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With this thought, we hereby present to you

REGULATING SMART CONTRACTS FOR REAL ESTATE TRANSACTIONS: LEGAL AND CYBERSECURITY IMPLICATIONS

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(Delhi Bar Enrolled 2025)

ABSTRACT

Smart contracts run on blockchain and can be considered as self-executing agreements that may or may not eliminate intermediaries. Smart contracts in real estate can automate the process of selling, transferring, and even escrow services, but the challenge that most cases face is the current ambiguous legal status of smart contracts.

The Information Technology Act, 2000, however, provides a legal framework for digital transactions but does not tackle complexities pertaining to smart contracts in real estate. These issues mainly involve their legality and general adaptation in comparison with regular property laws and the applicable mechanisms for conflict resolution. Based on the identified gaps, this paper examines India's legal framework and its potential amendments to incorporate smart contracts into real estate.

The paper discusses cybersecurity risks specific to smart contracts, including code vulnerabilities and hacking threats. It also comes up with measures like encryption and vulnerability assessments for ensuring transaction integrity. Finally, recommendations are made on updating laws and adopting global best practices to enhance security and support the integration of smart contracts into India's real estate market.

Keywords: Smart Contracts, Real Estate Transactions, Block Technology, Cybersecurity, Legal Framework, Digital Agreements, Information Technology Act 2000.

INTRODUCTION

Decentralized contracts "Smart contracts" are agreements written in program code which will reside on a blockchain. In the far future, proponents of smart contracts envision a world in which all transactions can only be conducted through smart contracts, evading the exorbitant cost of writing, opportunistic behaviour, judicial interference, and inherent ambiguities of the written word.

The decentralized code-only contracts are nothing less than the decade long effort to identify purported inefficiencies in conventional written agreements. A contracting Technology named Electronic Data Interchange (EDI), was designed to with the same objective and gained similar hype. The observers imagined a revolution in business transaction and a total shift from anything resembling a paper contract. However, EDI failed to achieve the objectives because it enabled human decision-makers and their "inefficient" way to international agreements rather than avoiding them. In this process, EDI managed to hold effective kinds of contractual flexibility while successfully reducing some of the transaction costs. It is true that the smart contracts have more technological advancements over EDI.

Smart contract scripting languages are more scalable and better support a wider range of processes. While EDI exchanges occurred in very early digital environments using human intermediates, smart contracts could interact much more easily with the operational and financial systems at the heart of today's businesses. Thus, supporters of the smart contract revolution believe that the technology can entirely avoid all stages of agreement formulation and performance and not merely improve activity. That is not beyond technical truth.

In the recent decade, these has been interested in applications Blockchain and the concepts of bitcoin.[1]Blockchain was first proposed in 2008 by someone using the pseudonym Satoshi Nakamoto, who described how cryptology and an open distributed ledger can be combined into a digital currency application.[2] The interest in Blockchain research is essentially driven by its characteristic properties of giving anonymity, security, and integrity without third-party organisations known to be trusted.

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[1] A.H. Lone & R. Naaz, *Applicability of Blockchain Smart Contracts in Securing Internet and IoT: A Systematic Literature Review*, 39 *Comput. Sci. Rev.* 100360 (2021).

[2] S. Nakamoto, *Bitcoin: A Peer-to-Peer Electronic Cash System*, *Decentralized Bus. Rev.* 21260 (2008).

Digital transformation is an all-around trend for any kind of financial institution and economy. Recently, cryptography-based blockchain technologies gained significant attention. Blockchain is essentially a distributed, shared ledger and database publishing all the data related to contracts, assets or transactions involving virtual currencies. Both the timestamp and contents will be sealed. A hash value will then be generated and stored in a data block. Blockchain cannot be easily altered or deleted due to a cryptography technology that blockchain is based on. Blockchain is a chain of blocks and information that contain which are entirely open to anyone. The sender will send the encrypted message through the public key that can only be deciphered with a private key of the recipient.

Some of the essential features of the modern economy and digital evolution in the current times include venturing into the world of blockchain and smart contracts. With each passing day, their growing dependency on blockchain and smart contracts keeps rising.[3]

Besides, eliminating contracts written in human language introduces new inefficiencies regarding three key aspects of Smart contracts such as automation makes it necessary that every agreement is based on clearly defined terms; decentralization relies on third-party verification for performance; the usage of business context to explain the meaning of agreement terms is eliminated when terms are anonymized. This, in turn, makes it very expensive to create smart contracts in an unpredictable environment or when there is uncertainty about contract's substance.

Smart contracts, for instance, have advantages. They force parties to follow their initial agreements, which saves money on litigation and lessens the resources each party much devote to keeping an eye on the other. Thus, "truthless' transactions – agreements in which parties feel safe even in the absence of a formal legal contract – are made possibly by smart contracts. There is a disadvantage to these benefits as smart contract requires participants to give up some degree of flexibility, which is a necessary component of transactional interactions' efficiency. Smart contracts are defined as those which execute automatically, usually through computers. The purpose of a smart contract is to facilitate the actual fulfilment of an agreement without having to resort to litigation between the parties to it. This automation assured execution, for

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[3] S. Sayeed, H. Marco-Gisbert & T. Caira, *Smart Contract: Attacks and Protections*, 8 *IEEE Access* 24416-24427 (2020).

better or worse; human judgment was relieved of the burden of contract formation. A simple example of a smart contract would be a vending machine. The sales contract is satisfied automatically when money is inserted and the machine works, which is a good definition of a smart contract. It raises obvious legal questions to question whether the issues of soda from the machine is a serious legal question if it issues heroin. Should regulations be created to ban vending machines because they have the potential to aid in illegal activities? Or should the regulations be after the fact? There are going to be certain situations that will arise that smart contracts need to be addressed to by the law. This paper will look at smart contracts to evaluate their legality and depict how little complication there exists in placing smart contracts within the framework of existing contract law. It is not necessary to create new legal principles for the emergence of new technology. Simply, traditional legal reasoning can develop straightforward rules to address this complex issue.[4]

In the recent past, the concept of smart contracts has been mainly brought to the fore in real estate, where the traditional sector is one marked by inefficiencies, costliness, and making processing lengthy. A real estate transaction often entails many representatives of parties taking part in the process, among them lawyers, lenders, notaries, and the government. The multi-lateral nature of the process has been a cause of delay, wrong information, and even extra costs. Everything can be standardized by the assistance of smart contracts. For example, conditions about a real estate transaction can be encoded into a smart contract as follows: purchase price, payment milestones, and even conditions in which property transfer will be done. The moment the buyer does so, a contract is automatically activated that transfers the title over the property to be written into the name of the buyer while releasing the said payment to the seller under regulatory compliance. This would mean automation for as long as there is no need for manual intervention to be done, thus doing away with the weeks or months it takes to close a deal, compared to the usual weeks or months.

SMART CONTRACTS AND PROPERTY TRANSFERS

A regular Indian property transaction involves steps in a process: negotiation, verification of ownership, due diligence, title transfer and registration. Each of these steps involves active participation by legal professionals, notaries and governmental agencies and therefore is full of human error potential and takes time to be processed. A smart contract uses an extrinsic data

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[4] Frank H. Easterbrook, *Cyberspace and the Law of the Horse*, 1996 U. Chi. Legal F. 207 (1996).

source that is programmed in a computer to "know" when to execute a contract.[5] They can automate most these steps and digitize them to make the whole process efficient. If a party has the capacity to contract on the blockchain and the other elements of a valid contract also exist, the contracts will be valid.[6]

Blockchain Technology has sneaked into the real estate industry. The applications and advantages of it in real estate market include smart contracts but are not limited to them. Smart contracts are those transactions which are repetitive such as auto-debit of instalments, etc. However, the question 'Why Smart contracts?" stands answered by the ability of smart contracts to reduce risk in a market where trust is hard found, besides, this process ensure the buyer has requisite funding and the seller has the requisite ownership of the property. In commercial world of real estate, it provide the players an inordinate advantage of 24/7 liquidity, which is how people want to invert.

There can be developed a smart contract for the transfer of property that will automatically enforce a sequence of actions upon satisfaction of such conditions. For instance, on certain terms and conditions agreed between a buyer and a seller for the deal, then the contract can be programmed to validate the ownership of the property, confirm that there are no existing liens on it, and check if the property is registered with the concerned authorities. Once the payment is made by the buyer-part payment, full payment, as the case may be the smart contract can automatically transfer ownership rights to the buyer and then update the record on a blockchain-based platform, which would then be integrated into the property registry.

The fact is that today many of the state governments in India are already experimenting with digitizing the land records and integrating blockchain technology to increase the transparency and decree litigation. Smart contracts will ensure the transfer if tamper-proof and the ownership is well documented by automating the transfer of title and recording the transaction in the blockchain, which reduces fraud and human errors. The purpose of the smart contracts is to create efficiencies and take undue interactions and human error out of a transaction.[7]

[5] Katri Suominen, Anjani Chatzky, William Reinsch & James Robison, 10 Big Questions (and Myths) Surrounding Blockchain, in *Harnessing Blockchain for American Business and Prosperity: 10 Use Cases, 10 Big Questions, 5 Solutions* 15, 15–22 (Ctr. for Strategic & Int'l Studies 2018), https://www.jstor.org/stable/resrep22491.6.
[6] Enforcing Smart Legal Contracts: Challenges and Prospects, Feb. 1, 2023, at 10-15
[7] Katri Suominen, Anjani Chatzky, William Reinsch & James Robison, 10 Big Questions (and Myths) Surrounding Blockchain, in *Harnessing Blockchain for American Business and Prosperity: 10 Use Cases, 10 Big*

Property Title Transfers and Land Registration

Some of the most relevant uses of smart contracts in India's real estate sector are property title transfer and land registration. Telangana and Andhra Pradesh Governments have been experimenting with blockchain storage of land records, with a long-term goal of integrating smart contracts for property transactions. For instance, **Telangana Blockchain District[8]** is experimenting on blockchain-based land record management in Telangana. Property data can be locked in the blockchain system so that their immutability and tamper-evidence are guaranteed. The smart contracts can be automatically delivering the property ownership upon satisfying all the conditions, for example, payment confirmation and regulatory clearances, which a buyer and seller may agree on. In such a way, the very smart contracts update the blockchain-based land registry, providing clear, transparent, and fraud-resistant records of property ownership. This will eliminate disputes arising from fake ownership documents given that smart contracts will significantly reduce reliance on manual processes that are predisposed to errors or fraud.

Indian case studies relating to the usage of smart contracts for property title transfers and land registration:

1. *Telangana State's Blockchain-based Land Records Project* – Telangana is one of the most dynamic states in India to experiment with the applications of blockchain in land records. In efforts to make the land record digitized with the use of blockchain technology for transparency and minimizing disputes over land, the Telangana government started a pilot in 2017 to implement blockchain in land record management. The project is aimed to becoming part of the Telangana Blockchain District Initiative in the development of a strong blockchain ecosystem for all kinds of services for the government, especially in the management of the land records.[9]

   Smart Contract Pilot Project: Telangana entered into partnerships with blockchain technology firms for creating a digital, tamper-proof immutable ledger of land records, which would be accessible and verifiable by all parties in property transactions. Land ownership records and details regarding properties are stored in the blockchain while

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Questions, 5 Solutions 15, 15–22 (Ctr. for Strategic & Int'l Studies 2018), https://www.jstor.org/stable/resrep22491.6.

[8] Telangana State Department of IT, Electronics & Communications, **Telangana to Set Up Blockchain District in Hyderabad**, (Dec. 2020), https://it.telangana.gov.in/.

[9] Telangana State Department of IT, Electronics & Communications, *Blockchain Initiative*, (last visited Nov. 17, 2024), https://it.telangana.gov.in/initiatives/blockchain/.

smart contracts were used to automatically execute property transactions upon fulfilment of certain conditions. For instance, in the process where a buyer and seller agree on terms, the smart contract could automatically verify the ownership of the property and if there are no legal encumbrances, and then see to the title transfer when the buyer makes the payment in a such a way that everything is done with no need for the availability of intermediaries.

2. *Andhra Pradesh's eLand Registry System* – Andhra Pradesh is also in the forefront in terms of technology usage in land records and registration. It has digitized land records under the eLand Registry scheme and plans to utilize blockchain technology for further ease in property transactions and registration.[10]

   An integration of blockchain and smart contracts: Thus, the state is trying to integrate blockchain to safeguard the digitized records and allow smart contracts for the transfer of title ownership. Such an integration will involve a blockchain platform that maintains all these land and property records in an accurately secured form where the title ownership will be automatically transferred through smart contracts as conditions are met, such as confirmation of payment and submission of required documents.

3. *Maharashtra's Blockchain-Based property Transaction System Pilot* – Among the reports of its usage in one of the India's largest real estate markets, it is also mentioned that a pilot project is being undertaken for the exploration of integrating blockchain with Maharashtra Land Records (M-land Records) system[11] in the state of Maharashtra. Private blockchain startups are joining up for this pilot.

   Integration with Smart Contracts: The dream of the Maharashtra pilot is to test how blockchain could be integrated into the existing property registration platform so that the transfer of titles and ownership verification becomes an automated process. On full operation, smart contracts may be put in place to automatically verify and transfer ownership rights once conditions like payment and document submission are fulfilled. This can help speed up completion and registration of property transactions and consequently enhance the buyer-seller experience.

4. *Karnataka's Land Record and Blockchain Pilot* – As a part of the modernization of land records, Karnataka is also experimenting with blockchain technology. The State

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[10] Nir Kshetri, Blockchain as a Tool to Facilitate Property Rights Protection in the Global South: Lessons from India's Andhra Pradesh State, *43 Third World Quarterly* 371, 371-92 (2022), https://doi.org/10.1080/01436597.2021.2013116.

[11] Kuldeep Vayadande, Rahebar Shaikh, Suraj Rothe, Sangam Patil, Tanuj Baware & Sameer Naik, Blockchain-Based Land Record System, *Vishwakarma Institute of Technology* (2022)

has initiated pilot projects on blockchain applications to improve management of land records. The inherent purpose of this exercise has been to prevent fraud in land titles and to automate transactions.

Smart Contracts for Title Transfers: The state of Karnataka is piloting the use of blockchain with the land registration system in the state. In such a structure, after agreeing on the terms of the property transaction between the buyer and seller, a smart contracts can be triggered to automatically verify ownership and validate title. The smart contract will ascertain whether the legal requirements are properly fulfilled, such a paying taxes, stamp duty, and registration fees, before really transferring ownership to the buyer. This reduces manual processing and ensure that only real transactions take place, thus less fraudulent activity.

5. *National Initiatives: National e-Governance Plan (NeGP) and Blockchain Exploration[12]* – More macro nationally, the Indian government has been actively scouting for blockchain technology under the National e-Governance Plan (NeGP). MeitY has supported several pilot projects at state level to understand how blockchain can transform public services for land record management among others.

Utilize blockchain to create blockchain for property title records: The concern for 'Digital India' and e-Governance in the Indian context is a motivation for using the full potential of blockchain in a property transaction. For instance, blockchain can be extended for a national land registry that integrates at the level of states and district across the nation to hold the records available, secure and transparent in the whole country. With smart contracts, property title transfer processes can be automated so that time and cost are reduced, and the title will not be in dispute. However, a widespread use of blockchain in property transactions would require gigantic transformation of legal frameworks, which must also reach cross-system interoperability of the systems of different states.

Automated payments and Escrow Services

Often, payments and escrow services on the traditional property transactions will be handled by banks or third-party escrow agents, thus taking additional time and cost in the transaction. It has potential to automate the segment because smart contracts reduce the number of

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[12]   Ministry   of   Electronics   &   Information   Technology,   National   e-Governance   Plan, https://www.meity.gov.in/divisions/national-e-governance-plan (last visited Nov. 17, 2024)

intermediaries, letting faster, yet more secure transactions occur. For instance, when the buyer deposits the amount in the escrow account, then the smart contracts can automatically cross-check whether the seller furnished all the necessary documents-cum papers. Since if the seller met the conditions prescribed then the smart contract would have allowed the transfer of funds to the seller's account, else return the money to the buyer's account.

For instance, **Propy[13]** is an international platform for real estate that applies blockchain and smart contracts on all its property dealings. A case in point and not limited to India is the one applied above, about how smart contracts in the escrow can apply even for international property transactions involving Indian properties. Propy's escrow services apply the automation of the services of an escrow agent, meaning all conditionals shall have been met before the buyer's funds are released and lessen chances of delays in transactions or fraud.

Platforms of similar nature are emerging in India. A very good example in **Rentomojo[14]**, which is a platform that offers renting furniture and appliances. The company has been exploring blockchain for automating payments and agreements. They have plans that relate to the extension of such aspects into the real estate sector, mainly rental agreements. They have plans that relate to the extension of such aspects into real estate sector, mainly rental agreements. This kind of platform can make property transactions, including renting, more efficient because it is possible to automate payment schedules and enforcement through smart contracts.

Regulatory Compliance and Land Record Verification

India's real estate market is complex with a multi-level system of regulations at the central, state and local levels. The system of compliance verification in the transaction process involves generally checking a lot documents, titles and certificates that may further prolong transactions. Compliance may be made faster through smart contracts by automatically running a verification procedure upon the fulfilment of all conditions to proceed with the transaction.

For instance, the state of Karnataka has piloted blockchain for the management of land records under its E-district project in which smart contracts can be integrated to verify compliance with land use and zoning laws and other regulatory requirements. A smart contract would

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[13] Propy, *Propy White Paper* (July 2017), available at https://www.propy.com/whitepaper
[14] Rentomojo, *Rentomojo – Rent Furniture and Appliances in India*, available at https://www.rentomojo.com

automatically verify whether the property is complying with local land-use regulations – ensuring that the property will be sold lawfully, and also verify it the taxes and dues have been paid, so that an encumbered property may not be sold.

The regulators might speed up the finality of property deals through the integration of blockchain with smart contracts, automating the scanning of compliance checks. For example, after a buyer and seller agree on the property deal, the smart contract might scan whether all clearances of government due payments such as property taxes or stamp duties have occurred before payment and transfer of ownership.

Real Estate Rental Agreements

Smart contracts can be implemented in the rental markets also for smoothening out lease agreements. **NoBroker[15] and NestAway** have experimented with blockchain to come up with leasing contracts and implement them with complete transparency. Smart contracts could automatically enforce the terms of a lease-including payments schedules, security deposits and renewal clauses.

For instance, a smart contract can automatically debit the amount of rent payable from the bank account of the tenant monthly and credit it to the account of the landlord. It can guarantee that if there are damages or other conditions which have not been fulfilled, the security deposit will be repaid at the time of leaving. In case of any dispute, the contract can use an automated dispute resolution mechanism involving, possibly an arbitrator to speedily resolve the dispute.

LEGAL FRAMEWORK FOR SMART CONTRACTS

Comparing Singapore and India in Terms of Smart Contracts in Real Estate Transactions

Using Smart contracts, the terms of an agreement are directly written into code and run on blockchain networks. Smart contracts can revolutionize real estate transactions by automating some processes and cutting out paperwork to increase transparency while reducing fraud. Both Singapore and India are exploring smart contracts for real estate, but their levels of progress

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[15] *Young startups like NoBroker, NestAway Technologies now eliminating brokers in real estate transactions*, *The Economic Times* (Apr. 11, 2016), https://economictimes.indiatimes.com/small-biz/startups/young-startups-like-nobroker-nestaway-technologies-now-eliminating-brokers-in-real-estate-transactions/articleshow/51319525.cms?from=mdr.

and approaches vary radically because of the level of legal frameworks, technological infrastructure, and maturity of markets.

Legal Framework and Regulatory Environment

Singapore: Clear and Supportive Legal Framework

Singapore clearly has a robust legal structure in support of blockchain and smart contracts. The **Electronic Transactions Act, 2010[16]** provides a legal foundation for electronic signatures and digital contracts, such as those executed via blockchain technology. If they satisfy basic contract law requirements and are accompanied with mutual consent, capacity to contract, and legality, smart contracts will be deemed legally binding.

Smart contracts are legally binding – The ETA does not explicitly define smart contracts but generally supports digital agreements if they meet the core criteria of a valid contract. In this regard, this law treats a smart contract, executed via blockchain, almost identically to the traditional paper-based ones as long as it meets the core principles governing contract formation.

Blockchain and Legal Validity: Since smart contracts appear on blockchain platforms with the full computerized execution without human interference, legal acceptance of such smart contracts through the ETA is necessary. If all parties agree with the terms embedded within the smart contract in a real estate transaction, it becomes legally enforceable. Blockchain's transparent and immutable nature increases its authenticity and reliability regarding execution of such contracts.

Role of the Monetary Authority of Singapore (MAS)

The MAS has played the forefront role in promoting adoption of Blockchain and smart contract technology for financial services, in particular property transactions. In fact, the MAS embraced blockchain technology as part of its strategy in positioning Singapore as a Global Fintech Hub.

Blockchain for Real Estate: MAS has enabled several pilot programs exploring the potential uses of blockchain in real estate, such as property tokenization and the development of automated land registration systems. The fact the blockchain may be applied to safety and security property title recording and transfer significantly reduces overheads, deters fraud opportunities and accelerates property transactions while making them transparent. This innovation lines up with the vision set by the Singaporean government to become a top

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[16] *Electronic Transactions Act, 2010*, Act No. 25 of 2010 (Sing.).

blockchain hub.

Role of the Singapore Land Authority (SLA)

The SLA is the government agency that handles all land administration in the country. It has been at the forefront of trying to explore and find applications of blockchain technology for the registration of titles for lands and other property transactions as part of efforts of modernising Singapore's real estate sector.

Blockchain for Land Title Registration: The SLA has entered one of the efforts aimed at streamlining land registries not only in terms of the accuracy and security but also their efficiency by proposing the use of blockchain technology. By utilizing the immutable ledger and distributed architecture of blockchain, the government is able to provide a far more transparent and secure method through which it shall handle the matters of the ownership title to lands at the same time minimizing risks of fraud or errors in the records of ownership of such properties.

The prime utility of blockchain in SLA is the digital facilitation of property transactions. Smart contracts automatically execute the transaction when conditions, such as playing or transferring the title are met. It therefore eliminates middlemen in the forms of notaries or attorneys and streamlines the process through quicker transfer of properties.

Land Digitization and Smart Contracts: It shows interest in blockchain by expressing its vision for having digital land records and tokenized real estate assets. Blockchain-based smart contracts will enable purchasers and sellers to enter into smart contracts that automatically execute when certain conditions, like payment, are met.

EMERGING LEGAL FRAMEWORK FOR SMART CONTRACTS IN INDIA

India is still in a nascent stage when it comes to establishing a well-defined and integrated legal structure specific to smart contracts. Smart contracts, including blockchain technology, represent enormous potential and the kind of revolutionary transformation that would occur with respect to any industry, including real estate. The legal and regulatory environment remains developing with uncertainty being a huge challenge.

1. **Role of IT Act, 2000**

The basic law that governs the legal recognition of electronic transactions, digital signatures and other electronic records in India is the Information Technology Act, 2000[17] or the IT Act.

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[17] *Information Technology Act, 2000*, No. 21 of 2000 (India).

This was enacted to promote and regulate matters relating to electronic commerce, digital signature, and cybersecurity in the country. Under this Act, it gives legal recognition to electronic contracts and digital signatures, ensuring that these digital documents are enforceable in Indian courts.

Electronic contracts and digital signatures: The IT Act recognizes the fact of electronic contracts, but only digital signatures issued by a certifying authority under the Act qualify to be admissible in law. This provision clarifies that electronic transactions are valid and enforceable, which is important for smart contracts operating on a digital medium like blockchain.

However, it does not specifically address the provision of smart contracts because it gives legal validity for digital signatures and electronic records. Smart contracts, moreover, are self-executing agreements in which the terms of the contract are directly written into lines of code, posing new challenges that are not entirely addressed by the existing legal framework.

Legal clarity gap - Since the legislation of smart contracts is exclusively recognized and promoted in Singapore, there is yet no particular legislation that legitimises its use in Indian property transactions by blockchain-based smart contracts. Such a situation places legal uncertainty in real estate especially in the cases of Titles Transfers, Escrow Services and Auto Property Deals.

Contractual Validity: Smart Contracts are probably enforceable under general contract law in India, though it remains within the realm of interpretation. Thus, in the case of a smart contract, interpretation of terms included in the smart contract, or on the mechanisms for dispute resolution, and remedies in case of non-performance of the contract will be relevant factors in such transactions related to properties. In other words there is lack of standards that would help parties in a real estate transactions rely on smart contracts, which can, therefore, raise questions related to the enforceability under the law.

2. **Government Initiatives and Pilot Projects**

Nevertheless, India's government still has not acknowledged it legally, but the Indian government is keen on researching the utility of blockchain technology and its implementation in various sectors; even the real estate sector has shown interest. Some pilot projects have already been initiated at state levels targeting land record management and property title digitization, thus abolishing fraud against enhancing transparency and simplifying transaction processes.

Telangana Blockchain Land Record Management

Digitization of Land Records: Amongst the pragmatic states of India, Telangana has adopted new technologies as well as implemented blockchain-based land record digitization. The Telangana government initiated a blockchain-based registry of land record tracking in association with NISG and Tech Mahindra that ensures safety of land ownership and transactions. This was undertaken to validate the legitimacy and eliminate fraudulent land dealings along with duplicating land titles.

Smart Contracts and Title Verification: Telangana is currently experimenting with the use of smart contracts in its property transactions through blockchain enabled recordation of land titles, which could eventually be integrated with smart contracts for the automated transfer of ownership. The blockchain ledger allows the property data are well recorded and is based on the basis of immutability which reduced the chances of issuing disputed or forged property titles.

Pilot Stage: Even in its infancy, the pilot has aided to lay down a foundation for the exploration on how blockchain may be leveraged for automating real estate procedures to ease the flow of property transfer, title verification and transaction settlement.

Land Record Modernization of Uttar Pradesh

Land Record Modernization: The Uttar Pradesh Land Records Modernization Program[18] is an initiative of government of Uttar Pradesh, which is aggressively pursuing blockchain technology, to digitize land records and prevent the manipulation of land titles. This project primarily intends to develop digital records that can be accessed and verified by the owners and buyers of the land and to some extent, the government authorities responsible for these transactions.

Land Ownership and Smart Contracts – Blockchain Pilot: Uttar Pradesh has further explored the prospect of using blockchain-based solutions to authenticate and secure land titles. The integration of smart contracts in the transaction may be feasible enough to automate, from time to time, the transfer of ownership once the amount is paid or until such time when agreed conditions are met.

Other States and Initiatives:

Other states have discussed or introduced blockchain-based land record systems for better

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[18] Mukesh Yadav, Deepika Jha, Ruby Moun & Amlanjyoti Goswami, *Land Records Modernisation in India: Uttar Pradesh*, (2021).

transparency and accuracy in the execution of property transactions. For example, the Maharashtra Land Records Modernization Programme digitizes and provides better access to land records with the support of the internet that can then be deployed using blockchain solutions.

Along with this, the Ministry of Rural Development and Ministry of Electronic and Information Technology (MeitY) is focusing more on broader research and applications on blockchain, which may also stretch towards real estate and land management systems.

CHALLENGES TO ADOPTION OF SMART CONTRACTS IN REAL ESTATE

While such pilot projects in states like Telangana and Uttar Pradesh are promising, several challenges exist with relation to the adoption of smart contracts in real estate transactions in India as whole.

Lack of National Standards: Land laws for real estate in India are typically state-specific, meaning that land records and property rights vary by state. There exists no uniform national land register, and regulations regarding digitization differ across different states. In the absence of standardization at a national level, implementing smart contracts universally across states for all real estate transactions is challenging.

Legal Framework Gaps: Smart Contracts, in property transactions, are not recognized or defined within Indian law. Instead, such lack of clarity makes it a challenging process for parties who want to purchase, sell, or even transfer an interest in property using a smart contract. An established framework would be required to ensure that the automated execution of contracts made by the parties is legally enforceable, especially in disputes.

Integration with Legacy Systems: In India, many states are still dealing in paper-based records, and the digitization of land titles is still in process. The integration of blockchain-based systems with legacy land registration systems is very complex and would involve significant investment and time. This adds to the obstacles against the adoption of smart contracts requiring accurate up-to-date in detail.

Regulatory and Data Privacy Concerns: Blockchain is fundamentally decentralized and it involved the storage of sensitive personal information either on a public or private ledger. Therefore, issues of data privacy and protection of personal information of citizens need to be overcome to fulfil the requirement of data protection law such as India's Personal Data Protection Bill. A blockchain solution in real estate brings about an extra layer of regulatory

duty.

CYBER SECURITY RISKS AND CHALLENGES

Smart contracts driven by blockchain technology, can transform industries through agreement automation, transparency and a reduction in the requirement for intermediaries. Smart contracts have a bright future in real estate, with potential applications involving the automatic transfer of properties, payment and lease, as well as more efficient escrow services, increased accuracy and secured transactions. Despite these benefits, using smart contracts in real estate poses major cybersecurity risks and challenges.

1. Code Vulnerabilities and Security Flaws

This code forms the foundation of any smart contract. If such code is defective or has a flaw in it, hackers can easily exploit the contract or even go around the terms within it. Little errors that occur when coding such high-value assets as real estate transactions, which take most of the time in the real estate field, can be devastating. Another such weakness is the DAO hack, which occurred in 2016 when an attacker could steal more than $50 million worth of cryptocurrency from the accounting of a smart contract caused by a weakness in the code.[19] In real estate terms, a vulnerable smart contract could allow an attacker to change terms on a property sale, avoid ownership verification, or change the recipient of funds to other unauthorized parties.

Real estate transactions are very complex, especially when there are parties involved and the terms are also complicated. Under such circumstances, writing error-free smart contracts is not easy. A smart real estate contract may have to deal with facets like property titles, payments, and regulatory compliance, for all of which rigorous coding standards are a must. Challenges can be seen in determining vulnerabilities in these contracts because some vulnerabilities may only be found after the deployment of the contract; for instance, re-entrancy attacks may be elusive until exploited. Therefore, ensuring that smart contract code is free from vulnerabilities is crucial to reducing the possibilities of exploitation.

Regular security audits by third-party experts and using formal verification techniques that prove the correctness of the code mathematically will further reduce the possibility of vulnerabilities. Designing with standardized well-reviewed code libraries, such as Open Zeppelin, can help developers avoid common pitfalls and implement more secure contract

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[19] 3 N. Atzei, M. Bartoletti & T. Cimoli, A Survey of Attacks on Ethereum Smart Contracts, in Proceedings of the International Conference on Principles of Security and Trust 164-86 (2017).

functions.

2. Legal and Regulatory Uncertainty

The legal ambiguity of the smart contract landscape is mostly true, at least in real estate. While blockchain technology ensures that smart contracts are immutable, transparent, and automatically execute upon conditions being met, the same may not necessarily be so lawfully recognized or enforceable under a country's specific jurisdictions. Where real estate transactions are heavily moderated by significant local laws affecting rights regarding property, title transfers, and contractual force, smart contracts face a major challenge simply due to unclear legal frameworks.

One of the greatest difficulties associated with implementing smart contracts in real estate relates to conformity with existing legal frameworks. For example, a smart contract implementation that executes a property transfer on a blockchain does not meet the legal requirements in transferring title to property in many jurisdictions, primarily where transfer of properties is still made on paper or needs notarization. In those jurisdictions, although the smart contract may be technically valid, it will lack legal enforceability where a dispute arises over it.

Another challenge is the regulatory aspect, especially AML and KYC. Real estate transactions involve huge amounts of money and entail verification of parties involved to stop illegal practices. Combination of such checks into blockchain-based systems wherein anonymity is a key feature may be quite complex, at times even impossible, without raising the benefits of decentralization and privacy to a great extent.

Hybrid models that combine using blockchain with more conventional legal procedures are underway to deal with these issues. For example, real estate transactions might use blockchain in automating transactions such as payment and transfer of properties but shall involve traditional paper work and notarization to ensure compliance with local jurisprudence. While cooperating with legal experts is indispensable to ensure that smart contracts comply with the relevant standards set by the regulatory jurisdictions.

INCIDENTS OF CYBERSECURITY BREACHES IN SMART CONTRACTS IN REAL ESTATE

Smart contracts are increasingly being looked for in order to transform the process of the transactions in real estate by reducing the number of intermediaries involved and increasing transparency. However, this will require a focus on security, since smart contracts essentially

entail high-value transactions and sensitive data. Even though the integration of smart contracts with real estate remains at its infancy stages, several cybersecurity breaches related to blockchain systems have shed light on the vulnerabilities inherent in these technologies.

The DAO Hack 2016 – Exploiting Vulnerabilities in Smart Contract Code

The most infamous event in the history of blockchain and smart contracts to date was when the hacker broke into The DAO (Decentralized Autonomous Organization) in 2016[20], which is not related to real estate but will be used here as the example to illustrate the vulnerabilities that can be exploited in smart contracts, which are relevant to real estate transactions that may use similar Ethereum-based smart contracts.

Details of the Incident

The DAO was one of the early versions of Ethereum-based venture capital funds, actually built using smart contracts. Given that it was a venture capital that's supposed to be open to anyone wishing to contribute Ether (ETH) and vote on investment ideas, problems started when a hacker identified a flaw in the recursive call function type of a reentrancy attack, draining a huge amount from the amount at the time, almost $50 million.

Impact on Real Estate

Although the hack did not directly involve real estate, it provides a valuable lesson in the importance of sound auditing and testing that must be done on any smart contract code before it gets into deployment, especially when dealing with large sums of money or high-value assets such as real estate properties. When such a vulnerability exists in a smart contract handling real-estate transactions, the attackers might change terms of property deals, reverse payment directions, or even steal property assets.

The "Bugs in the Contract" Incident (2020)[21]

In 2020, a vulnerability was reported in several DeFi smart contracts on the Ethereum blockchain that could also apply to real estate if such assets were tokenized or even via decentralized lending protocols. There is an error in the handling of certain data within these contracts. This will then lead to accidental executions of contracts, including erroneous transfers of tokens.

Impact on Real Estate

Similar bugs could exist in other real estate projects that tokenize ownership of property or

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[20] N. Atzei, M. Bartoletti & T. Cimoli, A Survey of Attacks on Ethereum Smart Contracts, in Proceedings of the International Conference on Principles of Security and Trust 164-86 (2017).

[21] C. Liu, H. Liu, Z. Cao, Z. Chen, B. Chen, and B. Roscoe, ''Reguard: Finding reentrancy bugs in smart contracts,'' in Proc. IEEE/ACM 40th Int. Conf. Softw. Eng., Companion, May 2018, pp. 65–68

manage decentralized mortgages with smart contracts. For example, an automated contract for the sale or financing of a property might unintentionally execute a transaction lacking any kind of reflection of the value or ownership, which would lead to a misplacement of property or funds.

Lessons for Real Estate

Complete testing and auditing: Smart contracts in real estate must be designed with thorough testing -including testing of edge cases-to avoid erroneous executions.

Formal verification. One would then have the possibility of formally verifying in addition, the correctness of the logic of the contract is mathematically proved.

"Typos and Vulnerabilities" in Blockchain-based Property Registration (2019)[22]

A 2019 report uncovered the vulnerabilities identified in blockchain-based property registration systems that were tested in several countries. Such systems record property ownership based on blockchain technology and show very low incidents of fraud in terms of tainted land registries. It was, however, found that minute flaws in the implementation of such systems, like typos in the code for smart contracts, could pose gigantic security threats that may include unauthorized transfer of properties or production of fake titles.

Blockchain Impact on Real Estate

In countries trying blockchain for property registration-from some parts of the UK, Sweden, and Georgia-in case any flaw occurs in the code, it would lead to unauthorized transfer of real estate titles, eventually creating false records of ownership. In India and other emerging markets, this vulnerability will be disastrous because land title fraud is already a huge problem, and attackers could easily alter the property ownership on the blockchain by fraudulent claims of ownership.

Lessons for Real Estate:

Correctness in code: The smart contract codes should be correct, especially while putting property registration systems into action, so as to avoid grave errors.

Government oversight and regulation: where developers are in direct contact with the governance and regulatory departments to ensure that blockchain property registration systems are error-proof and sound, particularly in jurisdictions that have listed the recognition of blockchain as a proper official methodology for verifying land ownerships.

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[22] Mohammed Shuaib et al., *Identity Model for Blockchain-Based Land Registry System: A Comparison*, 2022 *Comput. Intell.* 5670714 (2022), https://doi.org/10.1155/2022/5670714.

CASE STUDIES HIGHLIGHTING SUCCESS AND CHALLENGES OF SMART CONTRACTS IN REAL ESTATE TRANSACTIONS

Due to the automation of contract execution, payment processing, and transfer of ownership, smart contracts, which are self-executing contracts with their terms directly written into code, are being widely used to facilitate faster real estate transactions.

1. **Singapore: Use of Smart Contracts for Property Transactions**

Singapore has made giant strides in moving forward of others to discover the implementation of smart contracts into real property transactions. Singapore Land Authority (SLA) has shown interest in block chain technology by applying it to improve transparency in enhancing efficiency in property transfer. Smart Contracts for Property Sale Agreements have been implemented jointly with private companies such as KPMG and Upplication, which aim at automating land transactions using blockchain and smart contracts.

Key Success Factors:

Regulatory Support: The regulatory framework in Singapore was always supportive of blockchain technology. The Monetary Authority of Singapore (MAS) issued clear guidelines for blockchain-based initiatives, which made the environment friendly to experiment with smart contracts in real estate transactions.

Reduced Administrative Burden. Smart contracts help in streamlining the processing of a property transaction by automating terms related to payments and property transfers. With reduced intermediaries such as lawyers, notaries, and more persons of authority, it reduces the cost of a transaction to a significant level.

Security and Transparency: The terms of the contract are immutable, always transparent, with all parties obtaining clear and verifiable transaction history that can verify all participants' activities, furthering trust and avoiding fraud and disputes.

Challenges:

Legal Adoption and Regulatory Uncertainty: The Singapore government is known to support blockchain, but legal enforcement of smart contracts is still a complex issue. There may be uncertainty around the laws governing traditional contracts and their full recognition of automated, code-driven contracts. In the case of a smart contract, it may not alone be able to replace a traditional property sale agreement.

Integration with Infrastructure: In many transactions involving the purchase of real estate in Singapore, traditional entities play the role: lawyers, notaries, and banks. It will therefore require obnoxious technical and regulatory hurdles to be overcome in order to be replaced by

smart contracts in place.

Market Adoption: Although the technology has great prospects, adoption remains slow because many stakeholders, both buyers, sellers, and agents, might be nervous about adopting a fully digital and automated process, especially when it concerns legal documentation and dispute resolution.

2. United States: Smart Contracts fir Real Estate Closings (Propy)[23]

Propy is a platform in the United States which has greatly enabled smart contracts implementation in real estate. Propy uses blockchain technology to eliminate unnecessary bureaucracy in the closing of properties through its smart contract system, where sale, purchase, and payment procedures are all automated without intermediaries directly intervening. Propy demonstrated the effectiveness of a smart contract application in real estate by ending the very first cross-border real estate transaction in 2017. Propy was hosting the buyer and seller, both based in different countries.

Key Success Factors:

Smart Contracts: Propy will be utilizing smart contracts that automatically execute agreement terms based on the fulfillment of pre-set conditions, such as confirmation of a deposit or verification of documents. This means that there is no room for human error and it accelerates transactions, saves time, and even eliminates delays in closing a deal.

Inter-state transactions: Propy's website will accept property sales across borders, and the users can pay in different currencies or cryptocurrencies. Smart contracts will ensure that all parties concerned fulfill obligations and are not tied to where the parties are geographically located.

Low Costs and Rapid Closings: Elimination of all intermediaries involved in the process, such as title companies, real estate agents, and notaries, directly reduces the costs associated with a Propy transaction. Since this is an automation-based process, property closings are completed in days instead of weeks or months as in the traditional case.

Challenges

Legal Framework and Recognition. The smart contract is still far facing much legal recognition in transactions of property. Though Propy took a step, the smart contract remains to be not fully recognized as legally binding documents in the U.S. legal system.[24] Some states have different

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[23] Propy, *Propy White Paper* (July 2017), available at https://www.propy.com/whitepaper

[24] **Neo Global Blockchain Compliance Hub**, United States of America: Smart Contracts, https://neo-project.github.io/global-blockchain-compliance-hub/united-states-of-america/USA-smart-contracts.html (last visited Nov. 17, 2024).

standpoints on the legality and enforceability of smart contracts, and there is a need for a bit more clarity.

Industry resistance- Old-line real estate players, such as agents, attorneys, and title companies, are at times petrified that blockchain-based smart contracts can disrupt their business models. Education and training are required to make all these stakeholders familiar with the new processes.

Regulatory Uncertainty: Anti-money laundering rules and tax considerations surround almost every real estate transaction. Thus, putting in place smart contracts in the real estate sphere needs to be in line with the vast regulations facing them and is somewhat complicated in the legal landscape.

FUTURE TRENDS AND RECOMMENDATIONS FOR SMART CONTRACTS IN REAL ESTATE TRANSACTIONS IN INDIA

These smart contracts, through blockchain technology, aim to transform real estate transactions all across the globe, including those in India. The Indian real estate industry is one of the largest in the world and has always been criticized for inefficiencies such as bureaucratic red tape, long periods for transactional processes, frauds, and a lack of transparency. All these can be assuaged by smart contracts through the automation and surety of processes and compliance.

Technological advancement, regulation, market demand, and the collaborative environment between government, private players, and technology providers will influence the adoption of smart contracts in transactions to shape the Indian real estate.

Future Trends

Government Integration and Blockchain-Based Land Registry

Trend: The Indian government is making its way to digitization of land records through programs like the Digital India Land Records Modernization Programme (DILRMP)[25] and National Land Records Modernization Programme (NLRMP)[26]. In the future, smart contracts are likely to be integrated into land registries, thereby automating transfers of titles, payments, and ownership verification.

Impact: The blockchain system provides a tamper-proof, secure ledger that ensures a record of

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[25] **Department of Land Resources**, Digital India Land Records Modernization Programme (DILRMP), https://dolr.gov.in/programmes-schemes/dilrmp-2/#:~=DILRMP%20is%20a%20tool%20to,as%20AI%2C%20Machine%20Learning%20and (last visited Nov. 17, 2024).

[26] **Sikkim Land Revenue and Disaster Management Department**, National Land Records Modernization Programme (NLRMP), https://www.sikkimlrdm.gov.in/lrd/NLRMP.html (last visited Nov. 17, 2024).

land, eliminating fraud, delays, and disputes in terms of property ownership and transfer.

Digitisation of Property Transactions

Trend: With the gradual shift of India's real estate market towards digital platforms for buying and selling property, the use of smart contracts in transactions is more likely to become a new foundation, backed by the increasing usage of online platforms like NoBroker, MagicBricks, and 99acres.

Impact: Smart contracts could automate and speed up the disposal of property deals, allowing for real-time tracking, faster processing, and smoother execution. Blockchain could eliminate transparency issues related to illegal land sales, double registration in jurisdictions, and under-reporting of property values.

Smart Contracts for Lease and Rental Agreements

Trend: As Indians get more urban and houses on rent replace ghisased ownership, smart contracts would slowly become the norm for rental agreements, automating payment dates, renewal, and handling security deposits.

Impact: Efficiency will be increased especially by smart contracts, whose beneficial impact can be seen especially in commercial real estate since leasing agreements involve many people. Blockchain could automatically trigger payments, renewals, and maintenance requests based on the contract's pre-set conditions.

Recommendations

Regulatory Clarity and Legal Framework Development

Recommendation: India needs to evolve an integrated, comprehensive legal framework to enable adoption of blockchain and smart contracts in real estate transactions. Specific norms need to be evolved related to the validity and enforceability and recognition of these smart contracts in property deals.

Action: It must come up with a national policy on blockchain in real estate by MoHUA along with MeitY and focuses on the use of smart contracts whereby a set of guidelines would be developed to automate land titles, agreements, payments.

Adopt Blockchain for Public Land Record Systems

Recommendation: Digitize land records as early as possible and ensure public land registries are done through blockchain to guarantee transparency and security in land ownership.

Action: Integrate blockchain with the Land Records Modernization Programme for a completely digitalized and secure handling of land titles and transactions. One can use the

blockchain for precise record-keeping without altering it, which helps reduce land disputes.

Standardization of Smart Contracts Templates

Recommendation. To become uniform and reliable, standard templates of smart contracts for typical real estate transactions need to be developed; generally, those involving buying and selling, leasing, and rental agreements.

Action: Develop standardized contract templates that can easily be adopted by the industry and promote the work of the Indian Real Estate Regulatory Authority so that standardization and clarity under the law will be assured.

Integration with Payment Gateways and Banking systems

Recommendation: Smart contracts should easily be integrated with Indian payment systems like UPI and digital wallets, so that transaction happens promptly and securely without involving a bank for escrow services.

Activity: Partner with key banking institutions and payment networks in order to develop blockchain-enabled networks that can automatically process property payments when the criteria of predefined contractual conditions are satisfied.

CONCLUSION

Smart contracts do have the potential to revolutionize the Indian real estate market, but India would need a somewhat modernized legal framework and advanced cybersecurity architecture to cope with the specific issues involved in smart contracts. With legislation modifications, sound cybersecurity in place and adaptations from the experiences of other counties, India would be able to create an enabling environment for widespread adoption of smart contracts in the transaction of real estate. This is an efficient, transparent way toward keeping the security and integrity of property transactions intact.

The future of smart contracts in Indian real estate promises much-enhanced efficiency from the automatic increase in processes, fraud reduction, transparency, and cost-cutting. But this potential would require clear legal frameworks, technological integration, and collaboration at the government, industry, and stakeholder levels. Regulatory clarity will ensure that smart contracts are legally enforceable, while infrastructure will facilitate simple transactions. Educating professionals and public toward the advantages of blockchain technology is also equally important to be adapted in mass. With a single stand, India would become the world leader to deploy smart contracts on real estate, attract investments for both at home and abroad.

With India emerging as a digital future, smart contracts in real estate segment become the need of the hour, and legislators' technologists and other industry stakeholders must collectively create an ecosystem at the regulatory and technological levels, encouraging trust, security and innovation.

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