Design and Research of a Calculation System for Raw Material Consumption in Textile Spinning Production

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Abstract

In order to develop a textile spinning production, raw material consumption calculation system with the functions of intelligent maintenance of various parameters in the textile spinning production process, developed a system which can perform the selection of materials and input of outcome, and can complete inventory and raw material input and calculation of consumption per one-ton yarn. The thesis is based on Microsoft SQL database, Microsoft ASP.NET network framework, using JavaScript, CSS, C# and other languages to establish a B/S architecture system. The system is published on the intranet using the Internet Information Services (IIS) Manager for simultaneous manipulations by multiple terminals. The system has the required functions of product selection, data input and inventory, system automatic calculation and other functions. The system is based on a Two-Step Clustering (TSC) algorithm and adopts a self-proposed intelligent algorithm for parameter maintenance. At present, the system is tested in a textile enterprise in Shandong, and has been upgraded continuously in the process of using and in the timely communication with the technical personnel of the enterprise, and the software operation effect is good and is well received by the enterprise.

Keywords: Textile spinning production, raw material consumption, system development, ASP.NET, machine learning, Two-Step Clustering algorithm

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Chapter 1: Introduction

1.1 Significance of System Design

Textile engineering is one of China's traditional pillar industries. It integrates **modern technology with fashion trends** and plays a crucial role in both industrial production and daily life. According to China's **14th Five-Year Plan (2021-2025)** and the **2035 Long-Term Development Goals**, the textile industry is expected to become a **pillar industry for national economic development, a fundamental industry for improving people's livelihoods, and a key industry for international cooperation**.

With China's position as a **leading textile producer**, the country's **cotton spinning spindle capacity has reached 120 million spindles**, with **thousands of large-scale cotton spinning enterprises**. In these enterprises, **raw material costs account for approximately 70% of the total yarn production cost**. Therefore, real-time and **accurate calculation of raw material consumption per ton of yarn** is critical for cost management.

Due to limitations in **traditional management methods** and a **lack of digitalization**, many enterprises rely on **manual calculations or outdated spreadsheet-based methods**, which are prone to errors and inefficiencies. The **absence of a standardized, real-time digital system** makes it difficult for enterprises to **make data-driven decisions**, leading to financial risks.

This project aims to develop an **internal digital management system** for textile enterprises, allowing for **real-time, precise, and comprehensive calculations** of material consumption. The system will significantly **enhance competitiveness** and **improve the management capabilities** of textile enterprises.

1.2 Development of Textile Information Systems in China and Abroad

With the advent of the **Information Age**, digital processing systems have been applied in many areas of textile production. However, there are still **highly specialized business processes**—such as **cotton blending calculations and cost allocation for different raw materials**—that lack standardized digital solutions.

Currently, **most enterprises use Excel spreadsheets** to manually calculate **raw material consumption per ton of yarn**, but these methods struggle to **handle complex changes in yarn structures and spinning processes**. Enterprises frequently need to **adjust allocation formulas manually**, which is **time-consuming and error-prone**.

Some enterprises have **integrated modular systems with spreadsheets**, but these systems are often **complex to learn and operate**. Additionally, there is currently **no complete and systematic raw material consumption calculation system for cotton spinning enterprises** in China.

Internationally, **Japan and South Korea** have **advanced textile management technologies**, but **no academic papers or publications** have been found that introduce a similar raw material consumption calculation system.

1.3 Definitions of Relevant Terms

(1) Raw Materials (Cotton Blending)

- **Raw Cotton (净棉, Jìng mián)**: Purchased cotton used as raw material.
- **Recycled Cotton (回花, Huí huā)**: Cotton fibers produced as waste during production, including slivers and rovings.
- **Reusable Cotton (再用棉, Zài yòng mián)**: Cotton fibers that do not meet spinning requirements and are removed during production, such as broken seeds and combed-out cotton.

(2) Naming of Raw Materials, Semi-Finished Products, and Finished Products in the Inventory Process

1. **Raw Material (配棉, Pèi mián)**: Raw material inside the bale opener.
2. **Blowroom Lap (清花棉卷, Qīng huā mián juǎn)**: Semi-finished product processed in the blowroom stage.
3. **Carding Lap (梳棉棉卷, Shū mián mián juǎn)**: Cotton produced from the blowroom stage, placed on the carding machine, either in use or unused.
4. **Sliver (生条, Shēng tiáo)**: Cotton sliver produced by the carding machine or the combing unit, some stored before the carding machine, others stored after the first drawing frame, but not yet processed by the drawing machine.
5. **Pre-Drawing Sliver (预并条, Yù bìng tiáo)**: A sliver that has undergone one stage of drawing, prepared for the combing process. It corresponds to the first-stage drawing sliver in the drawing process.
6. **Lap for Combing (条卷, Tiáo juǎn)**: Cotton lap formed from the pre-drawing sliver using the lap former in the combing process.
7. **Combed Sliver (精梳条, Jīng shū tiáo)**: Sliver processed and refined through the combing machine.
8. **First Drawing Sliver (头道条, Tóu dào tiáo)**: Sliver that has undergone the first merging and drafting process in the drawing machine.
9. **Second Drawing Sliver (二道条, Èr dào tiáo)**: Sliver obtained after an additional merging and drafting process based on the first drawing sliver.
10. **Finished Sliver (熟条, Shú tiáo)**: Sliver processed in the final stage of the drawing process, which may be the third, second, or first drawing sliver, depending on the process setup.

(3) Calculation Process

1. **Equivalent Raw Material (折合原料, Zhé hé yuán liào)**: The inventory quantity at each stage multiplied by the equivalent raw material coefficient and weight ratio of that stage.

2. **Equivalent Raw Material (End-of-Period Mixed Cotton Inventory) (期末混棉盘存, Qī mò hùn mián pán cún)**: The inventory quantity at each stage multiplied by the equivalent raw material coefficient and weight ratio, including net cotton, recycled cotton, and reusable cotton.
    - (a) **Equivalent Net Cotton (折合净棉, Zhé hé jìng mián) / End-of-Period Net Cotton (期末净棉, Qī mò jìng mián)**: The inventory quantity at each stage multiplied by the equivalent raw material coefficient, weight ratio, and net cotton proportion, representing the amount of net cotton used.
    - (b) **Equivalent Recycled Cotton (折合回花, Zhé hé huí huā) / End-of-Period Recycled Cotton (期末回花, Qī mò huí huā)**: The inventory quantity at each stage multiplied by the equivalent raw material coefficient, weight ratio, and recycled cotton proportion, representing the amount of recycled cotton used.
    - (c) **Equivalent Reusable Cotton (折合再用棉, Zhé hé zài yòng mián) / End-of-Period Reusable Cotton (期末再用棉, Qī mò zài yòng mián)**: The inventory quantity at each stage multiplied by the equivalent raw material coefficient, weight ratio, and reusable cotton proportion, representing the amount of reusable cotton used.
    - **(a), (b), and (c) are all used to calculate the net cotton consumption per ton of yarn.**
3. **Beginning Inventory (期初盘存, Qī chū pán cún) / Beginning Mixed Cotton Inventory (期初混棉盘存, Qī chū hùn mián pán cún)**: The inventory quantities of each cotton blend from the previous month's inventory, including net cotton, recycled cotton, and reusable cotton.
    - (a) **Beginning Net Cotton (期初净棉, Qī chū jìng mián)**: The net cotton quantity in the previous month's inventory for each cotton blend.
    - (b) **Beginning Recycled Cotton (期初回花, Qī chū huí huā)**: The recycled cotton quantity in the previous month's inventory for each cotton blend.
    - (c) **Beginning Reusable Cotton (期初再用棉, Qī chū zài yòng mián)**: The reusable cotton quantity in the previous month's inventory for each cotton blend.
    - **(a), (b), and (c) are directly carried over from the previous month's end-of-period inventory.**

Chapter 2: Tools and Technologies Used in the System

The development platform used for this system is Microsoft Visual Studio 2017, a framework platform provided by Microsoft, widely used for system development. The system is designed based on the B/S (Browser/Server) architecture, utilizing Microsoft ASP.NET and C# as the development platform. Front-end pages are developed using JavaScript, HTML, CSS, JQuery-3.6.0, etc., for page styling, logic function control, and other tasks. Microsoft SQL Server 2017 is used as the database, and the system is published within the internal network using Internet Information Services (IIS) manager, which includes application development features such as ASP.NET 4.8 and .NET Extensibility 4.8.

2.1 Architecture Overview

C/S architecture, i.e., Client/Server architecture, is a typical two-tier architecture. By reasonably distributing tasks between the client and server, it reduces the system's communication overhead. The client consists of one or more programs running on the user's computer, with two servers: one is a database server, through which the client accesses server-side data via a database connection, and the other is a socket server, which communicates with the client via a socket program. The first version of this system uses this architecture to build a two-tier architecture model, connecting to the database via JavaScript's ActiveXObject object. This architecture is simple to develop and operate, but due to issues like difficult program maintenance, slow data access speeds, frequent lag, and compatibility limited to IE browsers, the system is considering adopting the B/S architecture for version upgrades.

B/S architecture, i.e., Browser/Server architecture, is a three-tier architecture. It consists of logically separated presentation, logic, and data layers. The presentation layer provides data to the client, which can be accessed by various browsers; the logic layer implements transactions and data rules; and the data layer defines data access standards. The core of this three-tier architecture is the Component Object Model. This architecture does not require client installation, and data can be accessed through a browser, supporting multiple browsers. It also simplifies development and maintenance. Furthermore, only the database needs to be installed on the server, allowing multiple terminals to interact with data simultaneously. This system is ultimately designed based on this architecture. The three-tier structure of the B/S architecture is shown in Figure 2.1.

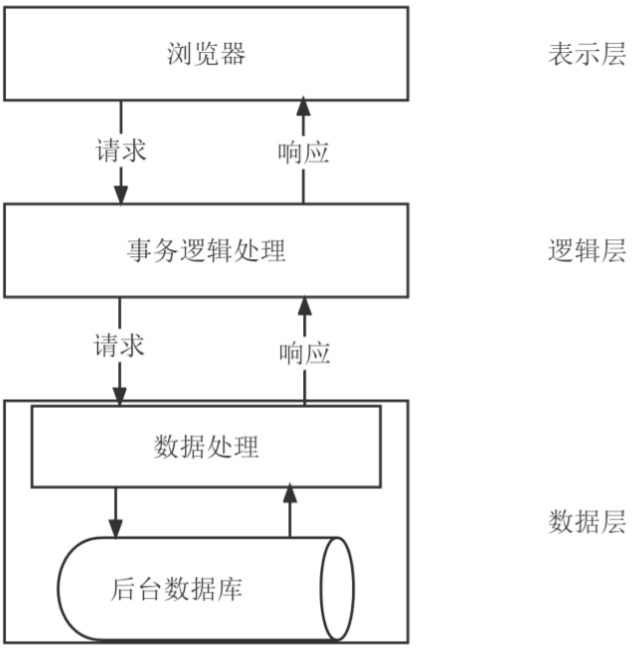

Figure 2.1: Three-Tier Structure of the B/S Architecture

2.2 Overview of ASP.NET

ASP.NET is a free web framework that can be used to build excellent websites and web applications using HTML, CSS, and JavaScript. It also supports creating web APIs and using real-time technologies like WebSockets. .NET is a technology platform from Microsoft, primarily used for rapid development and cross-platform operations. ASP.NET is a part of the .NET framework, allowing the development of C/S architecture software or B/S architecture websites.

2.3 Overview of Microsoft SQL Server

In system development, data is an indispensable element, and it is stored in databases. This system uses the commonly used relational database Microsoft SQL Server 2017, employing SQL language for data processing and allowing .NET within the same company to access or manipulate the data. The database is highly reliable, efficient, and intelligent, and SQL language is highly non-procedural, set-oriented, and simple to understand.

2.4 Overview of C#

There are many programming languages based on ASP.NET, and this system uses C#. C# (C Sharp) is a new, object-oriented and component-oriented programming language, based on C language and upgraded from C++. C# runs on the .NET platform and is key to .NET development. Developers can write various secure and reliable applications based on C#. Compared to C++, C# eliminates C++'s multiple inheritance, only supports single

inheritance, and does not define global functions or variables, making C# safer, capable of handling more errors, and implementing more comprehensive functions.

Chapter 3: System Analysis

The design process of this system follows the software engineering methodology. This chapter focuses on the feasibility and requirement analysis of the system, as well as the analysis of each functional module.

This information system is developed based on the original stand-alone cotton usage calculation system. The stand-alone version of the system has undergone more than twenty years of improvement and has taken into account various cotton usage calculations. All logic relations have been rigorously tested in practice. The stand-alone cotton usage calculation system has been used by several enterprises within the DeMian Group, Dezhou Huayuan Group, and Dezhou Hengfeng Group for many years. Related papers have been published in Chinese core journals on cotton spinning technology, and national patents have been applied for this technology. With the advancement of information technology and the increasing demand for management technology in enterprises, the stand-alone cotton usage calculation system can no longer meet the needs of modern management. The development of a network version of the cotton usage calculation system is a necessary step in the development of the times. This project modifies the original stand-alone computer program model and transitions it to a structure relying on browsers and databases, which are configured in most computers, allowing for interconnection and simultaneous use of multiple terminals within the internal network.

3.1 System Feasibility Analysis

3.1.1 Economic Feasibility

Before the introduction of an information system, the textile production process relied on manual data entry into spreadsheets and manual calculations, with data being disconnected. This often led to inaccuracies in data statistics and calculation errors. Even with the introduction of the stand-alone version, the system still faced the issue of needing to install software on multiple terminals. The design of this system benefits from accurate data storage and calculations, optimizes the data entry method, and, through network interconnection, greatly improves production efficiency. If the enterprise is satisfied with the system, it is likely to be adopted on a large scale, with promising prospects and considerable returns. Additionally, the development costs are low, and the operation and maintenance are simple with no significant expenses, offering high economic benefits.

3.1.2 Technical Feasibility

The system uses the Microsoft ASP.NET framework and Microsoft SQL Server database, both of which have matured over many years and are widely adopted by developers. With the updating of personal computers, the browser-side presentation layer is described using mature front-end languages, making development relatively easy and stable. Additionally, the use of the more complete C# language makes it easier for users to interact with the database.

3.1.3 Operational and Maintenance Feasibility

The system's data operations are handled by production data maintenance personnel who are familiar with modern network tools. The system's presentation layer is browser-based, and production maintenance personnel can complete operations using the browser according to the user manual. Additionally, the database storage procedures may require maintenance, and the system provides an interface function for superusers to modify the database storage procedures, making future system maintenance possible.

3.2 System Requirement Analysis

The system is divided into two types of users: super users (administrators) and regular users (operators). Based on communication with the enterprise and the requirements in the actual production process, the following requirements are summarized:

(1) Super User

The super user has full control over all pages, meaning they can access all functional modules, perform basic operations such as data querying, modification, addition, and deletion, as well as calculate data, print reports, and modify their own password. Unlike regular users, the super user has specific functions, such as deleting existing users, assigning or removing regular user permissions, and updating the backend database storage procedures. The super user use case diagram is shown in Figure 3.1.

(2) Regular User

Regular users can only perform operations within their own permissions, which include a subset of operations such as adding, deleting, modifying, and querying data, calculating data, and printing reports. Regular users need to request permissions from the administrator according to their role in the production process in order to access certain modules. Additionally, regular users can modify their own passwords. The regular user use case diagram is shown in Figure 3.2.

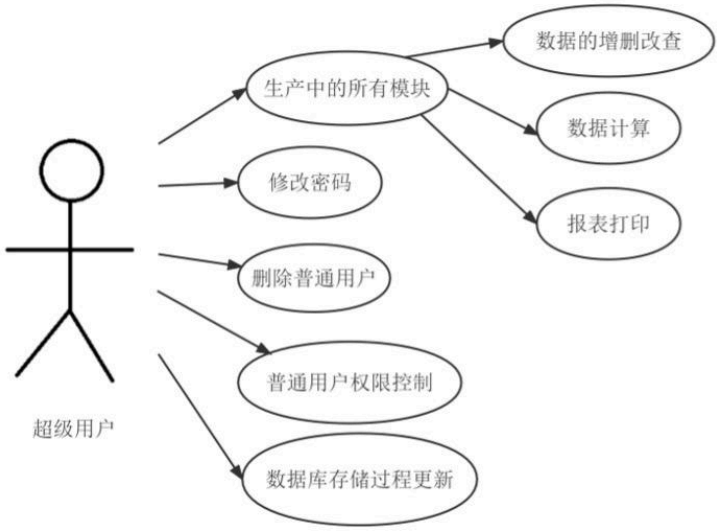

Figure 3.1 Super-user's Case Diagram

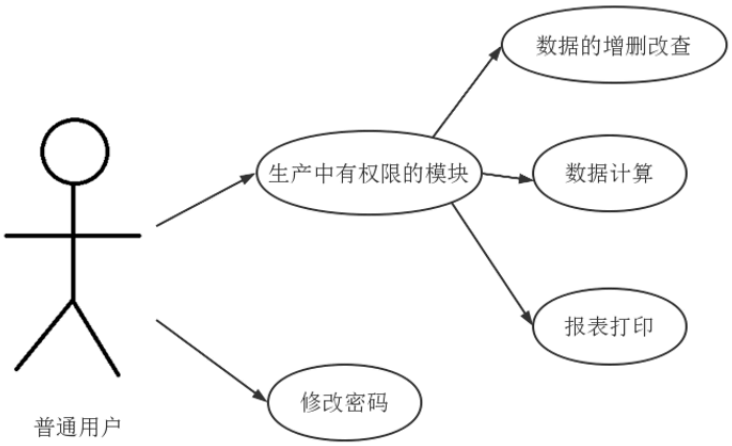

Figure 3.2 Normal Users' Case Diagram

3.3 System Function Module Analysis

The cotton usage calculation system for yarn production covers a wide range of content, requiring the classification of different functions within the system. Each category completes different calculation modules. The system can be divided into the following five categories: Parameter Design and Maintenance Module, Variety Selection and Yield Entry Module, Inventory Design and Calculation Module, Raw Material Entry and Calculation Module, and Data Precision Processing Module. The modules and their specific classifications are shown in Figure 3.3.

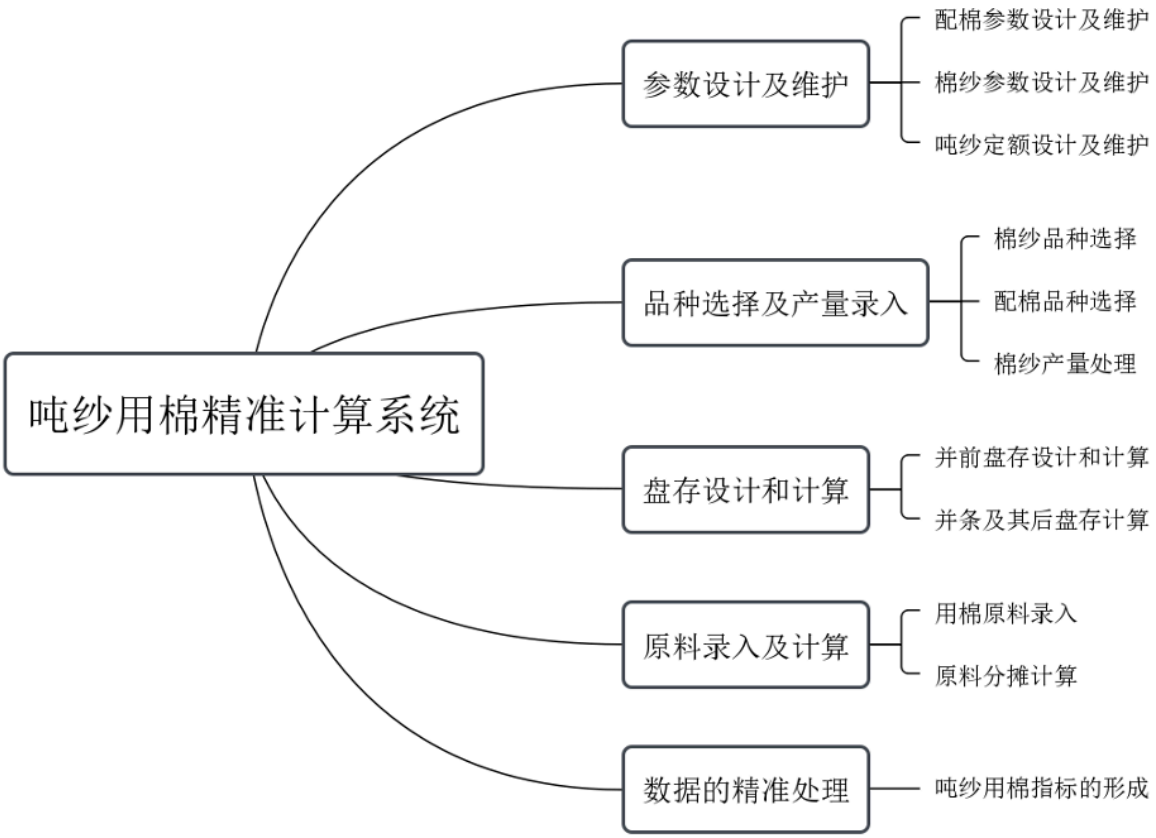

Figure 3.3 Schematic of the Program Function Module

3.3.1 Parameter Design and Maintenance

Parameter design and maintenance is the most fundamental part of the cotton usage calculation process. This section includes the design and maintenance of cotton blending parameters, yarn parameters, and yarn quotas.

(1) Cotton Blending Parameter Design and Maintenance

In textile production, the first task is to process cotton blending. Cotton blending requires many parameters such as blending name, carding or combing (process), blending attributes, and corresponding yarn numbers produced. Different cotton blends are assigned unique blending codes for easy machine recognition. Additionally, parameters such as cotton roll consumption coefficients and sliver consumption coefficients need to be maintained and converted into equivalent raw material coefficients. Special processes, like fine yarn input, require special notation. A "Cotton Blending Information" table is designed in the database, which includes fields such as "Blending Code," "Blending Name," "Blending Number," "Blending Attribute," "Carding/Combing," "Is Long Staple Cotton," "Is Fine Yarn Input," "Blending Entry Date," "Cotton Roll Consumption Coefficient," "Sliver Consumption Coefficient," "Pre-combing Consumption Coefficient," "Sliver Roll Consumption Coefficient," and "Combing Consumption Coefficient."

(2) Yarn Parameter Design and Maintenance

Yarn is the product processed from cotton blending, and like cotton blending, it requires parameter design and maintenance. These parameters include the yarn name, the machine type used in production, the carding or combing process, and the yarn's intended use. Similar to cotton blending, different yarns are assigned unique yarn codes for machine recognition. Since yarn is made from one or more cotton blends, the yarn code is connected with the cotton blending code, forming a one-to-one relationship with a comprehensive code. A "Yarn Information" table is designed in the database, with fields such as "Yarn Code," "Yarn Name," "Yarn Production Batch," "Yarn Count," "Yarn Type," "Production Machine," "Yarn Use," "Cotton Blending Carding Ratio," "Process Flow," "Yarn Entry Date," and "Number of Cotton Blends."

(3) Yarn Quota Design and Maintenance

Yarn quotas are important parameters used during calculations. As mentioned earlier, yarn is made from one or more cotton blends, so the system needs to store specific cotton blends and their proportions, and determine the yarn quota and raw material coefficients derived from semi-finished products and completed products during the production process. A "Yarn Parameter Information" table is designed in the database with fields such as "Yarn Code," "Yarn Name," "Yarn Production Batch," "Cotton Blending Code," "Cotton Blending Name," "Yarn Quota," "Specific Gravity," "Sliver Consumption Coefficient," "Roving Consumption Coefficient," "Yarn Tubing Consumption Coefficient," and "Cone Yarn Consumption Coefficient."

3.3.2 Yarn Production Yield Processing

Yarn production yield helps in calculating cotton usage per ton, and its recorded number is the yarn's stock-in quantity. Users first determine the yarns and cotton blends used for the month, and the system automatically generates a corresponding inventory report by month. After the yarn yield entry is completed, subsequent steps can continue to calculate the cotton usage per ton for different yarns to analyze cotton usage.

3.3.3 Inventory Design

For process description convenience and calculation uniformity, inventory is divided into different parts based on semi-finished products. Using sliver preparation as the baseline, semi-finished products before sliver preparation are named after the cotton blend, referred to as pre-sliver inventory. Pre-sliver inventory includes processes like cleaning, carding, and combing. Semi-finished products after sliver preparation are named after the yarn, referred to as post-sliver inventory, which includes processes like spinning, fine yarn, and after-spinning inventory. The program automatically processes the cotton blend investment inventory and yarn yield inventory reports, respectively, for each month.

3.3.4 Raw Material Entry and Calculation

Cotton blending is used as raw material, entered according to different varieties, with each cotton blend distinguished by its blending code. Each cotton blend is further divided into three categories: raw cotton, return cotton, and reused cotton. To simplify cotton usage

calculations, yarn quota usage is applied to handle the allocation of raw cotton for different yarns. A yarn uses one or more cotton blends, but a cotton blend can be used by multiple yarns, so the actual cotton usage per ton for yarns using the same cotton blend remains proportional to their respective quotas. Given the known yarn yield, inventory, and cotton blend input quantities for the month, the system calculates the raw material usage for each yarn. The cotton blends are divided into raw cotton, return cotton, and reused cotton, and the corresponding inventory is also divided into three parts: raw cotton inventory, return cotton inventory, and reused cotton inventory. The proportion of raw cotton, return cotton, and reused cotton in each cotton blend is calculated to derive the raw cotton, return cotton, and reused cotton coefficients. The total cotton blend inventory is multiplied by these coefficients to calculate the quantities of raw cotton, return cotton, and reused cotton.

3.3.5 Data Precision Processing

By following the above steps, the system can obtain the necessary data for calculating the net cotton per ton of yarn, including yield, inventory, and raw material allocation. By programming the calculations, the system accurately computes various required indicators, such as the net cotton per ton of yarn.

3.4 System Business Flow Analysis

This system does not provide access for anonymous users, so users must log in successfully before using the system. Users first access the login interface, input their username and password, and the encrypted information is sent to the database for verification. If the database confirms the provided credentials, users can access the system. The user login sequence diagram is shown in Figure 3.4.

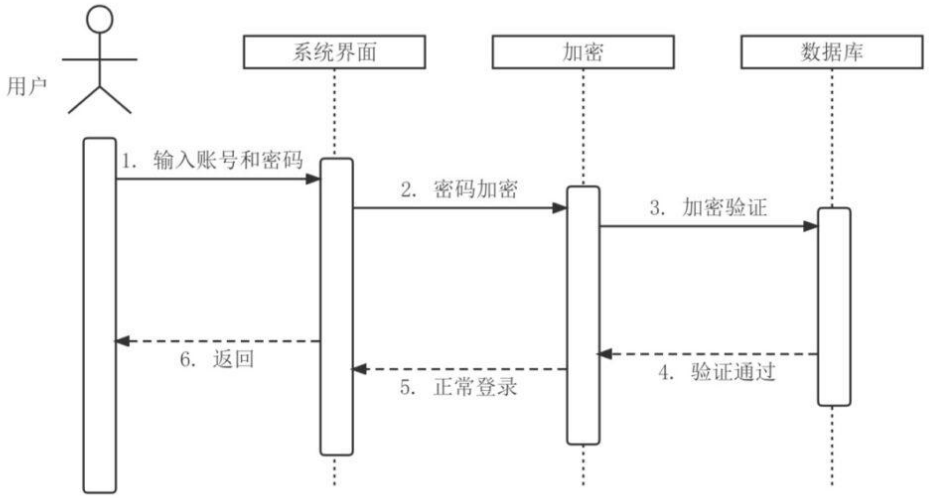

Figure 3.4 User logon timing diagram

Users also need the ability to change their passwords, and super users are responsible for controlling the permissions of regular users. This process also requires logging into the system. Changing passwords is available to all users, while modifying permissions requires

checking whether the user has superuser privileges. After users make the necessary changes, the information is submitted to the database, which then performs the corresponding updates. The sequence diagram for user information modification is shown in Figure 3.5.

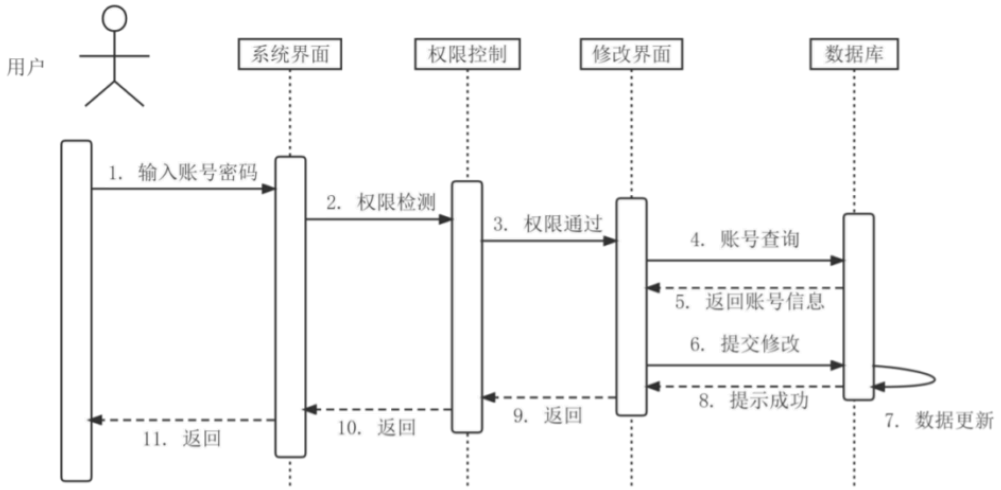

Figure 3.5 The modification of User Information Timing Diagram

During system usage, users need to interact with different sub-modules to perform data operations. The database first checks whether the user has the necessary permissions for the specific module. Once the permission verification is successful, the user is granted access to the module's interface to perform the relevant data operations. The sequence diagram for user interactions is shown in Figure 3.6.

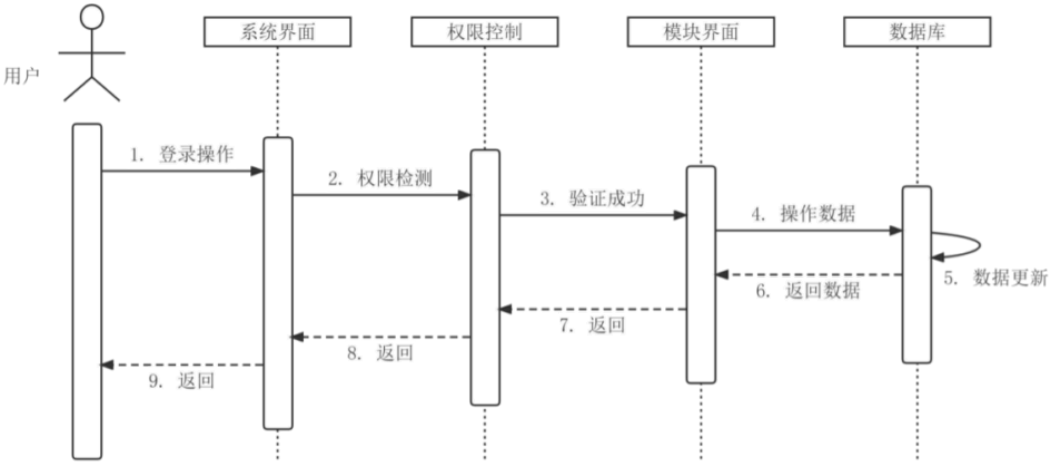

Figure 3.6 The Using Process Timing Diagram

Chapter 4 System Design

The system design process follows the completion of system analysis and is focused on solving the question of "how to implement the system." This process converts the logical models derived from user requirements in the system analysis phase into a logical model represented in the computer system.

4.1 System Architecture Design

This system adopts a B/S (Browser/Server) three-tier architecture, which is divided into three layers: the presentation layer, logic layer, and data layer. The system is developed in the Microsoft VS.NET environment. In the presentation layer, web-based development is used with Microsoft ASP.NET for the front-end design; in the logic layer, backend languages such as C#, JavaScript, and jQuery are used to complete transaction flows; in the data layer, Microsoft SQL Server 2017 is used as the database for data storage, and SQL is used to perform operations such as adding, deleting, modifying, and querying data. Compared to the C/S architecture, this design is more suitable for multi-terminal access, enabling faster data access, and the system's future upgrades and maintenance are also easier.

With the continuous development of the internet, textile enterprises now allow employees to access the system through the company intranet. The enterprise requires a server to host the system and provide access to other terminals, as well as a database server to store the data. After setting up the system, employees can access it by visiting the server's IP address, with interconnection provided by the router. To prevent threats such as injection attacks, a firewall can be set up to ensure the system's security and reliability. The system implementation architecture is shown in Figure 4.1.

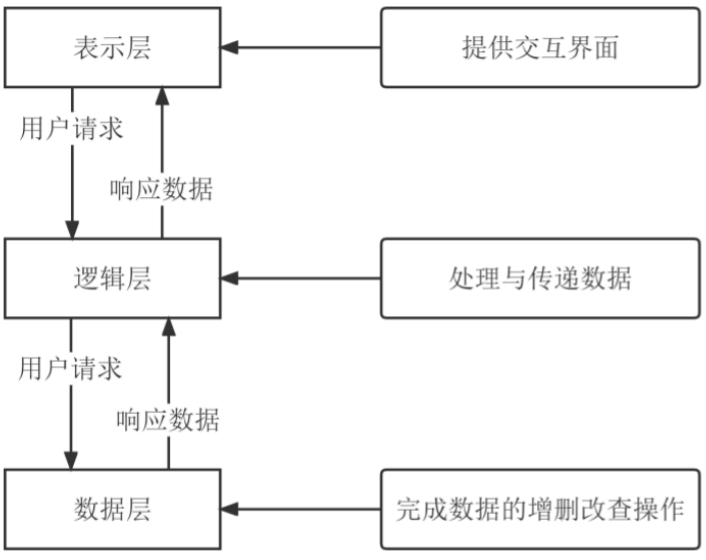

Figure 4.1 System implementation architecture

4.2 User Operation Logic Design

The user operation cycle primarily consists of the following steps: registration, login, permission control, operation access, and logout. If a user does not have an account, they must complete the registration process and request the administrator to assign appropriate permissions. Once the user has an account, they need to log in to validate their credentials in order to enter the system, and they can only access modules for which they have the corresponding permissions. After completing operations within a module, the user needs to log out and return to the login page. The detailed operation logic flow is shown in Figure 4.2.

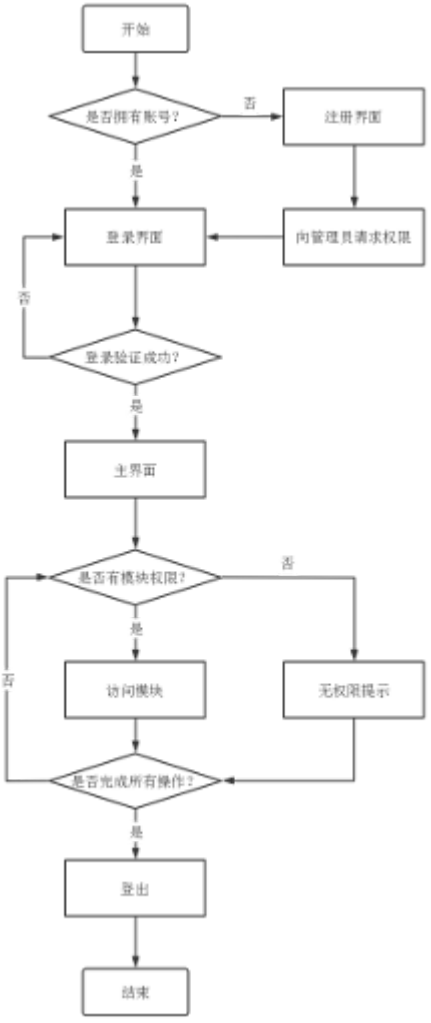

Figure 4.2 The Logic of User's Actions

4.3 Interface Design

The interface design primarily includes the login interface design, registration interface design, and main interface design.

The login and registration interfaces are relatively simple. The login interface only requires the login name, password, and a dynamic verification code. The registration interface includes input fields for the login name with duplicate checks, password input and confirmation, and additional user information such as contact number and department. User information is maintained through the server's database, and a "user information" table is

designed with various fields for detailed user information. Notably, for security purposes, user passwords are stored in the database using the MD5 encryption formula `GetMD5()`.

The main interface consists of a header section (system name logo, user login information, and logout button), a navigation page (which can navigate to various modules), a module page (where the selected module will be displayed from the navigation page), and a footer copyright page (containing copyright information and creator contact details). A conceptual design of the interface is shown in Figure 4.3.

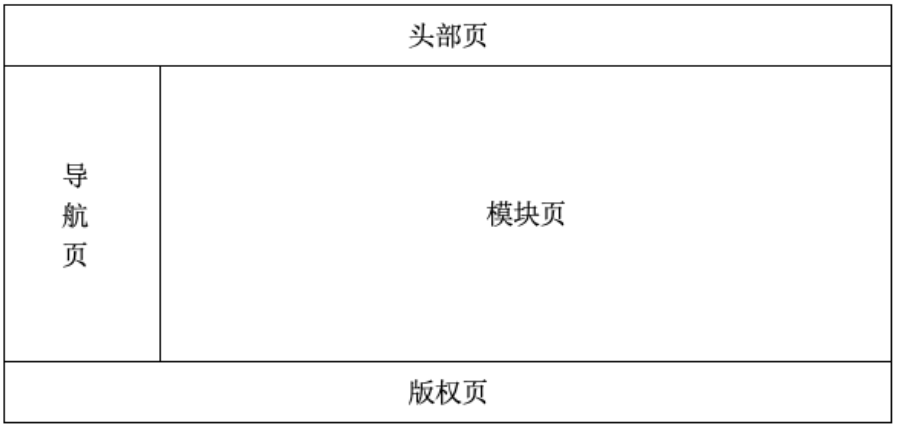

Figure 4.3 Main Page Design

4.4 Database Design

4.4.1 Conceptual Design

Based on the system analysis process, the conceptual design of the system's database identifies several necessary data tables, including the user information table, the cotton blending information table, the yarn information table, and the yarn parameter information table. Except for the user information table, which is used for the login control module, the other tables are interrelated in various ways.

The entity-relationship diagram (E-R diagram) for the aforementioned tables is shown in Figure 4.4.

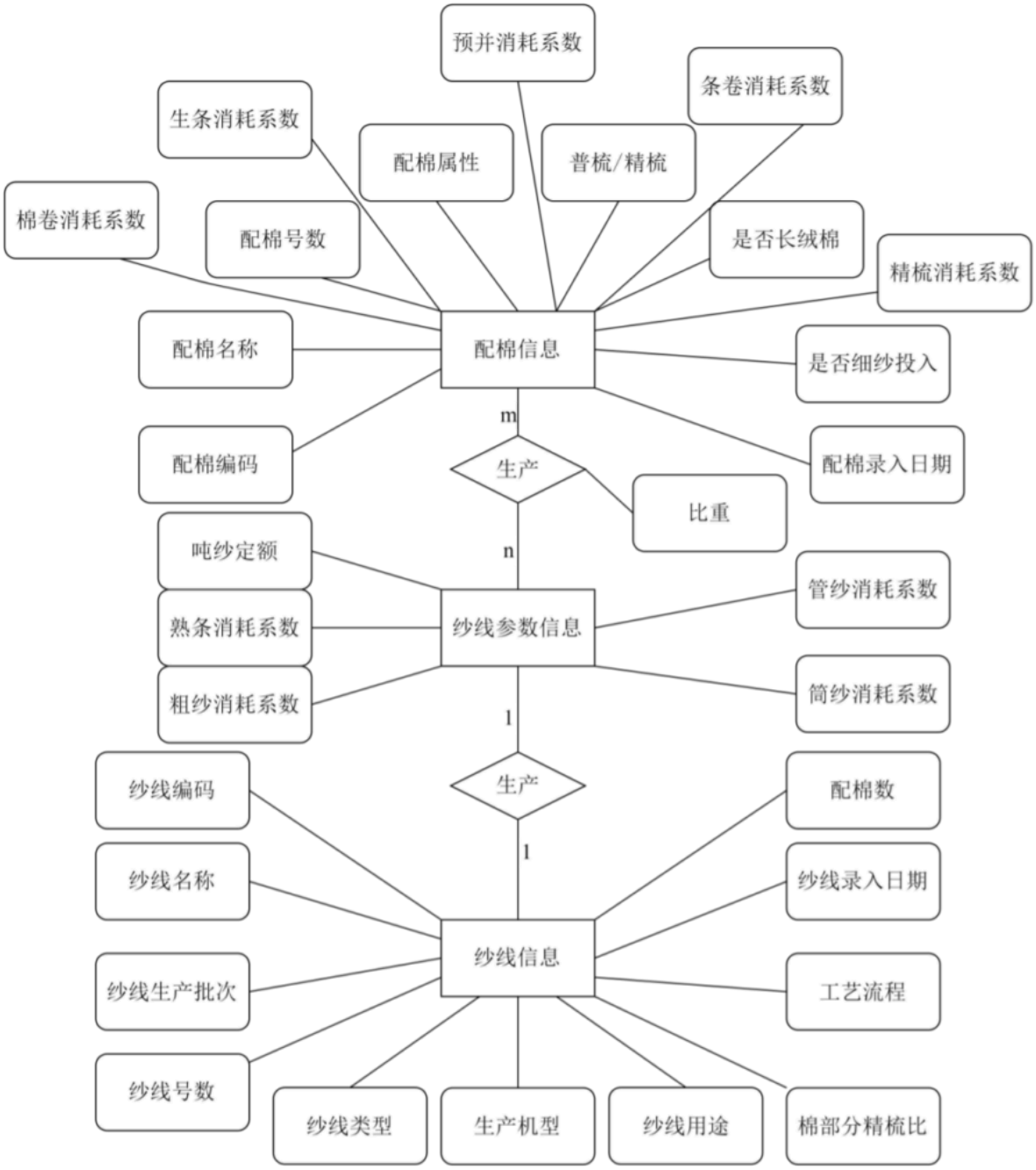

Figure 4.4 Entity-Relationship Diagram of the System Design

4.4.2 Logical Design

Based on the conceptual design, the system's database will consist of the following tables: the user information table, the cotton-blending information table, the yarn information table, and the yarn parameter information table.

1. **User Information Table**
    - Fields: UserID, UserName, Password, PhoneNumber, Role, EmployeeID, Department

    - Description: Stores user account details including authentication data and roles.
2. **Cotton-Blending Information Table**
    - Fields: CottonBlendingCode, CottonBlendingName, CottonBlendingCount, CottonBlendingAttribute, Carded/Combed, IsLongStapleCotton, CottonBlendingEntryDate, CottonRollConsumptionCoefficient, SliverConsumptionCoefficient, PreSpinningConsumptionCoefficient, YarnConsumptionCoefficient, CombedConsumptionCoefficient, IsFineYarnInput
    - Description: Contains cotton blending data including attributes and consumption coefficients.
3. **Yarn Information Table**
    - Fields: YarnCode, YarnName, YarnProductionBatch, YarnCount, YarnType, ProductionMachineModel, YarnUse, CottonCombingRatio, ProcessFlow, YarnEntryDate, CottonBlendingCount
    - Description: Stores yarn production details, including the associated cotton blending count.
4. **Yarn Parameter Information Table**
    - Fields: YarnCode, YarnName, YarnProductionBatch, CottonBlendingCode, CottonBlendingName, YarnQuota, SpecificGravity, SliverConsumptionCoefficient, FineYarnConsumptionCoefficient, SpindleConsumptionCoefficient, ConeYarnConsumptionCoefficient
    - Description: Contains the parameters combining the yarn and cotton blending data.

The **Yarn Parameter Information Table** uses the primary keys of both the yarn and cotton-blending codes to ensure data integrity.

4.4.3 Physical Design

After completing the conceptual and logical designs, the physical implementation of these tables follows the Microsoft SQL Server standards. The tables will be stored in the database as described below:

Table 4.1: User Information Table

Column Name	Description	Data Type	Remarks
UserID	User ID	int	Primary Key
UserName	User Name	nvarchar(20)	
PassWord	Password	nvarchar(30)	
Tel	Phone Number	nvarchar(50)	
Role	User Role	nvarchar(50)	
Gonghao	Employee ID	nvarchar(20)	NULL Allowed

Depar	Department	nvarchar(50)	NULL Allowed

Table 4.2: Cotton-Blending Information Table

Column Name	Data Type	Remarks
CottonBlendingCode	nvarchar(20)	PRIMARY KEY
CottonBlendingName	nvarchar(50)	
CottonBlendingCount	nvarchar(20)	NULL Allowed
CottonBlendingAttribute	nvarchar(20)	NULL Allowed
Carded/Combed	char(4)	NULL Allowed
IsLongStapleCotton	bit	NULL Allowed
CottonBlendingEntryDate	date	NULL Allowed
CottonRollConsumptionCoefficient	decimal(5, 3)	NULL Allowed
SliverConsumptionCoefficient	decimal(5, 3)	NULL Allowed
PreSpinningConsumptionCoefficient	decimal(5, 3)	NULL Allowed
YarnConsumptionCoefficient	decimal(5, 3)	NULL Allowed
CombedConsumptionCoefficient	decimal(5, 3)	NULL Allowed
IsFineYarnInput	bit	NULL Allowed

Table 4.3: Yarn Information Table

Column Name	Data Type	Remarks
YarnCode	nvarchar(20)	PRIMARY KEY
YarnName	nvarchar(50)	
YarnProductionBatch	nvarchar(50)	NULL Allowed
YarnCount	nvarchar(20)	NULL Allowed
YarnType	nvarchar(20)	NULL Allowed
ProductionMachineModel	nvarchar(20)	NULL Allowed
YarnUse	nvarchar(20)	NULL Allowed
CottonCombingRatio	decimal(6, 2)	NULL Allowed
ProcessFlow	nvarchar(20)	NULL Allowed

YarnEntryDate	date	NULL Allowed
CottonBlendingCount	int	NULL Allowed

Table 4.4: Yarn Parameter Information Table

Column Name	Data Type	Remarks
YarnCode	nvarchar(20)	PRIMARY KEY
YarnName	nvarchar(50)	
YarnProductionBatch	nvarchar(50)	
CottonBlendingCode	nvarchar(20)	PRIMARY KEY
CottonBlendingName	nvarchar(50)	
YarnQuota	decimal(10, 3)	NULL Allowed
SpecificGravity	decimal(6, 3)	NULL Allowed
SliverConsumptionCoefficient	decimal(5, 3)	NULL Allowed
FineYarnConsumptionCoefficient	decimal(5, 3)	NULL Allowed
SpindleConsumptionCoefficient	decimal(5, 3)	NULL Allowed
ConeYarnConsumptionCoefficient	decimal(5, 3)	NULL Allowed

Chapter 5 System Implementation

5.1 Installation and Configuration

5.1.1 Attach Database

The attached database contains the system's pre-written database, which mainly includes the related tables and stored procedures. The attachment operation is as follows:

(1) Copy the DSJS_data.mdf and DSJS_log.ldf files from the project folder to the "MSSQL.1"\"MSSQL"\"Data" directory under the Microsoft SQL Server installation path, as shown in Figure 5.1.

1.

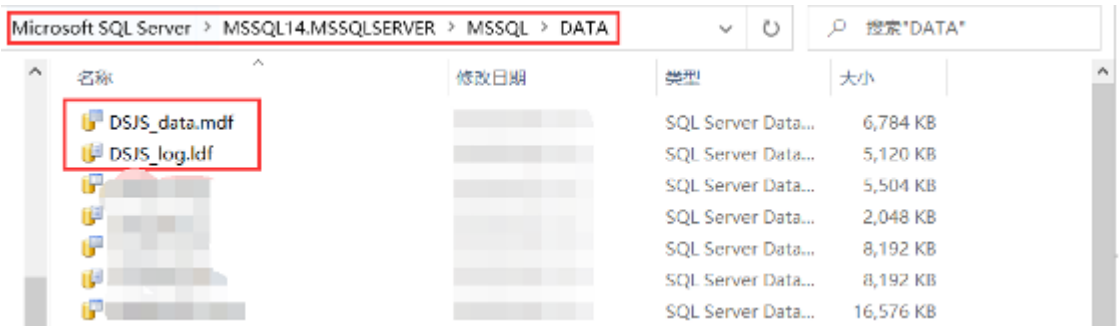

Figure 5.1 File Copy

(2) Select "Start"/"Programs"/Microsoft SQL Server /SQL Server Management Studio, and enter the "Connect to Server" page, as shown in Figure 5.2.

Figure 5.2 Connection to the Server

(3) In the "Server Name" dropdown list, select the SQL Server server name. The "LAPTOP-XXX" node represents the local SQL Server server name. Then click the "Connect" button.

(4) After entering the database server, right-click on the "Databases" node in the left "Object Explorer", and select the "Attach" option from the menu. This will pop up the "Attach Databases" dialog box, as shown in Figure 5.3.

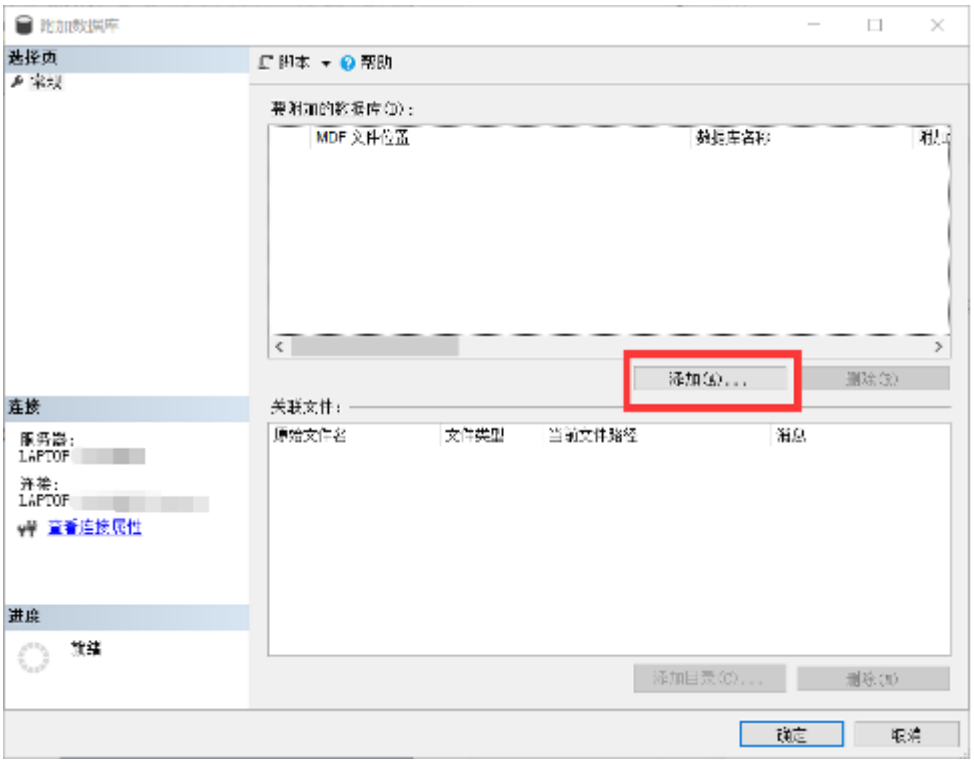

Figure 5.3 Attach the Database

(5) Click the "Add" button. In the pop-up "Locate Database Files" dialog box, select the database file path, as shown in Figure 5.4.

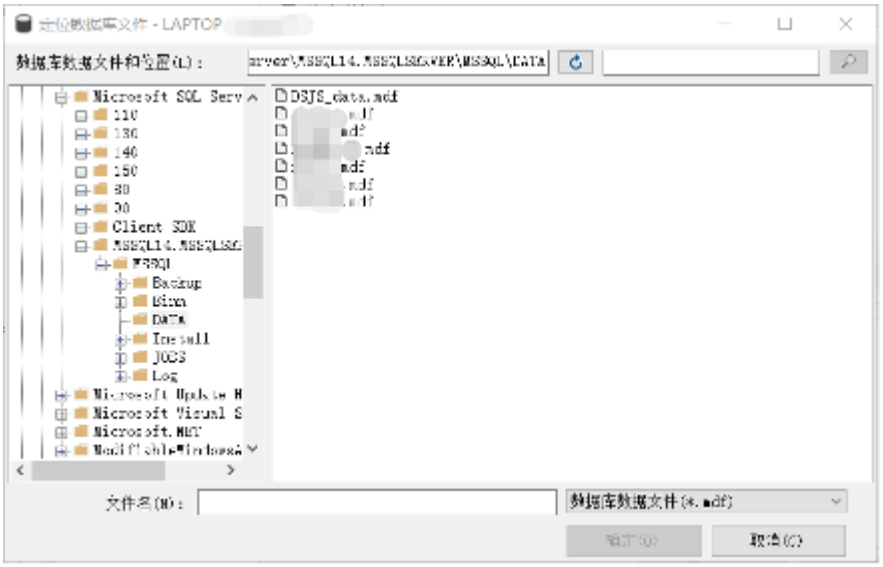

Figure 5.4 Locate the Database File

(6) Click "OK" to complete the database attachment operation.

(7) Open the "Security" options of the database, then open "Logins", find "sa", and double-click to open. In the "General" tab, change the password and confirm the password to "123". In the "Status" tab, select the "Enable" option for the login name, as shown in Figure 5.5.

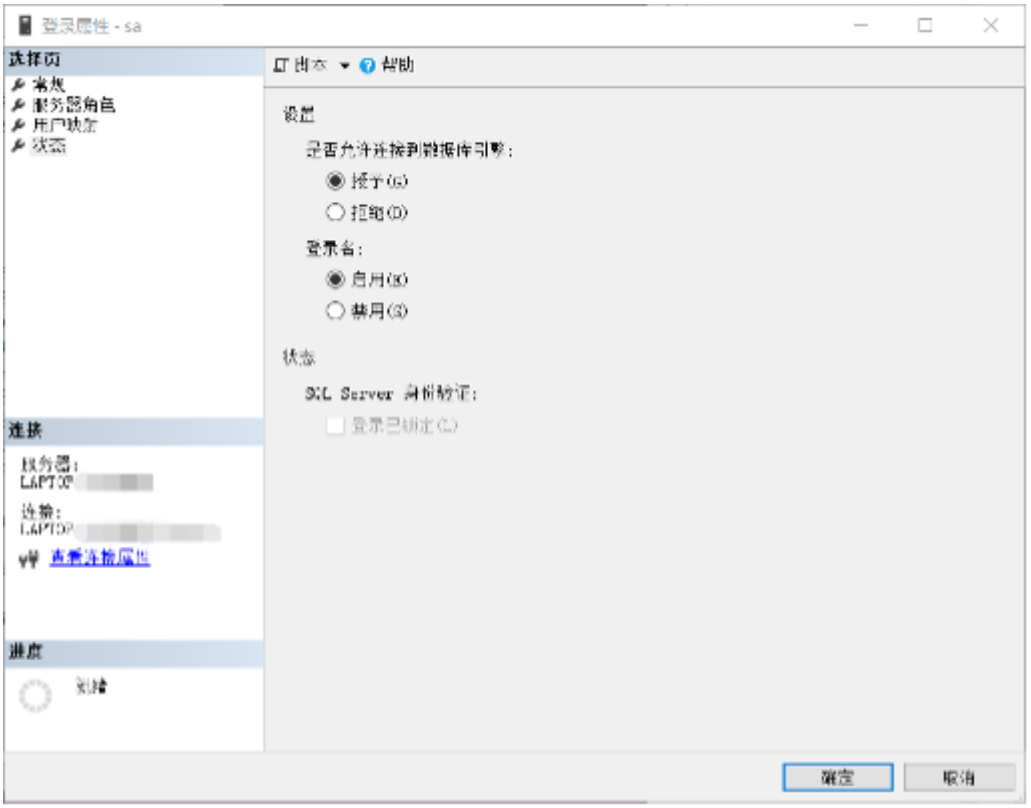

Figure 5.5 Enable Logins

(8) Open the SQL Server properties page, right-click on the server, select "Properties", go to "Security", and set the server authentication mode to "SQL Server and Windows Authentication mode (s)", then click "OK" to save, as shown in Figure 5.6.

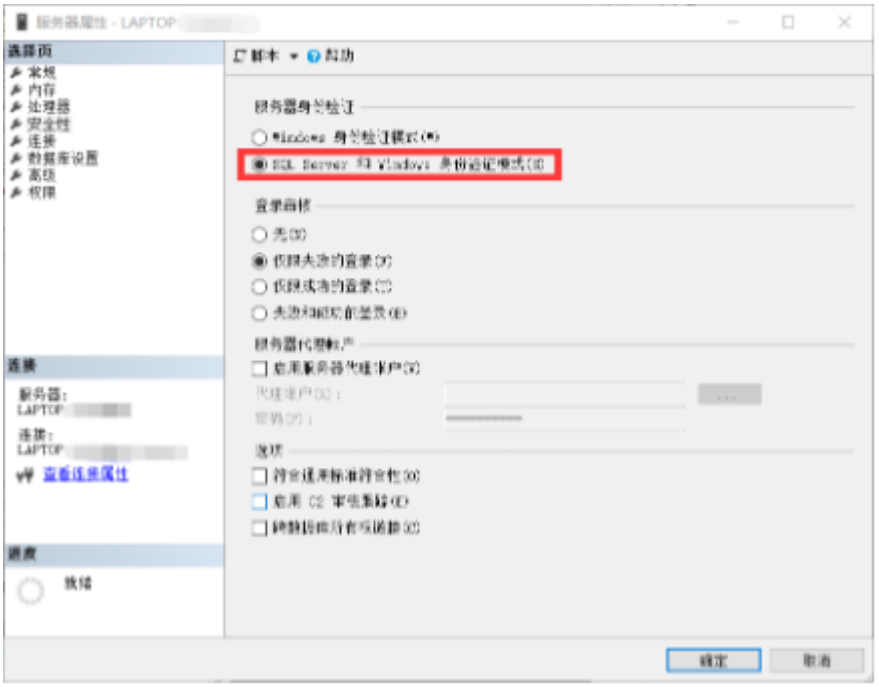

Figure 5.6 Server Logon Mode Control

(9) Finally, right-click the server and select "Restart (A)" to restart the server.

5.1.2 Modify Server Name

Open the Login folder, locate the web.config file, and open it with Notepad. Change the server name for the data source connection to the local SQL Server server's name (refer to Figure 5.2 for the local server name), as shown in Figure 5.7.

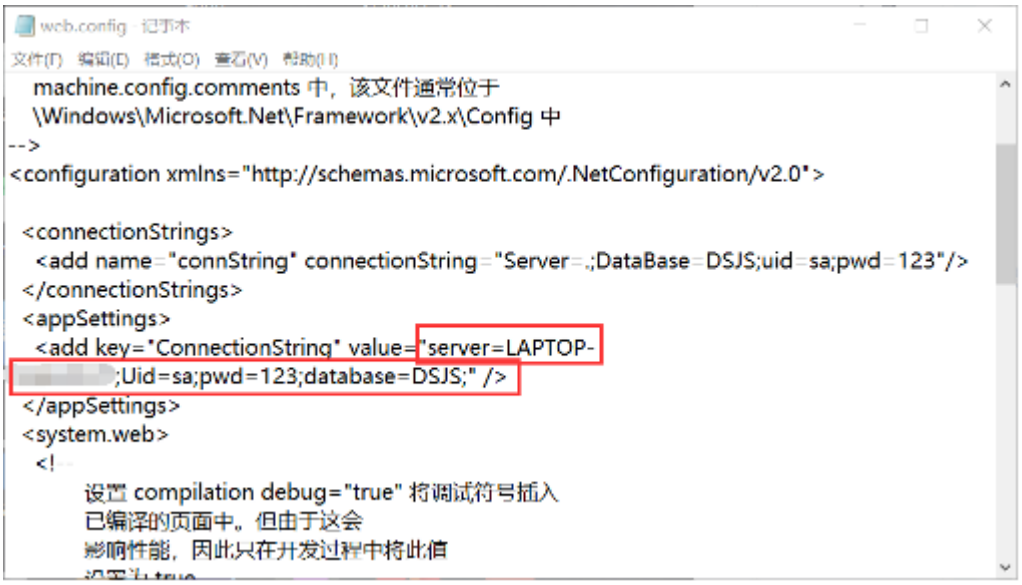

Figure 5.7 Modify the Server Name

5.1.3 Configure Internet Information Services (IIS)

(1) Search and open the Control Panel from the Start menu. In the Control Panel, select "Programs", then "Turn Windows Features On or Off". Check "Internet Information Services". Expand "Internet Information Services", expand "World Wide Web Services", expand "Application Development Features", then check ".NET Extensibility" and "ASP.NET", and click OK. After about 2 minutes, IIS services will be enabled on the Windows 10 system, as shown in Figure 5.8.

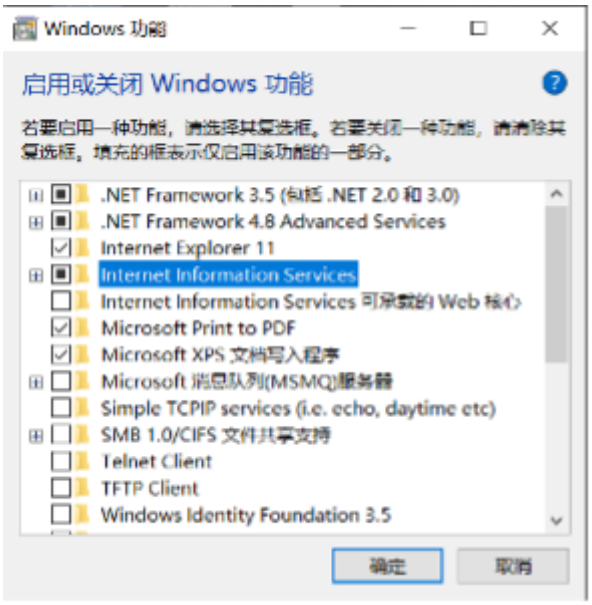

Figure 5.8 Open the Internet Information Services (IIS) Manager

(2) In the Control Panel, select "System and Security", then select "Administrative Tools", and open the Internet Information Services (IIS) Manager, as shown in Figure 5.9.

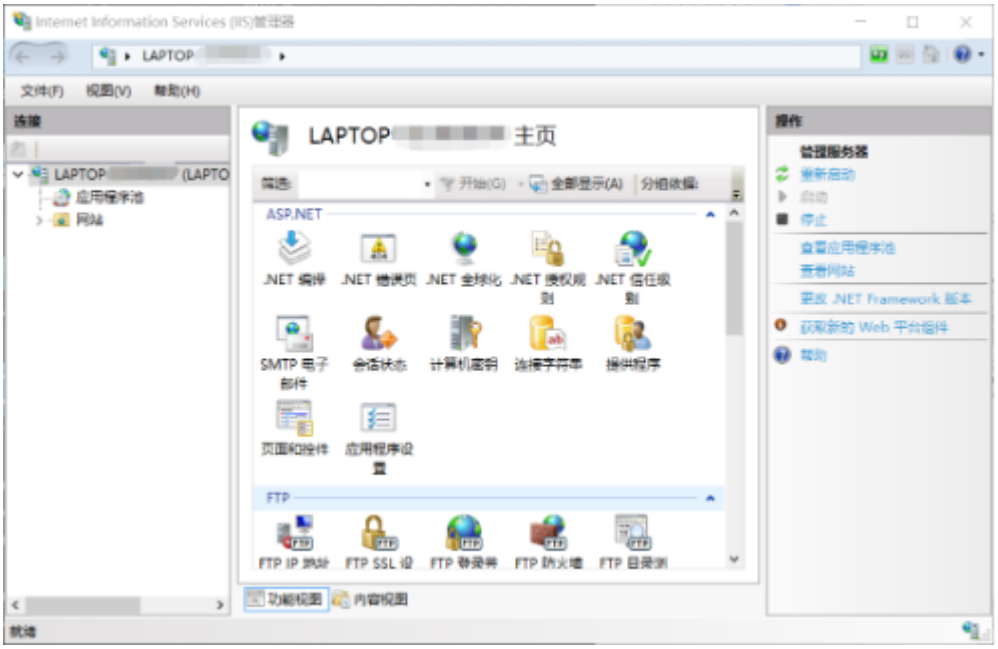

Figure 5.9 Internet Information Services (IIS) Manager Window

(3) Select the "Sites" node, right-click it, and choose "Add Website", as shown in Figure 5.10.

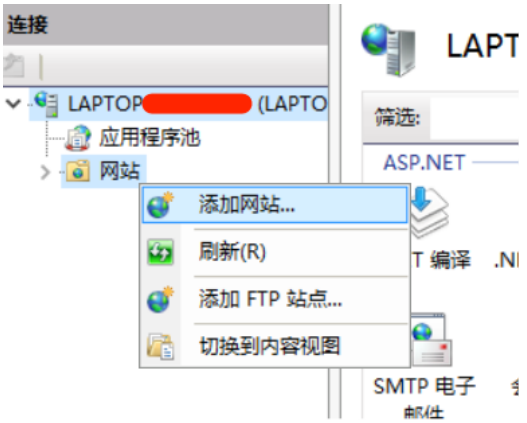

Figure 5.10 Select the Add Web Site Menu Item

(4) In the Alias field, give the site a name. Click the tab next to "Physical Path" (as shown in Figure 5.11), select the website path, navigate to the Login folder, and click the "OK" button.

Figure 5.11 Add Web Site options page

(5) After creating the new website, click the default website, and on the right tab, manage the website by selecting "Stop". Then click the newly added website, and on the right tab, manage the website by selecting "Start", as shown in Figure 5.12.

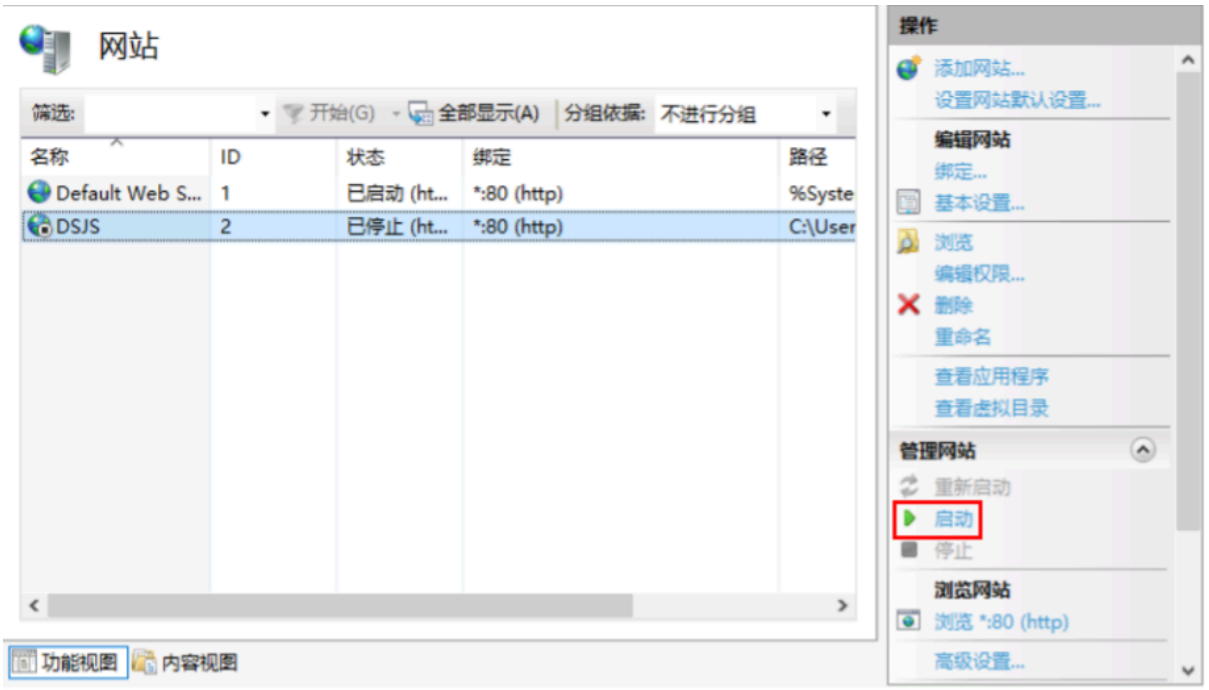

Figure 5.12 The Default Site Stops with the Start of a New Site

(6) Right-click the original project folder, select "Properties", open the "Security" tab, see the "Group or User Names", click the "Edit" button, add a new username "Everyone", then modify its permissions, setting the second permission "Modify" to allow, as shown in Figure 5.13.

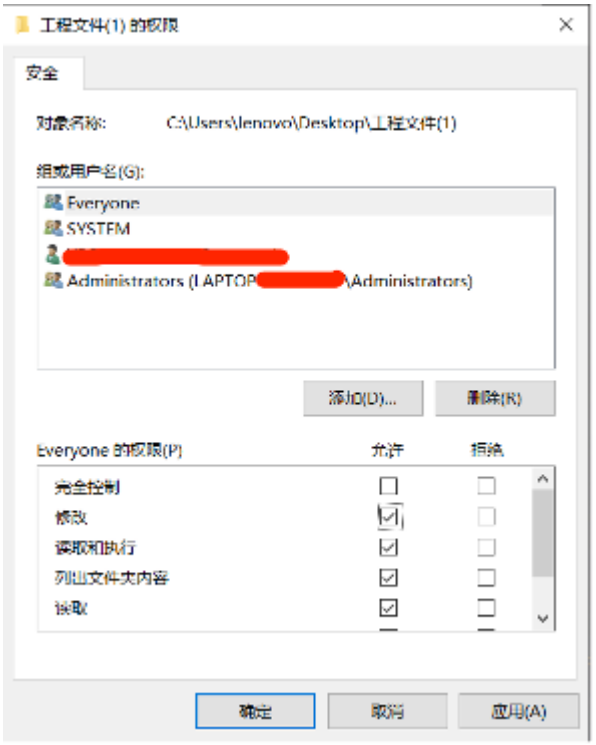

Figure 5.13 Permission Modification

(7) On the website homepage, click the "Default Document" option, and on the right tab, select "Add", enter "Login.aspx", and click "OK", as shown in Figure 5.14.

Figure 5.14 The Addition of a Default Document

(8) In the browser's address bar, enter "localhost". If the login page appears, the configuration is successful, as shown in Figure 5.15.

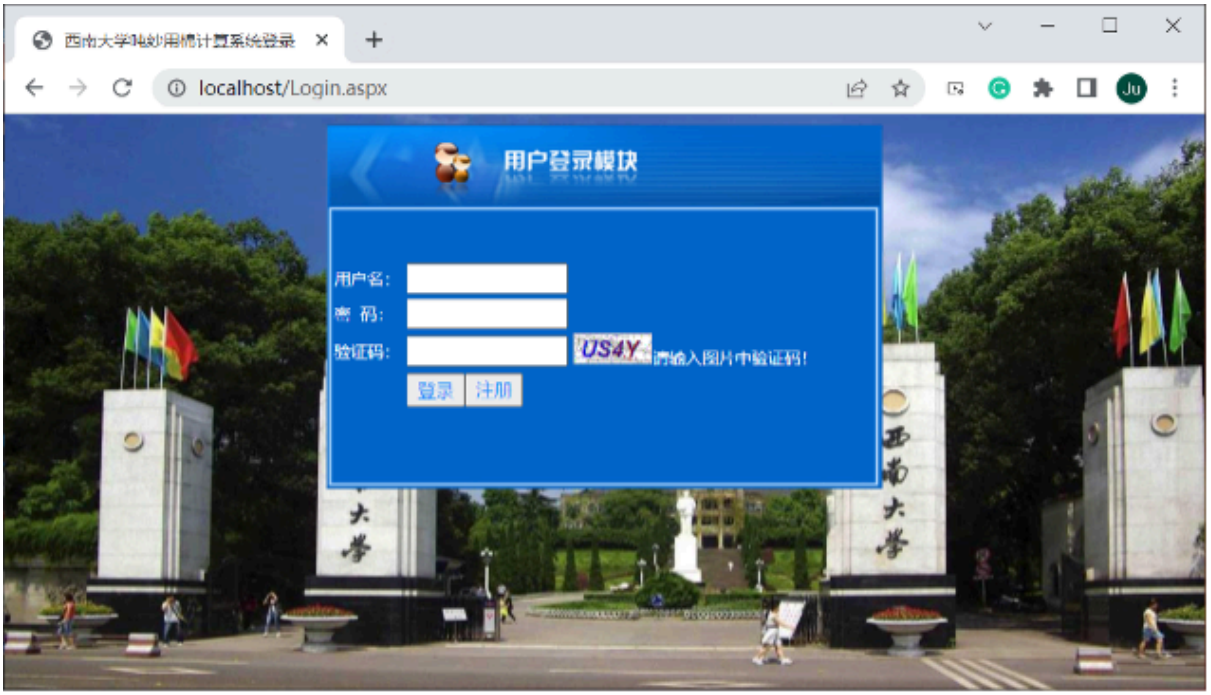

Figure 5.15 Verify Page

5.2 Module Implementation

5.2.1 Login Module Implementation

(1) **Implementation Design**
The user login module is the gateway to confirm user information, allowing only authorized users to access the system. Users can input their username, password, and verification code as prompted on the login page, and then click the login button. If the user doesn't have an account, they can directly click the register button. The user login process is shown in Figure 5.16.

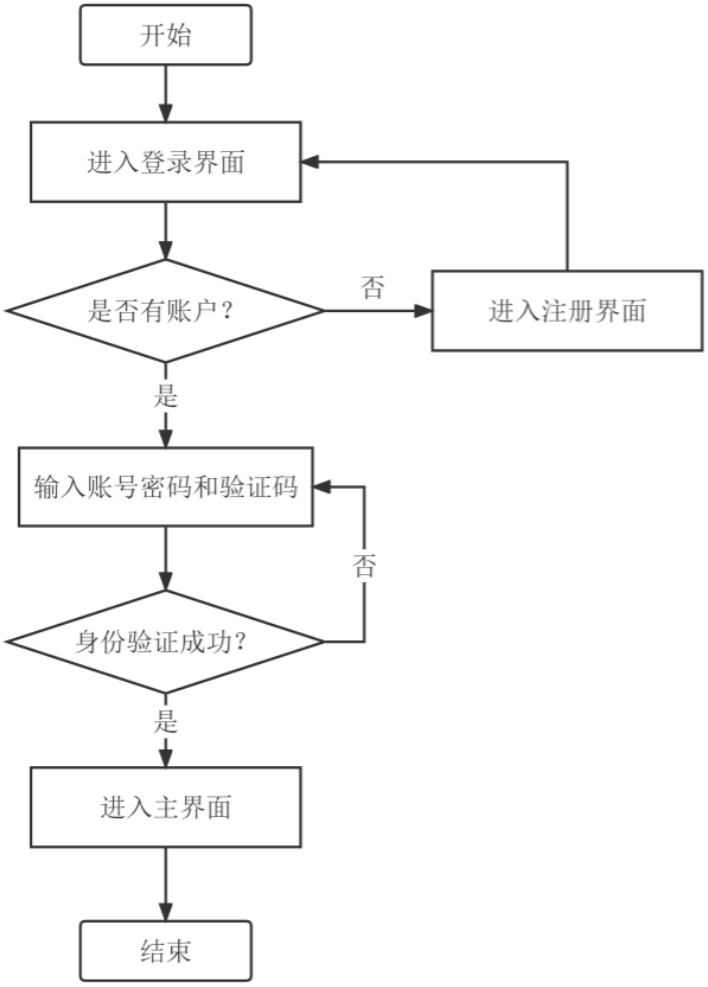

Figure 5.16 User Logon Flowchart

(2) **Implementation Result**
By entering the IP address in the browser (or "localhost" if it's the server's local machine), the login page can be accessed, as shown in Figure 5.17.

Figure 5.17 Using the Server IP Address to Access the System

5.2.2 Registration Module Implementation

(1) **Implementation Design**

When the user does not have an account, they can be directed to the registration module via the registration button on the login module. In this module, the user can input the relevant information as prompted. After entering the username, the system will check whether the username already exists to ensure there are no duplicate users. The user must also enter the password twice, and both entries must match in order to complete the registration. If they don't match, an error message will be displayed. Once the user enters the correct information, clicking the register button will show a registration success message, completing the registration process. Afterward, clicking the return button will bring the user back to the login page. The user registration process is shown in Figure 5.18.

(2) **Implementation Result**

After clicking the register button on the login page, the page will redirect to the user registration page, as shown in Figure 5.19. On this page, the user can enter the required information such as the username and password. To the right of the "Username" field, there is a "Check if the username exists" label. Clicking it will query the database for the username and prompt the user with a pop-up message.

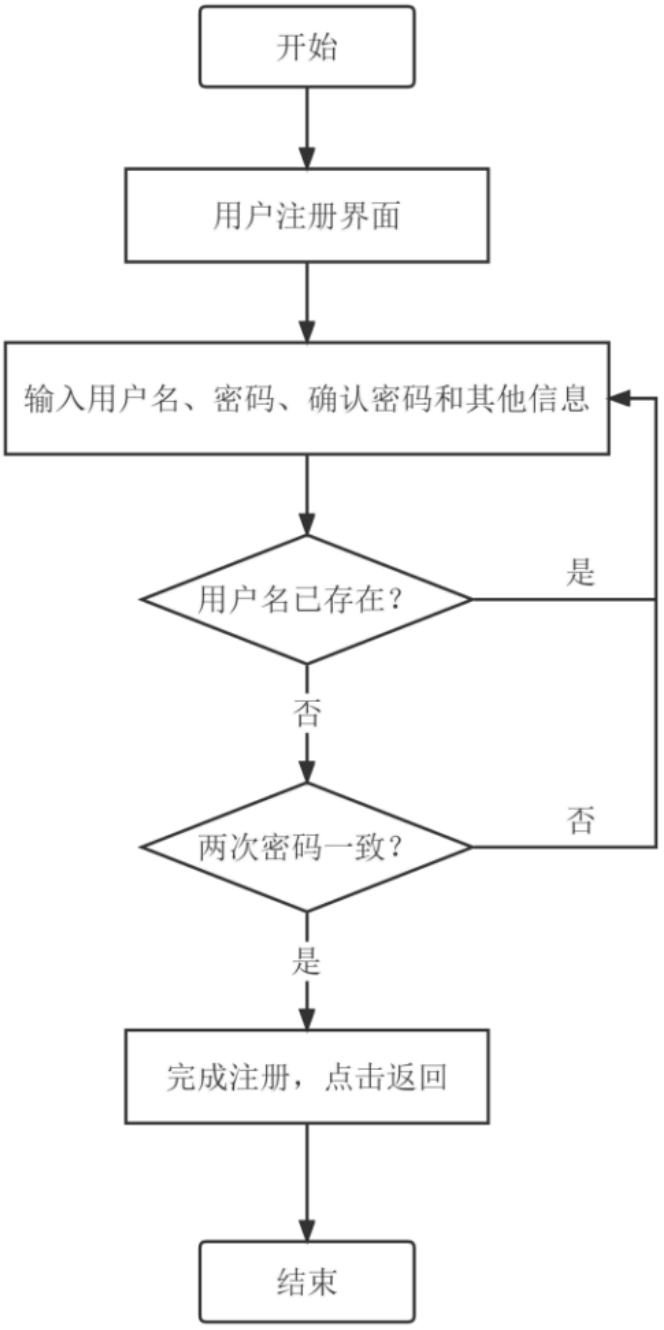

Figure 5.18 User Registration Flowchart

Figure 5.19 User Registration Page

5.2.3 Main Page Implementation

(1) **Implementation Design**

Once the user successfully logs in, they will enter the main page. The main page also includes a login status check, and if there is no activity for an extended period, the login session will expire, forcing the user to log out. The main page has navigation to access different modules, but proper permissions are required. Different users have different access levels, with the superuser having access to all pages. Additionally, the "Manage Users" page under "System Management" can only be accessed by the superuser. The main page process is shown in Figure 5.20.

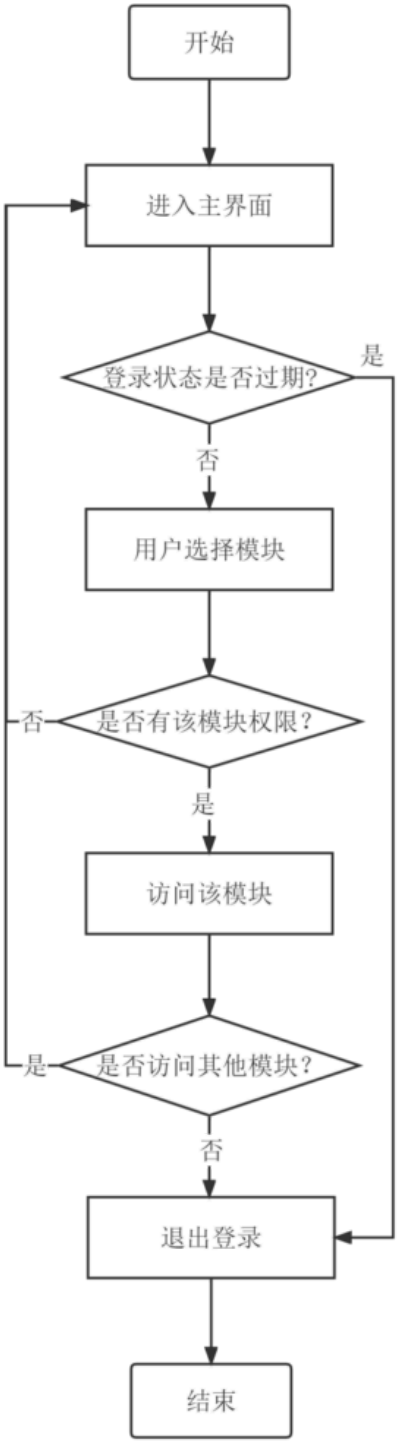

Figure 5.20 Main Page Flowchart

(2) **Implementation Result**
After entering the correct username and password to log in, the main page will appear as shown in Figure 5.21.

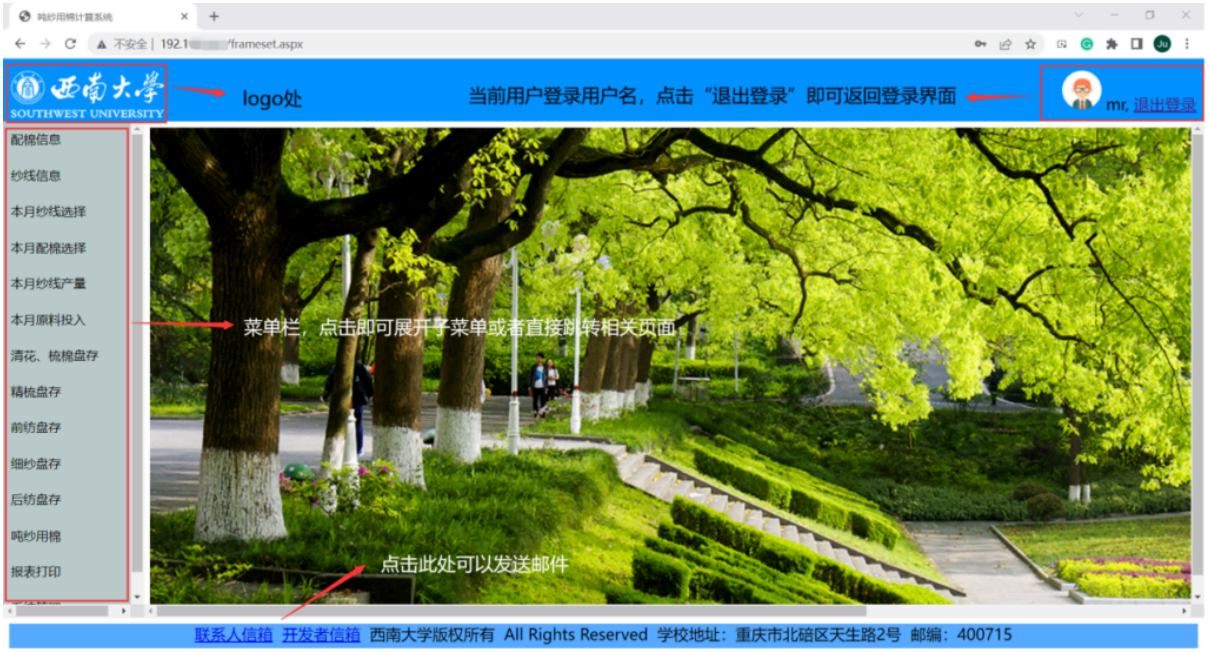

Figure 5.21 Main Page

5.2.4 Cotton-Blending and Yarn Module Implementation

(1) Design Implementation

The system provides a query function for cotton-blending and yarn, allowing for data editing and deletion during the query. Users can select the information they wish to query (for cotton-blending, the fields are cotton-blending name and cotton-blending number; for yarn, the fields are yarn name and yarn number) and enter it into the input boxes. Afterward, they click the "Query" button, and the results will be displayed below. If users wish to clear the results and display all cotton-blending data, they can click the "Reset" button. The query supports fuzzy searching, meaning the output will include all results containing the string in the input box. Furthermore, any unentered options will be considered as having no restrictions in that category. When no values are entered in any of the fields, clicking the "Query" button directly will display all the data. In the query results, there are "Edit" and "Delete" functions. After clicking the "Edit" label, it will change to "Update" and "Cancel" labels. The corresponding data row will be highlighted, and an editing box will appear, allowing users to modify the fields that can be edited. Once the modifications are made, clicking the "Update" label will complete the data update operation. If users do not want to update the data, clicking the "Cancel" label will leave the data unchanged. If there is an error or if a row is no longer needed, users can click the "Delete" label, and the system will prompt a confirmation box. Clicking "OK" will remove the data, and clicking "Cancel" will have no effect on the data. The use case diagram for the query module is shown in Figure 5.22.

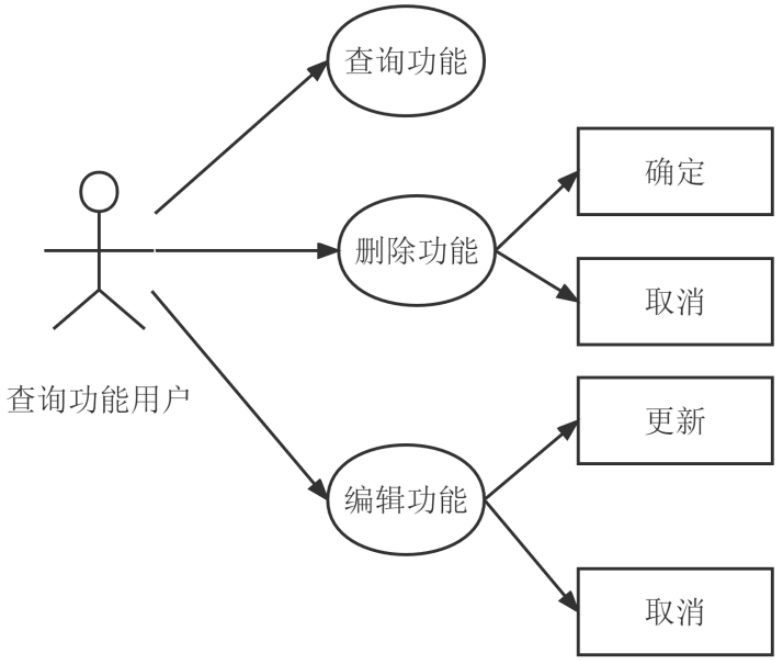

Figure 5.22 Query Module Use Case Diagram

(2) Implementation Results

The cotton-blending query page requires clicking the "Cotton-Blending Information" option in the menu, which will expand the submenu. After clicking the "Query Cotton-Blending" option, the query interface will be displayed on the right side, as shown in Figure 5.23. For the yarn query page, click the "Yarn Information" option in the menu, and the submenu will expand. After clicking the "Query Yarn" option, the query interface will be displayed on the right side, as shown in Figure 5.24. Since the cotton-blending and yarn query modules have similar functionality, this example demonstrates the cotton-blending query module. The query supports fuzzy searching, and the results will include all results containing the keywords provided by the user. After entering the required fields in the corresponding text boxes, click the "Query" button to complete the operation. To cancel the query results and show all information, click "Reset." The cotton-blending query results are shown in Figure 5.25. The edit interface is shown in Figure 5.26, and the delete prompt is shown in Figure 5.27.

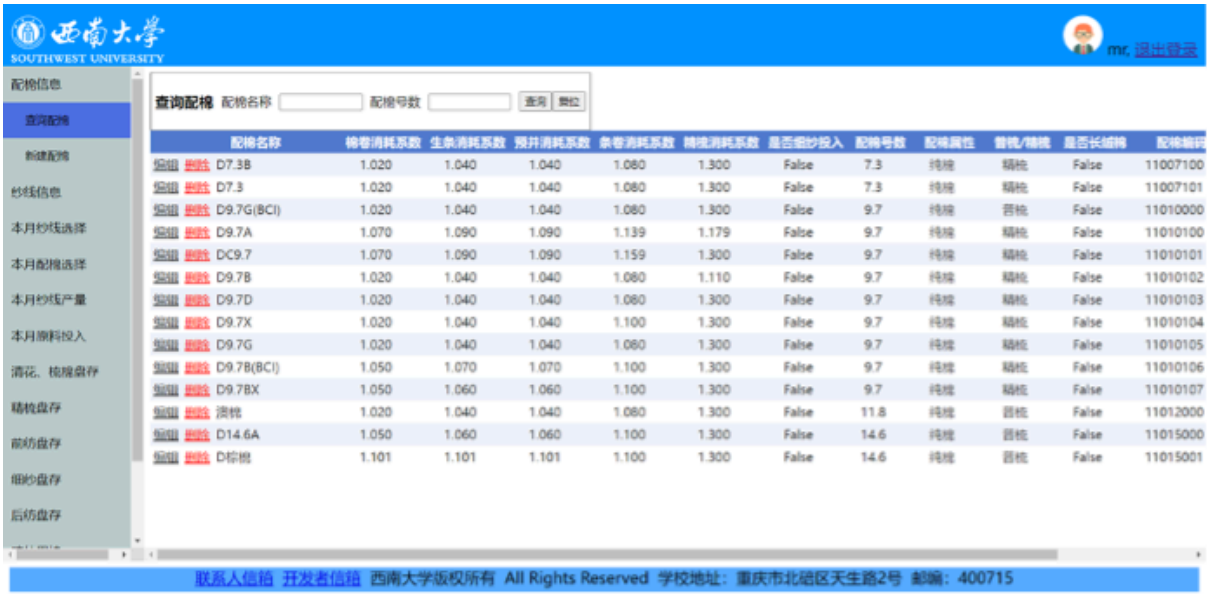

Figure 5.23 Cotton-Blending Query Page

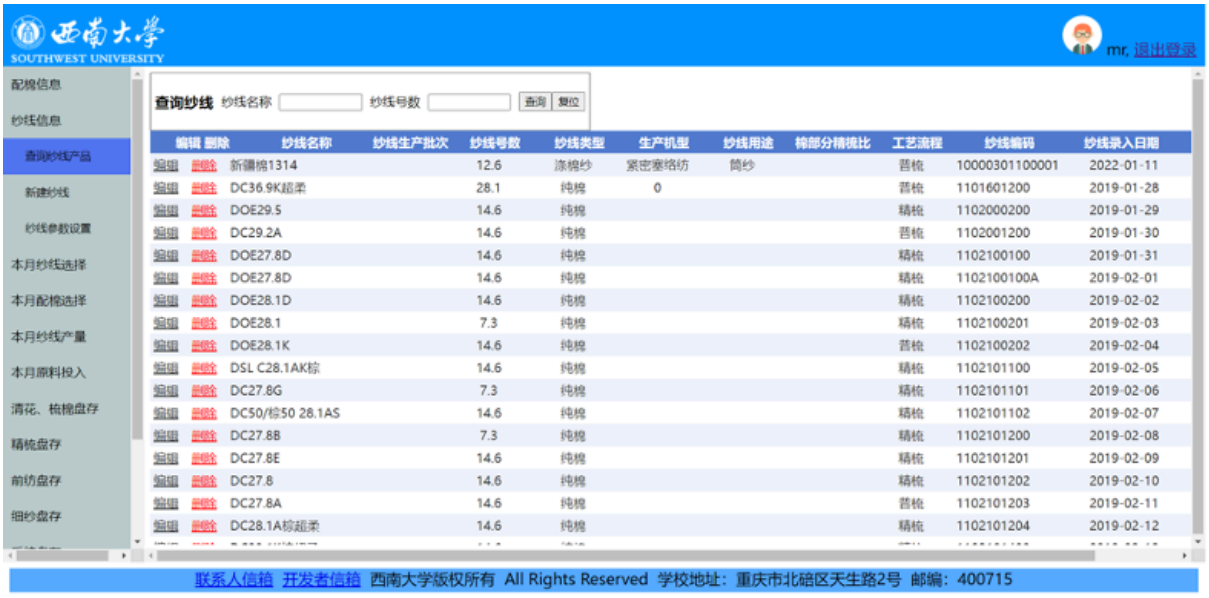

Figure 5.24 Yarn Product Query Page

Figure 5.25 Cotton-Blending Query Results

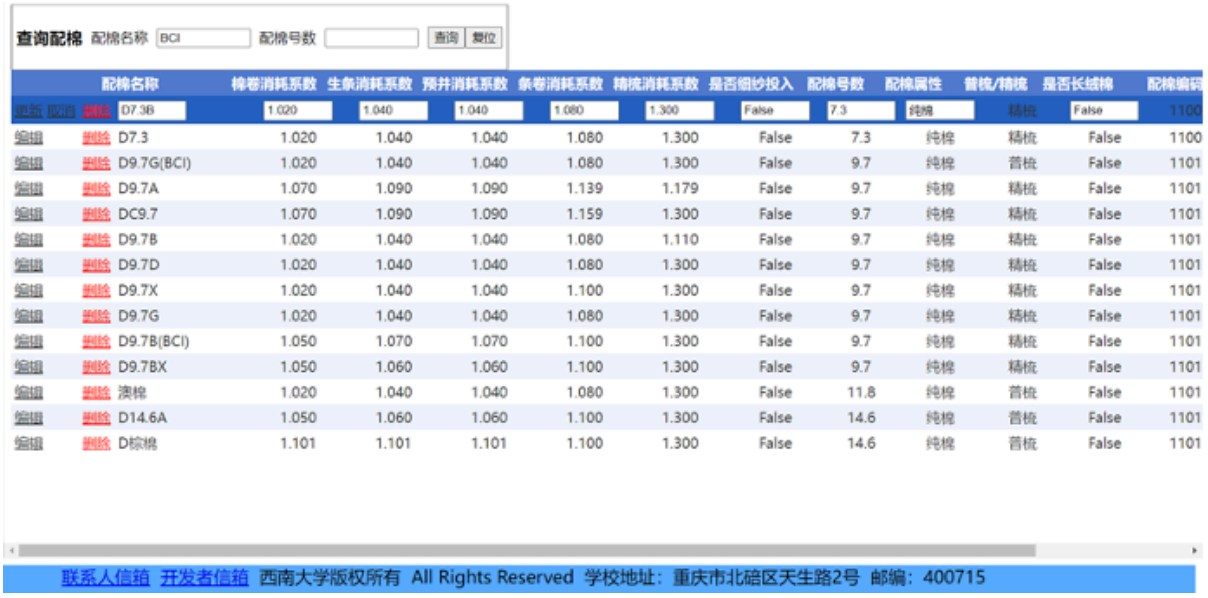

Figure 5.26 Edit Interface

Figure 5.27 Delete Prompt

The GridView display function has been improved. By dragging the scrollbar to the far right, this feature offers vertical scrolling and a display range function. By dragging the vertical scroll bar (or directly sliding the scroll wheel), users can view more data, while the title row remains frozen. At the same time, dragging the small triangle at the bottom-right corner can resize the table, which can be manually adjusted to an appropriate size for different computer screens, as shown in Figure 5.28. All subsequent data tables have the same functionality.

Figure 5.28 The Function of Grid View

5.2.5 Cotton-Blending and Yarn Creation Module Implementation

(1) Design Implementation

The system also needs to provide functions for adding new yarns and cotton-blending data. There are two options for the new data entry: single entry and batch entry. This module is divided into two parts: the upper part for single entry and the lower part for batch entry. For single entry, the interface will display all fields for users to input, while for batch entry, a template will be provided for users to download, along with an upload port for the batch entry table. The use case diagram for the new creation module is shown in Figure 5.29.

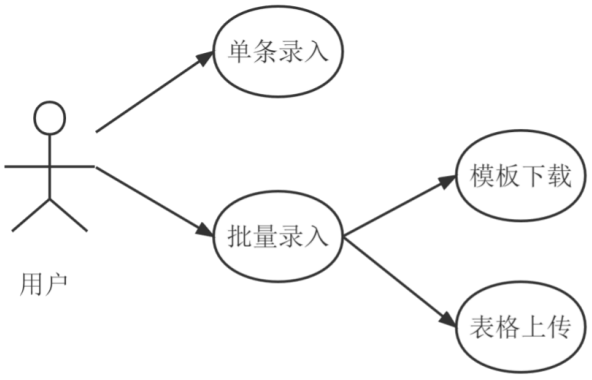

Figure 5.29 Insert Module Use Case Diagram

(2) Implementation Results

To create a new cotton-blending entry, users need to first click on the "Cotton-Blending Information" option in the menu, which will expand the submenu. After clicking the "Create New Cotton-Blending" option, the new entry interface will appear on the right, as shown in Figure 5.30. For creating new yarn entries, click the "Yarn Information" option in the menu, and the submenu will expand. After clicking the "Create New Yarn" option, the new entry interface will be displayed on the right, as shown in Figure 5.31.

Figure 5.30 Create New Cotton-Blending Page

Figure 5.31 Create New Yarn Page

For single cotton-blending entry, users will input relevant information in the interface above the scroll bar. In the cells, users fill in the corresponding information, select options by clicking radio buttons, choose from dropdown lists by clicking the right-arrow button, and select dates by clicking the "Choose Date" button. Cotton-blending code does not need to be entered as the system will automatically assign codes and consumption coefficients based

on cotton-blending attributes such as carded/combed. After all information is entered, users click the "Submit" button to save the newly created cotton-blending data into the database.

For batch cotton-blending entry, users can use the module below the scroll bar. They can click the "Download Template" button to download an Excel spreadsheet to their computer. After filling in the required information according to the template, users can click "Select File," choose the completed Excel file, and then click "OK" to upload. Once the "Upload Successful" prompt appears, the batch cotton-blending entry is complete. The first row of the template is for the title, and the second row is an example. Users need to delete the second row before entering new data, as shown in Figure 5.32.

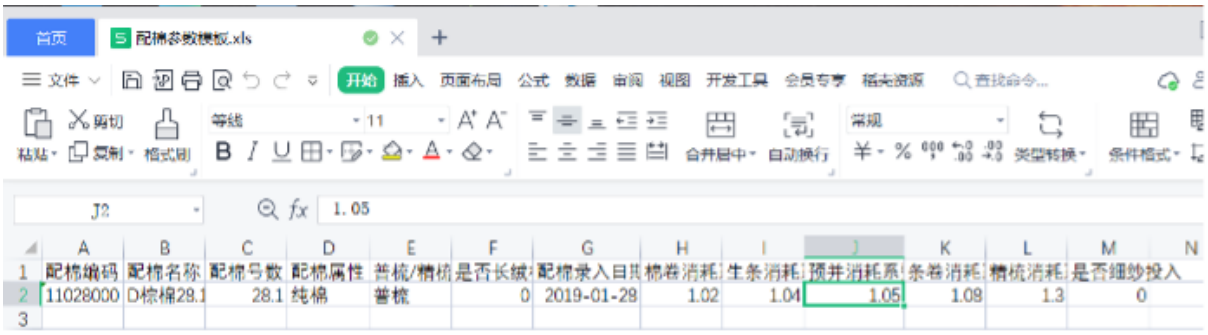

Figure 5.32 Table for Batch Cotton-Blending Entry

5.2.6 Yarn Parameter Setup Module Implementation

(1) Design Implementation

In the production process, one yarn type may use multiple cotton-blendings. This module is designed for pairing yarn with cotton-blending and filling in related parameters. The process is relatively complex, consisting of four steps: selecting yarn, selecting corresponding cotton-blendings, entering yarn-cotton-blending parameters, and submitting. Thus, the module is divided into four interfaces: Interface 1 displays yarn information for users to select the yarn (only one yarn can be processed at a time); Interface 2 displays cotton-blending information, where users can select cotton-blendings after choosing a yarn (multiple cotton-blendings can be selected); Interface 3 displays the selected yarn-cotton-blending information and allows users to enter related parameters, such as yarn quota per ton, material ratio, whether fine yarn is used, and the coefficients for various raw materials. There are constraints on these parameters: the yarn quota must be greater than 1000, the material ratio must sum to 100, each coefficient must be greater than 1 and increase progressively. Only when these conditions are met can the yarn parameters be submitted to the yarn parameters data table. Interface 4 provides detailed information about the selected yarn for reference. A batch upload module is also provided at the bottom of the page. The yarn parameter setup process is shown in Figure 5.33.

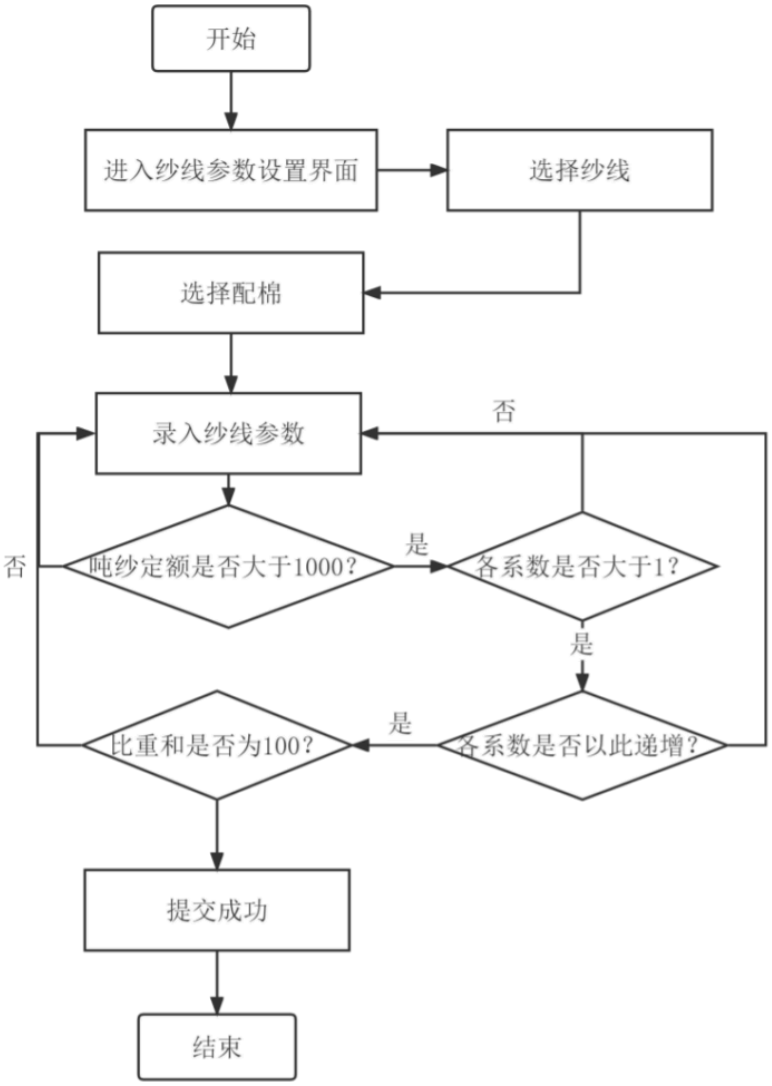

Figure 5.33 Yarn Parameter Setup Flowchart

(2) Implementation Results

To access the yarn parameter setup page, users first click the "Yarn Information" option in the menu, which will expand the submenu. After clicking the "Yarn Parameter Setup" option, the query interface will be displayed on the right side, as shown in Figure 5.34.

Figure 5.34 Yarn Parameter Setup Page

This page has four sections. Section 1 displays the selected yarn's information, Section 2 displays all yarn information, Section 3 displays all cotton-blending information, and Section 4 displays cotton-blending coefficient information.

1. First, select a yarn by checking Section 2. The system sorts yarns by the number of cotton-blendings in descending order and also supports fuzzy search by yarn name. If users do not want to filter results, they can click the "Reset" button to display all cotton-blendings. When the mouse moves to a row, it will highlight. Clicking anywhere in that row or selecting the radio button will choose the yarn, and the row text will become bold with the selection button activated. If selecting a yarn that already has cotton-blending, Section 1 will display the selected yarn's information, and the cotton-blendings associated with that yarn in Section 3 will be automatically selected. Section 4 will show other parameters for the yarn and cotton-blending, as shown in Figure 5.35.

Figure 5.35 Select A Yarn that Already has Cotton-Blending

When selecting a yarn that does not have cotton-blending, Section 4 will display empty headers, as shown in Figure 5.36.

Figure 5.36 Select A Yarn that Does Not Have Cotton-Blending

2. To select the appropriate cotton-blending for a yarn, go to Section 3. Click the checkbox in the first column or use the filtering options above to find the desired cotton-blending(s). Once selected, click the "Confirm Cotton-Blending Selection" button in Section 3 to finalize the selection. This action completes the pairing of the selected yarn with the chosen cotton-blendings, as shown in Figure 5.37.
3. After confirming the selection, the chosen cotton-blendings will appear in Section 4 for further parameter configuration, as seen in Figure 5.38.
4. If editing is needed, click the "Edit" button in Section 4. This action activates the editing feature, allowing users to fill in the required coefficients and parameters. Once the changes are made, click the "Update" tab to save the modifications. If the user does not wish to make any changes, clicking the "Cancel" button will leave the data unchanged, as shown in Figure 5.39 (1) and (2).
5. After completing the necessary edits and ensuring all parameters are filled in, click the "Submit Yarn Parameters" button at the top of the page to finalize and save the yarn parameter setup, as shown in Figure 5.40.

Figure 5.37 Selection of Cotton-Blending for Yarn

Figure 5.38: Completion of Selecting Cotton-Blending

Figure 5.39 (1): Start the Editing Function
Figure 5.39 (2): Click the "Update" Tab

Figure 5.40: Update the Parameter of Yarn

At the bottom of the page, the system provides a batch upload feature for yarn parameter settings. This feature, as shown in Figure 5.41, allows users to upload multiple yarn parameter configurations at once. The functionality is similar to the batch cotton-blending upload feature and will be detailed in a pop-up prompt when the page is initialized.

Figure 5.41: Yarn Parameter Settings in Batch

5.2.7 Selection of Yarn and Cotton-Blending for the Month

(1) Design Implementation

In textile production, data is settled on a monthly basis, so the system's functionality is designed around monthly calculations. The **Yarn and Cotton-Blending Selection for the Month** module requires users to first select and confirm the date, then choose the cotton-blending and yarn products used in actual production. After confirmation, a new table for the current month will be automatically created in the database. The flowchart for the monthly selection module is shown in Figure 5.42.

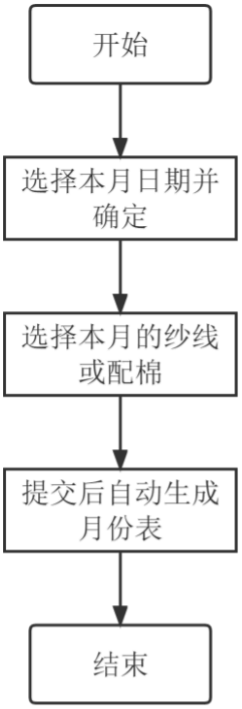

Figure 5.42: Flowchart of the Monthly Selection Module

(2) Result Implementation

Yarn Selection for the Month To access the yarn selection interface, click on the "Yarn Selection for the Month" option from the menu. The interface will be displayed on the right side of the page, as shown in Figure 5.43.

Figure 5.43: Yarn Selection of the Month Page

Cotton-Blending Selection for the Month Similarly, click on the "Cotton-Blending Selection for the Month" option to access the selection interface. After confirming the date, the interface will appear as shown in Figure 5.44.

Figure 5.44: Cotton-Blending Selection of the Month Page

inventory Date and Yarn Selection Process The system will default to the current year and month for the inventory date. After modifying it as needed, click the "Confirm Inventory Date" button to proceed. Once confirmed, the system will display all yarns, with the already selected yarns appearing first. The right side will show filter options for narrowing down the yarn list. You can select the yarns using checkboxes, as shown in Figure 5.45.

Figure 5.45: The Process of Yarn Selection

Wait for the system to respond when selecting or deselecting yarns. If the "Selected Products Count" changes, the operation is successful. Once you have selected all required yarns, click "Confirm Yarn Varieties for the Month" to complete the selection.

5.2.8 Yarn Production for the Month

(1) Design Implementation

This module provides functionality for entering yarn production quantities. Users input the actual production amounts for corresponding yarns. If a yarn uses multiple cotton-blendings, the system can also decompose the total production amount according to the proportions of each cotton-blending. The use case diagram for monthly production is shown in Figure 5.46.

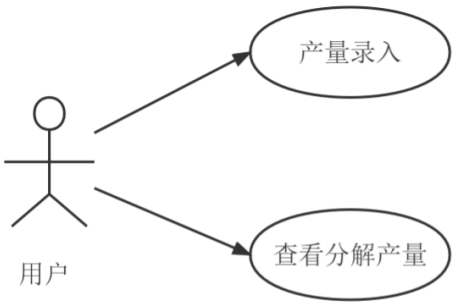

Figure 5.46: Monthly Production Use Case Diagram

(2) Result Implementation

Yarn Production for the Month To enter yarn production data, click on the "Yarn Production for the Month" option in the menu. The query interface will appear on the right side of the page, as shown in Figure 5.47.

Figure 5.47: Yarn Production of the Month Page

Input Yarn Production On this page, input the yarn's production quantity for the month. Use the "Tab" key to move between input fields. After completing the entries, click the "Submit" button to finalize the data. Once the left-side selection button is clicked, the corresponding cotton-blending for the yarn will appear on the right side. Only after clicking the submit button will the system calculate the breakdown of the production amount by cotton-blending, as shown in Figure 5.48.

Figure 5.48: Yarn's Decomposition Production

5.2.9 Inventory Module

(1) Design Implementation

The inventory module includes both pre-inventory (raw material input, cleaning, carding, and combing inventory) and post-inventory (spinning, roving, and winding inventory). Users will input the respective values into the relevant fields. No special requirements are needed. The use case diagram for the inventory module is shown in Figure 5.49.

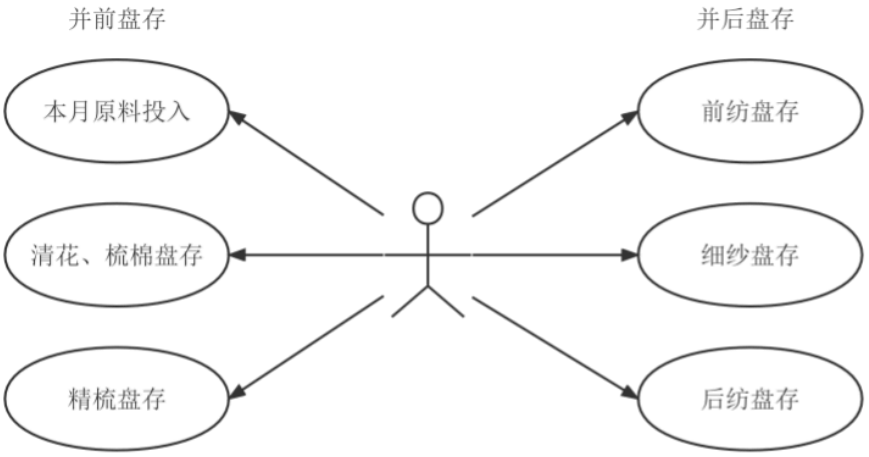

Figure 5.49: Inventory Module Use Case Diagram

(2) Result Implementation

Raw Material Input for the Month To access the raw material input page for the month, click on the "Raw Material Input for the Month" option in the menu. The interface will appear as shown in Figure 5.50. Based on production data, input the corresponding values and use the "Tab" key to navigate to the next field. After completing the entries, click the "Submit" button or press "Enter" to submit the data.

Figure 5.50: Input of Materials of the Month Page

Inventory Pages for Other Stages Similarly, for cleaning, carding, combing, roving, spinning, and winding inventory pages, click on the respective menu options (Figures 5.51 to 5.55). Each page allows users to input inventory values relevant to each stage of production.

Figure 5.51: Inventory of Cleaning and Carding Page

Figure 5.52: Inventory of Combing Page

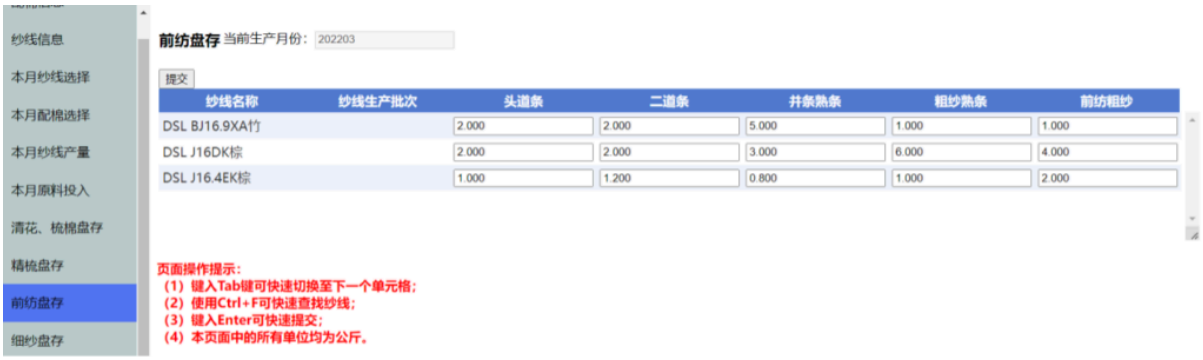

Figure 5.53: Inventory of Roving PagE

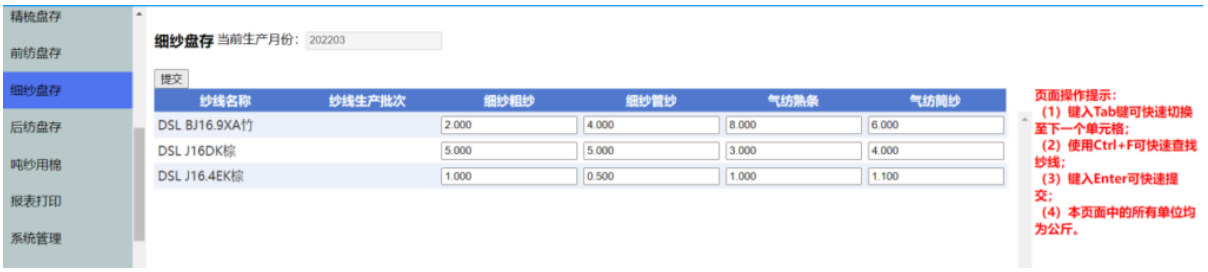

Figure 5.54: Inventory of Spinning Page

Figure 5.55: Inventory of Winding Page

5.2.10 Cotton Consumption per Ton of Yarn Calculation Module

(1) Design Implementation

The **Cotton Consumption per Ton of Yarn Calculation** module integrates previously entered data, such as production quantities and inventory, into a table and calculates the net

cotton and blended cotton per ton of yarn. The calculation is performed using stored procedures, and the front-end design only needs to display the date for calculation and provide a button to trigger the stored procedure. Upon pressing the button, the system automatically calls the stored procedure and displays the results below.

(2) Result Implementation

To access the **Cotton Consumption per Ton of Yarn** page, click on the "Cotton Consumption per Ton Yarn" option in the menu. The interface will appear as shown in **Figure 5.56**.

Figure 5.56: Calculation of Consumption Per One Ton Yarns Page

After confirming the date, click the button below to perform the calculation. The results will be displayed below, as shown in **Figure 5.57**.

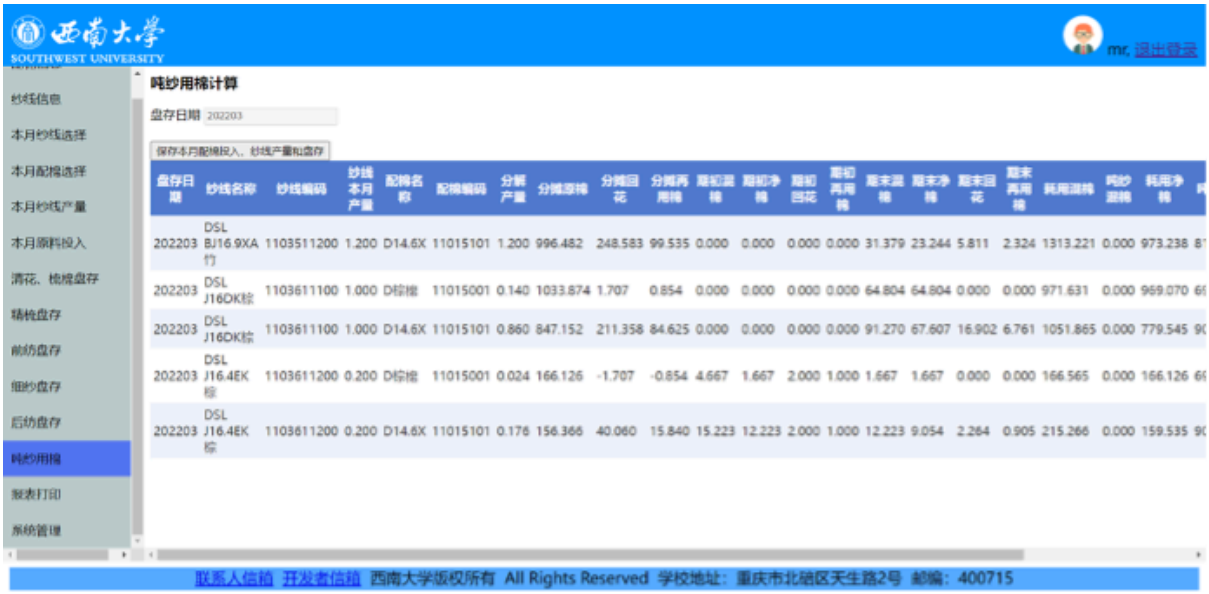

Figure 5.57: Result of Calculation of Consumption Per One Ton Yarns

5.2.11 Report Printing Module

(1) Design Implementation

The **Report Printing** module provides more intuitive data integration for the company's production. In this module, users need to select the reporting period (e.g., annual,

semi-annual, quarterly, monthly) and report type (e.g., raw material input, cotton inventory). After selecting the desired report, clicking the query button will display the report below. The user can then output the report in Excel format. The use case diagram for the report module is shown in **Figure 5.58**.

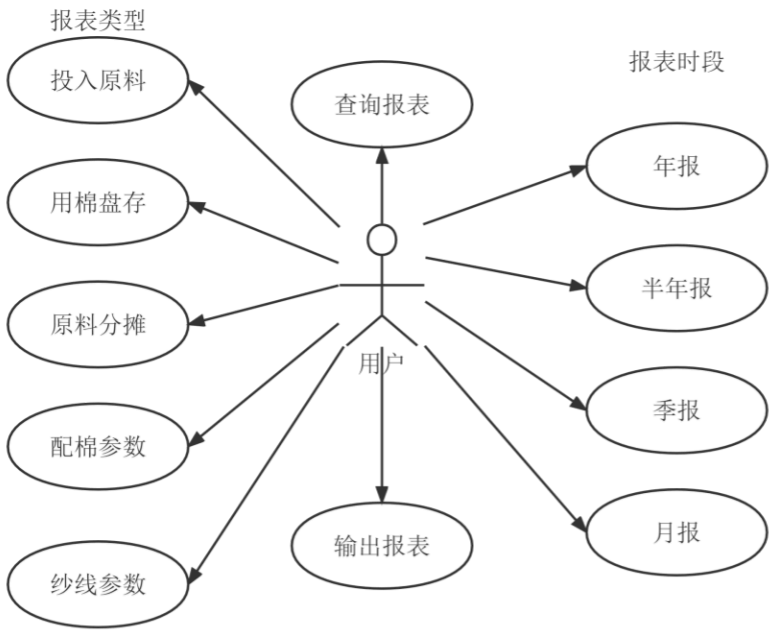

Figure 5.58: Report Module Use Case Diagram

(2) Result Implementation

Using a monthly cotton inventory report as an example, the user selects the date, reporting period, and report type, then clicks the query button. If no such report exists or the date is incorrect, an error message will be displayed. If no issues are found, the report interface will appear as shown in **Figure 5.59**.

Figure 5.59: Page of Printing the Report

Click the "Print Report" button, and the webpage will begin downloading the Excel file to the computer, as shown in **Figure 5.60**.

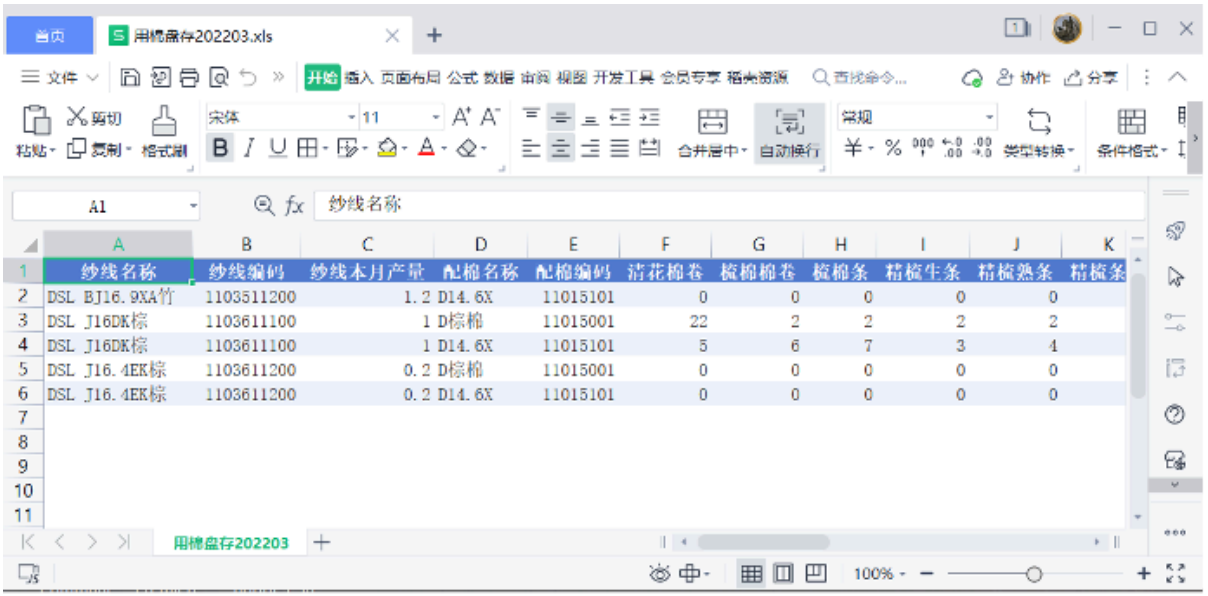

Figure 5.60: Output a Sample Report

5.2.12 User Management and Password Modification Module

(1) Design Implementation

When a regular user first registers, they have no permissions and can only access the "Change Password" page in "System Management." After registration, the user must contact the administrator, who will assign permissions. Once granted permissions, the user can only access the modules they have been assigned, and attempting to access other modules will result in an error page. The management user module is available only to the superuser to assign and delete user permissions. The password modification module provides a user interface for changing passwords. The management module use case diagram is shown in **Figure 5.61**.

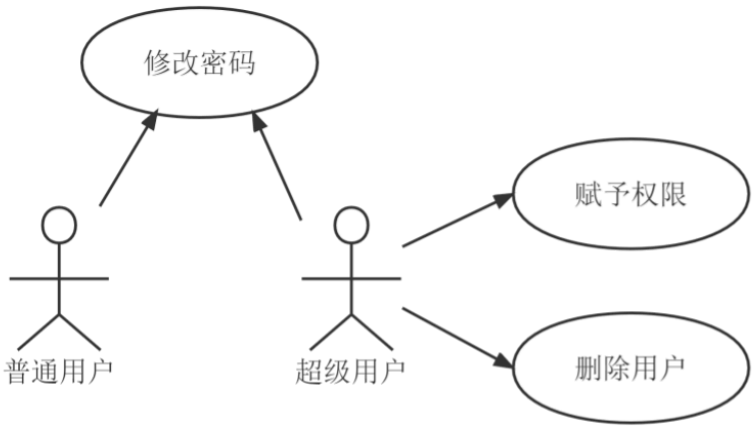

Figure 5.61: Management Module Use Case Diagram

(2) Result Implementation

User Management Page To manage users, click the "System Management" option in the menu, which will expand the submenu. Select the "User Management" option, and the user management interface will appear on the right side, as shown in **Figure 5.62**.

Figure 5.62: User Management Page

Delete User To delete a user, click the blue delete button, and a confirmation dialog will appear. Once confirmed, the user will be removed.

Manage User Permissions To manage user permissions, click the "Modify Permissions" radio button in the first column. The user's permissions will be displayed below. The superuser can assign the appropriate permissions, and after confirming the changes, click the submit button to save them, as shown in **Figure 5.63**.

Figure 5.63: User Rights Management

Modify Password To modify a password, click the "User Management" option in the menu and then select "Modify Password" from the submenu. The password modification page will appear, as shown in **Figure 5.64**. All users can access this page to input their current password, new password, and confirm the new password. Click "Confirm" to change the password. If the current password is incorrect or the new passwords do not match, an error message will be displayed.

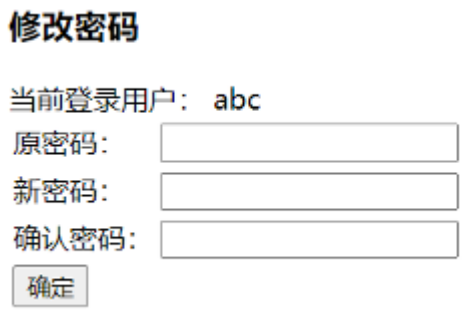

Figure 5.64: Modify Password Page

5.2.13 Background Management Module

This page is accessible only to the super administrator. The module is primarily used for database algorithm upgrades, allowing super administrators who are not familiar with database methods to directly modify stored procedures. The page allows the superuser to paste the developer-provided update file code into a text box and click the "Submit" button to complete the stored procedure upgrade. The management interface is shown in **Figure 5.65**.

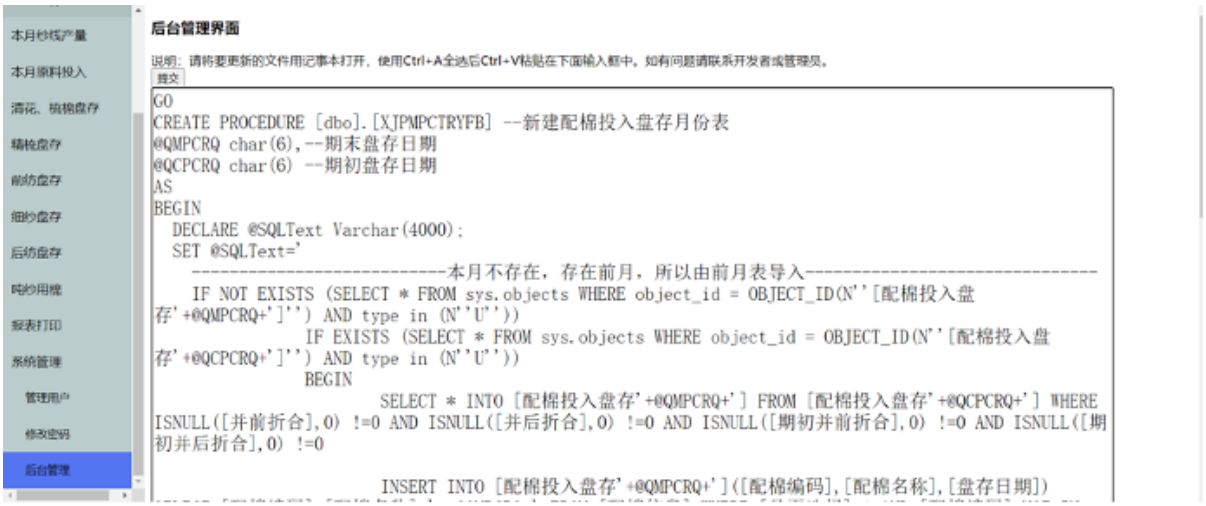

Figure 5.65: Background Management Page

Chapter 6: System Testing and Maintenance

6.1 System Testing

After the system is completed, it must undergo testing to ensure its normal and stable operation. This section focuses on unit black-box testing for several modules, where we do not concern ourselves with the internal code correctness but instead focus on whether the expected output results can be obtained from the given input. The development process already involved multiple rounds of white-box and black-box testing, and here we only list the black-box tests for certain modules.

6.1.1 Login and Registration Function Testing

(1) Normal Login When the username, password, and verification code are correct, the system successfully logs in and redirects to the main page, as shown in Figure 6.1.

Figure 6.1 Normal Login

(2) Incorrect Username or Password If the username and password do not match, the system displays an error message, "Incorrect username or password, please try again," as shown in Figure 6.2.

Figure 6.2 Wrong username or password

(3) Incorrect Verification Code When the user inputs an incorrect verification code, the system will show an error message, "Verification code is incorrect," as shown in Figure 6.3.

Figure 6.3 Wrong Verification Code

(4) Username Check On the registration page, if the username already exists in the system, the system will show a popup alert, "Username already exists," as shown in Figure 6.4.

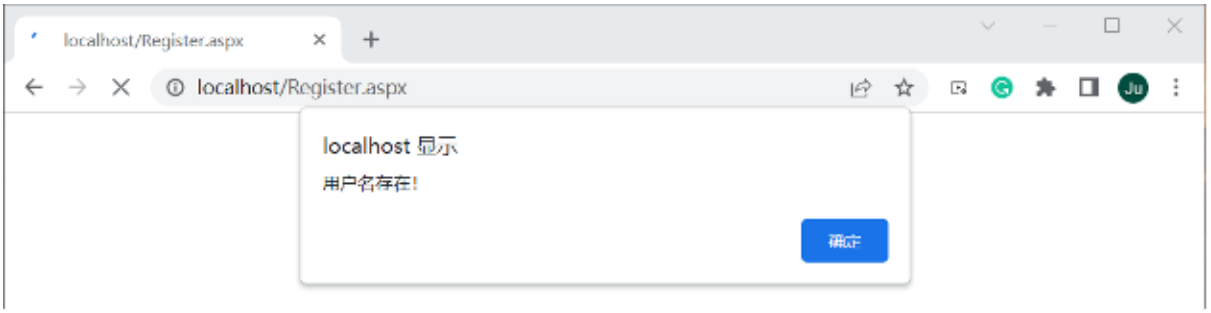

Figure 6.4 Alert of User Name Already Existing

If the username is not taken, the system will display "Congratulations! This username has not been registered!" as shown in Figure 6.5.

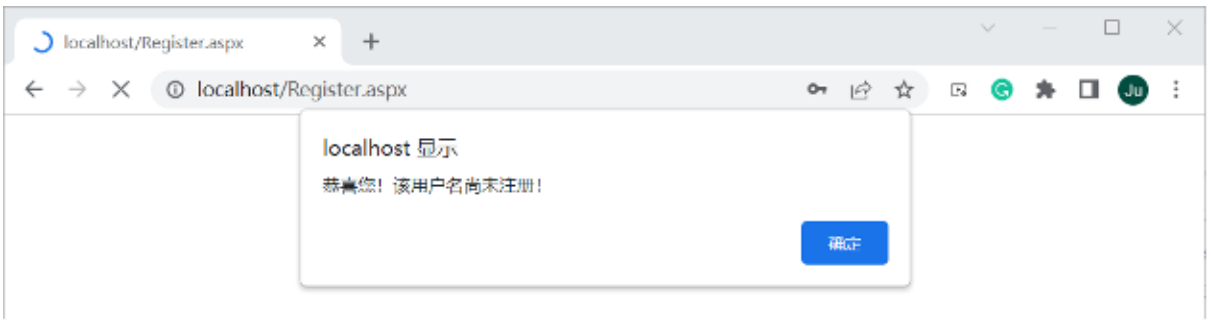

Figure 6.5 User Name Not Being Used

(5) Password and Confirmation Mismatch During registration, the user must enter the password twice. If the passwords do not match, the system will display "Confirm password does not match" next to the confirmation password field, as shown in Figure 6.6.

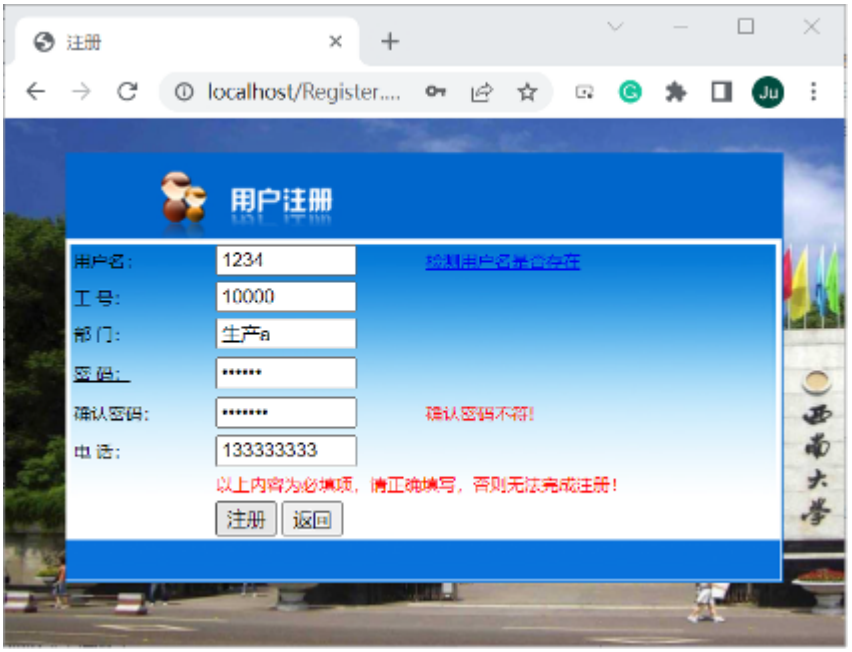

Figure 6.6 Confirm Password Incorrect

6.1.2 Permission Testing

After a regular user is granted permissions, they will be unable to access pages they are not authorized to view. The system will display a "No permission" alert, as shown in Figure 6.7.

Figure 6.7 Alert of No Permission

6.1.3 Login Timeout Testing

If no action is taken for a certain amount of time, the system will automatically log out. Upon attempting to access a module, the user will be prompted with "Not logged in, please log in first," and redirected to the login page, as shown in Figure 6.8.

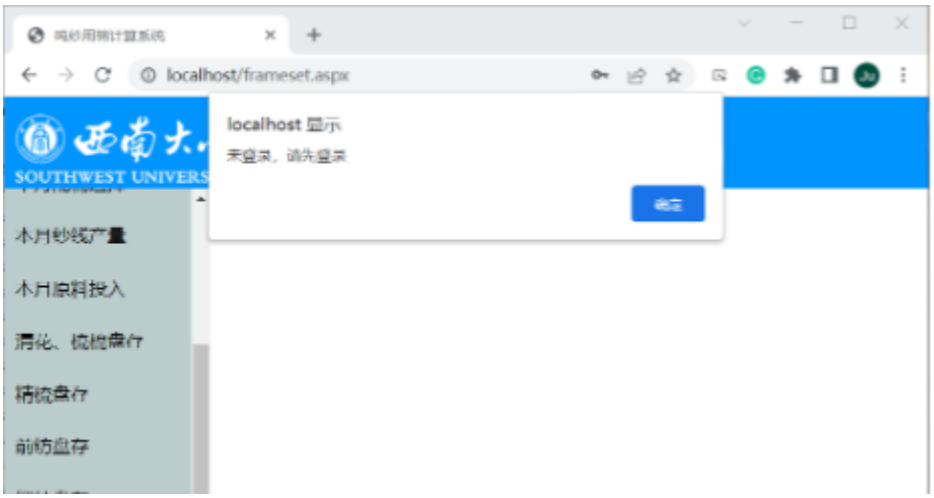

Figure 6.8 Logon Timed Out

6.1.4 Download and Upload Function Testing

(1) Download Function The system supports downloading functionality in modules like batch upload and report printing. Upon clicking the download button, the browser will automatically download the corresponding file, such as the batch entry template, as shown in Figure 6.9.

Figure 6.9 Download the File

(2) Upload Function After filling in the content according to the template, the user can select the file and upload it, completing the batch data entry, as shown in Figure 6.10.

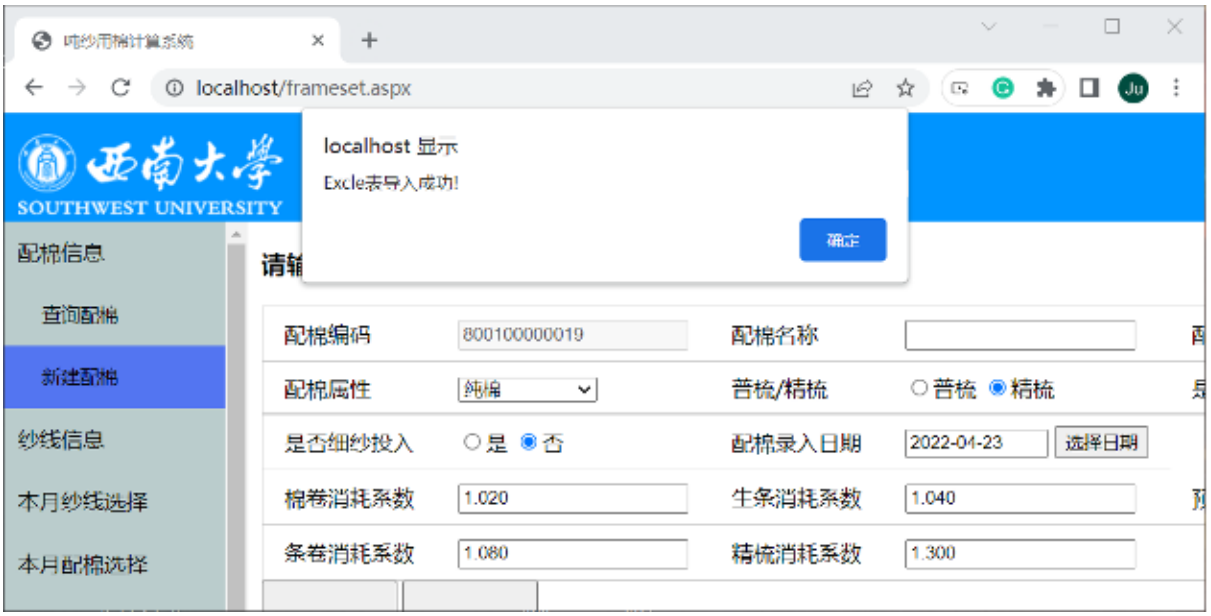

Figure 6.10 The File Successfully Upload

6.2 Multi-Browser Support Testing

The system supports browsers such as Google Chrome, Microsoft Edge, and Safari. The following are the login screenshots for each browser:

- Google Chrome (Figure 6.11)
- Microsoft Edge (Figure 6.12)
- Safari (Figure 6.13)

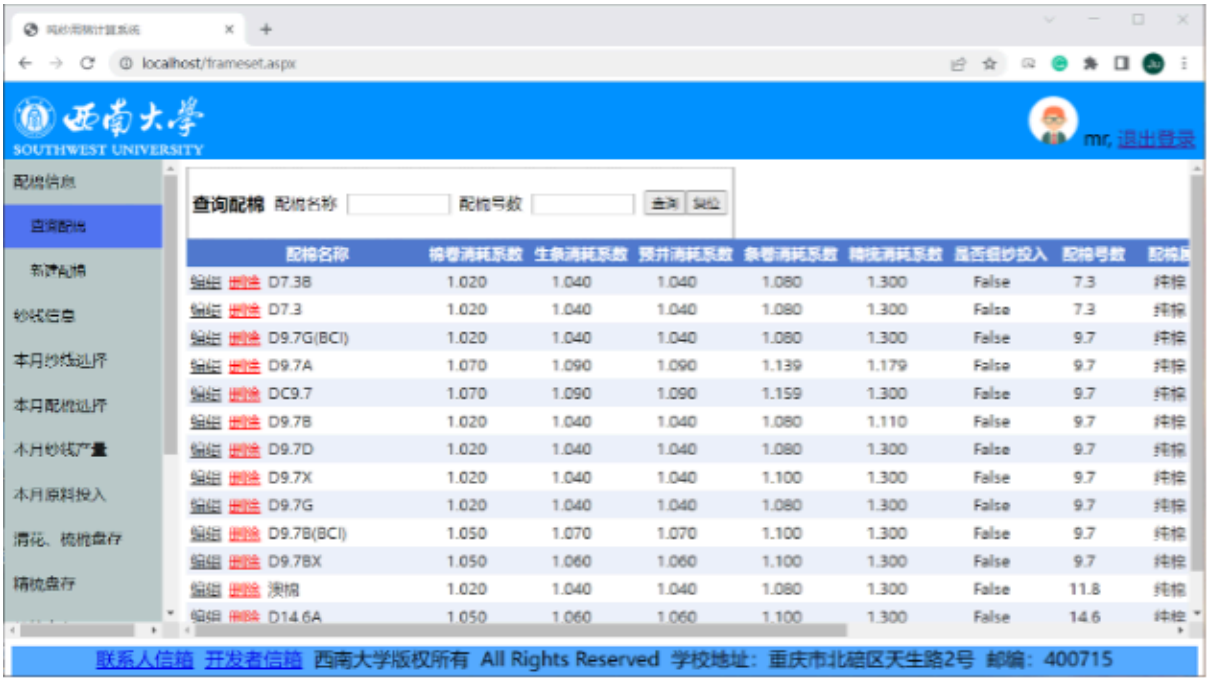

Figure 6.11 **Google Chrome Login**

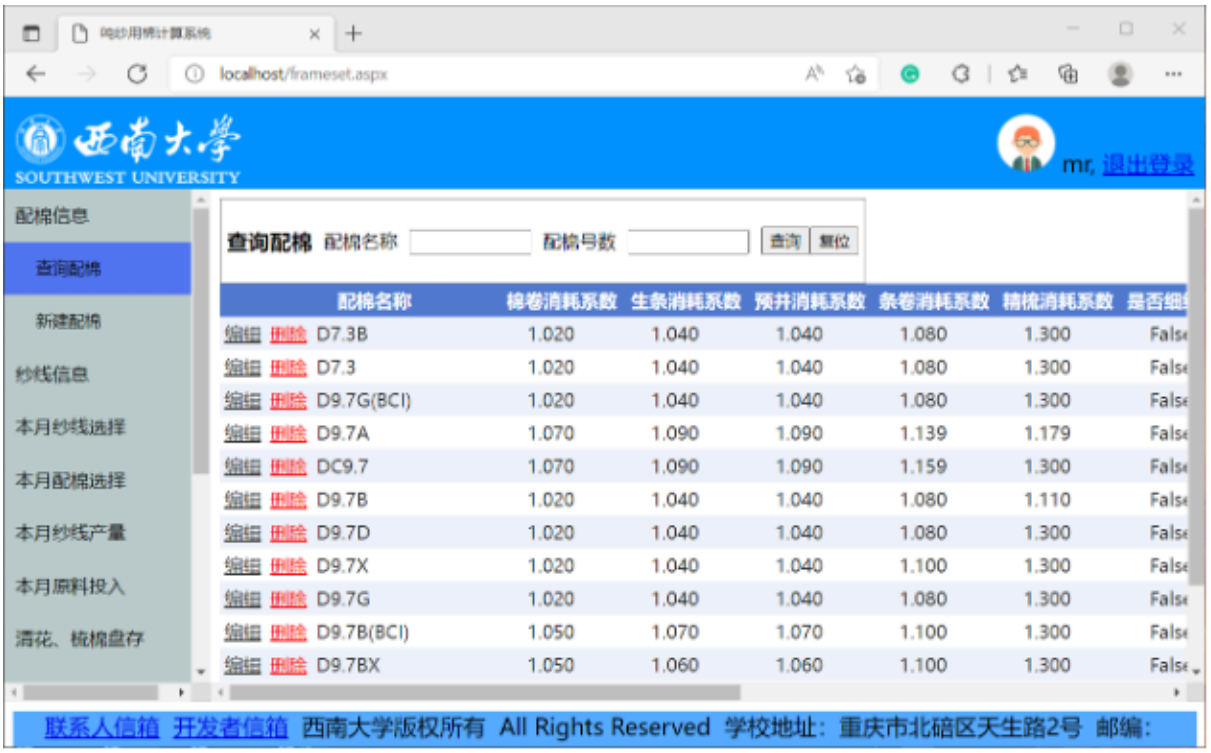

Figure 6.12 **Microsoft Edge Login**

Figure 6.13 Safari Login

6.3 System Maintenance

After two major version updates and several minor modifications, the system was finalized. Users may discover certain features or settings that are not intuitive or logical, and these requirements will be modified during subsequent maintenance phases. Both the development and maintenance processes are logged. Table 6.1 shows a portion of the development and maintenance logs.

Table 6.1: Partial Development and Maintenance Logs

Version	Log
1.0	Initial development completed, based on C/S architecture with JavaScript ActiveXObject.
...	...
2.0.0	Iterated the system to B/S three-layer architecture using ASP.NET technology.
...	...

2.2.1	- Removed yarn code and cotton code from GridView on each page.- Added scrollbars to GridViews and optimized the display format.- Added operation instructions to each page.
2.2.2	- Fixed issue where yarn information insertion failed due to inconsistent stored procedure versions.- Renamed "XX consumption coefficient" to "XX material conversion coefficient."
2.2.3	- Deleted redundant query conditions in cotton information.- Modified the layout of new cotton entry page.
2.2.4	- Added drag-and-drop feature to GridView for resizing columns.- Optimized database algorithms.

Chapter 7: Intelligent Parameter Maintenance Algorithm

After the system completes the calculations, it automatically generates the following tables: raw material input table, raw material inventory table, intermediate product inventory table, output table, cotton consumption per ton of yarn table, and product parameter table. These tables record various details about raw materials, products, and parameters in the production process. The most technically complex and labor-intensive process during system operation is parameter maintenance, such as the cotton consumption coefficients used in preliminary spinning inventories, drawing consumption coefficients, yarn consumption coefficients, and combing consumption coefficients, as well as the equivalent coefficients for materials like熟条 (cooked yarn),粗纱 (coarse yarn), 管纱 (tube yarn), and 筒纱 (spindle yarn) in subsequent spinning inventories. Different products might use the same cotton blend, and a single product might use multiple blends, which makes the coefficients in production processes not always accurate. By accumulating data over several years, it is possible to apply statistical learning methods (machine learning) to categorize the features of the data and compute estimated values for various types of data, enabling statistical updates to parameters. Therefore, the parameter maintenance algorithm is mainly divided into three steps: clustering, calculating related parameters, and error analysis.

7.1 Clustering

The most commonly used statistical learning methods are supervised learning and unsupervised learning. The distinction is based on whether there are labels in the learning model. Since no labels are available in the training data, unsupervised learning is applied. The dataset contains both categorical and numerical data, and the number of categories is unknown, so the Two-Step Clustering method is used.

Two-Step Clustering (TSC) consists of two phases: pre-clustering and formal clustering.

- **Pre-clustering**: This step uses the raw material characteristics of different products for clustering. The numerical data selected include yarn count and cotton consumption per ton of yarn, while categorical data include whether the yarn is fine, the cotton blend type, and the production process. This step uses the BIRCH algorithm to select category centers based on the data sample features, constructing a clustering feature tree (CF-Tree) and placing different data points in the leaves. Each time a new data point arrives, its distance to each center is calculated. If the distance is small, the data is placed in the corresponding leaf; otherwise, it becomes a new node.
- **Formal clustering**: The optimal number of clusters is determined based on the Schwarz Bayesian Information Criterion (BIC) and the change in the shortest inter-cluster distance. The likelihood log function decreases as categories merge, and the logarithmic likelihood function is used to process both numerical and categorical data. The distance between clusters i and j is represented by the reduction in log-likelihood when they merge.

$$d_{(j,s)} = \varepsilon_j + \varepsilon_s - \varepsilon_{(j,s)} \tag{7-1}$$

$$\varepsilon_v = -N_v\left(\sum_{k=1}^{K_A}\frac{1}{2}\ln(\sigma_k^2+\sigma_{vk}^2)+\sum_{k=1}^{K_B}E_{vk}\right) \tag{7-2}$$

$$E_{vk} = -\sum_{l=1}^{L_k}\frac{N_{vkl}}{N_v}\lg\frac{N_{vkl}}{N_v} \tag{7-3}$$

After performing the Two-Step Clustering using IBM SPSS Statistics 23, the clustering results are obtained, as shown in **Table 7.1**.

Table 7.1 The Result of Two-step Cluster

Cluster	Cluster BIC (Schwarz Bayesian Criterion)	BIC Change (d BIC)	BIC Change Ratio (r BIC)	Distance Measurement Ratio (r L)
1	17351.372			
2	11106.856	-6244.516	1.000	2.041
3	8104.258	-3002.598	.481	1.819
4	6503.814	-1600.444	.256	1.183
5	5168.678	-1335.136	.214	1.248
6	4121.679	-1046.998	.168	1.498
7	3460.116	-661.563	.106	1.857
8	3155.805	-304.311	.049	1.057
9	2873.897	-281.908	.045	1.165
10	2647.876	-226.021	.036	1.528
11	2538.822	-109.054	.017	1.290
12	2479.604	-59.218	.009	1.023
13	2424.175	-55.429	.009	1.097
14	2383.650	-40.526	.006	1.115
15	2358.898	-24.751	.004	1.374

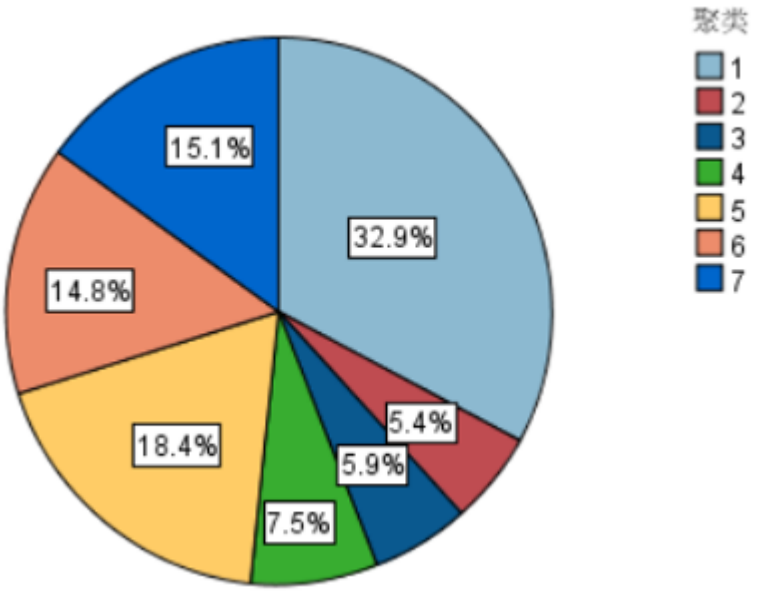

Figure 7.1 The Size of the Clusters and the Proportion of Each Category

Based on the automatic clustering rule, an initial estimate suggests 10 clusters, but fine-tuning indicates 7 clusters, with a silhouette score of 0.8, indicating good clustering quality.

7.2 Calculation of Related Parameters

The dataset is split into a training set (2000 data points) and a testing set (1116 data points). In the training set, normality tests are conducted on the parameters of each category using the Shapiro-Wilk and Kolmogorov-Smirnov tests. If the data passes the normality test, maximum likelihood estimation is used to replace the population mean with the sample mean. If the test fails, sample statistics like median or mode are used. The predicted parameters for each category are summarized in **Table 7.2**.

Table 7.2 Prediction of Parameters

Parameter/Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Cotton Roll Coefficient	1.02	1.01	1.01	1.01	1.01	1.01	1.02
Sliver Coefficient	1.04	1.02	1.02	1.02	1.02	1.02	1.04
Yarn Coefficient	1.08	1.03	1.04	1.02	1.04	1.04	1.08
Combing Coefficient	1.30	0.00	0.00	0.00	0.00	0.00	1.30
Pre-drawing Coefficient	1.30	1.01	1.01	1.01	1.01	1.00	1.30
Coarse Yarn Coefficient	1.32	1.02	1.02	1.02	1.01	1.01	1.32

Tube Yarn Coefficient	1.34	1.03	1.03	1.03	1.02	1.02	1.34
Spindle Yarn Coefficient	1.40	1.00	1.00	1.00	1.00	1.00	1.40

7.3 Error Analysis

The predicted parameter values from **Table 7.2** are substituted into both the training and testing datasets, and errors are computed using the formula in **Equation (7-4)**. This equation quantifies the cumulative error between the predicted and actual parameter values.

$$e_j = \sum_{i=1}^{A_k} | p_i - \hat{p}_i | \tag{7-4}$$

- **Figure 7.2** shows the relationship between the error threshold and prediction accuracy. The error threshold is the maximum allowable error, and prediction accuracy is the proportion of correct predictions.

The results indicate that when the error threshold is above 1.5, parameters can be predicted accurately. As the threshold decreases, the accuracy drops, but good predictions are still possible for smaller error thresholds.

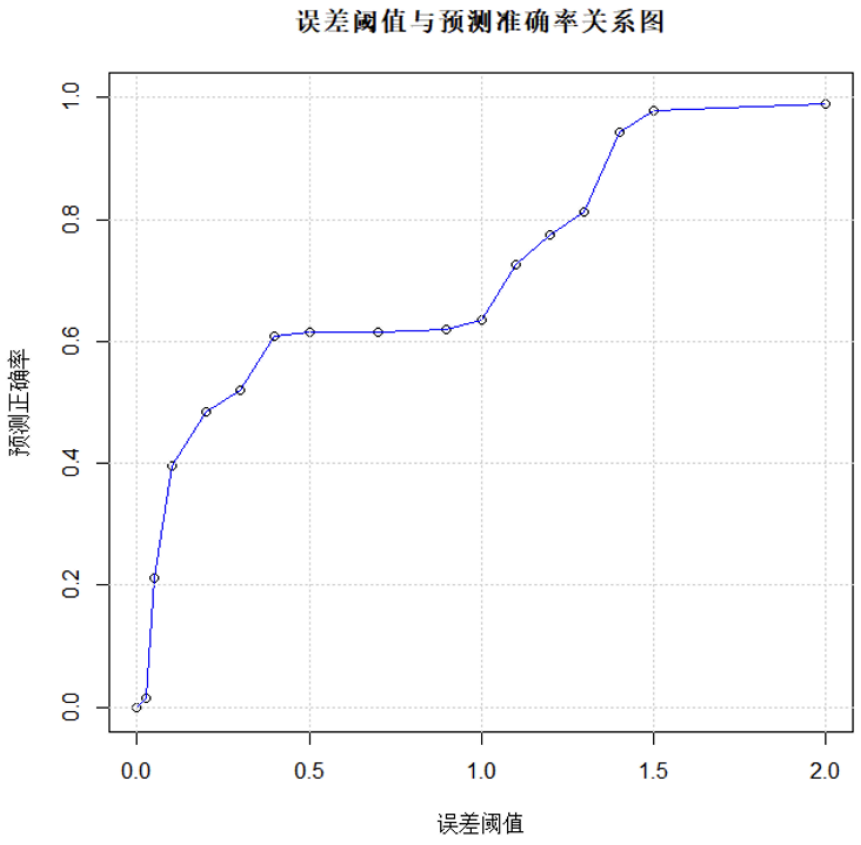

Figure 7.2: The Graph of Relationship Between Error Threshold and Prediction Accuracy

Chapter 8: Conclusion

1. **The system’s functionality has been fully developed and meets basic needs.** From the module implementation section, it can be seen that the system has a user management system, which allows users to be divided into different roles, such as administrators and operators. Based on the content each operator handles, different control permissions are granted to different modules, ensuring the security of the system's data. The left side of the system provides a menu bar arranged according to the production order, which is easy to operate and user-friendly. Users can locate the corresponding process module according to the process they are responsible for and complete their tasks. For more complex pages, there are operation tips and quick data entry methods to improve production efficiency. Various functional modules are continuously being refined to meet the demands for ease of use and convenience, such as freezing the first row of long tables for better data visibility and enabling batch import features to facilitate data processing.
2. **The calculation process has been continuously refined and has achieved the expected goals.** The system’s calculation functionality primarily relies on stored procedures in the backend database. During the development process, the backend stored procedures were continuously modified according to relevant literature and the algorithms from previous standalone systems. Test data was constantly used to observe whether the results from the calculations met the expectations. The front end also needs to predict various user errors to ensure that these errors do not result in fatal data losses. Through continuous refinement, the algorithms and the system's robustness have improved, making it more tolerant of most errors and capable of calculating the required results more reliably.
3. **The system has been provided for enterprise trial use, and communication with the enterprise has led to feedback for feature upgrades and interface improvements.** The system has been provided for trial use at a company in Shandong. During the trial, the company gave feedback based on their actual operational processes. For example, in the "Yarn Parameter Settings" page, the data in the yarn selection and cotton selection modules was overwhelming, making it difficult to find the target options. In response to this feedback, a search and reset button were added to this module. Additionally, in the "Current Month Selection" module, the "Confirm Current Month Yarn" button, an important function, was too small and not very noticeable. After receiving feedback, the button size was increased for better visibility. Other features and interface upgrades are continuously being tested and improved. More details about the post-launch maintenance process can be found in Section 2.4, which includes the development and maintenance logs.
4. **Future directions.** As mentioned earlier, the system has met the basic development and calculation requirements but still has some issues to address. Future improvements will consider adding subtotals to the inventory table, using improved algorithms for parameter fitting, and continuing to upgrade the system to make it more user-friendly and intelligent. Efforts will also be made to apply for patents and write academic papers to ensure the system is more widely used.