

Research on the Development and Application of an Expense Reimbursement Robot Based on AI+RPA Technology

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Abstract: Expense reimbursement business is a frequently occurring economic activity in enterprises. However, traditional expense reimbursement processes suffer from issues such as time-consuming manual operations, highly repetitive workflows, high error rates, high management costs, and underutilized data value. By introducing AI+RPA technology, it is possible to achieve intelligent handling of document reception, auditing, payment, and accounting processing, effectively addressing problems such as low efficiency, long processing times, and high error rates in expense reimbursement. When introducing RPA technology and constructing an expense reimbursement robot model based on the infrastructure layer, data layer, service layer, and application layer, attention should mainly be paid to key application points. During actual implementation, it is essential to ensure proper trial operation and log management, as well as systematic risk prevention.

Keywords: Expense Reimbursement Robot; Reimbursement Business; RPA; Expense Reimbursement Management; Digital Transformation.

1. Introduction

With the Chinese advancement of the "14th Five-Year Plan for Digital Economy Development," enterprise financial accounting—as a core management function—faces pain points such as data silos, high manual error rates, and fragmented processes [1]. RPA (Robotic Process Automation) technology, with its non-intrusive nature, low-code capabilities, and AI integration potential, can be used to build financial accounting robots, enabling end-to-end automation from voucher generation to report compilation, improving accounting efficiency, and supporting enterprise digital transformation in finance. [2]

Expense reimbursement business is a frequently occurring economic activity in enterprises and also the most widely involved business process for financial robots. The expense reimbursement process can be divided into the following stages: document reception, auditing, payment, accounting processing, and expense analysis [3]. Specifically, the process includes: scanning reimbursement documents, automatically generating reimbursement information via OCR (Optical Character Recognition), logging into the financial software platform, submitting reimbursement requests, having the finance department review the submitted information, verifying invoices, checking reimbursement standards, and—once approved—automatically executing payments and conducting expense analysis. In the expense reimbursement workflow, finance personnel may make errors due to high business volumes or experience emotional fatigue from repetitive tasks. The expense reimbursement robot can enable 24/7 interaction across multiple systems. At the same time, through the application of artificial intelligence (AI), PRA can be made intelligent. Thus, it helps finance personnel break free from repetitive and tedious tasks, improves operational efficiency, and enhances the decision-support role of financial data.[4, 16]

2. Development Approach for the Expense Reimbursement Robot

The expense reimbursement process includes obtaining documents, submitting reimbursement requests, document auditing, invoice verification, automatic payment, and expense analysis. Based on the capabilities and characteristics of AI+PRA technology, and in line with the digital transformation needs of reimbursement business, this paper designs the system architecture of the expense reimbursement robot along a timeline of pre-execution, during execution, and post-execution, and elaborates on its underlying logic.

2.1. Infrastructure Layer

The infrastructure layer is a prerequisite for the development of the expense reimbursement platform. It provides runtime environment configuration for the expense reimbursement robot, including hardware infrastructure, software and algorithms, data infrastructure, and network and communication. In terms of computing power, it is necessary to equip heterogeneous computing chips such as GPUs/TPUs to handle AI tasks, while deploying CPU clusters to run RPA workflows. The data layer requires building distributed storage systems and high-speed networks to ensure data transmission efficiency. The toolchain should include deep learning frameworks, RPA development platforms, and containerized deployment environments. Security-wise, it must integrate privacy computing technologies and domestic adaptation solutions. The entire architecture should adopt a cloud-native design, enabling intelligent scheduling for dynamic resource allocation to meet the mixed workload demands of AI model training and RPA process automation. AI+RPA technology combines AI's intelligent decision-making with RPA's precise execution to achieve automation of complex business processes, significantly improving efficiency, reducing costs, and expanding application scenarios, driving enterprises from simple automation toward intelligent decision-making.

2.2. Data Layer

The data layer provides the foundational data for the expense reimbursement robot. The data layer of an AI-powered expense reimbursement robot mainly includes the following core components: First, the basic data module stores static data such as employee information, department structure, and expense categories, providing foundational support for the system. Second, the business data module includes dynamic information such as OCR-identified invoice data, approval process records, and payment statuses. AI technology significantly enhances data processing capabilities, supporting parsing of 43 types of invoices via multimodal recognition with significantly improved accuracy, and uses NLP to extract semantic information. Then, the rule engine module uses machine learning to dynamically optimize approval strategies, such as elastic budgeting models and risk scoring systems. The behavioral feature library analyzes employee reimbursement patterns via LSTM neural networks to accurately detect fraud. Finally, smart audit logs use blockchain technology to ensure data immutability and fully record AI decision paths. Additionally, the system integrates ERP budget data and CRM project information to build a business-finance correlation analysis model. The data layer adopts a distributed architecture, supports high-concurrency processing and secure encryption, and provides data support for the full process of “intelligent auditing—automatic payment—multi-dimensional analysis,” improving reimbursement efficiency and reducing error rates. [5]

2.3. Service Layer

The service layer provides various pre-built components required for the development of the expense reimbursement robot. These components include four major pre-built

modules: First, the intelligent invoice processing module integrates multimodal OCR technology to automatically recognize 43 common types of invoices such as special VAT invoices, e-invoices, and travel itineraries, with high recognition accuracy and invoice authenticity verification capabilities. Second, the automated process engine pre-loads over 200 compliance rules such as travel standards, departmental budgets, and expense types, supporting automatic triggering of multi-level approval workflows based on amount and expense type. Lastly, the dynamic risk control module uses machine learning models to pre-load risk indicators such as duplicate reimbursements, excessive spending, and fake invoices, significantly improving anomaly detection speed compared to manual methods [6-7]. The entire system seamlessly integrates with existing enterprise OA, ERP, and other systems via standardized API interfaces, significantly shortening monthly closing cycles, reducing annual labor costs, and lowering reimbursement error rates. [8]

2.4. Application Layer

The application layer is the concrete implementation of intelligent automation for the expense reimbursement robot. By analyzing expense reimbursement business activities, it divides them into two independent yet interrelated financial robots: the expense accrual robot and the expense payment robot. The function of the expense accrual robot is to compile corresponding accounting vouchers in the financial software based on reimbursement information. The operational steps include two stages: collection of expense accrual data and execution and review of the expense accrual robot. The core tasks of the expense payment robot include executing bank transfers via the online banking platform and compiling accounting vouchers on the financial cloud platform.

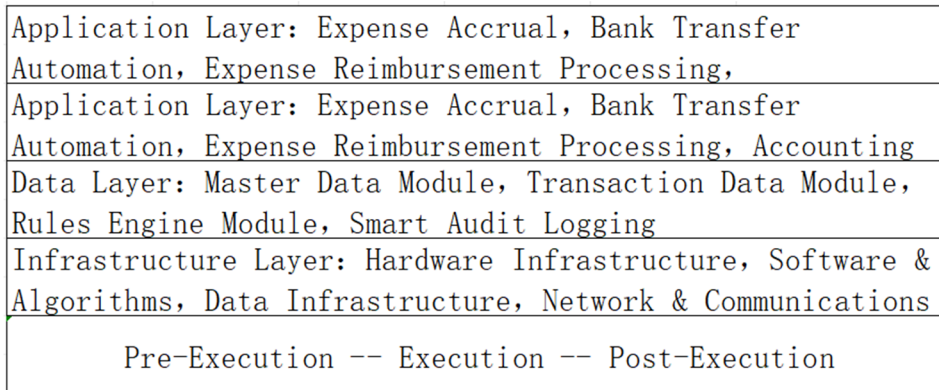


Figure 1. System Architecture of the Expense Reimbursement Robot

3. Application in Key Scenarios

3.1. Analysis of Key Application Points

The expense reimbursement robot is designed to automatically process accounting for expense reimbursement activities that occur in the daily operations and management of enterprises, covering various types of expense expenditures such as travel expenses, office expenses, and business entertainment expenses. Enterprise expense expenditures occur frequently, are diverse in type, and have varied financial accounting requirements (by department, by project), but their rules are clearly defined, making them suitable for the introduction of financial robots, which will greatly improve

work efficiency. The main key application points are described in Table 1 below.

3.2. Specific Application Analysis

The specific procedures executed by the expense reimbursement robot in actual application include invoice collection and recognition, compliance pre-check, document generation and filling, approval routing, accounting, payment, archiving, and exception monitoring and reporting, as shown in Figures 2, 3, and 4.

3.2.1. Invoice Collection and Recognition

First, paper, electronic, and third-party platform invoices are collected via multiple channels such as WeChat Work, DingTalk mini-programs, or PC drag-and-drop. At the

collection end, real-time quality gating is completed for clarity, missing corners, reflections, etc.

Table 1. Description of Key Application Points of the Expense Reimbursement Robot

No.	Key Application Point	Input	Rules/Tools	Output	Main Operational Description
1	Invoice Collection and Recognition	Scanned/photographed paper or electronic invoices, tickets, hotel receipts, etc.	OCR-CNN hybrid recognition engine, invoice verification API, image enhancement algorithms	Structured invoice data (amount, tax rate, invoice date, invoice code, verification code, etc.)	Automatically extract invoice information and call tax platform API to verify authenticity
2	Compliance Pre-check	Structured invoice data, employee basic info, expense standards/budget limits	Rule engine (expense standard table, budget freeze rules), blacklist database, RPA browser automation	Compliance/non-compliance flag with reason	Automatically block (exceeding standard), duplicate, or fake invoices based on company travel policy and budget limits
3	Document Generation and Filling	Compliant invoice data, travel request number, project/cost center code	Excel/ERP pre-built templates, RPA data-writing components	Completed reimbursement form (with image attachments)	Automatically write compliant data into reimbursement template and upload images, generate unique form ID
4	Approval Routing	Reimbursement form, approval matrix, budget control result	Workflow engine (OA/DingTalk/WeChat Work API), message push service	Approval task list, approval comments, electronic signature	Automatically route to approvers based on amount/level, real-time reminders and collect electronic approvals
5	Accounting	Approved reimbursement form	ERP interface, accounting subject mapping table	Accounting voucher number	Automatically generate accounting vouchers
6	Payment	Employee bank account information	Bank-enterprise direct connection	Payment receipt, fund flow	Push payment instruction and write payment status back to reimbursement system
7	Archiving	Reimbursement form, accounting voucher, e-invoice image	PDF/A archiving, electronic signature, object storage (OSS/S3)	Legally compliant electronic archive package (with index, signature, timestamp)	Automatically package and archive by year/project, support 10-second full-text search
8	Exception Monitoring and Reporting	Robot runtime logs, business audit logs, exception rule library	Log analysis, knowledge graphs, BI visualization, email/IM alerts	Robot ops daily report, exception handling list, compliance risk analysis report	Real-time monitoring of recognition rate, approval timeliness, abnormal invoices, auto-generate improvement suggestions

Then, the image is enhanced to precisely crop 12 key areas such as invoice password zone, amount field, and tax rate field. After OCR text recognition, over 30 invoice types are matched one by one using template fingerprints, converting invoice information into structured JSON. Fields with confidence below 0.95 are automatically pushed to a manual review pool, while compliant information is stored in the database. After recognition, the system immediately connects to the State Taxation Administration verification platform for invoice authenticity checks, while reconciling amounts and

tax rates against travel requests and business trip orders using a three-way match, and intercepts duplicate reimbursements via an invoice fingerprint library within seconds. The final output includes JSON with 28 standard fields, full-text searchable PDF/A originals, and desensitized thumbnails for mobile use. Rejected or failed invoices are automatically routed into an exception queue for closed-loop processing, truly freeing employees from pasting invoices and providing finance teams with clean and trustworthy data [9-10]. In the "Select Business" process, choose "Create New Business,"

and "Export" the created business



Figure 2. Expense Accrual Bot Workflow

3.2.2. Data Collection for Expense Accrual Operations

In the reimbursement process, the person requesting reimbursement must first submit the request in the OA system; only after approval is granted can the transaction enter the workflow of the expense-accrual robot. [11]

When a paper invoice is received for the reimbursement, it is photographed or scanned to capture its image; the captured image is then processed by OCR technology to extract the invoice data, which is stored in structured form in the database. If the invoice is electronic, the image-capture and OCR steps can be skipped. The OA system can call the invoice information in the database directly through a data

interface, so when a request is created in the OA system the relevant invoices can be pulled in automatically according to the business selected.

In the "Select Business" step the user chooses "Create New Business," and can "Export" the resulting business data to the local machine for review and verification. The program executed by the expense-accrual robot consists of a main flow plus nine sub-flows. The nine sub-flows are: Open the data sheet, Log in to ICBC online banking, Retrieve the data, Execute payments one by one, Query payment information, Log out of ICBC online banking, Log in to the financial cloud platform, Prepare accounting vouchers, Log out of the financial cloud platform.



Figure 3. Expense Payment Bot Workflow

3.2.3. Accounting-Voucher-Preparation Robot

The accounting-voucher-preparation robot consists of four sequential processes: Log in and retrieve data, Financial cloud platform, Prepare accounting vouchers, Exit the financial cloud platform

Specifically, the robot first fetches the accounting data from the "voucher-editing sheet." Next, it opens and logs in to the financial cloud accounting platform. Using the

retrieved business data, it fills in the debit/credit accounts, amounts, and other required fields to complete the voucher preparation. Finally, it logs out of the financial cloud platform.

This process is implemented in a loop design: after one payment voucher is prepared, the robot automatically proceeds to the next transaction—starting again from data retrieval—until all payment vouchers are processed, at which point the loop ends. [12]

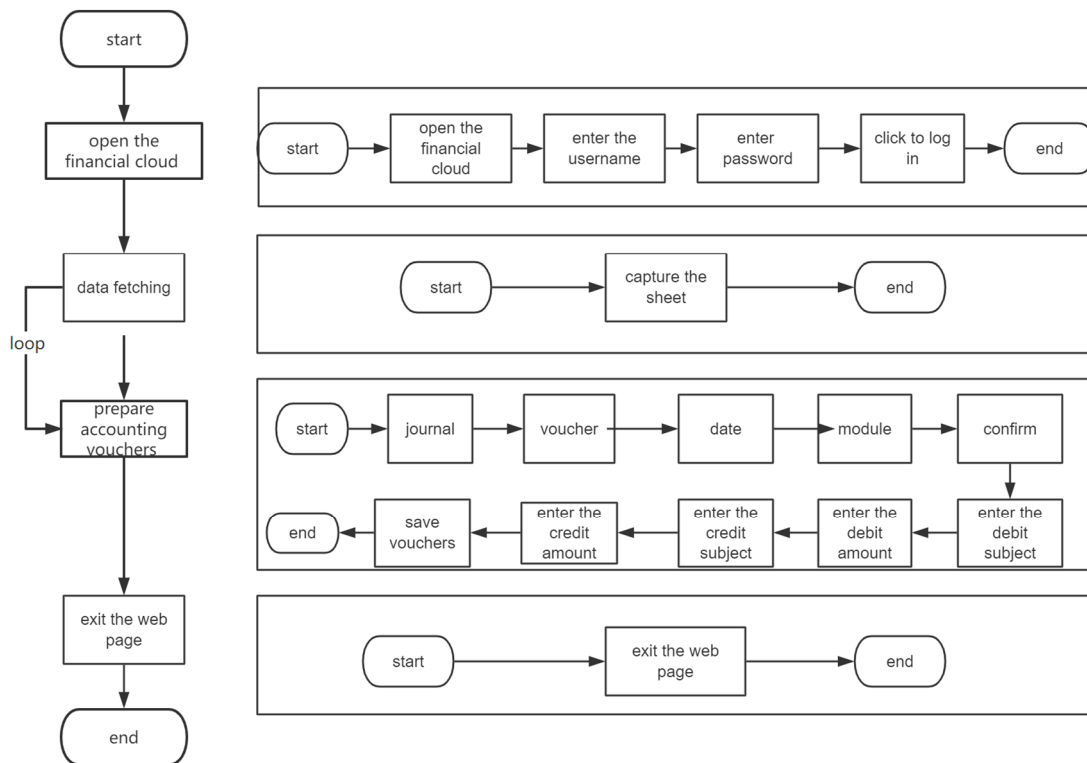


Figure 4. Accounting Voucher Processor Workflow

4. Issues to Note During Application

Whether the two tasks of “log operation & log management” and “systemic risk prevention” can be executed to the extreme after the expense-reimbursement robot goes live will directly determine whether the automation benefits can be realized on a sustained basis.

4.1. Daily Log-Management Issues

First, logs are not simple “running diaries”; they are the “black box” of every interaction between the robot and the outside world. In the expense-reimbursement scenario, logs must cover at least seven dimensions: original file name of each invoice image, OCR recognition result and confidence score, return code of each call to the tax-verification interface, rule-engine hit path, budget-quota freeze/release records, every node time and operator in the approval flow, bank-enterprise-direct-connection payment receipt number.

Log collection is recommended to use a lightweight agent cluster that records the robot’s operational trace in real time, including invoice-recognition timestamps, approval-rule trigger logs, payment-instruction generation logs, etc., ensuring every single reimbursement can be traced back to its original voucher. The logs are stored under a rolling “day-week-month” three-tier index: high-frequency operational logs are retained for six months, while finance-voucher-type logs are kept for 30 years, satisfying the *Administrative Measures for Accounting Archives* requirements for electronic vouchers and avoiding storage bloat. An abnormal-behavior model is built: machine-learning analysis of operation frequency (e.g., more than 50 rejections in one day triggers an alert) and time-slot distribution (batch processing outside working hours triggers review) automatically generates a Robot Operation Anomaly Report. [13]

A “three-level viewing permission” regime is established: Tier-1 operations staff can only view run-status codes, Tier-2 technical support can retrieve desensitized business fields, Security auditors can view the full message only after explicit authorization.

Every viewing action itself is written into the audit log to prevent “logs being tampered with by their own recorders.” In addition, scripts must periodically perform integrity checks on logs; any detected tampering triggers an immediate circuit-breaker.

4.2. Systemic Risk Issues

In terms of systemic risk prevention, the threats faced by the expense-reimbursement robot can be categorized into four types: data leakage, process interruption, rule failure, and external-dependency unavailability.

Data-leakage control hinges on “minimum usable + dynamic desensitization.” Process-interruption risks mainly originate from browser exceptions, ERP patch upgrades, and network jitter. Rule failures often stem from policy changes or the release of new invoice formats. External-dependency unavailability occurs when, for example, the tax-verification platform is down.

A closed-loop risk-control system is constructed through multi-dimensional technical means: At the invoice-verification stage, OCR extracts key fields from 43 invoice categories and connects to the tax system for real-time authentication, combined with blockchain notarization to

ensure data immutability [14]. The rule engine pre-loads more than 200 enterprise compliance policies, dynamically intercepts over-limit reimbursements, and automatically triggers multi-level approvals; cross-border scenarios support multi-country tax-rule configurations. On data security, dual-factor authentication combining biometrics and dynamic tokens is implemented, and all financial data transmissions are fully encrypted. An in-system machine-learning model continuously improves risk-identification capability: abnormal invoices (e.g., sequential-numbered invoices, cross-region expenses) automatically trigger alerts, and high-risk operations are mandatorily routed to human review as a fallback.

Through the triple mechanism of “technical verification + process control + audit traceability,” full-process risk coverage of the reimbursement workflow is achieved.

5. Conclusion

During the enterprise digital-transformation phase, finance robots are widely deployed for their non-intrusiveness, zero-error rate, 24/7 availability, and full-process visibility.

The expense-reimbursement robot uses OCR and NLP technologies to automatically extract key invoice data and verify authenticity. Coupled with a pre-set rule engine, it intelligently audits travel, entertainment, and other expenses, while supporting differentiated standards by department and job grade.

End-to-end automation spans mobile photo upload, automatic approval routing, real-time anomaly alerts, and seamless data synchronization with ERP/OA systems, forming a closed loop of “apply – approve – pay – record.”

On risk control, historical data are analyzed by machine-learning models to detect fraudulent behavior, and blockchain notarization guarantees audit traceability. Typical employee-reimbursement applications systematically address efficiency, compliance, and cost issues.

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