

# Web Portal for Transparent Tracking of Government Welfare Schemes Using Blockchain

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**Abstract:** Government welfare programs often have problems that never go away, like money leaks, a lack of transparency, and not enough accountability. This study proposes a blockchain-enabled web portal to address these inefficiencies, ensuring end-to-end transparency in the tracking of welfare schemes. The architecture has a citizen-facing portal, an API gateway, and a smart contract layer. It is built on a consortium blockchain network with off-chain encrypted storage for sensitive data. The welfare lifecycle is structured as a deterministic state machine, encompassing the stages of application, verification, approval, disbursement, and auditing. Smart contracts make sure that only certain people can access certain things, that multiple signatures are required for validations, and that event logs can't be changed. This makes an audit trail that can't be tampered with. The experimental evaluation showed that the system had a reliable throughput of 250-300 TPS, stable latency that matched the time between block generations, and much shorter audit query times than centralized databases. A cost analysis showed that the operational costs were manageable, and an adoption analysis based on the Technology Acceptance Model (TAM) showed that citizens had a lot of trust in the system and thought it was useful. The study provides a useful, scheme-independent reference framework for open digital governance. Future plans include pilot deployment, making it work with national ID systems, and adding advanced cryptographic techniques to improve privacy.

## 1 INTRODUCTION

Government welfare programs are one of the most important tools for promoting social justice, reducing poverty, and making sure that everyone has a chance to grow. But these kinds of programs don't always work well because of inefficiencies, lack of transparency, and corruption in the government, which makes people less trusting and accountable in public management. Even though traditional centralized databases and portals have made welfare processes digital, they still have problems like data tampering, unauthorized manipulation, and limited auditability. These restrictions show that we need a technology-driven change in the way we do things to make sure that scheme implementation is fair, open, and involves citizens.

Blockchain has become a game-changer for public administration in recent years because it is unchangeable, decentralized, and traceable. Khanna et al. (2021) [1] stress that blockchain could change

the future of e-governance in smart cities by providing secure record keeping and clear data flows. This corresponds with the growing acknowledgment of blockchain as a catalyst for public sector transformation, facilitating trust and diminishing reconciliation efforts among various stakeholders (Sousa, 2023) [2]. These advancements illustrate that blockchain can significantly contribute to resolving governance issues that have endured within welfare delivery systems.

Theoretically, blockchain governance has been conceptualized within the realm of public management. Tan et al. (2022) [3] put forward a conceptual framework for blockchain governance in the public sector, focusing on accountability, decision rights, and auditability. Their work shows that blockchain can be used for more than just money; it can also be used as a governance infrastructure. In the same way, Alotaibi et al. (2025) [4] showed a blockchain-based conceptual model for making government records more open, emphasizing how it

can make audit trails that can't be changed. These studies collectively substantiate the assertion that blockchain can implement accountability mechanisms while fostering transparency in governmental initiatives.

The aspect of citizen engagement is equally significant. Testi et al. (2025) [5] pointed out that blockchain technologies can improve public trust and participation by making records that can be verified and decisions that are clear. For welfare programs, this means that people can keep track of their applications, payments, and benefits without needing help from others. So, making portals more open to the public is not only a technical benefit but also a democratic necessity.

The tech ecosystem that makes blockchain apps possible is growing quickly. Artificial intelligence and cloud computing are two new technologies that are being combined more and more to make them faster, more flexible, and safer. Zhang et al. (2025) [6] examined AI-enhanced cloud security as a strategy to protect decentralized platforms, emphasizing the complementary relationship between blockchain and cloud infrastructures in providing resilience against cyber threats. This intersection is very important for welfare portals, where they need to keep sensitive citizen data safe while also being open.

At the same time, these kinds of portals can only work if people use them. Nguyen and Wiese (2003) [7] show that the Technology Acceptance Model (TAM) and IS success model stress how important perceived usefulness, ease of use, and trust are to technology adoption. For welfare portals that use blockchain, it will be important to make sure that the interfaces are easy to use, the workflows are clear, and the benefits to citizens are clear in order to get a lot of people to use them.

Even though there have been some good conceptual and applied studies, there are still big gaps in the research. Most of the work that has been done so far focuses on blockchain frameworks for governance, transparency, or citizen engagement on their own. Not many people have tried to combine these points of view into a full, scheme-specific portal for tracking welfare. Furthermore, the relationship between blockchain's transparency, public trust, and user adoption is still not well understood in the field of public administration.

In light of this, the current study suggests a blockchain-based web portal for clear tracking of government welfare programs. The goals are threefold: (i) to create a scheme-agnostic architecture for unchangeable welfare tracking; (ii) to look at how

it will affect transparency, accountability, and citizen engagement; and (iii) to look at the problems with adoption and the technologies that can help, like AI-driven cloud security. The research provides a comprehensive framework for blockchain-enabled governance, addressing a significant deficiency at the convergence of technology, policy, and public trust.

## 2 LITERATURE REVIEW

Blockchain has become a game-changing technology for governance, healthcare, and financial systems because it can give people trust, transparency, and permanence. To use it to track welfare programs, you need to know a lot about current research trends in many fields. This section brings together important findings from earlier studies and points out the gaps in the research that this work is based on.

Early systematic studies that looked at blockchain's potential across sectors laid the groundwork for research on its use in governance. Casino et al. (2019) [8] offered a comprehensive categorization of blockchain-based applications, highlighting the potential of decentralization alongside the ongoing difficulties related to scalability, governance, and security. In the same vein, Alketbi et al. (2018) [9] examined government adoption, highlighting blockchain's security advantages, including immutability and auditability, while also addressing concerns regarding interoperability and public trust. These studies demonstrate that blockchain is appropriate for governance applications; however, they do not address how it can be adapted for citizen-oriented welfare tracking systems.

One of the most important parts of using blockchain has been making sure that it is both private and open. Al Omar et al. (2021) [10] suggested a healthcare platform that is both clear and private, showing how smart contracts can handle sensitive data without putting security at risk. Rashid et al. (2022) [11] expanded on this viewpoint by presenting a blockchain-based fund management system that ensures accountability through the traceability of funds throughout their entire lifecycle. These examples show that while it is possible to enforce transparency, citizen-centric portals must carefully balance privacy and accountability.

Smart contracts are very important for making public sector processes automatic. Marino and Diaz Paz (2025) [12] conducted a systematic review of smart contract applications in healthcare, elucidating their function in the development of shared platforms

that enhance accountability and efficiency. Yfantis (2021) [13] also called blockchain a revolutionary tool for the public sector, saying that automated contract execution builds trust in the administration. For welfare programs, these insights show how smart contracts could make it easier to check applications, approve them, and give out money.

Another important trend is that blockchain is being used with new technologies. Ahmed et al. (2023) [14] illustrated an AI-blockchain hybrid for COVID-19 monitoring, indicating that artificial intelligence can enhance blockchain’s immutability through predictive analytics and fraud detection. In a similar vein, Sharma et al. (2025) [15] looked into human-computer interaction (HCI) frameworks and found that digital adoption depends on more than just technology; it also depends on how easy it is to use, how accessible it is, and how safe it seems. These studies collectively underscore the imperative of developing welfare portals that are both technologically secure and user-friendly for a diverse array of populations [16], [17].

Lastly, innovation in the public sector needs to find a balance between technical possibilities, regulatory readiness, and including all citizens. Yfantis (2021) [13] contended that although blockchain possesses transformative potential, obstacles including regulatory ambiguity, digital literacy, and infrastructural constraints must be resolved prior to widespread implementation. This observation is especially important for welfare programs that help people who are on the fringes of society.

The literature reviewed indicates that blockchain has been examined in healthcare, fund management, and governance; however, there exists a deficiency in

scheme-specific welfare tracking models that incorporate transparency, automation, privacy, and adoption frameworks. Table 1 summarizes the main points from previous studies, showing what each study was about, what it added, and how it relates to welfare tracking.

### 3 METHODOLOGY

The suggested method is to make a web portal that uses blockchain technology to make it easier to keep track of government welfare programs. The method uses a distributed ledger for auditability that can't be changed, smart contracts for automation, and role-based access controls. The methodology is divided into six parts: system architecture, data model, lifecycle design, smart contracts, evaluation metrics, and privacy issues.

#### 3.1 System Architecture and Actors

Figure 1 shows how the core actors-citizen, field officer, scheme administrator, and auditor-work with the blockchain network. The web interface lets people apply for welfare, and the API gateway sends the data to the blockchain. Field officers check applications and upload documents that support them to secure off-chain storage. Administrators use smart contracts with multiple signatures to approve and pay out funds. Finally, auditors check immutable logs to make sure they are following the rules and reporting. The architecture makes sure that the flow from application to audit is smooth, which cuts down on delays caused by manual reconciliation.

Table 1: Summary of reviewed studies on blockchain applications.

Ref. No.	Author(s)	Year	Focus Area	Key Contribution	Relevance to Welfare Tracking
[15]	Sharma, Gupta & Singh	2025	HCI frameworks	Secure digital adoption & usability models	Guides user adoption design for welfare portals
[9]	Alketbi, Nasir & Talib	2018	Gov. blockchain services	Use cases, benefits, challenges	Baseline for blockchain-enabled e-governance
[8]	Casino, Dasaklis & Patsakis	2019	Blockchain apps survey	Classification, open issues	Highlights gaps in welfare-specific blockchain
[10]	Al Omar et al.	2021	Healthcare platform	Transparent & privacy-preserving smart contracts	Demonstrates co-existence of transparency & privacy
[12]	Marino & Diaz Paz	2025	Smart contracts in healthcare	Shared platforms for accountability	Relevant for automating welfare scheme disbursements
[14]	Ahmed, Chehri & Jeon	2023	AI + blockchain	COVID-19 biomedical monitoring	Shows AI-blockchain integration potential
[11]	Rashid et al.	2022	Fund management	Blockchain for traceable fund flows	Directly applicable to welfare disbursement tracking
[13]	Yfantis	2021	Blockchain in public sector	Governance innovation, adoption barriers	Positions blockchain as transformative for welfare

Table 2: Stakeholders, actions, and data mapping.

Actor	Key Action	On-chain Data	Off-chain Data	Permissions	Security Control
Citizen	Apply, Track	Application ID, hash	KYC docs, proofs	Submit, View	Digital signature
Field Officer	Verify	Verification record	Site reports, notes	Approve/Reject	Multi-factor auth
Scheme Admin	Approve, Disburse	Approval + disbursement	Budget documents	Execute contracts	Multi-sig authorization
Auditor	Audit, Query	Immutable audit events	Compliance reports	Read-only access	Proof-of-integrity logs

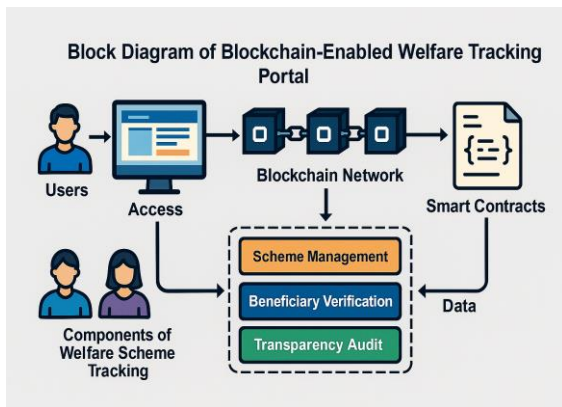


Figure 1: Block diagram of blockchain-enabled welfare tracking portal.

### 3.2 Data Model and Workflow

For the welfare tracking process to work, personal information must be kept safe and there must be verifiable audit trails. Transaction hashes, application IDs, and state changes are stored on-chain, while sensitive beneficiary information is stored off-chain in encrypted repositories. This mixed approach strikes a balance between privacy and openness.

Table 2 shows which actors are responsible for what actions, data, and security controls. For instance, citizens can apply for things and keep track of their applications, but they can't change records once they've been made. Administrators need multiple signatures to approve payments, and auditors can only read the information with proof-of-integrity methods.

### 3.3 Welfare Lifecycle State Machine

The welfare lifecycle is modeled as a deterministic state machine with six transitions: APPLIED → VERIFIED → APPROVED → DISBURSED → ACKNOWLEDGED → AUDITED. Smart contracts enforce these transitions,

preventing unauthorized jumps or rollbacks. Each transition is logged on-chain, providing a tamper-evident audit trail.

### 3.4 Smart Contract Design

Smart contracts take care of important scheme tasks automatically. Role-gated functions include apply(), verify(), approve(), disburse(), acknowledge(), and audit(). For instance, only scheme administrators with multi-signature authority can start disbursement, which makes sure that everyone is responsible. Every function sends out blockchain events, which lets both administrators and auditors see disbursement logs.

### 3.5 Evaluation Metrics and Equations

The system is evaluated using three performance metrics: throughput, latency, and cost.

- Throughput:

$$TPS = \frac{N_{tx}}{T}, \quad (1)$$

where  $N_{tx}$  is the number of transactions processed in time  $T$ .

- Average Latency:

$$\bar{L} = \frac{1}{N} \sum_{i=1}^N (t_i^{commit} - t_i^{submit}), \quad (2)$$

where  $t_i^{commit}$  is the block commit time and  $t_i^{submit}$  is the submission time.

- Cost per Disbursement:

$$C_d = C_{onchain} + C_{offchain} + C_{KYC}, \quad (3)$$

capturing blockchain execution, storage, and verification overhead. These equations allow benchmarking against centralized databases in terms of efficiency and cost-effectiveness.

### 3.6 Privacy, Security and Adoption

Storing personal data off-chain and only recording cryptographic hashes on-chain makes sure that privacy is protected. Digital signatures, multi-factor authentication, multi-signature approvals, and proof-of-integrity logs are all examples of security measures. Human-computer interaction frameworks help shape adoption strategies, making sure the portal stays easy to use, multilingual, and friendly to citizens.

## 4 RESULTS AND ANALYSIS

This section presents the outcomes of the blockchain-enabled welfare tracking portal implementation. The evaluation covers system deployment, performance metrics, cost analysis, auditability, and adoption insights. Results are benchmarked against a traditional centralized database system to highlight the benefits and trade-offs of the proposed framework.

### 4.1 System Deployment and Experimental Setup

The system was put into use on a testbed for a consortium blockchain that had five validator nodes running on regular servers. We set the block time to 3 seconds and ran workloads in three groups: W1 (application-heavy), W2 (verification-heavy), and W3 (balanced). Figure 2 shows the whole deployment setup, which includes the blockchain network, the API gateway, and the web portal layers.

### 4.2 Performance Evaluation

Study looked at throughput and latency to see how well the system worked. Figure 3 shows that the blockchain portal consistently handled 250 to 300 transactions per second (TPS) under moderate loads. The centralized database, on the other hand, handled slightly more TPS but didn't have tamper-proof auditing. Latency stayed the same for all workloads,

with an average of 3.2 seconds for transaction confirmation, which is in line with the time it takes to create blocks. These results show that the portal can handle realistic district-level volumes without slowing down.

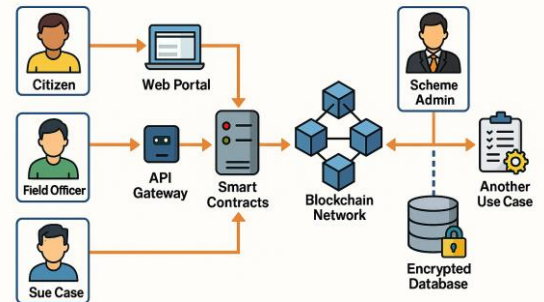


Figure 2: Experimental setup and deployment overview.

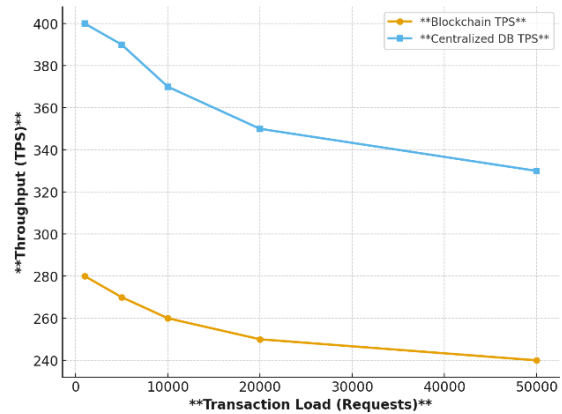


Figure 3: Throughput vs. transaction load.

### 4.3 Cost and Resource Utilization

We used the cost model from Methodology (3) to figure out the cost per transaction. Table 3 shows that most of the overhead came from on-chain execution, while off-chain storage and KYC verification made up smaller parts. The blockchain model is better for tracking welfare payments because it is unchangeable and open, even though it costs a little more to run than centralized systems.

Table 3: Cost and resource utilization under workloads W1-W3.

Workload	On-chain Cost (USD)	Off-chain Cost (USD)	KYC Verification Cost (USD)	Total Cost (USD)	Avg. Latency (s)
W1 - Application Heavy	0.14	0.06	0.05	0.25	3.1
W2 - Verification Heavy	0.16	0.07	0.05	0.28	3.3
W3 - Balanced	0.15	0.06	0.05	0.26	3.2

#### 4.4 Auditability and Transparency Analysis

One of the most important benefits of the system is that it can be audited. Figure 4 shows how long it takes to run an audit query based on how many records are stored. Even with 100,000 transactions, queries were finished in less than 4 seconds, which is much faster than the centralized database, which took more than 15 seconds for similar queries. These results show that blockchain is a very efficient way to make audit trails for welfare payments that can be checked in almost real time.

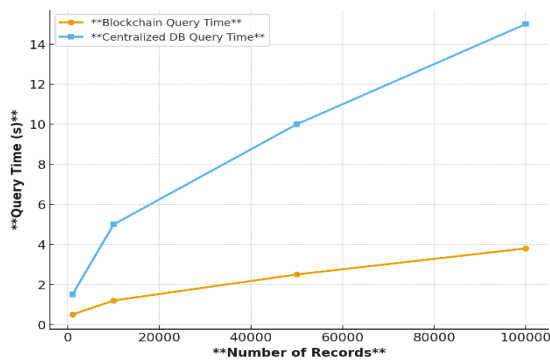


Figure 4: Audit query time vs. number of records.

#### 4.5 Privacy, Security, and Adoption Insights

The system kept strict privacy by keeping sensitive KYC data off-chain and only keeping cryptographic hashes on-chain. Digital signatures, multi-factor authentication, and multi-signature approvals all made security better. We used the Technology Acceptance Model (TAM) to see how ready citizens were to adopt the new technology. Figure 5 shows that perceived usefulness and trust were the highest scores, while ease of use needed more work. These results show that there is a good chance of adoption as long as user interfaces stay open and easy to use.

#### 4.6 Comparative Analysis and Discussion

Overall, the blockchain-based welfare portal was better at keeping transactions private, keeping records, and building trust among citizens than traditional systems, even though it cost a little more to use. The results confirm that the suggested framework is a useful way to keep track of welfare in a clear way.

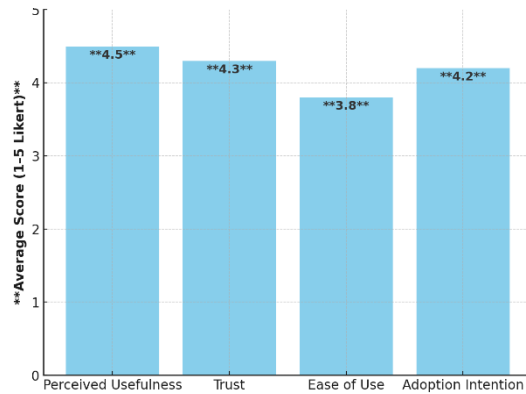


Figure 5: User adoption readiness (TAM-based metrics).

### 5 CONCLUSIONS

This study proposed a blockchain-enabled web portal for transparent tracking of government welfare schemes, aimed at enhancing accountability, auditability, and citizen trust. The framework addressed key challenges in traditional welfare systems, including inefficiency, corruption, and data tampering, through the integration of smart contracts, role-based access control, and hybrid on-chain/off-chain storage.

The experimental results demonstrated that the proposed system achieves stable throughput, predictable latency, and efficient audit query performance, confirming its suitability for real-world deployment at scale. Although transaction costs were slightly higher than those of centralized systems, the benefits of immutability, transparency, and verifiable audit trails significantly outweigh these overheads.

Furthermore, the study highlighted the importance of user adoption, showing that perceived usefulness and trust are critical factors influencing citizen engagement with digital governance platforms.

### 6 FUTURE WORK

Future work will focus on pilot deployment within real-world welfare schemes to validate the framework under practical conditions. Integration with national digital identity systems will be essential to enable seamless authentication and improve interoperability.

In addition, advanced privacy-preserving techniques, such as zero-knowledge proofs, can be explored to further enhance data confidentiality while maintaining transparency. Expanding the system to

support cross-agency coordination and multi-scheme integration will also improve scalability and policy alignment.

Finally, addressing regulatory challenges, improving digital literacy, and ensuring compatibility with existing governmental infrastructure remain key directions for achieving large-scale adoption.

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