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A Smart Contract Approach in Pakistan Using Blockchain for Land Management

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Management of land records includes actions such as registration and transfer of property ownership. For many nations, land ownership and management are important sources of income. Corrupted spans from small-scale payments to large-scale cause an abuse for government. In the literature, a number of concerns have been raised about Land Record Management. There are several problems with Land Record Management in developing nations, such as tampering with land records and no methods of retrieving a full property ownership record, operating multiple linked Land Record Management Systems independently, etc. Traditional land record management solutions do not solve these challenges. We propose a Blockchain-based Land Record Management system for Pakistan to solve these concerns. It has been decided to use the suggested system, and the specifics of its implementation are described in this thesis.

Key-words: Blockchain, Private blockchain, Land management, Smart contracts.

Recommendations

CONFLICT OF INTEREST:
The author(s) declare that the publication of this article has no conflict of interest in IJIST.

Project details. NIL

Introduction

The decentralized structures, storage mechanism, distributed notes, solidarity algorithm, intelligent contracts, and asymmetric encryption of the blockchain technology assure network security, visibility, and transparency throughout any transaction [1]. Blockchain has been applied in diverse fields for the privacy concerns, such as smart contracts to hunt forgeries in finance or secure medical records in the healthcare domain [2]. Blockchain technology has upgraded the ways of business, finance and commerce along with Blockchain technology 2.0, a smart contract. With the continuous enhancement in Blockchain technology, its potential has an enormous impact on the construction industry.

As a result of the Blockchains distributed consensus process, participants have access to an irrefutable public ledger record of every event that has happened. Blockchain technology is advancing many sectors, including banking, supply chains, real estate, healthcare, and E-healthcare. Blockchain's decentralized, verifiable, and unchangeable nature is having an immense influence on these industries [3]. The crucial cause for the recognition of Blockchain is its prominent factors that furnish anonymity, data integrity, and security without the involvement of third-party in control while trading. Hence with Blockchain, various research areas have been formed regarding technical challenges and limitations [4].

In a distribution fashion and without the central authority implementation, blockchains are used in the manner of tamper-evident and tamper-resistant digital ledgers [5]. On the initial level, blockchains are used to enable the users' society to record commerce in a balance sheet within that community in a specific manner that no transactions can be altered after the regular operation once the transaction is published [6]. Moreover, Blockchain established the Business process re-engineering framework with supply chain re-engineering. In the supply chain industry, each transaction using Blockchain provides a faster and more secure approach in the restructured transaction manner [7].

There are various modules of blockchain which have been used to create the protocols while establishing the blockchain application [8]. The Bitcoin network's permissionless blockchain is a good example of a blockchain. Anyone may become a verifier on the network without receiving any previous authorization [9]. A bulk of permission-less blockchains are open to everyone, but most permissioned blockchains are meant to keep data only for a specific group of people [10]. Regardless of whether the blockchain is public or private, numerous distributed ledger systems with consensus algorithms might be made available on the market depending on the use cases [11].

Over the past few years, second-generation blockchain applications have become more prominent, such as digitizing acquisition privilege, scholarly effects, and elegant accords. Contract conditions may be written as computer code, then replicated and executed by all of the blockchains' nodes in the latter use case. More than two decades have passed since [12] first presented the concept of smart contracts, but only recently have we seen actual blockchain-based implementations. Rather than only achieving agreement on data streams, these new blockchains enable the network to reach a consensus on computation as well [6]. There are main procedures in every Land Record Management System: the registration of properties, the transfer of properties, and the monitoring of properties. This research provides the following contributions:

1. We present a novel approach for automating land record management. A big volume of land record management in Pakistan is still done manually, however, these manual operations are supported by web-based applications and central databases.
2. In addition, many departments involved in Land Record Management, including NADRA, Revenue, and the Registrar Office, operate independently of one another, adding further complications. For example, the seller and buyer of property must go to different departments for documentation production and verification in a single

transaction.

3. We have developed a Blockchain-based Land Record Management system for Pakistan to address the outlined issues. Although land record management systems across Pakistan operate similarly, the proposed solution may be adopted with very modest changes across all of Pakistan.

The rest of the article is structured as follows: Related literature and the necessary background are briefly discussed in Section II. The proposed land management system in Pakistan using Blockchain is explained in Section III. In Section IV, we presented quantitative embedding results and use these embeddings for making different comparisons. Finally, Section V concludes the work.

Literature Review

Blockchain technology-based on a decentralized ledger and it was primarily used for bitcoin cryptocurrency. But it is now used in various fields for health care, land records, and many other fields due to its data integrity and security without the involvement of any third party. There are various unaddressed challenges in blockchain technology and this research intends to reveal new research areas in this technology because block chain has been used in bitcoin in 80% of researchers [13].

Blockchain-based on a decentralized database is a public ledger shared among the parties. Once a digital transaction is recorded it cannot be removed and it can be verified easily. Blockchain technology is much more powerful and has been adopted in various fields. But its adoption is low due to risks involved with the technology, but it would be faster in the future [4]. Blockchain technology has very good effects on the health industry for medical and pharmaceutical management it ensures a reliable transaction. It provides new digital modes for health care management [14].

The use of blockchain technology in biomedical can enhance medical research and can facilitate keeping the records maintained more precisely as compared to the traditional distributed database as the distributed ledger is used in blockchain but various issues need to be handled by careful implantation of blockchain [15]. Patient-driven interoperability data need to be exchanged for the further process and meditation but there are still various barriers that need to be addressed in patient-driven interoperability [16].

Smart contract and Land management with Blockchain

This article proposed a supply chain game in which two enterprises participate, one as a supplier and one as a retailer. The supplier supplied items to the retailer and oversaw the store's service approach. The store established the ideal buy amount and selling price. The supply chain may be controlled in one of two ways: through a conventional internet platform or using a blockchain.

The authors examined the applicability of an elegant wholesale pricing agreement and a wise gain sharing accord for improving the coordination of businesses' connections and discussions. The paper emphasized all instances in which the implementation of smart contracts enhanced the operational convenience and commercial attractiveness of blockchain applications [17]. Additionally, the companies benefited from increased visibility, security, and translucency, all of which were recapped in tokens. The authors identified the circumstances and stochastic scenarios in which adopting the blockchain was not worthwhile [18].

Edge-Chain was constructed and thoroughly tested by the authors to ensure the principles. While blockchain and smart contracts provide considerable security improvements, the cost of implementing them into Edge-Chain is within an appropriate and adequate scope, according to the study [19]. The authors, by this method, provide safe and trustworthy traceability to the authentic video maker or basis. The (Interplanetary File System) IPFS-based decentralized storage system, an Ethereum-based name service, and a decentralized reputation system were used in our approach. Cost estimates were kept to a minimum and were always

less than 0.095USD per transaction [20].

By adopting the blockchain technology land titling system should improve and people could trust to whom the land belongs [21]. The implementation of this technology will reduce the middle man and supply chain management can be done with the help of blockchain technology but there are still various issues that need to be examined and addressed [22].

Numerous additional cutting-edge technologies, such as cloud computing [23], mobile edge computing [24], fog computing [25], artificial intelligence, big data analytics [26], and cyber-physical systems [27] may be applied with Blockchain. Cloud computing enables the wide use of computing resources for further processing. Numerous backend apps may be implemented on the cloud end due to their high scalability.

Land Administration System (LAS) restrictions and challenges, including delays in registering and transferring land ownership, and the provision of incorrect/conflicting data, are highlighted in [22]. The authors provide a Blockchain-based solution for the Brazilian Development Bank's development programs, which increases transparency in the allocation of public funds and reduces human work [28].

Blockchain Implementation

A. Private Blockchain

For IoT systems and intelligent applications, the private-based blockchain offers a restricted and permitted solution for users to access information. Permission-based access to private data slots is supported by several essential requirements, including privacy level, trustworthiness, and security conditions. A private-blockchain technology is used to provide small platforms, such as social commitments and behavioral data management. Behavioral and social community apps are two examples of well-established use cases for private-based blockchain technology [29].

An organization or company uses a private blockchain platform where only authorized participants are allowed. The nodes of the consortium maintain the blockchain records. A member's access to a consortium's blockchain system is determined by the specified nodes. Consortium blockchains are hybrid networks that combine semi-public and semi-private networks, allowing members of the consortium to benefit from their unique features [30]. In terms of performance, private blockchains outperform public blockchains, which need more time and compute power to approve a transaction due to POW (proof of work) [31]. The transaction cost and block interval may be greatly lowered with this approach, significantly improving the transaction processing speed of the whole blockchain network and achieving the throughput necessary for practical implementation [32].

B. Hyperledger Fabric Framework

The fabric enables a paradigm that is fundamentally different from most blockchains to provide enhanced implementation, flexibility, and privacy features. Fabric employs an execute-order validate paradigm rather than an order-execute architecture [33]. One or more network peers are requested to approve a transaction by a client node, and the process then starts. The transaction is simulated by the peers, which provide the approval. It is then returned to the client and sent to the blockchain ordering service once the transaction has been approved. Finally, a committed peer verifies the transaction and adds it to the ledger, completing the process of consensus and validation [34].

C. Hyperledger Composer

HyperLedger Fabric and HyperLedger Composer, a development toolset for developing corporate networks, were used in this research. Managing user identities is a crucial part of Fabric's functionality. User authentication and authorization may be handled by developers using this capability. To avoid confusion, transactions that have been authorized but fail to go through are flagged as "failed" [35].

Hyperledger Composer's modular nature allows it to handle three alternative runtime implementations: Hyperledger Fabric, Playground, and Node.js. The state is saved in the

Hyperledger fabric ledger, the local browser using Playground, and RAM with Node.js [36].

D. Ethereum

An open-source alternative to Hyperledger is Ethereum, used to develop a blockchain-based decentralized application to provide digitally secured agreements [37]. It is a public platform, and anyone can access the blockchain network. Solidity programming language is used to write a smart contract on the Ethereum platform [38].

E. cURL

cURL is a data transport protocol that may be found in scripts and command lines. Curl is also the Internet transfer engine for thousands of software programs in over ten billion installations, including televisions, automobiles, printers, routers, mobile phones, audio equipment, set-top boxes, tablets, and media players. [39].

F. Node.js

Node.js is a runtime environment for JavaScript applications. JavaScript is a well-liked scripting language for web-based applications. Asynchronous event-driven JavaScript engine Node.js was built in 2009 to support scalable online applications. Many developers employ third-party modules, such as the I/O framework, to provide server-side functionality since JavaScript was designed for client-side scripting purposes. These modules are highly interdependent. As of December 2020, there are estimated to be more than a million modules registered in the Node Package Manager (NPM) for Node.js. As an example, the target module "A" is deemed vulnerable since its version is known to be so, but this approach is unable to explore previously discovered vulnerabilities. Without statistical research, other tools that aim to disclose security weaknesses in JavaScript applications tend to concentrate more on the detection of incorrect code than the rapid detection of vulnerabilities [40].

G. Docker

An example of container technology known as Docker is a de facto standard in software development and has helped shift the paradigm from full-stack virtualization to containerized development. Using domain-specific languages, Docker establishes container and orchestration standards [40].

Docker is now one of the most popular containerization systems. Docker has seized 83 percent of the containerization industry, which is expected to generate $2.7 billion in sales by 2020. In 2018, the Data log estimated that around a quarter of their clients had already used Docker [41].

The Conventional Manual System

A currently used land administration institution known as the patwar held an absolute monopoly and control over lands and land records. These vital land documents included:

Documents about land titles

1) Documents used to change the ownership of these land titles from one individual to another
2) Documents used to update land titles

Enormous power resides in the Patwar institution, the patwari became the sole holder of the record and was able to access and update the records without interference.

It is time-consuming and difficult to maintain the land revenue records manually, as they are stored in different books, locations, and registers. Punjab's long-term objective is to provide all the information in one electronic repository that is easily accessible to all. Several challenges are outlined in [22], including delays with registration, ownership transfers, and incorrect/conflicting data provided by the Land Administration System (LAS). Additional complications come from the fact that many departments involved in Land Record Management operate independently of one another, including NADRA, Revenue, and the Registrar. Property sellers and buyers, for example, have to attend separate departments for verification and production of documentation in the same transaction.

Proposed Methodology

In this section, the proposed approach to the land management system in Pakistan is discussed in detail using blockchain.

There is a discussion of the system architecture and a demonstration of that design. The proposed system, Blockchain-based Land Record Management in Pakistan, has a high-level architecture and a short description of its components. A three-part system design is presented (as seen in Figure 1), with the Registrar, Revenue, NADRA, and Blockchain all having equal stakes.

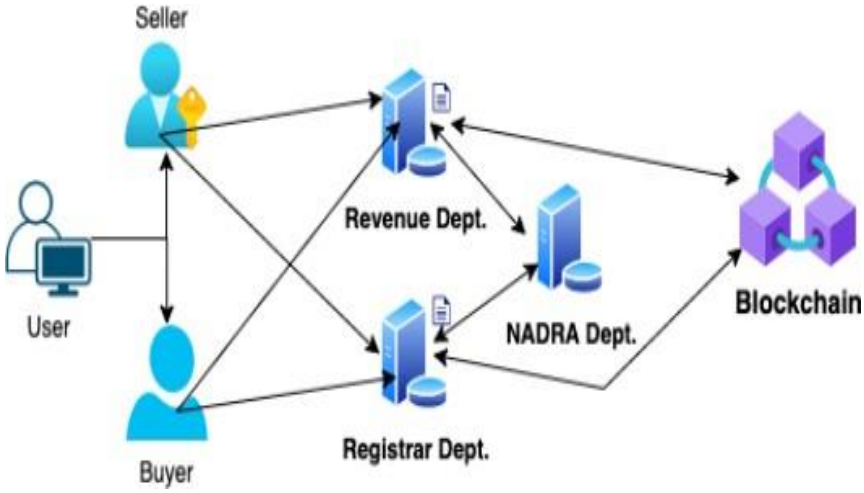

Fig. 1. Proposed system architecture

A. *Registrar department*

Sales and entry (FORM-II) certificates are issued by the Registrar Department, which also stores data both locally and on the Blockchain network. Every node in the network may access the data in this department's ledger.

B. *Revenue department*

A challan must be issued by the Revenue Department, which also maintains all previous papers as well as those of the new owner in local storage and on the Blockchain.

C. *NADRA department*

It is NADRA's responsibility to verify the customer and vendor bio-data provided by the Revenue and Registrar departments and feed a response to them. There are several advantages to using the immutable ledger and smart contracts provided by blockchain technology. To keep track of property ownership, an immutable ledger is used. Using smart contracts, you may restrict the number of certificates that can be issued at the same time.

D. *Workflow of the proposed system*

In this division, we confer the workflow of the proposed approach and demonstrate the results. As a result of a request from the owner, the Revenue Department plans to establish a system that will produce and store challan data on local storage in the owner's name. Following the submission of the bank challan, Revenue Department officials will use NADRA to verify that the information provided by the challan's owner is correct. Verification is completed, and a sales certificate in the owner's name for a certain period is issued. Both the local database and the Blockchain network save data from the sale certificate and the paid challan.

The Registrar's office will be equipped with technology that will link to the NADRA system to verify both the bio-data of the purchaser and the authenticity of the sale certificate itself.

A property register is created after verification is completed, and data is stored both locally and on the Blockchain. Following the completion of property registration, the Revenue Office will provide the new owner with a FORM-II certificate, according to the planned system (purchaser). This procedure completes the transfer of property ownership. The suggested system's operation is depicted in Figure. 2.

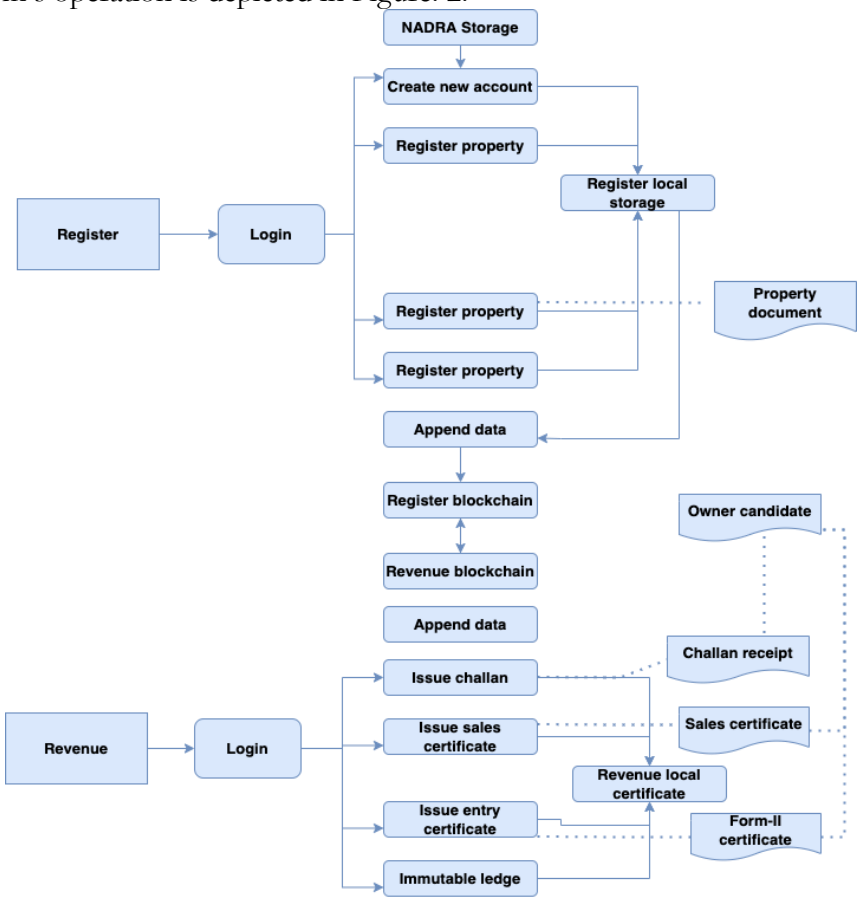

Fig. 2. Demonstration of the proposed system

E. Implementation

The interesting party shares the details of themselves and clicks on transact to create the account. After the creation of the user, NADRA needs to verify the authenticity of the user. NADRA adds the customer account number to verify the user. The system checks whether the user is verified or not. If the user is verified the system adds the land on the respective user's name.

After the addition of the land, the NADRA verifies the land. After the verification of the land, any verified buyer can purchase the land.

To purchase the land, the buyer adds the seller id and land id for the request Land, after clicking on the transact button. The green message shows the verification on the request Land. To purchase the land, after the land request, the user transfers the payment to the corresponding buyer. For the payment, it needs to be added the same amount as the seller added during the addition of the land.

After clicking on the transact, the green message shows on the screen to verify the purchase. The last step is to change the ownership of the land. To do so, the new owner id is added with the land ID for the ownership transfer.

The two screenshots in Fig. 3 are demonstrating the working of the prototype built for two features named ***register Buyer*** and ***land ownership transfer*** functions.

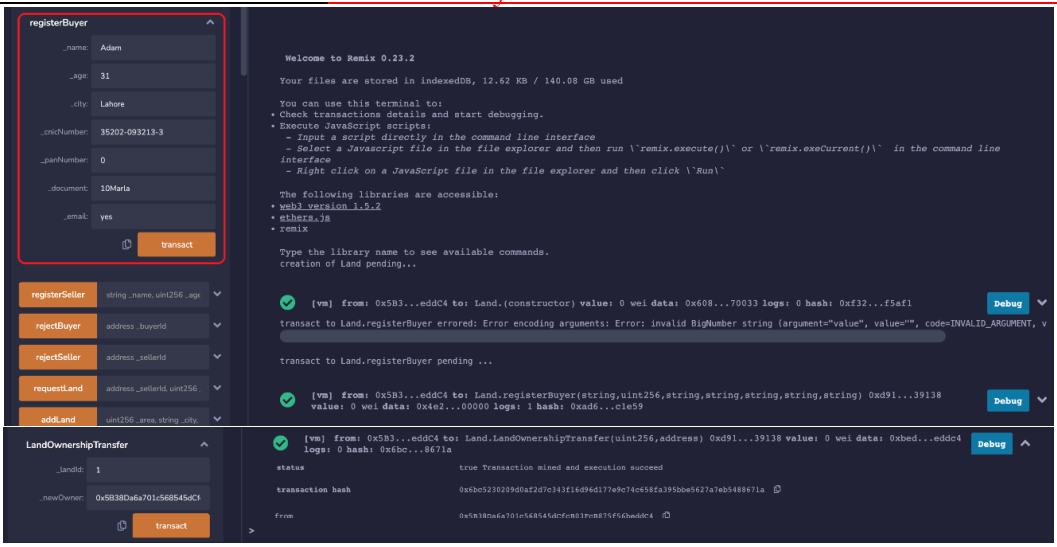

Fig. 3. Demonstration of the proposed system

Results and Discussion

The literature suggests that Blockchain technology may prove practical in land management. The advantages of blockchain technology come from many distinct characteristics, including inflexible ledgers, security, interoperability, and scalability, among others. The literature has highlighted several land managements concerns. However, despite Blockchain technology easing some aspects of this process in several countries, land management departments still employ traditional methods to resolve the issue.

This research has developed and tested a blockchain-based prototype for the land record management system. The prototype is working excellent and will be a basis for the future real systems in the domain. The prototype is based on our fundamental study of the major workflow of the current and manual land record management system being implemented in Pakistan, especially Punjab. We, being giving proof of the concept and not preparing a system for the end-users, considering it a major government-funded and enterprise-level software, just created a system to create a smart contract of the state-of-the-art Blockchain technology.

Conclusion and Future Work

The literature has emphasized the potential benefits of using Blockchain technology in multiple fields, including land management. These benefits stem from several unique characteristics of Blockchain technology, such as inflexible ledgers, security, interoperability, and scalability. We have identified several Land Management concerns in the literature. While several nations have lately offered solutions based on Blockchain technology to manage these difficulties, relevant departments in the county accountable for land management appear to have relied on conventional land management methods, leaving the challenges raised unsolved. To solve the constraints of Land Record Management in Pakistan, we developed a Blockchain-based Land Record Management solution and detailed its design and execution in this paper.

We have validated the proposed system's functionality using constructed sample data and intend to seek authorization from the relevant departments in the future to install and test it in real-world circumstances. The feedback and difficulties identified during real-world deployments may result in the development of a new version of the planned system. In the future, we will seek to reduce the costs associated with blockchain in land management and make the system more functional and efficient from a Pakistani perspective. Conduct further research on the scalability of Blockchain. The majority of current research on Blockchain technology is concerned with privacy concerns and security. Scalability concerns like throughput and latency must be solved before Blockchain technology can be widely used.

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