WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal Homepage: www.ijrpr.com ISSN 2582-7421

GovChain: An AI-Assisted and Blockchain-Inspired Framework for Transparent Public Fund Management

Preethi M, Prakruthi B, Sahana M H, Sushmitha S S, Mrs. Supriya M K*

B.E. Student, Department of Computer Science and Engineering, GM Institute of Technology, Visvesvaraya Technological University (VTU), Davanagere, Karnataka, India

***Under the Guidance of Assistant Professor, Department of Computer Science and Engineering, G M Institute of Technology, Davanagere, Karnataka, India**

ABSTRACT:

Public infrastructure projects require transparent fund allocation, milestone tracking, and evidence-based payment decisions. Conventional workflows can fragment budget records, contractor submissions, site evidence, and public updates across separate systems. This paper presents GovChain, a prototype framework that combines a hash-linked audit ledger, machine-learning-based anomaly screening, image-difference evidence checks, and role-based web workflows. The design aims to improve traceability and help reviewers identify requests that may need additional examination. The ledger uses SHA-256 hashes to link records; an Isolation Forest model screens selected numerical features for unusual payment patterns; and an image-processing module compares submitted construction images using a normalized pixel-difference score. The system supports government administrators, contractors, and public viewers. This manuscript describes the architecture, workflow, algorithm, evaluation plan, limitations, and future work. Quantitative performance is intentionally not claimed here because validated test results must be generated from the actual implementation and a documented dataset.

Keywords: Public fund management; blockchain-inspired ledger; SHA-256; Isolation Forest; computer vision; construction progress; transparency; auditability

Introduction:

Publicly funded construction projects involve multiple stakeholders, including government departments, contractors, auditors, and citizens. Project budgets and milestone payments must be managed in a way that is traceable, timely, and open to appropriate scrutiny. In fragmented workflows, financial records, progress photographs, approval notes, and public updates may be maintained in separate places. This can make it difficult to reconstruct the history of a decision or identify an unusual transaction early.

GovChain is proposed as a web-based decision-support platform for project and public-fund monitoring. It brings together project records, milestone-based payment requests, image evidence, anomaly flags, approval workflows, and a hash-linked audit history. Its purpose is not to replace financial auditors or engineering inspection. Instead, it organizes evidence and helps reviewers prioritize cases that require attention.

Contributions of this work are: (i) a role-based workflow for government, contractor, and public users; (ii) a SHA-256 hash-linked record structure for tamper-evidence; (iii) an Isolation Forest component for screening numerical payment features; (iv) a lightweight image comparison method for submitted site evidence; and (v) a test plan that separates functional correctness from measured model performance.

Literature Review

Blockchain and public services. Research on blockchain in public services discusses the potential of shared, traceable records to support accountability, process integrity, and coordination between institutions. A hash-linked ledger can

make changes to prior records detectable when hashes are recomputed and checked. However, a hash chain alone is not equivalent to a distributed blockchain network: it does not automatically provide decentralized consensus, independent validators, or protection against an administrator rewriting the entire database and recomputing every hash.

GovChain should therefore be described as a blockchain-inspired or hash-chained audit ledger unless the implementation includes and demonstrates distributed consensus.

Anomaly detection with Isolation Forest. Liu, Ting, and Zhou introduced Isolation Forest as an unsupervised approach that isolates unusual observations rather than building a complete profile of normal data. The method can be useful when labelled examples of fraudulent transactions are scarce. In GovChain, the model can screen features such as requested amount, contractor balance, and amount-to-budget ratio. An anomaly score is only a review signal; it is not proof of fraud. Training data, contamination settings, feature scaling, and threshold choices affect which requests are flagged.

Computer vision for construction progress. Reviews of computer-vision-based construction progress monitoring describe image acquisition, information extraction, progress estimation, and visualization as connected stages. Images can help document site conditions, but reliable progress estimation is difficult when camera position, lighting, weather, occlusion, or work stage changes. A simple pixel-difference method can identify image dissimilarity, but it cannot by itself establish the percentage of work completed or prove that a payment claim is correct.

Research gap. The reviewed research streams commonly focus on one capability—ledger integrity, anomaly detection, or visual progress monitoring. GovChain explores their integration into a single workflow for project-level public-fund review. The proposed contribution is system integration and traceable human review, not a claim that any one component independently guarantees transparency or fraud prevention.

1. Significance of the Study

GovChain is significant because it organizes information required to review public infrastructure spending in one workflow. Hash-linked records can support later integrity checks; anomaly screening can prioritize unusual requests; image evidence can provide a repeatable comparison signal; and role-based dashboards can make the status of projects and approvals easier to inspect. Public views can improve visibility when sensitive personal, commercial, or security-related information is appropriately excluded.

The expected benefits are conditional on implementation quality and governance. The system must enforce access control, protect credentials, retain original evidence, record reviewer decisions, and provide a way to correct mistakes without silently erasing history. Human reviewers remain responsible for decisions involving payments and construction quality.

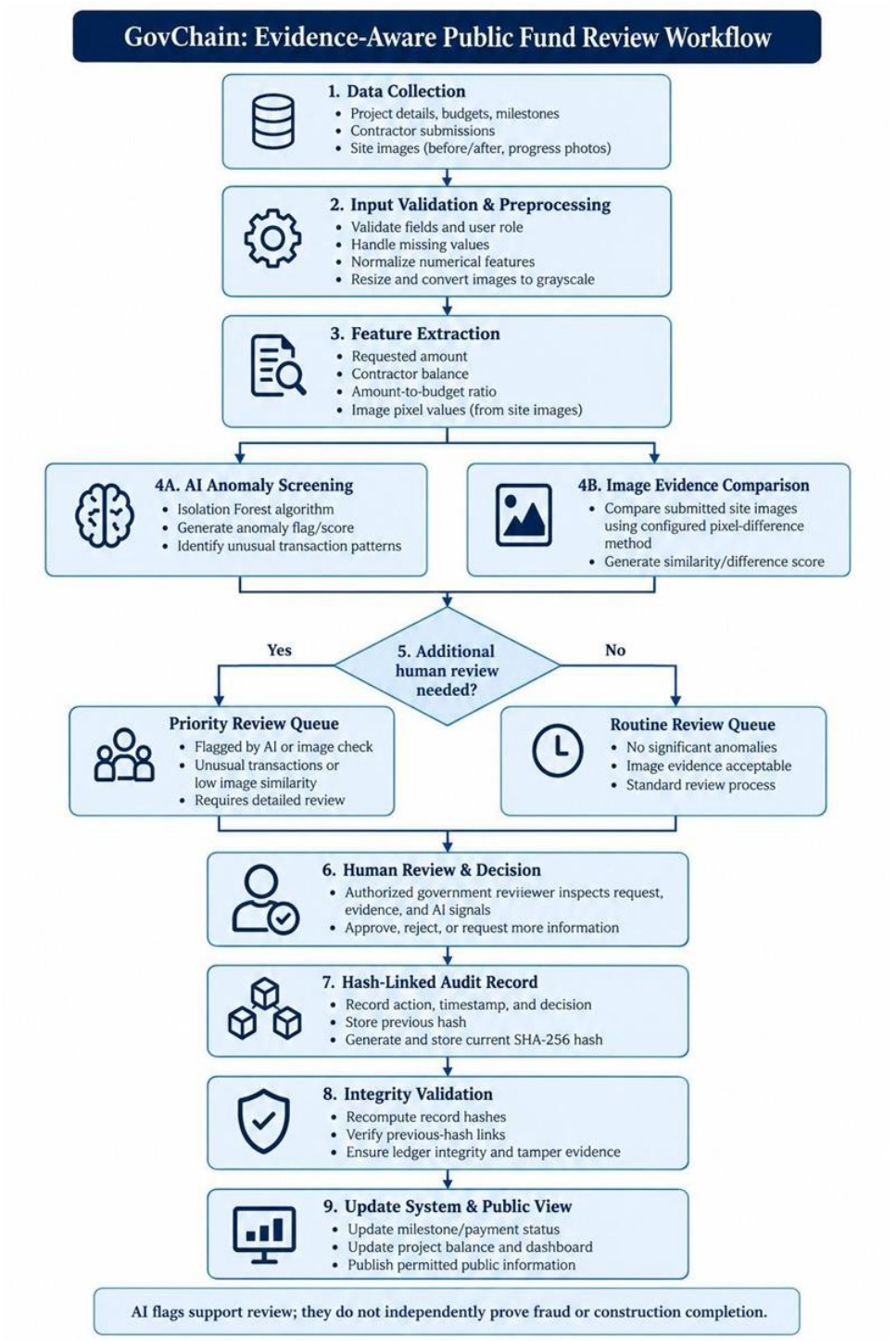
Methodology

System roles and workflow. Government administrators create projects, set budgets and milestones, review payment or budget top-up requests, and approve or reject submissions. Contractors submit milestone updates, payment requests, and before/after images. Public users view permitted project information and may provide feedback. Each action should be associated with a timestamp, actor, project identifier, and decision status.

Hash-linked audit ledger. A ledger record can contain an index, timestamp, event data, previous_hash, and hash. The hash is calculated from a deterministic serialization of the record fields, including the previous record's hash. Validation recomputes each record hash and verifies that each previous_hash matches the preceding record. A failed validation indicates a consistency problem requiring investigation; it does not identify the responsible actor by itself.

Anomaly screening. The prototype description specifies an Isolation Forest model with contamination set to 0.15 and a feature vector comprising requested amount, contractor balance, and requested amount divided by total project budget. The model convention is commonly -1 for an outlier and +1 for an inlier.

Image evidence comparison. The described image pipeline converts images to grayscale, resizes them to 64 × 64 pixels using Lanczos resampling, normalizes pixel values, and computes a mean absolute difference. A threshold of 0.08 has been described in the project notes. Before reporting results, confirm the score formula and threshold direction in the actual implementation: a larger difference usually means the images differ more, but whether that means 'verified' or 'rejected' is a product decision and cannot be assumed. This method is a similarity check, not semantic construction-stage recognition.



Application layer and interface. The stated implementation stack includes Python/Flask, Flask-SocketIO for real-time updates, scikit-learn for anomaly screening, Pillow for image processing, and HTML/CSS/JavaScript with Chart.js for visualizations. Role checks should be enforced on the server side, not only by hiding interface controls. Ledger validation, model outputs, and approval decisions should be recorded with sufficient context to support reproducibility.

Algorithm:

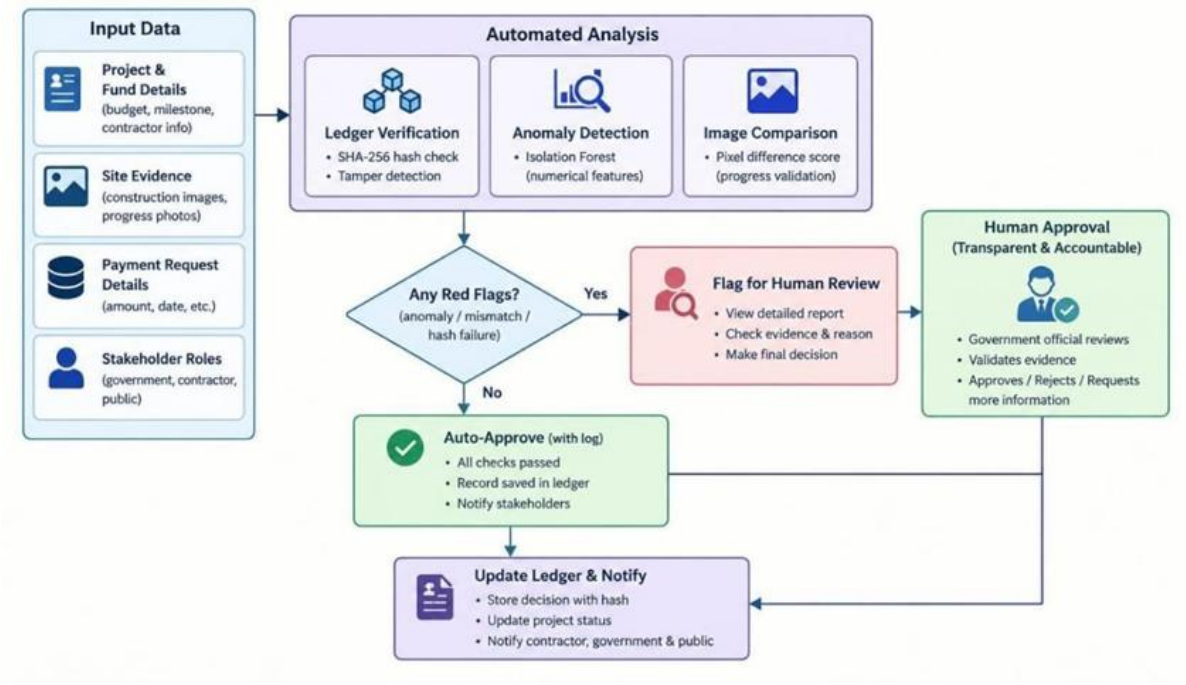
Algorithm 1: Evidence-aware fund-request review

Input: project and milestone identifiers, contractor identity, requested amount, available budget, evidence images, authenticated user.

1. Authenticate the user and confirm the role is permitted to submit the request.

2. Validate required fields, project state, budget constraints, and milestone association.
3. Extract the numerical feature vector and run anomaly screening if the model is available.
4. Compare submitted images using the configured image-processing method; retain the original files and calculated score.
5. Mark the request for routine review or additional review according to documented rules; do not treat an anomaly flag as proof of misconduct.
6. Present the evidence, score, and reason codes to an authorized human reviewer.
7. Record the reviewer decision, timestamp, and relevant event in the hash-linked ledger.
8. Recompute and validate ledger links; update project status and publish only permitted information.

Output: request status, review record, evidence references, and auditable event history.



Results and Discussions

Evaluation design. A reproducible evaluation should use separate test cases for ledger integrity, application workflow, anomaly screening, and image comparison. Results must be generated from the actual application and test data; screenshots or demonstration records alone are not a substitute for a defined test procedure.

Table 1. Recommended evaluation measures

Ledger integrity — test an unchanged ledger, altered event data, altered hash, and broken previous-hash link; report cases passed / total.

Role-based access — test allowed and denied actions for government, contractor, and public roles; report authorization pass rate.

Anomaly screening — report precision, recall, F1-score, confusion matrix, and false-positive rate only if labelled ground-truth data exists. If labels do not exist, report descriptive flag counts and review outcomes instead.

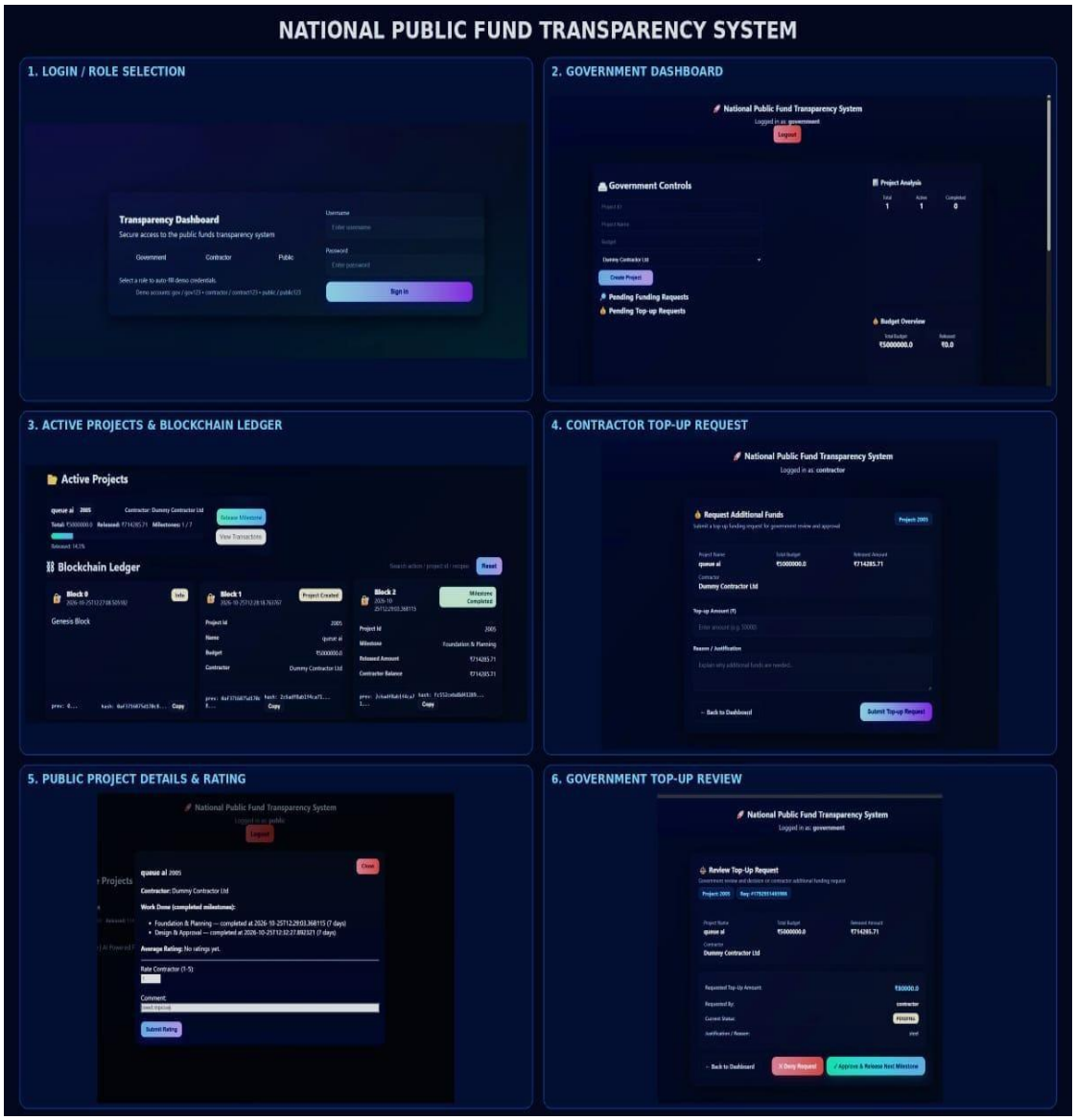
Image comparison — report the score distribution and threshold outcomes for a documented set of matched and mismatched image pairs. Do not describe the result as construction completion accuracy unless a valid ground truth and evaluation protocol support that claim.

Workflow reliability — test project creation, milestone creation, payment request submission, approval/rejection, balance updates, and public-view refresh; report pass/fail counts and environment details.

Result reporting template. Insert measured values only after running the tests. Example table columns are: Test case, Number of trials, Passed, Failed, Evidence/notes. For model evaluation, include dataset source, number of records, train/test split, feature definitions, random seed, library versions, and threshold. Do not invent accuracy percentages or claim that the model detects fraud without validating against labelled cases.

The combined design may improve traceability by connecting a request to its evidence and approval history. The ledger helps reveal inconsistent edits to linked records, while anomaly screening and image comparison provide signals for human review. The components have different failure modes: ledger

validation does not prove that entered data is true; an anomaly detector may flag legitimate unusual spending; and pixel differences may reflect lighting or camera movement rather than construction progress. These limitations should be visible in the dashboard and documentation.



Conclusion

This paper presented GovChain, a prototype framework for transparent public-fund workflow management using role-based web interfaces, a SHA-256 hash-linked audit ledger, Isolation Forest anomaly screening, and image-difference evidence checks. The main design value lies in connecting project, financial, visual, and approval records in a traceable process. These components can support oversight but do not independently prove that a transaction is fraudulent, that construction is complete, or that every record is truthful. A defensible evaluation requires repeatable tests, documented datasets, measured results, and transparent reporting of limitations.

Future Work

Future work includes evaluating the platform with a larger and independently labelled dataset; comparing Isolation Forest with statistical baselines and supervised models where labels are available; replacing pixel-only comparison with feature-based or object-detection approaches; capturing image metadata and fixed camera viewpoints; signing ledger entries and anchoring periodic hashes outside the application server; adding independent audit exports; and conducting usability and security testing with representative stakeholders. Integration with public procurement or government finance systems should be considered only after authorization, privacy, and interoperability requirements are established.

References

1. F. T. Liu, K. M. Ting, and Z.-H. Zhou, “Isolation Forest,” in *Proceedings of the Eighth IEEE International Conference on Data Mining*,

2008, pp. 413–422. https://doi.org/10.1109/ICDM.2008.17 .

2. V. K. Reja, K. Varghese, and Q. P. Ha, "Computer Vision-Based Construction Progress Monitoring," *Automation in Construction*, vol. 138, art. 104245, 2022. https://doi.org/10.1016/j.autcon.2022.104245 .
3. M. Mostafa and T. Hegazy, "Review of Image-Based Analysis and Applications in Construction," *Automation in Construction*, vol. 122, art. 103516, 2021. https://doi.org/10.1016/j.autcon.2020.103516 .
4. S. Paneru and I. Jeelani, "Computer Vision Applications in Construction: Current State, Opportunities & Challenges," *Automation in Construction*, vol. 132, art. 103940, 2021. https://doi.org/10.1016/j.autcon.2021.103940 .
5. "Explainable Intrusion Detection System Using Tree-Based Machine Learning Models and Explainable AI Techniques," *International Journal of Research Publication and Reviews*, vol. 7, no. 4, pp. 1290–1297, Apr. 2026. https://doi.org/10.55248/gengpi.07.0426.20825 .
6. D. Gourfinkel and Á. Fernández, "Enhancing Transparency: The Impact of Blockchain-Based Audit Trails on Public Financial Management," World Bank, September 2025. World Bank .