

A Practical Project Management System Based on Shiro Framework and B/S Architecture

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Project Management

Received November 24, 2025; revised February 3, 2026; accepted May 6, 2026

Available online May 29, 2026

Abstract: In a fiercely competitive business environment, consulting firms need to address challenges such as complex project business processes and tight delivery times. At this point, a practical Consulting Project Management System (CPMS) becomes particularly important for optimizing project management processes and improving execution efficiency. To design a practical CPMS, the study first conducts a requirements analysis and clarifies the design focus of the system based on the analysis of business processes. Secondly, the study conducts a detailed design of different functional modules in the system and adopts the Shiro framework to implement identity authentication and authorization. Finally, the study conducts an overall design of the CPMS and utilizes a browser/server architecture to reduce operational costs. The findings show that the designed system exhibits excellent performance, with both functional completeness and coverage reaching 100%. The core module utilization rate is outstanding, which is sufficient to promote the deep application and integration of practical project management systems in the consulting field.

Keywords: Shiro, B/S, consulting service, system, modular, design, requirement analysis.

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DOI 10.32738/IEPPM-2025-288

1. Introduction

In today's rapidly developing digital business environment, enterprises are facing increasingly complex challenges in project management and team collaboration. For instance, in the context of intensified market competition, diversified customer demands and expanded project scale, conventional project management methodologies are inadequate to facilitate the efficient operation of enterprises (Efimova et al., 2024; Rogalska and Hejducki, 2023). As a key tool for enterprises to improve project management efficiency, optimize resource allocation, and enhance team collaboration, the importance of project management systems is becoming increasingly prominent. Meanwhile, the design and construction methods of project management systems are constantly evolving. In current project management systems on the market, common design methods mainly include traditional Client/Server (C/S) architecture, Browser/Server (B/S) architecture, microservice architecture, and cloud native architecture (Liu et al., 2024; Ostapenko et al., 2024). Meanwhile, many scholars have also carried out research and design on project management systems.

Shi (2024) researchers suggested an intelligent human resource management system grounded on the Spring Cloud framework to address the problems in traditional human resource management and constructed an improved human resource recommendation model based on a hybrid genetic algorithm. At the same time, they also introduced the branch definition method and the heuristic method to solve scheduling problems. The findings denoted that the recommendation accuracy of the system could reach up to 0.982. Zhao (2024) designed a building information security management system to guarantee the security of building construction information. The system adopted an attribute-based encryption algorithm and incorporated it into the designed management system. The results showed that the system had good stability and security, with maximum values of 94% and 95%, respectively, which can effectively ensure the security of construction information. To promote the construction of intelligent perception cities, Wang et al. (2023) constructed a landscape design project operation information management system grounded on Internet of Things (IoT) technology and designed an IoT geographic information system communication model based on particle filtering algorithm. The findings denoted that the stability of the system was high, and it still achieved over 90% stability even with many transaction sets. To improve the safety and efficiency of the construction industry, experts such as Song and Choi (2024) adopted a risk-based approach and integrated it into buildings, developing specialized risk assessment modules and web-based management programs. Subsequently, the study developed a new building risk management system. The results showed that the system could

provide a structured process for risk identification, assessment, and mitigation, and could ensure project efficiency while ensuring safety.

However, current methods and research also have certain shortcomings. For example, the cost of updating and maintaining C/S architecture is high, and it performs poorly in cross platform compatibility. Meanwhile, the permission management function of the B/S architecture is relatively basic and difficult to meet the diverse organizational structure and personnel permission allocation needs of enterprises. Existing research exhibits two critical gaps: First, most project management systems are developed with a focus on general scenarios, lacking customized design tailored to the core needs of the consulting industry, which include “multi-role collaboration, fragmented processes, and fine-grained permissions”. This results in a disconnect between system functionality and actual business operations. Second, regarding the combined application of the Shiro framework and B/S architecture, existing research mostly remains at the level of basic security control or general architecture construction, without delving into exploring permission adaptation and process optimization solutions in the consulting scenario. Furthermore, the main reason Shiro-based systems have previously failed in consulting scenarios is that they often use the Shiro framework solely for single-user authentication. This means they do not integrate it with the multi-tiered role system of consulting projects, which includes ‘project leaders, participants, enterprise management and partners’, to achieve granular permission allocation. This leads to the leakage of critical project information or confusion in operational permissions. On the other hand, traditional B/S architecture systems, due to the rigid permission management module, cannot adapt to the complex organizational needs of consulting enterprises, such as “parallel multi-projects, cross-departmental collaboration, and customer information isolation”. Furthermore, they are prone to response delays in high-concurrency scenarios, making it difficult to meet the requirements of real-time communication and progress tracking in consulting projects. To design a project management system, starting from consulting enterprises, a practical CPMS based on the Shiro framework and B/S architecture is developed, aiming to achieve the subdivision of permissions for different departments and project roles through the powerful identity authentication and authorization functions of the Shiro framework, and thus solve the shortcomings of the B/S architecture. The target of the research is to design and construct a practical CPMS, enhance the project management capabilities and competitiveness of consulting enterprises, and facilitate a transition from traditional project management methods to modern, efficient consulting project management models. The novelty of the research lies in combining the Shiro framework with the B/S architecture, which improves the efficiency and collaboration of project management and addresses the shortcomings of the B/S architecture in permission management. Furthermore, the “Shiro Framework + B/S Architecture” solution proposed in this study exhibits significant differences from microservices and cloud-native architectures: while microservices architecture boasts high scalability, it incurs high deployment and maintenance costs, and suffers from inter-service communication latency issues, making it unsuitable for the lightweight requirements of small and medium-sized consulting firms; cloud-native architecture relies on cloud resources and demands stringent data security, whereas consulting projects often involve client business secrets, and a locally deployed B/S architecture is better able to safeguard data privacy. This solution addresses the shortcomings of B/S architecture in terms of permission management through the Shiro Framework, while retaining the advantages of B/S architecture, such as cross-platform access and low maintenance costs, to form a lightweight and highly secure solution that is more tailored to consulting scenarios.

2. Methods and Materials

To construct a practical CPMS, requirements analysis, detailed design, and overall design were conducted separately. In addition, the study adopted the Shiro framework and B/S architecture to achieve user authentication and authorization, and to reduce costs.

2.1. Requirement Analysis of CPMS

To design the CPMS, an analysis of the requirements involved was conducted first, followed by an overall design. Finally, the study utilized techniques such as the Shiro framework and B/S architecture to implement the CPMS. Business processes are the foundation of system design and requirement analysis. By comprehensively organizing business processes, the input, processing, and output of each link in the business can be clarified, as well as the responsibilities and collaborative relationships of different departments and roles, thereby improving the practicality of the system (Wang et al., 2023; Gaol et al., 2023). Therefore, before conducting a requirements analysis, the study needs to first gain a deep understanding of the business situation. Consulting projects are the core business of consulting enterprises, the business process of the CPMS is denoted in Fig. 1.

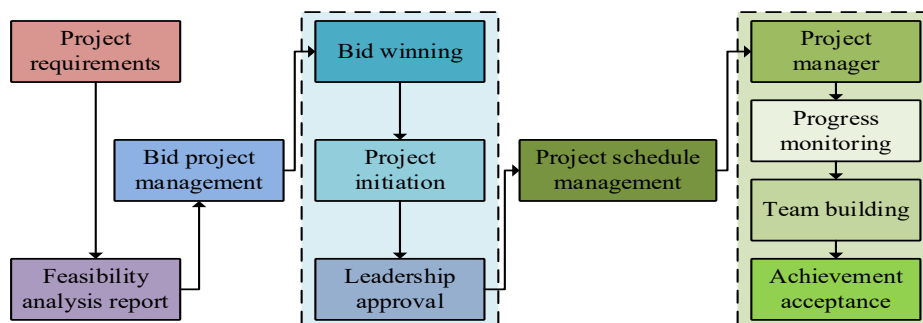


Fig. 1. Business process of CPMS

In Fig. 1, this business process involves project requirements, feasibility analysis reports, bidding, project management, and project schedule management. Among them, bidding project management involves winning the bid, leadership approval, and project initiation, while project progress management includes the project manager, progress monitoring, team building, and achievement acceptance. In addition, project schedule management can not only ensure the timely delivery of projects but also improve project quality and enhance customer satisfaction. Therefore, based on this business process, the key requirements of the CPMS have been identified and studied, as shown in Fig. 2.

In Fig. 2, the key requirements of the system include three aspects, namely the project management module, the user management module, and the visualization system panel. Among them, the requirements of the project management module include a more detailed division of process nodes and improving the transparency of processes and information. There are three main requirements for the user management module, which are to assign specific responsibilities, keep communication records, and ensure the timeliness and accuracy of communication. In addition, the requirements for the visualization system panel mainly include three aspects, namely simplicity, convenience, and practicality. After considering the key requirements of the CPMS, the study also analyzes the non-functional requirements of the system. Therefore, the overall requirements for the CPMS are shown in Fig. 3.

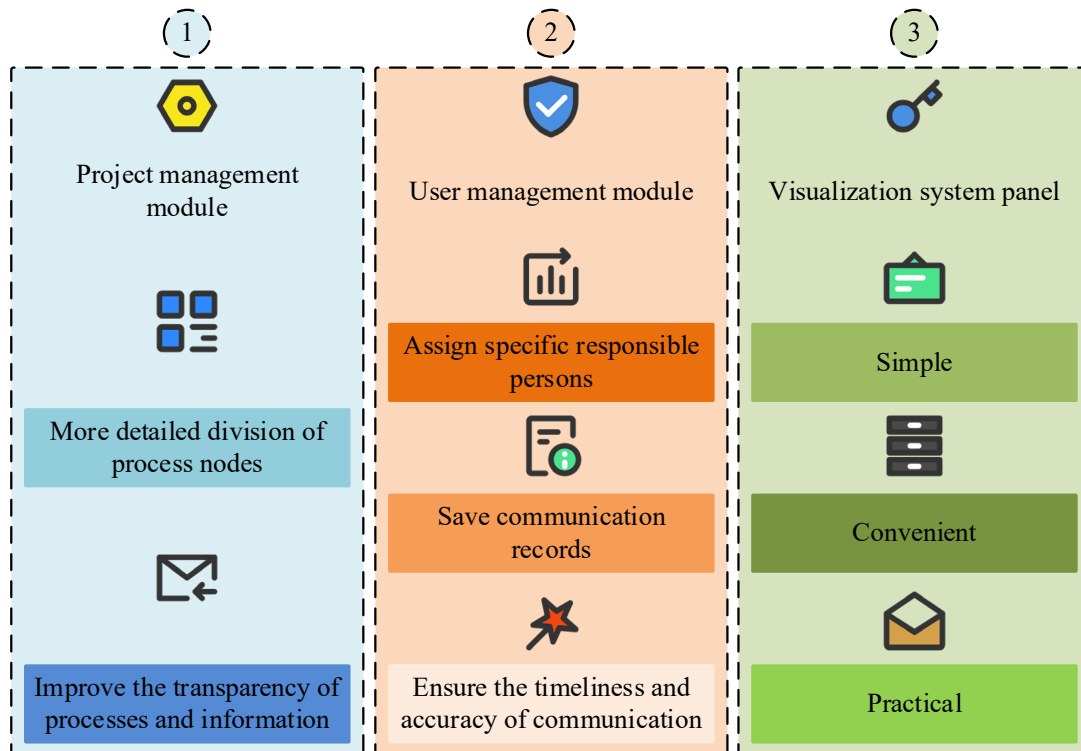


Fig. 2. Key requirements for CPMS

In Fig. 3, the overall requirements of the CPMS are divided into functional and non-functional requirements. Among them, non-functional requirements involve concurrency and responsiveness, ease of operation, security, and data storage. Based on non-functional requirements, the CPMS needs to ensure that the average response time of the page is below 180ms, and strict control of user operation permissions is required, as well as data backup in the system design. In addition, functional requirements mainly consist of five parts and revolve around information/project/system management, risk analysis and assessment, and SMS reminders. Based on functional requirements, research requires refined management of personnel and permissions to ensure that each user's behavior and responsibilities in the system are traceable, and to manage bidding projects and project progress. In addition, the study also needs to design risk analysis and assessment methods for consulting projects and send notifications to users via SMS.

2.2. Detailed Design of a System Considering the Shiro Framework

To design the CPMS, a requirements analysis was conducted to lay the foundation and direction for the system design. The summary narrative method is a common writing and expression structure, which has the advantage of being able to organize complex content, make logic clearer, highlight key points, and enhance persuasiveness. Therefore, when designing the CPMS, the research will also adopt a general narrative approach, that is, detailed design of each functional module will be carried out first, and then the overall design will be conducted to ensure the integrity and coherence of the system. In the user and customer management module, the Shiro framework was adopted to handle user authentication and authorization, ensuring that only legitimate users can access the corresponding project information and functional modules, and providing a solid security line for the entire project management system. Shiro is a simple and easy-to-use yet powerful Java security framework that focuses on security areas such as identity authentication, authorization, session management, and encryption. It not only helps developers quickly implement security control logic but also supports multiple data sources and storage methods, with advantages such as flexibility and scalability (Kim et al., 2024; Liu et al., 2024). The

authentication and authorization process of the Shiro framework is shown in Fig. 4

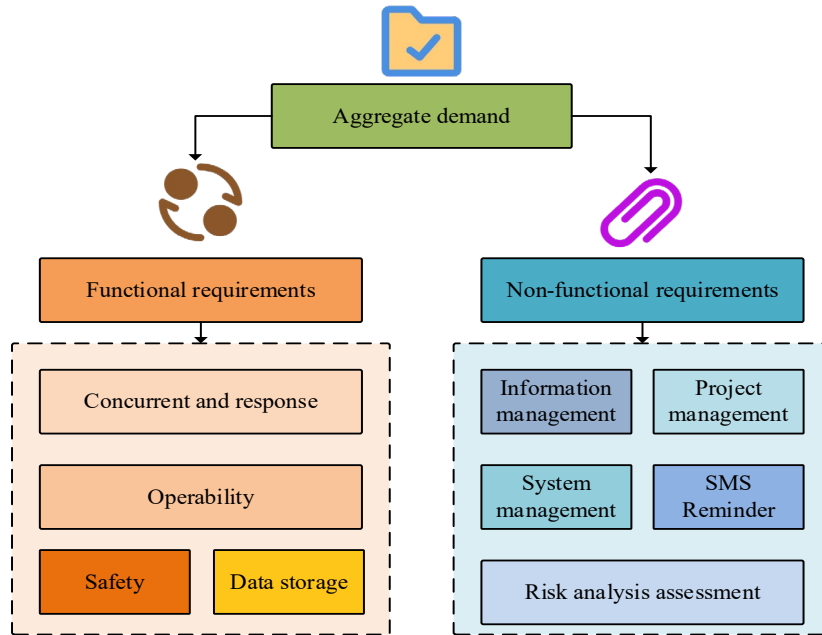


Fig. 3. Overall requirements for CPMS

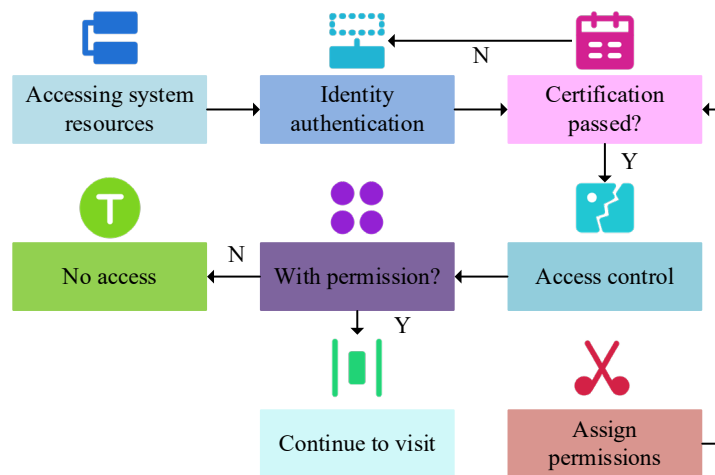


Fig. 4. Shiro framework authentication and authorization process

As seen in Fig. 4, the authentication and authorization process of the Shiro framework involves accessing system resources, identity authentication, permission control, assigning permissions, continuing access, and denying access. To clearly illustrate the interaction logic between Shiro and user roles and permissions in CPMS, a detailed workflow diagram is designed, as shown in Fig. 5.

In Fig. 5, the interaction between Shiro and CPMS is divided into two core processes. The first is authentication: when a user logs in, Shiro verifies the validity of the login credentials by comparing them with the user information table in the MySQL database, ensuring that only registered users can access the system. This is followed by the authorization: after successful authentication, Shiro extracts the corresponding operation permissions from the permission mapping table based on the user’s role (project leader, participant, enterprise management, administrative staff) and controls the user’s access to functional modules through an interceptor mechanism. For example, only the project leader role has the permission to “add/delete project operation nodes”, while other roles can only view or edit progress information, fulfilling the permission management requirement of “clear hierarchy and clear responsibilities” in consulting projects. Therefore, the process of the user and customer management module is denoted in Fig. 6.

As shown in Fig. 6, the user and customer management module comprises the user login and customer information management components. Among them, the user login part involves login verification based on the Shiro framework, while the customer information management part includes customer information viewing and management. In the bidding project

management module, the project director is mainly responsible for initializing bidding management data and updating bidding status. In the project management module, four users were studied and designed, namely the project leader, project participants, company management, and some managers. Different users have different system permissions, such as only the project leader can add or delete project operation node records. In the project management process, the most important steps are risk analysis, determining whether the bid is successful, and project schedule management. In the risk analysis management module, a combination of qualitative and quantitative methods was used in the study (Luo et al., 2023). First, experts from relevant fields were invited to rate the level of risk occurrence B and probability C , and express B using “High-5”, “Relatively High-4”, “Moderate-3”, “Relatively Low-2”, and “Low-1”. Second, the Analytic Hierarchy Process (AHP) was utilized to obtain the weight (risk level) B' of risk factors, and then the degree of risk impact C' was estimated and the risk score A' was calculated. The solution for A' is shown in Eq. (1).

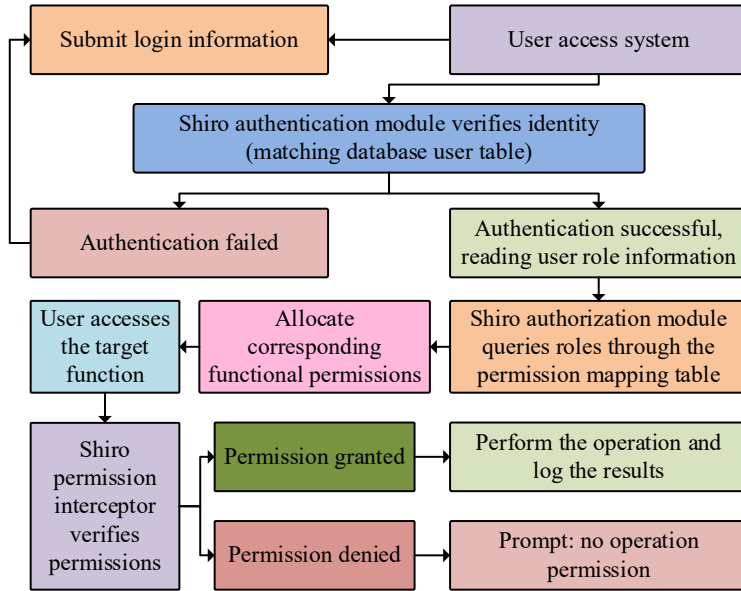


Fig. 5. Shiro and CPMS user role permission interaction flowchart

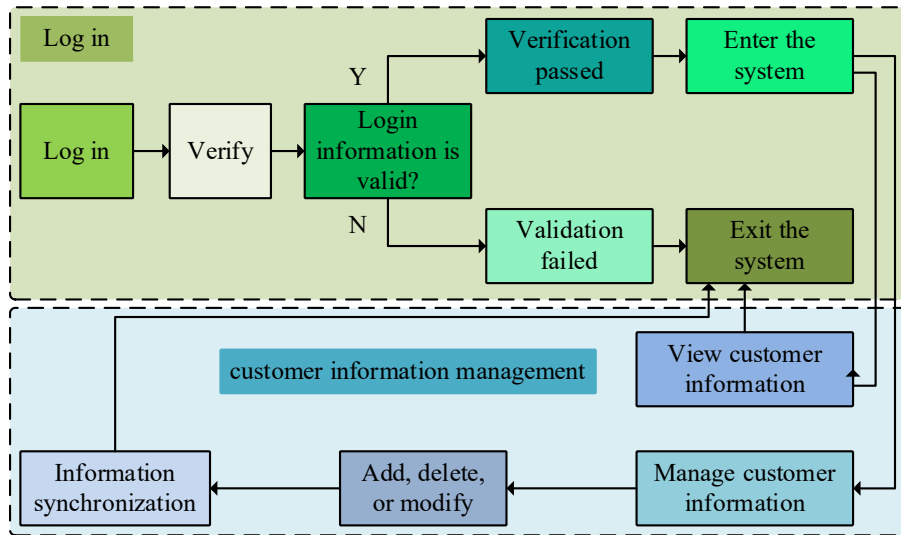


Fig. 6. The process of user and customer management module

$$A' = B' \times C' \tag{1}$$

The solution for C' is as shown in Eq. (2).

$$C' = C_1 \times C_2 \tag{2}$$

In Eq. (2), C_1 represents the risk occurrence degree score, and C_2 represents the risk occurrence probability score. The solution for the comprehensive risk score is denoted in Eq. (3).

$$S = A + A' = B \times C + B' \times C' \tag{3}$$

In Eq. (3), A represents the risk score for qualitative analysis. When using the AHP to solve B' , it is critical to pay attention to consistency testing. The expression of consistency index F is denoted in Eq. (4) (Zhang and Shi, 2025).

$$F = \frac{\alpha_{\max} - n}{n - 1} \tag{4}$$

In Eq. (4), α_{\max} means the max eigenvalue of the judgment matrix, and n means the order of the matrix. The solution for the consistency ratio G is shown in Eq. (5).

$$G = \frac{F}{H} \tag{5}$$

In Eq. (5), H means the random consistency index. The reasons for choosing AHP over other risk assessment methods, such as Monte Carlo simulation, are as follows. The risk factors in consulting projects are mostly qualitative indicators (such as customer demand change risk, team collaboration risk), which are difficult to quantify into continuous data. AHP can convert qualitative factors into calculable weights through hierarchical modeling, while Monte Carlo simulation is more suitable for quantitative risk assessment with sufficient data. Additionally, there is a clear hierarchical relationship among the risk factors in consulting projects (such as strategic-level risk, execution-level risk, and operational-level risk). AHP can reflect the relative importance of various factors through a hierarchical structure, which aligns with the management logic of consulting project risks. Furthermore, the calculation process of AHP is concise, and the results are intuitive, making it easy for consulting enterprise managers to understand and apply. Other methods (such as Bayesian networks) are complex to operate and require high professional expertise from users, which is not conducive to systematic implementation and promotion. In terms of the SMS reminder function, the study adopted the Alibaba Cloud SMS service. Alibaba Cloud SMS service is a communication service capability provided by Alibaba Cloud to users, which can send specified information to domestic or overseas mobile phone numbers, with advantages such as fast, stable, and comprehensive coverage. The key processes of SMS notification include organizing process flow information, sending SMS by calling the application programming interface of SMS service, determining whether the SMS has been resent 5 times, and saving the sending record based on the call return result. In project operation node management, the main design includes type management, process management, and process node management.

2.3. Overall Design and Implementation of CPMS Considering B/S Architecture

The study outlined the various details of a CPMS. To fully utilize the system's functionality, the researchers conducted an overall design and provided an explanation of its specific implementation. In the overall design, the B/S architecture was adopted to reduce maintenance costs and raise the scalability and accessibility of the system. The B/S architecture is a network architecture pattern that concentrates the business logic and data storage of applications on the server side, while the client side is only responsible for display and interaction. It has the advantages of easy maintenance, upgrade and deployment, strong cross platform compatibility, high cost-effectiveness and centralized data management (Yang et al., 2024; Zhang et al., 2023). Therefore, the architecture of the CPMS grounded on the B/S architecture is shown in Fig. 7.

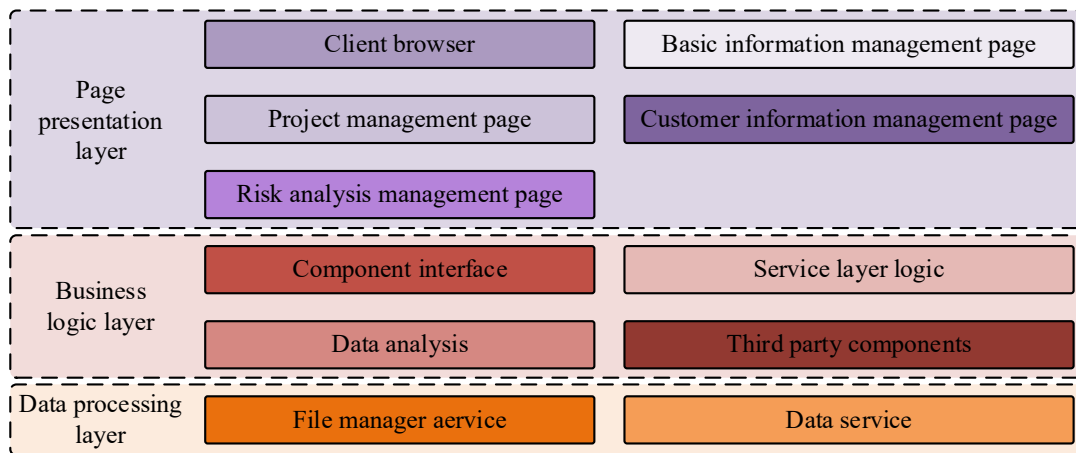


Fig. 7. Architecture of CPMS based on B/S architecture

In Fig. 7, the architecture of the CPMS includes a data processing layer, a business logic layer, and a page presentation layer. Among them, the data processing layer includes file management services and data services, while the business logic layer consists of data analysis, third-party components, component interfaces, and service layer logic. In addition, the page presentation layer involves client browsers, basic information management pages, project management pages, customer information management pages, and risk analysis management pages. In addition, in terms of database design, the entity relationship model is adopted, and role definition tables, permission definition tables, and user role permission tables are designed.

In the implementation of the CPMS, the research adopted the My Structured Query Language (MYSQL) database.

MySQL is an open-source relational database management system with a wide range of applications, including cross platform support, high performance, and ease of use and maintenance. On the browser, the study selected Internet Explorer 9. For specific operational details, in the customer information management module, data can be deleted by using Delete Customer Information (DCI). In addition, in the risk analysis management module, risk analysis can be conducted using the Analysis of Feasibility method. Common evaluation metrics for project management systems include response time, time consumption, throughput, resource utilization, and concurrent user count. Among them, response time I refers to the time it takes for the system to receive a request and return a result, and its solution process is shown in Eq. (6).

$$I = J - K \tag{6}$$

In Eq. (6), J refers to the end time of the request, and K indicates the start time of the request. Task duration L refers to the time required to complete a specific task, and its calculation process is shown in Eq. (7).

$$L = M - N \tag{7}$$

In Eq. (7), M and N represent the task end time and task start time, respectively. Throughput O means the amount of requests processed by the system per unit time, and its solution is shown in Eq. (8).

$$O = \frac{P}{Q} \tag{8}$$

In Eq. (8), P denotes the amount of requests processed, and Q is the time interval. The resource utilization rate Q refers to the degree of utilization of a certain resource in the system, and its solution is shown in Eq. (9).

$$R = \frac{T}{V} \times 100\% \tag{9}$$

In Eq. (9), T represents the amount of resources already used, and V represents the total amount of resources.

3. Results

To prove the effect of the CPMS, the experimental environment was set up, and the comparative system was chosen. This study also clarified the evaluation indicators of the system, such as response time, time consumption, throughput, and memory usage.

3.1. Performance Testing of CPMS

To assess the effect of CPMS, the study used the Windows 10 operating system, with an Intel Core i5-12600K Central Processing Unit (CPU), a CPU clock speed of 3.7GHz, an acceleration frequency of 4.9GHz, a max acceleration power consumption of 150W, and a max memory bandwidth of 76.8GB/s. In terms of comparative systems, the study selected the final project management system designed by Isa et al. (2024), the web-based project management system designed by Hambali et al. (2024), the modular water management system designed by Bessarabov et al. (2023), and the intelligent park comprehensive management system designed by Zhang et al. (2023), and named them System A, System B, System C, and System D, respectively. The study deployed these systems on test computers for analysis and validation. In terms of evaluation indicators, the study selected response time, time consumption, throughput, CPU utilization, and memory usage. To verify the statistical significance of performance improvement, the study conducted an independent sample t -test on three core indicators: response time, CPU utilization, and memory occupancy. When $p < 0.05$, it indicates that the difference is statistically significant. The comparison of response time and time consumption of different systems is denoted in Fig. 8.

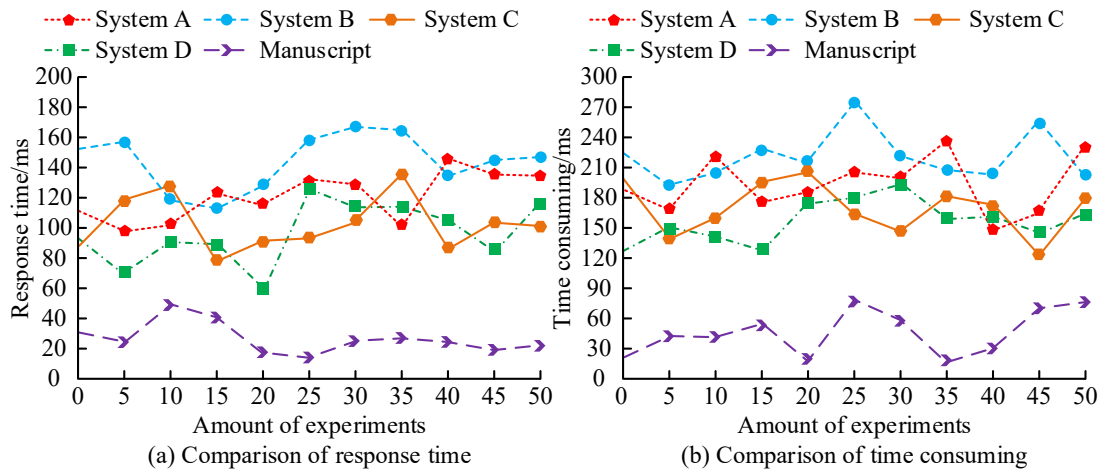


Fig. 8. Comparison of response time and time consumption of different systems

In Fig. 8(a), in response time comparison, the CPMS performed better, while the performance of the other four

comparison systems was slightly inferior. In specific response time values, the max values of the CPMS and the four comparison systems were 52ms, 145ms, 168ms, 137ms, and 124ms, respectively. The max response time of the CPMS was 93ms, 116ms, 85ms, and 72ms, lower than the max values of the four comparison systems, respectively. Furthermore, the test results revealed that in the comparison of the maximum response times between the proposed system and systems A, B, C, and D, the *t*-values were 11.26, 13.89, 10.53, and 9.78, respectively, with corresponding *p*-values all less than 0.001 ($p < 0.001$), significantly lower than the preset significance level. This indicates that the difference in maximum response times between the CPMS and the four comparative systems is highly statistically significant and not due to random fluctuations, further confirming the system's advantage in response speed and its stability and reliability. As shown in Fig. 8(b), there was also a significant gap in the comparison of time consumption between the research-designed CPMS and the four comparison systems. For example, in max time consumption, the values of the four comparison systems were 238ms, 275ms, 209ms, and 196ms, which were 158ms, 195ms, 129ms, and 116ms higher than the max value of 80ms in the research-designed CPMS, respectively. Overall, the CPMS's response time and resource consumption are more advantageous. This may be because the study adopted the Shiro framework and B/S architecture, which reduced the latency of request processing and enabled the system to respond quickly to user requests, significantly reducing response time and time consumption. The throughput comparison of different systems is shown in Fig. 9.

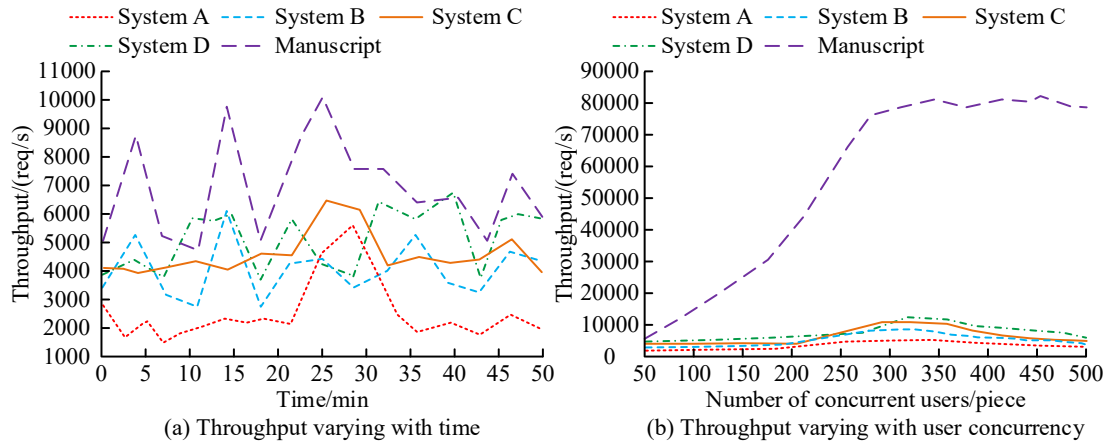


Fig. 9. Comparison of throughput between different systems

As shown in Fig. 9(a), with the increase of time, the throughput of different systems exhibited irregular fluctuations, and the peak value of the CPMS was higher. In the comparison of the maximum throughput values, the values of the four comparison systems were 5698req/s, 6025req/s, 6514req/s, and 6852req/s, respectively. The value of the CPMS was 10249req/s, which was 4551req/s, 4224req/s, 3735req/s, and 3397req/s higher than the values of the four comparison systems. In Fig. 9(b), as the number of concurrent users increased, the throughput trends of different systems also varied. For example, when the concurrent user count increased from 50 to 500, the CPMS throughput trend initially increased linearly, then stabilized after reaching saturation, and maintained relative stability even at high concurrency without a significant decrease. At this point, the trend of throughput changes in the four comparison systems was slow growth first, then quickly reached the bottleneck and showed a significant decrease in high concurrency situations. In addition, the maximum throughput values of the research-designed CPMS and the four comparison systems were 82014req/s, 9001req/s, 9852req/s, 10651req/s, and 12845req/s, respectively. Overall, the throughput performance of the research-designed CPMS is better. The comparison of CPU utilization and memory usage among different systems is shown in Table 1.

Table 1. Comparison of CPU utilization and memory usage among different systems

Method	CPU utilization/%					Memory usage rate/%				
	Number of experiments					Number of experiments				
	1	2	3	4	5	1	2	3	4	5
System A	30.87	33.50	36.09	30.51	36.97	35.27	30.93	37.89	35.41	38.65
System B	28.07	30.22	31.02	33.45	34.94	28.69	26.94	32.77	33.97	29.90
System C	26.62	28.34	26.63	24.02	27.88	28.46	28.64	24.73	24.93	24.13
System D	20.16	16.67	16.06	19.67	16.38	20.17	17.17	16.77	18.00	16.21
Manuscript	12.43	7.87	9.63	13.18	9.39	10.37	12.27	8.03	7.79	10.05

In Table 1, in terms of CPU utilization comparison, the CPMS performed better, followed by System D and System C, and finally System B and System A. In addition, the average CPU utilization of the CPMS was 10.50%, while the average CPU utilization of the four comparison systems were 33.59%, 31.54%, 26.70%, and 17.79%, which were 23.09%, 21.04%, 16.20%, and 7.29% higher than 10.50%, respectively. In terms of memory usage comparison, the CPMS still held the advantage, with a max value of 12.27% and an average value of 9.70%. Meanwhile, the average memory usage rates of

the four compared systems were 35.63%, 30.45%, 26.18%, and 17.66%, respectively, which were 25.93%, 20.75%, 16.48%, and 7.96% higher than 9.70%. Overall, the CPMS has lower CPU utilization and memory usage and better performance. In addition, an independent sample *t*-test was conducted on the average CPU utilization and memory occupancy rates. The results indicated that the differences between the CPMS and the four comparative systems all met the criterion of $p < 0.001$, confirming that the performance advantage has a highly significant statistical significance.

In addition, the CPMS exhibited excellent scalability beyond the testing environment, accommodating application needs across various scenarios and scales. In terms of user scale expansion, the current testing is based on a concurrent scenario of 100 users. The system employs a distributed deployment design with a B/S architecture. By adding server nodes and optimizing the database connection pool configuration (supporting a maximum connection count expansion to 500), it can smoothly scale to medium to large-sized consulting enterprises with 500-1000 users. According to the architecture performance deduction, the increase in response time after scaling can be controlled within 10%, with no significant increase in CPU utilization and memory occupancy. Regarding functional module expansion, the system adopts a modular design concept, with core modules loosely coupled with extension modules. Sub-modules such as customer relationship management, financial accounting, and contract management can be added according to the business upgrade needs of consulting enterprises. The expansion process does not require restructuring the core architecture; functional integration can be achieved simply through interface adaptation. As the deployment environment expands, the system is based on a cross-platform MySQL database and B/S architecture, compatible with mainstream server operating systems such as Windows Server and Linux. It supports both local deployment and private cloud deployment modes, meeting the low-cost local operation and maintenance needs of small and medium-sized enterprises while also accommodating the cloud resource integration needs of large enterprises. Furthermore, the data migration and system upgrade processes do not require interruption of business operations, demonstrating strong environmental adaptability.

3.2. Application Effect of CPMS

To further verify the performance of the CPMS, a detailed analysis of its application effects was conducted, including functional integrity analysis of different functional modules, functional coverage analysis, functional usage frequency analysis, operational error rate analysis, and task completion rate analysis. In addition, the study also used the Windows 10 operating system and Intel Core i5-12600K. The study invited 100 employees from consulting companies to use the system and conducted statistical analysis and organization of their usage data. The functional integrity effects of different functional modules are shown in Fig. 10.

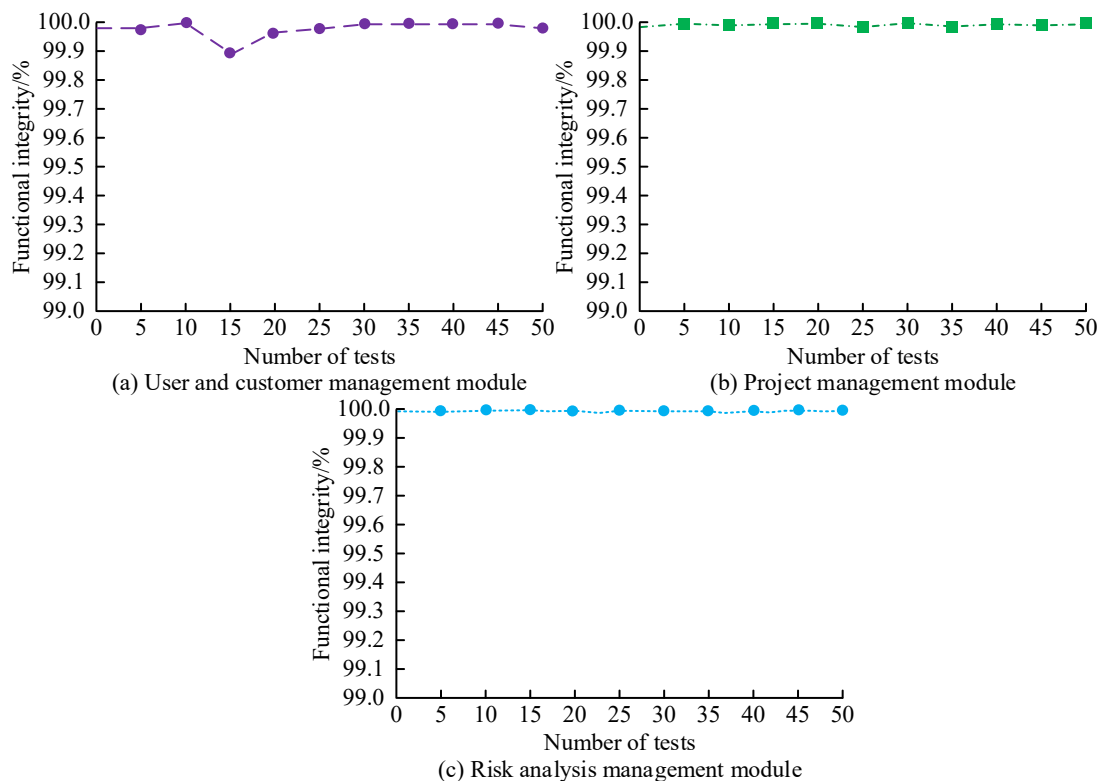


Fig. 10. The functional integrity effect of different functional modules

In Fig. 10(a), the functional integrity of the user and customer management module was above 99.8% under all functional testing cycles. The maximum functional integrity value of this module was 100%, and the minimum value was 99.89%, showing excellent performance. As shown in Fig. 10(b), in the project management module, the corresponding functional integrity could reach 100%. In Fig. 10(c), the designed functions in the risk analysis management module could operate normally, and the functional integrity also reached 100%. The CPMS has good application effects and potential, and the different functional modules it contains can fully play their roles in practical applications. The functional coverage and frequency of use of different functions in the research-designed CPMS are shown in Fig. 11.

In Fig. 11(a), both functional and non-functional requirements planned during requirement analysis have been implemented in the subsequent construction of the CPMS, with a functional coverage rate of 100%. For example, the Shiro framework and user and customer management module met the security requirements of non-functional requirements, and the project management module met the business functional requirements of “bidding project management” and “project schedule management”. This indicates that the functionality of the research-designed system can meet the actual needs of consulting enterprise employees. In Fig. 11(b), the maximum usage frequency of the user and customer management module was 75%, while the maximum usage frequency of the project management module and risk analysis management module were 89% and 65%, respectively. This indicates that the project management module is the most frequently used function by employees and plays a critical role in managing project tasks. At the same time, this also highlights the importance of the user and customer management module and the risk analysis management module. The results of the operation error rate and task completion rate are shown in Fig. 12.

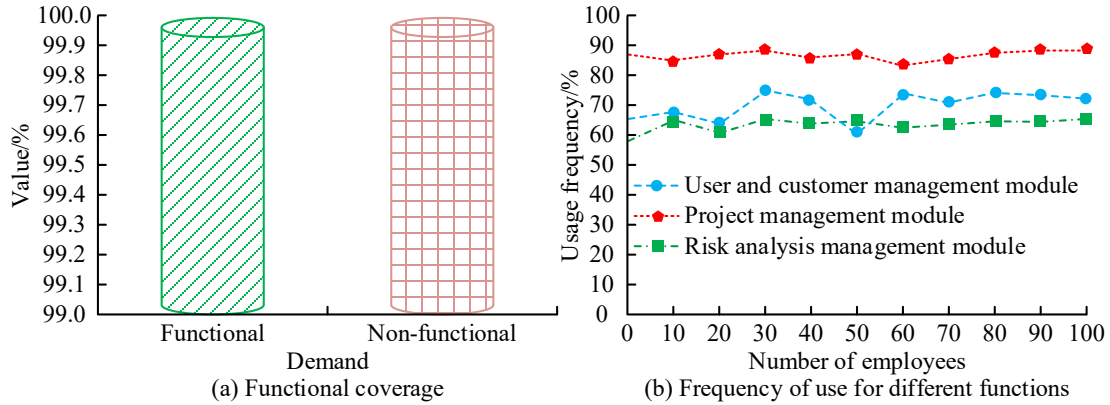


Fig. 11. The coverage rate of system functions and the frequency of use of different functions

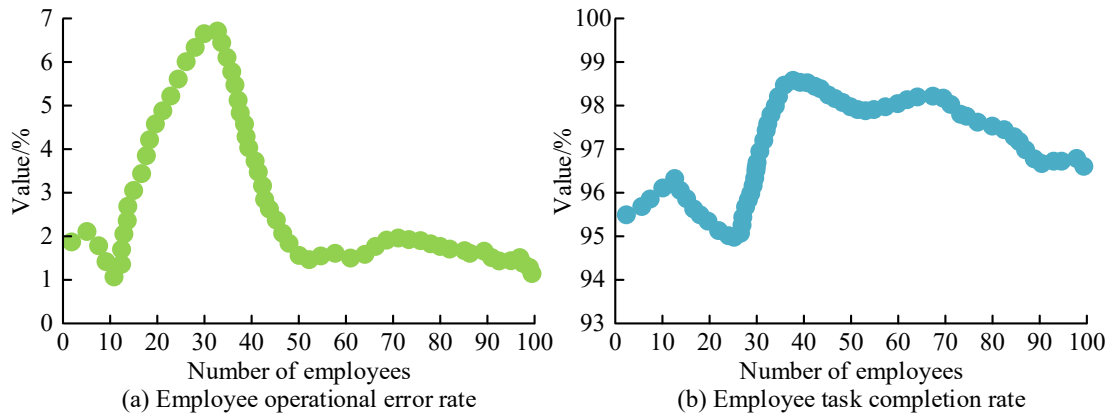


Fig. 12. Results of operational error rate and task completion rate

In Fig. 12(a), in terms of employee operational error rate, the maximum value was 6.89%, and the minimum value was 1.21%. Meanwhile, the operational error rate of most employees was around 1.5%. This indicated that the research-designed CPMS had high usability, and employees could quickly get started and use the system functions correctly. According to Fig. 12(b), in terms of employee task completion rate, the maximum value was 98.56%, and the minimum value was 94.89%, with a difference of 3.67% between the two. This result indicates that the CPMS can effectively support task management of consulting projects and help employees efficiently complete work tasks. The comparison between CPMS and the characteristics of existing systems is shown in Table 2.

In Table 2, the CPMS demonstrated significant advantages in core dimensions. In terms of permission management, it achieved granular allocation through the Shiro framework, circumventing the issues of poor adaptability in existing B/S architecture systems, complex configuration in microservice systems, and high privacy risks in cloud-native systems. In terms of consultation scenario adaptability, it met industry needs without secondary development, far surpassing other systems. In terms of cost, CPMS maintained the low-cost advantage of the B/S architecture, significantly lower than the operational and maintenance investment required for microservice and cloud-native architectures. In terms of concurrent processing and scalability, the optimized architecture ensured high stability, and the modular design supported flexible upgrades. In terms of applicable scale, it precisely targeted small and medium-sized consulting enterprises with 100-500 employees, filling a market gap. In summary, CPMS achieves a balance between adaptability, security, low cost, and easy scalability, better meeting the practical application needs of the consulting industry.

4. Conclusion

A requirement analysis was conducted for the design of a practical CPMS, and the Shiro framework and B/S architecture

were adopted during system construction. The results showed that the response time and time consumption of the CPMS were smaller. For example, in terms of the maximum time consumption, the values of the four compared systems were 238ms, 275ms, 209ms, and 196ms, respectively, which were 158ms, 195ms, 129ms, and 116ms higher than the maximum value of 80ms in the research-designed CPMS. This may be because the study adopted the Shiro framework and B/S architecture, which reduces the delay of request processing and enables the system to respond quickly to user requests, thereby significantly reducing response time and time consumption. At the same time, the throughput performance of the research-designed system was better, as it could maintain relative stability in high concurrency situations without significant decline. In terms of CPU utilization and memory usage, the average values of the research-designed system were 10.50% and 9.70%, respectively, which are better than those of the comparison system. In practical applications, most modules of the system had high functional integrity, such as the max value of 100% and the minimum value of 99.89% for user and customer management modules. In addition, the maximum frequency of use for the user and customer management module, project management module, and risk analysis management module was 75%, 89%, and 65%, respectively. For the research-designed system, the maximum operating error rate and task completion rate were 6.89% and 98.56%, respectively. Overall, the research-designed system has good performance and can effectively support task management in consulting projects. However, there are still shortcomings in the research on system anomaly warning. Future research can combine deep learning algorithms to utilize their powerful feature extraction and pattern recognition capabilities for real-time analysis of system operation data, thereby more accurately detecting and warning of abnormal situations.

Table 2. Comparison of CPMS and existing system features

Comparative dimension	CPMS	Existing Shiro-based system	Existing B/S architecture system	Microservice architecture system	Cloud-native architecture system
Permission management	Granular role-based access control	Basic identity authentication, with a single level of authority	The permission module is rigid and has poor adaptability. The function is disconnected from the consultation process	Distributed permission management involves complex configuration	Cloud access control poses a high risk to data privacy
Consultation scenario adaptability	Customized process design, tailored to consulting business	Universal scenario design, without industry specificity		Customizable but with high cost	Focus on resource elasticity, but lack of scenario adaptation
Deployment and maintenance costs	Low	Middle	Low	High	High
Concurrent processing capability	High	Middle	Low	High	High
Data security	High	Middle	Middle	Middle	Low
Functional extensibility	High	Middle	Low	High	High
Applicable enterprise scale	Small and medium-sized consulting enterprises (100-500 employees)	Small and micro enterprises (with fewer than 100 employees)	Existing B/S architecture system	Large enterprises (>1000 employees)	Large enterprises (>1000 employees)

Funding

This research received no specific financial support from any funding agency.

Institutional Review Board Statement

Not applicable.

Declaration of Artificial Intelligence (AI) Tools

The author used ChatGPT solely for language editing and readability improvement. The author reviewed and verified all content and takes full responsibility for the accuracy and integrity of the manuscript.

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