IJIRSET
International Journal of Innovative Research in Science | Engineering | Technology

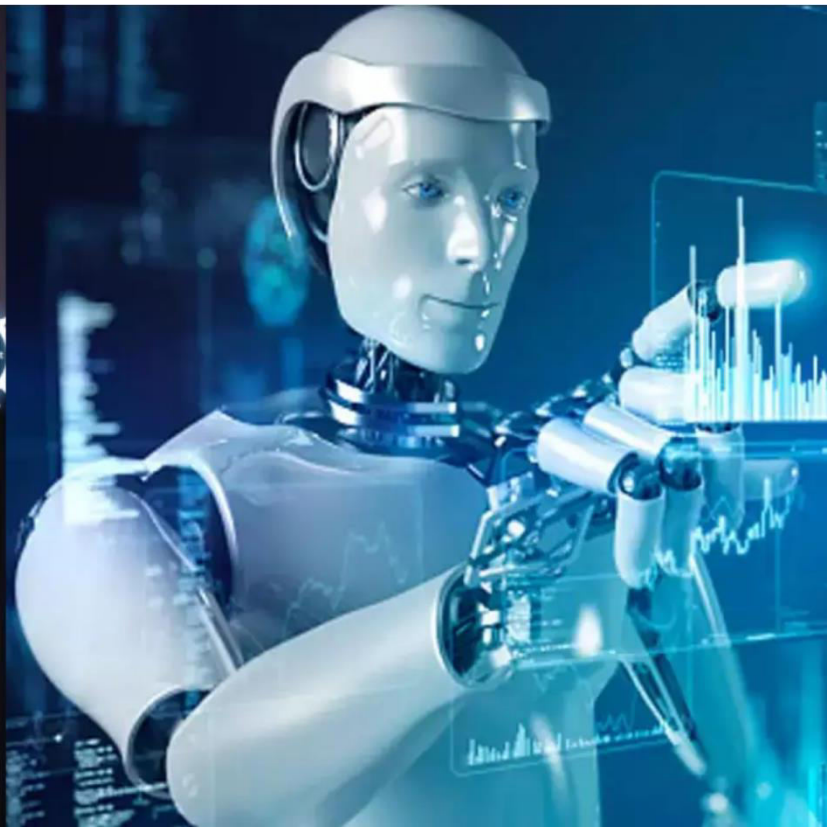
ISSN(O): 2319-8753
ISSN(P): 2347-6710



International Journal of Innovative Research in Science Engineering and Technology (IJIRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)





Impact Factor: 9.935

Volume 15, Issue 11, November 2026

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Volume 15, Issue 11, November 2026

|DOI: 10.15680/IJIRSET.2026.1511046|

EmpaySys – Payroll and Financial Management System: A Review of Web-Based and Control-Oriented Approaches and Their Implications for Cooperative Society Automation

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ABSTRACT: Payroll processing appears straightforward until calculation discrepancies, unauthorized changes, or audit delays occur. In many small and medium-sized institutions—particularly employment cooperative societies—monthly salaries are still computed manually, bank disbursement sheets are compiled in spreadsheets, and salary slips are distributed individually. This paper reviews three studies that examine payroll automation from complementary perspectives: a modular open-source web-based payroll application (Then et al., 2009), a garment-factory payroll system built around piece-rate wage rules (Barua and Whaiduzzaman, 2019), and a COSO-based evaluation of payroll internal controls in a public hospital (Rumapea et al., 2019), alongside supporting web payroll and cooperative society literature. We compare these works across methodology, system architecture, payroll logic, security and internal control, and empirical evaluation. While all three studies automate core wage calculations and divide responsibilities across roles, none integrates loan sanctioning with equated monthly instalment (EMI) balance tracking, automated detection of unusual payments, or maker-checker bank payment approval and reconciliation. These gaps directly shaped the design of EmpaySys, a five-layer web-based payroll and financial management platform being developed for employment cooperative societies. We present the architecture of EmpaySys, map its modules to the identified literature gaps, and outline future extensions including bank API reconciliation, learning-based anomaly detection, and cloud deployment.

KEYWORDS: payroll system; cooperative society automation; web-based application; internal control; role-based access control; anomaly detection; EMI management

I. INTRODUCTION

Paying employees accurately and on time is a core operational obligation that directly affects institutional trust and financial compliance. Even a minor mistake in net pay, statutory deductions, or loan recoveries is noticed immediately by staff and weakens confidence long after the figure is corrected. As workforce size grows, manual computation of earnings and deductions, spreadsheet-based bank payment sheets, and paper payslips handed out one by one become slow, error-prone, and difficult to audit. Prior studies have approached payroll automation from three main angles: how web-based payroll software should be structured, how domain-specific wage rules should be encoded, and how payroll transactions should be controlled internally [1]–[3].

Employment cooperative societies face a more demanding operational reality than standard commercial offices. Alongside routine attendance, allowances, and statutory deductions, a cooperative society manages member thrift deposits, loan sanctions, monthly equated monthly instalment (EMI) recovery, share capital adjustments, and consolidated bank payment schedules for members and statutory auditors [5]. Most payroll packages reported in the literature are designed for conventional enterprises and say little about these society-specific credit and reconciliation requirements.

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In this paper, we make three focused contributions. First, we review and compare three peer-reviewed studies [1]–[3] that represent the software-engineering, wage-logic, and internal-control perspectives of payroll systems, supported by recent web payroll and cooperative management studies [4], [5]. Second, we synthesize six concrete research gaps that limit their direct applicability to cooperative societies. Third, we present the layered architecture of EmpaySys—the system we are developing—and demonstrate how each module addresses those gaps.

The remainder of this paper is organized as follows. Section II describes our review approach and inclusion criteria, and Section III outlines technical and internal-control background concepts. Section IV critically reviews the three selected studies. Section V presents the layered architecture of EmpaySys. Sections VI and VII provide a comparative analysis and formalize the six research gaps. Section VIII maps the literature findings to EmpaySys features, Section IX discusses implementation challenges and future scope, and Section X concludes the paper.

II. REVIEW APPROACH

This work is designed as a focused narrative review rather than an exhaustive bibliometric survey. We purposefully selected three core studies [1]–[3] because each examines a distinct layer of the payroll problem: how a web payroll application is engineered across the development life cycle [1], how complex domain wage rules are structured across software tiers [2], and how payroll transactions are governed inside an organization using formal internal controls [3]. Two supplementary studies—one on modern web-based payroll evaluation [4] and one on cooperative society financial management [5]—were included to contextualize contemporary web engineering and cooperative domain workflows.

Each of the three core studies was read in full and analyzed across five consistent dimensions: (1) organizational setting and objective, (2) requirement elicitation and development methodology, (3) system architecture and technology stack, (4) payroll calculation logic and control mechanisms, and (5) empirical evaluation methods. Throughout our review, we report strictly what the authors document and explicitly distinguish empirically tested results from unverified claims.

III. BACKGROUND

A. Payroll Processing. A payroll system collects attendance records, overtime logs, fixed and variable allowances, and statutory or voluntary deductions to compute net payable salary. Beyond arithmetic calculation, it must generate itemized payslips, produce regulatory and accounting reports, and prepare verified bank disbursement files. Accuracy, audit traceability, and timely execution are the primary quality attributes required in production [4].

B. Software Development Life Cycle. Because payroll errors carry immediate financial and legal consequences, payroll applications are typically developed through structured, stage-gated software engineering phases: requirements analysis, data and process design, modular coding, and verification testing, following established life-cycle principles [6].

C. Internal Control. Internal control is an organizational process effected by management and personnel to provide reasonable assurance regarding operational effectiveness, reliability of financial reporting, and compliance with applicable laws [7]. The Committee of Sponsoring Organizations of the Treadway Commission (COSO) framework organizes internal control into five components: control environment, risk assessment, control activities, information and communication, and monitoring. Within payroll systems, essential control activities include separation of duties, documented authorization of master-data changes, restricted access to financial records, and independent verification of calculated totals.

IV. REVIEW OF SELECTED STUDIES

A. A Web-Based Payroll Application (Then et al., 2009)

Then et al. [1] describe the analysis, design, implementation, and testing of a custom web-based payroll application built for a corporate organization in Malaysia. Requirements were gathered through three complementary activities: reviewing existing client documents (payslips, personnel records, and leave forms), conducting individual interviews with IT and HR managers, and holding weekly group sessions with end users. System design was documented using an

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Entity-Relationship Diagram (ERD), a context diagram, and multi-level Data Flow Diagrams (DFDs from Level 0 to Level 3).

The software is organized into five functional modules—Setup, Personnel Information, Overtime, Payroll, and Report—serving three user roles: HR staff, ordinary staff, and supervisors. A notable workflow is the supervisor-mediated overtime process: an employee submits an overtime claim, the supervisor approves or rejects it, and HR is notified automatically so approved hours are locked into payroll processing. The payroll module computes net payouts after statutory tax, SOCSO, and EPF deductions plus overtime, issues payslips, and allows employees to query historical payouts by period. Reports are exportable to Microsoft Excel. Built with PHP, JavaScript, and MySQL on an XAMPP stack, the system was evaluated through a usability study with six participants covering ease of understanding, interface layout, and navigation.

Critical Reflection: The strength of Then et al. [1] lies in its disciplined account of requirement elicitation, clear modular separation, and reusable supervisor approval pattern. Its limitations are that the evaluation relies on a small qualitative usability sample (n = 6), arithmetic accuracy and response time are not measured quantitatively, and security does not extend beyond basic login validation.

B. A Garment-Factory Payroll System (Barua and Whaiduzzaman, 2019)

Barua and Whaiduzzaman [2] address payroll computation in the ready-made garment (RMG) industry of Bangladesh, where large numbers of workers are compensated under piece-rate wage structures based on garment style, size, and output quantity. In legacy factory operations, daily production is recorded manually on physical worker cards and priced via spreadsheets at month-end; whenever the rate for a style changes, thousands of manual entries must be revised.

To automate these rules, the authors structure their software across presentation, business, and data layers using Microsoft SQL Server and Crystal Reports. Configuration tables define factory sections, blocks, styles, sizes, basic grades, bonus slabs, and allowances. Net pay is calculated as piece-rate production earnings plus production bonus, attendance bonus, night allowance, festival bonus, and no-work pay, less any salary advance already disbursed. Updating a style rate in the configuration layer automatically recalculates affected wages across all payslips, and reports can be exported to spreadsheets or PDFs. The paper also discusses offering the platform as a cloud-hosted SaaS product.

Critical Reflection: Barua and Whaiduzzaman [2] provide a clear model for externalizing complex wage rules and propagating rate updates across a three-tier architecture. However, production quantities still require manual data entry, the authors' claim of complete calculation accuracy is unsupported by error-rate benchmarks, and security is addressed only briefly via user-ID access permissions.

C. Internal Control of Payroll in a Hospital (Rumapea et al., 2019)

Rumapea et al. [3] examine payroll from an auditing and accounting governance standpoint. Through direct observation, interviews with treasury and personnel officers, and document inspection at a public general hospital in Medan, Indonesia, they evaluate internal controls over honorary employee compensation against the five components of the COSO framework.

Their findings highlight strict organizational separation of duties: personnel staff prepare payroll schedules, finance officers verify calculations, the treasurer executes disbursements via bank transfer, and accounting personnel verify cash-out vouchers before posting entries to journals and general ledgers. Authorization relies on formal appointment decrees, salary-adjustment letters, verified deduction notices, and section-head approval of overtime. Technical controls include fingerprint biometric attendance capture, password-protected access, restricted database privileges, and regular data backups.

Critical Reflection: Rumapea et al. [3] offer a practical checklist of institutional controls that payroll software should enforce programmatically. On the other hand, the study is descriptive and uniformly favourable without reporting control-testing metrics or error rates, and part of the hospital's payroll administration depends on external municipal offices.

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V. SYSTEM ARCHITECTURE OF THE PROPOSED SYSTEM

EmpaySys is structured in cohesive functional layers, and every user request traverses them in a deterministic order, as shown in Fig. 1: from role-scoped client portals, through security middleware, into core domain modules, disbursement and control engines, and finally notifications and centralized storage.

A. Users and Front End. Three user roles interact with EmpaySys: Admin, Manager, and Employee. All roles access a unified web portal that dynamically tailors available views and actions to the authenticated user's permissions. The front end communicates via structured APIs so a dedicated mobile client can be connected cleanly in future releases.

B. Authentication and Security. Every incoming request passes through a security middleware layer enforcing JSON Web Token (JWT) authentication, Role-Based Access Control (RBAC), session validation, and server-side input checks. Users can view or modify only records permitted by their role, directly addressing the authentication and authorization gaps identified in Section VII.

C. Core Management Modules. Four domain modules execute the primary financial logic: Employee Management, Salary Management, Deductions, and Loan & EMI Management. Together they maintain member profiles and bank details, compute gross salary from configurable earnings rules, apply statutory and society deductions, and calculate monthly loan EMIs while updating the remaining principal balance automatically.

D. Payment Modules. Outputs from the core engine feed two disbursement modules. The Bank Payment Sheet module generates consolidated transfer schedules and enforces maker-checker verification and status tracking, while the Salary Slip Management module produces itemized payslips for member download—replacing manual spreadsheet payment sheets and paper slips.

E. Fraud Detection, Assistant, and Reports. Three oversight modules operate on processed payroll batches. Fraud Detection applies rule-based checks to flag duplicate bank accounts, duplicate payout entries, and unusual salary or deduction variances prior to disbursement. The Financial Assistant helps members interpret loan and payout details, and the Report Generator compiles monthly and annual summaries of salaries, loan recoveries, and disbursements.

F. Notifications and Database. Automated SMS and email alerts notify members and administrators of salary credits, EMI deductions, and approval events. All employee, salary, loan amortization, payment batch, and audit records are persisted in a centralized MySQL database serving as the single source of truth.

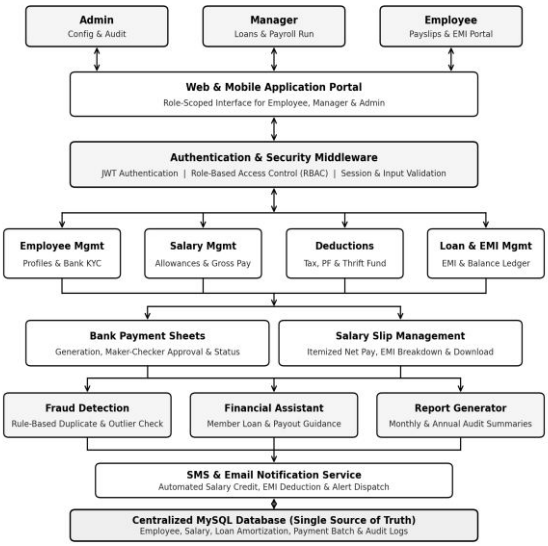

Fig.1. Layered system architecture and control flow of the proposed EmpaySys system.

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VI. COMPARATIVE ANALYSIS

TABLE I. COMPARISON OF THE REVIEWED STUDIES AND PROPOSED EMPAYSYS ARCHITECTURE

Dimension	Then et al. (2009) [1]	Barua & Whaiduzzaman (2019) [2]	Rumapea et al. (2019) [3]	EmpaySys (Proposed)
Setting	Corporate client, Malaysia	Garment industry, Bangladesh	Public hospital, Indonesia	Employment cooperative societies
Perspective	Software engineering & SDLC	Wage logic & layered design	Accounting & internal control	Integrated finance & internal control
Method	Waterfall; docs, interviews, group meetings	Factory visits & interviews with wage staff	Descriptive; observation, interviews, audit	Iterative modular SDLC with control mapping
Technology	PHP, JavaScript, MySQL, XAMPP	SQL Server; VB6 / ASP.NET; Crystal Reports	Computerised payroll with bank transfer	Modular Web Portal, REST API, JWT, MySQL
Payroll logic	Tax, SOCSO, EPF, overtime	Piece rate, bonuses, no-work pay, advances	Salary, deductions, overtime verification	Configurable salary, statutory/society deductions, EMI
Access & security	Role-based users; login validation	User-ID based access rights	Passwords, separation of duties, backups	JWT authentication, granular RBAC, audit logs
Approval workflow	Overtime approval by supervisor	Not described	Multi-level verification and authorisation	Maker-checker batch approval & status tracking
Reporting	Excel export	Crystal Reports, spreadsheet and PDF	Journals and ledgers	Itemized PDF payslips, bank sheets, audit ledgers
Evaluation	Usability test, 6 participants	Self-reported accuracy	Qualitative control assessment	Planned quantitative accuracy, latency & UAT
Loan / EMI handling	No	Advance deduction only	No	Integrated loan sanction, EMI & balance ledger
Anomaly detection	No	No	Manual supervision only	Automated rule-based duplicate & outlier flagging

Placing the three studies side by side highlights three clear patterns. First, responsibility is divided among roles in every case—whether through modules and actors [1], user-level access permissions [2], or accounting separation of duties [3]—yet none enforces token-based API authorization. Second, calculation logic is tightly bound to institutional rules (statutory deductions in [1], piece-rate slabs in [2], and honorary hospital regulations in [3]), confirming that generic payroll packages rarely suffice without configurable rule tables. Third, empirical evaluation is consistently thin: none of the reviewed papers reports quantitative tests of calculation accuracy, batch processing latency, or security resilience.

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VII. RESEARCH GAPS

Reading the three core studies alongside cooperative society operational requirements reveals six gaps that are either absent or only superficially addressed in existing literature:

1. Loans and Instalments (EMI). Only simple salary advance deduction appears in [2]. None of the reviewed studies links loan sanctioning, monthly EMI calculation, and real-time outstanding principal tracking directly to payroll execution, even though credit recovery is central to cooperative societies [5].

2. Automatic Detection of Unusual Payments. Control in existing studies relies on organizational hierarchy and manual review [3]. None incorporates automated pre-disbursement checks to flag duplicate bank accounts, duplicate payment entries, or abnormal salary and deduction values.

3. Bank Payment and Reconciliation Workflow. While employee payslips are well covered [1], [2], automated bank payment sheet generation, multi-step batch approval, payment status tracking, and reconciliation against bank statements are omitted.

4. Security and Audit Trail Design. Security is treated only at a basic perimeter level [1], [2]. Stateless token authentication (JWT), role-scoped request authorization (RBAC), strict input validation, and tamper-evident audit trails are not examined.

5. Self-Service and Automated Notifications. Employees are not informed of salary credits or deduction events via SMS or email, and self-service portals for inspecting historical loan balances and payout statuses receive minimal attention [4].

6. Quantitative System Evaluation. Arithmetic correctness against manual ledgers, response time under load, security testing, and multi-role user acceptance are rarely measured using an explicit evaluation methodology.

VIII. IMPLICATIONS FOR THE PROPOSED SYSTEM: EMPAYSYS

EmpaySys (Employment Cooperative Society Financial and Payment Management System) is a web-based platform serving Admin, Manager, and Employee roles, engineered specifically to close the six gaps above. Fig. 2 illustrates how insights from the reviewed literature and the identified cooperative gaps map directly onto EmpaySys architectural components.

From Then et al. [1], we adopted staged SDLC decomposition, modular separation, and supervisor-style approval routing. From Barua and Whaiduzzaman [2], we adopted three-tier separation of presentation, business logic, and data storage, as well as configurable wage rules that propagate updates automatically across payslips. From Rumapea et al. [3], we translated organizational internal controls—segregation of duties, documented authorization, restricted database access, and auditable transaction logs—into programmatic software rules.

Beyond these foundations, EmpaySys introduces integrated cooperative capabilities. Users authenticate via JSON Web Tokens and are constrained by RBAC middleware. The payroll engine computes gross salary, statutory and society deductions, and net pay while automatically deducting monthly loan EMIs and updating outstanding balances. It generates bank payment sheets, enforces maker-checker batch approval, tracks disbursement status, and produces downloadable salary slips and monthly or yearly audit reports. Rule-based checks flag duplicate payments and anomalous values before payout, while SMS and email notifications keep stakeholders informed. At the current stage of implementation, the landing portal, JWT login, employee registration, and role-specific dashboards for Employee, Manager, and Admin users have been completed.

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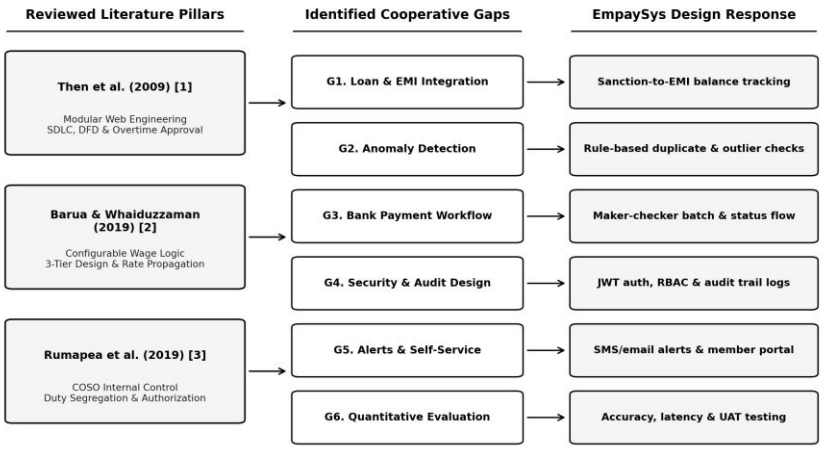

Fig.2. Synthesis of reviewed literature pillars, identified cooperative gaps, and EmpaySys design responses.

TABLE II. RESEARCH GAPS AND CORRESPONDING EMPAYSYS FEATURES

Gap Identified	Corresponding EmpaySys Feature
Loan and EMI integration	Automated monthly EMI calculation with real-time outstanding principal balance tracking
Anomaly and fraud detection	Pre-disbursement rule-based detection of duplicate payouts, duplicate accounts, and outlier values
Bank payment workflow	Automated bank payment sheet generation, maker-checker approval flow, and payment status tracking
Security and audit design	Stateless JWT authentication, role-scoped RBAC, server-side input validation, and audit logs
Notifications	Automated SMS and email notifications for salary credit, EMI deduction, and approval alerts
Self-service access	Dedicated employee portal for viewing and downloading salary slips, loan schedules, and payout history

IX. CHALLENGES AND FUTURE SCOPE

Challenges. Building and deploying an integrated payroll and loan-recovery system for cooperative societies presents several practical engineering challenges: maintaining strict transactional consistency between monthly salary runs and loan amortization ledgers; handling diverse allowance, thrift-fund, and deduction rules without hard-coding formulas; protecting sensitive employee KYC and bank account data; coordinating frontend, backend API, and MySQL database layers cleanly; and preserving complete, tamper-evident records of approvals and disbursements.

Future Scope. The review points directly to four next steps. First, integrating direct bank APIs or Electronic Clearing Service (ECS) file workflows with automated statement reconciliation will close the payment loop. Second, supervised and unsupervised machine-learning models can complement deterministic rules for detecting subtle payment anomalies once sufficient historical payroll records are collected and explainability requirements are satisfied. Third, we plan to migrate EmpaySys to a cloud deployment with encrypted automated backups and multi-branch support for larger cooperative societies, building on the SaaS direction noted by Barua and Whaiduzzaman [2]. Additional planned enhancements include a companion mobile application, biometric or QR-assisted attendance integration, regional localization in Marathi, Hindi, and English, and interactive financial analytics. Finally, we will conduct a rigorous

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quantitative evaluation measuring calculation parity against manual ledgers, API response times, security controls, and multi-role user acceptance to address the evaluation gap in prior literature.

X. CONCLUSION

We reviewed a modular web-based payroll application [1], a garment-factory payroll system built around configurable piece-rate rules [2], and a COSO-based assessment of payroll internal controls [3], supported by recent web payroll and cooperative society literature [4], [5]. Together, these studies demonstrate that reliable payroll software depends on modular architecture, clear division of roles, externalized wage rules, and enforceable internal controls. At the same time, they expose critical gaps—most notably the lack of integrated loan and EMI management, automated detection of unusual payments, structured bank-payment approval workflows, modern token-based security, and quantitative evaluation—that matter most for employment cooperative societies. EmpaySys, whose five-layer architecture is presented in Section V, addresses these needs through JWT/RBAC security, coupled salary and EMI processing, maker-checker payment tracking, rule-based anomaly flagging, and automated notifications. Future work will focus on learning-based anomaly detection, cloud deployment, and comprehensive quantitative testing.

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