# Analysis and Design of Identification and Management Service System for High-tech Enterprises Taking Hubei Province for Example

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**Abstract:** High-tech enterprise is the kind of enterprise which the main business involved in the high tech field. Refers to those enterprises who make continuous research and development and technological transformation in the "national key support of high and new technology" and has formed the core independent intellectual property rights of enterprise and registered for more than a year. The purpose of high-tech recognition is to determine whether the enterprise meets the basic conditions for enjoying the national high-tech enterprise tax preferential policies, various incentive and subsidy policies, and various scientific research project applications, etc. In order to implement the requirements of the measures for further optimizing the confirmation service of high-tech enterprises issued by the provincial people's government and build a department coordinated high-tech enterprise recognition service system, a high-tech enterprise identification management service system was established through the reconstruction of the business process of high-tech enterprise recognition. The jQuery easyUI framework was used to design the pages, and the SSH framework was used to develop the server side. Enterprise declaration, acceptance review, organizing expert review, and identification result management and other functions were realized in the system. Since the system had been running, it not only met the working needs of various users, but also ran stably. The system function had achieved the expected design goal.

**Keywords:** high-tech enterprise, identification management, business process reengineering, SSH Framework, generic data access

## 1 Construction Background

High-tech enterprises refer to the resident enterprises registered in China (excluding Hong Kong, Macao and Taiwan) that continuously carry out research and development and transformation of technological achievements, form core independent intellectual property rights of enterprises, and carry out business activities on this basis within the "high tech fields supported by the state" [1]. The Provincial Department of Science and Technology, the Provincial Department of Finance and the Provincial Tax Service form a local certification

ICICA 2022, December 02-04, Chongqing, People's Republic of China

DOI 10.4108/eai.2-12-2022.2327953

authority, which is responsible for the declaration, acceptance and review, expert review, confirmation and filing of enterprises within its jurisdiction.

The national high-tech enterprise identification management system is an information platform built according to the administrative measures for the recognition of high-tech enterprises. The users of the platform include enterprise users, local identification management institutions and leading group offices. The national high-tech enterprise management system had realized the functions of enterprise registration, declaration, annual development report and so on. The main functions of the identification management organization include: enterprise registration management, declaration management, certificate revocation management, inquiry and statistics, etc. However, the national high-tech enterprise identification management system did not provide a formal review indicator to review the application materials of enterprises item by item. It did not provide enterprise grouping, random selection of experts, expert rating and other functions.

At present, high-tech enterprise identification management systems had been built in Guangdong [2], Guangxi [3], Shanghai, Shenzhen, and other places. The acceptance and review of enterprise application materials and the organization of expert review are the responsibility of the local identification agencies. There are two main modes for enterprises to apply: one is that some places require enterprises to register their basic information on the national high-tech enterprise system, and then apply for data in their own local high-tech enterprise identification management system. The identification management organization will organize experts to conduct expert review after accepting the application in the local system. After the review, the enterprise's application data, attachments and expert review results are automatically connected to the national high-tech enterprise management system. Second, enterprises are required to register and apply in the national high-tech enterprise network and the local high-tech enterprise identification management system, and enterprises are required to fill in the application materials twice.

On December 25, 2020, the people's Government of Hubei Province issued the measures to further optimize the confirmation service of high-tech enterprises [4], which pointed out that the recognition application of high-tech enterprises should be normalized, accepted all the year round and reviewed in time. Enterprise application was facilitated, and the whole process was handled online. Promote the integration of identification work, and achieve one window acceptance and jointly handled by departments. Therefore, in order to implement the requirements in the measures for further optimizing the confirmation service of high-tech enterprises and build a department coordinated identification service system for high-tech enterprises, it was necessary to build a high-tech enterprises identification management service system, which included the functions of online application, acceptance and review, organization of expert review, comprehensive review and result management, and so on.

The main research results of this paper were as follows:

(1) According to the actual situation of high-tech enterprise accreditation in Hubei Province, the business process of high-tech enterprise accreditation was reconstructed.

(2) According to the newly designed business process, the functions of the system were analyzed in detail.

(3) The overall technical framework and technical route adopted by the system were designed.

(4) The key technologies adopted in the system, such as local page refresh, design of general data access interface and integration of Redis database, were described in detail.

(5) According to the actual application effect of the system, the next work was prospected.

## 2 System Business Process Design

The guidelines for the administration of the recognition of high-tech enterprises described the identification process in detail, which included enterprise register, submit application materials, expert review, report to the state, publicity, and issuance of certificates without objection. In combination with the actual situation of the identification and management of high-tech enterprises in our province, the business process of the reconstructed provincial high-tech enterprise identification and management service system is shown in Figure 1.

(1) Submit Application Materials

Application materials submitted by the enterprise users for recognition of high-tech enterprises.

(2) Acceptance, Formal Review and Recommendation

The users of Municipal Science and Technology Bureau accepts the application materials submitted by the enterprises in the region and distributes the application materials agreed to be accepted to the material reviewers. The material reviewer shall check the application materials of the enterprise item by item according to the form review form and fill in the form review opinions. Finally, the users of Municipal Science and Technology.

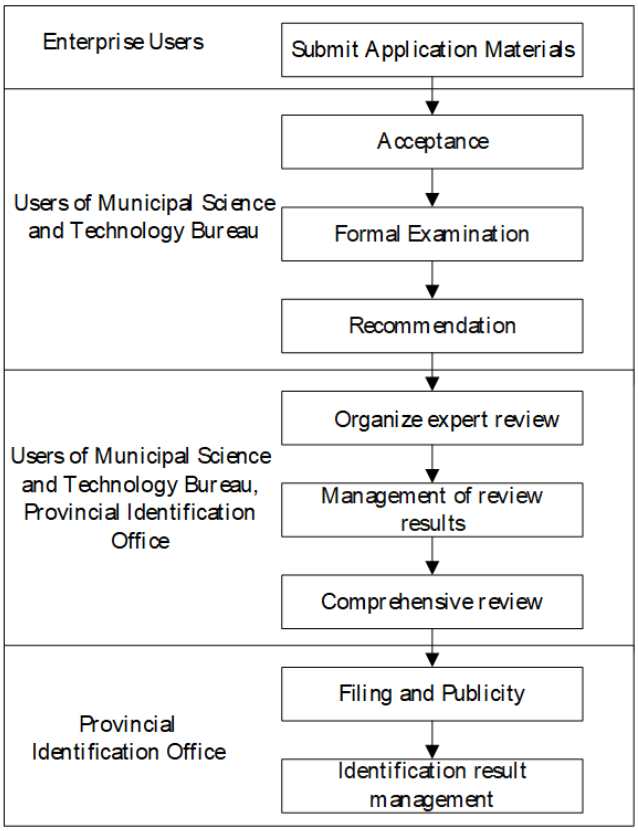


**Figure 1:** System Business Process

Bureau recommend the application materials of the enterprise according to the results of the formal examination.

(3) Organize Expert Review

The user of Municipal Science and Technology Bureau or the provincial identification Office accepts the application materials of the enterprises that agree to be recommended, and then organizes experts to review them, and audits them according to the expert review results.

(4) Comprehensive Review

The application materials of the enterprise that passed the review shall be comprehensively reviewed by the provincial identification office.

(5) Reported to the State System

The provincial identification office will report the enterprise application materials that have passed the comprehensive review to the national high-tech enterprise system, and then the leading group office will conduct spot checks and publicize the identification results. After the publicity, the provincial identification office manages the identification results in the

provincial high-tech enterprise system according to the identification results of the national high-tech enterprise system.

## 3 System Function Requirement Analysis

According to the analysis of the identification process of high-tech enterprises, the functional structure of the system is shown in Figure 2, which mainly includes application materials submitted by enterprise users, formal review, organizing expert review, comprehensive review, report to the state, data docking management, result management, review expert management, etc.

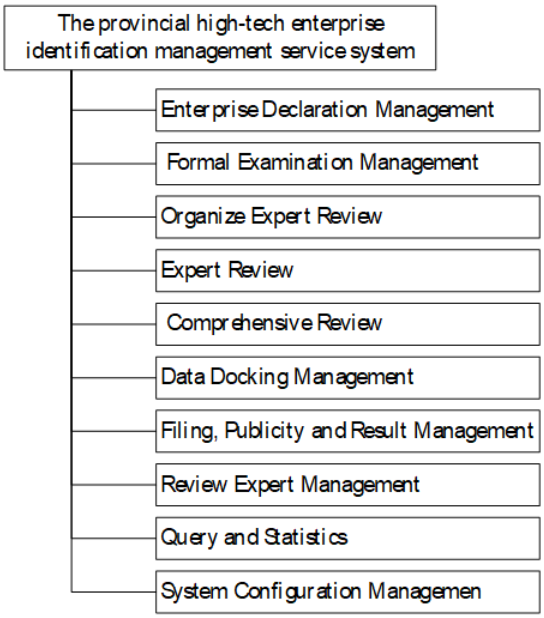


**Figure 2:** System Function Structure

(1) Application Materials Submitted by Enterprise User

Enterprise users submit application materials online, mainly including basic information of enterprises, intellectual property rights, human resources, R&D activities, R&D expenses, high-tech products in the previous year, transformation of scientific and technological achievements, special audit reports of R&D expenses in the past three years, etc. Finally, a summary of application materials is generated online.

(2) Formal Examination

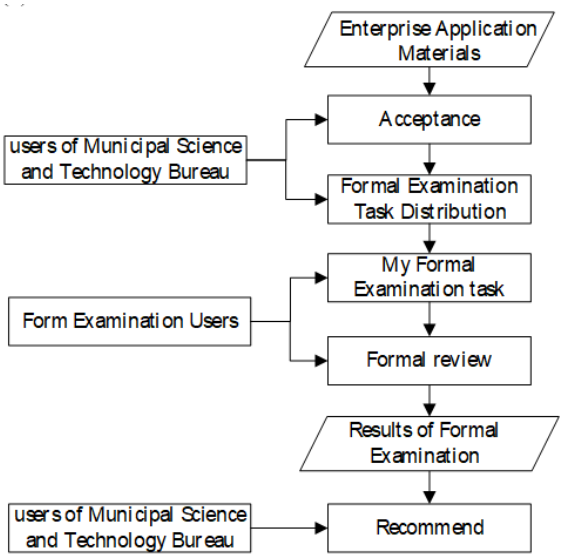


**Figure 3:** Formal Review Process

The process of formal review is shown in Figure 3. After the enterprise users submit the application materials, the users of Municipal Science and Technology Bureau accept the application materials of local enterprises, and assign the form review tasks to the formal examination users. The formal examination users review the application materials of enterprises one by one according to the form review indicators. Finally, the users of the Municipal Science and Technology Bureau will review and recommend according to the results of the formal review.

(3) Organize Expert Review

The organization of expert review is specifically implemented by the users of Municipal Science and Technology Bureau and the provincial identification office with the review authority. The functions include group management, enterprise grouping, expert selection, expert notification, expert scoring and review result management.

(4) Expert Review

Review experts are divided into technical experts and financial experts. Technical experts mainly score the enterprise's intellectual property rights, research and development activities, achievement transformation and high-tech products or services. The financial expert scores the financial audit report and tax return of the enterprise. On the basis of the independent evaluation of each review expert, the expert group leader shall fill in the comprehensive evaluation form of the expert group for the recognition of high-tech enterprises according to the average score of the review expert.

(5) Comprehensive Review

The provincial identification office will conduct a comprehensive review the application materials of enterprises that have passed the expert review. The provincial identification office

focuses on the consistency of sales income, R&D expenses, annual total income with the data in the provincial tax system, whether the collection of R&D expenses meets the requirements of the guidelines, and whether the income of high-tech products is consistent with the actual situation. When necessary, the provincial identification office will organize experts to conduct on-site verification.

(6) Filing, Publicity and Identification Result Management

The provincial identification office will submit the list of enterprises that have passed the comprehensive review to the leading group office for the record. The leading group office will publicize the list of enterprises identified and approved on the national high tech enterprise system. After the publicity is approved, the leading group office will issue the certificate number.

(7) Data Docking Management

According to the national high-tech enterprise system and local application data sharing scheme, the national high-tech enterprise system and the provincial high-tech enterprise system establish a connection through a VPN system. The application materials of enterprises are imported into the front-end server database. A data exchange platform is deployed on the front-end server, which regularly transfer the application materials of enterprises and expert review results to the national high-tech enterprise system.

(8) Review Expert Management

According to the requirements of the expert working mechanism for serving high-tech enterprises in Hubei Province [5], review experts are regularly collected and put into storage by the provincial identification office and local science and technology bureaus every year. Experts can become formal review experts only after they participate in online learning training and pass the assessment and test.

(9) Query and Statistics

Query, export and count the intellectual property rights, R&D activities, high-tech products of the previous year and other information declared by the enterprise users, so as to provide auxiliary reference for managers to make decision analysis and support the enterprise.

(10) System Configuration Management

Flexibly configure and manage users, roles, permissions, etc. in the system.

# 4 System Architecture and Technical Route

## 4.1 Technical Architecture of the System

The provincial high-tech enterprise system was committed to provide high-tech enterprise identification and management services for enterprise users, management users, expert users and the public users. The overall technical architecture of the system consists of four logical architectures: storage layer, technology layer, application layer and user layer [6]. As shown in Figure 4.

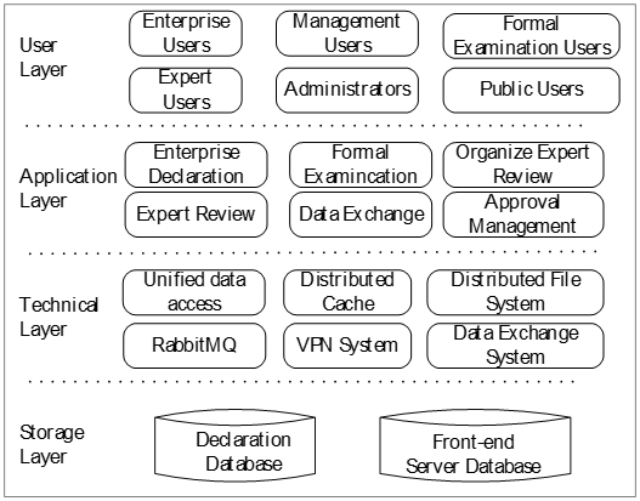


**Figure 4:** System Architecture

The storage layer includes an enterprise declaration database and a front-end server database. The technical layer provides technical support for the data management of the system through unified data access, distributed cache, distributed file system and other technical methods. The VPN system and data exchange system provide technical support for connecting and transferring the application data and attachment materials in the front-end server database to the national high-tech enterprise system. The application layer is mainly a specific business function module, including enterprise application, formal examination, organization of expert review, expert rating, etc. The user layer is for specific business handling personnel, including enterprise users, identification management users, expert users and the public users, etc.

### 4.2 System Technical Route

The provincial high-tech enterprise system was developed in MVC mode based on J2EE platform. The front-end page was designed using by JSP and jQuery easyUI framework. The server side was developed by using SSH (struts2 + Spring + Hibernate) framework. The data exchange between the front-end page and the server side was JSON format data. The system data were storage in Oracle11g database. The web server was deployed in clusters using Tomcat and Nginx, and the user session and business data were cached in the Redis database. The system could be clustered on Linux or windows servers.

The class relationship structure of the system is shown in Figure 5. In the web presentation layer, the interactive interface was implemented through JSP pages, which was responsible for receiving requests and transmitting responses. Struts delegated the received request to the corresponding action according to the configuration file. In the service business layer, business logic calculation was completed and transaction processing was provided to ensure data integrity. In the persistence layer, the persistence of data depended on Hibernates object-oriented mapping and database interaction. The Base Dao interface encapsulated the basic operations of addition, deletion, modification and query. Through this interface, the requested data were processed and the processing results were returned.

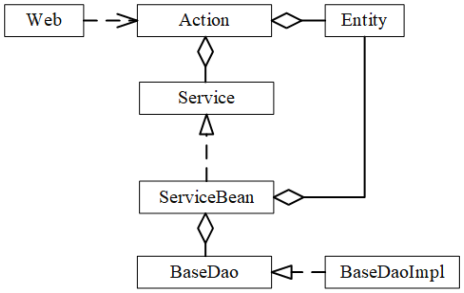


**Figure 5:** System Class Structure Relationship

# 5 Key Technology

## 5.1 Page Local Refresh

jQuery is a complete and excellent JavaScript library. Relying on its simple syntax and perfect compatibility, it enables users to easily handle HTML, manipulate object elements, handle front-end events, and implement component transformation. It can also easily provide Ajax interaction for web applications [7]. jQuery encapsulates Ajax operations by $. Ajax(), $. Get(), $. Post(), $. Load(), and so on.

When a user accesses a web application using a browser, the browser starts parsing and rendering the content of the web page while downloading the HTML page. CSS, JS and other resources in the header tag of the web page will be loaded in advance, and JS code will be executed when the page needs to be called. The jQuery easyUI framework was used to design the page layout and the management interface of the provincial high-tech enterprise system, which made full use of jQuery's page local refresh function, realized the effect that the system's management interface appeared to have only one page, and improved the response speed of user requests. The implementation process is as follows:

(1) The default page of the system loads the public necessary CSS, JA and other resource files, and uses the $. ajax() method to determine whether the user has logged in to the system.

(2) If the user does not log in to the system, the default page uses the $. Load() method to load the login page and displays it in the body tag.

(3) If the user has logged in to the system, the system will obtain the module permissions according to the user's role, and load the management interface into the body tag. The main management interface of the system contains a div tag, which named the main content area.

(4) When the user selects a column, the system uses the $. load() method to load the corresponding page into the div tag that displays in the main content area.

There is no html, title, head, body tags in the page of each column. The page only includes the div, table, span, form, input and other tags. If necessary, relevant JS, CSS and other resource files are referenced. JS scripts are written behind the tags to load data, add, delete, modify and query, etc.

### 5.2 Data Access Interface Design

SSH framework was adopted in the provincial high-tech enterprise system. Hibernate is the mainstream object relationship mapping tool today, which provides methods such as adding, deleting, changing and querying the operating database [8]. EntityManager is an interface used in JPA for adding, deleting, modifying, and querying. It connects Java objects in memory and data storage of databases. Hibernate implements the EntityManager interface. If the EntityManager interface is directly called in the business layer of the system, there will be a lot of the same methods for operating the database in the business layer. Therefore, these same methods of operating the database can be abstracted into a common data access interface, so that the business layer can focus on the processing of system business. The generic data access interface implements interfaces such as adding, deleting, modifying, querying and user-defined querying.

### 5.3 Integrated Redis Database

The default data cache plug-in in Hibernate is Ehcache, but Ehcache does not support distribution well enough, and multiple nodes cannot be synchronized. One of the most important application scenarios of Redis is business caching. Redis keeps some hot data that is not often changed but frequently accessed in memory, and completes the operation of data in memory, effectively reduces the number of databases reads and database pressure, improves response time, and enhances throughput [9].

In the provincial high-tech enterprise system, the Redis database was used to cache business data and saved user sessions. First, data cache and session related jar packages were added to the system, including redisson.jar, redisson-hibernate.jar, spring-data-redis.jar, spring-session-core.jar, spring-session-data-redis.jar, etc. Then corresponding parameters were added to the configuration files. The configuration of caching business data included: add cache annotations in the JavaBean, enable secondary cache in the persistence.xml, configure parameters for connecting to Redis database. The parameters and expiration time for connecting to the Redis database were added to the spring configuration file to save the user's session.

## 6 Conclusion and Prospect

Since the system was completed and put into operation, the overall response of the system has been stable, and the designed function had reached the expected goal according to the actual application effect feedback. The development and construction of the system had provided strong technical support for the efficient development of the identification management of high-tech enterprises in our province, and also provided a way of thinking for the development and construction of the identification management system of high-tech enterprises in various places. The next step we will focus on the following work: using the flow chart to show the progress of enterprise application, the statistical analysis of enterprise declaration data and expert rating data, so as to tap the use value of various data in the process of high-tech enterprise identification.

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