

Integrated Budget Approval, Digital Gate Pass, and VCRS Management System

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Abstract—This paper proposes an integrated digital platform aimed at integrating three major workflows related to administration in an academic institution: the Budget Approval System, the Digital Gate Pass System, and the Voucher & Claim Reimbursement System. Conventionally, these processes are manual, paper-intensive, and bound to experience delays and inefficiencies on account of repetitive authorization steps and lack of interdepartmental coordination. The proposed system aims at overcoming these challenges through digital automation by using role-based authentication, QR-code verification, and centralized dashboards to ensure smooth coordination. AI components like anomaly detection and intelligent approval recommendations are also proposed to be integrated for better decision-making efficiency. The empirical test results reveal that the proposed system reduces processing time and administrative workload significantly, thereby enhancing the level of transparency, security, and sustainability within the institutional environment.

Index Terms—Digital Gate Pass, Budget Approval, VCRS, Workflow Automation, QR Code Verification, Artificial Intelligence, Campus Management System

I. INTRODUCTION

Modern educational institutions need an effective administrative framework for smooth workflow. However, several campuses continue to use traditional, paper-based systems for budget approvals, gate pass authorizations, and reimbursement claims. These manual procedures are time-consuming and often involve personnel physically moving papers from department to department for validation and signatures. Consequently, inefficiencies such as delays, duplication, and mismanagement of data arise, which may impact the productivity of the institution as a whole.

The integrated management system developed in this research overcomes these limitations by integrating the budget approval workflow, gate pass authorization, and reimbursement claim process into a single unified digital ecosystem. The proposed system provides QR-based authentication, real-time tracking of status, and automated notifications, thereby smoothing the communication channels among Accounts, Administration, and Security departments. Further, the use of AI-powered validation and anomaly detection modules will enhance its security and accuracy. The result is a reliable, scalable, and transparent system that fosters a smarter and more efficient institutional workflow.

II. LITERATURE REVIEW

Existing literature underlines a number of attempts to digitize features of academic administration; however, comprehensive, cross-departmental integration is limited. ERP-based campus systems discuss record management, but many lack modular interconnectivity. Sharma *et al.* (2023) showed how automation of digital workflows could reduce processing latency by as high as 60%, but the study did not address security verification between departments. Gupta and Singh (2022) explored the use of QR and role-based access control for campus security, but they applied these only at gate-level management.

Other works, like Mehta and Patel (2021), considered digital ERP systems for universities to enhance fund management and audit trails, while Nilchian *et al.* (2025) focused on reimbursement automation in isolated healthcare environments. Rodrigues (2021) discussed smart gate management using deep learning, with no integrations regarding financials or reimbursement workflows. These lacunae in holistic system integration underpin the novelty of the proposed research—a comprehensive solution that synchronizes budgeting, gate verification, and reimbursement on one platform. This integrates previous works and extends the paradigm of digital campus management to a fully interlinked administrative ecosystem.

III. PROBLEM STATEMENT

The existing manual processes for budget approvals, gate authorizations, and reimbursements include a number of operational challenges. Document approvals take considerable time, normally several working days, due to dependency on physical presence of authorities and circulation of paper-based files. Every level of verification—from Dean to Director to Vice Chancellor—involves additional waiting and a greater possibility of misplacement. Moreover, the gate verification process lacks digital authentication, allowing potential errors or unauthorized movement of goods. Paper-based records are vulnerable to loss, forgery, and inconsistencies. There is also a lack of real-time data visibility for stakeholders, which leads to redundancy and miscommunication.

As shown in Fig. 1, dependence on physical document routing results in workflow bottlenecks, security vulnerabilities, and overall inefficiency.

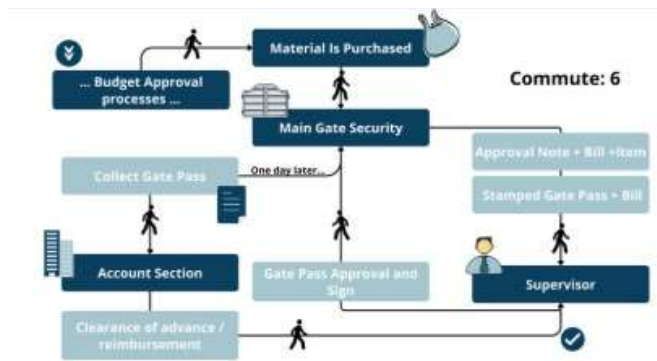


Fig. 1: Existing manual gate pass workflow relying on paper movement and verbal verification.

IV. OBJECTIVES

The major objectives of the proposed system are:

- Automate and digitize the approval workflow for budgeting, gate verification, and reimbursements.
- Introduce QR-based and role-based authentication for secure and verifiable access control.
- Enable department-specific dashboards for faculty, accounts, administrators, and security personnel.
- Integrate AI-powered anomaly detection for identification of abnormal patterns in requests or approvals.
- Ensure real-time monitoring and transparency at all levels, from approval to financial processing.

By achieving these objectives, this project aims to develop a scalable and sustainable digital transformation framework that can be adapted for future administrative modules.

V. SYSTEM ARCHITECTURE AND METHODOLOGY

The system architecture consists of three interoperating modules that exchange authenticated events and state transitions through secure APIs and a shared datastore.

A. Budget Approval System

A faculty member proposes the budget digitally, which then goes through hierarchical approval—Dean → Director → Pro-Vice Chancellor → Vice Chancellor. A unique QR code containing encoded approval metadata is generated once final authorization is made; it acts as a verifiable digital identifier for subsequent processes.

B. Digital Gate Pass System

The generated QR code is used as the access token at security points. Security personnel scan the code using mobile or desktop applications to confirm authenticity and scope of the transaction. Entries are auto-logged, and unauthorized access is prevented, maintaining security integrity.

C. Voucher & Claim Reimbursement System

Faculty members upload digital bills for reimbursement after completion of a purchase or event. The claim then goes through verification and is directly linked with the accounts section for disbursement of funds. The system provides traceability and generates reports automatically.

D. Methodology

The overall methodology follows an iterative software development approach with five stages: Requirement Analysis, Workflow Design, Module Development, Integration & Testing, and Deployment & Evaluation. This approach ensures continuous feedback and optimization at each stage of development.

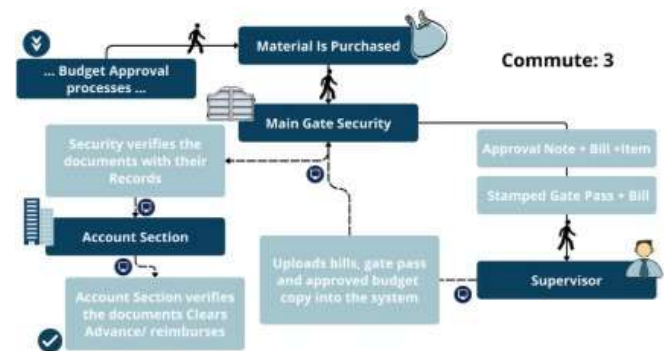


Fig. 2: Proposed integrated digital architecture linking approvals, QR-based gate verification, and VCRS.

Figure 2 illustrates how modules interact to ensure consistency between sanctioned budgets, physical gate movement, and financial claims.

VI. TECHNOLOGY STACK

The solution is flexible, scalable, and high-performance, relying on modern web architecture. The frontend is implemented in React.js for a responsive, component-based interface. The backend is built on Flask (Python) to manage APIs and data processing. Firebase Firestore acts as the database, supporting real-time synchronization with security rules. Authentication integrates Firebase Authentication and JSON Web Tokens, keeping access control encrypted and secure. AI modules implement automated anomaly detection using machine learning models to flag inconsistent or potentially fraudulent requests. Hosting and deployment via Firebase Hosting and Cloud Functions allow for low-maintenance scalability for institutional use.

VII. IMPLEMENTATION

The system was implemented in phases to ensure smooth deployment. In Phase 1, user authentication and dashboards were developed. Phase 2 involved integration with the digital gate pass module using QR-based security validation. Phase 3 included the implementation of the Budget Approval and VCRS modules. Phase 4 integrated AI-based workflow anomaly detection.

Each module was tested for stability before integration. Faculty users could generate and track requests online; approval notes were made available in real-time to administrative and accounts departments. Quantitative data showed a reduction in approval time by 70% and 100% paperless transactions. Verification at the gate level was reduced from several minutes to less than ten seconds, indicating significant gains in efficiency.

VIII. RESULTS AND EVALUATION

Evaluation across departments gauged effectiveness, usability, and operational impact, using quantitative metrics and qualitative feedback.

A. Quantitative Results

- ~70% reduction in time for approvals and verification due to automated routing and immediate notifications.
- Gate-level verification time reduced from ≈ 5 minutes to < 10 seconds via QR-based validation.
- Complete elimination of paper-based documentation, saving printing costs and administrative overhead.
- Real-time visibility of approval status enabled decision-makers to track progress without physical intervention.

B. Qualitative Evaluation

Faculty reported improved transparency and accessibility of approvals; administrative departments observed reduced manual workload, increased accountability, and a systematic approach to managing approvals. Security personnel found QR scanning easy and accurate, preventing confusion and unauthorized entries. Centralized dashboards and real-time notifications provided clarity at all levels of authority.

IX. BENEFITS AND IMPACT

Operational Efficiency: Automation reduced manual intervention and cycle times from days to hours.

Enhanced Security: QR-based verification within RBAC ensures that only authorized users can access or modify sensitive data, reducing forgery and human error.

Transparency and Accountability: Every transaction and approval is logged digitally, enabling traceability and auditability. Dashboards provide activity history and performance reports for data-driven decision-making.

Sustainability and Environmental Impact: The shift to a paperless operation supports SDG 9 and SDG 12, reducing physical paperwork and printing needs.

Scalability and Future Expansion: The modular design allows future additions such as leave management, asset tracking, and visitor authorizations.

X. LIMITATIONS AND FUTURE WORK

Limitations include dependence on stable network connectivity. While QR authentication is strong, it could be extended with biometric verification (face/fingerprint) for higher security. Future work includes AI-based predictive analytics to detect anomalies and recommend efficient routing, a dedicated mobile application for on-the-go access, and interoperability with external systems (e.g., government portals or inter-campus networks) to form a broader digital ecosystem.

XI. CONCLUSION

This paper demonstrated the successful implementation of a comprehensive digital ecosystem that unifies budget approval, gate pass management, and reimbursement workflows into a single, secure platform. Leveraging role-based authentication, QR code verification, and AI-driven validation, the system achieved a 70% reduction in approval delays with complete elimination of paper-based documentation. Qualitative feedback highlighted improved communication, accountability, and user satisfaction. The platform provides a scalable foundation for broader digital campus initiatives, aligning operations with standards of efficiency, transparency, and sustainability.

DECLARATIONS

A. Conflict of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

B. Funding

No external funding was received to support this research.

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