VILNIUS TECH
Vilnius Gediminas Technical University

Business, Management and Economics Engineering
ISSN: 2669-2481 / eISSN: 2669-249X
2024 Volume 22 Issue 01

PHYGITAL REAL ESTATE: EXPLORING THE FUSION OF BLOCKCHAIN, NFTS, AND GIS IN COMMERCIAL REAL ESTATES

Rajesh Soundararajan
B.E., M.B.A.
College of Management, SRM Institute of Science & Technology, Kattankulathur
ORCID: https://orcid.org/0000-0001-8806-3265
https://www.linkedin.com/in/rajessh/

Dr. V. M. Shenbagaraman
B.Sc., A.M.I.E., M.B.A., Ph.D., M.Tech.
Professor of Systems,
College of Management, SRM Institute of Science & Technology, Kattankulathur
ORCID: https://orcid.org/0000-0001-8806-3265

Abstract — Digital technologies such as Blockchain, Non-Fungible Tokens (NFTs), and Geographic Information Systems (GIS) are generating previously unheard-of prospects. Commercial real estate is one sector which can benefit vastly because of this digital wave. This paper examines the idea of "phygitalization," a term used to describe the merging of the digital and physical domains, in commercial real estate. We explore how Blockchain provides a transparent and safe environment for real estate transactions and how NFTs bring distinct, verifiable ownership structures. Simultaneously, GIS offers improved spatial analysis and visualisation capabilities, which support better informed decision-making. The paper offers a fresh framework for modernising commercial real estate, addressing issues with conventional methods, and clearing the path for a more effective, safe, and transparent market through a thorough analysis of these technologies. The suggested integration streamlines operations and also opens new avenues for value creation and investment in the real estate sector.

Key Words : Phygitalization, Blockchain, Real Estate, NFT, GIS

Introduction

Land Real Estate is a type of Commercial Real Estate(CRE). Land typically refers to undeveloped property and vacant land. It is always viewed as one of the best investment opportunities by investors and it is needless to say that it is an industry worth hundreds of trillions of dollars. Yet, in many countries, CRE are known to operate in secrecy to have possible competitive advantages. It should also be noted that operating in secrecy provides this industry an opportunity to commit fraudulent activities including money laundering and falsification of documents in some countries. This industry has many actors and stakeholders and does require huge paperwork which provides an opportunity for scams and malicious activities. To combat some of the issues which plague CRE and to fasttrack the process, they have embraced digitization. However, a significant portion of these systems are hosted on disparate systems which lack transparency and have high degrees of inaccuracies which still result in fraudulent activities.

Blockchain is an immutable distributed ledger which can be used to store and share data. This has the potential to help CRE to address the inaccuracies and inefficiencies. Non-fungible tokens(NFTs), are blockchain-based tokens that represent a unique asset like a piece of art, document, digital content, or media. An NFT can be viewed as an irrevocable digital certificate of ownership and authenticity for a given asset.

Geographical Information System(GIS) is a scientific system that provides and reports analytical information on geographical data. It is generally used wherever there is a need for mapping.

In this paper we will dive deep into blockchain technology along with NFTs and see how we can combine it with GIS systems to combat the aforementioned challenges faced by the land real estate industries.

Research Methodology

The primary data for this research was collected through a series of structured interviews with real estate professionals, blockchain developers, and GIS experts. These interviews were designed to gain insights into the practical challenges and potential benefits of integrating these technologies in commercial real estate. Additionally, we conducted an extensive review of secondary sources, including academic journals, industry reports, and case studies, focusing on recent advancements and implementations of Blockchain, NFTs, and GIS in various sectors.

In our study, each technology was scrutinised for specific features relevant to commercial real estate. For Blockchain, we focused on security, transparency, and transaction efficiency. NFTs were examined for their uniqueness, ownership representation, and asset tokenization potential. GIS was analysed for its spatial data management, visualisation capabilities, and to represent properties and features of a physical asset.

All primary data collection adhered to ethical research standards, ensuring the confidentiality and anonymity of interview participants.

Blockchain Technology

In simplest terms, blockchain is a cryptographically verifiable immutable distributed ledger which can be used to store transactions. Because of these characteristics, blockchains are an ideal solution to store transactions securely between multiple parties who don't have to trust each other priorly. All transactions in blockchain are time stamped and cryptographically signed. So it is practically impossible to hack the transactions in the blockchain. On a broader scale, blockchains are of two types namely

- Public Blockchain
- Private Blockchain

Public blockchains can be viewed as true open decentralised networks that allow anyone to participate without any prior permission. This blockchain does not have any single entity which controls or administers the network. It is completely self regulating. These blockchains allow

anyone to join the network and read, write, or participate within the blockchain. Data on a public blockchain is immutable so there is no compromise on security. These blockchains have the below characteristics

- High Security
- Open Environment
- Anonymous Nature
- No Regulations
- Full Transparency
- True Decentralisation
- Full User Empowerment
- Immutable Distributed

In contrast to a public blockchain, private blockchains have a centralised network that is controlled by a central authority or nodes. This central administrator role is played by a trusted authority like a consortium or any government agency. Usually In this type of blockchain only entities participating in the transaction have knowledge about the transaction performed whereas others will not be able to access it. This in a way guarantees privacy. These blockchain have the below advantages

- Full Privacy
- More Regulated.
- High Efficiency and Faster Transactions
- Better Scalability

Non Fungible Tokens(NFT)

Non Fungible Tokens are digital assets similar to cryptocurrencies except for the fact that they cannot be exchanged or swapped with another asset. NFTs are stored on blockchain to prove ownership. Anything which is inherently rare, scarce or which is backed by a royalty are good candidates for NFTs. In the initial days, NFTs were confined to digital assets like digital arts and music but a new class of NFTs are emerging known as Tangible NFTs(TNFT) or Physical NFTs or Phygital NFTs. This new class of NFTs are backed by a physical object which these tokens represent. Some of the advantages of the physical NFTs are

- The ownership of the asset can be easily verified beyond doubts
- It is easy to perform and automate transactions

Smart Contracts

As per internet, “A smart contract is self-executing code that carries out a set of instructions, which are then verified on the blockchain.” These can be used to carry out a business workflow when some business event occurs. The main characteristics of smart contracts are that they are trustless, autonomous, decentralised, transparent and are usually irreversible and unmodifiable once enabled. Smart contracts reduce the need for intermediaries and contract enforcement is done seamlessly. An example of a smart contract in the real estate industry could be like triggering a release of funds to the intermediaries or to government agencies (in the form of property transfer tax) if the purchase is completed successfully. As smart contracts operate in an autonomous fashion, it is practically impossible to corrupt the system or carry out any

fraudulent transactions there by keeping the system clean and secure. Smart contracts have also paved the way for what is known as Decentralised finance (DeFi) dApps. These operate parallel to the banking services like lending, borrowing, trading and also offer a variety of other services without any intermediaries thereby reducing the transaction and services cost

Geographical Information System

GIS is an intricate system of computer and satellites that stores, analyses, and visualises data for geographic positions on earth's surface. It can examine spatial relationships, patterns, and trends in geography. Even though it was created in the early 1960s, it continued to evolve over time and the recent systems can provide the accurate terrain of a land on a particular location on earth. GIS is a time tested and perfected technology which is used for scientific investigations, resource management, and development planning. Some of the government agencies use it to map the portions of the land and are available to the public at free of cost. There are other commercially available softwares which uses GIS to map regions more precisely and with additional information like the owner of the land, estimated prices and other such details which are of interest to land real estate industries.

Traditional Land Real Estate WorkFlow

Below is the simplified version of the steps involved in a real estate purchase. Some of the steps may involve additional activities depending on the country and the local law of the land.

1. Once someone has opted to invest a land real estate, he/she scouts for property on a Multiple Listing Service (MLS) directly or through a realtor
2. Upon finding a suitable property, a site visit is undertaken to have a feel for the neighbourhood and the terrain of the land.
3. If the property is found to be suitable after the site visit, documents related to the property are verified. Verification might involve validating the boundaries of the property, checking for any ongoing litigations, validating the ownership, and so forth.
4. After Successful verification, negotiations happen and the deal is finalised with a letter of intent.
5. Paper works follow. Paper works usually involve creating an agreement with the terms and conditions agreed upon.
6. Prepared document is signed by the parties and registered with the appropriate government agencies to imply the transfer of ownership
7. Payments are disbursed to the stakeholders in the form of tax, commission and sale price.

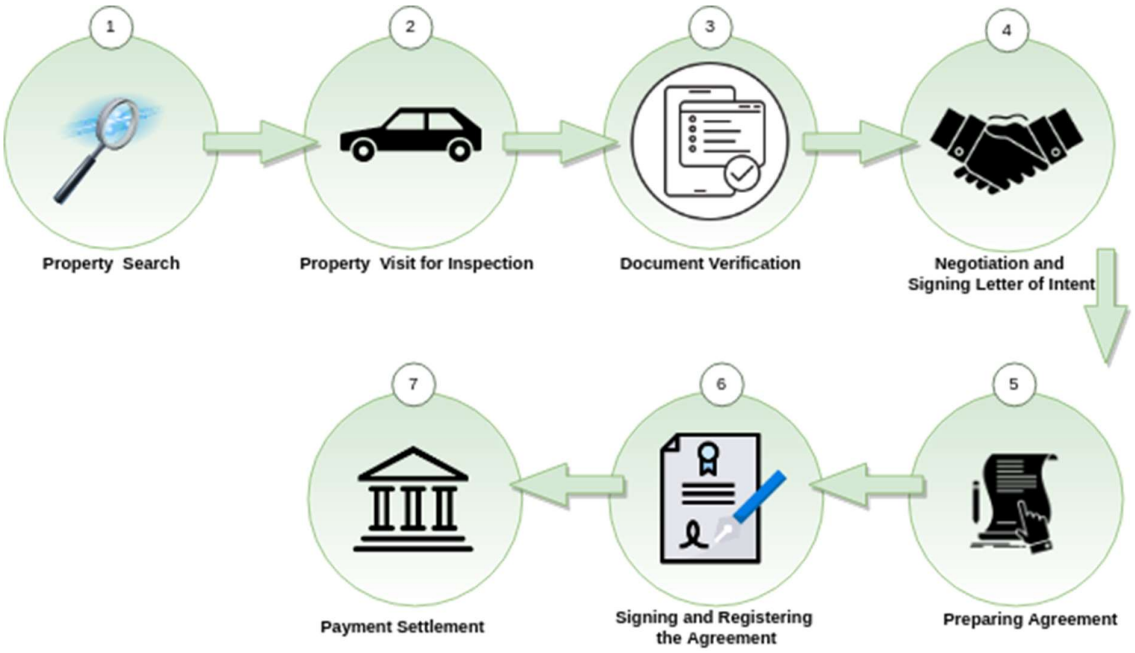

Fig 1. Traditional Land Real Estate WorkFlow

The complete process may take several weeks or even months. Most of the time will be spent on the property search, verifying the existing documents, preparing new documents or in securing the funds needed for the payment. This process is inefficient as it consumes a lot of time. The cost of the deal not happening is very high if any stakeholder backs out in any step.

Proposed Solution Using Physical NFT and GIS Systems for Land Real Estate

The proposed solution combines the advantages of Blockchain, Physical NFTs and GIS to mitigate the issues in Land Real Estate. GIS system backed data can be used to create physical NFTs which can be stored on the blockchain. Smart contracts can be used to automate the entire process to avoid any errors. It can also cross verify transactions to curtail fraudulent activities and notify the stakeholders appropriately. Marketplace is a digital place where the buyer and seller interact. Fig 2 shows the steps involved in the creation of a marketplace

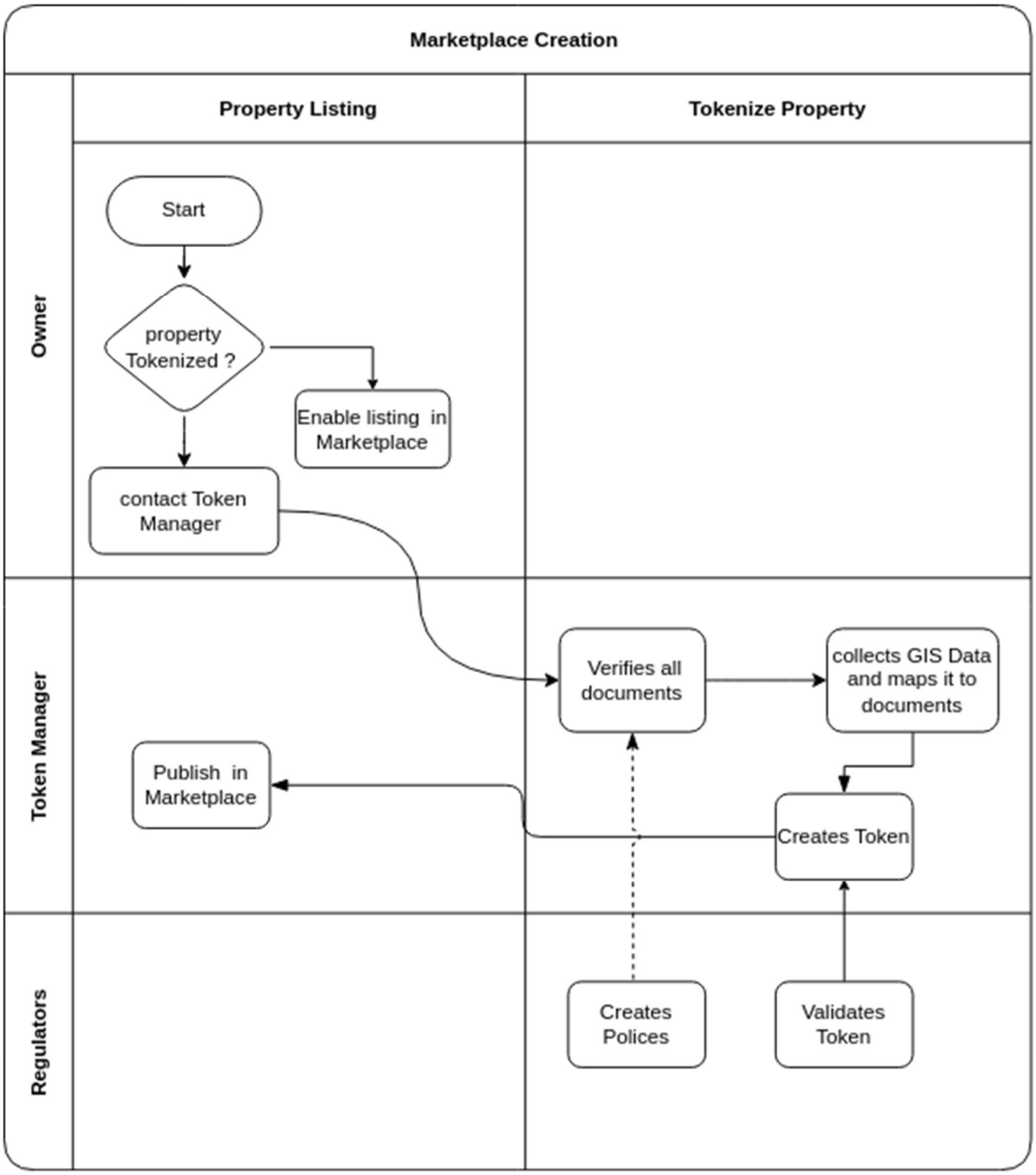

Fig. 2 Creation of Marketplace

Stakeholder of the Marketplace

The stakeholders of this marketplace place can be any one listed below. Apart from the usual buyer and seller, there could be other parties who have vested interest in the marketplace to keep it safe and clean. Below are the roles stakeholders identified. These roles can be played by single or multiple parties depending on the nature of the transaction

1. Owners - These are the class of users who own the current token. These classes of users don't have any modification or update privileges of the token in the marketplace but they will have the privilege to approve any transactions happening on the tokens they own. Unless otherwise they approve, transactions on their tokens cannot be completed.

2. Buyers - This group consists of users who wish to buy the tokens from its current owners. They also don't have privileges to modify the tokens. They just have permission to initiate transactions on tokens which are available to be bought. Initiating a transaction will automatically transfer funds from the buyer's account to the owner/s account. It will also apply transfer of funds to other third parties involved in the transaction. Transfer of ownership and other liabilities associated with the token will be updated accordingly. The transaction will be completed if and only if the current owner of the token approves it.
3. Third parties - These are institutions or individuals who have vested interest in the transactions. These could be banks which fund the transaction or insurance agencies which provide insurance or perhaps any individuals or organisations which provide additional support(realtor etc).
4. Regulators - Regulators are the governing body. They ensure the relevant laws and rights pertaining to the users are protected. They are responsible for creating necessary policies, taxations and laws to protect this marketplace. They also validate the transactions on the blockchain.
5. Token Managers - They are responsible for creating tokens and ensuring that the tokens have the most recent information about the physical asset backing the token.

Creation of Physical NFT Marketplace

Marketplace has to be populated with the digital asset in the form of a token which maps to the existing physical asset. For this, we will combine the data from the GIS systems and map it to the land parcel along with all existing documents. The documents may include but not limited to the below items

1. Proof of ownership (Deed or title)
2. Property tax receipt
3. Insurance Documents
4. Lease agreements
5. Hypothecation/Loan documents

These documents may vary depending on the law of the land. Combining the GIS data with the existing paper documents acts as a cross verification mechanism and leaves room for no repudiation. This saves a ton of time for the buyers and any financial institutions funding the transaction. Tokens thus created are stored on a blockchain which is managed by any government agency or regulating authority and is accessible to the general public. Anyone interested can use this marketplace to search and buy the property they are interested in

Transaction Processing

Below is the most probable sequence in which the transaction may happen in the real estate industry using blockchain. There can be different alternate flows depending upon different use cases but they can be modelled using the flow explained below

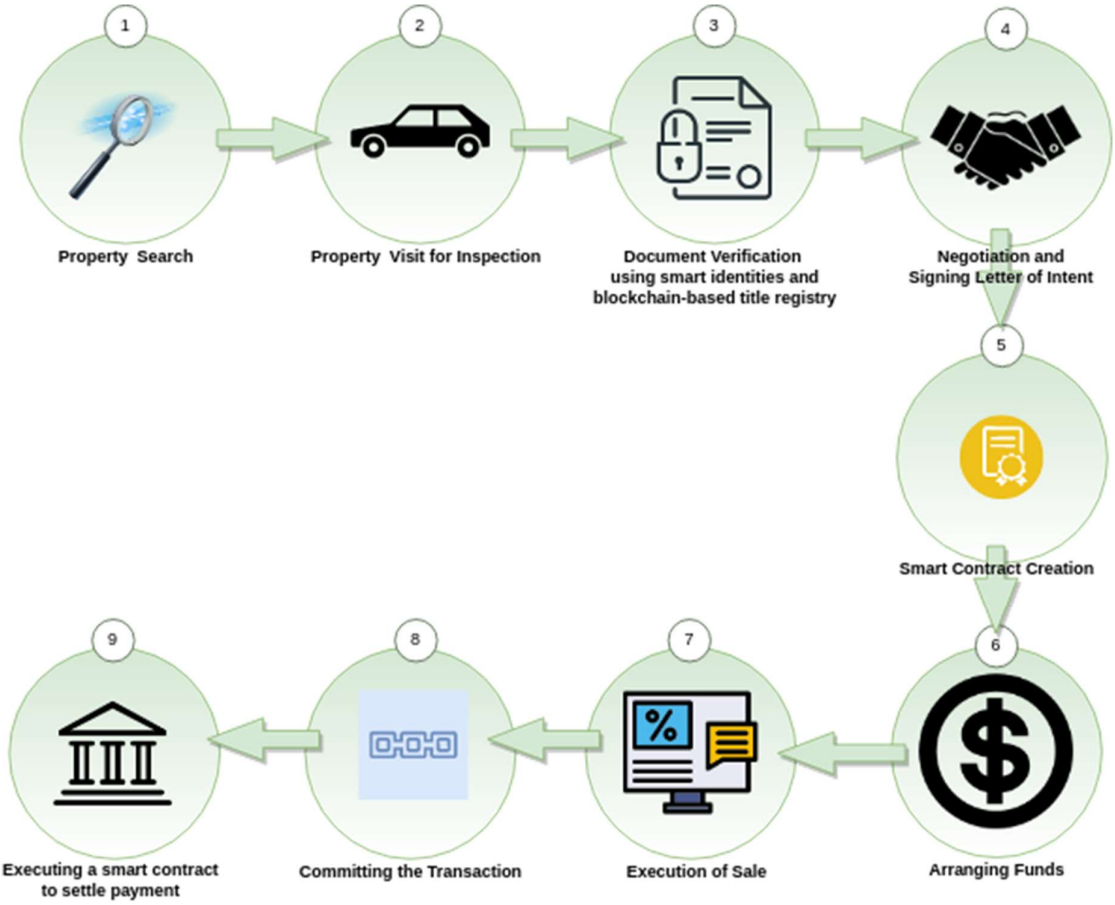

Fig 4. New Flow in CRE

Property Search

This can be done on the marketplace through any buyer facing system. Blockchain backs this marketplace as an intelligent datastore. This marketplace can be frontended by multiple systems. This allows individual realtors to develop systems with their custom intelligence to please and attract potential buyers. Buyers search this marketplace either by themselves or using any realtors service. Buyers elucidate their preferences and this system lists the properties available for sales matching the criterias of the buyer.

Property Visit for Inspection

The property listed in the MLS system can be virtually toured, if the frontend system the buyer uses has this option. The buyer can also conduct a physical visit. This is to give a feel of the property, neighbourhood and to compare it with other properties. This also serves as an option for the brokers to elicit his opinion.

Document Verification

The existing digital documents are verified for financial models of rents, mortgages and so on. The environmental clearance and other such approvals are also verified depending on the buyers interest in the property. This is an automated process and can be carried out online through a click of a button.

Negotiation and Signing Letter of Intent

Buyer and the Owner of the property negotiate on the price, duration of the payment and other such terms and conditions. The final accepted terms are documented in the letter of intent / memorandum of understanding and it is digitally signed and stored on the blockchain. This serves as a basis for the smart contract

Smart Contract Creation

The smart contracts are created based on the letter of intent / memorandum of understanding. The buyer's source of funds may need to be included in the smart contract depending on the law of the land. If the funds are arranged through any third parties, they may also be needed to be included in the smart contract.

Arranging Funds

This is an optional step. This is needed if the buyer opts to go for a loan or if the fund is provided by any third parties. As everything is digital, it will be easy for the third parties to verify the documents and provide the necessary funds depending on the buyer's financial health. This is one of the advantages of using blockchain. The complete process of securing funds is cut by many days.

Execution of Sale

This is where the actual sale happens after the due diligence and preparatory works are done successfully. The buyer initiates the transaction which the Owner has to approve to signal his commitment to the transaction. Upon owner's approval, the smart contract kicks-in and the transaction is executed successfully. This will create a transaction waiting to be committed in the blockchain

Committing the Transaction

This is something which happens behind the scenes. The transaction created in the previous step is committed to the blockchain along with other transactions which are supposed to be committed in the newly created block. This involves the approvers/validators of the block approving the transaction and it propagates throughout the network

Payment Settlement

This is done through the smart contract. Once the transaction is successfully committed to the blockchain, the smart contract triggers the release of the payment from the financial institutions to the owner's account. This also involves payment settlement to any third parties involved in the transaction. Illegal activities such as money laundering will be avoided as the transaction is irreputable. Tax payment and other charges to be paid can also be included into the smart contract to disburse funds swiftly to the parties involved.

Merits of proposed Solution

Based on the proposed solution, below are some of the advantages and challenges which were addressed.

Efficient Property Search

Challenge: Property brokers, owners, tenants, buyers and sellers often use Multiple Listing Service(MLS) or use their contacts to scout for properties of their interest. This is often time consuming. Some of the systems are proprietary and their service charges are often quite high to avail their service. Even in these systems the data are not accurate because of the fact that the data used by these systems are disbursed and there is no proper established protocol for information sharing across the systems.

Opportunity: Blockchain combined with GIS based systems can act as a single source of truth. This can provide an accurate view of the parcel of the land in near real time and help buyers in understanding the terrain of the property better. Property search can be performed in a efficient manner without room for any data falsification either intentionally or unintentionally

Faster Due-Diligence and Financial Evaluation

Challenge: One of the steps where more time is spent in property transactions is verification of the existing documents. Documents relating to a property could be ages old and it could be soiled or damaged. Also the documents could be issued by various governmental agencies and to verify or recreate damaged documents could take months if not years. The verification itself is a cumbersome process and it involves a big manual effort.

Opportunity: Storing the documents on a distributed immutable ledger like blockchain eliminates the chances of losing or damaging a document. The key areas of the document could be summarised in a more presentable and easy to understand format by the frontending system. This will certainly reduce the due-diligence time. In case if the transaction is funded by any third party like a financial institution, sharing of documents to them can be done at a click of a button. Also as the property's financial profile is readily available, it will be helpful for the decision makers (buyer and financing organisation) to make an informed decision

Cheaper property title management

Challenge: Legacy record keeping system and recent paper based documents always are prone to issues. Researches have shown that almost in all property transactions, there is some kind of mismatch in the property title. Because of this buyers have to employ third parties to verify the document or take insurance to mitigate the risk.

Opportunity: Storing data in blockchain and surveying the land using a GPS system, leaves room for no error. This system also has the potential to avoid any unnecessary intermediaries like insurance firms thereby saving costs to the buyer. Once the documents are digitised and stored on blockchain, the need for employing third parties to verify documents are eliminated and even if employed, their services can be completed in the least possible time as the documents are available in a single place. Because of this the time frame for the entire transaction will be reduced which will also help in reducing the total transaction cost.

Prevent Fraudulent Transaction

Challenge: As there is a huge manual effort in the transaction process, there is always a chance for fraudulent transactions by falsifying documents or marking property boundaries wrongly. The opportunity to find this fraudulent transaction may take ages before which the property may be resold multiple times. This may lead to legal complications for the very recent owner.

Opportunity: Using GIS to survey land parcels can provide the exact boundaries of the land. Storing this information in blockchain provides an irrefutable claim over the land. Even if anyone tries to falsify, the smart contract in the system will not allow the transaction to happen and will notify the concerned authorities and the owner.

Money Laundering

Challenge: Not all governmental agencies in all countries are interconnected. So the transaction happening on one system is not communicated to the other systems. This gives an opportunity for under quoting the price of the property to evade tax or over quoting the price to launder the money.

Opportunity: Blockchain creates a common ecosystem for all systems to operate and exchange data with one another. With this ecosystem it is possible to automate the process of notification of any transition to all concerned authorities/systems using smart contracts. This provides the opportunity for concerned authorities to weed out malicious transactions and stop them happening in real time.

Conclusions

Many industries have embraced technologies and have grown faster than they would have normally done. Some sectors like real estate happen to be slow adopters of technologies because of the implied limitations in that sector. This has given room for various malpractices across the industry. Blockchain technology has potential to fix many of the issues plaguing real estate. It is the right time for the real estate sector to join the technology revolution brought about by blockchain. This will definitely make real estate an affordable choice for investment for all income grades and help the industry grow. Also it should be noted that blockchain is evolving at a rapid pace, so the proposed solution should be course corrected as technology evolves so that the adopters of blockchain us not left behind.

REFERENCES

1. Adam, M. F., & Fazekas, I. (2021, September 15). Are emerging technologies helping win the fight against corruption? A review of the state of evidence. Information and Economics Policy. Advance online publication. https://doi.org/10.1016/j.infoecopol.2021.100950
2. Ahmad, M. A., Alqarni, A. A., Almazroi, A. L., & Alam, L. (2021). Real estate management via a decentralized blockchain platform. Computers, Materials & Continua, 66(2), 1813-1822. https://doi.org/10.32604/cmc.2020.011925
3. Akhmetbek, Y., & Špaček, D. (2021). Opportunities and barriers of using blockchain in public administration: The case of real estate registration in Kazakhstan. NISPAcee Journal of Public Administration and Policy, 14(2), 41-64.
4. Alketbi, A., Nasir, Q., & Abu Talib, M. (2020). Novel blockchain reference model for government services: Dubai government case study. International Journal of Systems Assurance Engineering and Management, 11(6), 1170-1191. https://doi.org/10.1007/s13198-019-00945-w

5. Allessie, D., Sobolewski, M., Vaccari, L., Pignatelli, F., European Commission, Joint Research Centre. (2019). Blockchain for digital government: An assessment of pioneering implementations in public services. Luxembourg: Publications Office of the European Union.
6. Balaji, L., & Muthukannan, M. (2021). European Journal of Remote Sensing; Cagiari, Vol. 54, Iss. sup2, (Mar 2021): 167-175.
7. Bennett, R. M., Pickering, M., & Kara, A. K. (2021). Hybrid approaches for smart contracts in land administration: Lessons from three blockchain proofs-of-concept. Land, 10(2), 220. https://doi.org/10.3390/land10020220
8. Benbunan-Fich, R., & Castellanos, A. (2018). Digitalization of land records: From paper to blockchain. In San Francisco (p. 10).
9. Bouraga, S. (2021). On the Popularity of Non-Fungible Tokens: Preliminary Results. Conference on Blockchain Research & Applications for Innovative Networks and Services, 49-50.
10. Chirtoaca, D., Ellul, J., & Azzopardi, G. (2020). A Framework for Creating Deployable Smart Contracts for Non-fungible Tokens on the Ethereum Blockchain. IEEE International Conference on Decentralised Applications and Infrastructures, 100-105.
11. Dinesh Kumar, R., & Manaswini, V. N. S. (2021). Chapter 6 - Applications of blockchain in smart cities: Detecting fake documents from land records using blockchain technology. In S. Krishnan, V. E. Balas, E. G. Julie, Y. H. Robinson, & R. Kumar (Eds.), Blockchain for Smart Cities (pp. 105-117). Elsevier.
12. Karandikar, N., Chakravorty, A., & Rong, C. (2021). Blockchain Based Transaction System with Fungible and Non-Fungible Tokens for a Community-Based Energy Infrastructure. Sensors, 21(3822).
13. Saginor, J., Simons, R., & Throupe, R. (2011). A meta-analysis of the effect of environmental contamination on non-residential real estate values. Journal of Property Investment and Finance, 29(4), 460–478.
14. Singh, J., & Singh, P. (2021). Distributed Ownership Model for Non-Fungible Tokens. Smart and Sustainable Intelligent Systems, 22, 309-321.
15. Shtan, M. V. (2016). Application of GIS methods in the framework of a comparative approach to real estate valuation. Property Relations in the Russian Federation, 11(182), 41–46.
16. Springer, T. M., & Ambrose, B. W. (1993). Spatial Variation of Nonmetropolitan Industrial Location. Journal of Real Estate Finance and Economics, 7(1), 17–27.