

Land records on Blockchain for implementation of Land Titling in India

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ABSTRACT

This paper explores the usage of Blockchain Technology for Land Records Management in India. It highlights issues, such as minimal transparency, accountability, incoherent data sets with different Government Departments pertaining to the same piece of land and delays in the current Land Records management process and how to overcome these problems using Blockchain Technology. The paper describes the current process of land records maintenance and land registration in the country, and discusses various challenges encountered during the implementation of Blockchain Technology like public key infrastructure and Internet, privacy rules and security issues. Finally, the paper illustrates a system design using Blockchain Technology for the implementation of Land Titling system in the country, so that land titles are tamper-proof, and provides authentic and conclusive rights on ownership.

1. Introduction

In India, Land Records can be defined as a generic expression that may include records, such as, the Records of Rights (RoRs); tenancy and crop inspection register; mutation register; disputed cases register etc. Land Records also include geographical information of each parcel of land with its boundary, size, soil-type of the land; and economic information related to irrigation and crops (Bal, 2017). Land Titling is a form of land reform in which individuals and families are given formal property rights for land that they have previously occupied informally, or used on the basis of customary land tenure.

The National Land Record Modernization Programme (NLRMP) was launched by the Government of India in August 2008 with the aim to develop a modern, comprehensive and transparent land records management system in the country that ensures guaranteed, conclusive Land Titling of the immovable properties (<http://dolr.nic.in>). The programme was later revamped and re-introduced as Digital India-Land Records Modernization Programme in the year 2014 to establish a modern and an efficient land records management system in the country (DILRMP, 2008). This requires real-time, updated land records for maintenance of conclusive Land Titling system with title guarantee (Thakur et al., 2019; Fetai, 2015).

Most of the States have successfully implemented the digitization of

the existing Land Records and computerization of property registration offices. However, these computerised systems work in standalone mode and there is a lack of trustworthy eco-system for managing transactions and updating the records. The need of a trusted and efficient ecosystem can be addressed by using Blockchain based system. In this paper, the issues related to implementation of a Blockchain based system for maintaining and integrating various sub systems like land records, registration, banks, survey, settlements and courts are described for implementation by the States. This study also tries to elicit a set of research objectives through research questions like...

- 1 How the Blockchain solution shall be used in the States?
- 2 Which PKI infrastructure should be used for digital identities of the individuals?
- 3 How to use the channels and design of smart contacts for better control of the system?
- 4 Provision, if any, in IT Act or Government Regulations related to Blockchain in India?
- 5 Is there any guidelines for use of Aadhaar (12 digit Unique ID to citizen) and Know Your Customer (KYC) in Blockchain?
- 6 What are the prerequisites to start the Blockchain implementation in the States?

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2. Current process of land records updation in India

Land Record management has gone through several reforms like Zamindari Abolition Act (confiscating land from land lords i.e. Zamindars), Land Ceiling Act (to redistribute surplus land to the landless), tribal ownership rights etc. after independence. The land is a State subject; hence the procedure of land records management differs from State to State. Records-of-Rights (RoR) are maintained in Tehsil/Mandal (sub-district administrative unit) office and are not updated frequently. As land records maintenance involves land related details, maps plan and land registration, the records maintenance is done by three State Departments/agencies i.e. Land Records Department, Survey Department and Registration Departments in the States. As each department works in its own standalone manner, records updated in one Department makes it outdated for the other Department. Transactions of land are recorded but the ownership titles remain presumptive. This gives scope for fraudulent transactions, such as double sale, sale by non-owners, unknown buyers (benami), back-dated transactions and so on. About 40 percent of disputes in various courts are related to illegal encroachments and title disputes etc. Land/property can be transferred from one party to another through sale/purchase, land acquisition, inheritance, court orders and bank mortgage as detailed below.

2.1. Process of land registration

In India, ownership updation mainly happens through sale transaction, which is done through registration of deeds. The registration systems are generally classified into two major categories i.e. Deed registration and Title registration (Aggarwal, 2018). In 'Deed Registration', a written conveyance deed is executed between the parties and is registered at registrar office. This registered deed is the proof of transaction for the property and serves the purpose of maintaining land records. The Transfer of Property Act, 1882 gives the right to transfer or selling of an immovable property through registered document. One can get the transaction registered but land title is not guaranteed. The ownership is established through a registered sale deed and some other documents, such as property tax receipts, survey documents and RoR documents etc. Whereas in 'Title Registration' the legal validity of the transaction is verified by the Registrar and the rights are transferred only, if the grantor has clear title to transfer (Aggarwal, 2018).

The current process of Land Registration in India, after the implementation of Digital India Land Records Modernization programme is outlined below and illustrated in Fig. 1.

- The buyer and seller finalize the 'Agreement to Sale' and get it notarized. Usually the buyer pays a token amount to the seller at the time of signing the deal.
- In case the buyer applies for any loan from any bank, the seller needs to obtain 'No Encumbrance Certificate' (evidence that the property in question is free from any monetary and legal liabilities) from the Land Registration Office and share the same with the buyer. The bank sanctions the loan on the basis of buyer's eligibility.
- The buyer pays the stamp duty to Treasuries & Accounts Department either online or through bank deposits after raising the challan through eGRAS (Government Receipt Accounting System, as running in few of the States, namely Maharashtra, Rajasthan, Haryana, Jharkhand).
- The final sale deed is drafted on stamp papers, thus obtained. The full and final amount is paid by the buyer or his/her bank to the seller and the sale deed is signed by both the parties and two witnesses.
- The deed is registered at the Sub-Divisional Registrar Office (SRO). The SRO checks for identity and map of the property and registers the property. The original registered deed is collected by the buyer or his/her bank.

- The buyer now applies for mutation with required documents (such as affidavit, property tax receipt etc.) at the Patwari's land revenue office at the Taluka (Tehsil/ Block) level.
- The Patwari records the statements of both the parties and matches them with the submitted documents. The Patwari issues a proclamation by inviting objections.
- Mutation is granted, if no objections are received. Otherwise, the case is transferred to the Revenue Assistant Officer for resolution.

2.2. Land records updation through land acquisition, inheritance and court order and mortgage

Land Acquisition is another process, wherein agricultural and/or non-agricultural lands are acquired by the Government for various developmental activities such as village/town extension, construction and/or development of Roads, Culverts, Reservoirs, Canals, Military Camps, Railways and Industries. The Land Acquisition Act, 1894 governs the process of acquisition of land in public interest, which is a central act. The land privately owned and occupied by the citizens and non-governmental organisations are subjected to acquisition. While the Land Records system helps in finding the land owners, and types and extent of land; Land Acquisition system helps in speedy land acquisition, and settlement of the dues and disputes. After the notification of the land and acquisition of the land, the title and ownership gets updated in the respective land registers (known as Khasra and Khatoni in majority of the States).

The ownership rights are also updated by Patwari/Talathi, revenue official at village level, because of inheritance or death cases. The Patwari has the power to transfer land to the heirs within the prescribed time.

The updation of ownership right is also done through court orders. Further, when owner takes loan, the lending bank makes the entry in the land records database about the mortgage of the property against which loan is taken by the land/property owner. Though the transactions generated through land acquisition, inheritance, mortgage and court orders are not many, they need to be recorded for keeping the system updated and complete.

2.3. Problems in the existing land records

The existing land records available in the country are not clear, poorly administered and often, do not reflect the ground reality. Maintenance and availability of information of land records are a few critical challenges faced by the Government. The major factors behind such inadequate systems are their derivation from the ancient 'Zamindari' system. Additionally, the current legal framework of India does not ensure guarantee of ownership. This information is updated and stored by different Departments at the District or village level. The data among these Departments is not synchronised regularly, which creates discrepancies in the records and often the information on the documents mismatches with the ground position. Poor handling of the processes of land transaction and record keeping affects the management of land markets in the country (Aggarwal, 2018).

According to Ease of Doing Business Survey 2017 by World Bank, India ranked at the 154th place in case of land/property registration. This index is based on the quality of land administration; transparency of information system; and time and cost. In the developing countries, land registry face a lot of issues and uncertainties in the demarcation of land. Some of the major issues with the existing system are:

- (1) Multiple Agencies such as - Land Records, Survey, Courts, Bank, and Registration Department) and the lack of coordination amongst them
- (2) Old and outdated cadastral (graphical and textual) records and their improper management
- (3) Inadequate usage of IT Systems

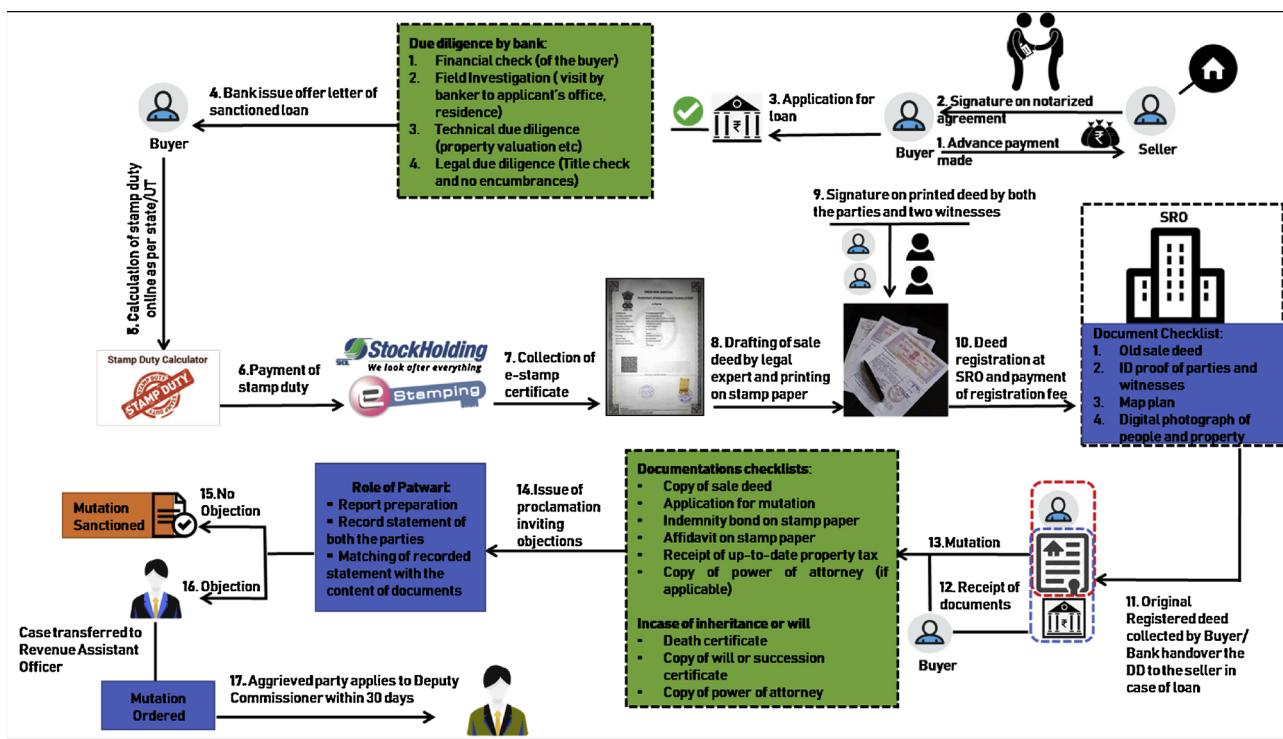


Fig. 1. Process of Land Registration in India.

- (4) Old/Traditional and costly methods of surveys/resurveys
 (5) Fraud and corruption - Some of these critical issues can be addressed by using emerging technologies such as Blockchain, which is briefly discussed in the next section

3. Application of Blockchain technology for land record management

Blockchain is a digital decentralised ledger distributed across a network of computers called ‘nodes’ that keeps record of all the transactions, which take place between peer to peer running the same protocol. This ledger runs over the internet and is cryptographically secure, append-only, immutable and updateable only via consensus or agreement among the peers. In Blockchain Technology, the transactions can be registered without the services of any Trusted Third Party. It is a method of recording data - digital ledger of transactions, agreements, contracts - anything that needs to be independently recorded and verified. It knows who owns what at a certain time. It keeps track of transactions, it knows when a transaction took place and it ensures that there is always one single owner of any item or unit and no double usage is happening of the same (Graglia & Mellon, 2018; Velasco & Steudler, 2016; Oprunenco & Akmeemana, 2018; Anand et al., 2016).

The digital signatures in Blockchain are replaced with a string of letters and numbers, called ‘hash’. Once a block of data is recorded on the Blockchain ledger, it becomes extremely difficult to change or move that particular data. If someone wants to tamper the data in Blockchain, participants in the network - all who have existing copies of the running Blockchain can verify the proposed transactions with the originating hash. The transactions ‘hash’ has to match the Blockchain’s history (Bowden et al., 2018) (Fig. 2). If the majority of the nodes reach to the consensus of the transactions validity, then it will be approved and added to the ledger (Baliga, 2017). This makes Blockchain a transparent platform.

All the data logic comprising of logs on what is getting saved, who is saving it and who is resolving conflicts are handled by smart contracts on Blockchain. Using them, people can trade on the Internet without the need of a middleman. They are governed by neither central

authorities nor human intervention (Mohanty, 2018; Spielman, 2016).

3.1. Smart contracts

Smart contracts are contracts that can be completed without any human interaction. They are the building blocks used for creating decentralised network. Through smart contracts, a person can exchange money, property, shares or anything valuable in a transparent and easy way, while avoiding services of a middleman.

A smart contract is a programme that runs on Blockchain, whose current execution is enforced by the consensus protocol (Luu, Chu, Olickel, Sxaena, & Hobor, 2016; Vos, 2016). It is an immutable digital notary that proves the ownership and existence of documents, which are subjected to deal with property. The advent of crypto currencies like ‘Bitcoin’ proved that valuables can be exchanged over Internet without involving any third party like banks in between. The decentralised distributed structures make it possible to distribute trust among all the nodes involved in the transaction. All nodes download and store the copy of each single transaction made in the network. The ‘proof of work’ algorithm makes the complete process secured and hence, tampering and hacking is less likely to occur. Contracts can be encoded on any Blockchain, but Ethereum is most favoured as it gives unlimited processing capability. In Ethereum Blockchain, we can store transaction along with smart contracts (code snippets) in the blocks (Mukhopadhyay, 2018).

The Hyperledger Composer is an extensive, open development toolset and framework to make developing Blockchain applications easier. Hyperledger Composer supports the existing Hyperledger Fabric, where transactions are validated according to policy by the designated business network participants (Hyperledger Composer, 2019). Hyperledger Fabric offers a number of SDKs to support various programming languages. There are two officially released SDKs for Node.js and Java (Hyperledger Fabric, 2019).

3.2. Land records in Blockchain

In present days, most of the land records in India are available in

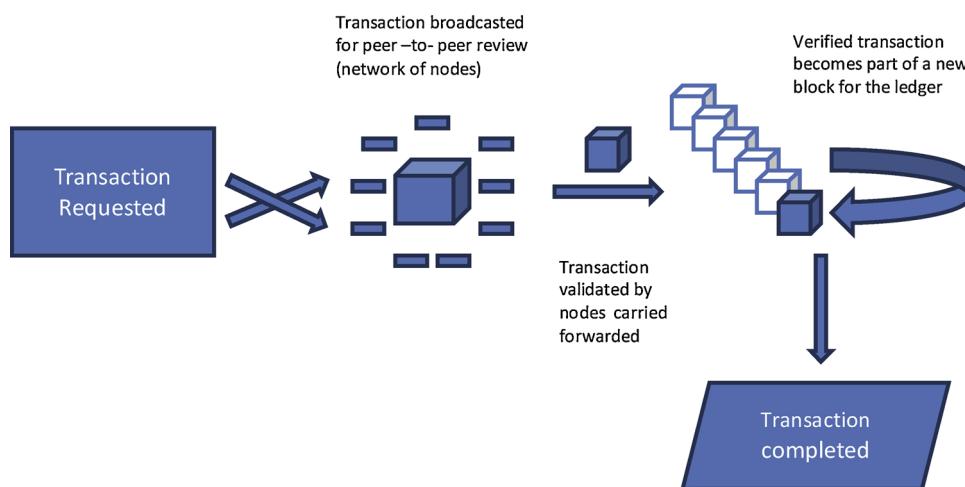


Fig. 2. Process of Transaction through Blockchain.

Management Information Systems (MIS). But making the changes in the ownership of the records is a major challenge for the present systems (Ratan, 2018; Swan, 2017). Blockchain Technology can play a crucial role in keeping the track of the records and in determining the ownership. By connecting the Land Records Department, Registration Department, Banks and other concerned Departments in a Blockchain Technology network, ownership can be determined easily, transfer of ownership can be done in lesser time and records can be maintained in a trustful way.

As base records are already digitised and available in MIS, to the existing transactions can be migrated to Blockchain architecture as shown in Fig. 3.

Land Records Maintenance and transfer of property using Blockchain would eliminate our dependency on third parties involved in the verification process. Thus, allowing us to have a greater degree of confidence in land titles and safer transactions. Adopting this new system of Blockchain in land records and registry would bring real digital trust among the parties involved as all the peers can make quick decisions, if they have complete data regarding the land at the same time. The system would be transparent and integrated because of the following reasons:

- 1 On demand access to records
- 2 Transactions are grouped in blocks
- 3 Each record is linked to previous one using cryptographic hash thus forming a chain of blocks
- 4 Records are incorruptible, immutable and cannot be duplicated
- 5 Have irrefutable unique digital signature
- 6 Records once set chronologically cannot be changed in time
- 7 Are decentralised and regulated without human discretion

3.3. Examples of Blockchain implementations in land registry management

The Government of Republic of Georgia is the first Government to introduce Blockchain Technology in Land Registry Management. The Georgians can register their lands and transact on Blockchain for the same thus, reducing the conflicts in registration process and property exchange (Dasgupta, 2017). The notary services for the ownership verification and proof of transaction is not required as such transactions are automatically added onto the digital ledger. The records of title are immutable on Blockchain and compared to paper records or digital database, they are held on a secure cloud (Mukhopadhyay, 2018; Ying et al., 2018).

Recently, the Government of Andhra Pradesh has partnered with a Sweden-based company Chromaway to build its Blockchain-based solution for land registry. The multiple Ethereum nodes (in case of

Andhra Pradesh Blockchain land registry) will allow property deeds to be stored on a Government Land Registry (Mukhopadhyay, 2018). The solution would facilitate asset ownership transfer from property seller to buyer, approved via Land Department, and it demonstrates possible integration with the other Government entities, such as State Municipal Department and Water Department.

3.4. Data flow and transaction process in Blockchain

The data flow between various entities in land registry process is shown in Fig. 4. The approach for applying the Blockchain Technology to land registration system in India has been discussed in the following section. The records are shown in blue colour in the centre. The traditional processes are shown in the outer ring. All the nodes (Bank, Notaries/Court, Survey, SRO, Tehsil) are part of the Blockchain. The nodes are distributed across a widespread network and carry the tasks assigned.

3.4.1. Participants (nodes) of the proposed Blockchain based land registry system

The nodes in the proposed Blockchain are shown below:

Node 1: Bank (Mortgage/Loan, Buyer, Owner)

The banks are the key institutions of financial lending and carry out the financial transactions between the buyer and seller.

Node 2: Notaries/Court (Property Deeds/Disputes)

The notaries are private entities and facilitate the preparation of deed papers for various transactions.

Node 3: Survey and Settlement Department

The Survey and Settlement Department in the States are entrusted with the responsibility of conducting surveys of the rural areas for mapping the land parcels. They usually prepare the cadastral maps in 1:4000 scale. This Department is also responsible for the updation of existing survey maps to carry out mutation by inheritance, sale.

Node 4: SRO Deed registration, Deed issue

The SRO office is the place, where the sub registrar officiates his basic activities like registration of the deeds and store the deed registers in safe custody. In a few States (Haryana and Punjab) the SRO and Tehsil office work as a single unit.

Node 5: Tehsil Office (Validation/Updating of records)

The Tehsil office is the basic unit of land records system, where all records are maintained and updation is carried out. All the basic land records and registers are also maintained at this office. This also acts as front office for various citizen services. Below Tehsil Office, Village Level functionaries (Patwaris) keep updating the land records for each village on a regular basis.

A node can either be a communication endpoint or a point of

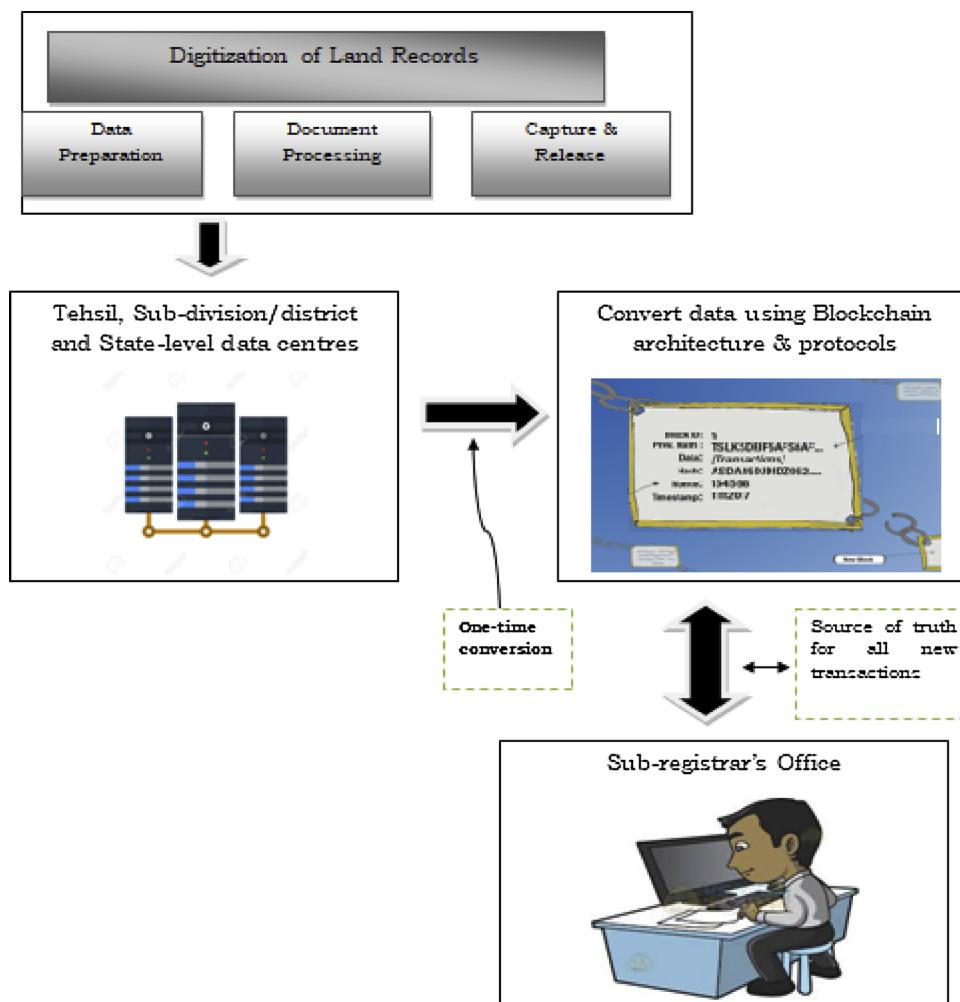


Fig. 3. Blockchain Architecture.

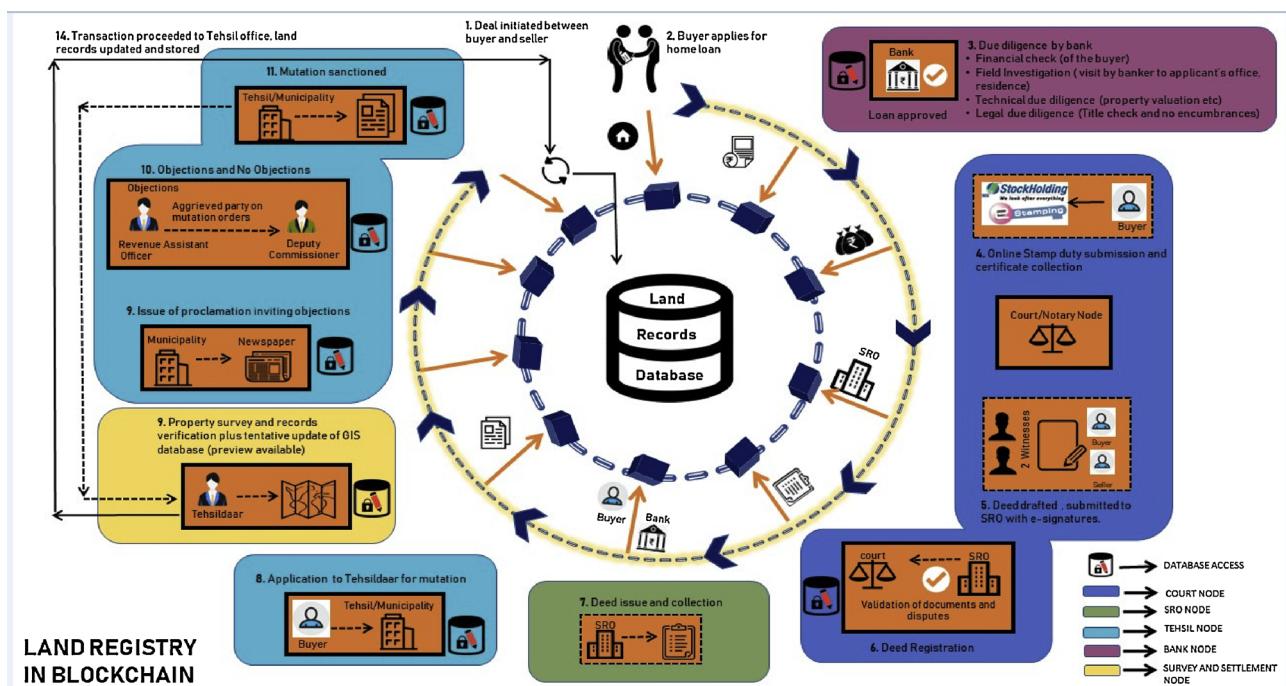


Fig. 4. Blockchain Usage to Update Land Records.

communication redistribution, linking to other nodes. Every node on the network is considered equal; however each node has different roles in which they support the network. For example not all nodes will store a full copy of Blockchain or validate transactions (LiskAcademy, 2019). However, all involved nodes listed above would have access to the full copy of Blockchain.

3.4.2. Step-wise process of land records process in Blockchain

The process flow of maintenance of land records during registration using Blockchain Technology is explained below:

- The buyer goes through the official 'Land Management Information' portal of the State, where he identifies and selects one among the listed lands/properties as per his/her requirement.
- Both buyer and seller negotiate and agree on the terms and conditions of the purchase. Once the deal is initiated, the transaction is made public through the council of administrators, (nodes) who independently holds identical copy of the transactions. A consensus is generated with the involved nodes and transaction is approved. As a result of the transaction, block is added to the ledger.
- The buyer now applies for property loan from a respective Bank, which is also one of the administrative nodes. The bank ensures due diligence in its process. Only after the complete authentication, it approves the proposed loan and offers approval letter to the buyer. The copy of the offer letter is issued to the buyer and a transaction is validated by the nodes involved. As a result, a block is added to the ledger again. (Node -1)
- The buyer calculates the stamp duty using e-stamp calculator and pays the stamp duty via eStamping system of Stockholding Corporation of India Limited. The transaction is validated by consensus of the nodes and a new block of data is added to the ledger. (Node-2)
- Buyer gets the deed drafted and electronically signed by self, the seller as well as two witnesses. The signed deed is submitted to the Sub Registrar Office and registration fee is paid online. The concerned authority puts up the receipt of registration fee and a copy of submitted deed on the network for approval. The majority of the nodes are approved and a block is added to the Blockchain (Node -4).
- Sub Registrar office (SRO) verifies all the submitted documents including map plans and ID proofs. Once done, the SRO issues the registered deed to the buyer/bank. The issued deed is approved by the consensus and a block is added for this transaction (Node-4).
- The buyer applies for mutation at the Tehsil office. The application is put up by the authority for approval of the nodes. A block is added to the ledger indicating the authenticated transaction. (Node -5)
- Tehsildar verifies all records and property maps. A preview of changed map on the Management Information portal is generated, which can be viewed by all the participating nodes including 'Buyer' and 'Seller'. Network of nodes validate the transaction for the approval of mutation. A block is added to the ledger (Node-3).
- The Revenue Office / Municipality issues proclamations inviting objections through newspapers and digital platform. Network of nodes validates the documents regarding proclamations and approve to publish them. As verification is completed, a new block of data is created for ledger (Node-5).
- If Department receives no objections, the Revenue Office/Tehsil Office/Municipality puts up documents to get the approval from the nodes before sanctioning the mutation. If there are objections regarding proclamations, the municipality transfers the issue to the Revenue Assistant Officer and later to the Deputy Commissioner (if any of the party is aggrieved). The orders regarding proclamations are put up for approval by the concerned nodes. The approved transactions lead to the generation of a new block to the ledger (Node-5).
- After the objections are solved, the municipality sanctions the

mutation and the order is put up for approval from the concerned nodes. The consensus is generated and a new block is added (Node-5).

- The addition of new block transfers the message to the Tehsil office to permanently update the land records database and all land records are updated and stored. (Node -3).

4. System design details for the implementation of Blockchain in land record registration

Any particular property has few elements like khatano (owner account number), khata owner (owner name), owner's father, address, khasrano (parcel ID), total area, buyer, buyer father and area to buy. So, new class is being created known as add New Property. When the property is registered for the first time, in its records is pushed into the block with hash. Next, when the owner sells his property then it takes the details of the buyer and how much (area) he/she wants to buy. The same information is stored with current hash along with the previous hash. If anyone changes it, it returns false that means this record is not valid. The interactions between the various modules are shown with the aggregation and association relationships. All the classes (Transfer Property, Land Records, Mutation Inheritance, Court, Land Acquisition, Survey and Settlement, Convert To Block) are indicated with the attributes and functions. The proposed details of the classes with attributes and functions are shown in Fig. 5.

5. Challenges in implementing Blockchain technology in developing countries

Blockchain offers faster, simple and hassle-free process of registering property and keeps the data tamper-proof. As every technology has some drawbacks, Blockchain also has a few limitations (Rangaraju & Chandra, 2017; Bal, 2017; Hughes et al., 2018; Kshetri, 2017).

- i) Being a new technique, there are very less proof of concepts available: Blockchain Technology started gaining momentum, since last few years. In India, there are very limited case studies and implementations of application with the use of Blockchain Technology in the Government sector. The efforts are initiated by some of the State Governments to adapt Blockchain Technology to track items in the manufacturing sector and supply chain sector. Few States, such as Haryana, Punjab and Madhya Pradesh have just started floating tenders to include Blockchain enabled system for integrated land records and registration process.
- ii) Lack of specialised expertise in Blockchain development: Blockchain being a new technology, the number of experts and programmers/developers familiar with various Blockchain platforms (public, private, hybrid) for development of smart contracts, crypto currency and various consensus protocols are limited. There are limited national level organisations (Private/ Government) with necessary pre-requisites and implementation for carrying out successful training on Blockchain Technology.
- iii) Its immutable nature makes it hard to modify anything at later stage: The immutable nature of transactions in Blockchain Technology creates fear in the minds of the employees and they (revenue functionaries) tend to continue with the existing computerised systems, rather than adopting the new technology.
- iv) There would be an issue of key management especially in private Blockchain: The Government PKI infrastructure and eSign mechanism (<http://cca.gov.in>) is not associated in key management in case of public Blockchain implementations yet. In case of private Blockchain, there are no guidelines till now regarding the usage of keys or key management from the Government of India. There are instances of closure of the existing PKI infrastructures because of cyber attacks and security lapses.

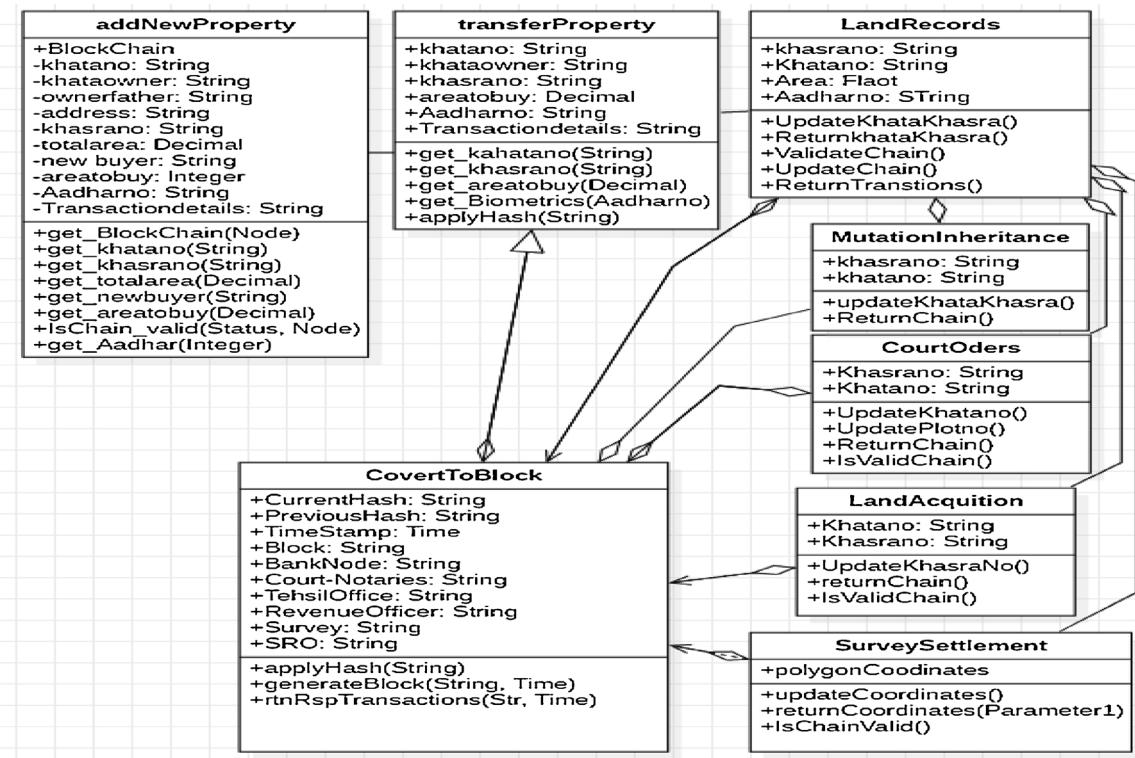


Fig. 5. Class Diagram of Operations, Blocks and Nodes in Land Record Management.

- v) There are no regulatory standards that govern application across jurisdiction. There are no regulations on how the transactions should be written. The minimum set of attributes required for recording a transaction is not fixed by any regulatory body in India. So for the implementation of Blockchain Technology, there should be identified, minimum set of attributes by the implementor State for each sector. Decisions like the number of Blockchains that can be maintained needs to be finalised by an approving or recommending organisation. May be theme wise, Blockchains can be maintained. In present land records maintenance ecosystem, we are maintaining single Blockchain for all transactions. The infrastructure requirements increase in case there is a need to maintain number of Blockchains based on themes.
- vi) The open source consortium organisations have their own standards and codes they follow: The open source implementation of Blockchain has their own consortium and there were many instances of security violations.
- vii) Cost of set-up of massive network for the implementation of Blockchain requires high initial costs: The establishment of a network with required bandwidth to maintain the nodes is a big task. In India, the network availability is still very low. Further, the databases for land records are still maintained at District Levels/Taluka levels in many States. The updation of land records data is still carried out in Taluka level offices, where the Tehsildar is the custodian of the basic registers.
- viii) A successful Blockchain network that consists of huge records of ledger may suffer from latency issues: The need of network and the interactions of the nodes with the traditional database servers are required for the complete knowledge about the transactions and the various entities associated with the transactions. There is a need of high-end servers not only to cater to the exiting load but also the extra connections required for replication of the transactions to all the participating nodes. Further, the layout nodes and its efficient implementations are yet to be explored and it becomes

difficult in case of non-availability of implementations. For example, in private Blockchain implementations, one can create multiple channels to facilitate a group of nodes and isolate them from the others to meet the business requirements. The multiple channels have to be incorporated with multiple smart contracts. The judicious use of business rules and smart contracts are highly essential for a successful implementation of Blockchain.

In order to overcome these issues, the Government of India has initiated installation of special technology excellence centers, i.e. Centre of Excellence (COE) with requisite manpower and resources. Further these centres have collaboration with various technology institutes like Indian Institute of Technology (IIT's) and National Institute of Technologies (NIT's). The Government of India (GoI) has also started funding Blockchain projects to various start-ups. The GoI has also started strengthening the PKI infrastructure and public network enhancements with the help of industry.

6. Findings and discussion

6.1. How the Blockchain solution shall be used in States?

It is understood that Blockchain Technology provides a tamper-proof and authentic solution for storing and managing transactions. But what constitutes the transactions, how many attributes should be taken up in the transactions related to a plot, ownership, geographic boundary coordinates of the plot etc., need to be finalised (Adam and Tomko, 2018). Further as all the business logics for interaction with Blockchain are kept in smart contracts, the development of smart contracts needs high attention. The mere recording of the transactions and few important attributes related to a plot, owner and the deed does not guarantee the preservations of the records for archival purposes. The digital versions of the actual records are available only in the relational databases not in the Blockchains. There should be a one-to-one relation of the transactions and the real physical, digital versions of the

records, which should also be planned thoroughly before or during the implementation of Blockchain Technology. The physical cadastral maps and ROR's are still valid in the court of law.

6.2. Which PKI infrastructure should be used for digital identities of the individuals?

In public Blockchain platforms, one can use the inbuilt module available for generating public keys and private keys. In case of consortium or Private Blockchain Systems, one can use external or internal fabric Certifying Authority (CA). The key generation process and the validity of the key (duration) in the current available infrastructures are limited. The duration of the validity of key and its management in case of transfers or changes in the manpower at different levels should be well documented and well regulated.

6.3. How to use the channels and design the smart contracts for better control of the system?

The channels help in providing privacy between different ledgers. The channels can be designed to enable sharing among specific peers to meet the local or constitutional requirements of a specific locality. And few peers can work in multiple channels. The chaincode (smart contracts) are instantiated as per the need of the channels and participating peers. This needs an ideal design to handle the performance and scalability requirement. This issue is applicable in case of private Blockchains only.

6.4. Provision, if any, in IT act or government regulations related to Blockchain in India?

So far, there is no specific provision for usage of Blockchain in IT Act. Also, the Government regulation is also not available though it was indicated that the supply chain ([Kshetri, 2018](#)) will have a better control in Blockchain based implementations ([Queiroz and Wamba, 2019](#)).

6.5. Is there any guideline for using of Aadhaar number and Know Your Customer (KYC) in Blockchains?

There are still no clear guidelines for usage of Aadhaar and /or KYC for Blockchain based implementations.

6.6. What are the prerequisites to start the Blockchain Implementation in the States?

First, the respective State has to ensure that all data related to basic systems like land records, cadastral mapping, Office of the Registrar and other stockholders, if any, should be consolidated at a Data Centre at an appropriate hierarchy (like Dist / Sub Dist) and available in digital formats. The respective State should also identify organisations and Departments from whom support can be availed for a solid public key infrastructure and certifying authority services. The decision of public or private Blockchain approach should also be decided based on the anonymity of the validators.

7. Conclusion

In India, maintenance of land records and its regular updation has been a challenging task. The citizens even lack confidence in the existing systems prevalent in the States. Citizens are unsure, if they legally own a piece of land, even if they have a legitimate sale deed. Others who want to buy a piece of land are not sure whether the seller legally owns it. In a situation like Kerala, where the flood destroyed paper records, Blockchain Solutions could have taken up as an alternative.

Blockchain Technology gives us a chance to fix many of these problems and provides cascading benefits. The solutions suggested in this

paper incorporates many key benefits of the technology, such as: an immutable history of transactional records, so no one can ever doubt the authenticity; records are permanently linked to the system, so no one can ever tamper with or forge a record of their own; and these records can be seen by any party, at any time. It is powerful and validating.

The introduction of Blockchain Technology for land ownership and land registration process will bring clarity in ownership, valuation and reduce fraudulent transactions. This will also lead to better land management and conveyancing, and enhance the Gross Domestic Product (GDP) of the country. Blockchain Technology will also facilitate achieving Sustainable Development Goals (SDGs) ([Hughes et al., 2019](#)). The correct and secured land records will strengthen the SDG goals including Peace Justice and strong institutions, as institutions will be effective and more accountable as the land transactions will be non-reputable and open to all.

The paper suggests leveraging the inherent benefits of Blockchain, with a focus on smart contracts. The system will capture and permanently record each transaction done either through sale of a property, inheritance, court orders and land acquisition etc. This means you achieve near real-time updated records with accurate traceability and transparency into the state of the property records. This will create a single source of truth of ownership status and history of a property transaction. The buyer will be assured that the land being bought is the correct plot, and that the seller is unequivocally the owner, reducing the potential of forgery and disputes, as well as the costs and time involved, for any given transaction, paving way to implement conclusive Land Titling system with title guarantee in the country.

7.1. Limitations and future research directions

The information related to land records, registration and surveying is maintained at different levels like Tehsils and Blocks. All the data is not available centrally, rather it is maintained in isolation at different levels. Further, the boundary updation of land parcels are still not updated and not clearly demarcated for individual users. Still the shares are maintained among the group of owners. The individual transactions should lead to clear, identified entity or object. Hence all the parcel boundaries and shares should be clearly identified by boundary coordinates ([Torun, 2017](#)). Before initiation of Blockchain implementation, the States should focus on this point. Further the data should be maintained in central servers at appropriate hierarchy and it should be for all the Departments like Land Revenue Department, Registration and Survey and Settlement Department etc.

Since the data is maintained at different Departments, business process engineering is required for each State to have a standard operating procedure. But land being a State subject in our legislation, the State has the exclusive power on this subject. The Government of India should make standard operating procedures for implementation of Blockchain based systems applicable to all the States.

The current process of designing of a Blockchain system is based on the subject or context. There is no generic and uniform design of Blockchain available. The research should be carried out in these directions. The load on the Blockchain system will gradually increase and the transactions will increase because of population growth. The legal requirements to meet the need of any disputes in case of Blockchain implementation also requires to be notified by the Government. In future, it is also essential to integrate Blockchain Technology with Artificial Intelligence (AI) for making the complete land management ecosystem safer, faster, transparent and responsive.

Disclaimer

The views expressed by the authors are not necessarily of the organization to which they belong nor should the article be viewed as the policy matter of the organization/the Government of India.

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