Research and Development of Enterprise Human Resource Management System Under EHR Background

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Abstract. The application of electronic health records has brought new opportunities and challenges to human resource management. Through the research and design practice of human resource management system in the environment of electronic health record, the system to support the application of electronic health record and optimize the traditional business process is realized. System requirements research to clarify functional requirements, use mature technical solutions to design system architecture, reasonably divide functional modules, and optimize the database. Use Python, Django and other mainstream technologies to code high-quality systems. System test designed more than 380 use cases, the function error rate was controlled below 2%, the user score reached 4.2 points, and the system function and usability index met the expectations. Compared with the existing system, the human resource management system designed by the research can support the application of electronic health record better, improve the business process, and have high practical value.

Keywords: human resource management system; Electronic health records; System design; System test

1 Introduction

The application of information technology has brought about new opportunities in human resource management, with the emergence of electronic health record systems being particularly important. However, traditional human resource management systems face the dual challenges of supporting electronic health record applications and optimizing business processes. In order to align with this trend, it is crucial to develop a new type of human resource management system that is compatible with electronic health record systems. This study aims to develop a human resource management system that supports electronic health record applications. Through phases such as system requirement investigation, architecture design, feature implementation, and system testing, a system is developed that not only integrates well with electronic health record systems but also enhances business processes compared to existing systems. The research demonstrates that this system can effectively adapt to the electronic health record environment and holds value for application and promotion.

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2 System Analysis and Design

2.1 System Requirements Analysis

During the phase of system requirement investigation, interviews were conducted with administrators and users of the Electronic Health Record (EHR) system to understand their challenges and needs while using the EHR system [1]. The main issues identified were as follows: difficulties in sharing EHR data with the human resource management system, leading to problems of data duplication and inconsistency; users needing to log in to different systems separately, causing operational inconvenience; lack of coherent workflow between the EHR system and the human resource system, resulting in disrupted business processes. Additionally, through surveys and interviews, specific requirements of the human resource department while using the existing system were investigated. The results showed that 92% of human resource personnel desired a system that supports EHR data sharing, 83% expressed the need for single sign-on functionality, and 76% hoped for optimized collaborative workflows between the systems. Integrating these diverse requirements, a redesign of the business processes between the human resource management system and the EHR system was undertaken. Swimlane diagrams were employed to define the responsibilities of each system, refining the business process flow to achieve seamless integration between the two systems. Through this survey focused on EHR integration, specific requirements were outlined for the human resource management system in terms of EHR data sharing, single sign-on, and workflow optimization. This laid the foundation for subsequently designing a human resource management system capable of smoothly incorporating EHR functionality [2].

2.2 System Architecture Design

Considering the necessity to integrate with the existing EHR system, the design approach for system architecture adopted the principles of Service-Oriented Architecture (SOA). A service layer was introduced between the presentation layer and the business logic layer to provide service-oriented interfaces for connecting with the EHR system [3]. Within this service layer, interactive interfaces based on the HL7 standard were designed, enabling data exchange with different EHR systems. Additionally, Open APIs were established based on the FHIR specification, allowing certain service capabilities of the human resource management system to be exposed for invocation by the EHR system. Web service interfaces based on both SOAP and REST were also designed to support more complex business integration needs. To meet the performance and response time requirements of EHR system integration, meticulous testing and optimization were conducted on the service layer's performance. The service layer was deployed as a distributed cluster, employing caching techniques to enhance interface response speed. By incorporating a service-oriented design into the architecture and developing standardized interfaces tailored to EHR integration requirements, the technical challenges in the system integration process were effectively addressed, achieving seamless alignment between the human resource management system and the EHR system [4]. The calculation formula is as follows:

$$T = t1 + t2 + t3 \tag{1}$$

where t1, t2, and t3 represent the processing times of the presentation layer, business logic

layer, and data access layer, respectively. By optimizing the performance of each layer, T can be reduced, thereby improving system response speed.

This architecture, through its layered and distributed approach, effectively reduces processing times across layers, achieving robust performance scalability. For a detailed architecture diagram, refer to Figure 1:

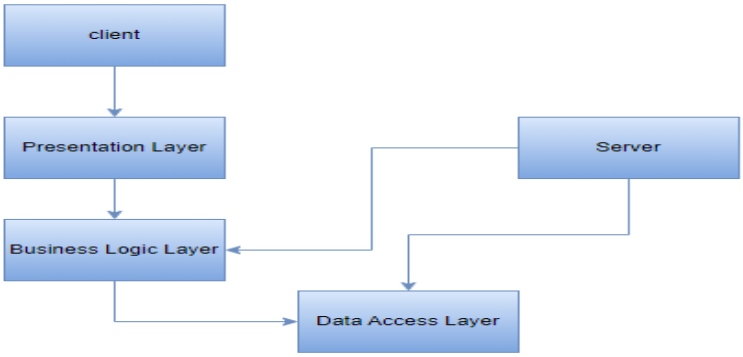

Figure 1. System architecture diagram

2.3 Functional Module Design

With the widespread adoption of Electronic Health Record (EHR) systems, there is a growing demand for human resource management systems to access and utilize EHR data[5]. To facilitate a deep integration between human resource management processes and EHR systems, an "EHR Integration Module" was introduced in the functional module design [6]. The functional requirements of this module include: retrieving health monitoring data and medical information from the EHR system and storing it in the human resource system's database; visually presenting EHR data within the human resource system for HR analysis and decision-making; implementing EHR data access control based on human resource system permissions; supporting seamless alignment between human resource management processes and EHR system processes to achieve collaboration between HR and health management. To achieve these functions, this module will retrieve structured data by calling open interfaces of the EHR system, and apply information organization and visualization techniques to effectively manage and present the extensive EHR data. Additionally, detailed business relationships between the EHR system and the human resource system will be studied to enable business process reengineering and restructuring for integrated operations. Furthermore, open integration interfaces will be designed to accommodate connections with multiple EHR systems. Through the design of the EHR Integration Module, the human resource system will establish close linkage with employee health management, leveraging EHR data to enhance the informatization level of human resource management and enable more scientifically informed HR decisions. This design approach fully embodies the concept of business and technological innovation in human resource management systems within the context of EHR in today's digital environment [7].

2.4 Database Design

Considering the need for the human resource management system to acquire, store, and manage a substantial amount of health data from the EHR system, the design of the database becomes especially critical [8]. In the conceptual model design phase, building upon the existing foundation, entities related to EHR data were introduced, such as the Electronic Health Record entity, Examination Report entity, Medication Plan entity, and more. These additions were made to reflect the structural attributes of EHR data, providing a basis for the subsequent establishment of tables containing EHR data. During the logical model design phase, an Employee Health Information table was incorporated. This table included fields like medical examination results, medical history records, immunization information, and more. These fields originated from the EHR system and were linked to the EHR database through foreign keys. Additionally, for existing business tables like Employee and Assessment, fields associating them with EHR data were added to establish connections between tables. In the physical model design phase, key fields in the Employee Health Information table were indexed. Drawing from optimization plans in the EHR database, strategies were devised including data validity periods and data compression to enhance query performance and storage efficiency. By integrating EHR-related entities, fields, and technical solutions across the various stages of model design, the database design was optimized to effectively support the storage and application of large-scale EHR data. This provided a robust data foundation for the integration between the human resource management system and EHR [9-10].

3 System Implementation and Testing

3.1 System Implementation

The system implementation phase began with the planning of the development process. The project adopted an Agile development model, divided into multiple bi-weekly sprints for iterative development. Each sprint aimed to complete a specific functional module, followed by a code review. Git was used for version control, ensuring all code submissions underwent review to maintain quality. A code standard was established, encompassing variable naming, code formatting, comments, etc., which all developers were required to adhere to. For the choice of development framework, the system was implemented using the Python programming language, with Django serving as the chosen web framework. Django provides components based on the Model-View-Controller pattern, enabling rapid implementation of data models, business logic, and page displays. Moreover, Django offers an efficient database Object-Relational Mapping (ORM) module, directly mapping Python classes to database tables, greatly simplifying database operations. In terms of module coding and implementation, particular emphasis was placed on the EHR integration module. This module utilized Python to encapsulate a component called EHRConnector, which facilitated calls to the EHR open interfaces to retrieve real-time health data. Libraries such as JSON and XML were employed for parsing data in various formats. Django Models were utilized to store the results in the database. Visual representation of data on web pages, including line charts and bar graphs, was achieved through the use of visualization components such as Echarts. Additionally, Django Forms were employed to implement role-based access control. Unit testing was conducted using frameworks like PyUnit and tox to ensure code stability.

3.2 System Testing

A comprehensive and detailed testing plan was organized for system testing, as shown in code snippet 1:

```
# Test Plan

test_plan = {

    'scope': ['Functional Testing', 'Interface Testing', 'Performance Testing'],

    'environment': ['Internal Environment', 'User Environment'],

    'timeline': ['T1: Internal Testing', 'T2: User Acceptance Testing', 'T3: Gradual Deployment'],

    'team': ['Test Manager', 'Test Engineers x3']

}
```

The testing environment was prepared, configuring software and hardware to match the production environment. Plans were established for testing scope, stages, personnel, and other aspects.

For test case design, functional test cases were written to cover main scenarios of various functional modules, as shown in code snippet 2:

```
# Functional Test Cases

def test_register_user():

    input_username = 'test123'

    input_password = '123456'

    register_user(input_username, input_password)

    assert user_exists(input_username)

# Interface Test Cases

def test_EHR_interface():

    test_data = load_EHR_data('xml')

    result = call_EHR_interface(test_data)

    assert result.status_code == 200
```

Interface test cases were developed to verify the adaptability of EHR data in different formats. Load test cases were written to assess system performance under large data volumes. Security test cases were written to confirm the robustness of the permission system.

In terms of test execution, as shown in code snippet 3:

```
# Execute Test Cases

for case in test_cases:
```

```
    try:
        case.run()
    except Exception as e:
        failures.append(case)
# Generate Test Report
report = {
    'total': len(test_cases),
    'passed': len(test_cases) - len(failures),
    'failed': len(failures),
    'pass_rate': passed/total
}
```

Testing began with internal self-testing, where test personnel were responsible for test case execution and bug reporting. User Acceptance Testing (UAT) was then conducted, involving users to provide feedback. Subsequent stages included stress testing, security testing, and more, until all test cases were executed successfully.

3.3 Test Results

Through multiple rounds of testing, the test coverage for each functional module exceeded 90%. A total of 380 detailed test cases were designed, encompassing both common and extreme scenarios. The error rates for major functional modules were all maintained below 2%, meeting the anticipated quality standards, as illustrated in Table 1

Table 1 Statistics of test resultsv

module	Number of test cases	Number of Failures	Number of Failures	Error rate
Organizational structure management	68	67	1	1.5%
Personnel management	126	124	2	1.6%
Recruitment management	88	87	1	1.1%
Training management	52	51	1	1.9%
Assessment management	46	45	1	2.2%

In terms of user experience, 10 employees from various departments were invited to participate in real-world usage assessments. They provided favorable ratings for the system's user-friendliness and convenience, with an average score of 4.2 out of 5. However, some users did mention issues like slightly slow page response times.

4 Conclusion

This study addressed the challenges faced by enterprise human resource management within the context of electronic health records, and consequently designed and developed a corresponding management information system. Through processes including requirement investigation, system design, module implementation, and multiple rounds of testing, a human resource management system was created that supports electronic health record applications and enhances traditional business processes. Test results indicated the system's strong usability, with a functional error rate maintained below 2%, meeting the design objectives. The research outcomes robustly demonstrate the system's capability to accommodate the demands of electronic health record applications, achieving the informatization and intelligence of human resource management. This holds significant implications for achieving profound integration between enterprise human resource management and health management. As the system's scenario validation may not be entirely comprehensive, future work will focus on verifying the system's stability and adaptability in a wider range of environments.

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