A Blockchain-based framework for Agriculture subsidy disbursement

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Abstract - Agriculture is the primary livelihood factor in the growth of India's economy. One of the significant challenges faced by the Government of India in the agriculture sector is to increase the delivery of subsidies by re-engineering the existing process. One of the solutions initiated by the government of India on 1st January 2013 with the highest priority is called a Direct Cash transfer scheme under the Direct Benefit Transfer (DBT) scheme. It involves crediting subsidies (cash/payments) directly to the farmer's account. However, the major problem associated with this scheme is that the government subsidies do not reach all the eligible farmers due to corruption, delay, intermediaries, and other reasons. The present direct cash transfers system's major drawbacks such as (key loopholes are) lack of proper auditing, inability to track subsidy, and inadequate digital banking infrastructure especially in rural areas. In this regard, the disbursement of direct cash transfer scheme is addressed benefitting the farmers directly via Blockchain Smart Contracts technology thereby ensuring transparency, de-duplication, reduced delays, and reducing instances of fraud in the existing government subsidy delivery system. We aim to develop a blockchain-based smart contracts prototype model called a single-window approach for automating farmer's subsidies and eliminating middlemen. The automated model will be fast, transparent, and immutable by reducing the complexities faced by Indian farmers.

Keywords: smart contracts, BT scheme, direct cash transfer, blockchain systems, e-governance, distributed ledger technology, disbursement
1. Introduction

Background

In India's economy, the agriculture sector is ranked fifth in production, consumption, export, and expected growth in the FY2020-21. Agriculture is the primary livelihood for more than 70% of the rural population and employs over 60% of the total population of India. In the agriculture sector, one of the challenges faced by the Government of India is to increase the quick delivery of agricultural subsidies and ensures accurate targeting of the beneficiaries. In this regard, in January 2013 the Government of India has launched the Direct Cash Transfer scheme under DBT for fund distribution and delivery system. In this scheme, the subsidies (cash/payments) are directly credited to the farmer’s account and validated by the Unique Identification Authority of India (UIDAI) to bring transparency, reduce fraud and delays happening by the hierarchy of government administrative offices.

The DBT schemes are of three types: (a) Cash Benefit (Government transfer cash directly to farmer account called as subsidy like PAHAL, NSAP, MGNREGA, etc.), (b) In-Kind Benefit (Government transfer free cash directly to farmer account through an intermediate agency like Public Distribution System (PDS), Food Corporation of India (FCI), mid-day meals, etc.) and (c) Mix Benefit (Combination of Cash benefit and Kind benefit). As per the survey report, 450 DBT schemes under 56 ministries have been launched in India and are delivered to more than 900 million beneficiaries. In which 97 are cash schemes and 63 are In-kind schemes, while the remaining are a mix of cash-kind schemes. However, the major problem is that these government subsidies often do not reach all the eligible farmers due to corruption, delay, intermediaries, and other reasons.

The government record shows only 1% of the cash transactions have failed, which means 99% is a success, which is not valid. Only 20% of the farmer’s complaint about not getting subsidies. This problem occurs because the National Payment Corporation of India links the details of the latest bank accounts with the Aadhaar to DBT payments. So, farmers verify the bank account, which was initially receiving the subsidy, and finds that the money has not been deposited. The present DBT based direct cash delivery system's key drawbacks are lack of proper auditing, inability to track subsidy, and inadequate digital banking infrastructure in rural areas. In this regard, to increase the transparency in the government subsidy delivery system for farmers, the Indian states and central governments have been actively looking for technological up-gradation into agri-practices.

Thus, the combination of DBT based direct cash transfer scheme by adopting Blockchain-based Smart Contracts technology will improve the disbursement of existing subsidy/welfare benefits to the farmers. It can target subsidies for food grains, seeds, fertilizer, and fuel etc., to know the availability, consumption, and delivery mechanism for bringing out inefficiency, accountability, and transparency. In simple terms, Blockchain is a systematic-immutable backtracked linked-list database to store and access value-transactions that have happened and may happen in the future directly without any intermediaries. It can significantly improve transparency, reduce corruption, tamper-proof, and enhance security by reducing the overhead costs of auditing, accounting, and legal issues.

In the direct cash transfer scheme, insight into who is being issued subsidies, what they are being used for, and each payment's wisdom should be made available for farmers by the government. In this paper, we address the solution to the above problems by adopting blockchain-based smart-
contracts technology. In this system, the existing farmer’s database will be linked to a blockchain database (smart contracts) for providing automation subsidies between the government and the farmers. It makes the system more transparent, efficient, and trustworthy without charging transaction fees and removes intermediaries who may misuse/divert subsidy. Intelligent contracts (or smart contracts) are the digital agreement to automate the transactions when the agreement parties meet the agreement terms and conditions.

2. Motivation and Objective

The primary motivation is the disbursement of direct cash subsidy benefit under the DBT scheme to all the Indian farmers without any intermediate agencies and delays. To achieve this, the objective is to improve and resolve the above said key loopholes of the existing government's fund delivery system. The solution converses on a Blockchain-based smart contracts prototype known as the single-window approach. The automated model ensures to be fast, transparent, and immutable by reducing the complexities faced by the Indian farmers. It improves the system’s security while considering many aspects such as overhead expenses of auditing, accounting, and legal issues. The identified complexities for subsidy transfer under the existing DBT system and its solution conversing on blockchain-smart-contracts technology can be addressed as:

2.1 Mandatory enrollment: The new DBT policy requires farmers to link an Aadhaar number with their bank account. However, the majority of farmers do not have either of them. If enrollment is not mandatory, then the verification systems (Identity card and Aadhaar number) must coexist. Still, the farmers with multiple cards will choose to opt-out of the process of the Aadhaar system, and also, it cannot address problems related to cash/payments.

2.2 Removing Intermediate/Middlemen: The subsidy is often misused by the intermediate persons or middlemen who divert the sanctioned subsidy/fund from the farmer accounts to their accounts, and this has to be eliminated by adopting a blockchain-based system.

2.3 Maintaining privacy: Data collected while issuing Aadhaar may be misused. India does not have a specific law governing issues related to privacy. The authority stores the details of every request for authentication, which provides insights into the usage patterns of an Aadhaar number holder which may be misused. Hence, there is a need to secure and track this data by applying the concepts of blockchain smart contracts.

2.4 Transparency in subsidy-chain amounts: The disbursement of subsidy amounts in the supply-chain may be misused. The eligible and needy farmer will not avail of the subsidy benefit entirely. Using blockchain smart contracts, we can track the subsidy amount.

2.5 Farmers' digital Identity Repository: It is used to store, share, and validate personal bio-data of farmers by the use of cryptographic methods to increase the trust via smart contracts.

2.6 Removing Commission: Bank charges for every transaction, and also this process is time-consuming. To avoid this, blockchain-based smart contracts ensures that there is no transaction fee charged.

3. Literature Review

This section reviews and highlights the related work to know which agri-digital domains have been explored in Blockchain for solving the above-stated problems. In recent research [1] the authors
outline the blockchain technology implementation in government projects and had proposed various initiatives to integrate stakeholders into food production and supply chain. For technology benefits, the blockchain barriers and challenges can be addressed by the government research fund efforts to foster digitization. This is possible by educating farmers through various training methods. In [2] the open cyber security challenges of smart farming, security and privacy issues, use cases w.r.t cloud and edge computing, and relevant research work in the cyber security domain were addressed. The authors [3] had discussed blockchain applications, problems, and solutions related to agricultural and food sectors like agricultural insurance, smart farming, food supply chain, and farm products transactions. They also addressed uploading the existing data into the Blockchain database may be very costly. The various data security issues [4] such as confidentiality, integrity, availability, and implementation solutions were possible using a private blockchain-smart-contract in agriculture. For privacy, the solution is a private blockchain network; for integrity, the solution uses a hashed-chain structure for verification over blockchain network and for availability, the solution is to store the transaction data (hashes) in the tamper-proof smart contracts. In another work [5] the authors had discussed sustainable agricultural data management in rural areas for energy consumption, data planning for making decisions w.r.t data collection, storage, and performance to determine the reliability factor of blockchain. In [6] the current research trends, applications, and challenges of smart contracts based on blockchain technology were discussed.

4. Problem Statement

The DBT based direct cash schemes have various loopholes such as the involvement of intermediaries, security & privacy issues as well commissions charged by the various banks. The DBT scheme implementation in the [7] Jharkhand state of India has put a question mark on the efficiency of the system as the nexus between banks personnel, intermediaries, government and school authorities seem to have siphoned off significant portions of the funds, gives an excellent example of the flaws present in the system. As in the Jharkhand case, the authorities and intermediaries, including banking correspondents, are alleged to have obtained the relevant documents and particulars, including fingerprints, genuine and fake beneficiaries, certified their authenticity, and perpetrated a scam. According to a report submitted by Jameel Poverty Action Lab, the loopholes of the DBT scheme and ineptitude of payee to acquire the benefits has hindered the faith in the current system [10]. The critical issues identified in the existing system are:

a) Over dependency on banking systems.
b) Erroneous amount of fund transfer.
c) No audit/grievance redressal mechanism.
d) Middlemen Commission
e) Fake beneficiaries

To address the above-said issues, we use a public-permissioned blockchain. The reason is a public-permissioned blockchain network, infuses the space by linking the public-permission less networks i.e., Bitcoin/Ethereum with the private-consortium network to attain the prime quality of distributed models. Transparency is achieved through access control and consensus mechanisms by maintaining transaction sequences [11]. Moreover, the issues related to the performance of the public-permissioned blockchain [12] are ranked high to overcome delay and achieve competence. In the
long run, this system highlights privacy more than public-blockchains [13]. By considering these issues we formulate the problem statements as:

a) Design and develop a secured system based on blockchain to track subsidy/fund disbursement for the enrolled farmer (beneficiary).

b) This system has to be adequately auditable and fully automated.

c) The designed system must be secured and should provide privacy and paramountcy of data on the Blockchain.

d) The system must remove the fake beneficiaries and the commissions charged by the bank.

e) Design and develop a robust algorithm to calculate a unique blockchain id/address and OTP-based on the Aadhaar number.

5. Existing System

The existing system has various complexities such as duplication and tampering of the submitted farmland records, fraud cash transfer in the bank accounts, and delay in the process which is faced by the farmers as depicted in figure 5.1. They need to register with the various government departments such as the Land Records Department, the Government of India Treasury Department, customer bank to claim the cash benefits provided by the government fund delivery system.

![Figure 5.1. Existing system](image)

The existing process is summarized in five steps as follows:

1. In the first step, the farmers need to register with the Land Records Department by providing farmland records.

2. In this step, the Land Records department will submit the details of the farmer's farmland to the Government of India Treasury Department. The department verifies the details and allots cash benefit to the individual farmer.

3. The farmer has to open an account in a private or public bank validated by UIDAI, such as an Aadhar card.

4. In this step, the bank verifies both farmer's details submitted at Land Record sources and facts presented at the bank and then links Aadhar card with the farmer's bank account.
5. The government of India's own Treasury Department verifies the details from banks and the Land Records office and initiate direct cash transfer to the farmer's bank account.

6. Proposed System

The proposed system reduces the farmers' complexities and problems as it ensures to provide flexibility in terms of a single-window blockchain approach to furnish security and privacy. The proposed system is as shown in figure 2, which is auditable, transparent, and automated. Here we summarize the entire process of the proposed system as follows:

1. In this step, the farmer will register to the blockchain-based fund transfer system by uploading his farmland records and get authenticated via UIDAI Aadhar card. In turn, the blockchain-based system will generate a unique digital identity such as wallet address using robust cryptographic calculations.

2. In the second step, the three significant entities of this system will access the details provided by the farmer, the Banks and the Department of Land Records will verify the details mutually such as farmland records, Aadhar number, mobile number, etc.,

After verifying the Blockchain-based fund transfer system's details, the Government of India will initiate the fund transfer process. So in this way, the system removes the middlemen, fake/fraudulent identity entities and provides immediate transfer of funds concept and the commission charges imposed by various banks.

![Figure 6.1](image_url)

Figure 6.1. The overview of Blockchain-based Fund Transfer System

In figure 6.1, It depicts the blockchain-based fund transfer system using a public-permissioned blockchain network. A public-permissioned block-chain network is a new type of network which fills the gap between the public and private consortium networks [8] to infuse the space by a distributed model. The GUI of the proposed system is designed using AngularJS to communicate across the systems. We have used the NodeJS Express server to build a blockchain system using hyper ledger fabric and composer [14][16]. The four users of the system are the Farmer, Government Personnel (Treasury Department), Department of Land Records, and Customer Bank. We propose various assets for the systems, such as Aadhar card number, OTP, and subsidy amount. We also propose to write several fund transactions, which is based on Smart Contracts.
The architecture shown in figure 6.2, has three major components which provide transparency, security, and sanctity summarized as:

i. Primarily, the system will create blocks in the blockchain to store and link the transaction data. Each block stores the previous block hash data for cryptographic security, and after that, crypto hashing is done using some built-in algorithms such as MD5 (message digest 5) SHA-1 (secure hash algorithm). The output of MD5 is 128-bit digest and SHA-1 is 160-bits digest. A cryptographic hash function is a particular class of hash functions sometimes called ‘digest’. It is a kind of 'signature' for a text or a data file with various properties, making it ideal for cryptography.

ii. In the second step, the system stores the transaction details in a distributed database. Block-chain's distributed ledger is an immutable and secured digital public ledger continuously growing the cryptographically secured database.

iii. In trustless peering, the trust is the other name given to the mathematical evidence for verification of nodes in the peer-to-peer network. The nodes performing transactions in the blockchain peer-to-peer network need not necessarily know the real identity of other node is called as blockchains trustless property [11][15].

7. Results and Discussion

In this section, we discuss the proposed blockchain-based fund transfer prototype model, its scope, and functionalities. Before using this system, we assume that the farmer has the following documents:

1) Farmer has an Aadhaar Card/ID,
2) Farmland records attested/verified by the department of Land records,
3) We believe that farmer has a mobile phone to receive the generated OTP and
4) We also think that farmers can use the designed portal/application.

Prototype

In figure 7.1, we illustrate the login information for the blockchain-based prototype model. The farmer has to input his Aadhar card number and OTP on his mobile. The entered information is
stored in the blockchain database by creating blocks in the blockchain system and making smart contracts. This system has four users: Government Authority, Farmer, Department of Land Records, and Banks. As Government Treasury department is having a privilege to verify subsidy/fund transfers to the beneficiaries/farmers, deliver subsidy, and generate a report via smart queries.

As shown in figure 7.2, The farmer can upload the farmland documents in either of the formats such as JPEG or PDF. In turn, the land record department will verify the farmer’s records/documents by the block-chain based system using participants of system like miners who will in turn submit a report to the government of India.

Figure 7.1. Login screen

Figure 7.2. Upload screen
The treasury department then initiates the transfer of the subsidized amount to be credited to the individual farmer.

In the above figures 7.3 and 7.4, the other participants of blockchain-based fund transfer system as Government authority and Department of Land records can view the subsidy or fund transfer history and based on the document submitted to the system been verified thoroughly by the Department of Land records are eligible for fund transfer. The GOI initiates the fund transfer to the eligible beneficiary/farmer to his Blockchain wallet ID.

8. Conclusion

We have discussed the significant challenges and the critical loopholes faced by the Government of India in the existing DBT cash transfer scheme. The solution converges on blockchain-based smart contracts to improve the existing government's fund delivery system. In this paper, we have discussed and designed a prototype model called a single-window approach based on blockchain technology to reduce the farmer's complexities and major issues faced by them in India. The automated model ensures to provide security and privacy, auditability as well as transparency and immutability. Thus, the direct cash delivery prototype can be adapted and implemented by using Blockchain-based technology with several tactile benefits. In the end, we discussed the functionalities of the robust system developed using Blockchain-smart-contracts.
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