

Can Blockchain Spark off the Reincarnation of India's Living Dead?

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Abstract—A large number of studies have found a negative correlation between economic growth and corruption. Therefore, governments implement various anti-corruption measures particularly technology-based mechanisms. The government of India has launched various initiatives such as Digital India and Digital India Land Records Modernization Program (DILRMP) to modernize land records in the country and curb the corruption at various levels of land transactions. However, despite a push for reform through the DILRMP, India's current land title management system remains plagued with deficiencies. The current system of land records and property ownership is rife with corruption. DILRMP is heavily dependent on the government functionaries to act as a trusted third party for the verification of data and processing of deeds. This leaves a space for unscrupulous elements to trick the system and register a fraudulent deed, transfer land titles, and so on. This paper investigates the usefulness of an emerging technology called Blockchain and its integration with India's biometric identity program called Aadhaar for management of land records and property registration. This paper proceeds with relevant case studies, by identifying the requirements and outlining the concept and system architecture for such a solution. From our analysis, we conclude that the blockchain technology in association with Aadhaar would be an effective mechanism to bring in much-needed transparency in the government functionaries, eradicate fraud and corruption, and enhance socioeconomic benefits.

Keywords—Aadhaar; Blockchain; Corruption; India; Land.

I. INTRODUCTION

India recorded high economic growth in the last decade, with the Gross Domestic Product (GDP) growth at 8.2% and 7.1% in the fiscal year 2015-16 and 2016-17 respectively [1]. Furthermore, Government of India launched several initiatives such as Digital India program, Digital India Land Records Modernization Program (DILRMP), seeding of biometric identification number called Aadhaar [2], and so on, to bring in the much-needed efficiency and transparency in the government functionaries. However, despite these initiatives and buoyant economic activity, India still has a long way to go. One of the areas that need regulatory attention, digitization of processes and stricter enforcement of laws is the land records and property registry system. Furthermore, despite a push for reform through the DILRMP, India's current land title management system remains plagued with deficiencies. The current system of land records and property ownership is rife with corruption.

DILRMP is heavily dependent on the government functionaries to act as a trusted third party for the verification

of data and processing of deeds. This leaves a space for unscrupulous elements to trick the system and register a fraudulent deed, transfer land titles, and so on. It is estimated that USD 700 Million in bribe is exchanged every year at the office of property registrars across the country [3]. Furthermore, due to lack of coordination between various departments such as those handling the land records and identity records, there is a lack of standardization in the records of different government institutions. This leads to ambiguity in identification documents resulting in innumerable delays and fraudulent transactions.

Hundreds of "Living Dead" in the state of Uttar Pradesh, India have been running from pillar to post for many years to prove their identity and that they are alive. The plight of the hundreds of living dead in the state of Uttar Pradesh, India was for the first time presented to the world in 1999 when the TIME magazine published a story on the living dead [4]. *Living dead* are the people who are very much alive in biological terms - they can walk, talk, eat, and do everything else that any other normal living person can do; however, *living dead* have been declared dead in government records particularly in the land revenue and property records. Thus, they do not have any valid identification document to prove that they are alive. TIME reported that it costs between USD 1 and USD 50 - depending on the wealth of the farmer and size of the land to declare a person dead in government records and usurp his or her share of the property.

In Oct 2016, the Dubai Blockchain Strategy 2020 was announced for the adoption of blockchain technology by the Emirate to improve the delivery of government services [5]. Emirate's government estimates that with blockchain it can save nearly \$1.5 billion and 25.1 million hours in document processing time per year. Hence, for India, ranked 100th on the World Bank's Ease of Doing Business Index against UAE's 21st rank [6], the benefits of blockchain are obvious and endless. In such a scenario, India's huge biometric-based identification database called Aadhaar should be harnessed in association with Blockchain, a distributed ledger technology. Therefore, this paper attempts to address the issues that are *Important, Complex, and Timely*. The issues are *Important* because they affect more than a billion Indian residents and interacts with almost every sector of the Indian economy. The issues are *Complex* because digital identity and e-governance research encompasses various fields including economics, computer science, sociology, and law - that need to work together to further our understanding. Lastly, this is the *Right*

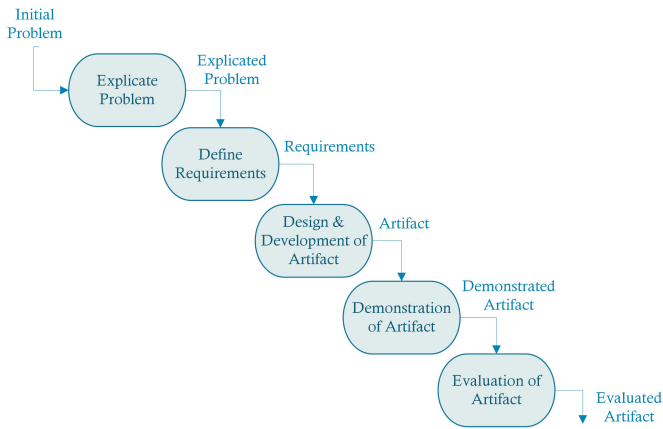


Figure 1. Design Science Research Method Framework [8].

Time for this paper because despite near-universal coverage of adult Indian residents and resulting proliferation of uses across various sectors, there remains important gaps in our understanding of Aadhaar with regards to its integration with Blockchain based e-governance particularly land records and property registration systems.

The objective of this paper is to examine the usefulness of blockchain technology in association with Aadhaar in curbing fraud and corruption, increasing data integrity, and socioeconomic benefits. The contributions of this paper are structured under the Design Science Research Framework, i.e., problem explication, requirements definition, the design of system architecture, demonstration of the usefulness of the designed architecture with case studies, and evaluating the outlined concept and technical specifications.

The remainder of the paper is structured as follows: Section 2 describes the research method. Section 3 presents an overview of the research background. Section 4 presents the case study used for this paper. Section 5 identifies the problems in the existing system. Section 6 identifies the Aadhaar and Blockchain as the potential solution to the problems. Section 7 explains the system architecture. Section 8 lists the potential benefits of the outlined system and Section 9 concludes the paper.

II. RESEARCH METHOD

Design Science Research Method (DSRM) is used for this research. Design science research involves the creation of "knowledge and understanding of a design problem, and its solution are acquired in the building and application of an artifact" [7]. A DSRM Framework presented by Johannesson and Perjons [8] consisting of five main activities as shown in Figure 1 is followed in this paper.

Offermann et al. [9] studied the artifacts designed and developed in the area of information technology and information systems and based on their study they classified the artifacts in the following eight categories:

- *System Design*: Described the structure and related behavior of a system using text and some formal language.

- *Method*: Defines the activities to create or interact with a system.
- *Language/Notation*: A (formalized) system for the formulation of statements related to a domain.
- *Algorithm*: An executable description of the behavior of a system.
- *Guideline*: A suggestion on behavior to deal with a particular situation.
- *Requirements*: A statement on the required functions and behavior of a system.
- *Pattern*: Definition of design elements that can be reused with their benefits and context of the application.
- *Metric*: A mathematical model that can be used to measure the aspects of systems or methods.

The artifacts presented in this paper are a combination of *Method* and *Requirements* type of artifacts in Offermann et al. [9] classification.

The evaluation of an artifact is typically carried out by using methodologies available in the knowledge base. An evaluation method is selected by its appropriateness with the designed artifact and the evaluation criteria [10]. A summary of evaluation methodologies is presented in Table 1.

TABLE I. Design Science Research Evaluation Methodologies [10].

Core Methodology	Sub-Methodologies
Observational	- Case Study: Study artifact in depth in business environment - Field Study: Monitor use of artifact in multiple projects
Analytical	- Static Analysis: Examine structure of artifact for static qualities (e.g., complexity) - Architecture Analysis: Study fit of artifact into technical IS architecture - Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior - Dynamic Analysis: Study artifact in use for dynamic qualities (e.g., performance)
Experimental	- Controlled Experiment: Study artifact in controlled environment for qualities (e.g., usability) - Simulation: Execute artifact with artificial data
Testing	- Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects - Structural (White Box) Testing: Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation
Descriptive	- Informed Argument: Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact's utility - Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility

The evaluation methodology used in this paper is a combination of *Observational (Case Study)* and *Descriptive (Informed Argument)* form of evaluation.

III. RESEARCH BACKGROUND

This section is divided into four subsections to present a brief background of this research.

A. Brief History of Land Records in India

In erstwhile India, Emperor Sher Shah Suri who ruled from 1538 to 1545 was the first ruler to implement mechanisms for categorization and measurement of agricultural land to fix the crop rates. Later, Mughal King Akbar who ruled from 1556 to 1605 implemented various methods for determination of land class, land survey and land revenue. It was Raja Todarmal, the Finance Minister of Akbar who is credited with the implementation of huge land survey and settlement system in India. During the British era, the British administration and land laws catering to the specific needs of five hundred princely states in India were introduced. This led to the introduction of local land laws such as Agra Tenancy Act, Bengal Land Act, Oudh Land Act, Uttar Pradesh Land Revenue Act, etc. Independent India inherited these land records laws and management system from British and with little to no modification. The government of India has spent a huge amount in computerization of land records, records of title, etc. since 1988-89; however, these efforts to modernize the land records and the system have failed to bring in any major socioeconomic benefit [11].

B. Economics of Land Registration

There is no doubt that sustainable economic growth is highly dependent on robust property rights system [12]. Secure land rights have also been found to lead to higher market efficiency, better access to the formal credit system, incentivize investments in physical and human capital, enhance growth performance, minimize macroeconomic volatility, and promote equitable and efficient distribution of opportunities [12]. The discussion on the economic benefits of land titling and registration has evolved from a discussion based on descriptive statistics and theoretical discussion to a discussion based on quantitative analysis [13]. Researchers across the globe have made significant efforts in quantifying the economic benefits of robust land titles, in general, and land registration system in particular. For instance, a study in India reported that the land registration leads to significant savings in interest payments [13]. In Costa Rica, it was reported that a strong correlation exists between the degree of security of tenure and farm investment per unit of land [14]. In Thailand, it was found that the land titling stimulates land transactions [15]. In Indonesia, it was reported that higher tenure security leads to higher prices of land [16].

Hernando De Soto, an Economist from Peru, argues that the lack of a secure property rights system is the root cause of poverty in developing countries [17]. He coined the term "*dead capital*" to refer to the land assets that cannot be easily traded, valued or used for investments; furthermore, he estimates that the value of "*dead capital*" stands at USD 20 Trillion. Furthermore, he reported that only 2 billion out of 7.3 billion people in the world have a legal and effective land title [17]. De Soto is currently assisting the Government of Georgia in developing a blockchain-based land registry system.

C. Effect of Corruption on Economic Growth

Numerous studies have been conducted to study the correlation between corruption and economic growth. Mauro presented a correlation between corruption and economic growth on the basis of cross-sectional national data [18]. He measured the degree of corruption on the parameters like political stability, judiciary, the legal system, and terrorism, and he named it as the Bureaucratic Efficiency Index (BE Index). Further, he reported that with an increase in BE index there is an increase in economic growth as well implying that the lower level of corruption is directly proportional to the higher economic growth. This finding was reported in many other studies as well [19][20].

Direct and indirect impact of corruption leaves a lasting impact on the economic growth. With an increase in corruption, there is an increase in the uncertainty and transaction cost. This leads to a reduction in domestic and foreign investments [21]. Mauro reported that the corruption seriously hampers the private investment thereby adversely affecting the growth [22].

For the first time in the history of India, Chief Secretary, Government of Uttar Pradesh was convicted and jailed in a multimillion-dollar land scam in the state [23]. In a recent case of land scam worth INR 15000 Crore (USD 2.1 Billion) in the state of Telangana in India, major domestic and international companies including Google, Microsoft, etc. are affected [24]. In this scam, the scammer colluded with the local land registry office to corner hundreds of acres of contentious land parcels.

In addition to the property frauds, there is an angle of "*Black Money*" in the real estate dealings in Indian market. In India, it is commonly known as *Benami* transaction; *Benami* implies that the property is held in someone else's name or a false name instead of the name of the original owner to park the black money of original owner. The government of India has seized benami properties worth over USD 614 Million between Nov 2016 to Jun 2018 [25]. In another case of fraud, crop loans were claimed on the non-existent 9000 acres of land in Telangana [26]. This fraud was materialized because of the irregularities in the land registry department. It is not difficult to imagine the kind of economic loss such incidents have caused to the government, financial institutions, and the public at large.

D. Technology to Fight Corruption

Countries across the globe have introduced a variety of anti-corruption measures including enforced regulations, strengthened monitoring system, and adoption of technology. In particular, Information and Communication Technology (ICT) tools can reduce the need to trust a third party, reduce human intervention and improve the transparency in the governance system.

E-governance in developing countries such as India is focused on how to transform and strengthen weaker governance structures through the use of technologies such as Biometrics and Information and Communication Technologies (ICTs). The potential for ICTs to improve efficiency and effectiveness of governance has been widely recognized in the literature. For instance, in a White Paper submitted to the Norwegian Parliament, the two main objectives of the Government's ICT

policy are: a user-centric and efficient public administration and value creation and inclusion [27]. The report further states that users shall perceive the public services as seamless and integrated, irrespective of the public agency providing the services. The public administration should *reuse the information* instead of repeatedly requesting the information previously provided by the users. Also, *common solutions* should be used to create an effective, user-friendly digital services system for the whole of the public sector; and *interoperability* with European solutions should be facilitated. The report refers to a study that digitization accounts for 30% of growth in Norway's productivity during 1995-2005, and for 50% between 2006-2013 [28]. In an international study, it was found that the digitization accounted for 30% of GDP growth in Europe during 2001-2011 [29].

IV. CASE STUDY

The most famous case of a *living dead* is of Lal Bihari [4][30]. Lal Bihari was recorded as deceased in 1976 [4]. It took him about 18 years to get him alive in the land revenue books. In this period he added the word *Mritak* meaning Dead to his name. It was not easy for him to get his name restored in the land revenue records. He tried to run for parliamentary elections, sought his arrest, kidnapped the son of his uncle who had got him declared dead, insulted judges, threatened murder, etc. Further, Lal Bihari's ordeal with Indian legal system is not yet over. He is still fighting a case against the State Government of Uttar Pradesh in the High Court of Allahabad [31]. In Aug 2017, a leading news television channel in India - News Nation carried a report on the living dead in the state of Uttar Pradesh [32].

Bhagwan Prasad Mishra has been declared dead in land revenue records since 1977 when his four young nephews stole his land [4]. Mishra, armed with a rifle, visited the boys and got an affidavit signed by them accepting that they got the land transferred to their name fraudulently and they had no claim to the land. Mishra filed the said affidavit in a local land revenue court, but the matter was forgotten. Subsequent petitions to get him declared alive in the land revenue records have been mired in judicial procedures.

There are hundreds of such cases in the state of Uttar Pradesh where living people have been declared dead in the land revenue records to usurp their land. However, the primary case under consideration for this paper is of Prema Devi Pandey and her husband, Bare Lal Pandey. A land mafia named Vinod Kumar Tiwari got Prema Devi Pandey declared dead in land revenue records in 1996 [33]. After a stiff legal battle, a local land revenue court ordered in 2003 to restore the name of Prema Devi Pandey in the land revenue records and the possession of her land to be given back to her [34]. During the court proceedings, the said land mafia's wife named Manoj Kumari Tiwari applied to the same land revenue court claiming that her name is Manoj Kumari Tiwari alias Prema Devi Pandey and her husband's name is Vinod Kumar Tiwari alias Bare Lal Pandey [34]. The court, however, refused to accept her claim. Despite the restoration of Prema Devi Pandey's name in the land revenue records, the land mafia in connivance with the corrupt local land revenue officials continued to have possession on her land. Furthermore, the real Bare Lal Pandey has served in the Indian Air Force, also recorded in the order

of the land revenue court [34] and to this effect several letters were shot by the Indian Air Force to the land revenue court and revenue officials certifying the photo and identity of Bare Lal Pandey and Prema Devi Pandey who were then living in Air Force campus. Yet, the matter of identifying the real Bare Lal Pandey and Prema Devi Pandey by the land revenue officials is lost in the long legal battle, and the corrupt revenue officials continue to help the said land mafia in this and many other cases of land encroachment by the same mafia [35].

We have analyzed the above-mentioned case in detail by reviewing over 300 pages of the documents, interviewing Bare Lal Pandey and Prema Devi Pandey, and discussing and questioning the case with land revenue officials. The issues - fraud and identity theft (impersonation), identified in this case were thoroughly considered while designing the proposed blockchain-based land records and property registry architecture. Therefore, the biometric identity system - Aadhaar is included as a core component in the proposed architecture.

V. PROBLEMS IN THE CURRENT SYSTEM

The land records and property registration system in Uttar Pradesh, India suffers from the following flaws:

- *Lack of Professional Approach*:- The process of maintenance of land records is primarily for land revenue collection; its use in providing a proof of title is secondary. Furthermore, the village level land revenue accountant called *Lekhpal* and the land revenue inspector called *Kanoongo* tend to display apathy towards cross-referencing and verification of data.
- *Lack of Standardization*:- The DILRMP system is dependent upon the data and information received from the village level government staff. The village accountant maintains a hand written record of land ownership, etc. This leads to a lack of standardized data, difficult to retrieve data, and wear-tear of hand written data.
- *Manipulation*:- Due to a lack of coordination between the various departments handling land records and property ownership data, the information registered is not standardized. This creates an ambiguity in the nature of rights and boundaries of the land being transacted. Furthermore, the process of updating the records is lengthy and cumbersome. Therefore, the true nature of ownership is often not reflected in many of the records, hence making it difficult to trace if any anomalous entry has been made.
- *Lack of Coordination*:- There is a lack of communication and coordination between various departments such as land records management, land registration, judiciary, taxation, etc. Registration of land only provides an agreement between the two parties on public notice, but the registry is silent on the legal validity of the underlying transaction. Therefore, the title to the underlying land is purely presumptive.
- *Litigations*:- The presumptive nature of title in the registration is open to challenge in a Court of Law. Indian judicial system is currently under the weight of over thirty million pending cases, 70% of which

is related to land and property disputes [36]. Property Registry officer will register any deed without verifying its validity in the absence of countervailing claims. The Registration Act., 1908 requires no vetting of validity of the documents and transactions [37].

- *Fraud and Black Money*:- Property fraud is one of the major problems in India. A report from the Comptroller and Auditor General (CAG) of India reported that in 2015 there were about 124,325 cases pending under the Registration Act. In addition, real estate is one of the major mode of parking the black money. Black money in real estate is usually dumped through the *benami* (false name) transactions. In a famous case of benami transactions, the Crime branch found that the promoters of the Nirmala Krishna Nidhi Fund purchased several high-end properties pegged to be around USD 5 billion [38]. The usual modus operandi of fraudsters and mafia encroachers is depicted in a famous Hindi movie *Khosla Ka Ghosla*.

VI. POTENTIAL SOLUTION: MARRYING AADHAAR AND BLOCKCHAIN

This section presents a brief introduction to the two core solutions - Aadhaar and Blockchain that are proposed to be used in integration to achieve the transparency and efficiency in land records and property registration system in Uttar Pradesh, India.

A. Aadhaar

An estimated 1.5 billion people around the world cannot prove their identity [39]. Lack of formal identification can deny individuals access to entitlements such as social safety nets, voting rights, and basic financial products. An unidentified population also inhibits the state's capacity for effective governance. Targeted design and delivery of government services rest on a state's ability to identify (who are you?) and authenticate (are you who you say you are?) individuals [40]. Private enterprise, too, relies on establishing an identity for the provision of a range of services.

The goals of identity systems - to uniquely identify individuals and to do so efficiently - may be well served by emerging digital technologies. Digital identities have the potential to increase coverage, accuracy, efficiency, and convenience relative to traditional paper-based methods [41]. This potential has led nations across the world from Germany to Ghana to adopt a digital identity as a key policy instrument [42]. At the same time, digital identities also raise important concerns for individuals' privacy and security [41]. India, too, has seen an evolution in identification systems. Paper-based forms of identification are gradually giving way to digital forms of identity. The most ubiquitous among these is *Aadhaar* - a digital biometric identity backed by a unique number [43]. The Unique Identification Authority of India (UIDAI), which issues Aadhaar numbers, aims to use Aadhaar's scale and growth in usage to have a far-reaching impact on India's governance capabilities and socioeconomic prosperity [43].

B. Blockchain

The way internet revolutionized the society a few decades ago, today, an emerging digital technology called *Blockchain* is again revolutionizing the society. The blockchain technology involves the creation of digital tokens for digital files, such as documents or transactions. These digital tokens can be considered as digital fingerprints of the files. These digital fingerprints are saved in groups called *block*. The individual blocks are then linked in a chain of blocks, and each subsequent block has a digital token from the previous block. Thus, it becomes impossible to modify the information in an old block in the chain without modifying the subsequent blocks. The ability of blockchain to secure the data and history of transaction lead it to be called as "The Trust Machine" by the Economist [44]. World Economic Forum conducted an expert survey in 2015 and reported that the majority (57%) of respondents estimated that by the year 2025 the 10% of the world's GDP would be registered in a blockchain [45].

With Aadhaar numbers deeply penetrating the e-governance in India, adopting blockchain would be the next logical step in India's pursuit of becoming a digital economy. Blockchain can play a vital role in storing individuals data, helping conduct secure transactions, maintaining a permanent and private identity record, and turning India into a digital society. Thus, by embracing blockchain, various state governments and the central government in India can create a steel-framed bureaucracy that focuses on innovation and experimentation, a government working towards maximizing efficiency and governance, and an economy that sustains on the promise of technology.

VII. PROPOSED ARCHITECTURE

Technically there are four core components of the proposed architecture namely: Aadhaar-an Identity Solution, Multiple Signature Wallets, Digitized and Accurate Data, and a Permissioned Blockchain. A detailed discussion on each of these components is beyond the scope of this paper; however, each of these components are briefly discussed below. The proposed system architecture is presented in Figure 2.

- *Identity Solution*: Property registries maintain the records of *who* has what rights to the respective property, hence, "*who*" is a critical element in the land records and property registration. So, the first issue to address is how to validate the identity for the land records to be deployed over a blockchain? Decentralized blockchain-based identity solutions such as uPort, Civic, EverID, etc. are being developed for various blockchain-based applications. However, it is better to use an existing identity solution than developing a new one for land records and property registration. Given the deep penetration of Aadhaar, it is a logical choice for an identity solution in the land records and property registration system.
- *Multisignature Wallets*: The purpose of public-private keys in a blockchain system is to ensure that only those who know the associated keys can register or transact. However, if the keys are lost or stolen, then to protect a genuine user a simple solution called

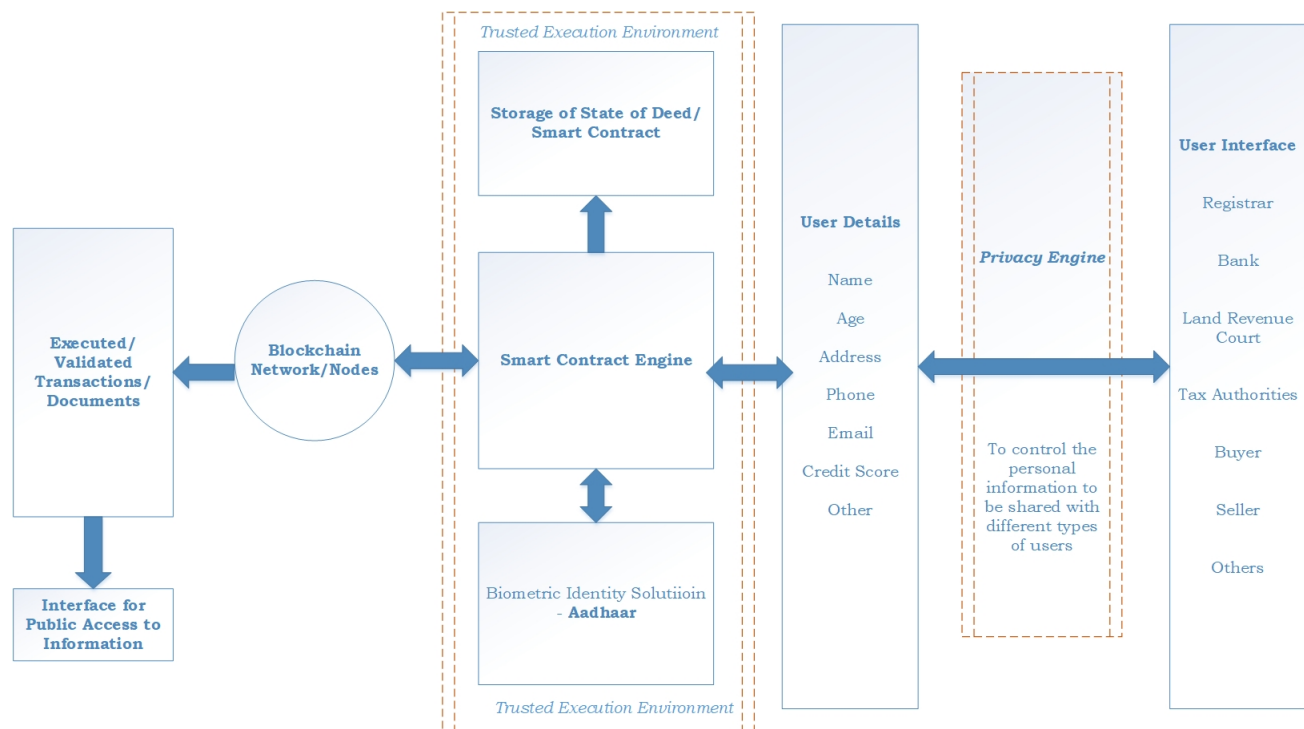


Figure 2. Proposed Architecture for Blockchain-based Land Records and Property Registry.

multiple signature wallets is used. The multiple signature wallets work on the principle of verification by a minimum number of keys instead of just one key. Therefore, in a blockchain-based land records and property registration system, a transaction would be completed only if the transaction is signed by a minimum number of users such as the seller and the property registrar. The multiple signatures requirement can be designed in multiple ways such as requiring two of two or three of five designated authorities.

- *Digitized and Accurate Records:* A paper document cannot be hashed and deployed over a blockchain. Indeed, the document should be first scanned and then the scanned copy of the document would be hashed. If any changes are made in the document after it has been hashed, then the modified document would need to be re-scanned before being hashed. Furthermore, all the verifying nodes should have the same copy and in the same format to validate the hash. Therefore, it is must to have a clean digitized records before it can be deployed over a blockchain. DILRMP program has led to digitalization of old land and property registry records in many places. However, as the blockchain records are immutable, thus, requiring the accuracy of data, the land records and property registry digitized under the DILRMP program would need some data cleaning, formatting, and standardization before integrating it with blockchain.
- *Blockchain Type:* The proposed architecture is for a permissioned blockchain type network. Permissioned blockchains are designed to allow special permissions to different participants for different functions to be

performed by them, such as for accessing, reading and writing information. Generally, permissioned blockchains are well suited for enterprise solutions such as for land records and property registry solution by selectively putting in the necessary restrictions while configuring the networks, and controlling the activities of various stakeholders. Furthermore, a permissioned blockchain will perform better over an unpermissioned blockchain as the nodes in a permissioned network are required to do the only computation necessary to support the given application. Hence, a permissioned blockchain architecture is well suited for a land records and property registration system to achieve maximum confidentiality, integrity, and flexibility of functions.

VIII. BENEFITS OF PROPOSED SOLUTION

The potential benefits of the proposed solution as identified from the analysis of the cases discussed above and over the problems identified in the previous sections are as follows:

- *Cost-effectiveness:-* The initial cost of developing a full-fledged blockchain network and the required infrastructure would be high. However, once the infrastructure is ready and allows sharing and coordination between various processes and systems, the services would become much more efficient and the long-term costs such as those incurred on record maintenance, verification, and litigations would be saved. Furthermore, if the utilization of the blockchain infrastructure is expanded to include other e-governance services offered by the Government of Uttar Pradesh in the

state, the entire e-governance process would become extremely efficient and transparent.

- **Efficiency:-** The delivery of services through a user-interface available over a smart phone as a one-stop-shop for all the property related computer-mobile based services will significantly improve the efficiency of the land records and property registration system. Furthermore, the system is expected to drastically cut down on the number of intermediaries that inundate the current system. The security, data integrity, and provenance would be useful in curbing the corruption as the *lekhpal/kanoongo* would no longer be able to go back and change the records in lieu of bribe.
- **Easing Administration and Financing:-** Blockchain-based land records and property registration system would bring in standardization in the data to be stored, data storage standards, and verification of the data with other relevant stakeholders or systems. This would lead to a decrease in the number of land-related litigations and lessen the fraud and corruption. Furthermore, clear titles and verifiable data would lead to lower transaction cost and mortgage rate.
- **Improved Agri-Governance:-** Population Census in 2011 reported that 77.73% population of Uttar Pradesh lived in rural areas, and more than 70% population of Uttar Pradesh is directly or indirectly dependent on agriculture and allied sectors. However, the agricultural economy and thus, the rural population is not in good health. The government of Uttar Pradesh had to announce waiver of farm loans for over 8.7 Million small and marginal farmers with debts of up to Rs. One Hundred Thousand (USD 1428), and is expected to cost the state government Rs. 36,359 Crore (USD 5.2 Billion) [46]. Furthermore, in Dec 2015, there were at least 600,000 cases pending in various district (agricultural land) revenue courts [47]. Overall, these issues can be efficiently and effectively dealt and governed by a blockchain-based system.
- **Prevention of Benami Transaction and Black Money:-** With the inclusion of Aadhaar as the source of verification of the identity of the parties involved in the transaction, it would be almost impossible to do a *benami* transaction. Further, with the deployment of land records and property registration over a blockchain and impending automation, the concerned tax, and enforcement authorities would be able to run algorithms on the data for detection and prevention of *benami* transactions. Also, past such transactions could also be detected by analyzing the paper-based property registration records deployed over the blockchain network.
- **Transparency:-** Deployment of land records and property registration details on the blockchain would mean that the information available to the public is secure and accurate in the (almost) real time. The different departments responsible for various activities related to land records and property registration, mutation, title enforcement, etc. should be brought onto the platform so that as and when an attempt is made to alter the records then the relevant department can view

the transaction details and take an appropriate action. This would make it almost impossible to register fraudulent land transactions.

IX. CONCLUSION

We presented a case for adoption of *Aadhaar* and *Blockchain* technology in an integrated architecture to achieve the highest level of trust and integrity in land records and property registration system in the state of Uttar Pradesh, India. Furthermore, in our analysis, we found that the marriage of *Aadhaar* and *Blockchain* technology would be highly useful in delivering corruption-free and fraud-free government services. These two solutions if used together can solve many, if not all, of the problems faced by the people of Uttar Pradesh in the land revenue and property registry offices. If implemented properly, the proposed architecture would be highly useful in mitigating the fraud risk such as those of *living dead*, and the number of court cases related to property frauds and disputes will come down. However, the adoption of *Aadhaar* and *Blockchain* may pose several technological challenges and risks, which we intend to identify in our future work. Furthermore, we expect that the implementation of such a solution would require several disruptive changes such as in the legislature, infrastructure, and training of government staff.

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