in the BPMN model in Appendix E*):

- **Step 1:** Termination of rent
- **Step 2.1:** Pre-inspection
- **Step 2.2:** Selecting new candidates and offering of dwelling
- **Step 3:** Final inspection
- **Step 4:** Acceptation of the dwelling by a new tenant;
- **Step 5:** Maintenance activities;
- **Step 6:** After sales

As mentioned earlier, a CJM of the current way of working is developed, which is presented on the following page. This template represents the steps a housing association will have to undertake in order to assign a dwelling to a new tenant. The involved actors are indicated in different colors (*icons with double colors represent that two or more actors are involved*). Furthermore, the impediments and pains are indicated by means of red circles, along with numbers represented the weight of the pain. These steps will be described in the following sections.

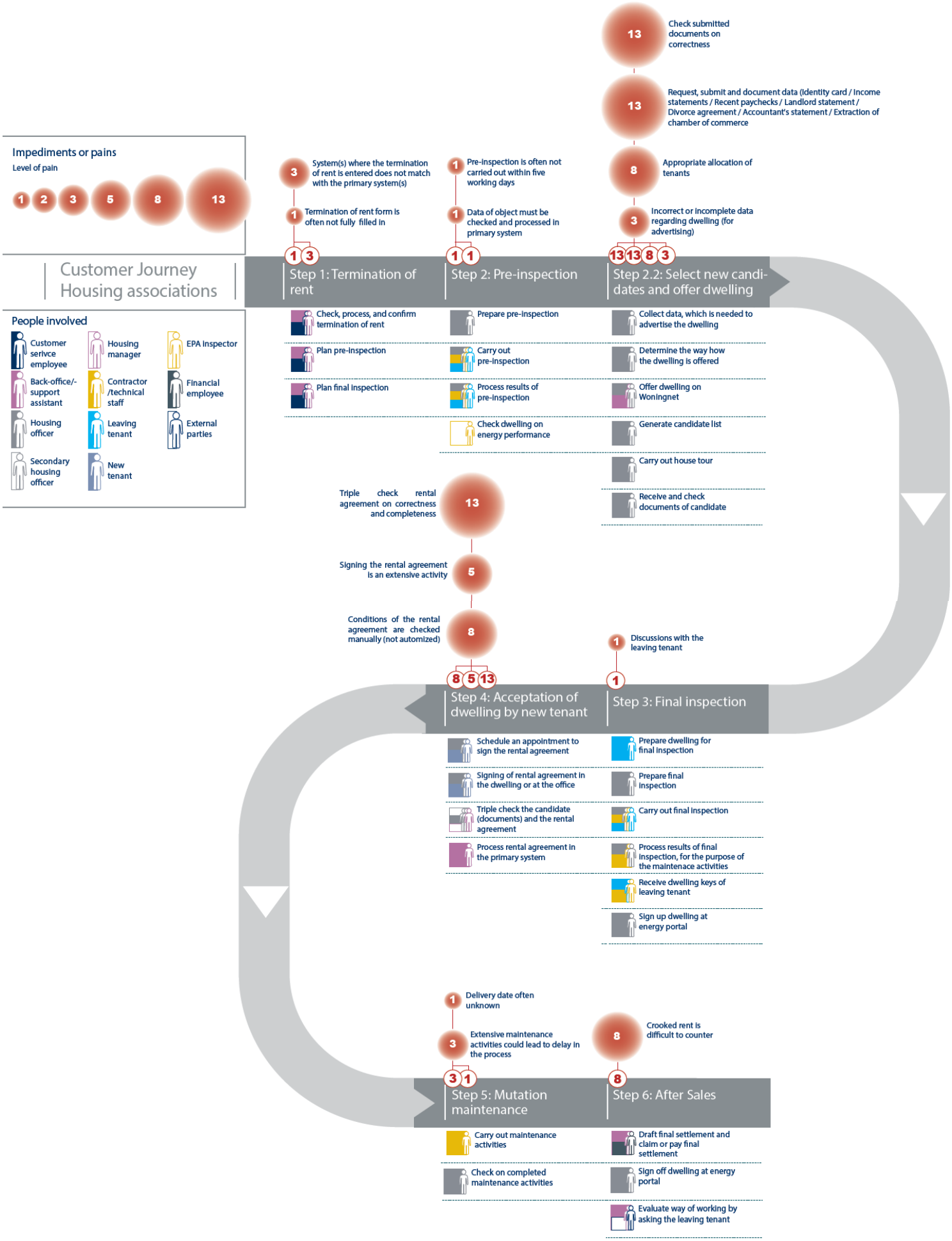


Figure 23: Customer Journey Map of the current way of working by housing associations (own ill.)

5.1.1 Termination of rent

Table 3: Involved actors and BPMN activities for the termination of rent.

Involved actor:	Leaving tenant Customer service employee Back-office/support assistant
Steps in BPMN model:	1. Termination of rent *(by: leaving tenant)* 2. Check of termination *(by: customer service employee)* 3. Process termination of rent *(by: back-office/support assistant)* 4. Register termination of rent *(by: back-office/support assistant)* 5. Plan pre- and final inspection *(by: back-office/support assistant)* 6. Confirm termination of rent *(by: customer service employee)* 8. Receive confirmation of termination *(by: leaving tenant)*

Check, process, and confirm termination of rent.
The first step in the tenant mutation process is the termination of rent by the current tenant. Tenants can choose whether to terminate the rent by phone, e-mail or by letter. The customer service department of housing associations is responsible for this termination. Once this termination is being handled it is of high interest for the association to know whether the tenant applied self-installed facilities. If this is the case, then the data of the dwelling is outdated. Therefore, customer service will ask the tenant several questions regarding self-installed facilities, the termination date, and personal information.

Figure 24: Step 1 of CJM (own ill.)

Plan pre-inspection and final inspection.
The termination of rent event is a departure point for housing associations employees to arrange their activities. Once, a tenant is terminating his rent, an appointment is made for the pre-inspection and final inspection of the dwelling. Furthermore, housing associations need to have an energy label on every dwelling. Therefore, it needs to be checked whether there is an existing energy label of the dwelling. If there is none, then the EPA inspector is contacted to be present at the pre-inspection as well. After all this information is gathered, a back-office/support assistant will process and confirm the termination. Finally, the tenant will receive a confirmation of the termination by letter or e-mail.

Processing the termination of rent causes the following two steps to be put into action: 'pre-inspection' and 'selecting new candidates and offering of dwelling'. These two activities take place at the same time.

Impediments and pains in this activity.
1. Termination of rent form is often not fully filled in;
3. System(s) where the termination of rent is entered does not match with the primary system(s).

5.1.2 Pre-inspection

Table 4: Involved actors and BPMN activities for the pre-inspection.

Involved actor:	Leaving tenant Housing officer Contractor/technical staff/EPA inspector
Steps in BPMN model:	7. Gather all documents of the tenant and dwelling *(by: housing officer)* 10. Prepare pre-inspection *(by: contractor/technical staff)* 11. Carry out pre-inspection *(by: leaving tenant, housing officer, contractor/technical staff)* 12. Check dwelling on energy label *(by: contractor/technical staff/EPA inspector)* 13. Process results of pre-inspection *(by: housing officer)* 14. Check pre-inspection report *(by: leaving tenant)*

The pre-inspection is a check that is performed by associations in order to check the condition of the dwelling. This is important because it should be known whether maintenance activities are necessary.

Figure 25: Step 2 of CJM (own ill.)

Prepare pre-inspection.
First, a housing officer will gather all documents regarding the tenant and the dwelling. Examples are documents regarding the energy label, floor plans, photos, descriptions regarding the dwelling and complex, a technical file of the dwelling, and value of the dwelling. The data regarding the involved dwelling is necessary to check whether the leaving tenant ever arranged and reported self-installed facilities. This way, the housing association does have the opportunity to update the data of the housing stock.

Carry out pre-inspection and the check on energy performance.
The pre-inspection is carried out by the housing officer, the leaving tenant, and contractor/technical staff/EPA inspector. During this pre-inspection these parties will check the condition of the dwelling. During this inspection, it will be determined what activities are necessary to rent the dwelling to a new tenant. The EPA inspector will check the dwelling on its technical condition and will arrange an energy label. Every newly rented dwelling is obliged to have an energy label because housing associations need to meet the 2021 targets, which is ensuring that the entire housing stock at least consists of an energy label B. The findings of the EPA inspector are supportive for possible maintenance activities executed by the contractor.

Process results of pre-inspection.
Additionally, during the pre-inspection, the housing officer and leaving tenant will discuss on what needs to be done, based on the record state of the dwelling. This record state describes the conditions of the dwelling at the delivery date. This is called the takeover procedure. Thus, what facilities should be removed before the tenant may leave the dwelling. Once the pre-inspection is finished, all parties will have to check and sign the pre-inspection report.

The pre-inspection report can be supportive to the data that needs to be gathered, once a dwelling is being offered on 'Woningnet'. Woningnet is a website where housing associations are able to offer the available dwellings. People, which are registered to this website, can express their interest in specific dwellings and are able to register on these dwellings. The steps that are taken in order to advertise the dwelling to new tenants are described in step 5.1.3.

Impediments and pains in this activity.
1. Data of the dwelling must be checked and processes in the primary system;
1. Pre-inspection is often not carried out within five working days. This could result in a delay for the entire tenant mutation process.

5.1.3 Selecting new candidates and offering of dwelling

Table 5: Involved actors and BPMN activities for selecting new candidates.

Involved actor:	Leaving tenant New tenant Back-office/support assistant
Steps in BPMN model:	9. Report dwelling as available in system *(by: back-office/support assistant)* 15. Create advertisement of dwelling *(by: back-office/support assistant)* 16. Registration for available dwelling *(by: new tenant)* 17. Generation of candidate list *(by: back-office/support assistant)* 18. Plan house tour *(by: back-office/support assistant)* 19. House tour *(by: leaving tenant, new tenant, housing officer)* 20. Selection of candidate *(by: housing officer)* 21. Agreed? *(by: new tenant)* 22. Collect documents *(by: new tenant)* 23. Perform check on documents *(by: housing officer)* 24. Approve? *(by: housing officer)* 25. Contact candidate *(by: housing officer)* 26. Officially assign dwelling to candidate *(by: housing officer)*

Collect data, which is needed to advertise the dwelling

The advertisement activities run parallel to the pre-inspection activities, for the reason that housing associations aim to rent the dwelling to a new tenant right after the one month notice period. It regularly occurs that the data regarding the dwelling is insufficient and, therefore, the association will need to wait for the pre-inspection to complete before advertising the dwelling.

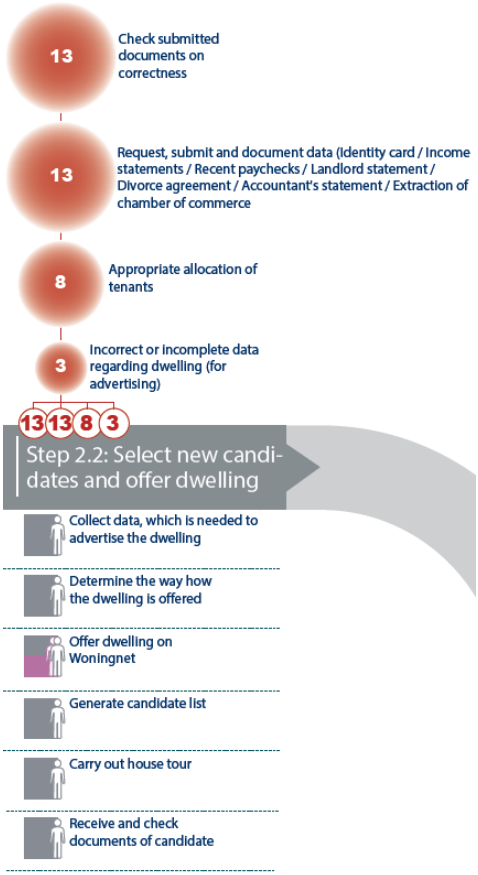


Figure 26: Step 2.2 of CJM (own ill.)

Offer the dwelling on Woningnet

To the advertisement on Woningnet, the following characteristics need to be defined:

- Way of allocating the dwelling (*priority characteristics*);
- Date of availability;
- Dwelling and complex information (*floor plans, photos, location, whether it's a care complex or not, energy label, year of construction, services within the dwelling*);
- Information regarding the neighborhood;
- Rental price and service fees;
- Terms and conditions.

Generate candidate list

As soon as the advertisement is posted online people can register on the dwelling. Woningnet is designed in a way that the tenant's characteristics are matched with specific dwellings in order to allocate the tenants appropriately. The current tight housing market causes that every single dwelling receives around 200 to 500 registrations. The housing officer can check the registrations and by means of determining the way of offering, a candidate list will be generated automatically.

Carry out house tour

Based the tenant's ranking on the candidate list, an invitation will be sent for a house tour. The house tour will be organized by the housing officer, the leaving tenant, and invited candidates. The reason

that this house tour is organized in an occupied state of the dwelling is because the leaving tenant can the takeover procedure with the potential new tenants. Secondly, housing associations are obliged to inform new tenants on neighborhood- and complex characteristics. Obviously, the leaving tenant can explain this better than no one. Finally, having a house tour organized during the one month notice period ensures that throughput of the tenant mutation process is more efficient.

Receive and check documents of candidate

After the house tour, the housing officer will, most probably, offer the dwelling to the candidate that is ranked first on the candidate list. Within a day after the house tour, the candidate will receive the offer of the dwelling by e-mail along with guidelines for the steps to take. Once the candidate accepts the offer, several documents have to be handed over (*table 6*).

Table 6: Requirements of documents that need to be handed in by the tenant

Document type	**Source** (*where should the tenant request this document*)
Identity card of all the moving persons	Government / municipality
Income statement (IBRI or IB60 statement) of all the moving persons	Tax authority
Three recent paychecks or benefit specifications of all the moving persons	Previous employees of the tenant
Landlord statement by other housing association or landlord (overview of housing history)	Housing association or other landlords
Divorce agreement (if this is the case)	Municipality or notary
Accountant's statement of the previous year (once the tenant owns a company or once the tenant is a freelancer/self-employed)	Accountant
Chamber of Commerce statement	Chamber of commerce

The tenant is required to hand over the documents within three-to-five working days. This can be done digitally, by letter, or by personally handing it over to the housing association. These documents are checked on correctness. Only certain data is stored because housing associations are checked whether they handle privacy standards correctly.

The tenant will be informed whenever the housing officer notices that the submission of the documents is incomplete or invalid. If this occurs, the tenant mutation process will take longer.

Based on the documents and the appropriate allocation check, the housing officer can determine whether the dwelling can be assigned to the candidate. If this is the case, the candidate will receive an e-mail. This e-mail will state further directions (*e.g. when to sign and what to bring*). Signing the contract will always take place in the dwelling or at the housing association *(section 5.1.5)*.

Impediments and pains in this activity.

3. Incorrect or incomplete data regarding the dwelling (*for advertising*);
8. Appropriate allocation of tenants;
13. Request, submit, and document/archive the data;
13. Check summitted documents on correctness.

5.1.4 Final inspection

Table 7: Involved actors and BPMN activities for the final inspection.

Involved actor:	Leaving tenant Housing officer Contractor/technical staff/EPA inspector
Steps in BPMN model:	28. Prepare dwelling for final inspection *(by: leaving tenant)* 29. Carry out final inspection *(by: leaving tenant, housing officer, contractor/technical staff)* 30. Leave dwelling (hand in the keys) *(by: leaving tenant)*

Preparation and execution of the final inspection
At the pre-inspection, the housing officer and leaving tenant made arrangements for the takeover procedure. At the end of the one month notice period, the arrangements are checked at the final inspection. If the leaving tenant did not meet the arrangement he may receive a final settlement. Examples of these arrangements could be removing several pieces of furniture or removing self-installed facilities.

Process results of final inspection, for the purpose of the maintenance activities
The final inspection is executed by the leaving tenant, the housing officer, and the contractor/technical staff. The contractor can directly draft an indication of maintenance activities and discuss this offer with the housing officer. During this visit, the delivery date will be determined based on the maintenance activities.

Sign up dwelling at the energy portal
Furthermore, during the final inspection, the housing office will need to ensure that the dwelling is up to the energy portal. For the reason that, during the maintenance activities, the bills for gas, water, and electricity are paid by the housing association.

Figure 27: Step 3 of CJM (own ill.)

Thus, based on the final inspection, the housing officer will draft directions for maintenance, which will be done by filling in a notice of defaults form. Finally the delivery date will be determined and communicated to the new tenant.

Impediments and pains in this activity.

1. Discussions with the leaving tenant (*regarding the takeover procedure*).

5.1.5 Acceptation of the dwelling by a new tenant

Table 8: Involved actors and BPMN activities acceptation of a new tenant.

Involved actor:	New tenant Customer service employee Back-office/support assistant
Steps in BPMN model:	27. Receive and check rental agreement *(by: new tenant)* 31. Transfer of dwelling *(by: new tenant, housing officer)* 32. Sign rental agreement *(by: new tenant, housing officer)* 33. Update tenant file *(by: back-office/support assistant)* 34. Archive tenant file *(by: back-office/support assistant)*

As soon as the delivery date is established, a date can be set to sign the rental agreement. Every housing association is working with a standard rental agreement (*Appendix G*). Both due regulations

and also because a housing association is mutating approximately 5-8% of their entire housing stock on an annual basis (Aedes, 2017). Therefore, drafting custom rental agreements is not desired because it leads to a time-consuming process.
The housing officer will draft the rental agreement by capturing arrangements in the primary system and this system will automatically fill in the contract. Personal information, the starting date of the rental agreement, the rental price, and the service fees are filled in manually. The draft and directions for the signing date will be sent to the new tenant. These directions are regarding the first rental note and the costs for administrative work.

At the signing date, the housing officer will check and print the rental agreement. As mentioned, this appointment will take place in the dwelling or at the housing association. During this appointment, the housing officer could help the tenant with questions or uncertainties. Once all uncertainties are resolved, the agreement will be signed by pen and the first rental note and administrative costs are paid. Afterwards, the tenant will receive the delivery date, which is based on the maintenance activities

Before scanning the rental agreement, the agreement will be checked on appropriate allocation once more. This is done because housing associations are strictly checked by accountants, due to the strict Housing Act regulations. Therefore, housing associations are handling a four-eye principle on every new rental agreement. If correct, the tenant file will be updated.

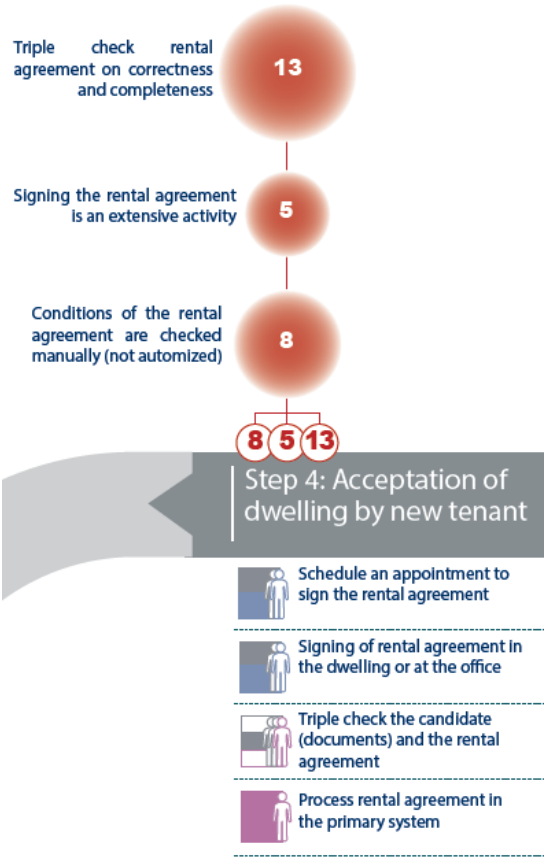


Figure 28: Step 4 of CJM (own ill.)

That is to say, a secondary housing officer is obliged to check the engaged rental agreement on the following matters:

- Personal information of the tenant(s);
- Whether the agreement meets the appropriate allocation standard;
- Rental price (did the mutation cause a change in rental price, then it needs to include the approval of the Housing Manager);
- Service fees;
- Starting date of the agreement;
- Presence of the annexes;
- Identity document of the new tenant(s);

Once all checks are performed, the rental agreement can be included in the tenant file. The profile of the tenant on Woningnet will be reset to lower his rank on future candidate lists.

Impediments and pains in this activity.

5. Signing the rental agreement is a time-consuming activity;
8. Conditions of the rental agreement are checked manually (*not automated*);
13. Triple check the rental agreement on correctness and completeness.

5.1.6 Maintenance activities

Table 9: Involved actors and BPMN activities for the maintenance activities

Involved actor:	New tenant Housing officer Contractor/technical staff Financial employee
Steps in BPMN model:	35. Agreed? *(by: housing officer)* 39. Request offer/quotation at contractor *(by: housing officer)* 40. Calculate costs *(by: contractor/technical staff)* 41. Draft offer/quotation *(by: contractor/technical staff)* 42. Check offer/quotation *(by: housing officer)* 43. Agreed? *(by: housing officer)* 44. Adjust conditions *(by: housing officer)* 45. Assign contractor to work *(by: housing officer)* 46. Prepare maintenance *(by: contractor/technical staff)* 47. Carry out mutation activities *(by: contractor/technical staff)* 48. Check completed maintenance activities *(by: housing officer)* 49. Approve? *(by: housing officer)* 50. Support new tenant with moving in into new dwelling *(by: housing officer)* 51. Move into dwelling *(by: new tenant)*

Carry out maintenance activities

Regularly, the contractor can immediately start his maintenance activities because the leaving tenant will hand over his keys at this final inspection. Once large-scale maintenance activities are necessary it is desirable that the contractor drafts a quotation for the activities and. Housing associations wish to be informed if these quotations are higher than €5.000,- because in these cases approval from the housing manager is required.

Figure 29: Step 5 of CJM (own ill.)

Housing associations cooperate closely with contractors. Therefore, contractors exactly know how and when to execute their maintenance activities. In other words, the contractor knows precisely how to deliver the dwelling on the desired quality level.

Check on completed maintenance activities

The housing office remains in close contact with the contractor. It is therefore possible to monitor whether the delivery date is feasible. This is important to monitor because if the contractor requires more time for this maintenance activities it may lead to a delay in the tenant mutation process.

The new tenant may move in once the maintenance activities are completed. The housing officer will handle the transfer of the dwelling for the reason that a delivery report can be drafted. This is a technical file that involves photos of the dwelling, a description of the condition, the energy label, and can include possible defects that will have to be fixed by the contractor. This file will be used to update the housing stock data.

Impediments and pains in this activity.

1. Delivery date is often unknown;
3. Extensive maintenance activities could lead to delay in the process.

5.1.7 After sales

Table 10: Involved actors and BPMN activities for the after sales

Involved actor:	Leaving tenant Customer service employee Back-office/support assistant
Steps in BPMN model:	36. Draft final settlement *(by: financial employee)* 37. Claim or pay final settlement *(by: financial employee)* 38. Pay final settlement *(by: leaving tenant)* 52. Sign off dwelling at energy portal *(by: back-office/support assistant)* 53. After-sales *(by: back-office/support assistant)*

Draft final settlement and claim or pay final settlement
The after sales activity is the final step of the tenant mutation process. It involves the final settlement among the housing association and the leaving tenant. This final settlement includes payments for the neglected takeover procedure activities.

Sign off dwelling at energy portal
The dwelling will need to be signed off at the energy portal.

Evaluate way of working
Housing associations are concerned on the satisfaction of the customers and are, therefore, curious about the experience of the customer. Thus, housing associations make sure that new tenants are asked on how they experienced the process of obtaining a dwelling.

Figure 30: Step 6 of CJM (own ill.)

The tenant mutation process requires the involvement of many different actors. The described process is the most general process that housing associations can run through. Obviously, there are scenarios where tenants run through a different process. One can think of scenarios where the current tenant died. In these situations the housing association will wait with the inspections and house tour. The optimal tenant mutation process lasts at least thirty days caused by the one month notice period. Afterwards, the contractor is able to start with his maintenance activities. The delivery date by the contractor is dependent on the condition of the dwelling and the maintenance activities that accompany it. Housing associations indicate that the average vacancy rate of the housing stock is 20-40 days. Unfortunately, vacancy leads to an increase in operational costs and reduces the customer satisfaction because tenants will have to wait a longer period before they can move in. Therefore, the involved actors will need to take care that the tenant mutation process will need to be run through flawless.

5.2 Major pains in the process

As mentioned in chapter 4: research methodology, the interviews are conducted to understand the tenant mutation process. In addition, questions were asked how housing associations experience certain activities in this process. Based on the interviews, the impediments and pains could clearly be determined.

Housing associations are mainly experiencing pains in activities that are sensitive to errors. The strict regulations require housing associations to work with a low margin of error. Hence, housing association will check certain aspects over and over again. It is noticed that this is especially the case when the housing officer checks the documents of the tenant (*section 5.1.3*). Furthermore, the rental agreement is checked again (*section 5.1.5*). These two activities are the two major impediments and pains in the process and are most interesting to address.

5.2.1 Check on new tenants

"It occurs that candidates are rejected after the house tour because they handed in the wrong or false documents, or that they have reacted incorrectly because they do not belong to that particular target group. This happens frequently, which results in an enormous loss in time because you cannot accept the candidate and you have to organize another house tour" (Appendix C – Interviewee 6).

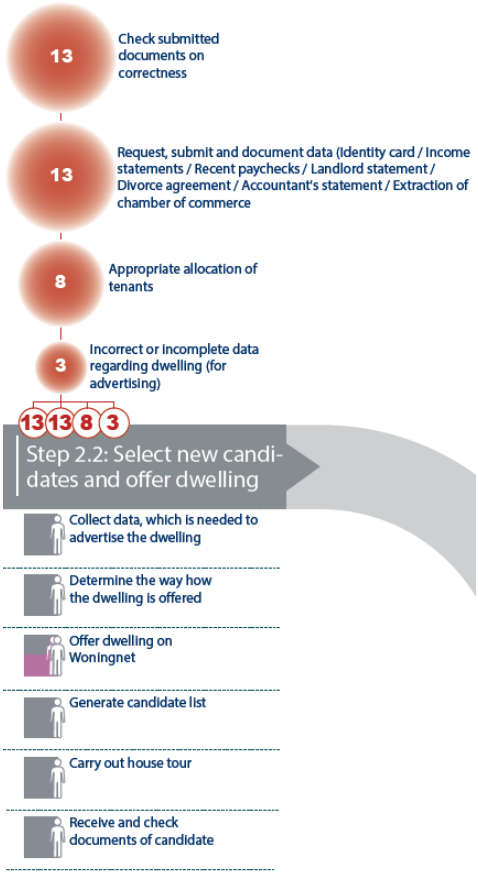


Figure 31: Major pain in the process – check on new tenants (own ill.)

The check on new tenants is one of the major impediments and also an error sensitive activity. Seeing that the selected candidate needs to hand in many documents regarding the appropriate allocation check. This works as follows: after the house tour the candidate will receive an e-mail with a delivery procedure of these documents. A tenant is obliged to hand in the documents, within 3-5 working days. Unfortunately, many candidates do not understand what to hand in, notwithstanding the comprehensive explanation on how they should request these documents. Interviewees indicated many candidates are unable to hand in the documents within the given time. This could have serious consequences the tenant mutation process.

"In my region, we work with three housing officers. Firstly, the housing officer that manages the tenant file will check the documents. He or she will check these documents and directs this assessment to the housing manager, who will assess it again. The housing manager will sign the file. Afterwards, a second housing officer performs a third check. We want to make sure that we handled everything correctly. That is to say, there are three moments we check the documents" (Appendix C – Interviewee 7).

The Housing Act intent that housing associations allocate tenants appropriately (*Dutch: passend toewijzen*). This is for the purpose that housing associations have targets for appropriate allocation. That is to say, tenants pay €576,87 for one or two-person households and €618,24 for three- or more person households. This regulation intent that tenants never pay too much rent. Accountants frequently check housing associations whether they meet the appropriate allocation targets. Housing associations are allowed to wrongly allocate tenants with a 5% error margin. If they exceed this margin they will be imposed with a fine.

"It is noticeable that the candidates are becoming more creative and smarter with falsifying the documents" (Appendix C – Interviewee 8).

"This is especially the case because everything can be handed in digitally, such as the income statement from the tax authority. For example, the digital version of the income statement does not have watermarks. Thus, checking these documents on authenticity is almost impossible" (Appendix C – Interviewee 2).

The tight housing market results in situations where people are uncertain whether they find a suitable dwelling. Subsequently, when people find an available suitable dwelling they make sure to do all they can to be assigned to that dwelling. Under such circumstances, people seem to falsify the documents. One can think of falsifying the recent paycheck statements or the income statements. IN Furthermore, employer's statements are a concern because candidates are creative in falsifying this document. Housing associations checks whether the company exist. Once housing officers find out that a

candidate falsified documents, they will have to contact the candidate and engage a conversation. One can imagine that this activity is a problem for housing associations because they have to continuously check the documents. This is time-consuming and may lead to a lower customer satisfaction.

To summarize, housing associations are dependent several third parties. Because these third parties do not have an unified interest it results in situations where there is no trust. Falsifying documents cause time-consuming situations, which may lead to delays in the tenant mutation process.

5.2.2 Signing the rental agreement

"The contracts are not digital, which causes manual actions like scan work so that the file can eventually be added to the digital archive. But if, for example, the contract is not on paper anymore but digitally then the process will most likely be reduced by one to two hours work" (Appendix C – Interviewee 2)

"For social tenants, we are working with a standard agreement. We have to insert the data into the system, which will elaborate the agreement" (Appendix C – Interviewee 4).

"We work with paper contracts, which have to be signed by a pen. Service fees are included in the standard contract because there are no separate contracts for service fees" (Appendix C – Interviewee 7)

These quotes are just a few of many regarding activities around signing the rental agreement. It can be concluded that signing the rental agreement is an time-consuming activity. Annually, all the Dutch housing associations sign approximately 220.000 rental agreements. This means that many manual activities are executed to generate the agreement, sign it, and archive it.

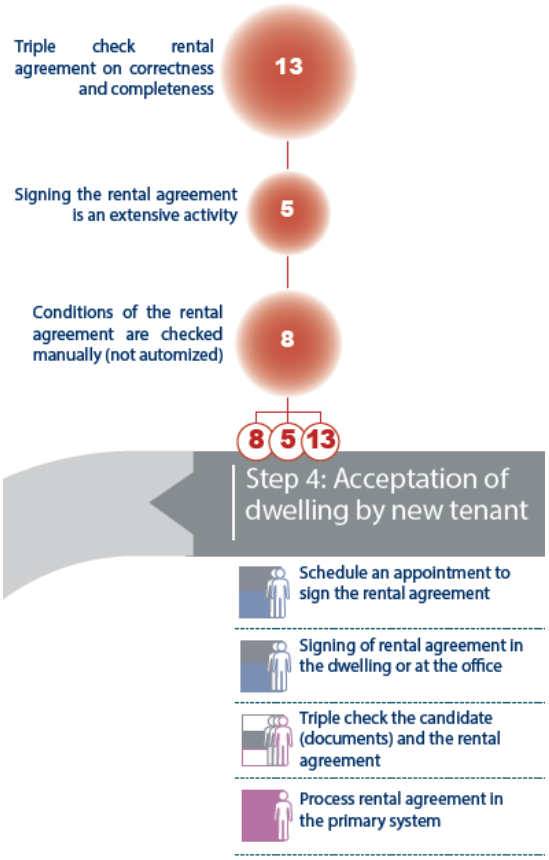


Figure 32: Major pain in the process – sign rental agreement (own ill.)

In short, housing officers will draft the rental agreement by means of loading in data from the customer relationship management system (*CRM system*) and from the housing stock system. Every (*new*) tenant is inserted in the CRM system, which includes information regarding the tenant (*e.g. personal information and notes*). After all the data is included in the rental agreement, the housing officer will need to check whether everything is correctly. If this is the case, the agreement can be printed in order to take it to the signing appointment. At this appointment, the tenant will have to show his identity card. The housing officer will check whether the data on the identity card matches with the data on the agreement. Afterwards, the tenant have to pay the administrative costs and his first month of rent. Subsequently, the agreement is checked by two housing officer and a housing manager. If correct, the agreement will be scanned in order to archive the agreement digitally. Finally, the tenant will receive a copy of the agreement by e-mail.

Housing associations indicate that this activity is time-consuming and error sensitive. Reason for this is that many manual actions may lead to errors and this is now being avoided by many checks. Associations aim to digitize the agreement in order to eliminate manual actions like printing, scanning and signing. Consequently, this could lead to a reduction in time and operational expenses.

5.3 Summary

This chapter described the current way of working by housing associations and the major impediments and pains in this way of working. Finally, this section will summarize this chapter, in order to answer the following sub-question: "How does the current tenant mutation process at housing associations look like, and what are the impediments or pains for housing associations in this process?"

Housing associations indicate that the average vacancy rate is 20-40 days. Unfortunately, this not only leads to an increase in costs but also lowers the customer satisfaction because tenants will have to wait a longer period before they can move in. Therefore, the involved actors will need to take care that the tenant mutation process is run through without any delays. The activities for a housing associations to allocate a new tenant in a dwelling are as follows (*visually represented in the BPMN model in Appendix E*):

- **Step 1:** Termination of rent
- **Step 2.1:** Pre-inspection
- **Step 2.2:** Selecting new candidates and offering of dwelling
- **Step 3:** Final inspection
- **Step 4:** Acceptation of the dwelling by a new tenant;
- **Step 5:** Mutation maintenance;
- **Step 6:** After sales

These steps are conducted by different employees and some of the activities are inefficient and time-consuming due to manual actions. Different interviews are conducted in order to investigate the current way of working and the impediments and pains. The biggest impediments and pains are probably most interesting to address because an efficiency solution to this matter would result in a solution with major benefits. Housing associations are mainly experiencing impediments and pains in activities that are sensitive to errors. The strict regulations require housing associations to work with a low margin of error. This ensures that housing association check every step in the process over and over again. It is noticed that this is especially the case when the housing association have to check the documents of the tenant (*section 5.1.3*) and everything involved in signing the rental agreement (*section 5.1.5*).

Employees of housing associations indicated that these two activities should be enhanced in order to realize efficient improvements in the tenant mutation process. Optimizations in terms of digitalization would be most desirable because it could eliminate manual activities and lower the margin of error.

The following chapter will describe a solution to the two major impediments and pains that could enhance the current way of working by housing associations.

Part 4 – Model

6. Model

In the previous chapters an overview is presented of the theoretical framework and the results of the empirical findings. This part will continue with an explanation on how blockchain could be used in the current way of working. Afterwards, a blockchain-based proposal is developed. Finally, the following sub-question will be answered: "What features of blockchain technology could be used to improve the current way of working and how can these features be implemented?"

First, *section 6.1* will start with a description how the major impediments and pains are addressed by means of a blockchain solution. *Section 6.2* shows the value proposition of the solution, followed by a reflection on the solution by means of a SWOT-analysis in *section 6.3*. Finally, this chapter will end with a summary in *section 6.4*.

6.1 Permissioned blockchain ecosystem

In the previous section a comprehensive overview of the collected data is represented. The current way of working is understood and the impediments and pains are clear. The theoretical framework, along with the empirical results, will serve as input for a discussion about the results.

It is obvious that housing associations are in need of reducing operational expenses. This is understood by reviewing the literature study and empirical findings. Housing associations experience several pains in the current way of working. The biggest pains should be improved in order to achieve desired enhancements. Therefore, a solution to the activities in *section 5.1.3* and *section 5.1.5* should be developed.

Housing associations are in need of validated and structured data in order to efficiently serve the candidates. Currently, the tenant is responsible to request the data. This is undesired because housing associations are currently dependent on the tenants and third parties (*tax authority, the municipality, and the chamber of commerce*). However, these parties do not have an unified interest. As mentioned, many candidates are unable to hand in the documents within the given time. This could have serious consequences for the tenant mutation process. Additionally, it often occurs that tenants falsify documents, which is harmful for housing associations because they aim to appropriate allocate every tenant. When in a fact, a blockchain database is implemented with API's (*digital links*) between databases it ensures that tenants are not responsible for obtaining the data, but the database request the data automatically. Obviously, due to privacy regulations the tenant will have to grant access. The documents that are gathered could be registered in the blockchain ledger. This will result in a complete audit trail, which could be advantageous for accountants or regulators. A solution like this could lead to an enhancement in terms of its usability, efficiency, transparency, and could be beneficial to the relationship between tenants and housing associations because a blockchain database improves the trustless exchange of information.

Furthermore, signing the rental agreement is a time-consuming activity that requires many manual actions, which could lead to human errors. Many checks on agreements are executed to minimize the errors. Optimizing this current activity by implementing a smart rental agreement could improve the current way of working as well. A smart contract could ensure that the information of tenants, dwellings, and housing associations is inserted automatically. Also, checks and reminders can be automated. Ensuring a digital and automated agreement could reduce the paper-driven and time-consuming signing activity. The outcomes of implementing smart contracts could lead to instant settlements and management of certain cash flows, simplified property management, faster agreements of rent increases and an enormous decrease in manual actions. Thus, a solution that supports both the collection of the documents and the activity of signing the rental agreement is useful.

However, it is important to bear in mind that it can only be useful whenever the current activity requires the same characteristics as the blockchain technology characteristics:

- The requirement of a database;
- The users do not have an unified interest;
- The users do not want, or do not want to trust a third party to maintain the data.

The current activity corresponds with the same characteristics as the blockchain technology and, therefore, a blockchain ecosystem could be created (*figure 33*). This blockchain ecosystem should be a permissioned network, which is only accessible by users that have certain credentials to have access to the network in order to interact. A permissioned blockchain environment can be used to link databased, which results in a single source of truth.

The following two sections will explain, on the one hand, how information is obtained from the databases of the tax authority, the municipality and the chamber of commerce. On the other hand, a smart contract solution will describe how the current rental agreements can be digitized and automated.

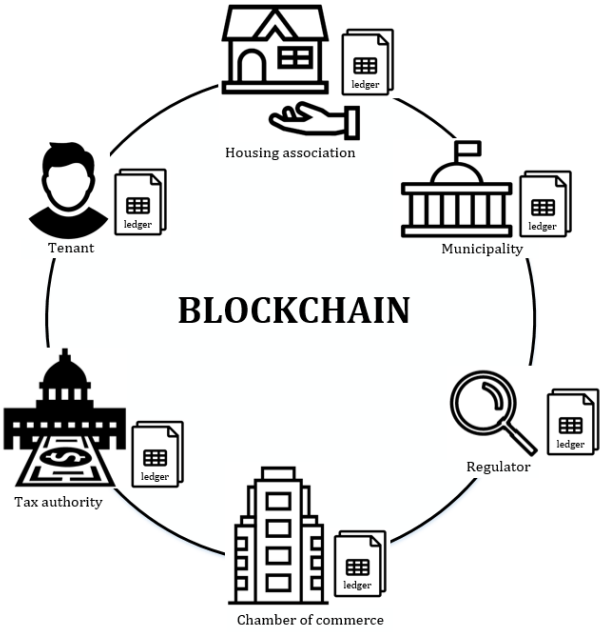


Figure 33: Permissioned blockchain environment (own ill.)

6.1.1 Blockchain database

As mentioned, housing associations and tenants are in need of trustless exchange of information. That is why a database is desired where housing associations can automatically derive the required information under supervision of the particular tenant. To start with, *figure 34* and *figure* 35 will show how tenants require the data in the current process. Afterwards, a proposed solution will show how a blockchain database gathers the documents (*figure 36 and figure 37*).

Many activities that take place in the current way of working could be eliminated, which result in a more efficient way of working. *Figure 33* shows the activities that are currently undertaken by the tenant, housing association and third parties to gather the documents.

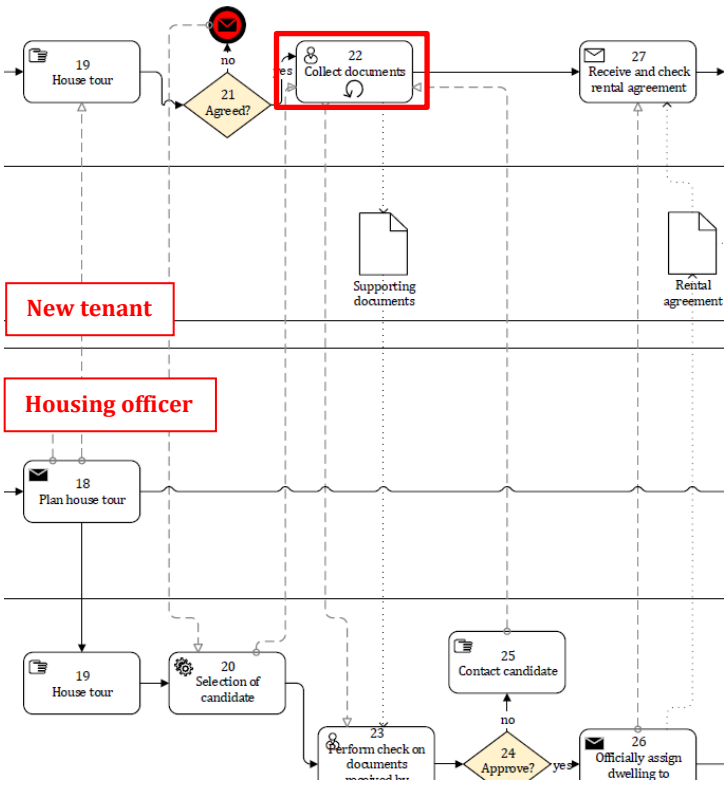


Figure 34: Collection of documents in current process (own ill.)

The figure on the right shows that currently the documents are manually derived from centralized databases (*step 22 – collect documents in BPMN model)*. After obtaining the documents it is unknown whether the gathered documents are still up-to-date. However, information held on a blockchain exist as a shared – and continually reconciled – database. This means you do not have to wait until the other party returns the documents because the documents can automatically be consulted (Rosic, 2017).

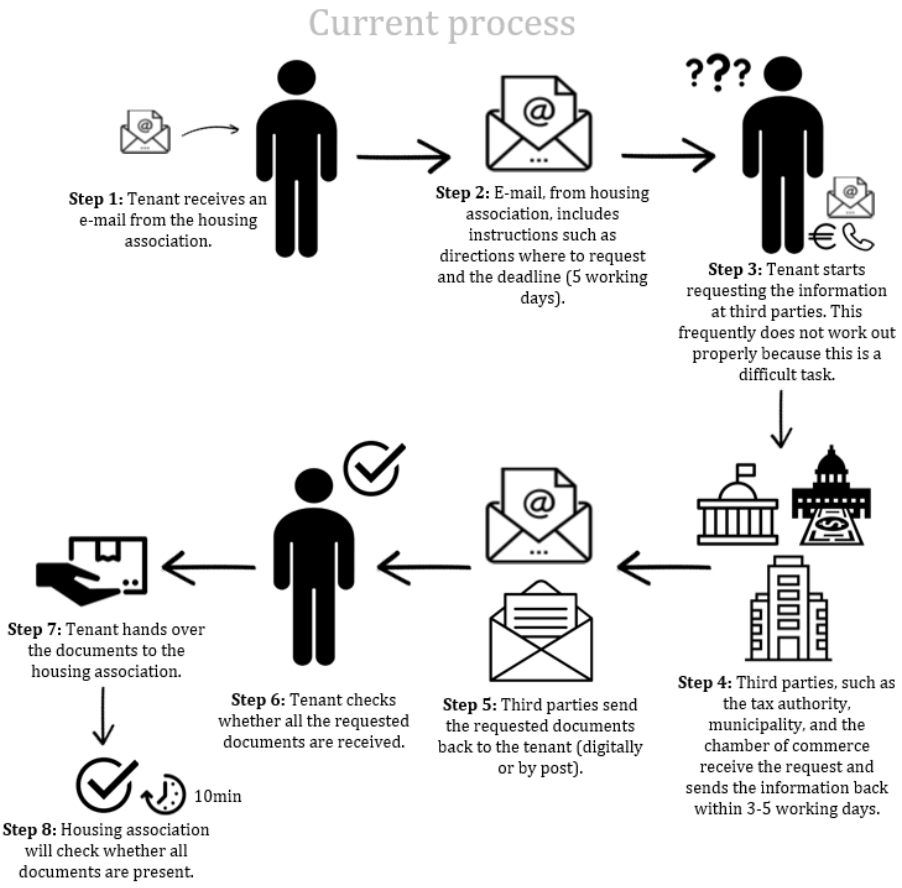


Figure 35: Current process: requesting documents by tenant (own ill.)

This infrastructure leads to the fact that there is no single point of failure and that it cannot be altered. Thus, a blockchain database on ensures that the documents are gathered and stored automatically and that the information in these documents is validated. The proposed solution causes a shift in actions for both the housing association as the tenant. *Figure 36* and *figure 37* represents the performed activities whenever a blockchain database solution is implemented to gather the required documents

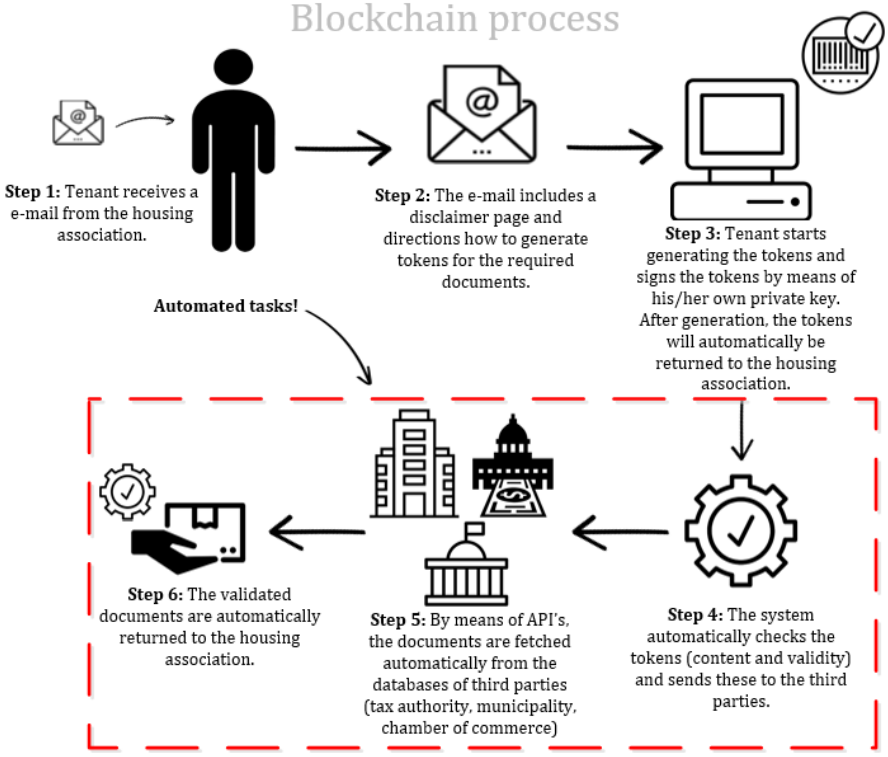


Figure 36: Activities undertaken by involved actors in new situation (own ill.)

Step 1 and 2: The tenant receives a message from the housing association stating he or she can move into the dwelling. The message includes a link to a disclaimer page where the tenant can agree to the terms and conditions. If he or she does agree, the housing association gains approval to request the data their self;

Step 3: After approval, the tenant will automatically

generate tokens. The tokens are generally a series of numbers or characters, which is specifically issued to one person and serves for authentication. The tokens are used by the housing associations to gain access the data at a third party. For every document a special token will be generated. The generation of the tokens will be signed by the tenant with his or her own private key. The housing associations can check if the tenant signed the documents, with a public key of the tenant. The public and private key are both generated by the system;

Step 4: The tokens are returned to the housing association. The smart contract can automatically perform a check whether all requested tokens are present and whether the content is as requested. This is because the parties do not have a unified interest. Once the content and validity of the tokens are checked, it is necessary to send the tokens to the external parties, such as the tax authority, the municipality, and the chamber of commerce.

Step 5: The external parties can fetch the documents in their database by means of the token content. Before they send the documents back, they will sign the documents. Again, this is because the parties do not have a unified interest. Also, this is an insurance for housing associations and tenants that the external party cannot deny that the documents are returned. Once all external parties returned the documents it is possible for the housing association to start execute a check on the tenant.

Figure 37 presents a sequence diagram that shows how the system works. Sequence diagrams can be used by blockchain developers to model the system's interactions. Thus, *figure 37* shows how the proposed solution works technically.

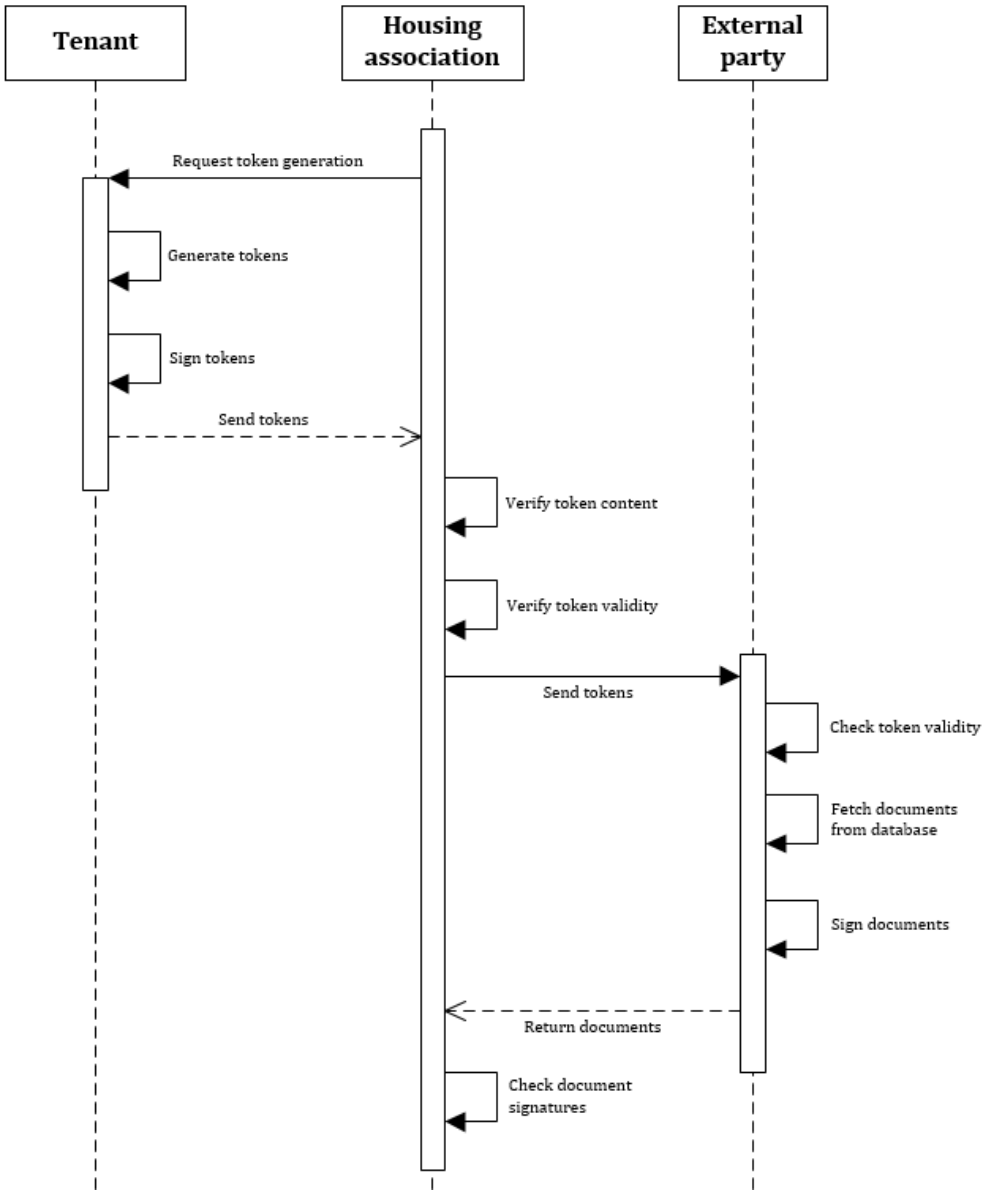


Figure 37: Sequence diagram how the connection between databases work (own ill.)

There is a huge difference between the current situation and the proposed solution. The blockchain database offers enhancements for the tenant and the housing associations, namely:

- Disintermediation and trustless exchange;
- A high quality of data;
- A high level of transparency and immutability;
- The simplification of the ecosystem;
- Faster and cheaper transactions;
- Empowered users in the network.

The red rectangle represents (*figure 36*) that all these steps are digitized and step four, five, and six are automated. This means that the time and effort required for gathering the documents is reduced enormously. Once the tenant accepted the disclaimer page and generated the tokens, then the housing association can receive the documents within minutes. Also, every transaction is recorded on the ledger of the database to ensure that a complete audit trail is present. This ensures that everyone in the ecosystem is able to check the performed activities. Finally, after receiving the documents the housing association can perform the check on the tenant with the validated documents. Once the tenant is checked and approved, a contract can be drafted. The following section will describe how smart contracts are implemented in the proposed solution.

6.1.2 Smart contracts

Basically, a smart contract is a digital contract that can automatically be conducted without the involvement of a trusted third party (PwC, 2016). In order words, it is a computer program that stores rules for negotiating the terms of a contract, automatically verifies the contract and then executes the agreed terms. That means, untrusted parties can transact directly with each other using smart contracts. According to Swan (2015) a smart contract can also be used to register, confirm, and transfer all manner of contracts and properties. As mentioned, the activities regarding signing the rental agreement are currently paper-driven and takes a lot of time and manual activities (*figure 38*).

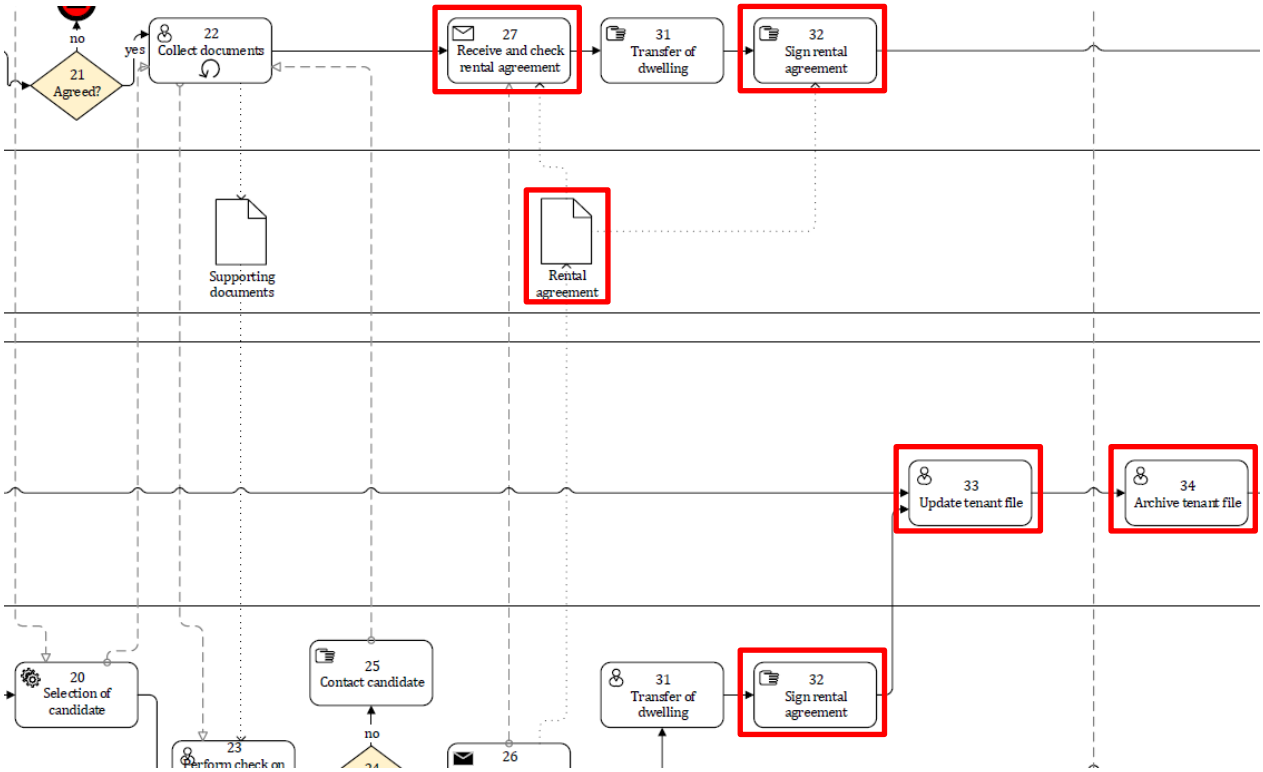


Figure 38: Signing the rental agreement: current process (own ill.)

Many activities in the current way of working should be eliminated in order to make this activity more efficient. *Figure 39* visually represents the steps that currently are undertaken by the tenant and housing association in order to sign the rental agreement.

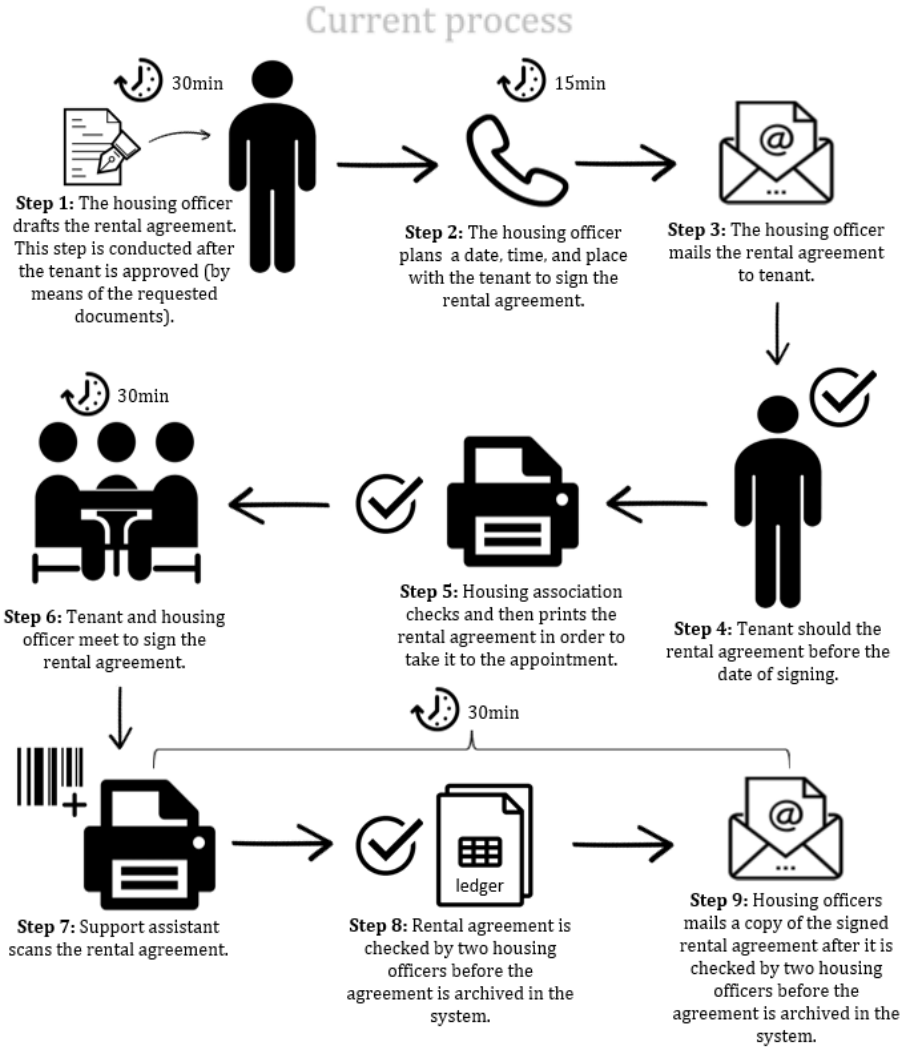


Figure 39: Activities around the activity of signing the rental agreement – current way of working (own ill.)

The figure clearly shows that currently many manual actions are needed in order to sign the rental agreement.

Interviewee 9 (*Appendix C*) shared data that shows how long some steps takes. This data is obtained by monitoring several housing officers in their activities. Housing associations indicate that the described process is experienced as inefficient, labor intensive and error sensitive. Therefore, many checks are performed. As mentioned, the implementation of smart contracts could eliminate many manual activities because standard contracts are digitized and automated. Smart contracts are able to automatically handle specific events. Once an event is successfully completed, the next event will be put in motion. This is all done automatically.

To determine what events could be automated it is necessary to decompose the used standard contract (*Appendix G*). *Table 11* presents what agreements are included in a standard contract.

Table 11: Agreements included in a standard contract (Aedes, 2017).

Clause	#	Category	Variable
N/A	1	Housing association	Name
N/A	2	Housing association	City
N/A	3	Housing association	Street
N/A	4	Housing association	House number
N/A	5	Tenant	Name of first tenant
N/A	6	Tenant	Date of birth of first tenant
N/A	7	Tenant	Name of second tenant
N/A	8	Tenant	Date of birth of second tenant
N/A	9	Current address of tenant	City

N/A	10	Current address of tenant	Address
1	11	Object to rent	City
1	12	Object to rent	Street
1	13	Object to rent	House number
3	14	Rental period	Starting date agreement
4.2	15	Rental price	Rent per month
4.3	16	Price (total)	Service fees
4.3	17	Part of service fees	Cleaning of common areas
4.3	18	Part of service fees	Garden maintenance
4.3	19	Part of service fees	Water consumption
4.3	20	Part of service fees	House keeper
4.3	21	Part of service fees	Electricity use in common areas and facilities
4.3	22	Part of service fees	Service package rental maintenance
4.3	23	Part of service fees	Glass fund
4.3	24	Part of service fees	Unblocking fund
4.3	25	Part of service fees	Management and administration costs
4.3	26	Part of service fees	Heating
4.3	27	Part of service fees	Other
4.3	28	Part of service fees	Total service fees
5.1	29	First rental period	Administration costs
5.1	30	First rental period	Rental period – start
5.1	31	First rental period	Rental period – end
5.1	32	First rental period	Rental price + service fees
5.1	33	First rental period	Total of 32 + 28
9.1	34	General conditions	Date
9.2	35	General conditions	Deviation/Addition Clause ..
9.2	36	General conditions	Deviation/Addition Clause ..
9.2	37	General conditions	Agreement on deviation/addition
9.2	38	General conditions	Agreement on deviation/addition
10.1	39	Attachments	General rental conditions
10.1	40	Attachments	Description of the rented property
10.1	41	Attachments	Rules of procedure
10.1	42	Attachments	The general conditions regarding heating supply
10.1	43	Attachments	Name of other attachments
N/A	44	Signature	City
N/A	45	Signature	Date
N/A	46	Signature	Name of housing association and housing officer
N/A	47	Signature	Signature of housing association and housing officer
N/A	48	Signature	Name first tenant
N/A	49	Signature	Signature first tenant
N/A	50	Signature	Name second tenant
N/A	51	Signature	Signature second tenant

The clauses from the standard rental agreement (*table 11*) need to be converted to the digital smart contract. In order to automatically insert the data into the contract a code needs to be developed that can interact with databases and other contracts. One can think of API's with housing association databases that contain information regarding tenants (*e.g. identity and housing stock information databases*). *Figure 40* represents a class diagram with all the information from *table 11* inserted in a smart contract. Also, links between different actors and objects are shown. The links between the different class boxes do have different meanings.

- Tenant – contract: One tenant is able to sign only one contract;
- Housing association – contract: One housing association can sign zero or more contracts;
- Contract – service fees: One contract contains one amount of service fees;
- Dwelling – contract: One dwelling governs zero to one contracts.

The latter is designed in this way because dwellings can be untenanted.

All these different classes need to collaborate in order to set a complete contract. If certain information is missing the contract cannot be executed and needs manual support.

Blockchain developers have to make sure that this information is integrated into the smart contract code. Once this task is performed, housing officers can draft and monitor contracts on the user web interface. The user web interface is not elaborated in this research because the focus is on the technical development of a blockchain solution.

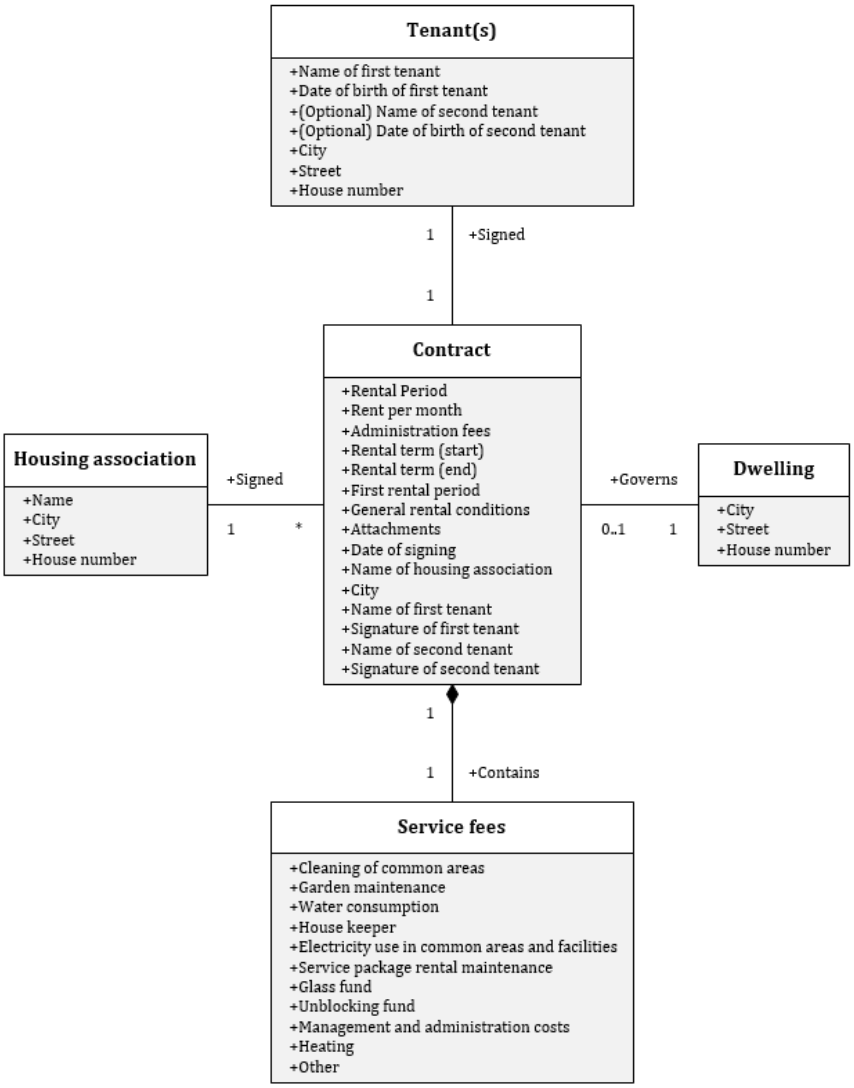


Figure 40: Class diagram of a smart contract (own ill.)

The sequence diagram (*figure 41*) shows how the smart contract solution interacts with the tenant and the databases of third parties. In a case where a housing officer wants to use smart contracts, he will have to select the specific tenant in the CRM system. This allows the smart contract to automatically load in all the needed data in the digital contract. The tenant can log in to the user web interface to check and sign the agreement. Signing the agreement will happen by means of a digital signature. Automatically a copy of the contract is e-mailed to the tenant and he can check the contract at all times on the user web interface.

Annually, the smart contract automatically requests the income statement of the tenant at the tax authority. This is done by means of the tokens, which are generated by the tenant in an earlier stage. The reason that a housing association wishes to receive an updated income statement is because housing associations are allowed to annually increase the rent up to 6,5% (Hoekstra J. , 2017). Once the newly received income statement states a higher income, in comparison with the registered income, then the smart contract automatically update both the income and rental price because these two variables are correlated. The smart contract ensures that the tenant is informed by means of sending a message (e.g. by e-mail or text message).

Once implementing a smart contract solution, housing associations benefit from several advantages such as an increase in efficiency because settlements can take place immediately without the use of third parties. The absence of manual actions results in huge reductions of time spend for this activity and eventually personnel costs. Furthermore, a greater transparency is established, which leads to a greater trust among the involved parties. Smart contracts features that an autonomous check will

consider whether the parties fulfilled its side of the obligation. This can be accomplished by means of automated checks (*figure 41*). For example, a smart contract can automatically check the income of a tenant every year by implementing an automated request of the income statement.

This can only be done whenever the third parties agree to participate in the blockchain database. This event-based request can ensure that the yearly increase in rent, which is caused by an increase in income, can be automatically updated. A result could be the reduction of crooked living (*Dutch: scheefwonen*). Furthermore, payment reminders can be integrated. The smart contract ensures that a reminder is sent to the tenant whenever the monthly rent is not fulfilled. This only requires an API among the smart contract and the ledger of the housing association.

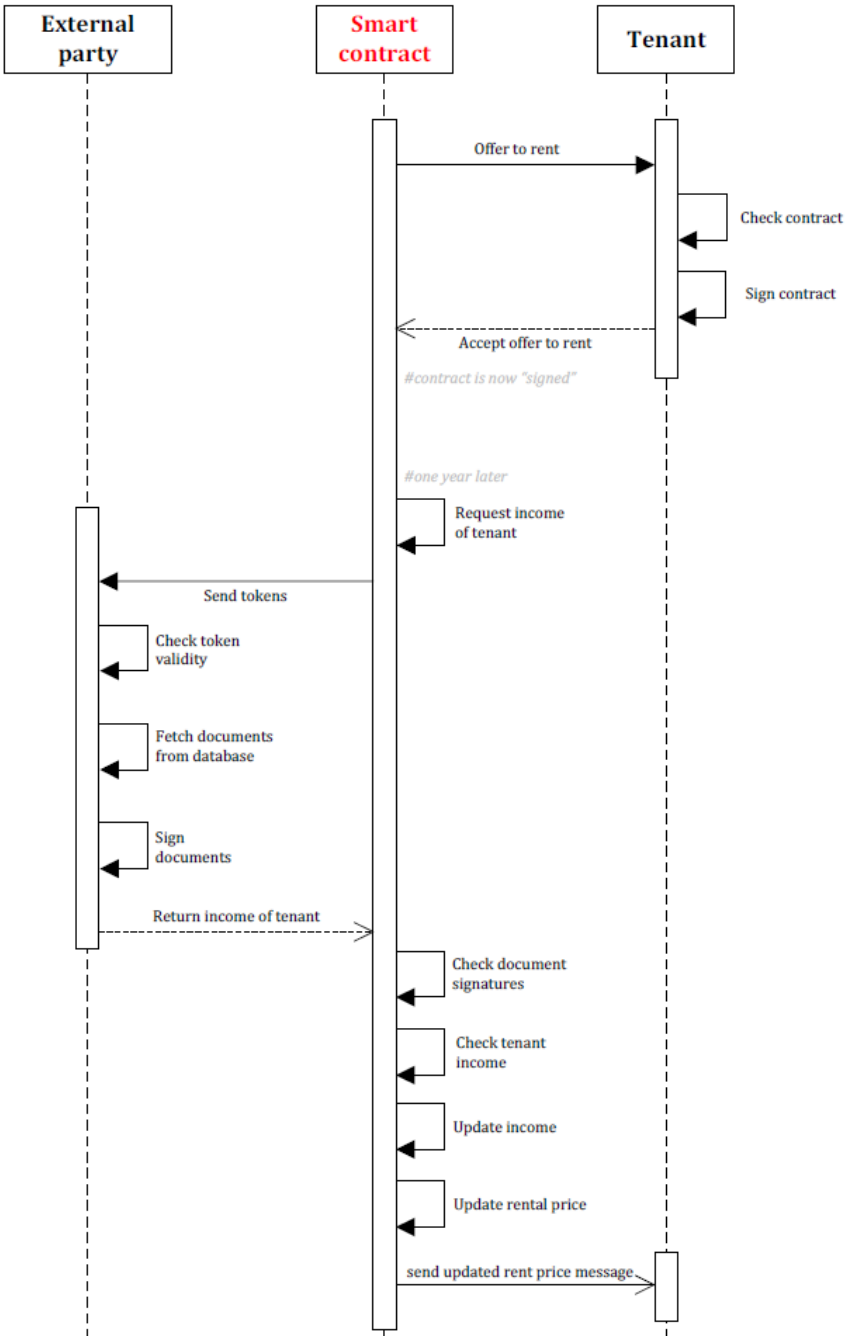


Figure 41: Sequence diagram how a smart contract system operates (own ill.)

Figure 42 represents a state diagram, which depicts various states of the contract and the transitions between those states. This diagram shows how the contract is monitored by the system. In this example the automated reminders and payments can cause the smart contract to shift between different states.

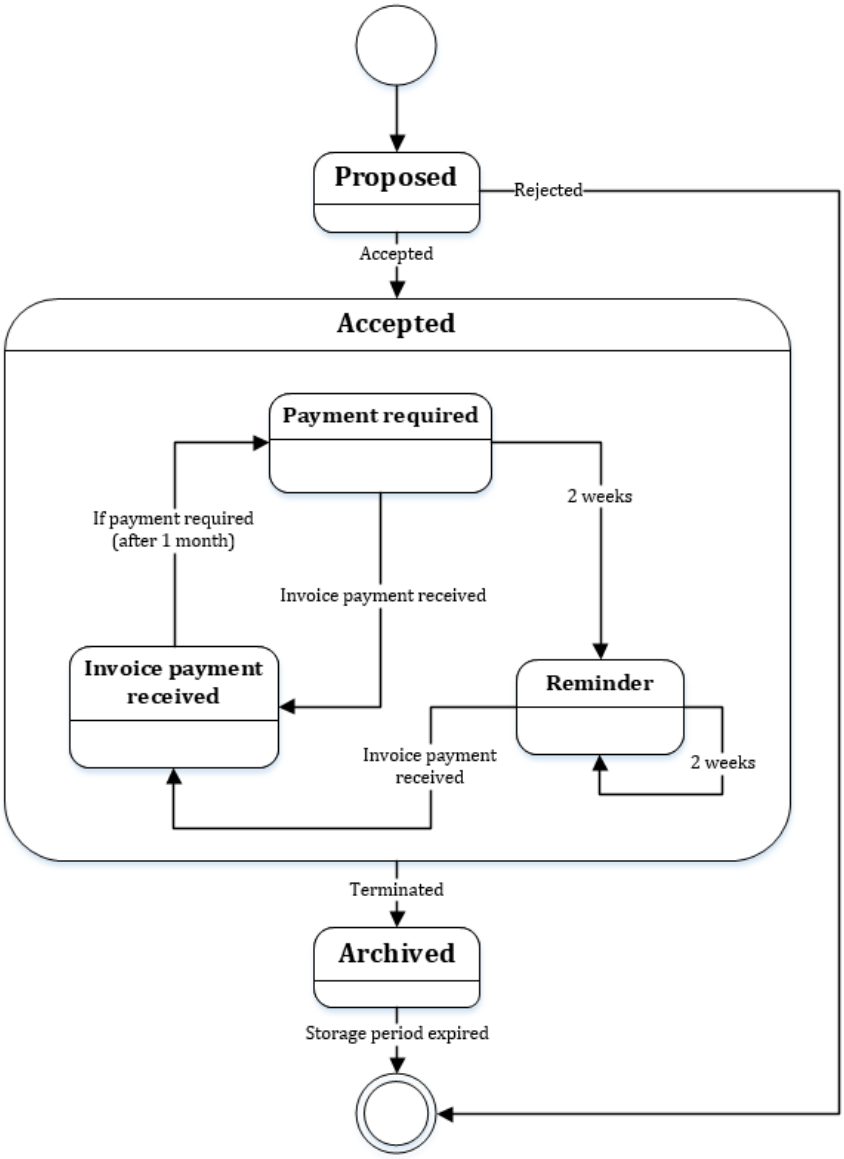


Figure 42: State diagram (own ill.)

The contract can be expressed in three different states: proposed, accepted, and archived. The action of the tenant causes the contract to move from the proposed state into an accepted state, by means of signing the contract on the user web interface. During the 'accepted state' the contract automatically checks if an invoice payment is required, a reminder is required or whether a payment is received. The contract can swift from the accepted state to archived stated once the tenant or housing association decides that, for some reason, the contract should be terminated. The contract is automatically archived for at least one year because the accountant still have to consult and check contracts.

This system monitors the contract and can notify housing officers or financial employees if there is a swift in states or when, for example, there are several reminders sent to the tenant.

Finally, *figure 43* visually presents the process that will be proceeded in order to sign a smart contract. This process is called the smart contract process (*updated activity of signing the rental agreement – current way of working*).

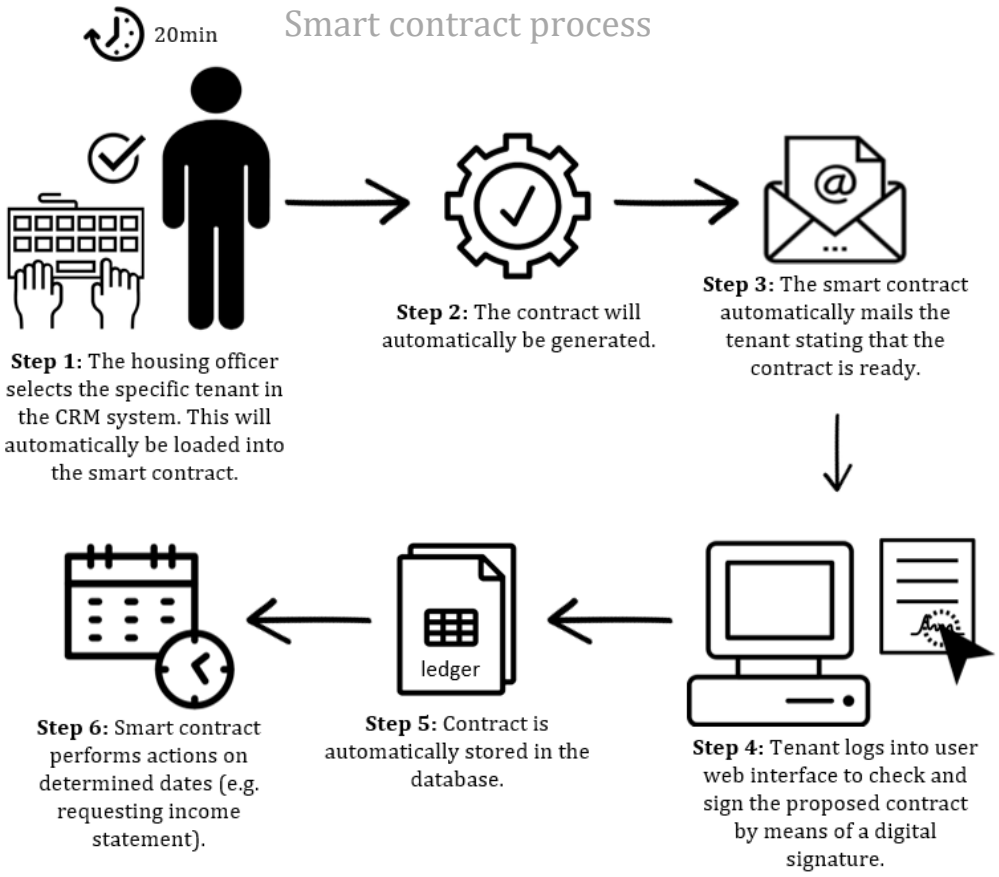


Figure 43: Activities around the activity of signing the smart contract (own ill.)

As can be noticed in the updated process, the housing officer only have to execute one manual action, which is a check on the information of the tenant and to select the tenant's information in order to be taken over in the smart contract. By means of generating the smart contract, the tenant will automatically be notified that the contract can be signed.

The implementation of smart contracts result in a different way of working for both the housing association and tenants. *Figure 44* present the current way of working and *Figure 45* present the new way of working in the BPMN model. *Appendix F* includes the entire BPMN model where the solution is implemented.

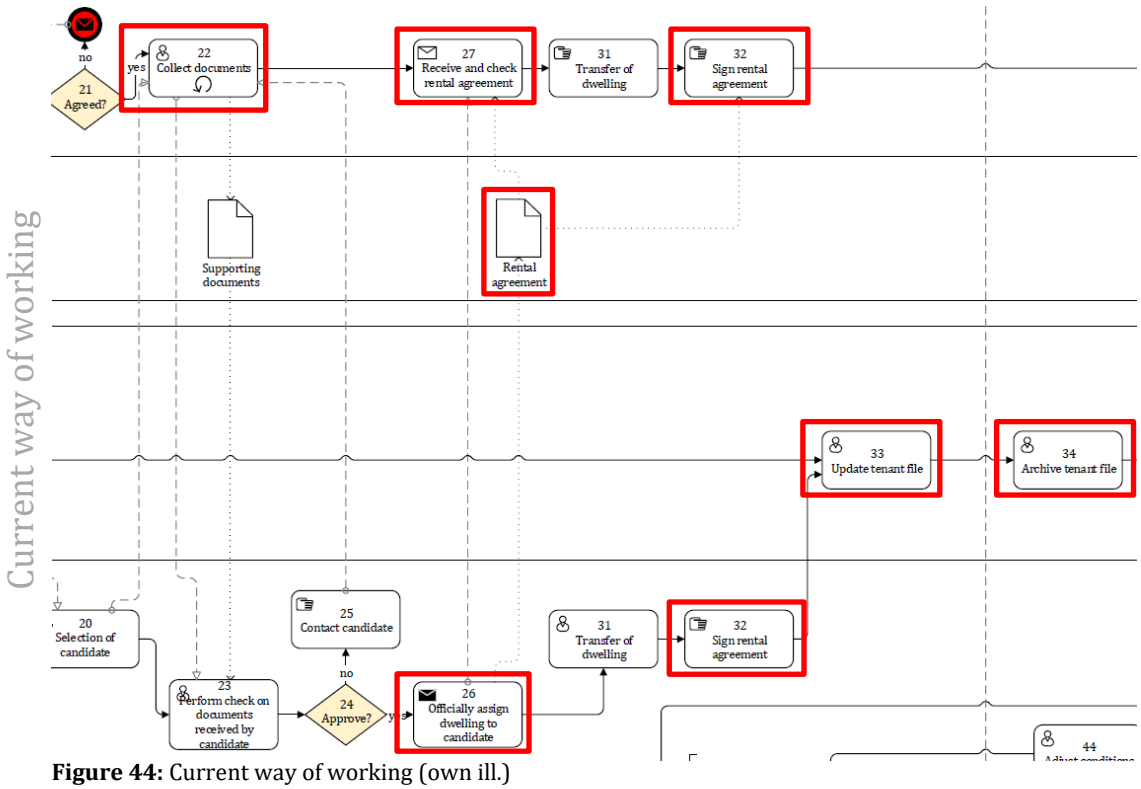


Figure 44: Current way of working (own ill.)

Once the current way of working is compared with the new way of working, it can be noticed that many manual activities are eliminated. This is desired by the housing association, as indicated in the interviews. *Section 6.2 – Value proposition* will explain the value proposition for the tenant and housing association in high detail.

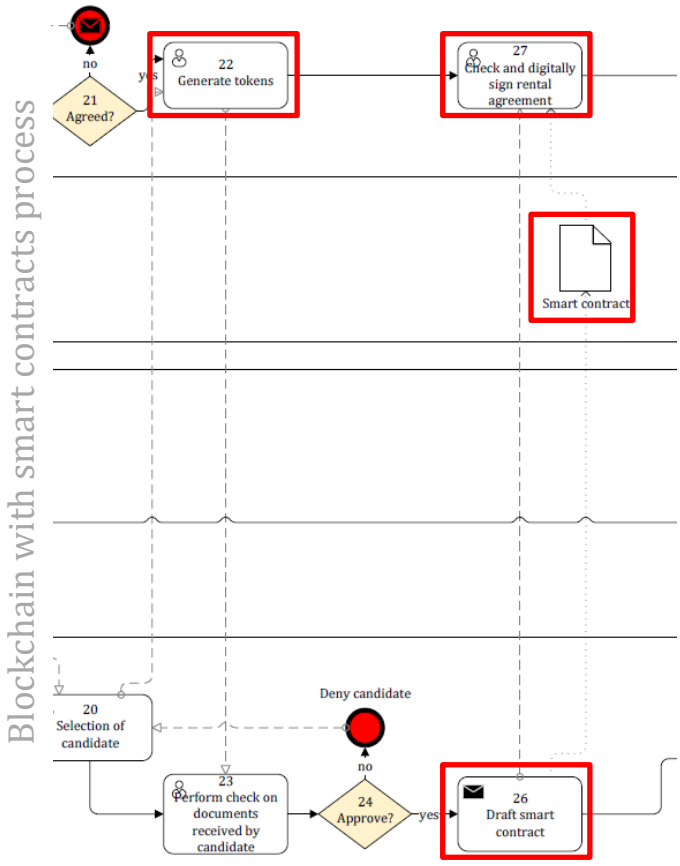


Figure 45: New way of working (own ill.)

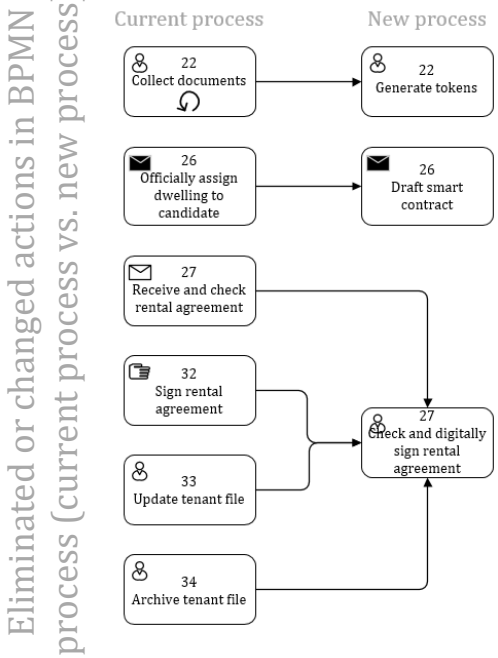


Figure 46: Current process steps in comparison with new process steps (own ill.)

6.2 Value proposition

In this research a blockchain solution to collecting documents and signing the rental agreement is proposed. There is a value proposition for the two main stakeholders in this process. This section will describe the value propositions shortly.

6.2.1 Tenant

Besides the housing association, the tenant will also experience several benefits. These are:

- ✓ **Efficiency:** Tenants are able to obtain a dwelling by a more efficient way, which results in a shorter tenant mutation process;
- ✓ **Customer satisfaction:** Being able to supported in a more efficient and quicker way may result in a higher customer satisfaction. Also the trust among the two main stakeholders will increase;;
- ✓ **Low effort:** No struggles with obtaining personal information and a quicker review whether the dwelling is available;

6.2.2 Housing association

Housing associations will use the blockchain solution as a service by connecting to the ecosystem and will benefit from the following:

- ✓ **Security:** by means of cryptography a higher level of security is provided;
- ✓ **Data handling:** An increase in data handling is reached because the system automatically requests data at the desired oracles and stores it in the blockchain database. Every step is recorded in the ledger, which results in an audit trail. This audit trail could come in handy for regulators, accountants, and regular checks;
- ✓ **Speed:** Tenants can be allocated a dwelling in a quicker way because the required data is gathered at a higher speed caused by the transaction speed that a blockchain network provides;
- ✓ **Low margin of error:** Automation and digitization will lead to less manual actions. The reduction of manual actions lead to a lower margin of error;
- ✓ **Efficiency:** The blockchain database with smart contracts will result in a more efficient tenant mutation process. Employees of housing associations can, therefore, focus on other activities;
- ✓ **Customer satisfaction:** Aedes (2017) is benchmarking the customer satisfaction every year because it is important to determine what improvements are necessary to tenants. By means of allocating dwellings quicker, the customer satisfaction should increase;
- ✓ **Low cost:** Housing associations and tenants can handle the tenant mutation process quicker. For housing associations, this will result in a reduction of operating expenses;

This research focused on automating and digitizing two activities in the tenant mutation process. Reason for this is because the reduction of operating expenses is important to housing associations (*chapter 2.2*). A focus on reducing operating expenses was noticeable at many interviews. Interviewee 9 (*Appendix C*) shared data that shows the spend minutes for many tasks in a single tenant mutation process. By means of this overview a value proposition can be calculated in terms of expenses.

Table 12: Minutes spend on certain activities (*Interviewee 9 – Appendix C).*

Activity	Duration (minutes)
Offering strategy	15
Advertising	30
Planning of house tour	20
House tour (city)	60
House tour (region)	90
House tour (single)	10
Check whether all documents are present	10
First check appropriate allocation	30
First check income statements	20
Second check income statement	15
Second check appropriate allocation	20
Plan an appointment to signing the rental agreement	15
Draft the rental agreement	30
Sign the rental agreement	30
Archive the rental agreement	30
Request income statement (after one year)	15
Check income statement and implement rent increase	30

As presented in *figure 47,* there are several current activities that will be reduced in time or completely eliminated in the proposed solution. *Table 12* represents how much time is currently spent to certain activities (*Interviewee 9 – Appendix C*). The actions marked in grey are outside the scope of the proposed solution.

The current way of working counts 160 minutes for activities around the check on documents, signing the rental agreement and annually requesting the income statement.

In the new situation, a housing association will have to spend approximately 20 minutes on drafting the agreement.

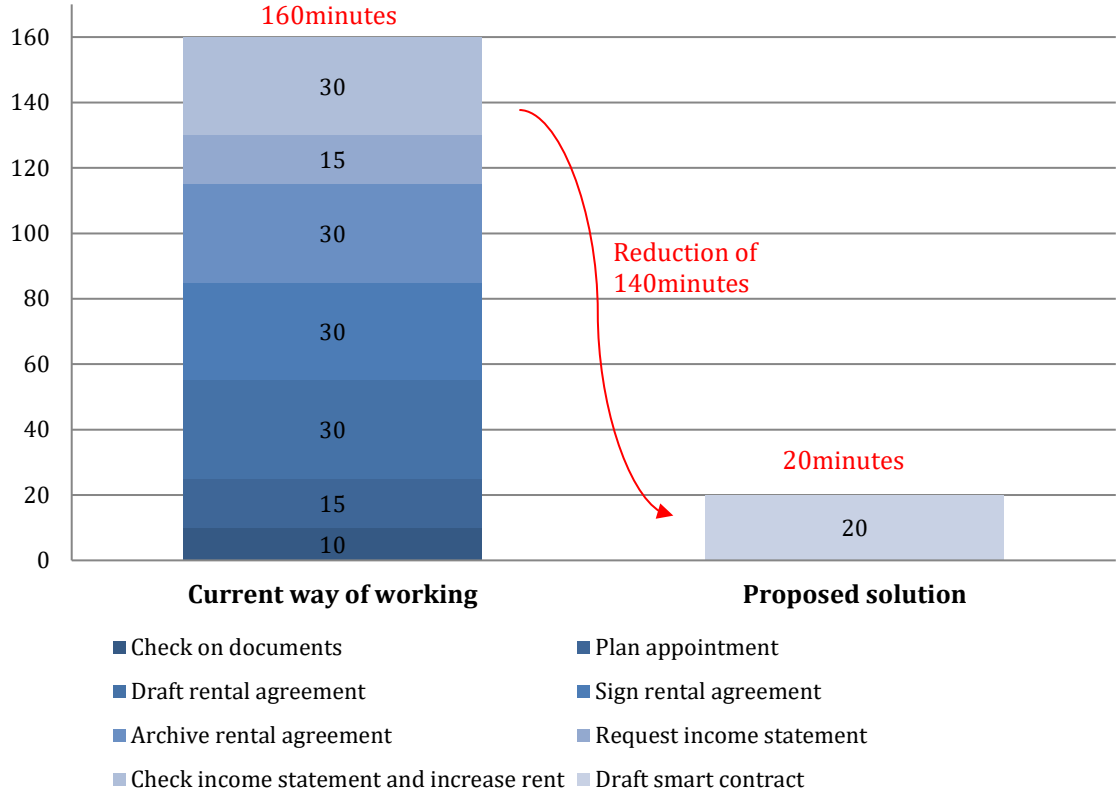


Figure 47: Time spend in current way of working versus proposed solution (own ill.).

Chapter 2.1 mentioned that all the housing associations in The Netherlands are responsible for 220.000 new rental agreements.

Total time that could be reduced: 220.000 agreements * 140 minutes = 513.333 hours

The following page will show a calculation on the operational expenses reduction.

In the Netherlands, every business sector does have a collective labour agreement (*Dutch: CAO*), which is a commercial agreement among certain parties regarding terms and conditions of employees in that business sector (Aedes, FNV, CNV Vakmensen, De Unie, 2014). The collective labour agreement of the Dutch housing services will be used in order calculate the personnel cost reduction. The salary scale of housing officers is scale F to H (*table 13)* (Aedes, FNV, CNV Vakmensen, De Unie, 2014).

Table 13: Salary scales for a housing officer (Aedes, FNV, CNV Vakmensen, De Unie, 2014).

Scale	Minimum salary (€)	Maximum salary (€)	Mean (€)
F	2.540	3.174	2.857
G	2.777	3.474	3.125,5
H	3.057	3.820	3.438,5
		Total	3.140,33

In order to calculate the total expenses for a housing officer it is necessary to take other expenses in account as well. For example: holiday fees, bonusses, employee insurances, unemployment premium, and pension premium. To calculate these other expenses, a payroll factor will be used because many of these factors are unknown. This payroll factor usually a factor of 1.6x to 1.8x to the gross salary. The mean salary of a housing officer will be multiplied with the payroll factor. This will result in the monthly expenses per housing officer. Afterwards, the yearly expenses can be calculated (*table 14*).

Table 14: Total expenses per housing officer.

Mean salary (€/month)	Payroll factor	Total expenses per housing officer (€/month)	Total expenses per housing officer (€/year)
3.140,33	1.6	5.024,53	60.294,36
3.140,33	1.8	5.652,59	67.831,13

The collective labour agreement states that the salary is based on a 36-hour workweek, with a total of 39 workweeks. Thus, a housing officer will be paid for 1.404hours of labour per year. Now, the hourly expenses per housing officer can be calculated. This is determined by dividing the total expenses of a housing officer with the total hours that a housing officer gets paid.

Table 15: Hourly expenses per housing officer.

Total expenses per housing officer (€/year)	Total hours of labour (hours/yearly)	Hourly expenses per housing officer (€/hour)
60.294,36	1404	42,94
67.831,13	1404	48,31

The expenses for a housing officer is between €42,94 and €48,31 per hour. This is based on the data in the collective labour agreement and the payroll factor. As presented in *figure 47* the proposed blockchain solution will reduce the time spend by a housing officer with 140 minutes. *Table 16* calculates the expenses that can be saved if the solution is used.

Table 16: Total operational expenses saved as a result of the solution

Hourly expenses per housing officer (€/hour)	Minutes reduced by proposed solution (hours/agreement)	Operational expenses saved as a result of the solution (€/agreement)
42,94	140/60 = 2,33	100,05
48,31	140/60 = 2,33	112,56

For every rental agreement, the housing association can save €100,05 to €112,56 of operational costs. This is a lot, if you compare this with the total expenses per rentable unit. Namely, *chapter 2.2* described that the net controllable operating expenses per rentable unit is €790,- per rentable unit

(in 2016). Thus, a reduction of €100,05 will result in a reduction of 12,7% in net controllable operating expenses. If the payroll factor of 1.8 is more likely, then a reduction of €112,56 will be taken into account, which is a reduction of 14,2%

Chapter 2.1 shows that all the housing associations in The Netherlands are responsible for 220.000 new rental agreements. *Table 17* presents the total operational expenses that can be saved by all housing associations. This scenario is only the case once every housing association in The Netherlands will make use of the proposed solution.

Table 17: Total operational expenses saved by all housing associations

Operational expenses saved as a result of the solution (€/ per agreement)	**Total mutations by all Dutch housing associations (annually)**	**Total operational expenses saved by all housing associations (€)**
100,05	220.000	22.011.000
112,56	220.000	24.763.200

Total operational expenses that could be saved: 22mio – 24.7mio.
(*excluding costs for the solution*)

The gross estimation represent the reduction in operational expenses, without taking into account the costs to use the proposed solution. Reason for this is because the service fees that housing associations should pay for the solution is outside the scope of this research.

6.3 SWOT-analysis

This section will provide a SWOT-analysis to evaluate the blockchain solution. This is done for the simple reason that besides the benefits that the solution offers, it is also necessary to understand the weaknesses and threats.

Table 18: SWOT-analysis that evaluates the solution

Strengths	Weaknesses
• Facilities disintermediation and trust less exchange of information; • Operational efficiency; • Low margin of error in certain activities; • A higher level of customer satisfaction due to better service; • Reduction in operational expenses; • High level of transparency and immutability; • High quality level of data;	• Unavailability of other pilot projects, which causes uncertainties for implementation; • Blockchain is not on the agenda of housing associations. Thus, the customer is unfamiliar with the technology and does not have any experience;
Opportunities	**Threats**
• The solution could lead to other pilot projects run by blockchain technology; • Business process optimization; • A shift in focus could lead to enhancement of other processes; • Reduced fraud; • Solvency to invest in other projects, such as sustainability projects • A shift in focus could lead to enhancement of other processes;	• Regulation and compliance conflicts; • Organizational issues; • High investment costs; • Technology failures; • Unable to make ledgers interoperable;

The previous section (*Chapter 6.2 – Value proposition*) comprehensively described the strengths and opportunities of a blockchain solution. Therefore, this section will focus on the weaknesses and threats.

Weaknesses

Unavailability of other pilot projects, which causes uncertainties for implementation: Currently there are no other pilot projects that reveal the opportunities of blockchain. Therefore, it is hard to convince the implementation of the blockchain solution.

Blockchain is not on the agenda of housing associations. Thus, the customer is unfamiliar with the technology and does not have any experience: Blockchain is a new technology that is still unknown to many housing associations. This could be cause by the unavailability of pilot projects. The customers will have to be taken into account that they are not experienced with the solution and will require to change the current way of working enormously. Therefore, it could be hard to implement a blockchain solution if all the weaknesses are taken in consideration.

Threats

Regulation and compliance conflicts: Currently there are many features of blockchain technology that are in conflict with legal requirements. For example, liability of distributed ledgers are in conflict with the current regulations. No party could be held responsible for the functioning of the distributed ledger and the exchange of the information.

Organizational issues: Because blockchain is a disruptor in the current process it could lead to organizational issues. Housing associations will have to change the current way of working, which require some time to set up. Furthermore, it may be required for housing associations to train the

employees in using the new system. It may be desired to implement several other optimizations first and implement these step-by-step. For example, digital rental agreements and link API's but use a centralized database. Housing association employees will be easier used to several small disruptions and implementing the final goal could be achieved easier. How this could be done will be explained in *chapter 7.0 – next steps: how to implement?*

High investment costs: One of the threats is the high investment cost for the development of a blockchain solution. High investment costs for the platform provider could lead to high service fees for housing associations. It should be taken into regard that the investment costs are worth it.

Technology failures: Because blockchain technology is still a nascent technology and it does not support any other pilot projects it could lead to different technology failures. One example is the size of the network because scalability is one of the current failures of the technologies.

Unable to make ledgers interoperable: Assuming the interoperability among ledgers of different parties may result in problems. Blockchain lacks the interoperability of many systems.

Blockchain offers many strengths and opportunities, but it is always necessary to also consider what the weaknesses and threats. As explained in this chapter it is necessary to conduct research to the weaknesses and threats before one would start with the development of the solution.

6.4 Summary

Based on the theoretical framework, the research methodology, and the empirical findings a solution is proposed to reduce the operational expenses of housing associations. This section will summarize this chapter, in order to answer the following sub-question: "What blockchain technology features could be used to improve the current way of working and how can these features be implemented?"

It is obvious that housing associations are in need of reducing operational expenses. This is understood by reviewing the literature study and empirical findings. Housing associations experience several pains in the current way of working. The collection of documents by the tenant and the activities around signing the rental agreement are the two biggest pains that are addressed in this research.

When in a fact, a blockchain database is implemented with API's (*digital links*) between databases it ensures that tenants are not responsible for obtaining the data, but the database request the data automatically. Housing associations are ensured of validated data because the documents originate from the oracles (*tax authority, the municipality, and the chamber of commerce*). Also, an audit trail is realized because everything is registered in the blockchain ledger, which could be advantageous for accountants or regulators. A solution like this could lead to an enhancement in terms of its usability, efficiency, transparency, and could be beneficial to the relationship between tenants and housing associations because a blockchain database improves the trustless exchange of information.

Furthermore, signing the rental agreement is a time-consuming activity that requires many manual actions, which could lead to human errors. Many checks on agreements are executed to minimize the errors. Optimizing this current activity by implementing a smart rental agreement could improve the current way of working as well. A smart contract could ensure that the information of tenants, dwellings, and housing associations is inserted automatically. Also, checks and reminders can be automated. Ensuring a digital and automated agreement could reduce the paper-driven and time-consuming signing activity. The outcomes of implementing smart contracts could lead to instant settlements and management of certain cash flows, simplified property management, faster agreements of rent increases and an enormous decrease in manual actions.

Thus, a solution that supports both the collection of the documents by means of a permissioned blockchain and the activity of signing the rental agreement by means of smart contracts is useful. There is a huge difference between the current situation and the proposed solution. The blockchain database with smart contracts offers enhancements for the tenant and the housing associations, namely:

- Disintermediation and trustless exchange;
- A high quality of data;
- A high level of transparency and immutability;
- The simplification of the ecosystem;
- Faster and cheaper transactions;
- Empowered users in the network.

Implementing the solution in the current way of working will result in less actions for both the housing association as tenant. Therefore, the tenant will experience benefits, such as an increase in efficiency in the tenant mutation process, an increase in customer satisfaction due to the increased service, and a reduction in effort because the tenant will have to conduct less manual actions. Furthermore, the current way of working by housing associations will change, the security of the database is increased, transaction speeds are higher, there is a lower margin of error and an increase in efficiency, a higher customer satisfaction, and a reduction in operational expenses.

The latter is most important because housing associations are focusing on reducing the operational costs in order to realize a healthy solvency level to conduct investments in the housing stock and to

focus on the social tenants. The proposed solution could lead in a reduction of 140 minutes per rental agreement. This is enormous because interviewees indicated the entire tenant mutation process takes approximately 12-14hours. If the solution is plotted on every rental agreement in The Netherlands then it can reduce the operational expenses by 22mio – 24.7mio. This is a gross estimation, without taking into account the costs to use the proposed solution.

However, besides the strengths and opportunities, one should also bear in mind that there are weaknesses and treats to this solution. Blockchain is hyped, but this does not lead to the fact that the technology is on the agenda of housing associations. Therefore, setting up partnerships with housing associations could be difficult. Furthermore, smart contracts are not legally binding. This means that smart contracts may be unable to implement. Also, the development of blockchain technology requires enormous investments because it is hard to implement in the current business processes. Finally, it is unknown whether API's are able with the current used ledgers of third parties. This may lead to the fact that third parties have to work in other systems.

The following chapter will shortly explain how the proposed solution could be implemented and what the role of the external organization of this research should be.

7. Implementation

Disrupting of the current way of working by means of a blockchain solution requires several steps that need to be taken. This section provides an approach to implement the proposed solution, not taken into account the technical characteristics of blockchain to become mature. By means of this chapter it should be clear what steps need to be undertaken and what parties should join in order to grant success. Finally, the following sub-question will be answered: "What could the potential role of a bank be in a tenant mutation process at housing associations, which is supported by blockchain technology?"

7.0 Next steps: how to implement?

First of all, the theoretical framework and the interviews both prove that there is a need to reduce the operating expenses by means of enhancing the current way of working in terms of efficiency. In order to get broad acceptance of using a blockchain solution, a set of technical standards will need to be produced and agreed upon. Reason for this is to let the blockchain solution link and communicate to other systems. The feasibility of this factor is arguable because this blockchain ecosystem will cooperate on a national scale. As a starting point, regulations will have to ensure that smart contracts are legally binding. In order to find out if the proposed solution could work in legally terms, further research needs to be done. Furthermore, to gain acceptance by housing associations it is necessary to implement the solution step-by-step. This can be done as follow:

- Usage of digital contracts by housing associations. If housing associations will use a solution like this, then it will be easier to implement smart contracts. If this is a success, then it will not be necessary to convince housing associations to implement smart contracts that is linked with the blockchain database. Also, employees are already used to working with digital contracts;
- Convince third parties to cooperate and set up API's that are linked to a centralized database. This way, the systems are already interoperable before a blockchain solution is used. API's with a centralized database could also function as fundament for the development of a blockchain database;
- All the solution above could function as 'pilot project' for the development of a blockchain solution. This way, the developer will require less steps because the way of working by housing associations is known;

To investigate how the blockchain platform works best, a cooperation with several housing associations will have to result in a user friendly platform. This cooperation will have to ensure that developers can continuously evaluate the platform with employees from housing associations. Thus, widespread adoption is crucial in order to succeed. The major treat to overcome is the shift of current platforms and systems to a blockchain platform. The usage of a blockchain solution will change the business process and data storage. To achieve a widespread adoption, firstly a platform will have to be built by blockchain developers. Secondly, the tax authority, housing associations and municipalities will have to unanimously agree to use the platform and will have to make use of the service. Once the advantages are recognized in the annual reports, it will cause other housing associations to consider it. Incorporating Aedes with the adoption of a blockchain solution may strengthen these developments.

Once the platform is accepted by different associations and other parties the platform can be improved by means of exploring solutions for the other parts of the tenant mutation process. A full ecosystem would perform better. For instance, the payment of monthly rent by means of cryptocurrencies. Finding other use-cases is outside the scope of this study and is, therefore, not elaborated.

However, during the elaboration of this research a question arises over and over again. Who should be responsible for the solution? The next section will provide a short overview whether the external organization of this research should be the solution provider or not.

7.1 Role of the bank

This research is conducted in collaboration with ABN (*hereafter: ABN*), which is the third-largest bank in the Netherlands with its headquarters in Amsterdam. ABN offers a variety of services. One of these services would be solution provider to housing associations. This section will discuss two parts. One part will explain why a bank should be solution provider and the other part will explain why a bank should not be solution provider. Reason for this is because banks are currently investigating the impact on blockchain and could use this knowledge on other business models.

A bank as solution provider

- A bank considers customer due diligence (*CDD*) or KYC as one of the most essential building blocks for the customer acceptance. This is for the simple reason that a bank wants to understand correctly the interests of the customer in order to manage any risks. After all, the integrity and reputation of banks are partly determined by the integrity and reputation of the customers. Banks are heavily regulated and checked on CDD by the Dutch National Bank (*Dutch: De Nederlandsche Bank*). Therefore, a bank could use this experience in the tenant mutation process because it involved CDD as well (*after requesting the documents*);
- Dutch banks already executed many experiments regarding blockchain technology. This is mentioned in *chapter 3.3* because Dutch banks are implementing the technology in their own real estate processes. Therefore, a bank can be considered as blockchain expert that knows exactly how to implement this technology;
- A bank is an independent party and is not directly related to the tenant mutation process. This is an advantage because they do not have an interest in the process. Therefore, banks are considered as a trusted advisor if they are responsible for the solution. For example, Aedes is an independent party and trusted advisor as well. A collaboration between many independent parties that are able to enhance the business processes could be desired;
- Whenever a bank chooses to provide the solution then it will have to maintain the database as well in terms of technological updates or the elimination of failures;

No participation for a bank as solution provider

- The tenant mutation process is a process that is far outside the core business of banks;
- The culture of a bank is all about risk minimisation, which is in direct conflict with a blockchain solution on the tenant mutation process;
- Integrity and reputation is very important for a bank. Thus, if a bank is providing a solution for housing associations, which could be considered as a solution outside the core business of them, then everyone should be aware of the risks associated with this solution. For example, a mistake could have serious consequences that reflect on other departments of a bank. One could think of data leaks in the system;

7.2 Summary

It is important to be aware of the steps that need to be taken in order for the solution to succeed. Furthermore, it is interesting to know what the role of a bank would be in this proposed solution. This section will summarize this chapter, in order to answer the following sub-question: "What could the potential role of a bank be in a tenant mutation process at housing associations, which is supported by blockchain technology?"

In order to get broad acceptance of using a blockchain solution, a set of technical standards will need to be produced and agreed upon. As a starting point, regulations will have to ensure that smart contracts are legally binding. The major treat to overcome is the shift of current platforms and systems to a blockchain platform. The usage of a blockchain solution will change the business process and data storage. Therefore, the tax authority, housing associations and municipalities will have to unanimously agree to use the platform and will have to make use of the service. Incorporating Aedes with the adoption of a blockchain solution may strengthen these developments.

The provider of a blockchain solution provider should be an independent party. A bank could be blockchain solution provider to housing associations because the bank has extensive experience in KYC processes, blockchain technology, and is a trusted advisor. However, it is important to bear in mind that integrity and reputation is very important for the bank. Therefore, risk will have to be minimized. This can be done by in cooperating third parties, such as the tax authority, housing associations, municipalities, Aedes, Social House-Building Guarantee Fund (*Dutch: WSW*), and The Dutch Authority of Housing Associations (*Dutch: AW*). Along with these parties knowledge can be shared and risks can be minimized.

8. Conclusion

The aim of this thesis was to validate a problem that housing associations face. Mainly caused by the redefined Housing Act and imposed priorities. By validating the problem, an blockchain technology optimization is suggestion. To do so, a total of six sub-questions are answered in order to answer the main research question:

What are the different opportunities and constraints for the implementation of blockchain technology in the tenant mutation process at housing associations?

Firstly, the conclusions from the sub-questions will be reviewed in order to answer the main research question, which is represented at the end of this section.

8.1 Sub-question conclusions

Q1: How does the current housing association sector look like and why should housing associations focus on reducing operating expenses?

To start with, there are approximately 350 Dutch housing associations. They are dominant players in the rental market with approximately 2.3 million rental properties in ownership. They have a public task, which is ensuring that people with low income can live well and affordable. After the credit crunch of 2008, the Dutch government has decided to firmly take control of the social rental sector. This caused housing associations to make strategic choices in short term. Housing associations are focusing on reducing the operational costs in order to realize a healthy solvency level to conduct investments in the housing stock and to focus on the social tenants. The biggest reduction in operational costs could be accomplished in making the core business more efficient, which are the rental and management activities.

Q2: What is the status quo in regard to the blockchain technology?

Blockchain is an online decentralized ledger that records executed transactions parties and is managed by a network of computers. On the one hand, blockchain technology can be used to transfer value by means of cryptocurrencies. On the other hand, blockchain features the implementation of smart contracts. Smart contracts can be further developed into a decentralized autonomous organization (DAO). These three blockchain features can be used individually or jointly to support the businesses of corporations. Blockchain technology still faces major challenges and risks. First, more and more blockchain applications need to be developed in order to gain more popularity and adoption. In order to do this, businesses will have to change their current way of working to imbed the technology. Secondly, regulatory status regarding the technology is still uncertain. Furthermore, the usage of the network is still expensive due to the fact that it requires huge computational power, a high level of connectivity, and a lot of energy. Also, the scalability of the networks are still too small for widespread adoption. Blockchain is a technology that enables the enhancement of current processes in every sector. However, it is important to bear in mind that it can only be useful whenever the current process requires the same characteristics as the blockchain technology:

- The requirement of a database;
- The users do not have a unified interest;
- The users do not want, or do not want to trust a third party to maintain the data;

Whenever a current process meets the mentioned requirements and a blockchain application is possible, then this process can benefit from many advantages

Q3: How does the current tenant mutation process at housing associations look like, and what are the impediments or pains for housing associations in this process?
The activities for a housing associations to allocate a new tenant in a dwelling are as follows:

- **Step 1:** Termination of rent
- **Step 2.1:** Pre-inspection
- **Step 2.2:** Selecting new candidates and offering of dwelling
- **Step 3:** Final inspection
- **Step 4:** Acceptation of the dwelling by a new tenant;
- **Step 5:** Mutation maintenance;
- **Step 6:** After sales

These steps are conducted by different housing association employees and some of the activities are inefficient and time-consuming due to manual actions. Different interviews are conducted in order to investigate the current way of working and the impediments and pains. The biggest impediments and pains are probably most interesting to address because an efficiency solution could result major benefits. Housing associations are mainly experiencing impediments and pains in activities that are sensitive to errors. This is mainly because strict regulations require housing associations to work with a low margin of error. This ensures that housing association check every step in the process over and over again. This is especially the case when the housing association have to check the documents of the tenant and everything involved in signing the rental agreement.

Q4: What features of blockchain technology could be used to improve the current way of working and how can these features be implemented?
When in a fact, a blockchain database is implemented with API's (*digital links*) between databases it ensures that tenants are not responsible for obtaining the data, but the database request the data automatically. This way, housing associations only obtain validated data because the documents originate from the oracles (*tax authority, the municipality, and the chamber of commerce*). Also, an audit trail is realized because everything is registered in the blockchain ledger, which could be advantageous for accountants or regulators. A solution like this could lead to an enhancement in terms of its usability, efficiency, transparency, and could be beneficial to the relationship between tenants and housing associations because a blockchain database improves the trustless exchange of information.

Furthermore, signing the rental agreement is a time-consuming activity that requires many manual actions, which could lead to human errors. Many checks on agreements are executed to minimize the errors. Optimizing this current activity by implementing a smart rental agreement could improve the current way of working as well. A smart contract could ensure that the information of tenants, dwellings, and housing associations is inserted automatically. Also, checks and reminders can be automated. Ensuring a digital and automated agreement could reduce the paper-driven and time-consuming signing activity. The current way of working by housing associations will change because the security of the database is increased, transaction speeds are higher, there is a lower margin of error and an increase in efficiency, a higher customer satisfaction, and a reduction in operational expenses. The solution could reduce operational expenses with €100,05 to €112,56 per rental agreement, without taking into account the services fees for the platform. If the solution is plotted on every rental agreement in The Netherlands then it could reduce the operational expenses by 22mio – 24.7mio.

Q5: What could the potential role of a bank be in a tenant mutation process at housing associations, which is supported by blockchain technology?
The provider of a blockchain solution provider should be an independent party. A bank could be blockchain solution provider to housing associations because the bank has extensive experience in KYC processes, blockchain technology, and is a trusted advisor. However, it is important to bear in mind that integrity and reputation is very important for the bank. Therefore, risk will have to be minimized. This can be done by in cooperating third parties, such as the tax authority, housing

associations, municipalities, Aedes, Social House-Building Guarantee Fund (*Dutch: WSW*), and The Dutch Authority of Housing Associations (*Dutch: AW*). Along with these parties knowledge can be shared and risks can be minimized.

8.2 Main research question conclusion

As mentioned, based on the answers on the sub-questions a well thought out answer could be given to the main research question:

What are the different opportunities and constraints for the implementation of blockchain technology in the tenant mutation process at housing associations?

Blockchain technology could solve major impediments and pains in the tenant mutation process at housing associations. Mainly in the activities of gathering data for new tenants and in the activity of signing the rental agreements. To do this, databases of third parties have to be linked by means of API's to ensure that tenants are not responsible for obtaining the data, but the database request the data automatically. This way, housing associations only obtain validated data, which is stored on the blockchain ledger. Furthermore, a digital and automated agreement could reduce the paper-driven and time-consuming signing activity. Also, checks and reminders can be automated. The implementation of the proposed solution could reduce operational expenses of housing associations enormously. Namely, by €100,05 to €112,56 per rental agreement.

Unfortunately, there are several constraints for implementing blockchain technology in this process. It would be wise to keep blockchain as a final goal but implement other solutions first, such as digital rental agreements and API's among different systems. This will result in easier implementation at housing associations and less organizational issues. In the meantime regulatory issues and the lack of ledger interoperability can be studied. Currently, there is no regulations regarding smart contracts. Thus, this feature is not legally binding. Also, ledgers will have to be linked but this is impossible for some systems. Finally, it could be hard to implement blockchain in the current process due to the fact that housing associations are unfamiliar with the technology and there are no other projects available. Therefore, it could be a challenge to enter in a cooperation with third parties.

8.2.1 Scientific relevance

This research of scientific relevance by contributing to limited available scientific publications related to blockchain technology and to optimization of the core business of housing associations. The research regarding the current way of working is approached rather practically than scientifically. Furthermore, this research summarized the limited literature on blockchain technology and housing associations. In other words, it managed to combine two business sectors, which have no points of connection in any research. It can be concluded that new insights have been added to these two domains.

8.2.2 Societal relevance

Optimisation of the current way of working by housing associations is of high relevance for the Dutch society. Reason for this is that the biggest players in the Dutch housing stock market can serve their customers better with lower costs. This will result in a higher customer satisfaction and enables housing associations to focus better on other priorities. For example, by reducing operational expenses, the housing associations are able to invest in their sustainability targets. Currently, data reveals that nearly 45% of the housing associations do not meet the energy and sustainability commitments for the reason that these 2021 targets are accompanied with enormous investments, which are difficult to bring up (Autoriteit woningcorporaties - Inspectie Leefomgeving en Transport, 2017).

8.3 Recommendations for future research

Due to the explorative nature of this study there are many recommendations for future research. It may even be considered that this research might have raised more questions than it provided answers to. Several examples for future research are:

Process use cases

The focus of this research is primarily on exploring different implementations within the current way of working by housing associations. However, practical implementation of the solution is left outside the scope of this research. Therefore, providing a comprehensive study on the practical implementation of blockchain technology seem to be an interesting case for further research.

Technical standards

In order to get broad acceptance of using a blockchain solution, a set of technical standards will need to be produced and agreed upon. Reason for this is to let the blockchain solution link and communicate to other systems. In real estate, this kind of standardization could be considered scarce because many different companies are using different infrastructures and systems. Therefore, exploring technical standards of blockchain for the real estate sector is considered interesting for future research.

Juridical framework

As mentioned, smart contracts are not legally binding. This means that smart contracts may be unable to implement. Features of blockchain can only be applied when there are regulatory measures to this technology. Research into the blockchain technology, from a legal perspective would add benefits to eventual implementation. In addition, this could lead to better adoption by many different organizations.

Governance

The governance of the permissioned blockchain is hard to define because it reduces the real power of blockchain, which is the fact that no one is the owner of the network. That is the whole reason that the role of the bank is researched in this thesis. Currently there are many governance models applied to blockchain networks because it is still unknown what governance model works best. Therefore, it is interesting to conduct research to the governance structures of blockchain networks.

Re-inventing business models

Blockchain ensures disintermediation. This is the reason that banks are exploring the possibilities of blockchain because the technology can also be used for many other opportunities. Practical and scientific research can be conducted to the impact of business models by blockchain.

Extending the value chain

Besides opportunities in the rental and management department of housing associations, it might be interesting to conduct research to other departments of housing associations in order to reduce operational expenses even more. For instance, the implementation of blockchain on the financial department.

8.4 Reflecting on the results

In this final section the emphasis will be on a reflection of the results and the view of the author on the possible implementation for the proposed solution.

This research extensively answered the main research question. Not only by means of a proof-of-concept delivery but also by technically developing the solution. However, many aspects lack in-depth explanation on the way these aspects can be elaborated or implemented. This is for the simple reason that blockchain is currently a nascent technology that is resolving many challenges in order to gain worldwide adoption. Therefore, several aspects remain rather unclear in this research.

The research provided a solution to optimize the current way of working by housing associations. I strongly believe that this solution could enhance the current way of working in terms of efficiency, usability, and transparency. Furthermore, once housing associations will implement this technology and benefit from the advantages then other real estate companies will follow as well. In other words, the most dominant players in the Dutch housing market can be considered as catalyst for the implementation of blockchain in the real estate sector in The Netherlands.

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Part 5 – Appendices

Appendix A – Interview protocol: unstructured interviews

Interview length 60-90 minutes

Name/names + department + job title	
Name of housing association	
Rentable units of housing association	
Region	
Date and time	

Goal of interview: determine current way of working by housing association. Identify possible pains or impediments in the way of working wherever possible.

Start

- Objective of the interview
- Permission to record the interview
- Structure of the interview

Introduction and general information regarding the housing association

1. How many rentable units does your housing association have?
2. What region in The Netherlands do you serve for?
3. Based on the rentable units you have, how many mutations does your housing association have on yearly basis?
4. Do you sell rentable units to tenants or third parties? If not, why not?
5. What is your role within the company?

Tenant mutation process

1. What steps does your housing association take, when a termination of rent is received?
2. Can you describe the entire tenant mutation process?
3. What departments/external parties are involved in this process?
4. How do different departments communicate with each other?

Closure

Once again, thank you for taking part in this interview. I am sure I will be able to use this data for this research. If we have missed anything, please do not hesitate to inform me now or later on. I am wondering if you have any comments on the interview? Do you wish to receive the transcription? Also, I will share the possible outcomes and findings of this research.

Appendix B – Interview protocol: semi-structured interviews

Interview length 60-90 minutes

Name/names + department + job title	
Name of housing association	
Rentable units of housing association	
Region	
Date and time	
Interviewer	

Goal of interview: determine current way of gathering pieces of information in order to agree that the new tenant may move into a new dwelling and how is a contract established?

Start

- Objective of the interview
- Permission to record the interview
- Structure of the interview

Introduction and general information regarding the housing association

1. How many rentable units does your housing association have?
2. What region in The Netherlands do you serve for?
3. Based on the rentable units you have, how many mutations does your housing association have on yearly basis?
4. Do you sell rentable units to tenants or third parties? If not, why not?
5. What is your role within the company?

Tenant mutation process – gathering information of tenants

5. What steps does your housing association take, once a tenant agreed to rent a specific dwelling?
6. What supporting documents regarding the new tenant will need to be provided?
    a. Where should the tenant request this kind of information?
7. How long does it take in order for a new tenant to gather these documents?
8. How do you experience this step?
9. From these documents, what pieces of information do you use in your contracts?
10. How long does it take in order to contract a new tenant?
11. As a housing officer, do you need to guide tenants in the process of gathering the supporting documents?
12. As a housing officer, does the new tenant request guidance in the process of signing the contract?
13. What is going well in the contracting process? What do you experience as an impediment or pain? Where is room for optimization?
    a. Note: whenever anyone expresses pains or impediments in the process. Try to determine the involved department or person and ask if a follow-up meeting is possible.
14. How would you redesign the current process of contracting new tenants?
15. How do different departments communicate with each other? Do you (as a housing association) register conversations?

Closure

Once again, thank you for taking part in this interview. I am sure I will be able to use this data for this research. If we have missed anything, please do not hesitate to inform me now or later on. I am wondering if you have any comments on the interview? Do you wish to receive the transcription? Also, I will share the possible outcomes and findings of this research.

Appendix C – Interview transcripts and coding schemes

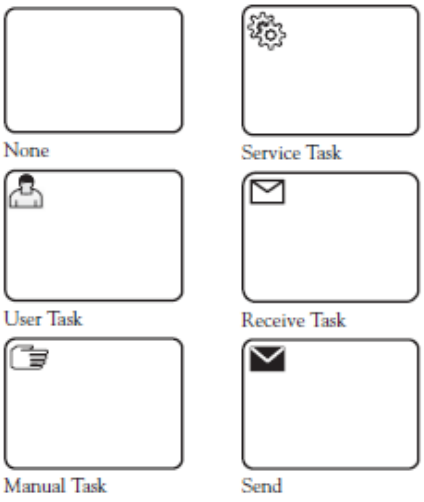
Confidential

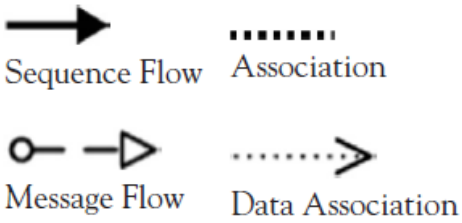
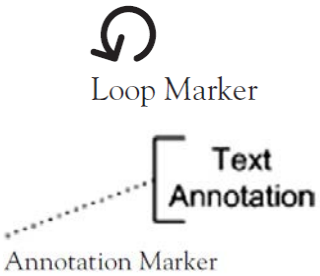
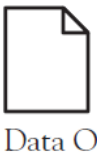
For the full version of the Appendix, please contact the author.

Appendix D – BPMN shapes

This appendix includes additional information regarding the BPMN model that is represented in *chapter 5*. As stated in the research methodology chapter, this model is based in the BPMN specification. This appendix describes the notations and the understanding of these notations.

Table 19: The BPMN shapes **(Rosing, White, Cummins, & Man, 2015; White & Miers, 2008)**.

Notation category	Graphical element	Description
Swimming-pool and swimlanes		**Pools:** act as containers for a process, each one representing a participant in a collaborative Business Process Diagram. **Lanes:** Often assumed to represent internal business roles within a Process, Lanes actually provide a generic mechanism for partitioning the objects within a Pool based on the characteristics of the Process or elements.
Tasks		**None:** No special task type is indicated. **User task:** a typical "workflow" task in which a human performer performs the task with the assistance of a software application and could be scheduled through a task list manager of some sort. **Manual task:** task that is expected to be performed without the aid of any business process execution engine or application. **Service task:** a task that uses some sort of service, which could be a web service or an automated application. **Receive task:** a simple task that is designed to wait for a message to arrive from an external participant (relative to the process). **Send task:** a simple task that is designed to send a message to an external participant (relative to the process).

Flows		**Sequence Flow:** represented by a solid line with a solid arrowhead and is used to show the order (the sequence) in which activities will be performed in a process or choreography diagram. **Message Flow:** represented by a dashed line with an open arrowhead and is used to show the flow of messages between two separate process participants (business entities or business roles) that send and receive them **Association:** represented by a dotted line, which may have a line arrowhead on one or both ends, and is used to associate text and other artifacts with flow objects. **Data Association:** represented by a dotted line with a line arrowhead and is used to associate data (electronic or nonelectronic) with flow objects. Data Associations are used to show the inputs and outputs of activities.
Markers		**A Loop Marker** is used to represent an activity that will be executed multiple times until the condition is satisfied. The condition can be validated either at the start or end of the activity. An **Annotation Marker** is a mechanism for a modeler to provide additional text information (i.e., notes) for the reader of a BPMN diagram. Annotations can be connected to other objects through an Association (see above).
Data		A **Data Object** represents the data that are used as inputs and outputs to the activities of a process. Data Objects can represent singular objects or collections of objects.
Events	 Start event  Non-interrupting start event  Intermediate and boundary event  Non-interrupting boundary events  End event	**Start Events** indicate the instance or initiation of a process or an Event Sub-Process and have no incoming sequence flow. **Non-interrupting Start Events** can be used to initiate an Event Sub-Process without interfering with the main process flow. **Intermediate Events** indicate something that occurs or may occur during the course of the process, between Start and End. **Non-interrupting Boundary Events** can be attached to the boundary of an activity. **The End Event** indicates where a path in the Process will end. A Process can have more than one end. The Process ends when all active paths have ended.

Events: messages	 Message (receive)   Message (send) 	**Receive messages** to start a Process or in the middle of a Process, either in the flow or attached to the boundary of an activity. **Send messages** in the middle or at the end of a Process path.
Gateways	   	**Gateways** are used to control how process paths converge and diverge within a process. The **Event Gateway**, when splitting, routes sequence flow to only one of the outgoing branches, based on conditions. The Gateway can be displayed with or without the "X" marker, but the behavior is the same. The **Inclusive Gateway**, when splitting, allows one or more branches to be activated, based on conditions. The **Parallel Gateway**, when splitting, will direct the flow down all the outgoing branches.

Appendix E – BPMN model of current way of working

The **following page** will represent a BPMN model that comprehensively visualizes the current way of working by housing associations. The interviewees explained their activities in detail and the data from the interviews is translated into a process model. Subsequently, this process model is validated in other interviews to identify the correctness and to track down whether all housing associations do have the same way of working.

Step 1: Termination of rent | Step 2.1: Pre-inspection | Step 2.2: Selecting new candidates and offering of dwelling | Step 3: Final inspection | Step 4: Acceptation of dwelling by new tenant | Step 5: Mutation maintenace | Step 6: After sales

Housing association

External party — Leaving tenant

Termination of rent
1 Terminate rent
8 Confirmation of termination
11 Carry out pre-inspection
14 Check results of pre-inspection report
19 House tour
28 Prepare dwelling for final inspection
29 Carry out final inspection
30 Leave dwelling (hand in the keys)
38 Pay final settlement
End of rent period

Documentation
Termination of rent letter
Confirmation of termination letter
Pre-inspection report
Final settlement

External party — New tenant

Found dwelling based on tenants' conditions
16 Registration for available dwelling
19 House tour
21 Agreed?
no
yes
22 Collect documents
27 Receive and check rental agreement
31 Transfer of dwelling
32 Sign rental agreement
50 Move into dwelling
Start of rental agreement

Documentation
Supporting documents
Rental agreement

Back-office / Support assistant

3 Process termination of rent
4 Register termination of rent
5 Plan pre- and final inspection
9 Report dwelling as available in system
15 Create advertisement of dwelling
17 Generation of candidate list
18 Plan house tour
33 Update tenant file
34 Archive tenant file
52 Sign off dwelling at energy portal
53 After-sales
Start rental agreement

Housing officer

7 Gather all documents of the tenant and dwelling
11 Carry out pre-inspection
13 Process results of pre-inspection
19 House tour
20 Selection of candidate
23 Perform check on documents received by candidate
24 Approve?
no
yes
25 Contact candidate
26 Officially assign dwelling to candidate
31 Transfer of dwelling
32 Sign rental agreement
29 Carry out final inspection
35 Agreed?
yes
no
Dependent of specific 'type' of dwelling
39 Request offer/ quotation at contractor
42 Check offer/ quotation
Costs >€5.000
44 Adjust conditions
43 Agreed?
no
yes
45 Assign contractor to work
48 Check on completed maintenance activities
49 Approve?
no
yes
50 Support new tenant with moving in into new dwelling

Customer service employee

Termination of rent
2 Check termination
6 Confirm termination of rent

Contractor / technical staff / EPA inspector

Information of dwelling
10 Prepare pre-inspection
11 Carry out pre-inspection
12 Check dwelling on energy performance
29 Carry out final inspection
40 Calculate costs
41 Draft offer/ quotation
46 Prepare maintenace
47 Carry out maintenance activities

Financial employee

Data from final inspection
36 Draft final settlement
37 Claim or pay final settlement
Final settlement

Documentation
Termination of rent letter
Mutation report
Confirmation of termination letter
Information of tenant and dwelling
Pre-inspection report
Energy label checklist
Information of dwelling
Directions for maintenance
Notice of defaults
Final settlement
Offer/quotation
Invoice

Legend

- Service task — A Service Task is a task that uses some sort of service, which could be a web service or an automated application.
- User task — A User Task is a typical "workflow" task in which a human performer performs the task with the assistance of a software application.
- Manual task — A Manual Task is a task that is expected to be performed without the aid of any business process execution engine or application.
- Send task — A Send Task is a simple task that is designed to send a message to an external participant (relative to the process).
- Receive task — A Receive Task is a simple task that is designed to wait for a message to arrive from an external participant (relative to the process).
- A Sequence Flow is represented by a solid line with a solid arrowhead and is used to show the order in which activities will be performed in a process.
- A Message Flow is represented by a dashed line with an open arrowhead is used to show the flow of messages between two separate process participants.
- A Data Association is represented by a dotted line with a line arrowhead and is used to associate data with flow objects.
- <text> — An Annotation Marker is a mechanism for a modeler to provide additional text information (i.e., notes) for the reader of a BPMN diagram.
- A Data Object represents the data that are used as inputs and outputs to the activities of a process.
- Start Events indicate the instance or initiation of a process or Event Sub-Process and have no incoming sequence flow
- The End Event indicates where a path in the Process will end.
- The Message End Event indicates where a path in the Process will end and that a message will be sent to another process participant
- Conditional Events are used to determine whether start (or continue) only if a certain condition is true.
- Receive messages to start a Process or in the middle of a Process, either in the flow or attached to the boundary or an activity.
- Gateways are used to control how process paths converge and diverge within a process.
- The Parallel Gateway, when splitting, directly wants the flow down all the outgoing branches.

Appendix F – BPMN model: New Way of Working

The **following page** will represent a BPMN model that comprehensively visualizes the way of working by housing associations once blockchain is implemented.

Step 1: Termination of rent | Step 2.1: Pre-inspection | Step 2.2: Selecting new candidates and offering of dwelling | Step 3: Final inspection | Step 4: Acceptation of dwelling by new tenant | Step 5: Mutation maintenace | Step 6: After sales

External party

Leaving tenant

Termination of rent

1 Terminate rent

8 Confirmation of termination

11 Carry out pre-inspection

14 Check results of pre-inspection report

19 House tour

28 Prepare dwelling for final inspection

29 Carry out final inspection

30 Leave dwelling (hand in the keys)

38 Pay final settlement

End of rent period

Documentation

Termination of rent letter

Confirmation of termination letter

Pre-inspection report

Final settlement

External party

New tenant

Found dwelling based on tenants' conditions

16 Registration for available dwelling

19 House tour

21 Agreed?

no

yes

22 Generate tokens

27 Check and digitally sign rental agreement

50 Move into dwelling

Start of rental agreement

Documentation

Smart contract

Housing association

Back-office / Support assistant

3 Process termination of rent

4 Register termination of rent

5 Plan pre- and final inspection

9 Report dwelling as available in system

15 Create advertisement of dwelling

17 Generation of candidate list

18 Plan house tour

52 Sign off dwelling at energy portal

53 After-sales

Start rental agreement

Housing officer

19 House tour

20 Selection of candidate

23 Perform check on documents received by candidate

Deny candidate

24 Approve?

no

yes

26 Draft smart contract

7 Gather all documents of the tenant and dwelling

11 Carry out pre-inspection

13 Process results of pre-inspection

29 Carry out final inspection

35 Agreed?

yes

Dependent of specific 'type' of dwelling

no

39 Request offer/ quotation at contractor

42 Check offer/ quotation

Costs >€5.000

44 Adjust conditions

43 Agreed?

no

yes

45 Assign contractor to work

48 Check on completed maintenance activities

49 Approve?

no

yes

50 Support new tenant with moving in into new dwelling

Customer service employee

Termination of rent

2 Check termination

6 Confirm termination of rent

Contractor / technical staff / EPA inspector

Information of dwelling

10 Prepare pre-inspection

11 Carry out pre-inspection

12 Check dwelling on energy performance

29 Carry out final inspection

40 Calculate costs

41 Draft offer/ quotation

46 Prepare maintenace

47 Carry out maintenance activities

Financial employee

Data from final inspection

36 Draft final settlement

37 Claim or pay final settlement

Final settlement

Documentation

Termination of rent letter

Mutation report

Confirmation of termination letter

Information of tenant and dwelling

Pre-inspection report

Energy label checklist

Information of dwelling

Directions for maintenance

Notice of defaults

Final settlement

Offer/quotation

Invoice

Legend

Service task	A Service Task is a task that uses some sort of service, which could be a web service or an automated application.		A Sequence Flow is represented by a solid line with a solid arrowhead and is used to show the order in which activities will be performed in a process.		Start Events indicate the instance or initiation of a process or Event Sub-Process and have no incoming sequence flow		Gateways are used to control how process paths converge and diverge within a process.
User task	A User Task is a typical "workflow" task in which a human performer performs the task with the assistance of a software application.		A Message Flow is represented by a dashed line with an open arrowhead is used to show the flow of messages between two separate process participants.		The End Event indicates where a path in the Process will end.		The Parallel Gateway, when splitting, directly wants the flow down all the outgoing branches.
Manual task	A Manual Task is a task that is expected to be performed without the aid of any business process execution engine or application.		A Data Association is represented by a dotted line with a line arrowhead and is used to associate data with flow objects.		The Message End Event indicates where a path in the Process will end and that a message will be sent to another process participant		
Send task	A Send Task is a simple task that is designed to send a message to an external participant (relative to the process).	<text>	An Annotation Marker is a mechanism for a modeler to provide additional text information (i.e., notes) for the reader of a BPMN diagram.		Conditional Events are used to determine whether start (or continue) only if a certain condition is true.		
Receive task	A Receive Task is a simple task that is designed to wait for a message to arrive from an external participant (relative to the process).		A Data Object represents the data that are used as inputs and outputs to the activities of a process.		Receive messages to start a Process or in the middle of a Process, either in the flow or attached to the boundary or an activity.		

Appendix G – Standard rental agreement

Source: https://www.aedes.nl/artikelen/klant-en-wonen/huurbeleid/standaardmodel huurovereenkomst- zelfstandige-woonruimte.html

Model huurovereenkomst zelfstandige woonruimte (versie juli 2017)

Aedes biedt de corporaties een modelhuurcontract aan voor zelfstandige woonruimte. Bij dit modelhuurcontract is een voorbeeld gevoegd van standaard algemene huurvoorwaarden die horen bij de huurovereenkomst voor zelfstandige woonruimte. Corporaties kunnen onderdelen van het model aanpassen en afstemmen op het eigen beleid en de lokale situatie.

Bij enkele onderdelen van de algemene huurvoorwaarden zijn eindnoten geplaatst. U treft deze aan op het laatste blad van de documentatie. Wij attenderen de corporaties erop dat de eindnoten bedoeld zijn als toelichting voor de verhuurder bij het gebruik van het model en dus bij uiteindelijk gebruik uit de tekst verwijderd moeten worden.

De model huurovereenkomst is ontwikkeld door VBTM Advocaten in opdracht van Aedes vereniging van woningcorporaties.

De wijzigingen ten opzichte van het vorige model, versie oktober 2014, zijn grijs gearceerd.

MODEL-HUURCONTRACT ZELFSTANDIGE WOONRUIMTE

De ondergetekenden:

De ....., statutair gevestigd en kantoorhoudende te ....., aan de ..... nr. .. hierna te noemen: "verhuurder",

en

1. ....., geboortedatum:
2. ....., geboortedatum:

wonende te..... aan de .....
hierna zowel ieder afzonderlijk als beiden gezamenlijk te noemen: "huurder",

VERKLAREN ALS VOLGT TE ZIJN OVEREENGEKOMEN:

Het gehuurde
Artikel 1

Verhuurder verhuurt aan huurder die in huur aanneemt de woning, gelegen aan de ..... nr. ... te ....., inclusief onroerende aanhorigheden en inclusief het medegebruik van de om het complex eventueel gelegen groenstroken, en tuinen die als onroerende aanhorigheid zijn te beschouwen en het medegebruik van eventueel gemeenschappelijke ruimten, hierna te noemen: "het gehuurde". Een beschrijving van het gehuurde is als bijlage opgenomen.

De bestemming van het gehuurde
Artikel 2

Het gehuurde is uitsluitend bestemd om voor huurder en de leden van zijn huishouden als woonruimte te dienen.

De huurperiode
Artikel 3

De huurovereenkomst is met ingang van ..... aangegaan voor onbepaalde tijd.[1]
‘

[1] Sinds 1 juli 2016 is het op grond van de Wet Doorstroming Huurmarkt in sommige gevallen ook tijdelijke verhuur mogelijk. In opdracht van Aedes vereniging van woningcorporaties en Platform 31 heeft VBTM Advocaten hiervoor aparte modelcontracten opgesteld. Te vinden op de website van Aedes, Platform 31 en VBTM Advocaten.

De door huurder te betalen prijs

Artikel 4

4.1.

Vanaf de ingangsdatum van de huur is huurder maandelijks een prijs verschuldigd. Deze bestaat uit de huurprijs, het voorschot van de kosten voor nutsvoorzieningen met een individuele meter, de kosten van warmtelevering en de servicekosten.

Onder kosten voor nutsvoorzieningen met een individuele meter wordt verstaan: de vergoeding in verband met de levering van elektriciteit, gas en water voor het verbruik in het woonruimtegedeelte van het gehuurde op basis van een zich in dat gedeelte bevindende individuele meter.

Onder servicekosten wordt verstaan: de vergoeding voor de overige zaken en diensten die geleverd worden in verband met de bewoning van de woonruimte.

4.2.

De door huurder verschuldigde huurprijs bedraagt: €.....

De huurprijs wordt jaarlijks gewijzigd overeenkomstig de bij of krachtens de wet bepaalde wijze.

4.3.

Het maandelijks voorschotbedrag met betrekking tot de kosten voor nutsvoorzieningen met een individuele meter, warmtelevering en de servicekosten bedraagt € ……

Dit bedrag is als volgt samengesteld:

a.	schoonhouden gemeenschappelijke ruimten	€.....
b.	tuinonderhoud	€.....
c.	waterverbruik	€.....
d.	huismeester / buurtconciërge / flatwacht	€.....
f.	elektra gemeenschappelijke ruimten en - voorzieningen	€.....
e.	servicepakket huurdersonderhoud	€.....
f.	glasfonds	€.....
g.	ontstoppingsfonds	€.....
h.	beheer- en administratie kosten	€.....
i.	het eigen verbruik per woonruimte van verwarming conform het bepaalde in art. 9	€...
j.	……..	€...
Totaal		€.....

4.4.
Huurder voldoet de te betalen prijs voor het gehuurde in zijn geheel, bij vooruitbetaling, vóór de eerste van de maand op de door verhuurder aangegeven wijze.

De administratiekosten en de eerste huurtermijn
Artikel 5

5.1.
Bij ondertekening van dit contract betaalt huurder:

a.	administratiekosten:	€.....
b.	de huurprijs en het voorschot met betrekking tot de kosten voor nutsvoorzieningen met een individuele meter en de servicekosten over de periode van ..... tot en met .....:	€.....
Totaal:		€.....
		===

De woonplaatskeuze van huurder
Artikel 6

6.1.
Huurder verklaart gedurende de huurovereenkomst woonplaats te hebben gekozen in het gehuurde.

6.2.
Bij beëindiging van de huurovereenkomst zal huurder aan verhuurder zijn nieuwe adres schriftelijk doorgeven. Voor het geval huurder het gehuurde definitief verlaat zonder opgave van het nieuwe adres aan verhuurder blijft het adres van het gehuurde als woonplaats van huurder aangemerkt.

Verstrekking gegevens huishoudinkomen en gezinssamenstelling
Artikel 7

7.1.
Huurder verklaart dat de door hem aan verhuurder vóór aanvang van de huurovereenkomst verstrekte gegevens met betrekking tot zijn huishoudinkomen en gezinssamenstelling juist en volledig zijn.

7.2.
Indien huurder onjuiste of onvolledige gegevens verstrekt en hij bij verstrekking van de juiste en volledige gegevens niet in aanmerking zou zijn gekomen voor het gehuurde, moet huurder het gehuurde ontruimen op eerste aanzegging van verhuurder. Indien huurder hiertoe niet overgaat, start verhuurder een gerechtelijke procedure met als doel ontruiming van het gehuurde.

Levering van warmte

Artikel 8

8.1.

Huurder is verplicht vanaf de ingangsdatum van de huurovereenkomst warmte uitsluitend te betrekken van verhuurder tegen de voorwaarden opgenomen in deze huurovereenkomst en de Algemene Leveringsvoorwaarden van verhuurder, waarvan een exemplaar als bijlage bij de huurovereenkomst is gevoegd.[2]

8.2.

Verhuurder zal huurder gedurende de looptijd van de huurovereenkomst voor de levering van warmte een variabele vergoeding en een vastrecht in rekening brengen. Verhuurder zal tevens kosten in rekening voor de meting/verdeling van het warmteverbruik. De tarieven zullen door verhuurder worden gepubliceerd op haar website. Verhuurder is te allen tijde gerechtigd de kosten op een wijze in rekening te brengen die het werkelijke aandeel van de individuele huurder in de totale kosten van de collectieve installatie zo nauwkeurig mogelijk benadert.

8.3.

Verhuurder is gerechtigd de vergoedingen jaarlijks aan te passen. Verhuurder zal ten aanzien van de vergoedingen met betrekking tot de levering van warmte niet meer in rekening brengen dan de maximumprijs zoals deze wordt vastgesteld door de Autoriteit Consument en Markt op basis van de Warmtewet.

8.4.

Verhuurder is gerechtigd haar rechten en verplichtingen betreffende de warmtelevering uit deze overeenkomst over te dragen aan een door haar te bepalen derde, waarmee huurder zich op voorhand, door ondertekening van de huurovereenkomst akkoord verklaart.

8.5.

Indien en zodra de levering van warmte door verhuurder aan huurder als gevolg van een wijziging van de Warmtewet niet meer (verplicht) valt onder de Warmtewet, zullen de kosten met betrekking tot de levering van warmte worden beschouwd als servicekosten en zal de levering van warmte en de afrekening hiervan plaats vinden conform het (wettelijke en contractuele) regime betreffende servicekosten. De Warmtewet zal dan niet meer op de levering van warmte van toepassing zijn.

[2] Het is niet langer noodzakelijk om een aparte leveringsovereenkomst voor warmte te sluiten, zoals dat in het vorige model, versie oktober 2014, was opgenomen. Er is inmiddels zelfs een wetsvoorstel aanhangig tot wijziging van de Warmtewet op grond waarvan de Warmtewet in het geheel niet meer van toepassing is voor verhuurders.

De Algemene Huurvoorwaarden van verhuurder

Artikel 9

9.1.

Op deze overeenkomst zijn de Algemene Huurvoorwaarden zelfstandige woonruimte d.d. ..... van verhuurder van toepassing.

9.2.

In afwijking van, respectievelijk als aanvulling op:

artikel .....;
artikel .....;

van de Algemene Huurvoorwaarden zelfstandige woonruimte van verhuurder is het volgende overeengekomen:

- .....;
- .....;

De bijlagen bij dit contract

Artikel 10

10.1.

Huurder verklaart te hebben ontvangen:

a. de Algemene Huurvoorwaarden zelfstandige woonruimte van verhuurder d.d.;
b. de beschrijving van het gehuurde;
c. de splitsingsakte / het splitsingsreglement / het huishoudelijk reglement;[3]
d. de Algemene Leveringsvoorwaarden betreffende warmtelevering
e ….....

10.2.

De in het eerste lid van dit artikel bedoelde bijlagen maken deel uit van de huurovereenkomst.

[3] Indien het gebouw of complex waarvan het gehuurde deel uitmaakt, is gesplitst in appartementsrechten, dan dienen deze stukken -indien van toepassing- te worden toegevoegd als bijlagen.

Aldus in tweevoud opgemaakt en ondertekend te ..... op ..... 20 ..

Verhuurder: Huurder:

1.

2.

STANDAARD ALGEMENE HUURVOORWAARDEN HUUROVEREENKOMST ZELFSTANDIGE WOONRUIMTE AEDES

Het toepassingsbereik van deze voorwaarden
Artikel 1
1.1.
Deze Algemene Huurvoorwaarden maken deel uit van de huurovereenkomst, waarin zij van toepassing zijn verklaard. Indien de bepalingen van de huurovereenkomst afwijken van die van de Algemene Huurvoorwaarden, gaan de bepalingen van de huurovereenkomst voor.

1.2.
Verhuurder is gerechtigd wijzigingen aan te brengen in deze Algemene Huurvoorwaarden voor zover het gaat om redelijke wijzigingen. Huurder is aan deze wijzigingen gebonden.[i]

Meer dan één huurder
Artikel 2

2.1.
De in de aanhef van de huurovereenkomst genoemde huurders hebben elk een zelfstandig en volledig recht van huur, dat zij gelijktijdig en met eerbiediging van elkaars rechten uitoefenen.

2.2.
Elk van de huurders is hoofdelijk aansprakelijk voor het gehele bedrag van de huurprijs en voor alle overige verplichtingen die voor hem en voor de andere huurder(s) uit deze overeenkomst en de wet voortvloeien.

2.3.
De huurprijs, de kosten voor nutsvoorzieningen met een individuele meter en de servicekosten zijn slechts enkelvoudig verschuldigd voor de hierboven bedoelde huurrechten gezamenlijk. Indien de overeenkomst ten aanzien van één of een aantal huurders eindigt, blijft (blijven) de andere huurder(s) het volledige bedrag van de huurprijs, de kosten voor nutsvoorzieningen met een individuele meter en de servicekosten verschuldigd.

2.4.
Om de huurovereenkomst te doen eindigen, moet de opzegging aan of door (alle) in de aanhef genoemde huurder(s) geschieden. De in de aanhef genoemde huurders kunnen derhalve slechts gezamenlijk de huur opzeggen, tenzij verhuurder uitdrukkelijk instemt met een enkelvoudige beëindiging door één van de in de aanhef genoemde huurders.

2.5.
Indien verhuurder op grond van een wettelijke dan wel contractuele regeling verplicht is tot het verrichten van een prestatie jegens huurder, bevrijdt nakoming aan één van de in de aanhef van de huurovereenkomst genoemde huurders, verhuurder van haar verplichting.

De terbeschikkingstelling en aanvaarding van het gehuurde
Artikel 3

3.1.
Verhuurder zal het gehuurde op de ingangsdatum van de huur ter beschikking stellen, tenzij dit geen werkdag is.

3.2.
Vóór of bij aanvang van de huurovereenkomst is tussen huurder en verhuurder een beschrijving van het gehuurde opgemaakt. Huurder en verhuurder ontvangen een door beiden ondertekend exemplaar van deze beschrijving.[ii]

Kosten voor nutsvoorzieningen met een individuele meter en servicekosten
Artikel 4

4.1.
Huurder betaalt maandelijks een voorschotbedrag met betrekking tot de kosten voor nutsvoorzieningen met een individuele meter en de servicekosten.
Jaarlijks verstrekt verhuurder aan huurder een overzicht van de in dat kalenderjaar in rekening gebrachte kosten voor nutsvoorzieningen met een individuele meter en de servicekosten.[iii]

Verschillen tussen de gemaakte kosten en de door de huurder als voorschot betaalde kosten voor nutsvoorzieningen met een individuele meter en servicekosten zullen daarbij door de verhuurder met de huurder worden verrekend, tenzij het een vergoeding betreft voor een door verhuurder ingesteld fonds. Met betrekking tot deze fondsen geldt dat het door de huurder betaalde voorschot gelijk wordt gesteld met de eindafrekening; er vindt derhalve geen verrekening plaats.

4.2.
Het tussen verhuurder en huurder geldende maandelijkse voorschotbedrag kan, behoudens een tussen partijen aangegane nadere overeenkomst, slechts worden verhoogd met ingang van de eerste maand, volgende op de maand waarin het in het eerste lid van dit artikel bedoelde overzicht is verstrekt.

4.3.
Huurder is gebonden aan een wijziging van de levering van zaken of diensten, dan wel een wijziging van de berekeningsmethodiek van de geleverde zaken of diensten, en het daarbij behorende gewijzigde voorschotbedrag, indien die wijziging betrekking heeft op zaken en diensten die slechts aan een aantal huurders gezamenlijk geleverd kunnen worden en tenminste 70% van die huurders daarmee heeft ingestemd.

Een huurder die niet met de wijziging heeft ingestemd, kan binnen acht weken na de schriftelijke kennisgeving van de verhuurder dat overeenstemming is bereikt met tenminste 70% van de huurders, een beslissing van de rechter vorderen omtrent de redelijkheid van het voorstel.

4.4.
Indien niet tenminste 70% is bereikt, is huurder voorts gebonden aan een wijziging van de levering van zaken of diensten, dan wel een wijziging van de berekeningsmethodiek van de geleverde zaken of diensten, en het daarbij behorende gewijzigde voorschotbedrag, indien:
1. het belang van verhuurder bij de wijziging zodanig is dat huurder - in redelijkheid de belangen van beide partijen in aanmerking genomen- zijn toestemming daaraan niet mag onthouden
   en
2. verhuurder huurder over de wijziging tijdig heeft geïnformeerd en met huurder, de eventueel aanwezige bewonerscommissie, en indien nodig de huurdersorganisatie, overleg heeft gevoerd.

De algemene verplichtingen van verhuurder
Artikel 5

Verhuurder is verplicht op verlangen van de huurder gebreken aan het gehuurde te verhelpen, tenzij dit onmogelijk is of uitgaven vereist die in de gegeven omstandigheden redelijkerwijs niet van de verhuurder zijn te vergen, dan wel voor zover deze ingevolge de wet, deze huurovereenkomst of het gebruik, voor rekening van huurder komen.

De verplichtingen van huurder
Artikel 6

6.1.
Huurder voldoet de te betalen prijs voor het gehuurde in zijn geheel, bij vooruitbetaling, vóór de eerste van de maand door betaling van het verschuldigde bedrag op de door verhuurder aangegeven wijze.

Vanaf de eerste dag van de maand is huurder voor de termijn voor die maand in verzuim en is hij wettelijke rente verschuldigd.
6.2.
Verrekening door huurder is uitgesloten, behoudens in het geval van artikel 7: 206 lid 3 Burgerlijk Wetboek.

6.3.
Huurder zal het gehuurde gebruiken en onderhouden zoals het een goed huurder betaamt.

6.4.
Huurder zal het gehuurde, waaronder begrepen alle aanhorigheden en de eventuele gemeenschappelijke verkeersruimten, overeenkomstig de bestemming gebruiken en deze bestemming niet wijzigen. Het is huurder niet toegestaan bedrijfsmatige activiteiten in het gehuurde, delen van het gehuurde of in de gemeenschappelijke ruimten te ontplooien.

Onder gemeenschappelijke verkeersruimten wordt onder meer verstaan ruimten zoals trappenhuizen, liften, kelders, zolders, garages, bergingen, galerijen, tuinen, binnenplaatsen, voor zover huurder het gebruik van deze ruimten met andere huurders of gebruikers deelt.

6.5.
Huurder zal het gehuurde gedurende de huurtijd feitelijk bewonen en de woonruimte daadwerkelijk voor hemzelf en de leden van zijn huishouden gebruiken. Huurder zal in het gehuurde zijn exclusieve hoofdverblijf houden.

6.6.
Het is huurder slechts met voorafgaande schriftelijke toestemming van verhuurder toegestaan het gehuurde geheel of gedeeltelijk onder te verhuren of aan derden in gebruik te geven, dan wel het gehuurde op internet of anderszins aan derden te huur of gebruik aan te bieden, bijvoorbeeld via websites als www.airbnb.nl of www.marktplaats.nl. Een verzoek tot toestemming dient schriftelijk te worden gedaan, onder vermelding van de naam van de onderhuurder, de onderhuurprijs en de ingangsdatum van de onderhuurovereenkomst. Verhuurder is bevoegd aan zijn toestemming voorwaarden te verbinden.[iv]

Voor ongeoorloofde onderhuur geldt voorts dat huurder alle door onderhuur verkregen inkomsten aan verhuurder dient af te dragen. Daarnaast is huurder een onmiddellijk opeisbare boete verschuldigd van € 2.500,-- te vermeerderen met € 50,-- (prijspeil november 2013 geïndexeerd volgens de CBS Consumentenprijsindex, Alle Huishoudens) per dag voor iedere dag dat de overtreding voortduurt met een maximum van € 15.000,--.[v]

6.7.
Indien huurder het gehuurde niet feitelijk bewoont, dan wel het gehuurde zonder toestemming van verhuurder geheel of gedeeltelijk heeft onderverhuurd, in huur heeft afgestaan of aan derden in gebruik heeft gegeven, rust de bewijslast dat huurder onafgebroken het hoofdverblijf in het gehuurde heeft behouden op huurder.

6.8.
Huurder dient ervoor zorg te dragen dat aan omwonenden geen overlast of hinder wordt veroorzaakt door huurder, huisgenoten, huisdieren of door derden die zich vanwege huurder in, rondom of in de directe nabijheid van het gehuurde of in de gemeenschappelijke ruimten bevinden.

Tevens dient huurder zich als goed huurder te gedragen richting medewerkers van verhuurder en/of door verhuurder ingehuurde derden. Fysiek of verbaal geweld, agressiviteit, dan wel ander wangedrag leidt tot passende (juridische) maatregelen jegens huurder, die kunnen leiden tot beëindiging van de huurovereenkomst.

6.9.
Het is huurder niet toegestaan in het gehuurde hennep te (doen) kweken, drogen of knippen, dan wel andere activiteiten te (doen) verrichten die op grond van de Opiumwet strafbaar zijn gesteld. Huurder is bij overtreding van dit verbod een onmiddellijk opeisbare boete verschuldigd van € 2.500,-- te vermeerderen met € 50,-- (prijspeil november 2013 geïndexeerd volgens de CBS Consumentenprijsindex, Alle Huishoudens) per dag voor iedere dag dat de overtreding voortduurt, met een maximum van €15.000,--.[vi]

6.10.
Huurder is verplicht zijn voor- en achtertuin als sier- of moestuin te gebruiken en deze zodanig te onderhouden dat deze -naar het oordeel van verhuurder- een verzorgde indruk maakt en zal geen bomen, struiken of andere beplanting aanbrengen die overlast voor derden kunnen veroorzaken.

Verhuurder heeft het recht te vorderen dat huurder bij het einde van de huur op kosten van huurder door hem geplante bomen en/of hoogopschietende beplanting (laat) verwijderen.

6.11.
Het is huurder niet toegestaan de tuin, dan wel andere gehuurde buitenruimte(n)te gebruiken voor opslag en/of stalling van voer- of vaartuigen, caravans, aanhangwagens, handelswaren, afval, dan wel gevaarlijke of milieubelastende zaken en andere zaken van welke aard dan ook.

Het is huurder voorts niet toegestaan de gemeenschappelijke ruimten te gebruiken voor opslag en/of stalling van tweewielers, kinderwagens, handelswaren, afval, gevaarlijke of milieubelastende zaken en andere zaken van welke aard dan ook. Doet huurder dat toch, dan is verhuurder gerechtigd deze zaken te verwijderen op kosten van huurder.[vii]

6.12.
Huurder zal het gehuurde voorzien van behoorlijke meubilering en stoffering. In gestapelde bouw dient een zodanige vloerbedekking te worden aangebracht, dat er voldoende geluiddemping is.[viii]

6.13.
Huurder is verplicht de nodige maatregelen te nemen ter voorkoming van schade aan het gehuurde, in het bijzonder in geval van brand, storm, water en vorst. Huurder dient door welke oorzaak dan ook ontstane dan wel dreigende schade, alsmede gebreken aan het gehuurde onverwijld aan verhuurder te melden.

Bij nalatigheid van huurder in dezen zal de daardoor ontstane schade zowel aan het gehuurde als aan de eigendommen van derden, voor rekening van huurder komen.

6.14.
In verband met controle door verhuurder van de naleving van de verplichtingen van huurder op grond van deze Algemene Huurvoorwaarden, dan wel in verband met mogelijk door verhuurder uit te voeren werkzaamheden

of controle van meterstanden en dergelijke, zal huurder verhuurder, in het gehuurde toelaten. Onder verhuurder wordt mede verstaan: de door of namens verhuurder aangewezen personen.

6.15.
Indien het huurrecht van huurder is geëindigd als gevolg van echtscheiding of scheiding van tafel of bed, is huurder verplicht van de beëindiging van zijn huurrecht schriftelijk mededeling te doen aan verhuurder, onmiddellijk nadat de rechterlijke beschikking waarbij dit is bepaald, onherroepelijk is geworden. Zolang huurder deze mededeling niet heeft gedaan, blijft hij tegenover verhuurder aansprakelijk voor de nakoming van alle verplichtingen uit deze huurovereenkomst. Het vorenstaande is eveneens van toepassing op de beëindiging van geregistreerd partnerschap.
Indien de medehuurder de huurovereenkomst voortzet als huurder is hij verplicht verhuurder hiervan terstond schriftelijk mededeling te doen.

De herstellingen door huurder
Artikel 7

7.1.
Voor rekening van huurder komen de kleine herstellingen.

Tenzij anders is overeengekomen, is huurder in ieder geval verantwoordelijk voor het schoonhouden van gemeenschappelijke ruimten, waaronder begrepen trappenhuizen, liften, kelders, zolders, garages, bergingen, galerijen, tuinen en binnenplaatsen.
7.2.
Alle door huurder te verrichten werkzaamheden zullen vakkundig moeten worden uitgevoerd. Huurder zal daarbij de door overheid of verhuurder gegeven voorschriften in acht nemen.

Het uitvoeren van dringende werkzaamheden en renovatie door verhuurder
Artikel 8

8.1.
Huurder zal alle dringende werkzaamheden aan het gehuurde of aangrenzende woningen, als ook aan de centrale voorzieningen daarvan toestaan.

8.2.
Huurder heeft geen recht op vermindering van de huurprijs of schadevergoeding als gevolg van het uitvoeren van de dringende werkzaamheden of renovatie.

8.3.
Indien verhuurder het complex waarvan het gehuurde deel uitmaakt, geheel of gedeeltelijk wil renoveren, zal hij huurder daartoe een schriftelijk voorstel doen. Dit voorstel wordt vermoed redelijk te zijn wanneer 70% of meer van de huurders van het complex daarmee heeft ingestemd. Indien huurder met het voorstel niet heeft ingestemd en ook niet binnen acht (8) weken na de schriftelijke kennisgeving van de verhuurder, dat 70% of meer van de huurders met het voorstel heeft ingestemd, bij de rechter een beslissing heeft gevorderd omtrent de redelijkheid van het voorstel, is hij hieraan gebonden. Huurder is dan verplicht alle medewerking te verlenen bij de uitvoering van de werkzaamheden.

8.4.
Bedoelde werkzaamheden vinden, na voorafgaande aankondiging van het tijdstip, plaats op werkdagen, dringende gevallen evenwel uitgezonderd.

Het aanbrengen van veranderingen en toevoegingen door huurder
Artikel 9

9.1.
Het is huurder toegestaan veranderingen en toevoegingen die zonder noemenswaardige kosten weer ongedaan kunnen worden gemaakt aan de binnenzijde van het gehuurde aan te brengen, behalve indien het gaat om veranderingen die gevaar, overlast of hinder voor verhuurder of derden opleveren.

Voor overige veranderingen en toevoegingen heeft huurder vooraf schriftelijke toestemming van de verhuurder nodig.[ix]

9.2.
De verhuurder kan aan zijn toestemming voorwaarden verbinden, die onder meer betrekking hebben op:
- aard en kwaliteit van te gebruiken materialen;
- het voorkomen van schade aan de constructie van het gehuurde of het gebouw;
- (bouwtechnische) voorschriften van de overheid;
- het onderhoud van de verandering;
- aanvullende voorzieningen om overlast voor derden te voorkomen;
- verzekering, belasting en aansprakelijkheid.

Verhuurder zal bij het verlenen van toestemming aangeven of de verandering of toevoeging aan het einde van de huur door huurder ongedaan moet worden gemaakt.

9.3.
Alle veranderingen die zonder de vereiste toestemming of in strijd met de voorwaarden van verhuurder zijn aangebracht zullen op eerste aanzegging van verhuurder ongedaan worden gemaakt door huurder.

9.4.
Huurder is verplicht tot het onderhouden, het verhelpen van gebreken en het uitvoeren van herstellingen aan de veranderingen of toevoegingen die door huurder zijn aangebracht.

9.5.
Huurder is verplicht, voor eigen rekening, door hem aangebrachte veranderingen of toevoegingen op eerste aanzegging van verhuurder te verwijderen, indien dit noodzakelijk is voor de uitvoering door verhuurder van dringende of renovatiewerkzaamheden.

9.6.
Huurder is aansprakelijk voor de schade die wordt veroorzaakt door een verandering of toevoeging die door huurder is aangebracht. Huurder vrijwaart verhuurder voor aanspraken van derden voor schade veroorzaakt door huurder zelf aangebrachte veranderingen aan het gehuurde.

9.7.
Voornoemde leden hebben eveneens betrekking op door huurder, in overleg met verhuurder, overgenomen veranderingen of toevoegingen van de vorige huurder.[x]

De beëindiging van de huur
Artikel 10

10.1.
Opzegging van de huurovereenkomst geschiedt schriftelijk bij aangetekende brief of deurwaardersexploot.

10.2.
Opzegging door huurder kan geschieden op welke grond dan ook, tegen elke dag van een kalendermaand mits deze niet valt op een zaterdag, zondag of algemeen erkende feestdag, in welk geval opgezegd wordt tegen de eerstvolgende werkdag erna. Huurder dient een opzeggingstermijn van één maand in acht te nemen**.**

10.3
Opzegging van de huurovereenkomst door verhuurder geschiedt met inachtneming van een termijn van tenminste drie maanden. Deze termijn wordt verlengd met één maand voor elk jaar, dat huurder onafgebroken in het genot van het gehuurde is geweest tot ten hoogste zes maanden.

10.4.
De opzegging door verhuurder kan slechts geschieden op grond van één of meer van de in het Burgerlijk Wetboek genoemde gronden.

10.5.
Huurder is verplicht, als verhuurder na het einde van de huur, tot verhuur of verkoop wenst over te gaan, aan belangstellenden gelegenheid te geven tot bezichtiging.

De oplevering van het gehuurde bij het einde van de huur
Artikel 11

11.1
Bij het einde van de huurovereenkomst is huurder verplicht het gehuurde onder afgifte van alle sleutels geheel ontruimd en schoon aan verhuurder op te leveren in de staat, waarin hij het gehuurde conform de beschrijving bij aanvang van de huurovereenkomst heeft ontvangen, behoudens voor zover er sprake is van normale slijtage, die voor rekening en risico van verhuurder komt. Voor door huurder in het gehuurde aangebrachte veranderingen en toevoegingen geldt het bepaalde in het derde lid van dit artikel.

11.2.
Vóór het einde van de huurovereenkomst zullen huurder en verhuurder gezamenlijk het gehuurde inspecteren. Huurder zal verhuurder daartoe in de gelegenheid stellen.
Bij die gelegenheid respectievelijk die gelegenheden zal een opnamerapport worden gemaakt, waarin zal worden vastgelegd, welke herstellingen voor het einde van de huurovereenkomst door en ten laste van huurder verricht moeten worden, alsmede de geschatte kosten van herstel. Beide partijen ontvangen een exemplaar van het opnamerapport.

11.3.
Ten aanzien van door de huurder tijdens de huurtijd met of zonder toestemming aangebrachte veranderingen en toevoegingen zullen bij het einde van de huur de volgende regels gelden:
a. veranderingen die zonder noemenswaardige kosten ongedaan kunnen worden gemaakt, dienen bij het einde van de huur door huurder te worden verwijderd. Hieronder worden onder meer begrepen spiegels, lamellen, jaloezieën en dergelijke;
b. verhuurder kan vorderen dat aangebrachte veranderingen en toevoegingen die zonder toestemming zijn aangebracht, of niet voldoen aan de voorwaarden in artikel 9.2, door huurder ongedaan worden gemaakt;
c. huurder is verplicht om veranderingen en toevoegingen bij het einde van de huur weg te nemen indien verhuurder dit bij het verlenen van toestemming schriftelijk heeft bedongen;

d. huurder is gerechtigd door hem aangebrachte veranderingen en toevoegingen ongedaan te maken mits hij het gehuurde terugbrengt in de staat waarin het zich overeenkomstig artikel 3.2 bij de aanvang van de huur bevond, tenzij verhuurder bij het verlenen van toestemming schriftelijk anders heeft bedongen.

11.4.
Indien huurder bij het einde van de huurovereenkomst aan zijn verplichtingen tot herstel, volledige ontruiming en eventueel ongedaanmaking van aangebrachte veranderingen of toevoegingen niet heeft voldaan, is verhuurder gerechtigd alle ten gevolge daarvan noodzakelijke werkzaamheden op kosten van huurder zelf uit te voeren of te doen uitvoeren, waarbij huurder zich reeds nu voor alsdan verplicht deze kosten te voldoen. Ook overige schade ontstaan door nalatigheid van huurder, komt voor zijn rekening.

11.5.
In het geval huurder bij het einde van de huurovereenkomst in het gehuurde zaken heeft achtergelaten is verhuurder bevoegd die zaken te verwijderen, zonder dat op verhuurder een bewaarplicht komt te rusten. Alle kosten van verwijdering van de zaken zijn voor rekening van de huurder.

Het in dit lid bepaalde is niet van toepassing op roerende zaken die huurder heeft overgedragen aan de opvolgende huurder, mits van deze overdracht schriftelijk aan verhuurder is kennis gegeven.

De aansprakelijkheid van huurder en verhuurder
Artikel 12

12.1.
Huurder is aansprakelijk voor de schade die tijdens de huurtijd aan het gehuurde, waartoe ook de buitenzijde wordt gerekend, is ontstaan door een hem toe te rekenen tekortschieten in de nakoming van een verplichting uit de huurovereenkomst. Alle schade, behalve brandschade en schade aan de buitenzijde van het gehuurde, wordt vermoed daardoor te zijn ontstaan.

Huurder is jegens verhuurder op gelijke wijze als voor eigen gedragingen aansprakelijk voor de gedragingen van hen die vanwege huurder het gehuurde gebruiken of zich vanwege huurder daarop bevinden.

12.2.
Verhuurder is niet aansprakelijk voor de schade aan de persoon of aan zaken van de huurder en/of diens huisgenoten, veroorzaakt door storm, vorst, blikseminslag, ernstige sneeuwval, overstromingen, stijging of daling van het grondwaterpeil, atoomreacties, gewapende conflicten, burgeroorlogen, opstanden, onlusten, molest en andere calamiteiten. Aansprakelijkheid van verhuurder krachtens artikel 6:174 BW is uitgesloten.

Het in verzuim zijn van huurder en verhuurder
Artikel 13

13.1.
Indien één der partijen in verzuim is met de nakoming van enige verplichting, welke ingevolge de wet en/of de huurovereenkomst op hem rust en daardoor door de andere partij gerechtelijke en/of buitengerechtelijke maatregelen moeten worden genomen, zijn alle daaruit voortvloeiende kosten voor rekening van die ene partij.

13.2.
Indien één van de partijen een uit hoofde van de overeenkomst of uit andere hoofde overeengekomen verschuldigd bedrag niet volledig en stipt op de vervaldag voldoet, dan verkeert deze partij direct vanaf de vervaldag in verzuim en is deze partij vanaf die dag de wettelijke rente verschuldigd.

Daarnaast is de partij die in verzuim verkeert en die een natuurlijk persoon is, niet handelend in de uitvoering van beroep of bedrijf, een vergoeding verschuldigd voor de redelijke incassokosten, zulks met in acht neming

van artikel 6:96, leden 2 tot en met 6 van het Burgerlijk Wetboek. De hoogte van de verschuldigde incassokosten wordt berekend conform artikel 2 van het Besluit vergoeding voor buitengerechtelijke incassokosten, waarbij tenminste het aldaar opgenomen minimumbedrag van € 40,-- verschuldigd zal zijn.[xi]

Is de partij die in verzuim verkeert geen natuurlijk persoon, dan is deze partij direct vanaf het intreden van verzuim een vergoeding verschuldigd voor de buitengerechtelijke incassokosten, welke 15% van de verschuldigde hoofdsom bedraagt met een minimum van € 75,=.

Belastingen en andere heffingen
Artikel 14

Tenzij dit op grond van de wet of daaruit voortvloeiende regelgeving niet is toegestaan, zijn voor rekening van huurder, ook als verhuurder daarvoor wordt aangeslagen:

- de afvalstoffenheffing en waterschapslasten, voor zover deze lasten betrekking hebben op het feitelijk gebruik van het gehuurde en het feitelijk medegebruik van gemeenschappelijke ruimten;
- overige bestaande of toekomstige belastingen, precariorechten, lasten, heffingen, retributies ter zake van het gehuurde en/of ten aanzien van zaken van huurder;
- milieuheffingen, waaronder de verontreinigingsheffing oppervlaktewateren en de bijdrage zuiveringskosten afvalwater en aanslagen of heffingen op grond van enige andere milieuwet, alsmede de rioolheffing.

Indien de voor rekening van de huurder komende heffingen, belastingen, retributies of andere lasten bij verhuurder worden geïnd, moeten deze door huurder op eerste verzoek aan verhuurder worden voldaan.

Boete
Artikel 15

Indien één van de partijen enige bepaling uit deze Algemene Huurvoorwaarden overtreedt, is die partij verplicht ten behoeve van de andere partij een onmiddellijk opeisbare boete te betalen van € 25,- (prijspeil november 2013 geïndexeerd volgens de CBS Consumentenprijsindex, Alle Huishoudens) per kalenderdag met een maximum van € 15.000,-- verschuldigd, onverminderd de verplichting van die partij om alsnog overeenkomstig deze Algemene Huurvoorwaarden te handelen en onverminderd de overige rechten van de andere partij op schadevergoeding.[xii]

Deze boete zal, zonder rechterlijke tussenkomst voor elke dag waarin de overtreding voortduurt, verschuldigd zijn.

Overige bepalingen
Artikel 16

16.1.
Indien een deel van de huurovereenkomst of van deze Algemene Huurvoorwaarden vernietigbaar is, dan laat dit de geldigheid van de overige artikelen onverlet. In plaats van het vernietigde of nietige deel geldt alsdan als overeengekomen hetgeen op wettelijk toelaatbare wijze het dichtst komt bij hetgeen partijen overeengekomen zouden zijn indien zij de nietigheid of vernietigbaarheid gekend zouden hebben.

16.2.
Indien het gebouw of complex waarvan het gehuurde deel uitmaakt, is of wordt gesplitst in appartementsrechten, is huurder verplicht de uit de splitsingsakte, het splitsingsreglement en huishoudelijke reglementen voortvloeiende voorschriften omtrent het gebruik in acht te nemen. Tevens is huurder verplicht besluiten van de Vereniging van Eigenaars na te leven. Verhuurder verplicht zich deze besluiten zo spoedig mogelijk ter kennis van huurder te brengen.

16.3.
Huurder is vanaf de aanvang van de huurovereenkomst de enige afnemer van energie terzake van het gehuurde en is verplicht een overeenkomst tot levering van energie ter zake van het gehuurde aan te gaan met één of meer energieleveranciers en de verplichtingen uit die overeenkomst na te komen. Voorts dient de huurder zijn verplichtingen uit hoofde van de aansluit- en transport overeenkomst terzake van het gehuurde met de netbeheerder na te komen. Huurder zal verhuurder te allen tijde vrijwaren voor aanspraken van netbeheerder en/of energieleveranciers ter zake.

16.4.
Huurder is gebonden aan wijzigingen in het door verhuurder gevoerde beleid, mits deze beleidswijziging past binnen de geldende wet- en regelgeving en binnen deze algemene huurvoorwaarden.

Eindnoten

[i] Om eenzijdig algemene voorwaarden te kunnen wijzigen is onder meer van belang dat in de algemene voorwaarden wordt vermeld dát de voorwaarden gewijzigd kunnen worden. Of dit beding in rechte stand houdt hangt af van de omstandigheden van het geval. Een rol daarbij speelt of het gaat om wezenlijke veranderingen of slechts kleine veranderingen, zoals het nader uitwerken van het begrip goed huurderschap.

[ii] Op grond van artikel 7:224 BW dient de huurder het gehuurde bij einde huur op te leveren conform de bij aanvang van de huur opgemaakte beschrijving. Als er geen beschrijving is opgemaakt, mag de huurder het gehuurde oplevering in de toestand waarin het gehuurde zich bij einde huur bevindt. Het belang van een gedegen en volledige beschrijving van het gehuurde (waaronder de tuin) is derhalve groot. Een beschrijving kan ook bestaan uit foto's.

[iii] Naast de kosten voor nutsvoorzieningen met een individuele meter en servicekosten, die samenhangen met het wonen, kunnen ook posten worden opgevoerd voor bijkomende kosten die geen verband hebben met de bewoning, zoals maaltijdverstrekking en paramedische hulpverlening. Deze kosten kunnen niet worden getoetst door de huurcommissie.

[iv] Op grond van artikel 7:244 van het Burgerlijk Wetboek is onderverhuur verboden, tenzij het gaat om kamerverhuur en huurder zelf zijn hoofdverblijf in de woning houdt. Deze bepaling is van regelend recht. Dat betekent dat verhuurder een grote mate van beleidsvrijheid heeft op dit punt. Afhankelijk van het beleid van verhuurder kan deze bepaling derhalve worden aangepast, bijvoorbeeld door uitdrukkelijk op te nemen dat huisbewaarderschap onder bepaalde voorwaarden wordt toegestaan. Ook blijkt uit rechtspraak dat het van belang is om de huurder er nadrukkelijk op te wijzen dat verhuur van (een gedeelte van) de woning via websites als Airbnb niet is toegestaan en leidt tot een procedure tot ontbinding van de huurovereenkomst. Dit kan door een bepaling op te nemen in de huurovereenkomst of door het verstrekken van een informatiebrochure.

Ook kan de verhuurder kamerverhuur toestaan, waarvoor de volgende bepaling kan worden toegevoegd: *"Voor het onderverhuren of het in gebruik geven van een gedeelte van het gehuurde zal die toestemming door verhuurder worden gegeven, mits de huurder zelf het gehuurde als hoofdverblijf heeft en er geen sprake is van overbewoning, waardoor de verhuurder schade zou kunnen lijden."*

[v] Op grond van rechtspraak van het Europese Hof van Justitie en nationale rechters is het van belang dat een maximum wordt verbonden aan de boete en dat het geen eenzijdige boete betreft, die alleen geldt voor de huurder. Dat brengt het risico met zich mee dat het beding als onredelijk bezwarend wordt aangemerkt en om die reden buiten toepassing wordt gelaten. Een rechter zal dan ook niet overgaan tot matiging. Om die reden verdient het ook de voorkeur te concretiseren in welke situaties de boete verschuldigd is, vandaar dat in dit model gekozen is voor een aparte boete bij onderhuur (art. 6.6.) en handelen in strijd met het hennepverbod (artikel 6.9). Het staat verhuurder vrij andere bedragen op te nemen in dit artikel, met dien verstande dat de hoogte van de boete niet mag leiden tot een verstoring van het evenwicht tussen de uit de huurovereenkomst voortvloeiende rechten en verplichtingen van partijen dan wel tot een onevenredig hoge schadevergoeding.

[vi] Idem eindnoot 4.

[vii] De juridische houdbaarheid van deze bepaling hangt mede af van de omstandigheden van het geval, waarbij het in ieder van belang is dat de verhuurder de huurder vooraf schriftelijk heeft gewaarschuwd en de gelegenheid heeft geboden alsnog de spullen zelf te verwijderen, waarbij huurder tevens is gewezen op de consequenties als hij hier geen gehoor aan geeft.

[viii] Deze bepaling kan naar gelang van het beleid van de verhuurder worden aangepast. Harde vloerbedekking in flatwoningen kan bijvoorbeeld verboden worden of er kunnen aanvullende normen worden opgenomen ten aanzien van geluidsdemping.

[ix] De bepalingen rond zelf aangebrachte voorzieningen zijn gebaseerd op de artikelen 7:215 en 216 van het Burgerlijk Wetboek en de toegestane mogelijkheden om hier nadere afspraken over te maken. Ook hier geldt dat het model aan de hand van het eigen beleid van de verhuurder kan worden aangepast. Dit eigen beleid kan zien op bomen en struiken, schotelantennes en andere veranderingen en toevoegingen en kan desgewenst ook worden uitgewerkt in een brochure.

[x] Het verdient aanbeveling om de afspraken tussen huurder en verhuurder omtrent door de huurder overgenomen (onroerende) veranderingen of toevoegingen van de vorige huurder, ook expliciet overeen te komen in een apart formulier in aanvulling op de huurovereenkomst.

[xi] De buitengerechtelijke incassokosten kunnen slechts gevorderd worden wanneer de verhuurder de huurder schriftelijk heeft aangemaand om binnen een termijn van veertien dagen over te gaan tot betaling, met vermelding van de hoogte van de buitengerechtelijke incassokosten die de huurder bij het uitblijven van tijdige betaling verschuldigd is. Het gaat niet om het moment waarop de brief is verstuurd, maar op het moment waarop de brief is ontvangen. Belangrijk is daarom dat in een dergelijke brief de navolgende zinsnede wordt opgenomen: "*Incassokosten worden verschuldigd indien niet betaald is binnen veertien dagen vanaf de dag nadat deze brief bij u is bezorgd".*

Indien (nog) niet de maximale vergoeding voor buitengerechtelijke kosten wordt gevorderd maar een lager bedrag, dient in de aanmaning ook het maximale bedrag te worden genoemd dat op grond van het Besluit vergoeding buitengerechtelijke incassokosten maximaal gevorderd kan worden. Indien de huurder een consument is dient de verhuurder voorts in de aanmaning op te nemen dat hij de BTW niet kan verrekenen en dat de incassokosten derhalve met het BTW percentage worden verhoogd.

[xii] Deze bepaling betreft een aanvulling op de boetebepalingen uit de artikel 6.6 en 6.9. Om te voorkomen dat het beding als onredelijk bezwarend wordt aangemerkt en om die reden buiten toepassing wordt gelaten (zie ook de toelichting onder de eindnoten 5 en 6), is de boete aan een maximum verbonden en is dit algemene boetebeding niet langer eenzijdig. Het geldt ook voor verhuurder die bepalingen uit deze algemene voorwaarden schendt. Het staat verhuurder vrij andere bedragen op te nemen in dit artikel, met dien verstande dat de hoogte van de boete niet mag leiden tot een verstoring van het evenwicht tussen de uit de huurovereenkomst voortvloeiende rechten en verplichtingen van partijen dan wel tot een onevenredig hoge schadevergoeding.