

Towards A Blockchain Based Smart Contracts Model Design For Housing Market Applications.

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Abstract— Industries worldwide are facing a technological revolution where there is a need for technologies that can speed up business processes with more safety and transparency. The real estate industry is among many other industries that would benefit from such technologies due to the magnitude of financial transactions handled. The current management strategy employed by real estate owners depends on a number of intermediaries, including brokers, agents and banking service providers. This strategy of operation results to inefficiencies within the real estate industry that cause problems such as lack of transparency, high transaction costs, personal biases, tax evasion or under taxation, landlord versus tenant conflicts and slow transaction processes. This paper examines the potential of implementation of blockchain based smart contract technology in the real estate industry and how it might resolve the inefficiencies within the industry. Blockchain is a new and emerging technology with the potential for implementation in various industries. Previous research in blockchain technology has concentrated on its potential application in digital currency. In this paper, the researcher endeavored to propose a blockchain based smart contract model for management of real estate property that would address the weaknesses of the existing management models and potentially reduce the housing cost by elimination middlemen in the management process.

Index Terms — Blockchain, Smart Contract, Real Estate.

I. INTRODUCTION

Technological revolution worldwide is rapidly changing the way of doing business. This has resulted in business entities reengineering their business processes and improving the efficiency of operations with a general aim of maintaining data flow, managing contacts, tracking processes and keeping transaction records (Kasemsap, 2018). To any market and organizations, an ideal Technology not only facilitates efficient and effective operation with minimal manpower and helps to reduce the overall operational cost but also speeds up the different processes and bring more safety and transparency into the market (Tapscott, 2016). One of these markets is the real estate market that is highly important for the overall well-being of a country. (Ansar et al, 2018) argues that a real estate crisis often affect and creates financial crises which in turn could lead to economic meltdowns not only on micro but also on macro level. The real estate crises are in many cases linked to inefficiencies within the market. Inefficiencies such as illiquid market, transparency issues, high transaction costs, personal biases, intermediaries and slow transaction processes (Franke & Krahn, 2017).

The overall cost of renting a house depends mainly on the market structure and the management strategy employed by real estate owners. The current management strategy is such

that part-time landlords choose to work with middlemen to bring their rental properties to market (Pattillo, 2017). Most large rental corporations often choose to work with freelance middlemen to market their properties, vet potential tenants, and take care of maintenance (Ziemann, 2017). This increases the overall rental fee without contributing any significant value to the final consumer (Tenant). In this market, the tenant is often the least well-informed and with the least wealth player (Scott, 2018). In combination, this leads to a power imbalance to Tenant's disadvantage. Though, strict laws designed to protect tenant's rights exist, property owners and middlemen often find a way around them (Chordia, 2018). From this, cases of unexplained rent increment or unequal rental fee for tenants on the same rental house is common.

The most fundamental transaction in housing market is rental contract. Property owners and tenants agree that the tenant will be allowed to live in and use a certain allocation of space within the building (Layard, 2018). For this, the tenant pays the property owner (landlord or landlady) a certain sum of money in an agreed-upon period of time. In most countries, rent is paid fortnightly or monthly, but shorter and longer payment intervals are possible too (Hills, 2017). Currently rent can be paid via bank transfer, credit card, cash, or in any other form that owner or agents and tenant agree upon. This means of rental payment and management strategy has resulted to high rental fee and high level of bureaucracy where cases of minimum balance requirement, transaction costs, early notifications and middlemen are common.

A. The Present Real Estate Transaction Procedure

According to Social Networks and the Success of Market research conducted by (Crowston et al, 2015) real estate transactions presently depend on a number of intermediaries, including brokers, dealers, agents, banks service providers etc. In the short term, sharing contracts and approvals in real time will reduce delays caused by mailing and delivery. Indeed, (Goldman, 2018) estimated that blockchain technologies could lead to a yearly savings of 2-4 billion USD in the real estate market alone. It would also eliminate the need for parties to reconcile documents, as all parties maintain an identical, immutable copy. In addition, several time consuming, expensive functions can be replaced with blockchain and smart contracts. Payments of rent, deposits, and fees could be automated. Escrow accounts could be restructured around smart contracts and multisig wallets (Veuger & Jan, 2018). The same infrastructure could be harnessed for other transactions that occasionally require resolution by a neutral party, such as disputes over rent deposits. In the longer term, blockchain-based registries

could allow peer-to-peer asset transfers or payment of rental fee, reducing transaction times from months or weeks to minutes. Transaction costs could come down from thousands of dollars per sale or lease to a modest service fee. The ease and security of transactions could also permit the efficient unbundling of property rights. A landlord could lease a house quickly and cheaply.

It takes on average a whole day to finish a bank transaction if queues are long (Flink, 2017). Rental payments move from tenants account to agent's account that after deducting his/her commission sends to the real estate owner. This process is time-consuming and inefficient. (Crowston & Wigand 2016) argue that a real estate transaction usually involves three parties; Agent, Landlord and Tenant which in turn results to transaction costs of constitute up to 10% of the total rental fee according to (Lantmäteriet et al 2016) (see figure 1).

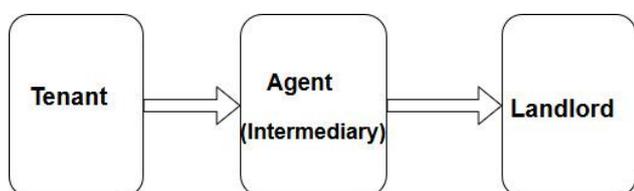


Figure 1 present real estate rent transaction process (Corluka & Lindh,2017)

(Lantmäteriet et al, 2016) argues that this system is slow due to several reasons; the major one is due to the repeated process of validating information. Many of the documents are signed on paper and need send from agent to Landlord. The validation of the documents needs to be done through manual processes. Due to the amount of signed papers, mistakes occur and needs to be corrected. Chances of fraud and corruption are possible. All these combined, makes the process slow and inefficient due to the time-consuming process, high transaction costs and frauds.

II. LITERATURE REVIEW

In this section, the paper explores existing related work and presents a critical appraisal of existing studies with the aim of rationalizing the need for blockchain based models for housing market. The first part presents The Real Estate Property Management Conundrum, then it proceeded to explore Existing Smart Contract Models for Housing Market followed by an in-depth justification for a need to design new model based on blockchain smart contract.

A. The Present Real Estate Property Management Conundrum

i. Unexplained Rent Increments

Citing imminent taxation of rental income by the government, landlords are demanding additional monthly rental fee giving petty reasons for doing so (Cohen, 2018). Most tenants are young and sometimes don't have guts to confront landlords about the sudden increase in rent. They accept any new development without much ado (Roach, 2018).

ii. Conflict between tenants and landlord over late payment of rent

A major cause of friction between tenants and landlords is late payment of rent (Bandopadhyay, 2018). A Landlord During an interview with Daily Nation points out that one (landlord) needs to be firm with his tenants and not relent when it comes to ensuring that they pay their rent in time (Swift, 2016). He further said that if a landlord is not firm tenants will develop a tendency of walking all over him.

iii. Complicated to Authorize occupants' rights and commitments

Among the core values of Urban Tenants Association of Kenya (UTAK) is addressing conflicts and disputes arising from landlords and tenants, advocating for tenants in case of infringement, awareness creation, education and training on tenants' obligations among other things (Kisubi & Kisubi, 2012). According to (Koulu, 2016) tenants remain ignorant of their rights and obligations despite the work UTAK in creating this awareness leaving themselves vulnerable to exploitation by landlords or other people when they fail in their obligations.

iv. Difficult to enforce lease agreement

Lease agreement states the actions to be taken when a tenant defaults on paying rent by certain agreed date of the month and indicates the penalty to be added onto the rental fee for every day defaulted (Bandiera, 2007). It also contains the rights and obligations of tenants and landlord. A manually written agreement might not optimally serve its purpose. According to (Levy, 2017) Smart contracts are perfectly suited to being adapted to all kinds of contractual agreements, particularly those which involve some kind of value transfer where there are multiple, potentially distrusting, parties.

v. Need for trusted intermediaries

Many apartments that are rented out to tenants or students are found via agencies where they pay a fee to an agent (Goodbrand & Hiller, 2018). According to (Mankoff et al, 2018, June) Intermediaries make a profit for their part in the distribution process. Paying the intermediary a commission, results in higher selling expenses. The agencies will increase the rental fee to meet this extra fee. The smart contracts are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries (Christidis & Devetsikiotis, 2016). This will lower the rental fee as well as improving transparency.

vi. *Trouble in claiming deposit*

When a tenant signs a rental contract, in most cases, he/she have to pay a deposit, which is equivalent to the amount of one month accommodation rent. At the end of the stay, a tenant is supposed to receive this amount back, unless he/she leave the room in poor condition. Even with a positive inspection report, Money-hungry landlords fleece tenants of their deposit refunds (Nightingale, 2018). An Ethereum based Solidity smart contract which resides on the Ethereum blockchain Will solve this issue. Where tenant signs the contract and the tenure begins and the smart contract collects money from the renter and sends it to the landlord. When the contract terminates the, all Ether left in the contract is sent to the owner (Molina-Jimenez et al, 2018).

B. *Existing Models for Real Estate Management*

One of the important things to remember for all technology products is that there needs to be a reason for the technology to exist. Therefore, to justify the need for a new blockchain smart contract, the existing real world alternative needs to exhibit inefficiencies in its use cases. That is why blockchain technology is rapidly hitting the mainstream and according to a World Economic Forum survey of executives and ICT experts, 57.9% of the respondents believe that 10% of the global GDP information will be stored on blockchain technology by 2025. For that case Industry players now realize that blockchain-based smart contracts can play a much larger role in real estate dealings, potentially transforming core real estate operations such as property transactions. The following are existing smart contract systems for real estate management that have been analyzed in this research.

i. *E-Resident Platform in Kenya*

This platform was developed through a partnership between KCB Bank Kenya Limited and E-Resident Limited (A bill management and rental payment services company) with an aim of changing the management of rental payment for the real estate market (Raja & Seetharaman, 1970). E-Resident has been publicized to offer a host of benefits such as security, convenience and cut collection cost for landlords and agents. The benefits apply to tenants too who will not have to deal with agents or queue at the bank to make payments. The platform also makes tracking of payments easier since the money is sent from any of the money transfer platforms straight to the bank. Accounting functions such as reconciliation make it easier for agents and property owners to see real-time the amount paid and the amount due at any given time. This innovation has been crafted to cut across multiple payment channels such as credit and debit card, mobile money transfer as well as bank deposits. E-Resident Limited owns all intellectual property rights to and operates www.eresident.co.ke, an electronic payments solution, for collecting payments on behalf of its Clients.

ii. *SPENN mobile based platform*

SPENN is a mobile based platform for banking application

that enables Rwandans to make a range of financial transactions (bizimungu, 2018) . The application allows smartphone users to transact and pay for goods and services. Unlike many other blockchain technology platforms, SPENN uses a different model whereby it removes the need for cash by digitalizing national currencies. As a user, after downloading and registering with the app, you immediately have a digital account and the ability to transact and interact with others in the financial system. Using blockchain technology, Block-bonds is bringing ease in transacting as SPENN account holders are able to keep track of the transactions and funds on their accounts. The mobile banking platform doesn't only target the unbanked but also the banked to ultimately bring efficiency and effectiveness in the way people transact and make payments in the country.

iii. *Deed-coin agent location*

Deed's platform replaces the way you find your next real estate agent. Instead of finding the next agent on Google for higher commission, customers access deed-coin platform, input their property information, and link up with their local Deed agent for a 1% commission. Deed customers use DEED to decide the commission or rebate before linking with the Deed agent (Arruñada, 2018). All discounts are reflected on the standard HUD forms during a property closing and all homes are listed or purchased through standard MLS. Customers have access to a groundbreaking technology dashboard allowing 24/7 access to an agent or licensed transaction assistant.

iv. *The Bit-property platform.*

Bit-property is a decentralised real estate platform powered by Ethereum smart contracts that aims at giving users a seamless, quick, and low-cost way to own and trade real estate revenue streams (Bitproperty, 2017) . It has two types of token: the BTP platform token and individual property asset tokens. BTP tokens represent the inherent value of the platform and provide holders with income from transaction fees within the platform in proportion to the amount they own. BTP tokens also pay income from the energy revenues of Bit-property's solar farm. Asset tokens will be issued for each property listed on the platform. The numbers of tokens issued against a specific property represent the value of that property. Token holders get income dependent on the performance of the asset and the stake that they hold.

C. *Why New Blockchain Based Model*

E-Resident in Kenya is a web based platform that focuses only on creating convenience to tenants who will not have to deal with agents or queue at the bank to make rental payments. This platform aside from creating convenience, it does not address all of the above mentioned real estate property management Conundrum. The Bit-property smart contract platform aside from being decentralized smart contract platform that aims at giving users a seamless, quick, and low-cost way to own and trade real estate revenue streams, it does not address issues surrounding renting a rental property. On the other hand SPENN is a blockchain mobile based

platform for banking application that only enables users to make a range of financial transactions including rental fees payment. This model tries to remove the need for cash by digitalizing national currencies as an effort to gap corruption within any chain of distribution, however it does not entirely troubleshoot the real estate issues stated in this research. For the case of DEED'S platform, it focuses on reducing challenges in finding real estate agent and to decide on the best commission. It does not meet the researcher objective of this paper. Although these existing models examined seek to improve real estate management, not much on reducing frictions in claiming of deposit, eliminating intermediaries, enforcement of tenants' rights and obligations, reducing conflict between tenants and landlord over late payment of rent or reducing cases of unexplained rent increments which are the core issues highlighted in the SDGs and the big four agenda. The management approach in the real estate industry specifically housing market need to consider Ethereum Based Solidity Smart Contract Model for Housing Market best practices. This study therefore aims to bridge this gap by designing Smart Contract Model for Housing Market with a more comprehensive approach that reduces the above mentioned issues.

III. PROPOSED FRAMEWORK

The model will have the following modules as shown in figure 2-3; A User Registration module for both the tenant and the landlord, User login and authentication module that will be regulating access to only authorized users, Smart contract to automate transaction and create immutable transaction blocks of records, personal wallet to store individual ethers and contract wallet to store deposits, and a chain of transaction blocks. The model must be very robust as it will be holding cash, must not show any authentication details, due to occupancies being private matters, and must have an intuitive and simple user interface for non-technical or Amateurish users. The tenant will be paying the deposit in ether to the smart contract which is storing the logic for the model, therefore not subject to long bank processing times and high fees in the case of international payments. The funds are locked in until the end of the tenancy when the landlord can decide the appropriate deduction amount. An arbitrator makes the final decision for the withdrawal split in the case of a dispute. In addition to the deposit being paid in ether, using smart contracts facilitates the rent installments to also be paid to the landlord in ether. The smart contract enforces logic on these payments, such as preventing the rent from being overpaid or transferred after the tenancy is complete. This automatic payment will involve the user allowing a program access to their account in order to transfer rent on their behalf.

A. The Proposed model as a System of smart contracts

Every non-trivial Dapp will require more than one contract to work well. According to Beck and others, there is no way to

write a secure and scalable smart contract back-end without distributing the data and logic over multiple contracts (Beck et al, 2016). Therefore, the proposed architecture of the system of smart contracts is based on the design principle of having different types of contracts to perform different classes of tasks. To classify the contracts, a model called "The Five Types Model" is used (Monax, 2017), although not all of the five models are actually used in this proposed model. This model divides contracts into: Database contracts, Controller contracts, Contract managing contracts, Application logic contracts and Utility contracts (monax, 2017).

i. Database contracts

These Contracts are used only as data storage. The only logic they need is functions that allow other contracts to write to, update and get data, and some simple way of checking caller permissions.

ii. Controller contracts

One step up in the layer of abstraction is contracts for controlling database contracts. These contracts operate on the storage contracts. In a flexible system, both controllers and databases can be replaced by other, similar contracts that share the same public API (although this is not always needed). Controllers can be advanced, and could for example do batched reads/writes, or read from and write to multiple different databases instead of just one. They can also act on multiple database contracts.

iii. Contract managing contracts (CMCs)

These contracts are needed to control and manage the actions and existence of other contracts. Their main task is to keep track of all the contracts/components of the system, handle the communication between contracts and other components, and to make modular design easier. Keeping this functionality separate from normal business logic should be considered good practice.

iv. Application logic contracts (ALCs)

Any contract that is implementing application-specific code tasks through controllers is an application logic contract. Generally speaking, if the contract utilizes controllers and other contracts to perform application specific tasks it's an ALC.

v. Utility contracts

These contracts usually perform a specific task, and can be called by other contracts without restrictions. It involves some small, generic functions that can be outsourced into utility contracts that are highly specialized.

The framework that will aid in the implementation of the model for real estate market is as shown in Fig 2.

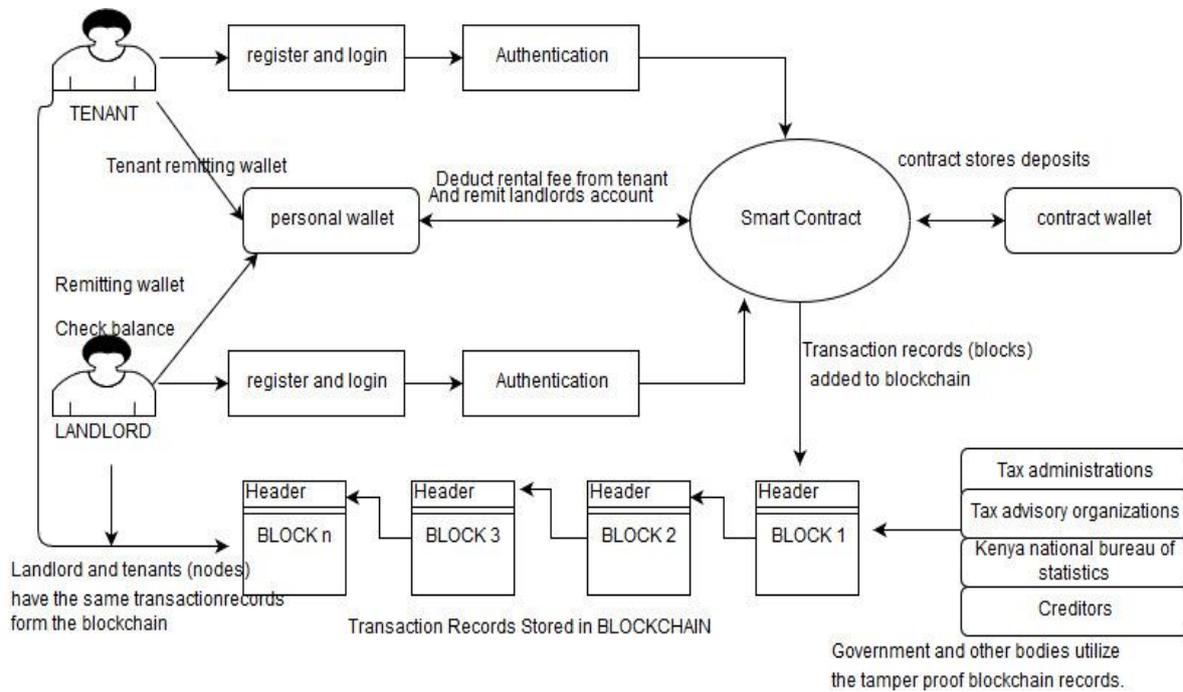


Figure 2 proposed framework Source: (Researcher, 2019)

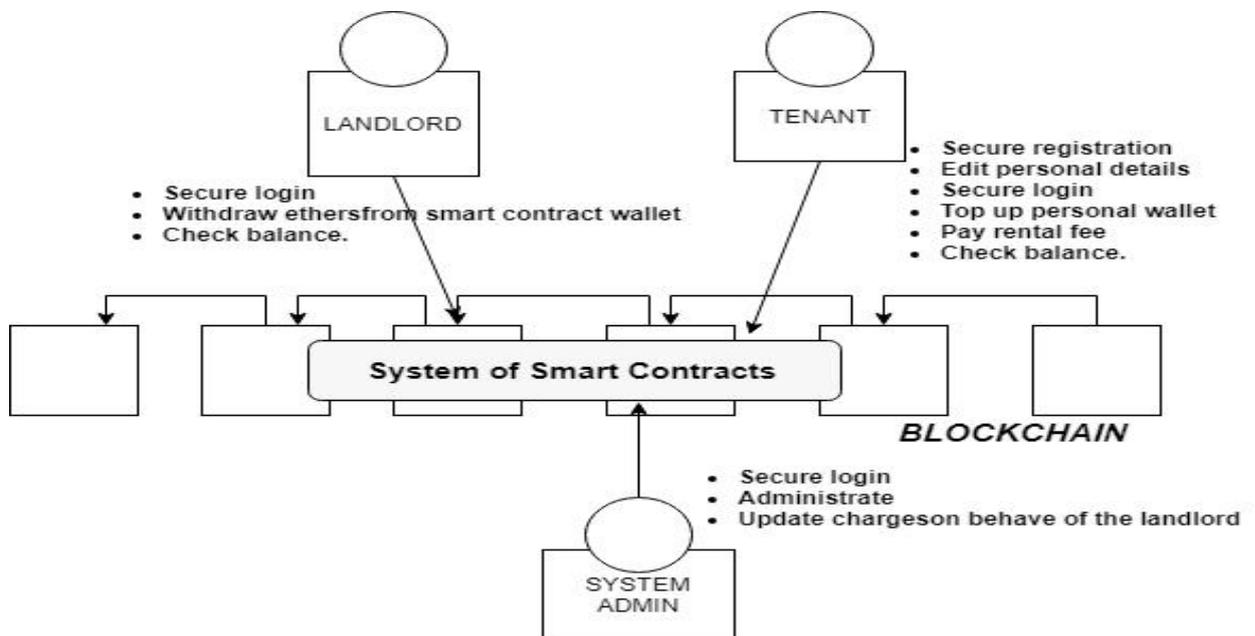


Figure 3 A Prototype Implementation Overview, With Different Users And Their Interactions With The Blockchain as a System Of Smart Contracts Which Exist On The Blockchain. Source: (Researcher, 2019)

B. Proposed contracts

Based on the above proposed monax model and the proposed models functional requirement, the model design proposes the following contracts.

Table 1 proposed model contracts Source: (Researcher, 2019)

EToken	Contract that creates ETokens that are used in the PoC. The created Etokens are used for gas prices and rental fee.
Interface	Composite contract that manages the RPC and links all other contracts.
Migrations	Migrations are JavaScript files that help to deploy contracts to the Ethereum network. These files are responsible for staging deployment tasks, and they're written under the assumption that the deployment needs will change over time.
TenantInfoDb	A database contract to store information about tenants. The information stored for each tenant is personal information and Addresses. A Tenant-struct is created for each Tenant to contain the corresponding data as well as a next and a prev-attribute so that a doubly-linked list can be used to iterate over them.
Cmc	The contract-managing-contract is simply named Cmc and contains a collection of the different contracts. All other contracts must be connected to the Cmc or inherit from the class CmcEnabled.
CmcEnabled	Base class for contracts that are used in a cmc system
Tenant	Application logic contract for handling requests from Tenants such as retrieving making payment, changing consent-level for a certain house description-Admin tuple etc
Landlord	Application logic contract for handling requests from Landlords. These include adding a new room features, payment or confirming that a certain feature has been posted
InfoManager	Application logic contract with which users interact. It also checks all permissions and provides one point of contact for a user. See Figure 3-4.
ContractProvider	Interface for getting contracts from Cmc.

C. Overview of the system of Smart Contracts for the Real Estate Management PoC

Systems development can generally be thought of as having two major components: Systems analysis and Systems design (Chapman, 2018). System design is the process of planning a new business system or one to replace or complement an existing system (Alles et al, 2018) while System analysis, then, is the process of gathering and interpreting facts, diagnosing problems, and using the information to recommend improvements to the system (Van Aken et al, 2018). This has been done in the previous sections and the overall design and requirements are captured in figure 17. To manage the project through its entire life cycle, from

setting up a structure, to drawing up detailed plans, to executing and completing the project the following overview of the system of smart contracts for the Real Estate Management PoC figure was of help. It describes what the system is and what it does. Although, based on visualization technique by (Brown, 2016) not all smart contracts are included in the PoC for sake of clarity and relevance.

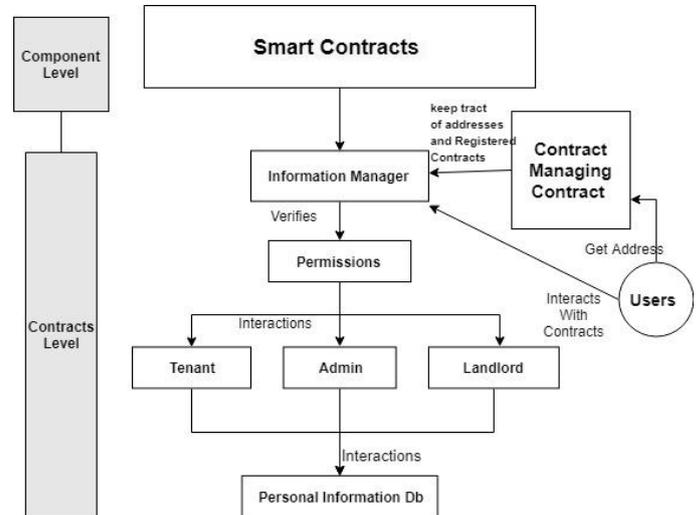


Figure 4 Overview of the system of smart contracts for the EMP PoC Source: (Researcher, 2019)

IV. CONCLUSION

This paper set out with the aim of proposing a blockchain based smart contract model for real estate management. It uses a decentralization principle and encryption involving public and private keys. It works by placing transactions in groups called blocks and linking these blocks through what is called blockchain. From a technical perspective, there are three types of blockchain: public, consortium and private. The basic elements are the blocks where the data is stored, digital signatures to authenticate transactions, a decentralized network for user interaction, and a network consensus to verify the transaction. Perhaps the use of these basic elements may vary depending on which type of blockchain is used. Looking from business point of view, we could group blockchains into two categories: closed for private or consortium blockchains and open for public blockchains. Both types offer different economic advantages and can lead to different market players for example machines who own themselves that exist in an open blockchain.

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