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“Usage of Blockchain in Indian Land Registration and Land Recording System - A Revolutionary Step”

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Abstract: In present-day land recording and land registration systems of India can be professed as mistrustful, inefficient and outdated despite that India has completed 94.53% digitization of its land records. Due to loose coupling among different land related government departments and centralized data storage system, various types of forgery and lots of legal disputes are still there in the present system. For this reason real landowners are still suffering from numerous land related litigations and which creates confusion about the existing system's reliability and effectiveness. This causes judicial huge waste of time. The government needs to protect dwellers rights of records rendering a smart transparent web-application enabled e-Governance, supported by a competent substratum technology. Adoption of the Blockchain, the underlying technology of cryptocurrency, could be a most exclusive and assured way out to solve these issues related to land recording and land registration systems. Established systems could achieve a peer-to-peer, collaborative, trustworthy, secure, transparent, reliable, scalable and real-time based system. Blockchain technology assures users of inviolability and has no way to anticipate breach of contracts. The objective of the present study is to focus on how significant impacts we can observe through the implementation of a Blockchain based land registration and land recording system.

Keywords: Blockchain technology, Hyperledger Fabric Blockchain, land records, land registration, chaincode.

I. INTRODUCTION

In the technological world Blockchain technology is the most viral research topic for its well acceptance in vast sectors, from academia to business houses. After digital war, when security of data is the main issue, recognition of Blockchain comes at that point.

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With the help of Blockchain technology, one can securely store and manipulate important data like copyrights, property data, business data, health related information etc. Blockchain technology follows peer-to-peer architecture in which transactions can happen directly one-to-one, without any third party intervention and its efficacy of distributed networking

establishes an uninterrupted network of services. Blockchain technology is the world's first peer- to-peer electronic monetary system. In 2008; Satoshi Nakamoto first implemented this technology on an electronic transmission system and has started a new era of cryptocurrency [1]. Depending upon different variants of Blockchain technology viz permissioned or permissionless and using cryptographic key, digital signature etc Blockchain technology successfully satisfied the process of authentication which reduces the possibility of user's information being unveiled to cyberpunk. Another uniqueness of Blockchain technology is the use of consensus mechanisms which take the leadership part and conduct the transaction process by imposing different algorithms. As Blockchain is a network based database (Distributed Ledger Technology), it cloned on multiple computers (nodes) worldwide. So, instead of individuals, a large community managed this distributed database and chances of malfunctioning of data are negligible. Whenever any transaction happens, it goes viral all over the network. Then consensus algorithms of all participating computers verify the legitimacy of the transaction. If the majority (more than 50 percent of participants) of the computers validates the transaction then the transaction is confirmed and this new transaction is linked with the

previous related transaction via hash functions and that's how the immutable Blockchain data structure is established. Some of the remarkable consensus algorithms used to apply for Blockchain technology are PoA (Proof-of-Authority), PoI (Proof-of-identity), PoS (Proof-of-stake), PoW (Proof-of-work), Ripple, DPOS (Delegated proof of stake), PoC (Proof-of-concept) etc[2][3].

The ability of Blockchain has extensive reach. Besides the electronic monetary system, Blockchain technology also started adoption in different sectors like banking and finance, insurance, music and entertainment, artificial intelligence (AI) based systems, health care, records of property, smart contracts, supply chain, voting, Internet-of-Things(IOT), media etc[4]. Among these, the Land Records Management System is one of the most effective practical examples. Because the Land record management system is associated with different government departments, financial institutions, non profitable organisations and above all, the land records of all the countrymen should be carefully and securely recorded here. Therefore the successful implementation of the Blockchain technology with a small piece of codes (smart contracts) which defines the protocol for the system, can restrain land related document forgery in land recording and land registration [5].

Different countries are coming forward to implement Blockchain technology in their land registration and land recording systems. They are in the following different development stages: Japan, Canada, Ukraine, United States- State Government, United Arab Emirates (UAE), Dubai are in initial Stage; Russia, Ghana, India, Netherland are in Development State; Sweden, Brazil are in testing stage and Republic of Georgia is in successfully functioning stage [6].

India has also started stepping towards this revolutionary change. In India we don't have any universal system for land registry and it's also under state governments. It is necessary to have a common platform for land recording and land registration systems throughout the country. Traditional land record and land registration system in India suffer from many following drawbacks: most part of the system is still paper based; lack of transparency; time consuming and slow process; poor and asynchronous maintenance of land records; chances of data loss and malfunctioning; threats of Cyber-attack; double spending problem; corruption; third party interference; high operational expenses; difficult to establish ownership and growing number of litigations [7]. To eliminate these issues regarding transfer and recording property rights, The Department of Revenue & Land Reforms is looking forward to adopting

Blockchain technology all over the country and though pilot projects have already been implemented in a few states [8][9][10]. In this paper we have discussed

The rest of the paper is arranged as follows. Section II the types of Blockchain network, section III essential components of Hyperledger Fabric and its logical architecture, section IV functioning strategy of Hyperledger Fabric Blockchain, section V explains cardinal factors of land registration and land records system using Blockchain technology, section VI explains proposed Blockchain technology implemented land recording and land registration system and section VII explains conclusion.

II. Types of Blockchain Network [11][12][13]:

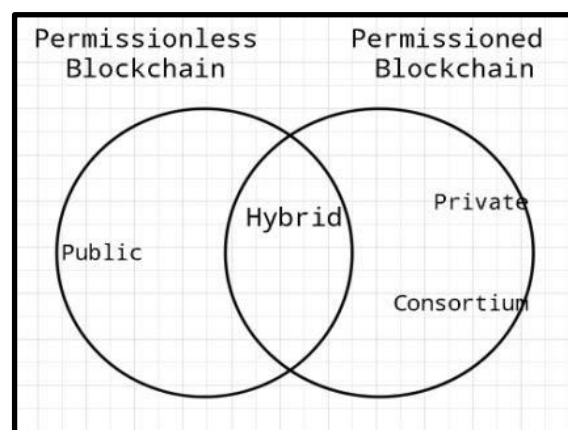


Figure 1 types of Blockchain network

- Public: Permission less; without any central authority; completely decentralised, highly secure; no restriction for joining; for accessing data, create new node and

authenticating transactions all nodes have equal rights.

- Private: Permissioned; governed by single authority; partly decentralised because restricted public access, less secure; restricted joining; for accessing data, creating new node and authenticating transactions all nodes does not necessarily have equal rights.
- Consortium: Permissioned; governed by a group; better decentralised than private Blockchain, more secure; restricted joining; governing group select who may access data, create new node and authenticate transactions.
- Hybrid: Combination of a private permission-based system alongside a public permissionless system; governed by authority who can access specific data stored in the Blockchain, and what data will be opened up publicly; transactions and records are not made public but can be verified when needed, such as by allowing access through smart contracts.

III. ESSENTIAL COMPONENTS OF HYPERLEDGER FABRIC AND ITS LOGICAL ARCHITECTURE:

Following components enrich Hyperledger Fabric [14]:

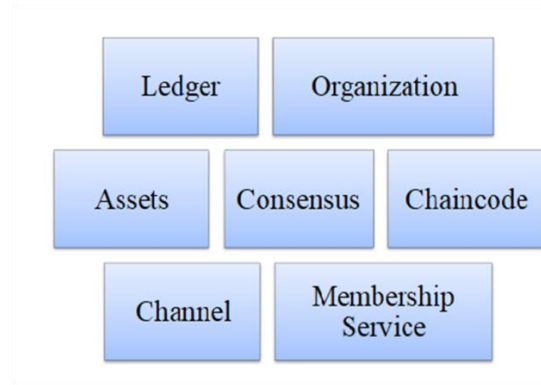


Figure 2 components of Hyperledger Fabric

Ledger:

It stores crucial information about business objects, both the current value of these attributes of the object (World state, database of the ledger) and the history of transactions that result in these current values (Blockchain). The value of the world state changes over time, but once recorded in the Blockchain, it does not. So we can easily derive the value of the world state at any given moment from the Blockchain.

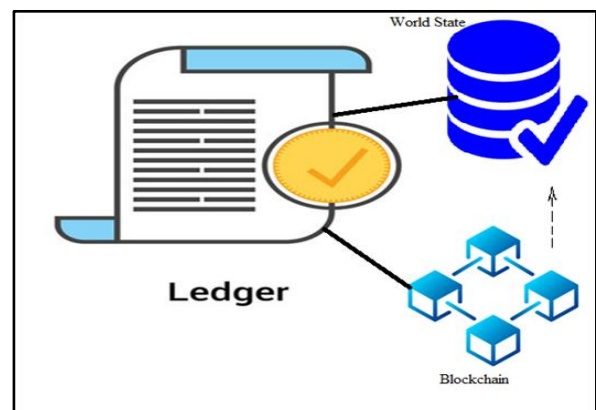


Figure 3 ledger consists of world state and Blockchain

Assets:

In Hyperledger Fabric, assets can be anything, for example real estate, land, contract etc. Assets defined by Hyperledger

Fabric as key-value pairs, for example key=LAND and value= Sali/ Suna / Pond /Bastu/ Apartment etc. Executing chaincode Hyperledger Fabric can modify assets data through transactions.

Consensus:

Though different permission-less Blockchain networks rely on probabilistic consensus, Hyperledger Fabric relies on deterministic consensus algorithms. Also the modular architecture of Hyperledger Fabric supports the kind of flexibility that organizations can choose their own consensus mechanism which best suits their network among three: SOLO, Kafka, and Simplified Byzantine Fault Tolerance (SBFT).

Chaincode:

For installation in Hyperledger Fabric, multiple smart contracts are collectively placed in a wrapper, called chaincode to be made available for applications. Chaincode of land registration process is shown in the Fig.4.

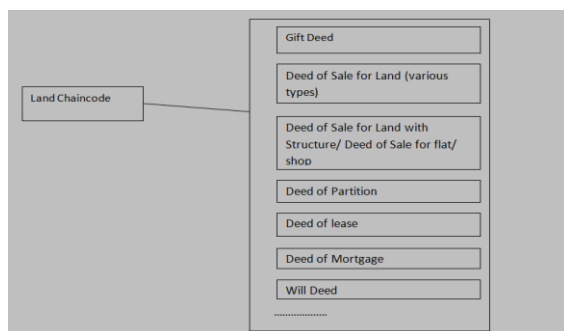


Figure 4Chaincode of land registration process

Organization:

Organizations establish business policies governed by the consortium while a new network has been configured. The organizations are further divided into small parts and each transactional endpoint of an organization is called Peer.

Channel:

In a Hyperledger Fabric Blockchain network, channel is a multilateral, private transactional path to create abstraction for other members of that network and preserve confidentiality, privacy and security. Channel linked with organizations is shown in the Fig.5.

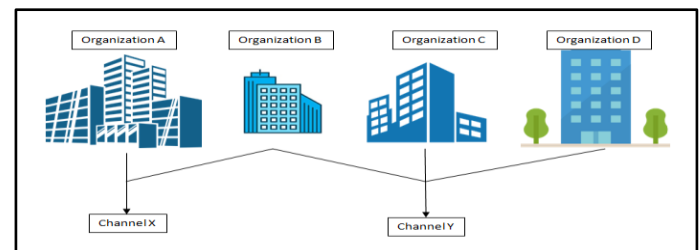


Figure 5 channel linked with organizations

Membership Services:

Hyperledger Fabric network works in a trusted environment. Without recognized identities anyone can not transact in this network .The (Membership Service Provider) MSP is an authorized body who can provide certificates defining rules to validate member's identity for transaction

and scope of their activity across the network.

Logical Architecture[15]:

In 2015 Linux foundation initiated Hyperledger Fabric, a cross-industry solution of Blockchain and not dependable on mining as well as crypto currency- based typical Blockchain [16]. Programmable modular architecture of Hyperledger Fabric intended to develop flexible solutions where customers have the ability to plug-n-play with its components according to their needs. Another unique powerful feature is that any mainstream programming languages like java, Node.js, Go etc can be used for smart contracts development hosted by the container technology. Hyperledger Fabric can be logically divided into three parts in terms of application and the services they provide:

- Identity verification, auditability and registration of members through Membership Service.
- Transactions management, distributed ledger, consensus manager, ledger storage and point-to-point protocol through Blockchain Service.
- Secure container and secure business condition implementation by Chaincode Services.

The logical architecture of the Hyperledger Fabric is shown in the Fig.6.

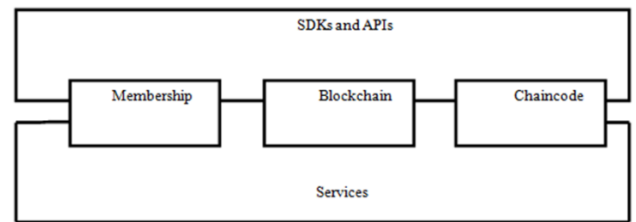


Figure 6 logical architecture of the Hyperledger Fabric

IV. FUNCTIONING STRATEGY OF HYPERLEDGER FABRIC BLOCKCHAIN [17][18][19]:

Peer-to-peer network of Hyperledger Fabric Blockchain connects the certified authority, network peers and corresponding client application. The functioning process is shown in Fig. 7.

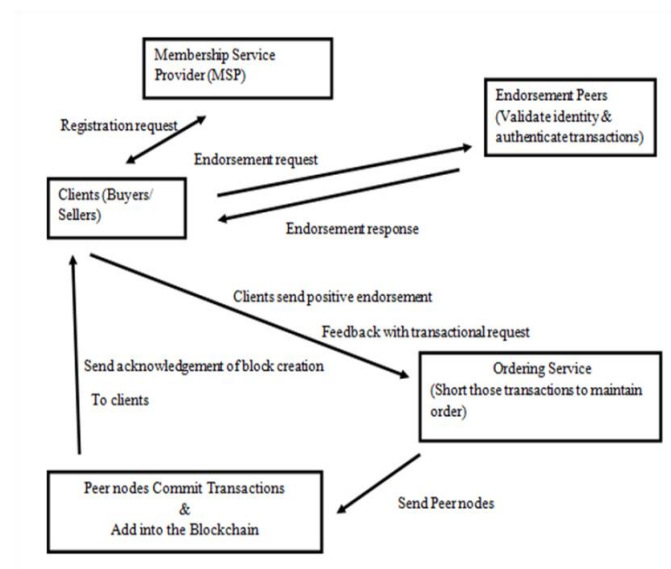


Figure 7 functioning strategy of Hyperledger Fabric Blockchain

A. Initialization of transaction:

The transaction initiates when any member of an organization receives or proposes a transaction request using Hyperledger Fabric's client application (Software Development Kit (SDK)).

B. Proposal creation:

Hyperledger Fabric's client application then sends a transaction proposal to the all organization's peers for endorsement.

C. Peers Endorsement:

After receiving transaction requests, peers first verify the client's identity and authorization to execute the chaincode. Then see what the result of the proposed transaction can be. If it matches the expected result, the peers send back client endorsing outcomes indicating acceptance or refusal of transaction with peers signatures.

D. Ordered and broadcast by Ordering-Service:

If the client accumulates proper number of endorsement results from peers according to endorsement policy and then sends the endorsed transaction to the ordering service. The ordering service then sorts those received transactions from different channels sequentially. The ordering-service binds transactions per channel into blocks including their identity and sends those blocks through gossip messaging protocol to all peer nodes of the network.

E. Transactions Validation and Committing to ledger:

Final verification and validation have done by the peers after receiving new blocks of transactions from the ordering service. Once that over, the new block is added to the ledger. So transactions of that block are committed and finally the ledger state is revised.

V. CARDINAL FACTORS OF LAND RECORDS AND LAND REGISTRATION SYSTEM USING BLOCKCHAIN TECHNOLOGY:

To implement Blockchain technology in land records and land registration system the initial steps followed by registration and final recording are vividly projected below [20]:

A. Systematic entry of land records:

The initial collection of records should be without any ambiguity by the authorities. Data of land records are divided into following two parts:

- Record of land position
- Record of land holders

Records of land positions are already recorded by GIS (Geographical Information System) driven cadastral land management system which collects spatial data through different techniques viz digital photography,

GPS (global positioning system), RS (remote sensing) etc [21].

Record of land holders is a cumbersome job which needs to be done properly without any discrepancies in holders.

B. Identification of land record holders:

Land holder's identity is still not recorded for all lands in our country. However, in some states digitized land registration has already been implemented. In the Blockchain system, it holds an important role. The Indian Emperor tried to reform the land record started with the king Sher Shah Suri. During the British period, a proper Patwari System with two basic components of land data – Spatial and tabular format was established and starting systematically from 1888 onwards, cadastral surveys (CS); another survey known as revisional survey (RS) happened after 50 years of CS survey. The Transfer of Property Act was established in 1882 [22] and the Central Land Registration act was established on 18th December, 1908 for all over India (except the state of Jammu and Kashmir) [23]. Land reforms started in different states of India in the early 1950s. But to find the previous history of land records is time consuming and lots of manipulation there. So these land record holders identification is a precondition for the implementation of the Blockchain system. If it is implemented

then from the starting point onwards the history of land records easily finds out at any moment. So in conclusion in India attachment of Aadhaar number with land holder's name with 14 digit Unique Land Parcel Identification Number (ULPIN) [24] identities which will be the digital identity of the land. In case of companies or institutional land their specific identity also needs to be introduced.

B. Transaction of land through digitization:

Blockchain technology Maintain data confidentiality, where chances of tampering information tend to zero and smart contracts authenticate instant transaction verification. Transactions can be possible by participants at 24 * 7 from anyplace. To avail all these kinds of benefits, we need to consider the consequence of Blockchain technology i.e. automation and digitization. Mapping of transaction records for Blockchain based land recording and land registration system, the initial infrastructure required following policy: Digitization of land records, geo-referencing accompanied by map digitization, Aadhaar linked with each and every land or property, neoteric record rooms for data storage etc.

The Land Reforms (LR) department of Government of India has started scheme Digital India Land Records Modernization Programme (DILRMP) on 21.8.2008 and

also developed a hyaline and Integrated Land Information Management System (ILIMS) in the country[25]. But these processes are not uniformly installed in all the states due to various practical obstacles from basic trained manpower to lack of infrastructural development and initiative of state governments towards public involvement to secure their land records properly. Computerization of Land Records (CLR) under the DILRMP scheme is 93.27% completed in 24 States and Union Territories till April, 2022 and 94.53% till April, 2023. The total percentage of Right of Records (ROR) linkage with Aadhaar in villages 5.68% completed till April, 2022 and 5.80% till April, 2023. The total percentage of cadastral maps digitization 68.64% completed till April, 2022 and 75.62% till April, 2023, where total percentage of cadastral maps geo-referenced 31.76% completed till April, 2022 and 37.34% till April, 2023 and the total percentage of cadastral maps linked to ROR 58.85% completed till April, 2022 and 64.27% till April, 2023. Another important aspect, the total percentage of the number of modern record rooms completed 71.35% till April, 2022 and 85.75% till April, 2023 in all states and union territories of India [26]. Last year onwards the ULPIN numbering of land which is developed by the National Informatics Centre (NIC) has started in only a few states [27].

D. PROPOSED BLOCKCHAIN TECHNOLOGY IMPLEMENTED LAND RECORDS AND LAND REGISTRATION SYSTEM

Now a day's different Blockchain architectures are available, but to manipulate land records like huge data with accuracy and covertness, the study proposed a hybrid conceptual Blockchain framework. In this suggested mixed structure, first land information will be recorded in the blocks of private Blockchain linked with hashing technique, then made public through permission [28]. The hybrid Blockchain technology could provide detailed integrated decentralized solutions involving G2C (Government to customers (buyers are sellers)) punching with the 'chain of trust.' A perfect combination of both private permissioned (symbol of trust) and public permissionless (symbol of transparency) Blockchain [29] is Hyperledger Fabric. Hyperledger Fabric does not require permissioned at the entire level of the Blockchain network; the necessity of permissions depends on the discretion and preference of whoever sets up the network. So, the Hyperledger Fabric provides a new viewpoint to enable us customized permissioned networks with prior privacy, confidentiality and scalability, exactly what is expected by the autonomous land

management system from Blockchain networks. Land Transactions through the registration process should be confidential, secured and private. Each participant in this transaction has to register with proof of identity to the network's membership services provider to gain access permission

to the network system. Sophisticated encryption key derived function ensures the trading confidentiality of transactional contents and partitioned communication of liable framework guarantee that only intended participants can visualize the content [30][31][32]. Please see Figure 8.

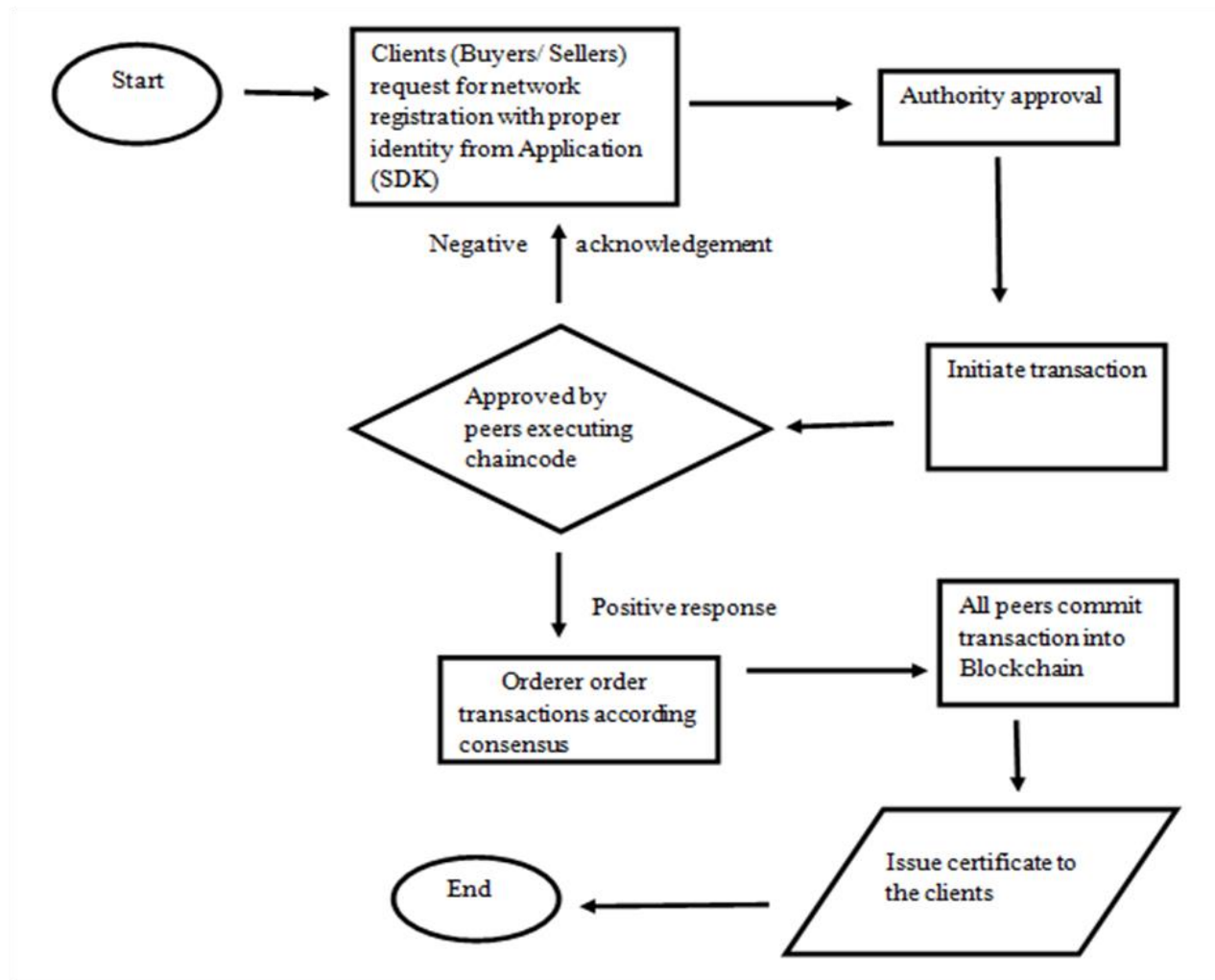


Figure 8 Proposed flowchart for land registry system

Validating land registration process, rules among different participating stakeholders should be defined in automated executable code format, called smart contracts. In Hyperledger fabric, related smart contracts are deployed through chaincode container and make available for application program. Application program invoke this executable code in order to generate transactions. *An endorsement policy also associated with every chaincode which applicable to all smart contracts those are defined to that chaincode.* According to endorsement policy the participating organizations of that network should sign a transaction which has been generated by the particular smart contract before recognize it is a **valid one**. All **valid** or **invalid** transactions are added to the distributed ledger, though only **valid** transactions are updating to the world state. Whether transactions read, write, update, create, or delete from the world state of the distributed ledger accessing smart contracts, but Blockchain holds entire log of the transactional records immutably. Following pseudo code shows a typical land smart contract [14]. The organizations accomplish their transaction according to their predefined rules via smart contracts and once defined in the distributed ledger, its turn into invariable.

land contract:

query (land):

```
get (land);
return (land);
```

transfer (land, buyer, seller):

```
get (land);
land.owner = buyer;
put (land);
return (land);
```

update (land, properties):

```
get (land);
land.types = properties.types;
land.area = properties.area;
land.location = properties.location;
land.shape = properties.shape;
land.frontage = properties.frontage;
land.legalIssues = properties.legalIssues;
put (land);
return (land);
```

a. Hybrid Blockchain ensures following opportunities before applied in land registration systems:

- In this context also, like financial institutions before recorded in blocks of Blockchain at least 3 stages verification should be there and tally with past land records. For example: Suppose a piece of land first goes from 'D' to 'K', and then from 'K' to 'L', then the right transfer sequence should be maintained at the time of record. As-if it never went straight from D to L or it may be that someone else went to L's.
- Valuation of land should always be considered according to the price of land.

- If there is no inheritance, then the authority (Both the Judiciary and Registrar) has the power to determine the exact inheritance of the land and be able to adjust the ledger.
- If land's various partners did not respond at the right time, the authority must have the ability to accurately determine their partnership.
- If the judgment of the judge changes any landowner, the authority concerned must also have the power to change it.

b. Impact of Blockchain technology adoption:

Blockchain technology in the Land Registry System is a revolutionary step. It could create changes registry system in the following aspects [12]:

- Land records updating will be dynamic in nature and once recorded data will not be reverted. So most reliable and transparent.
- Banks or financial authorities or governments can easily sanction agricultural / Industrial/ Housing loans using land as collateral security. After clearing the loan Borrowers will automatically get back mortgaged land.

- Government will also easily make distinct agricultural or industrial policy /decisions.
- Help to drastically reduce judicial complications and increase Revenue collection of our country.

VIII. CONCLUSIONS:

In this paper, we have discussed various complications in the present Indian land registration and land recording system. Also, we have considered how new Blockchain technology could provide a more robust, secure, transparent and unalterable land registration and land recording system over traditional one. In Indian circumstances, Blockchain technology has already been introduced in some states as a pilot project, it's the high time to explore conceptual framework, so that a complete, well accepted and detailed system should be developed in the future for all over the country.

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