Applying Action Design Science Research to Develop a Conceptual Design for Smart Contracts in Real Estate Transaction Processes

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Abstract

Commercial real estate transactions are notorious for their complexity, which stems from multiple property brokers, legal entities, illiquidity, heterogeneity, and a lack of transparency. This conceptual study proposes a novel approach to address these challenges using blockchain technology, which enables buyers and sellers to transact in an informationally symmetrical way within an open real-estate ecosystem. The proposed conceptual model employs tokenisation on the blockchain and is developed using the Design Science Research Methodology and Action Design Science Research approach. The model undergoes multiple stages of evolution, including pre-design, which is validated through expert interviews, to arrive at the final conceptual design. The study identifies six key factors that influence the application of blockchain in real estate transactions, including adoption, governance and compliance, transaction costs, transparency and immutability, security, and scalability. Overall, the study suggests that blockchain has the global potential to significantly reduce transaction costs and improve efficiency in the real estate industry, making it a promising solution for the challenges facing the sector.

Keywords

Real estate, financial services, financial inclusion, sustainable urbanisation, Blockchain Technology, urban development, Smart Contract

I. INTRODUCTION

The real estate market is one of the main pillars of economic growth and employment on the international scale [1]. However, heterogeneity and immobility create complex value flow and inefficient processes with high cost structures, placing the market under significant pressure [1]. It is also facing a social and technological transformation accompanied by profound and irreversible changes [2].

There are several studies focuses on utilizing the blockchain data structure in various B2B and B2C applications which allows to transform E-Commerce for enterprises [3].

In the frame of the E-Commerce, this study focuses on segment of the commercial real estate where the nature of the business focuses business-to-business (B2B) and business-to-customers (B2C) between the partners. With the uprising scale of the technological advances of the Distributed Ledger Technology (DLT), the role for the frequent contact between the notaries and brokers, by acting in a Peer-to-Peer (P2P) way within one ecosystem, makes a perfect suitable condition to apply the Blockchain technology in the future.

For this reason, the Blockchain technology has a fundamental impact on the design of the current real estate contract and acts as a potential disruptor in an increasingly liquid economy. Those changes are described in the real estate design flaws. The academic literature on real estate transactions identifies several flaws in the current design of this process, leading to six major issues:

1. intermediaries [4] and [5] associated trust weaknesses [6], [7], often leading to an exponential growth of potential errors [8] but removing the need for so called ‘middleman’ stakeholders and potentially redundant processes could bring direct interaction between buyer and seller [9].

2. asymmetric information (Duta, 2020, [10], [7], where the parties involved (i.e. investors, vendors and their supply chains) tend to have very different knowledge about a particular asset, leading to inequality during the contract formation stage [11] particularly during high volume periods, which often causes misinterpretations within contracts [12],

3. speed of transaction [13] and [14] is often low due to aforementioned complexity, intermediaries and asymmetric information,

4. transaction costs for the real estate transactions as mentioned by [15], [16], [17] and [18],

5. market entry barriers [19] from title plants in the USA [20] to lack of transparency [21], as well as institutional and legal barriers in general [22]; [23], real estate markets worldwide are characterised by different entry barriers – including, for example, title insurance approaches in US and Europe being substantially different [24].

6. investment management, non-scalable finance, risk diversification and complex legal set-up for micro-investments [25], creating a complex burden on the investor due to high market barriers to access illiquid real estate investment class product [26].
II. Background

Blockchain technology has recently been identified as a potential disruptor in several industries, allowing notaries and brokers to be within a single ecosystem with impact on property owners, tenants, brokers, notaries and the land registry [27]. As a result, the recent fintech developments have led to “tokenisation”, providing the frictional ownership and significant investment liquidity in a real estate market [4]. The underlying process improvements are translated into the practical semantic models blockchain-enabled Multiple Listing Service (MLS) [4]. The process improvements then impact on transaction workflows [34], faster cash settlements but also auto-execution of Smart Contracts [35], p.7 by enabling Peer-to-Peer digital payments [36], [37]. For example, if conveyancing transactions are made through blockchain-based smart contracts, it would be possible to create a blockchain for EU real estate conveyance [38]. Further, the improvements include blockchain-based decentralized applications for the Commercial properties (DApps) [39]. The strategic use of efficient smart contract structure based on the blockchain consensus protocols have been shown to reduce administrative intermediary burden as mentioned by [40] and also illustrate that the decentralised Blockchain solution would resolve the asymmetric information challenges via the automatic updates of each Peer-to-Peer node within the chain. In accordance with conceptual analysis by [9] and demonstrated by [41] as well as [4] strong changes are reported to occur related to real estate core processes like planning, construction, asset management as well supporting processes such as administration, marketing, operation, tenant’s management, maintenance, facility management which have been mentioned by taxonomy of blockchain consensus [42] and reported in PropTech [43]. While approaches so far have mostly focused on coding and layering of smart contracts, there is a need to better address legal requirements in different jurisdictions (i.e. Know Your Customer (KYC) and Anti Money Laundering (AML) as well as the six real estate transaction design flaws.

III. RESEARCH AIM AND OBJECTIVES

The research aims and objectives are developed in conjunction with the extant literature on blockchain in the real estate context implies that the real estate investment process could be translated into a decentralized store of information [27], leveraging the effect of crowdfunding [26].

The key focus of this study is to provide a conceptual underpinning to transform traditionally inflexible asset allocation into a new liquid asset class. As mentioned by Montgomery [28], the commercial real estate market for B2B and B2C relations can be significantly improved conditions for the major stakeholders in the real estate transaction process (such as land registry, housing authority, appraiser and notary office as B2B and buyers-sellers B2C).

On the basis of the reviewed literature and the identified gaps, in terms of the design flaws and KYC/AML, the following concrete research objectives have been identified:

1. Determine potential weaknesses and the capacity for novel solutions related to traditional Commercial Real estate contracts. Such weaknesses might arise from market risk of platform failure, credit risk of default or liquidity. Those risk allocations is subject to terms of funding, level of stakeholder commitment and complex relationships of public and private partnerships in information and communications technology [29].


3. Conduct a qualitative transcription and coding structure interviews as Venable [32] recommends carrying out a structured interview study. The interview structure has various types of the stakeholders (Buyer, Seller, Notary, Land Registry, Housing Authority) and a fixed duration of the interview (max. 1 hour). The transcription and parameters build the fundament to design and build an appropriate platform to meet the requirements of the modern real estate platform where the novel P2P relation of buyer and seller with various B2B and B2C components are integration into one open eco-system by using the permissionless Ethereum technology.

4. Conduct a quantitative market study based on previous interview results data gathering and compare with the empirical data analysis supported by means of the SPSS The regression analysis is applied to evaluate expected and unexpected returns and how liquidity risk is priced in the cross-section of cryptocurrency returns [33] understanding of markets price cryptocurrencies and project to crypto pricing of the commercial real estate contract.

IV. METHODOLOGICAL APPROACH

This study uses the Design Science Research lens by Gregor/Hevner [30] and applies a pragmatic Action Design Science Research (ADSR) approach by Mullarkey/Hevner [31] to develop ensemble artifact through an iterative process (see Figure 1 and Figure 2). The DSRM includes the DSR guidelines, applied to achieve the research aim of finding a novel solution as a replacement for the traditional process.

Figure 1: Design Science Research methodological lens (DSRM) (Gregor/Hevner, p.80, 2004)

Figure 2: Action Design Science Research Methodology (DSRM) (Mullarkey & Hevner, 2018, p. 7.)
The external validation of the newly designed concept (i.e. pre-design) is conducted through the qualitative content analysis of 20 interviews with experts. The interview responses are analysed by means of a qualitative content analysis technique using NVIVO software [46].

V. ANALYSIS OF THE RESULTS AND DISCUSSION

This section presents the analysis of the results in the Context of ADSRM based on the three research artefacts.

A. Artifact 1a – “As-is” Model: Problem formulation

Traditional commercial real estate process is a highly complex process and has been simply summed up based on [47] with the main components – actors/roles (buyer/seller), business processes and manual intervention steps for each stage (search, due-diligences, inspection, negotiation, payment, contract signature).

B. Artifact 1b – “As-is” Model: Artifact creation

Evidence in the literature shows that current real estate transaction processes are characterised by heterogeneity, creating the challenges of complex value flows (see Figure 3) of information inefficiencies and of corresponding high transaction costs [10].
F. Artifact 2c – Concept Design: Evaluation, Reflection and Learning translated into final concept design

The evaluation looks at both, existing models identified in the context of the literature review and the proposed new concept. To develop a concept design (Artifact 2b) and therefore move beyond the unvalidated pre-design (Artifact 2a), a qualitative analysis of 20 structured interviews with real estate and blockchain professionals in Middle-East, Europe and the USA is utilised. The questions, derived from extant literature, relate to the viability of blockchain application in the real estate market (see Table 2)

Table 2: Questionnaire for the semi-structured interviews (questions derived from the Research on blockchain financial derivatives cluster [48]):

<table>
<thead>
<tr>
<th>#</th>
<th>Questions</th>
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<tbody>
<tr>
<td>1</td>
<td>How is your interaction with block-chain and what projects have you worked on with regards too blockchain/smart contracts?</td>
</tr>
<tr>
<td>2</td>
<td>Is Smart Contracts a feasible substitute to the legacy system which includes paperwork, bank transfer and series of interest rates and commissions?</td>
</tr>
<tr>
<td>3</td>
<td>If Smart contracts is a feasible option and negates heavy fee structure, why do we still rely on the legacy system? What are the roadblocks?</td>
</tr>
<tr>
<td>4</td>
<td>Will Smart Contracts be customizable for real estate contracts?</td>
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<tr>
<td>5</td>
<td>Conflict resolution responsibilities generally fall on the broker or the legal court (after transaction). Will Lawyers be equipped to handle disputes once its implemented through smart contracts? Or will a part of legality still not be under the control of smart contracts?</td>
</tr>
<tr>
<td>6</td>
<td>Scalability has always been an issue with block-chain. Do you think Smart Contracts will face scalability issues if Real estate incorporates this?</td>
</tr>
<tr>
<td>7</td>
<td>What would be the challenges of having an end to end seamless blockchain based escrow with respect to real estate finance?</td>
</tr>
<tr>
<td>8</td>
<td>What will be the legal issues while implementing smart contracts? As real estate is heavily regulated and smart contracts will have less regulation.</td>
</tr>
<tr>
<td>9</td>
<td>Smart Contracts will replace the agent in the agent-centric transactions as the agent will no more be the middle of this ecosystem. How will this affect brokerage. (Pros/Cons)</td>
</tr>
<tr>
<td>10</td>
<td>Though transparency increases with Smart Contracts about the lenders payment history etc., will it be trustworthy as it heavily relies on Programmed code and a bug could potentially be disastrous?</td>
</tr>
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</table>

The interviews have identified the following key categories of factors to influence the application of blockchain in real estate transactions (see Table 3):

1. **Adoption**: ability to distribute efficiently an asset to multiple parties through multiple transactions.
2. **Governance and Compliance**: Smart Contracts enforce the contractual conditions digitally with no middlemen.
3. **Transaction Costs**: significant cost savings are anticipated because Smart Contract self-executes the transaction with the terms of the agreement between buyer and seller who are directly Peer-to-Peer connected to all the Peer-to-Peer nodes on the decentralized blockchain network.
4. **Transparency and Immutability**: Smart contracts are viewed by interviewees as a solution to address asymmetric information through automation that underpins the symmetry in the consensus between parties in the process.
5. **Security**: algorithm-based security is built-in within the ERC 777 Smart Contract.

(6) Skills and Learning: any blockchain-based solution could have resistance to change but due to automation, the experts believe there will be a reduced need for human tasks.

Table 3. Qualitative content analysis mapped against “Diagnosis” phase factors from the literature review.
To address the challenges associated with the above categories from the qualitative content analysis, the final concept design includes the 3-layer smart contract structure (Actors & Roles, Business Process, Databases) (see Figure 5).

Figure 5: Design of the Conceptual Model (verified factors) – old design vs. new design.

The extant literature is clear that simplified Smart Contract without intermediaries allows the realisation of simplified administrative processes compared to existing term-securitisation schemes. In this context, the research by [34] addressing process steps model [41] that focuses on Smart Contract office building; and tokenization concepts [49] on Real estate tokens represent the basis for the this study (i.e. development of Artifact 2a,b). In this regard, the practical approach of Multi-Layer architecture by [27] informed the conceptual model that is presented as a three layers model (Actors & Roles, Business Processes and Databases). The conceptual model includes three main actor categories (i.e. Real estate Owners, Buyers, Investors), on business process (Framework) and two databases (Property Info, KYC/AML). Looking at the above-mentioned process models, one aspect that seems to be surprisingly often overlooked is the combination of business concept, implementation and practical applicability of the blockchain technology in the real estate industry. The KYC/AML in a tokenised real estate needs to be part of the business process layer to improve collaborative business process management (BPM) [37] (included). It is necessary to ensure that KYC- and AML-procedures and operations remain feasible and controllable through the business registration process performed in detail only for the initial investments. Once traded on the secondary market and the regulatory burden in terms of financial and KYC/AML obligations is reduced, the token can be traded through the automatic KYC/AML decision matrix [50] and explained on the practical case of Dopo Di not project [5].

G. Artifact 3 – Proof of Concept (Prototype implementation)

Based on collected feedback from the structured expert interviews provided by the NVIVO tool, the future research will build the prototype based on the conceptual model for the Smart Contract “ACCAS Shopping Mall” where the organisation, stakeholders, relations, transactions, scenarios are defined. The Prototype requires the development on the open-source protocol (Ethereum Contract protocol (ERC 820/777) which is widely recommended by the worldwide Github community The Smart Contract on the ERC 820/777 will be demonstrated based on the development framework - called “Truffle Framework”. The “Truffle framework” allows to compile, deploy Smart Contracts from the command line and launch the tests on a local blockchain machine by using simple Visual Basic Studio and Solidity as a programming language (Solidity version 0.4.19), Ethereum Client Version (geth 1.7.3) and Remix Online Version Remix IDE Online (Version 0.1.3).

Initial assessment has identified the implementation roadmap for the contract development a) develop and program Smart Contract on Solidity as a programming language and use text editor Visual Basic Studio for coding activities and b) globally test the results by taking the “Truffle Framework” as recommended by the Github community – preliminary Ganache to run local Ethereum Blockchains and Truffle to compile and deploy smart contracts from the command line and launch Truffle tests on the global blockchain.

Once the implementation phase is successfully achieved, the user experience tests need to be performed, manage an Ethereum account with Java and Web3j Angular for the User interface. By using the Web3j, it is possible to retrieve the balance of an account at a given block using the function.

VI. LIMITATIONS

The application of the blockchain technology has also certain limitations. On one hand, the cost that should be taken into account is the cost of transactions relative to the complexity of mining increasing over time as more transactions are being processed and the probability for a transaction to be processed quickly increases with the fee level [51] The fear is that, under the current Ethereum blockchain, the difficulty of processing a transaction could result in significantly higher blockchain transaction costs and smart contract deployment would actually represent a significant proportion of a real estate transaction cost. This poses the threat of scalability of such solutions in the future.

On the other hand, the tokenization concept does not provide ownership rights as the blockchain-based transactions enable a user to only usage of the rights instead of a transparent and a clear concept of the ownership rights [49]. The Blockchain technology is also purely algorithmic and does not imply the social aspects such as cultural background for land registration (e.g. land registration of high-conflict areas). Hence the implementation of the proposed model could end up being much more complex under real-life circumstances such as land registry, housing authority, appraiser and notary office and further difficulties faced by the legal systems [52] and legal burdens associated with EU legal aspects [53] (included).
Furthermore, additional future research needs to be conducted to resolve the immaturity of the technology, a lack of standardization and limited examples of successful application in the practical world of Real estate show a clear limitation of the concept. The scalable implementation would only be possible if the information throughout the process is standardised and harmonised across multiple jurisdictions. Once the data harmonisation has been achieved, the record-keeping application could be linked to external databases through the application programming interface (API) for the purpose of automatically data validation. Furthermore and in relation to the proposed concept, the instant verification without the revealing authority could be resolved by applying the “Zero-knowledge” Zk Snark Technology (i.e. “Zero-Knowledge Succinct Non-Interactive Argument of Knowledge”), and refers to a proof construction where one can prove possession of certain information, e.g. a secret key, without revealing that information, and without any interaction between the prover and verifier [54].

VII. CONCLUSIONS AND RECOMMENDATIONS

The study investigated the current complexities of traditional commercial real estate processes and the challenges they create in terms of information inefficiencies and high transaction costs. The study proposes a globally novel conceptual model based on blockchain technology to address the drawbacks of the traditional model. The pre-design of the conceptual model proposes tokenisation on the blockchain, while the final conceptual design was developed through qualitative analysis of structured interviews with real estate and blockchain professionals. The interviews identified six key factors that influence the application of blockchain in real estate transactions, including adoption, governance and compliance, transaction costs, transparency and immutability, security, and scalability. Overall, the study suggests that blockchain has the global potential to significantly reduce transaction costs and improve efficiency in the real estate industry.

The recommendation goes into the direction of the tokenization. In our study, it is a cryptocurrency token that allows token holders to utilize a blockchain-based product or service (e.g. Ethereum GAS). Thus, every Ethereum transaction, made on the Public Ethereum ledger, would result in a fee paid in the form of GAS. The GAS can vary although very slightly in ETH terms, vastly in FIAT terms. The amount of orders being treated simultaneously and the rate at which the ETH converts to any FIAT would pose a threat to the proposed system that, itself, bets on long term stable rates. An increase in the amount of transactions of the blockchain would in turn increase the race to get the transaction cleared earlier and raise the GAS fee that systems would be ready to pay.

However, the future research depends on the regulation which puts additional burden for the technical side. The regulation of the token character is subject to the policy and lawmakers how to classify the utility token (in our study it is the ERC20 and migration to the Smart Contract Token ERC777 protocol). In case, the investment product is classified as a collateral, the contract would bear a note without equity or other assets backed security pledged for that particular investment note. Moreover, the asset-backed security foresees the compliance requirements for the secondary market entry and the legal character of the swap-based token for the stakeholders and finally clarify the tax implications for all entities and stakeholders of that related investment note product.

REFERENCES
