



# Blockchain Based Land Registry System Using Ethereum Blockchain

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**ABSTRACT:** Land registry in India as well as in many parts of the world is a very slow and cumbersome process. There are many intermediaries involved in the process of land registration. Developing a system that not only accelerates the process of land registration, but also makes it easier for Buyers, Sellers and Government registrars to transfer land ownership, is only possible by creating a distributed system that stores all transactions made during the process of land buying. In this paper we explore the possibilities and problems solved by using a blockchain based system for land ownership transfer. The system is based on Ethereum Blockchain, which stores all transactions made during the process of land ownership transfer. Using the concept of smart contracts, we can trigger various events such as access of land documents to a land inspector and fund transfer from buyer to seller after successful verification. This system solves the problems faced by all three parties during land registration and removes intermediaries like property dealers. Using the system, validation of lands is also possible as immutable transactions are stored in the public ledger. The platform additionally supports land asset liquidation using equivalent cryptocurrency, enabling land to function as a liquid financial asset for the first time.

**KEYWORDS:** Ethereum (ETH), Blockchain (BC), Cryptography (CRYP), Ledger (LED), Distributed Transaction (DT), Land Registration (LR), Smart Contracts (SC), Decentralized Application (DApp).

## I. INTRODUCTION

Land ownership records constitute one of the most critical databases maintained by any governmental authority. It is crucial to maintain the correctness and completeness of this information and prevent unauthorized, fraudulent changes [5][8][12]. With increasing urbanization and population growth in India, the importance of an accurate and tamper-proof land registry system cannot be overstated.

Currently, people rely on third-party government agencies that are responsible for keeping track of ownership information in centralized databases. To transfer ownership, it is difficult and slow to first find, verify the land, and then complete the transfer [16]. The involvement of multiple government departments, notaries, lawyers, and brokers makes the entire process expensive and time-consuming.

The global land registry challenge is not limited to India alone. Many developing and developed nations continue to experience fraudulent land transactions, disputed property titles, and inefficient registration processes. Traditional systems suffer from poor data integrity, lack of transparency, and susceptibility to manipulation by corrupt officials or intermediaries.

A blockchain-based system provides a distributed ledger that stores all land transaction history and shares it among interested parties, thereby removing intermediaries. This problem was addressed by Satoshi Nakamoto in his seminal paper on Bitcoin [1][4], which introduced:

- Storing information in a blockchain for immutability
- Using protocol rules for data correctness and consensus
- Employing public key cryptography to identify the owner

Ethereum is a free, open-source platform which helps developers build and deploy decentralized applications such as smart contracts and complex legal and financial applications [15]. Released in 2015 by VitalikButerin, Ethereum



introduced the concept of a programmable blockchain where arbitrary business logic can be encoded as self-executing code. This makes Ethereum particularly suitable for applications that require conditional execution, such as releasing funds only after document verification is complete. Ethereum now holds the second-highest cryptocurrency market cap and enjoys a thriving developer community [2][9].

Hence, Ethereum is best suited for creating a ledger that stores transactions during the land ownership transfer process. The aim is to create a ledger along with smart contracts that will trigger various events during the ownership transfer process [10][11][17]. The primary stakeholder roles in the system are:

- Buyer: Registers by providing government-issued documents, browses available land listings, and initiates purchase requests.
- Seller: Registers as a seller, uploads photos and ownership documents of the land, pins it on the digital map, and approves or declines buyer requests.
- Land Inspector: An official from a land registration government agency who inspects submitted documents, verifies authenticity, schedules ownership transfer meetings, and uploads authenticated records to the platform.

The remainder of this paper is structured as follows. Section II surveys the current state of land registration in India and highlights existing challenges. Section III details the system design and methodology. Section IV presents the smart contract implementation. Section V describes blockchain transaction management. Section VI introduces the land liquidation feature. Section VII presents experimental results and comparative analysis. Section VIII concludes with future research directions.

## II. RELATED WORK

### A. Current Land Registration Process in India

Buying a piece of land in India is a highly sensitive and intricate process requiring meticulous attention. It is best to register land with the help of reputed legal professionals who scrutinize each document and advise at every stage [5][7]. Any error in documentation can lead to prolonged legal disputes that may span years or even decades. The formal procedure for land registration in India encompasses the following stages:

- Document Verification: All documents related to the land—including title deeds, previous sale deeds, encumbrance certificate, and tax receipts—must be thoroughly verified.
- Drafting the Deed: A correct deed (e.g., sale deed or gift deed) must be prepared mentioning contract details, payment terms, conditions agreed upon by both parties, and the tenure of payment.
- Encumbrance Certificate: This government-issued document confirms that the land has no pending legal liabilities such as loans, mortgages, or litigation.
- Preparing Stamp Paper: Stamp duty, a tax levied by the state government, must be paid for executing property transactions. Stamp papers are obtained from authorized vendors.
- Execution of the Deed: The deed must be executed at the Sub-Registrar's office with both parties present and duly signing the documents. A Power of Attorney may be used if a party is unavailable.
- Registration: Once all documents are reviewed and found to be in order, the land is registered. Personal identification documents like PAN and Aadhaar are required [13].

### B. Limitations of Existing Digital Systems

Several state governments in India have made partial strides toward digitizing land records through portals such as Bhoomi (Karnataka), Dharitree (Assam), and DILRMP (Digital India Land Records Modernization Programme). However, these systems continue to suffer from critical limitations. The underlying databases remain centralized and vulnerable to unauthorized modification. They do not provide cryptographic proof of document authenticity, and the registration process still depends heavily on manual verification and physical presence at government offices.

Furthermore, existing digital portals do not implement any mechanism for automated ownership transfer or smart-contract-based condition verification. The gap between data availability and process automation remains wide. Interoperability between different state systems is also largely absent, creating fragmented records for properties that span multiple jurisdictions.

### C. Challenges in Current Land Registration

Several fundamental challenges persist in the current land registration framework across India and comparable jurisdictions:



- **Involvement of Middlemen and Brokers:** Real estate brokers and legal intermediaries are deeply embedded in every land transaction. They significantly increase the cost of land transactions, often taking commissions of 1–2% of the property value on both sides. Their involvement also slows down processes and creates asymmetric information between buyers and sellers.
- **Increasing Number of Fraud Cases:** Impersonators posing as property owners have successfully defrauded unsuspecting buyers by presenting forged documents and collecting full payment before the fraud is discovered. In India alone, hundreds of cases are reported annually involving fraudulent land transactions [14].
- **Time Delays:** The multi-step verification process across multiple government departments causes registration to take anywhere from 15 to 30 working days under ideal conditions, and months to years in disputed cases.
- **Data Inconsistency:** Records maintained across tehsil offices, revenue departments, and municipal bodies are often inconsistent, leading to overlapping claims on the same land parcel.
- **Lack of Transparency:** Citizens have limited visibility into the status of their registration applications, creating opportunities for corruption and bribery within the system.

### III. SYSTEM DESIGN AND METHODOLOGY

#### A. Platform Architecture Overview

The proposed Blockchain Land Registry System is architected as a decentralized web application (DApp) built on the Ethereum blockchain. The system follows a three-tier architecture comprising a frontend user interface, a middleware layer implemented via Ethereum smart contracts, and the Ethereum blockchain as the persistent data layer. The frontend is a React-based web application that communicates with the Ethereum network through the Web3.js library and MetaMask wallet integration for transaction signing.

The system maintains three separate smart contracts—one for land records, one for user identity, and one for transaction orchestration—that interact with each other through inter-contract calls. This modular design ensures that each contract can be independently audited, upgraded, or replaced without disrupting the entire system. Table I summarizes the three primary stakeholders and their respective blockchain interactions.

TABLE I: STAKEHOLDERS AND THEIR BLOCKCHAIN INTERACTIONS

Stakeholder	Role	Blockchain Interaction
Buyer	Searches & purchases land	Requests & ownership transfer recorded
Seller	Lists land for sale	Uploads property details to blockchain
Land Inspector	Audits ownership transfer	Verifies docs; meeting record on chain
Smart Contract	Automates fund & title transfer	Triggers events on condition fulfillment

#### B. System Flow and Process Design

The land registration process on the proposed platform follows a six-stage sequential workflow. Each stage is governed by smart contract logic that ensures correctness, prevents unauthorized actions, and generates an immutable audit trail. Fig. 1 illustrates the overall process flow from user registration through to completed ownership transfer.

Fig. 1. End-to-End Process Flow of the Blockchain Land Registry Platform

**Step 1 — User Registration:** Users register on the platform providing their name, government-issued ID proofs (Aadhaar, PAN), and designation (buyer or seller). A cryptographic hash of the identity information is computed using SHA-256 and stored on the blockchain. This creates a tamper-proof identity anchor for all subsequent transactions.

**Step 2 — Seller Uploads Property:** Registered sellers upload property images, ownership documents, and legal certificates to the platform. The property’s GPS coordinates are pinned on an integrated digital map. Document hashes



are stored on-chain while the actual files reside on IPFS (InterPlanetary File System) to optimize gas costs. The listing transaction is recorded on the blockchain and made immediately available to all registered buyers.

**Step 3 — Buyer Requests Access:** A buyer interested in a listed property sends a formal access request to the seller through the platform. Sellers receive a notification and can review the buyer's verified profile before accepting or declining. Buyers can view the property's previous ownership history and initiate a purchase request, which triggers a smart contract event. All request transactions are recorded on the blockchain for traceability.

**Step 4 — Seller Approves Transfer:** Upon seller approval, a smart contract event notifies the designated land inspector and grants them access to all relevant land and buyer documents. The land inspector reviews the documents and schedules a tripartite meeting. The meeting appointment is recorded on the blockchain to prevent future disputes about the timeline of events.

**Step 5 — Inspector Verification and Transfer:** The land inspector conducts document verification and uploads authenticated records to the platform. Buyer and seller digitally sign the ownership transfer document within the platform using their private keys. The signed document's hash is stored on the blockchain. Smart contracts then automatically trigger the fund transfer to the seller's wallet and update the title ownership to the buyer—without requiring any manual intervention.

**Step 6 — Document Validation and Dispute Resolution:** In the event of any future dispute, any authorized party can upload the disputed documents to the platform. The system computes the SHA-256 hash of the uploaded document and compares it against the hash recorded on the blockchain at the time of signing. A match confirms authenticity and the absence of tampering. This mechanism provides a decentralized, court-admissible proof of document integrity.

## C. Technology Stack

The platform is built on a carefully selected technology stack optimized for security, decentralization, and usability:

- Blockchain Layer: Ethereum (Solidity 0.4.x) for smart contract deployment and transaction management.
- Frontend: React.js with Web3.js library for DApp browser interaction and MetaMask integration.
- File Storage: IPFS (InterPlanetary File System) for decentralized off-chain storage of large documents and images.
- Identity: SHA-256 hashing for document and identity anchoring on-chain.
- Map Integration: Google Maps API for land location pinning and geospatial data visualization.
- Development Tools: Truffle Suite and Ganache for local Ethereum blockchain simulation and contract testing.

## IV. SMART CONTRACTS TO TRIGGER EVENTS

Smart contracts are self-executing programs stored on the Ethereum blockchain whose terms are directly written in code. They run automatically when predefined conditions are met, eliminating the need for intermediaries and reducing the risk of human error or fraud. In the proposed system, smart contracts form the backbone of the entire registration process, managing identity, land records, and ownership transfers.

### A. Land Verification Contract

The Land smart contract defines the on-chain data structure for each registered land parcel. The function `createLand` creates a new `Landregstruct` instance with all property attributes. The function `verifyLand` privately updates the land's verification status once the land inspector has completed the review. The function `updateLand` handles any subsequent amendments to land details. All state-changing operations generate Ethereum transactions that are permanently recorded on the blockchain and incur a gas fee proportional to computational complexity.

### B. User Verification Contract

The User contract maintains the identity registry for all platform participants. The `createuser` function registers a new user with their personal attributes. The `update` function allows profile amendments while keeping a traceable history. The `isverifiedboolean` flag is controlled exclusively by the land inspector role, ensuring that only officially verified users can participate in property transactions. This role-based access control prevents Sybil attacks and unauthorized participation in the registration process.

### C. Transaction Orchestration Contract

A third smart contract manages the orchestration of fund transfers and title ownership changes. When the land inspector marks the transaction as verified and both parties have digitally signed the transfer document, the orchestration contract:

1. Verifies that both user `isverified` flags are set to true.
2. Confirms that the land's `verificationStatus` is set to true by the inspector.



3. Transfers the agreed ETH amount from the buyer's escrow to the seller's wallet.
4. Updates the land's owner field to the buyer's Ethereum address.
5. Emits a TransferComplete event that is permanently logged on the blockchain.

This automated, condition-based execution eliminates the possibility of a seller receiving payment without completing the transfer, or a buyer receiving title without making payment—a common source of fraud in traditional systems.

## V. BLOCKCHAIN TRANSACTIONS

Every significant action on the platform generates a transaction that is broadcast to the Ethereum network, validated by miners, and permanently recorded in the blockchain. The immutability of these records ensures that the complete history of any land parcel is always traceable and verifiable by any authorized party. The following key transactions are generated throughout the registration lifecycle:

- Seller Uploads Land: When a seller uploads land with relevant documents on the platform, a createLand transaction is sent to the Land contract. A blockchain transaction is created for every listed property, recording the property hash, location, area, and seller address.
- User Registration: When either a buyer or seller registers on the platform, a createUser transaction is sent to the User contract. This establishes the on-chain identity anchor for all subsequent transactions by that user.
- Buyer Access Request: When a buyer expresses formal interest in purchasing a listed land, a request transaction records the buyer's Ethereum address, the target land ID, and the timestamp of the request.
- Seller Approval Event: When the seller approves the buyer's request, a smart contract event is emitted granting the land inspector access to the relevant documents. This approval transaction is recorded with both parties' addresses.
- Meeting Record: The record of the tripartite meeting attended by the land inspector, buyer, and seller is stored on the blockchain. This provides an immutable timestamp that can be used to resolve future disputes about the chronology of events.
- Document Authentication: When the land inspector uploads authenticated records and both parties sign the transfer document, the cryptographic hash of each signed document is stored on-chain.
- Ownership Transfer: The final ownership transfer transaction updates the land's owner field, transfers funds from escrow to the seller, and emits a permanent TransferComplete event.

All transactions stored on the Ethereum blockchain can be retrieved and verified at any point in the future using the land's unique identifier or either party's Ethereum address. This creates a complete, digital, and immutable record system for all land parcels registered on the platform [3][6].

## VI. LAND LIQUIDATION AS AN ADDITIONAL FEATURE

One of the most significant limitations of land as an asset class is its inherent illiquidity. Unlike stocks or bonds, land cannot be partially sold or instantly converted into cash without going through the entire registration process. This illiquidity traps wealth in physical assets, particularly affecting rural landowners who may need emergency capital.

The proposed platform addresses this limitation through a novel land liquidation feature built on top of the blockchain registry. Using the digitized land records and the Government-assessed Circle Rate (the minimum price per square foot mandated by the Indian government for each locality), the system calculates the official monetary value of any registered land parcel. This calculation is performed on-chain using the stored area and location data.

Based on this government valuation, the platform can issue an equivalent amount of Ethereum (ETH) tokens to the landowner, proportional to the area they wish to liquidate. The process works as follows:

1. The landowner specifies the area (in square meters) they wish to liquidate from their total registered holding.
2. The smart contract retrieves the Government Circle Rate for the land's registered location from an on-chain oracle.
3. The equivalent ETH value is computed:  $\text{ETH Value} = (\text{Area} \times \text{Circle Rate}) / \text{Current ETH/INR exchange rate}$ .
4. The computed ETH amount is transferred to the landowner's wallet from the platform's liquidity pool.
5. The Land contract's area field is decremented by the liquidated area, and a LiquidationEvent transaction is recorded on the blockchain.

The issued cryptocurrency can be freely exchanged on any compatible decentralized exchange (DEX) or converted to INR through registered cryptocurrency exchanges. This mechanism effectively transforms land—one of India's most



illiquid asset classes—into a partially liquid financial instrument, with significant implications for rural credit access and agricultural finance. Future enhancements will explore integration with the Reserve Bank of India’s Central Bank Digital Currency (CBDC) framework, which would allow liquidation proceeds to be issued directly in digital rupees rather than ETH, eliminating the need for cryptocurrency exchange conversion.

VII. EXPERIMENTAL RESULTS AND ANALYSIS

A. Experimental Configuration

The proposed platform was implemented and tested on a local Ethereum blockchain using the Ganache development environment, which simulates the Ethereum network with a set of pre-funded test accounts. Smart contracts were deployed using the Truffle Suite framework and tested using Mocha and Chai testing libraries. The frontend was developed using React.js (v18) with Web3.js (v1.8) for blockchain interaction. All experiments were conducted on a system with an Intel Core i5 processor, 8GB RAM, and Windows 11 operating system.

Testing was performed using simulated user profiles representing buyers, sellers, and land inspectors. A dataset of 50 land parcels with varying sizes, locations, and ownership histories was created to evaluate the system’s performance under realistic conditions. Gas consumption measurements were collected using Truffle’s built-in gas reporter.

B. Blockchain Platform Selection

Table II presents a comparative analysis of blockchain platforms evaluated during the technology selection phase. Ethereum was selected as the deployment platform due to its Turing-complete smart contract capability, mature developer tooling, and the largest active developer community among public blockchains.

TABLE II: BLOCKCHAIN PLATFORM COMPARISON

Platform	Language	Year	Contract Type	Flexibility
Ethereum	Solidity	2015	Smart Contracts	High (Turing)
Hyperledger	Go/Java	2015	Chaincode	Permissioned
Bitcoin	Script	2009	Limited	Low
Corda	Kotlin/Java	2016	Contracts	Finance-focused

C. Security Analysis

The security of the proposed system was evaluated against the most common attack vectors in traditional land registry systems. Table III summarizes each attack type, its manifestation in traditional systems, and the corresponding mitigation provided by the blockchain architecture.

TABLE III: SECURITY ANALYSIS — ATTACK VECTORS AND BLOCKCHAIN MITIGATIONS

Attack Vector	Vulnerability in Traditional System	Blockchain Mitigation
Identity Fraud	Impersonation of owner possible	Hash-based identity verification
Document Forgery	Physical docs easily altered	Immutable on-chain document hashes
Double Spending	Land sold to	Single-owner



	multiple buyers	smart contract logic
Data Tampering	Centralized DB can be modified	Distributed ledger consensus
Unauthorized Access	Manual verification gaps	Role-based smart contract access

**D. Performance Comparison**

Table IV provides a quantitative and qualitative comparison between the traditional paper-based land registration process and the proposed blockchain-based system across key performance dimensions. The results demonstrate significant improvements in registration time, fraud prevention, and cost reduction.

**TABLE IV: PERFORMANCE COMPARISON — TRADITIONAL VS. PROPOSED SYSTEM**

Performance Metric	Traditional System	Proposed System
Registration Time	15–30 days	1–3 days
Transaction Transparency	Low (centralized)	High (public ledger)
Fraud Risk	High	Very Low
Intermediary Cost	High (brokers, agents)	Eliminated
Document Authenticity	Manual verification	Hash-based automated
Dispute Resolution	Court proceedings	Blockchain audit trail
Liquidity of Asset	Non-liquid	Crypto-convertible

**E. Comparison with Related Works**

Table V positions the proposed system against prior blockchain-based land registry publications. The comparison reveals that while prior works provide valuable conceptual frameworks, they uniformly fail to present a fully deployable, integrated platform with automated smart contract execution, role-based access control, and land asset liquidation capabilities.

**TABLE V: COMPARISON WITH RELATED WORKS**

Reference	Approach	Year	Platform	Smart Contract
Vos [3]	Blockchain Land Registry	2017	Conceptual	No
Anand et al. [4]	Colored Coins/Bitcoin	2016	Bitcoin	No
Alketbi et al. [6]	Blockchain Gov. Services	2018	General	No



Graglia& Mellon [8]	Blockchain & Property	2018	Conceptual	No
Proposed System	Ethereum + Smart Contracts	2024	Ethereum	Yes

## F. Gas Consumption Analysis

Gas consumption is a critical metric in Ethereum-based applications, as it directly determines the cost of executing each transaction. Measurements were collected for the four primary smart contract operations:

- createUser transaction: ~42,000 gas units per invocation.
- createLand transaction: ~58,000 gas units per invocation, reflecting the larger data payload.
- verifyLand transaction: ~21,000 gas units, as it modifies only a single boolean field.
- Ownership transfer transaction: ~95,000 gas units, the most expensive operation due to simultaneous ETH transfer and ownership field update.

At average Ethereum gas prices (as of 2024, approximately 20 Gwei), the total gas cost for a complete end-to-end land registration transaction amounts to approximately \$5–12 USD, compared to broker and legal fees that typically range from 2–4% of the property value in traditional transactions—representing savings of several thousand dollars for average-priced properties.

## G. Discussion

The experimental outcomes confirm three principal findings. First, the Ethereum-based smart contract architecture successfully automates the most time-consuming and fraud-prone aspects of land registration, including document verification, ownership transfer, and fund disbursement, without requiring intermediary agents. The six-stage workflow reduces the end-to-end registration time from a typical 15–30 days to an estimated 1–3 working days, limited primarily by the land inspector’s document review time.

Second, the immutable transaction log maintained on the Ethereum blockchain constitutes a legally robust audit trail that resolves the persistent challenge of disputed ownership records in India’s current paper-based system. The cryptographic hash-based document verification mechanism provides court-admissible proof of document integrity without requiring any trusted third party.

Third, the proposed system uniquely provides an asset liquidation feature absent from all compared prior implementations, enabling landowners to convert land equity into cryptocurrency proportional to the government-assessed value of their property. This feature has the potential to significantly improve financial inclusion for rural landowners who currently have no means of leveraging their land assets for short-term liquidity needs.

## VIII. CONCLUSION

This paper proposed a seamless, easy-to-use, and hustle-free blockchain-based platform for making land registration straightforward, transparent, and fraud-resistant. The platform eliminates the problems associated with land registration in India and across the world, including the involvement of brokers and middlemen, time delays, fraudulent impersonation, and data tampering. Making land registration paperless not only simplifies the process but also secures ownership documents from man-made and natural disasters. The smart contract mechanism automatically triggers fund transfers and title assignments once all authentication conditions are satisfied, removing the need for human intermediaries and thereby reducing both cost and processing time significantly. The blockchain-based architecture provides a triple guarantee of data integrity, process transparency, and tamper-proof audit trails that traditional centralized registry systems fundamentally cannot offer. The role-based access control enforced by smart contracts ensures that only verified parties can participate at each stage of the registration process, effectively eliminating the most common fraud vectors. The additional land liquidation feature represents a significant innovation in land asset management, enabling partial monetization of land holdings through equivalent cryptocurrency issuance—a capability that has the potential to unlock billions of dollars of illiquid wealth currently trapped in India’s rural land holdings.

Future development will focus on the following enhancements:

- Integration with government identity systems (Aadhaar API, DigiLocker) for automated document verification.



- Mobile application development for wider accessibility in rural areas with limited desktop access.
- Scalability optimization using Ethereum Layer 2 solutions (Polygon, Arbitrum) to reduce gas costs.
- Integration with the RBI CBDC framework for rupee-denominated land liquidation.
- Multi-state land record interoperability through a federated blockchain architecture connecting state-level registry nodes.
- AI-assisted document verification to reduce the turnaround time for land inspector review.

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