Campus Card Service System(CCSS)

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Catalogue

1. Brief Introduction of CCSS

1.1 Background

In the ever-evolving landscape of information technology and societal needs, university campuses are witnessing a transformation in management approach. The Campus Card Service System (CCSS) materialized in response to this, aiming to streamline services, bolster administration efficiency, and provide a secure monitoring system for personnel movement, goods management, and consumer habits. As students' expectations for campus life quality escalate, the demand for accessible, personalized, and smart services intensifies. In light of the digitization of education, the necessity and timeliness of the CCSS design are evident, providing a stepping stone towards comprehensive modernization of education.

1.2 Purpose of product design

- **Efficiency improvement:** Through the integration of various services in one system, such as canteen, library, dormitory access control, etc., effectively improve the efficiency of campus operation and management, and reduce the burden of school administration.

- **Security improvement:** CCSS can effectively monitor consumer behavior, personnel access and other information on campus, which helps to enhance campus security measures and protect students' personal information and property.

- **User experience improvement:** To provide students with a card service, to facilitate their various consumption or use of campus facilities in the campus, so as to enhance their campus life experience.

- **Promoting education modernization:** Combined with information technology, CCSS caters to the needs of education modernization, promotes innovation in campus management, and helps to improve the overall quality of education.

1.3 Some constraints

CCSS is subject to the following conditions:

- The amount in the campus card is non-refundable in our system. Once the user transfers funds to the campus card, they cannot be transferred out or withdrawn.

- The Campus card can only be used within the school and cannot be used at any other school or institution.

- The campus card has a maximum limit beyond which it cannot be recharged. This limit is set by the school administration and may be adjusted at any time.

- According to the university's regulations, users must abide by the relevant consumption rules and ethics code, or they may face the risk of fines or having their campus cards deactivated.

2. Users Requirements Analysis

This section describes the users for which the product is intended, the needs of the users, and the needs of the administrators.

2.1 Service Scope

Students and staff(users): They are the main users who can use the system to complete online learning, borrowing books, dining in the cafeteria, campus consumption and other activities. Staff can use this system to manage teaching work. In addition to managing student information, they can also make purchases such as dining in the cafeteria.

Cooperative businesses: Bookstores, canteens, convenience stores and other businesses in the school can also use the system for business activities, such as selling goods and receiving payments.

Administrators: The operators, who can use CCSS's back-office management system for account management, transaction data analysis, abnormal problem handling and other operations.

Cooperative businesses: Bookstores, canteens, convenience stores and other businesses in the school can also use the system for business activities, such as selling goods and receiving payments.

Third-party payment platforms: Third-party payment platforms can provide interfaces to CCSS to realize the transfer in and out of funds between the public bank account of the campus card and the user's account, and return the transfer result.

2.2 Functional Requirements

User Account Management: Students and staff can create and maintain personal accounts. The

system should support account activation, loss reporting, freezing and cancellation functions.

Fund Management: Users can recharge their campus card accounts through third-party payment platforms. The system should ensure the accuracy of the recharge amount and provide a history of the recharge.

Consumption Management: Students and faculty members are able to use campus cards to make payments in a variety of consumption scenarios on campus. The system should record the details of each purchase, including the time, location and amount.

Quota control: The system should set the maximum recharge limit of the campus card according to the regulations of the school, and provide clear prompts when the user recharges.

Non-refundable: The system should ensure that once the funds are charged to the Campus card, they cannot be returned to the original payment account.

Restrictions on use on campus: Campus cards should be restricted to use on campus and may not be used at other schools or institutions off campus.

Student Information Management: Faculty members are able to manage student information, including personal information, course registration, and grade records.

Business activities support: Cooperative merchants such as bookstores, canteens and convenience stores on campus can use the system to sell and collect goods.

Background management system: The system administrator can use the background management function to manage accounts, analyze transaction data, and handle abnormal problems.

Third-party payment platform integration: The system should be integrated with the third-party payment platform to realize the transfer of funds between the campus card public bank account and the user account and return the transfer results.

Network Availability Requirements: CCSS needs to use a stable network connection to ensure smooth communication between the mobile application and the background management system and the server to avoid network failure or interruption

User interface: The system should provide an intuitive and easy-to-use user interface to improve the user experience.

2.3 Non-functional Requirements

Consumer Rules and ethics: The system should enforce consumption rules and ethics on campus and take action when users violate the rules.

Security and Privacy protection: The system should have strong security features to protect the security of users' personal information and transaction data.

Performance requirements: The system should be able to handle high concurrent transactions to ensure response times during peak hours.Fast top-up and payment processing should be supported to provide a seamless user experience.

Reliability and availability: The system should have high reliability to ensure failover and disaster recovery mechanisms.99.9% system availability should be guaranteed, with minimal maintenance and downtime.

Scalability: The system design should allow for easy scaling to accommodate the growth of the number of users and the addition of new services.

Compatibility: The system should be compatible with mainstream payment platforms and other management systems on campus.

Ease of use: The system interface should be intuitive, easy to operate, and suitable for users with different technical levels.

Maintainability: The system should be designed to be easy to maintain and upgrade for future feature enhancements.

Interoperability: The system should be able to exchange data with other campus systems (such as library management systems, dormitory management systems, etc.).

Documentation and training: Provide detailed user manuals and online help documents, as well as necessary user training.

Technical support: Provide effective technical support and user services to solve the problems encountered by users in the process of use.

Disaster Recovery: Develop a disaster recovery plan to ensure that services can be quickly restored in the event of a system failure.

Cost effective: System development and operating costs should be within budget, and long-term operating costs should be competitive.

3. Functional division

Based on the above requirements analysis, we subdivide the functions into the following three parts: user requirements, system platform design, and system management.

Figure 1 Function tree
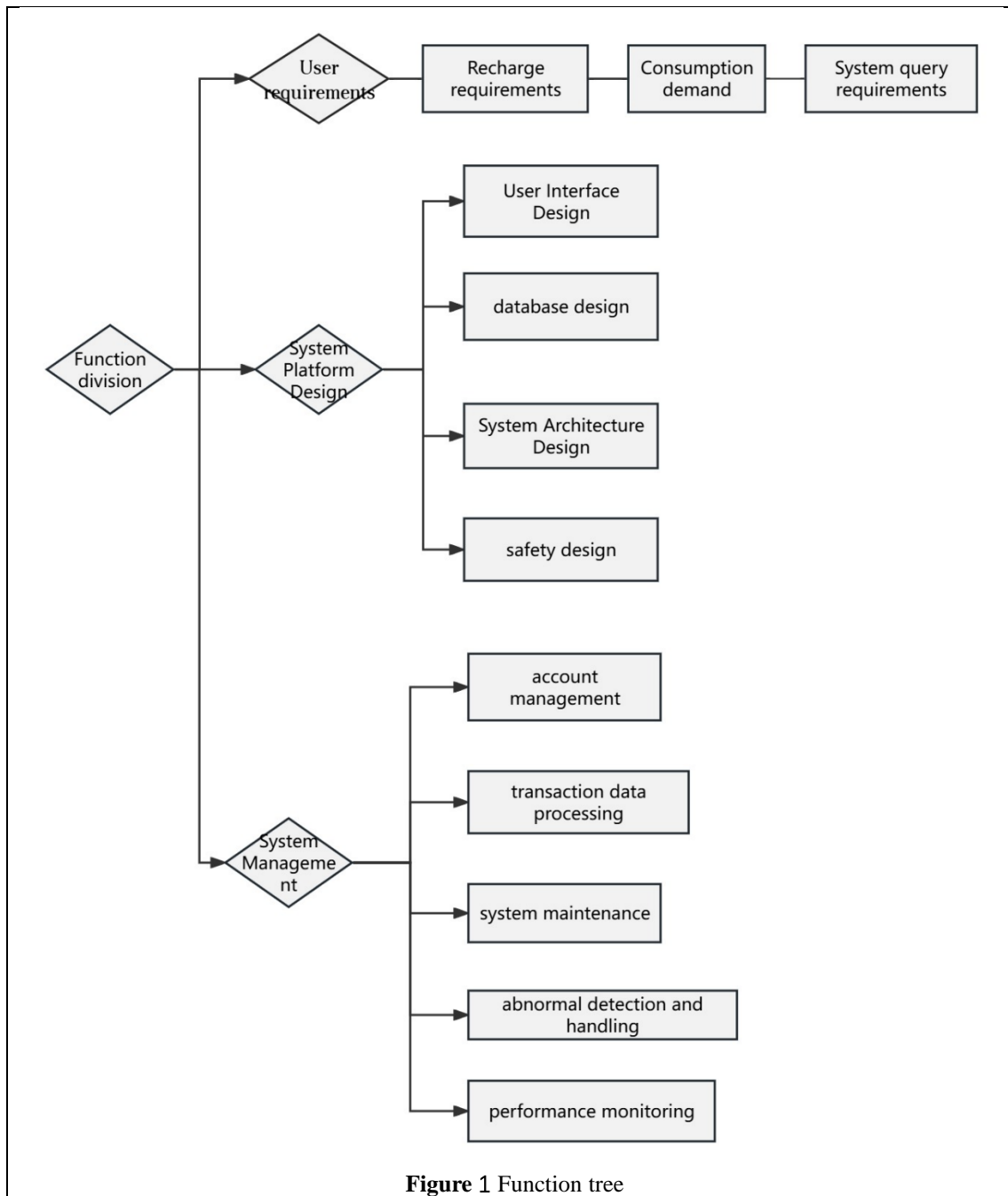
3.1 User Requirements

Recharge requirements:
- Users must be able to easily top up their accounts through various payment methods.
- The system should support a seamless and secure recharge process.
- Provide users with real-time balance updates and transaction confirmations.

Consumption demand:
- Allow users to make purchases or use services by deducting the corresponding amount from their account balance.
- Offer a clear and transparent view of available services and their costs.

- Ensure a smooth and secure consumption process that reflects the transaction immediately.

System query requirements:
- Allow users to make purchases or use services by deducting the corresponding amount from their account balance.
- Offer a clear and transparent view of available services and their costs.
- Ensure a smooth and secure consumption process that reflects the transaction immediately.

3.2 System platform design

User interface design:
- Design an intuitive and user-friendly interface that simplifies navigation and interaction.
- Ensure the interface is accessible on various devices and platforms.

Database design:
- Develop a robust database structure that supports efficient storage and retrieval of user data and transactions.
- Ensure data integrity and consistency through proper normalization and indexing.

System Architecture Design:
- Develop a robust database structure that supports efficient storage and retrieval of user data and transactions.
- Ensure data integrity and consistency through proper normalization and indexing.

Safety design:
- Implement security protocols to protect user data and transactions from unauthorized access and breaches.
- Use encryption and secure communication channels to safeguard sensitive information.

3.3 System management

Account management:
- Implement security protocols to protect user data and transactions from unauthorized access and breaches.
- Use encryption and secure communication channels to safeguard sensitive information.

Transaction data processing:
- Implement security protocols to protect user data and transactions from unauthorized access and breaches.
- Use encryption and secure communication channels to safeguard sensitive information.

System maintenance:
- Schedule regular maintenance windows to perform system updates and upgrades.

- Monitor system health and performance to prevent downtime.

Abnormal detection and handling:
- Schedule regular maintenance windows to perform system updates and upgrades.
- Monitor system health and performance to prevent downtime.

Performance monitoring:
- Schedule regular maintenance windows to perform system updates and upgrades.
- Monitor system health and performance to prevent downtime.

4. Functions and menus

4.1 Mission Statement

System Responsibilities：
User function:
- Campus card recharge
- Campus card payment
- Account inquiry
Administrator function:
- View and modify bank account information
- View and analyze data
- Exception handling

Exclusion of Responsibilities:
- The Campus Card Service System (CCSS) does not handle refunds for campus card balances.
- CCSS does not support direct payments within the campus using Alipay, WeChat, or bank accounts.
- CCSS does not manage the point of sale (POS) systems within the campus.
- CCSS is not responsible for the issuance and loss reporting of campus cards.

Here is the Function refinement tree:
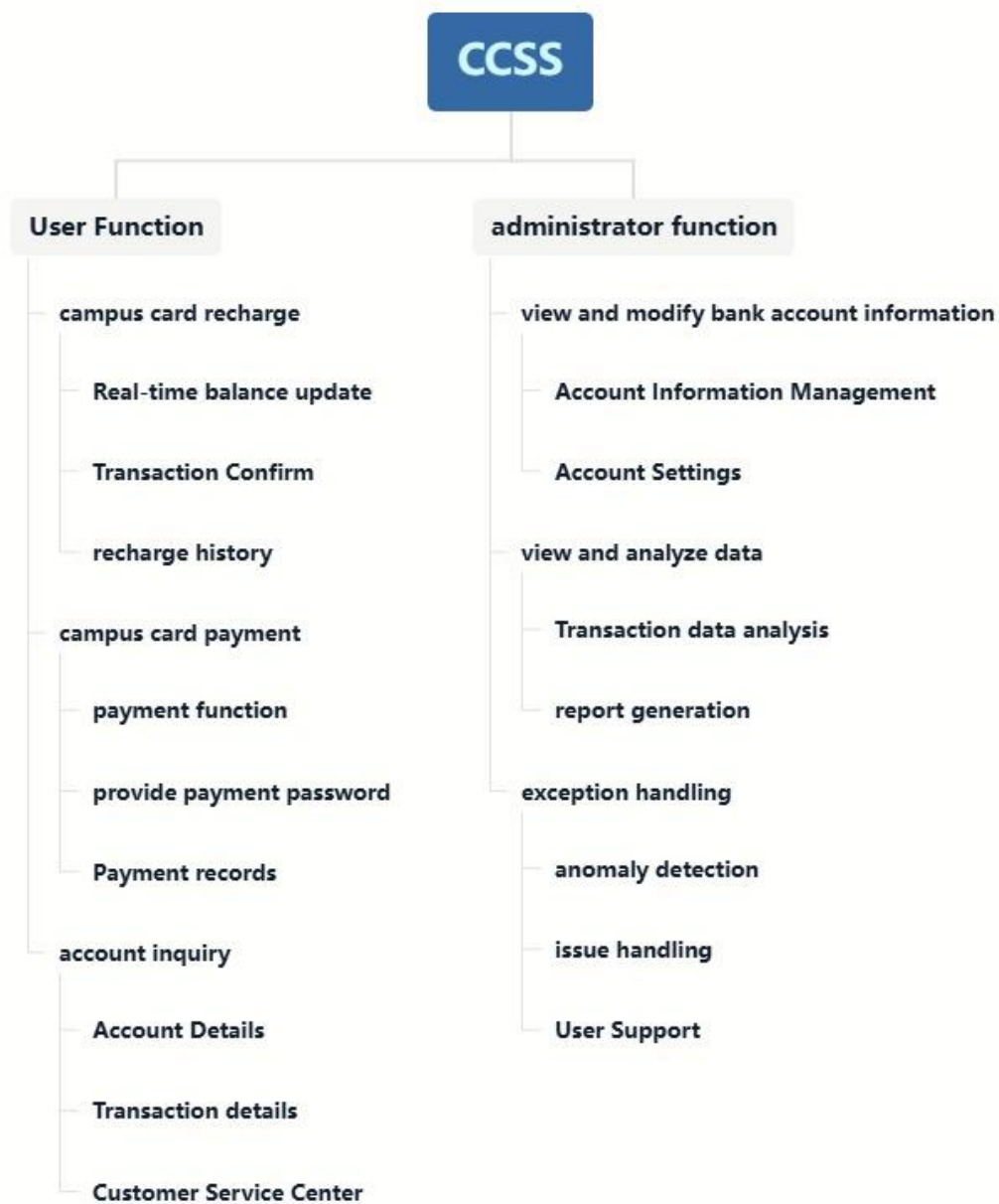
Figure 2 Function refinement tree for user and administrator i

When implementing the above services, the basic operations involved are shown in the following table:

No.	Basic Operation Description	Related Functionality/Module
A1	Input the transfer amount and payment method	Campus card recharge
A2	Call the payment interface	Campus card recharge
A3	Input the password	Account security
A4	Compare the payment result with the transfer amount	Transaction verification

A5	Update the database	Database management
A6	Consumption request	Campus card payment
A7	Generate a temporary QR code	Quick payment processing
A8	Verify user identity and campus card balance	Account inquiry
A9	Deduct the campus card balance	Fund Management
A10	Update consumption records	Consumption Management
A11	Input the information and conditions for inquiry	Account Inquiry
A12	Call the data layer to retrieve data	Data retrieval
A13	Display inquiry results	Inquiry results display
A14	Provide export functionality	Data export
A15	View public traffic information	Transaction data analysis
A16	Provide a bank interface	Third-party payment platform integration
A17	Verify administrator identity	Administrator authentication
A18	Process public bank account information	Fund Management
A19	Record operation logs	System logging
A20	Request transaction data analysis	Data analysis
A21	Call the data layer to get transaction data	Data retrieval
A22	Display analysis results and reports	Reporting
A23	Check the result reports	Report review
A24	Request to view the list of exceptions	Exception handling
A25	Select an exception to view detailed information	Exception details
A26	Contact user or merchant	User/merchant communication
A27	Confirm the authenticity and severity of the issue	Issue verification
A28	Compensate, reject, or deactivate the card	Issue resolution
A29	Send notification of the processing result	Notification

4.2 User function description

This section describes the specific information of the services provided by CCSS to users, including Trigger Event, Provide Service, Supporting Activities, and Service Details.

4.2.1 Campus card recharge

Real-time Balance Update

Trigger Event: User completes a top-up transaction for their campus card.

Provide Service: The system automatically updates the user's campus card balance in real-time upon successful completion of the recharge.

Supporting Activities: A5 (Update the database), A6 (Consumption request)

Service Details:
- After a recharge transaction is completed, the system instantly reflects the new balance on the user's campus card account.
- Users are immediately notified of the updated balance through the system's interface or via email/SMS, ensuring transparency and accessibility to their account information.
- The real-time update prevents any discrepancies and ensures that users can continue their campus transactions without interruption.

Transaction Confirm

Trigger Event: User initiates a payment using the campus card.

Provide Service: The system confirms the transaction details and completes the payment process.

Supporting Activities: A2 (Call the payment interface), A4 (Compare the payment result with the transfer amount), A10 (Update consumption records)

Service Details:
- When a payment is initiated, the system verifies the transaction details, including the amount and the user's available balance.
- Upon verification, the system processes the payment and provides the user with a confirmation receipt, including the transaction ID and the updated balance.
- The confirmation ensures that the user is aware of the successful transaction and maintains a record for future reference.

Recharge History

Trigger Event: User requests to view their campus card recharge history.

Provide Service: The system presents a detailed record of all previous recharge transactions associated with the user's campus card.

Supporting Activities: A11 (Input the information and conditions for inquiry), A12 (Call the data layer to retrieve data), A13 (Display inquiry results)

Service Details:
- Users can access their recharge history through the system's interface, where they can specify the date range or transaction criteria.
- The system retrieves the relevant transaction data from the database and displays a comprehensive list of past recharges, including dates, amounts, and payment methods.

- This feature allows users to track their spending habits, monitor their account activity, and manage their finances effectively.
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4.2.2 Campus card payment

Payment Function
Trigger Event: User selects an item or service for purchase on campus.

Provide Service: The system facilitates the payment process by deducting the corresponding amount from the user's campus card balance.

Supporting Activities: A6 (Consumption demand), A7 (Generate a temporary QR code), A8 (Verify user identity and campus card balance), A10 (Update consumption records)

Service Details:
- Users can purchase goods or services by presenting their campus card at the point of sale or through a digital interface.
- The system calculates the cost of the purchase and prompts the user to confirm the transaction.
- Upon confirmation, the system deducts the purchase amount from the user's campus card balance and completes the payment.
- The transaction is recorded, and the user receives immediate feedback, including a receipt or confirmation of the payment.
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Provide Payment Password
Trigger Event: User initiates a payment transaction from their campus card.

Provide Service: The system requires the user to enter a payment password to authorize the transaction.

Supporting Activities: A3 (Input the password), A9 (Deduct the campus card balance)

Service Details:
- To enhance security, the user is prompted to enter a pre-set payment password before a transaction can be authorized.
- The system verifies the password and, if correct, proceeds with the payment process, ensuring that only the authorized user can make transactions.
- This step adds an extra layer of security to prevent unauthorized use of the campus card and protect the user's funds.

Payment Records
Trigger Event: User requests to view their transaction history or needs a record of past payments.

Provide Service: The system provides a detailed list of all past payments made using the campus card.

Supporting Activities: A11 (Input the information and conditions for inquiry), A12 (Call the data layer to retrieve data), A13 (Display inquiry results)

Service Details:
- Users can access their payment history through the system's interface, where they can view a list of all transactions associated with their campus card.
- The system retrieves the transaction data from the database and presents it in a readable format, including the date, location, amount, and details of each purchase.
- Users can filter the payment records by date, merchant, or transaction type to easily locate

specific transactions.
- This feature enables users to keep track of their spending, reconcile their accounts, and manage their finances effectively.

4.2.3 Account inquiry

Account Details
Trigger Event: User logs into the campus card system and requests to view their account information.

Provide Service: The system displays comprehensive details of the user's campus card account, including balance, account settings, and contact information.

Supporting Activities: A11 (Input the information and conditions for inquiry), A12 (Call the data layer to retrieve data), A13 (Display inquiry results)

Service Details:
- Users are able to access their account details through a secure login process within the campus card system.
- The system presents a dashboard that includes the current balance, account status, and any relevant settings or preferences associated with the campus card.
- Users can also view and update their personal information, such as contact details and communication preferences.

Transaction Details
Trigger Event: User seeks information on a specific transaction or a detailed breakdown of their spending.

Provide Service: The system provides a detailed view of individual transactions, including the purpose, date, and amount of each transaction.

Supporting Activities: A11 (Input the information and conditions for inquiry), A12 (Call the data layer to retrieve data), A13 (Display inquiry results), A22 (Display analysis results and reports)

Service Details:
- Users can request transaction details for a specific time period or transaction ID through the campus card system.
- The system retrieves and displays a detailed record of each transaction, including where and when the transaction occurred, the purpose, and the exact amount.
- This feature allows users to understand their spending habits, monitor their account activity, and identify any discrepancies or unauthorized transactions.

Customer Service Center
Trigger Event: User encounters an issue or has a query related to their campus card usage.

Provide Service: The system directs the user to a customer service center where they can receive assistance from support staff.
Supporting Activities: A26 (Contact user or merchant), A27 (Confirm the authenticity and severity of the issue), A28 (Compensate, reject, or deactivate the card), A29 (Send notification of the processing result)

Service Details:
- When users face problems or have questions about their campus card, they can access the customer service center through the system's interface or by designated contact methods.
- The customer service center is equipped to handle a variety of issues, from transaction

disputes to technical difficulties with the campus card system.
- Users can expect to receive prompt attention, with support staff working to resolve their issues, provide explanations, or escalate the matter to the appropriate department if necessary.
- After the issue is addressed, users are notified of the outcome and any actions taken, ensuring transparency and user satisfaction.

4.3 Administrator function description

This section describes the specific information of the services provided by CCSS to administrator.

4.3.1 View and modify bank account information

Account Information Management
Trigger Event: User or administrator accesses the campus card account management interface.

Provide Service: The system allows users and administrators to manage and maintain personal or student account information.

Supporting Activities: A11 (Input the information and conditions for inquiry), A12 (Call the data layer to retrieve data), A13 (Display inquiry results), A19 (Record operation logs)

Service Details:
- Users can view and update their personal details such as names, contact information, and passwords.
- Administrators have access to a broader set of tools to manage student records, including enrollment status and account activation/deactivation.
- The system ensures that all account-related actions are logged for security and audit purposes.

Account Settings
Trigger Event: User or administrator requires modifying account preferences or access controls.

Provide Service: The system enables customization of account settings according to user or administrator privileges.

Supporting Activities: A17 (Verify administrator identity), A18 (Process public bank account information)

Service Details:
- Users can change their account settings like notification preferences, privacy settings, and security questions.
- Administrators can configure system settings, such as access controls, transaction limits, and integration with third-party services.
- All changes to account settings are secured and require appropriate authentication to prevent unauthorized modifications.

4.3.2 View and analyze data

Transaction Data Analysis
Trigger Event: Administrator initiates a request for analyzing transaction data for strategic or operational purposes.

Provide Service: The system provides tools for analyzing transaction data to identify trends, user behavior, and potential issues.

Supporting Activities: A20 (Request transaction data analysis), A21 (Call the data layer to get transaction data)

Service Details:
- Administrators can request detailed analysis of transaction data, which includes frequency of use, peak times, and most common transactions.
- The system compiles the data and applies statistical methods to provide insights that can inform decision-making and policy development.
- Analysis can also highlight anomalies that may indicate fraudulent activity or system errors.

Report Generation
Trigger Event: There is a need for a formal record or summary of transaction data for a specific period or event.

Provide Service: The system generates comprehensive reports based on the analyzed transaction data.

Supporting Activities: A22 (Display analysis results and reports), A23 (Check the result reports)

Service Details:
- Administrators can generate reports that summarize transaction data, which can be used for internal review or external disclosures.
- Reports can be customized to include specific details such as total transactions, average spending, or user demographics.
- The system allows for the export of reports in various formats, such as PDF or Excel, for easy sharing and further analysis.
- Generated reports are reviewed for accuracy and completeness before being made available to the intended recipients.

4.3.3 Exception handling

Anomaly Detection
Trigger Event: The system processes campus card transactions and identifies patterns or activities that deviate from the norm.

Provide Service: The system employs algorithms to detect anomalies in transaction data, potentially indicating fraudulent or erroneous activities.

Supporting Activities: A22 (Display analysis results and reports), A24 (Request to view the list of exceptions)

Service Details:
- The system continuously monitors transaction data for unusual patterns, such as sudden spikes in spending or transactions outside of normal operating hours.
- Upon detecting an anomaly, the system flags the transaction for further review and may automatically notify administrators or security personnel.
- Anomaly detection helps maintain the integrity of the campus card system and protects against unauthorized use or system glitches.

Issue Handling
Trigger Event: A user or administrator reports a problem or raises a concern regarding the campus card system.

Provide Service: The system provides a structured process for addressing and resolving issues related to campus card usage.

Supporting Activities: A25 (Select an exception to view detailed information), A27 (Confirm the authenticity and severity of the issue), A28 (Compensate, reject, or deactivate the card)

Service Details:
- Users or administrators can report issues through a dedicated interface within the system, detailing the nature of the problem.
- The system logs the issue and assigns it to the appropriate support team for investigation.
- Once the issue is verified and its severity assessed, the support team takes the necessary actions, which may include compensating the user, rejecting the claim, or deactivating a compromised campus card.

User Support
Trigger Event: A user requires assistance with their campus card, including inquiries, complaints, or guidance on using the system.

Provide Service: The system offers multiple channels for users to receive support, including a help desk, online chat, or email support.

Supporting Activities: A26 (Contact user or merchant), A29 (Send notification of the processing result), Customer Service Center

Service Details:
- The system directs users to a customer service center where they can get help for various issues, from account management to transaction disputes.
- Support staff are equipped to provide immediate assistance, answer questions, and guide users through the resolution process.
- The system allows for the logging of support requests and their outcomes, ensuring that users can follow up on their issues and that the support team can track and improve service quality.

5. System Specification

5.1 Technical Requirements

- **Compatibility:**
  - Network Protocols: Ensure the system supports communication protocols used by the campus network, such as HTTP/HTTPS, TCP/IP, etc.
  - Network Security: Align with the campus network security policies, including firewall rules, VPN access, and intrusion detection systems.
  - API Integration: The system must be able to interact with the campus's existing payment gateways via APIs, handling Alipay, WeChat Pay, and bank transfers.
  - Data Formats: Ensure the system can process and exchange data formats used within the campus, such as CSV, XML, or JSON.

- ■ Operating Systems: Compatibility issues within Android and iOS systems.

- ● **Security:**
  - ■ Data Encryption: Use strong encryption standards (such as AES) to protect stored and transmitted data. Encrypt sensitive information, such as Personally Identifiable Information (PII) and payment details.
  - ■ User Authentication: Implement Multi-Factor Authentication (MFA) to add security layers, ensuring that only authorized users can access the system.
  - ■ Access Permissions: Set different system permissions for users and administrators to ensure the security of the system's operation and user data.
  - ■ Payment Security: Comply with the Payment Card Industry Data Security Standard (PCI DSS). Use secure payment gateways and third-party payment services to ensure the security of the payment process.
  - ■ Network Security: Use firewalls and Intrusion Detection Systems (IDS) to protect network boundaries. Implement network isolation and segmentation to reduce potential security threats.
  - ■ Data Backup and Recovery: Regularly back up data and ensure the security and integrity of the backups. Develop a disaster recovery plan to quickly recover in case of data loss or system failure.

- ● **Reliability:**
  - ■ Stability: Ensure the system does not crash under high load and high data transfer operations, which could impair user experience or even cause user financial losses.
  - ■ Fault Handling:
  - ■ System Failure: Implement fault transfer mechanisms to avoid service interruptions due to single point of failure.
  - ■ User-end Failure: For issues such as incorrect data input and user operation errors, the system should provide timely feedback and instruct users on how to make changes.

- ● **User Interface:**
  - ■ Intuitive Design: Design an intuitive user interface that allows users to easily find and use functions.
  - ■ Consistency: Maintain consistency in interface elements and operations to reduce the learning curve for users.
  - ■ Feedback: Provide timely user feedback to let users know if their operations are successful.
  - ■ Aesthetics: The interface should have a professional appearance and feel, making users enjoy the process of using the system.
  - ■ User Testing: Conduct user testing, collect feedback, and adjust according to user needs and preferences.

5.2 Performance Metrics

- ● **Response Time:**

- Optimize response time and user experience by taking various measures such as code optimization, database indexing, caching, load balancing, hardware upgrades, network optimization, and asynchronous processing.
- **Maximum Concurrent Users:**
  - Improve concurrent processing capacity by expanding server resources, using load balancing, and optimizing database connections to ensure the system can stably respond to user requests during peak times.
- **Transaction Processing Capacity:**
  - High transaction processing capacity is key to ensuring user experience and business continuity for payment systems. By optimizing transaction processing processes and using efficient database designs and indexing, we can enhance processing speed.
- **Mean Time to Recovery (MTTR):**
  - A low MTTR can minimize system downtime and reduce the impact on business. We plan to establish a disaster recovery plan, using redundant systems and quick switching mechanisms to minimize the time to recover from faults.
- **Load Testing:**
  - We need to test the system's performance under the expected maximum load. Load testing can verify whether the system can meet performance requirements and identify potential performance bottlenecks. Finally, adjust the system according to the test results, increase resources, or optimize code.
- **Performance Monitoring:**
  - Use professional monitoring tools, set alert thresholds, and quickly locate and resolve issues. When performance degradation or system abnormalities are detected, ensure the system can respond quickly, resolve issues in a timely manner, and ensure a good user experience.

6. System architecture

Our group ultimately decide to utilize Data flow diagram (DFD) and CRUD table to describe the system architecture of CCSS and provide corresponding data field requirements. The data flow diagram illustrates the flow and processing of data within CCSS, as well as the relationships between them. By visualizing the data sources, flow, and processing steps, the DFD helps in understanding the overall structure and functionality of the system. CRUD tables are employed to ensure data consistency and integrity in CCSS, while also establishing connections with its functions. CRUD stands for Create, Read, Update, and Delete, representing the operations performed on data. Through the CRUD table, the data operations associated with different functionalities are identified, along with their impact on the data.

6.1 Data flow graph

DFD is shown in the figure below, which allows us to identify the individual components in

the system, as well as their interactions and dependencies.

Figure x Data flow graph