
Software Requirements Specification

for

Smart Printing Service for students at HCMUT

Version 5.0 approved

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Revision History

Name	Date	Reason For Changes	Version
Luu Chí Cường	20/09/2024	Update requirement elicitation (Domain Context, StakeHolders and Needs)	1.0
Khuru Vĩnh Kiên	21/09/2024	Update requirement elicitation (Benefit, Function Requirements)	1.1
Lê Minh Quốc	27/09/2024	Update usecase Diagram for whole system	1.3
Lê Văn Đức Anh	28/09/2024	Update usecase Authentication and Authorization Module and detail	1.4
Lê Dũng	06/10/2024	Active Diagram, Sequence Diagram	2.0
Luu Chí Cường	07/10/2024	Class Diagram	2.1
Lê Minh Quốc, Khuru Vĩnh Kiên, Lê Văn Đức Anh	14/10/2024	User Interface MVP1	2.2
Lê Văn Đức Anh	27/10/2024	Layered Architecture	3.0
Lê Dũng	28/09/2024	Component Diagram	3.1
Luu Chí Cường	22/11/2024	Usability Test	4.0
Luu Chí Cường	15/12/2024	Update missing information	5.0

1. Requirement elicitation

1.1 Domain Context

The Student Smart Printing Service (HCMUT_SSPPS) at Ho Chi Minh City University of Technology (HCMUT) is intended to provide an efficient, accessible, and centralized printing solution for students. The system allows a student to print a document by uploading a document file onto the system, choose a printer, and specifying the printing properties such as paper size, pages (of the file) to be printed, one-/double-sided, number of copies, etc. With file types configured by administrators and a default number of A4-sized pages allocated each semester, this service aims to streamline printing activities. Additionally, the system integrates a balance management feature that allows students to buy additional pages if needed and leverages the university's existing online payment gateway, BKPay. This context reflects a growing trend toward digital transformation in higher education institutions, aiming to improve campus services through technology..

1.2 Stakeholders and Needs

1.2.1 Students

An efficient, user-friendly, and cost-effective way to print academic documents such as assignments, reports, and lecture notes. Students have the ability to easily upload documents in permitted file formats, customize printing preferences (e.g., paper size, one-/double-sided printing), and track their usage through a detailed printing log.

Flexibility in managing their print quotas, which includes knowing how many pages are left, purchasing additional pages when their default allocation runs out, and making payments seamlessly through the university's online system.

1.2.2 Student Printing Service Officers (SPSOs)

Responsible for maintaining and managing the printing infrastructure and system configuration. Their needs revolve around system administration, which includes adding, enabling, and disabling printers across campuses and configuring the service for permitted file types. SPSOs also need access to detailed logs and reports to monitor system usage, troubleshoot issues, and ensure that printing stations are functioning correctly.

Track individual and collective student printing behaviors, including the types of documents being printed, the frequency of use, and the balance of pages available to students. SPSOs also need the capability to configure and adjust the default number of pages allocated to students each semester and set important dates (such as when page balances are refreshed). Additionally, they need to generate monthly and yearly usage reports to provide insights for university management and ensure operational efficiency.

1.2.3 Administrators

Involved in day-to-day operations, has a vested interest in ensuring that the system is cost-effective, sustainable, and in line with the university's goals for digital transformation and student service improvement.

Detailed reports to assess the system's effectiveness, the level of resource utilization, and areas for potential optimization.

1.3 Benefits of the System

1.3.1 Students

- Convenience and Accessibility:

Students can print documents from anywhere just by using the web or mobile app without having to be present at the printer until they need to pick up their documents.

Saving time and reducing the need to carry digital copies.

- Cost Efficiency:

By tracking the number of printed pages and allowing students to purchase additional pages, the system helps students to manage their printing costs effectively.

Additionally, the school has already allocated a default number of pages per semester, which gives students a free printing quota.

- Environmental Friendliness:

The system promotes responsible printing by allowing students to select only the pages they need and specify double-sided printing.

Reducing paper waste.

- Enhanced Tracking and Transparency:

Students have access to their printing history and usage reports, ensuring transparency in printing resource consumption and helping them to better manage their printing habits.

- Secure Authentication:

Using the HCMUT_SSO authentication service, the system ensures that only authorized users (students and administrators) can access the service, keeping the system secure.

1.3.2 Student Printing Service Officers (SPSOs)

- The HCMUT-SSPS will offer significant benefits for SPSOs by simplifying the management and oversight of printing services across the university. SPSOs can efficiently manage printer availability, ensuring seamless access for students while minimizing printer downtime.

- The system's configuration features give SPSOs precise control over the printing environment. Additionally, the ability to monitor detailed logs and access automatically generated reports will help SPSOs track usage, identify potential issues, and optimize resource allocation. Overall, HCMUT-SSPS will reduce administrative workload, improve operational efficiency, and enhance the overall student printing experience.

1.3.3 Administrators

- Centralized control over all printers across the campus, allowing administrators to monitor, manage, and configure resources efficiently.

- Optimized resource allocation through real-time monitoring, reducing operational costs and minimizing printer downtime.

- Automated monthly and yearly report generation, saving time and ensuring transparency in system usage and financials.

- Enhanced security through integration with the university's single sign-on (SSO) service, ensuring controlled and secure access to the system.

- Increased operational efficiency with reduced need for manual intervention in managing printers and monitoring usage.

1.4 Functional Requirements

1.4.1 Students

- Upload and Print Documents:

Students should be able to upload a document file to the system from the web or mobile app, select a printer, then specify printing properties such as paper size, number of copies, one-/double-sided printing, and page range.

- View and Manage Printing Logs:

Students must be able to view their own printing history, including details like printer ID, document name, pages printed, and printing time period.

Additionally, they should have access to a summary of the number of pages printed per page size.

- Buy Additional Printing Pages:

Students can buy additional printing pages when they run out of their allocated quota.

The system should allow payment through the university's BKPay system, and the updated page balance should be reflected in real-time.

- View Account Balance:

Students should be able to see the current balance of their printing pages (A4/A3 equivalents) at any time within the system.

- Receive Notifications:

The system should notify students via the app when their document has been successfully printed, when their page balance is running low, or when there are issues (e.g. printer malfunction, low balance,...).

1.4.2 Student Printing Service Officers (SPSOs)

- SPSO shall be able to limit and configure permitted file types.

SPSO shall be able to view the printing history (log) of all students or a student for a time period (date to date) and for all or some printers.

- SPSO shall have a feature to manage printers such as add/enable/disable a printer.

SPSO shall have a feature to manage configuration of the system such as changing the default number of pages, the dates that the system will give the default number of pages to all students, the permitted file types accepted by the system.

- SPSO shall be able to view the reports the printing system generated.

1.4.3 Administrators

Admin shall be able to manage all printers, including adding, enabling, disabling, and configuring printers across campuses.

Admin shall be able to set and manage user access permissions to control system configurations and functionalities.

Admin shall be able to monitor real-time usage and status of all printers, including receiving alerts for errors or maintenance needs.

Admin shall be able to automatically generate and view detailed monthly and yearly reports of system usage and printing activities.

Admin shall be able to configure system settings, such as default page allocations, permitted file types, and payment integration options.

1.5 Non-Functional Requirements

- Product requirements:

The HCMUT_SSPPS system shall be available to all users during normal working hours (Monday - Sunday, 04:00 - 00:00)

System response time for uploading documents, selecting print options, and submitting a print job should not exceed 3 seconds.

The system should support concurrent usage by up to 1000 students across all campuses.

The system should handle a surge in usage during peak periods, such as semester start/end, without a slowdown.

Student account balances and transaction details must be protected by encryption during transmission and storage.

File uploads should be scanned for viruses and malware before processing.

The user interface must be simple and intuitive for students to upload documents, configure print jobs, and review printing logs.

Students should be able to complete the process of uploading, selecting a printer, and submitting a print job in under 1 minute.

- Organizational requirements:

Provide clear user guides, tutorials, and FAQs for students to understand how to use the printing service, upload documents, and manage their print logs.

Ensure that the budget for the development, maintenance, and operation of the system is approved and allocated by university management annually.

Ensure organizational policies are in place for data protection, such as student printing logs and financial transactions, in compliance with university privacy policies and legal standards.

The system must provide remote management, automated notifications for maintenance and updates.

- External Requirements:

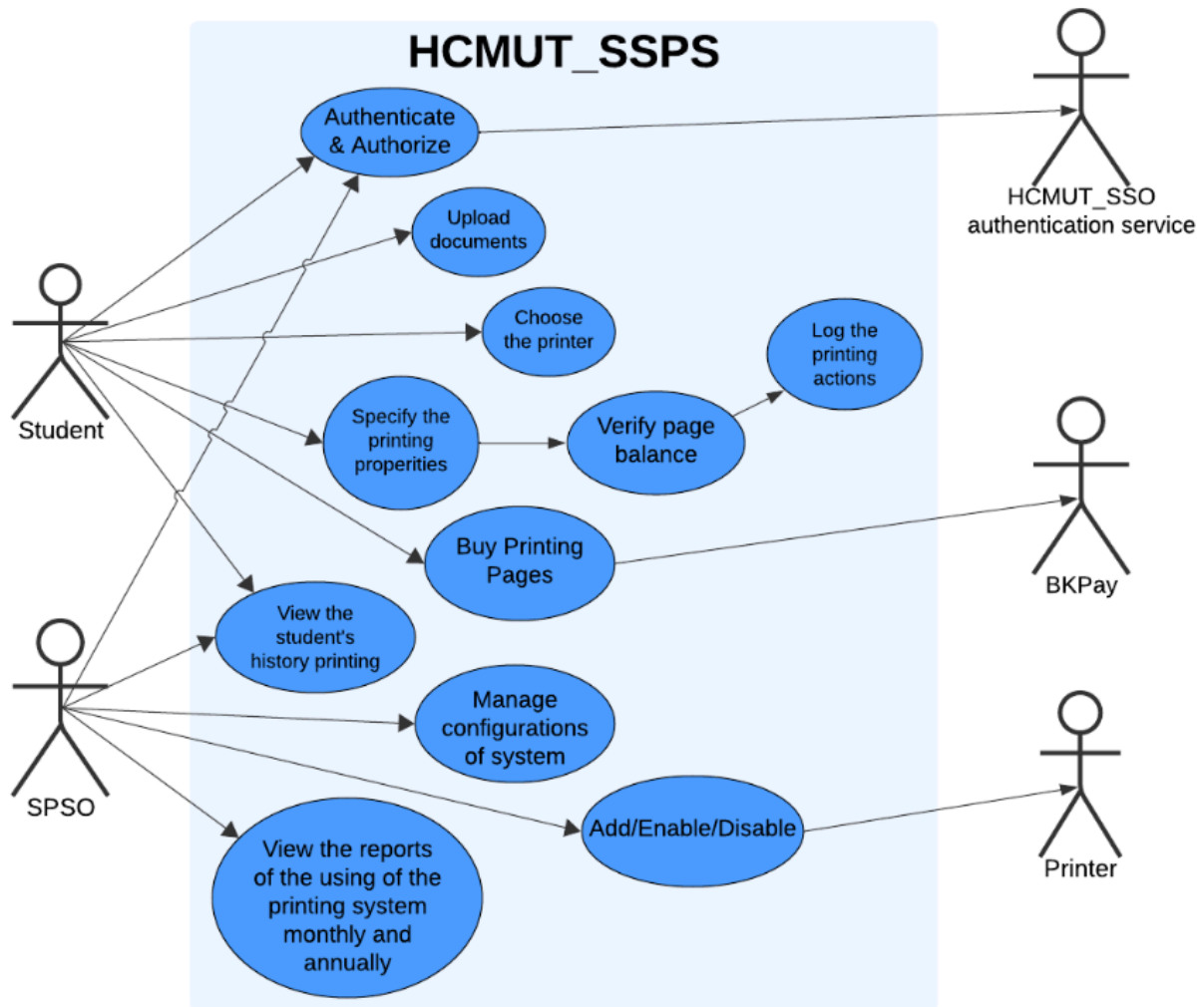
The printing system must not allow printing illegal documents that can affect the university or other organizations negatively.

The system must ensure the privacy of the user's content in each document; it must not save or use their personal information without their agreement.

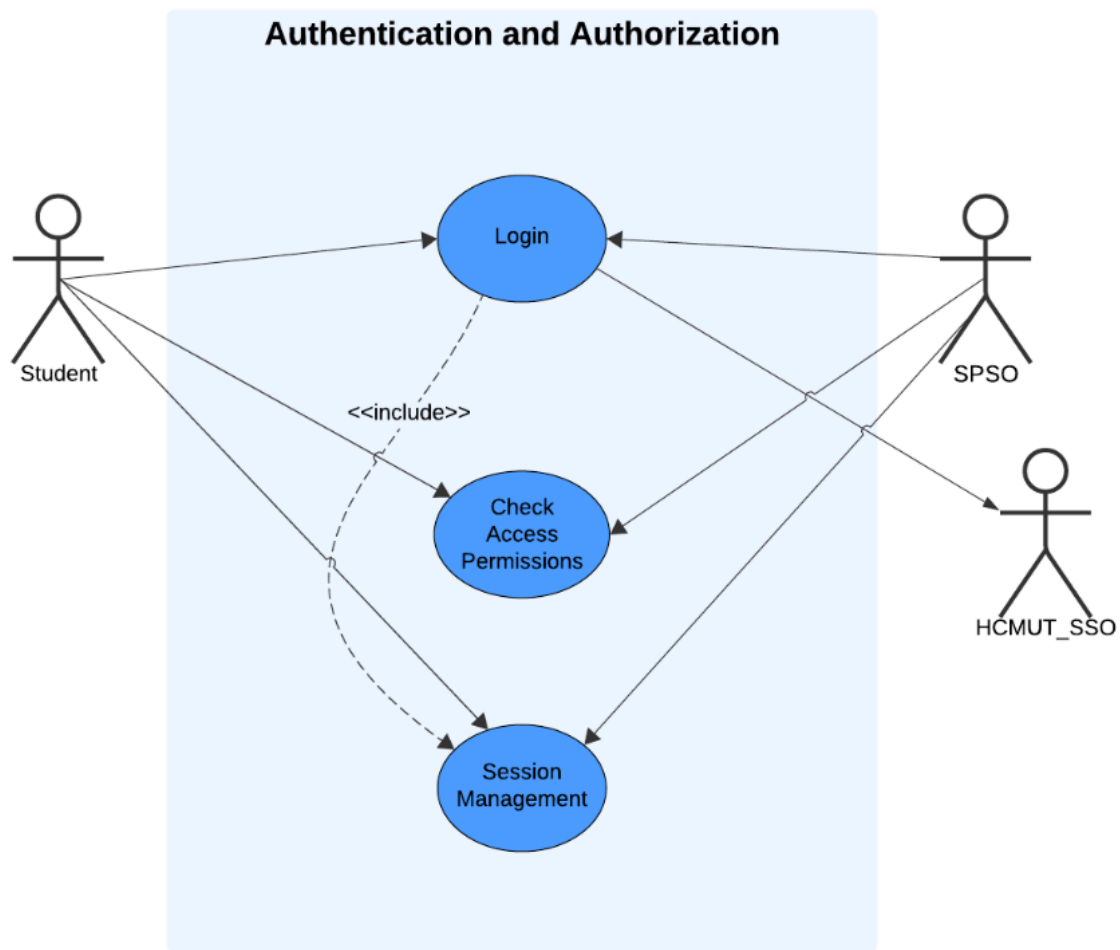
All document uploads, print jobs, and personal data exchanges between users and the system must be encrypted using industry-standard encryption protocols (e.g., SSL/TLS) to prevent unauthorized access or tampering.

2. Use-case Diagrams

2.1 Use-case Diagram for the Whole System



2.2 Use-case Diagram for Authentication and Authorization Module



2.3 The Details of Usecases in Authentication and Authorization Module

2.3.1 Usecase Login

ID and Name	UC-1 Login
<i>Created By</i>	Duc Anh
<i>Date Created</i>	27/09/2024
<i>Primary Actor</i>	Student, SPSO
<i>Secondary Actors</i>	HCMUT_SSO

<i>Description</i>	The user provides their credentials (username and password) to the system. The system sends these credentials to the HCMUT_SSO service for verification. If the credentials are valid, the user is authenticated and logged in. If invalid, an error message is displayed.
<i>Trigger</i>	User initiates the login process by entering credentials and clicking the login button.
<i>Preconditions</i>	PRE-1. Users must have an existing account. PRE-2. The HCMUT_SSO service is online.
<i>Postconditions</i>	POST-1. User is logged into the system. POST-2. User's roles and permissions are stored in the session.
<i>Normal Flow</i>	1.0 Login to the system 1. User enters username and password. 2. System sends credentials to HCMUT_SSO for validation. 3. HCMUT_SSO validates credentials. 4. If valid, the system logs the user in and creates a session. 5. Users are redirected to the dashboard based on their role.
<i>Alternative Flows</i>	1.1 Invalid Credentials 1. HCMUT_SSO returns an invalid credentials response. 2. System displays an error message. 3. User retries login or chooses "Forgot Password".
<i>Exceptions</i>	1.0.E1. HCMUT_SSO service is unavailable 1. System displays a "Service Unavailable" message. 2. Users can retry or contact support.

2.3.2 Usecase Check Access Permissions

ID and Name	UC-2 Check Access Permissions
<i>Created By</i>	Duc Anh
<i>Date Created</i>	27/09/2024
<i>Primary Actor</i>	Student, SPSO
<i>Description</i>	This use case checks if the user has the necessary permissions to perform a certain action or access a specific resource based on their role.
<i>Trigger</i>	User tries to access a restricted feature or resource.
<i>Preconditions</i>	PRE-1. Users must be authenticated and have an active session. PRE-2. Role-based permissions must be defined in the system.

<i>Postconditions</i>	POST-1. Users are allowed or denied access based on permissions.
<i>Normal Flow</i>	2.0 User are checked Access Permissions 1. User tries to access a restricted feature (e.g., managing printers). 2. System checks the user's role and permissions. 3. If permissions are sufficient, the system allows access. 4. Users continue to use the feature without interruption.
<i>Alternative Flows</i>	2.1. Denial of accessing 1. system denies access and shows a warning message.

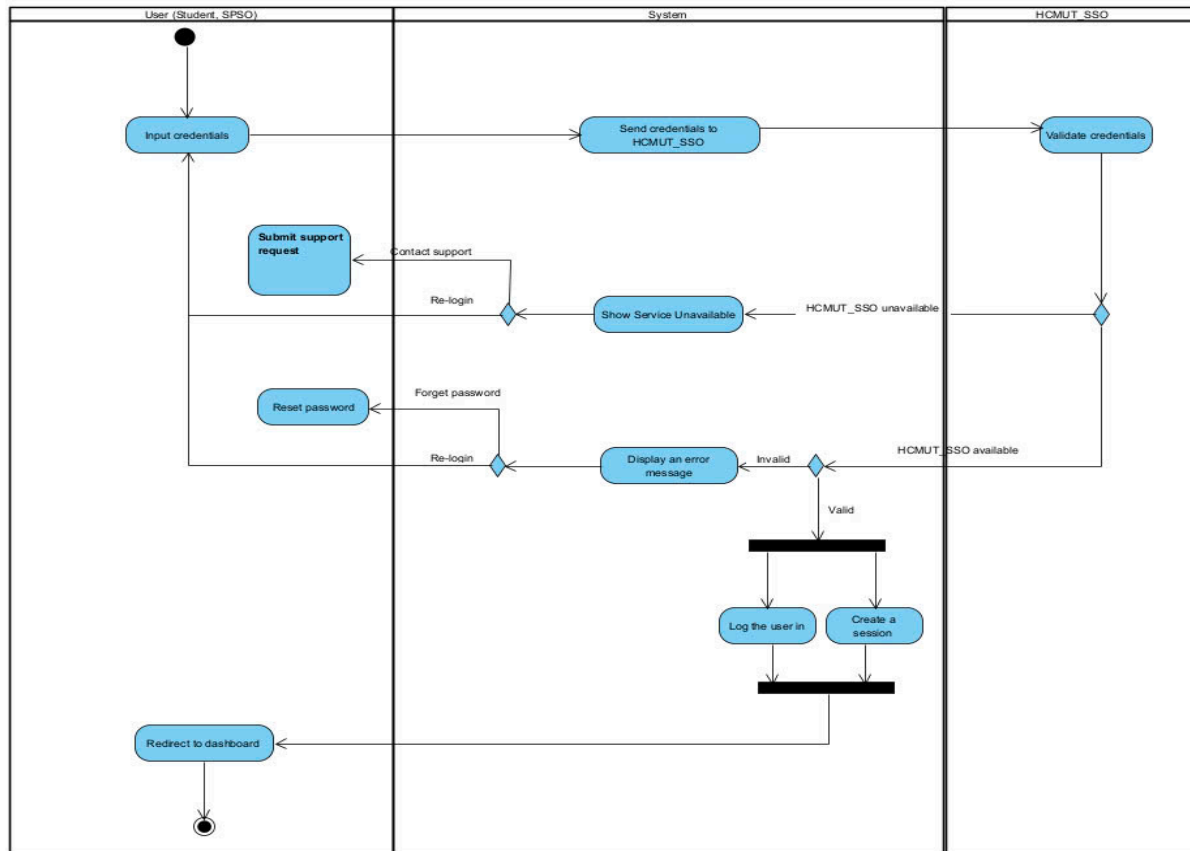
2.3.3 Usecase Session Management

ID and Name	UC-3 Session Management
<i>Created By</i>	Duc Anh
<i>Date Created</i>	27/09/2024
<i>Primary Actor</i>	Student, SPSO
<i>Description</i>	This use case manages user sessions after they log in. It involves creating a new session upon login, updating the session when user permissions or roles change, and terminating the session when the user logs out or the session expires.
<i>Trigger</i>	User logs in, logs out, or session times out.
<i>Preconditions</i>	PRE-1. Users must be authenticated.
<i>Postconditions</i>	POST-1. User sessions are created or updated. POST-2. Session is terminated upon logout or timeout.
<i>Normal Flow</i>	3.0 Manage the session of user 1. System creates a new session when the user logs in. 2. Session stores user ID and fetch role, and permissions from the database 3. System updates session if user role or permissions change. 4. System terminates session due to timeout or User logs out
<i>Alternative Flows</i>	3.1. Session Extension 1. User activity is detected before timeout. 2. System extends the session duration. 3. Users continue to use the system without interruption.
<i>Exceptions</i>	3.0.E1. Session data is corrupted 1. System logs the user out and shows an error message. 2. Users must log in again.

3. System Modeling

3.1 Activity Diagram for the Authentication and Authorization Module

3.1.1 Usecase Login



Usecase Login activity diagram

The activity diagram describes the user login process involving three actors: User (Student, SPSO), System, and HCMUT_SSO. The flow includes:

User Input: The user inputs credentials to log in.

System Processing: The system sends credentials to HCMUT_SSO for validation.

HCMUT_SSO Validation:

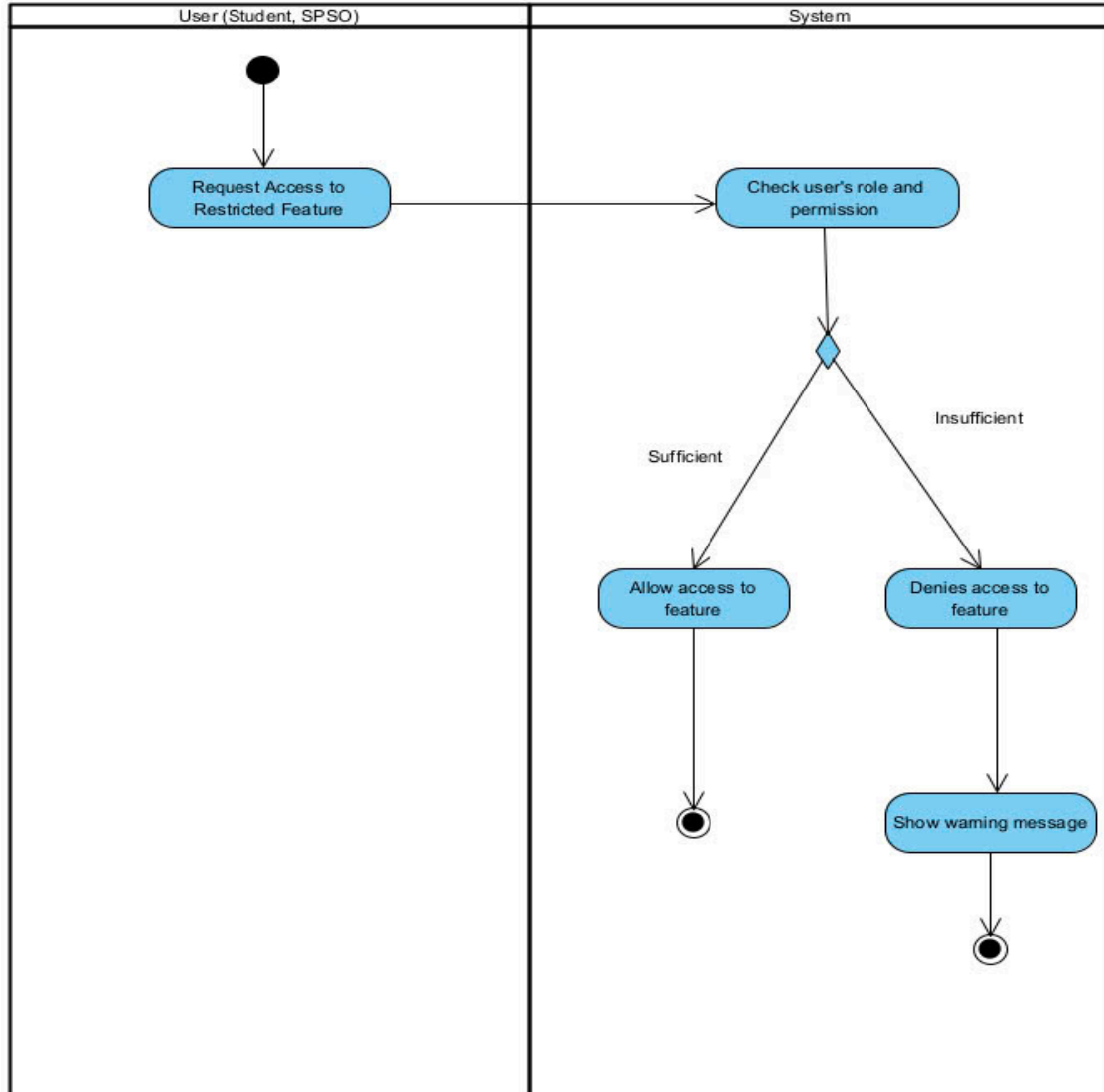
If the service is unavailable, the system shows a Service Unavailable message.

If credentials are invalid, the system displays an error message and allows the user to reset the password or re-login.

If credentials are valid, the system logs the user in and creates a session.

Final Step: The user is redirected to the dashboard after successful authentication.

3.1.2 Usecase Check Access Permissions



Use Case Check Access Permissions Activity Diagram

The activity diagram illustrates the process of requesting access to a restricted feature. The flow involves two main actors: the User (Student, SPSO) and the System.

User Request: The user initiates a request to access the restricted feature.

System Processing: The system checks the user's role and permissions.

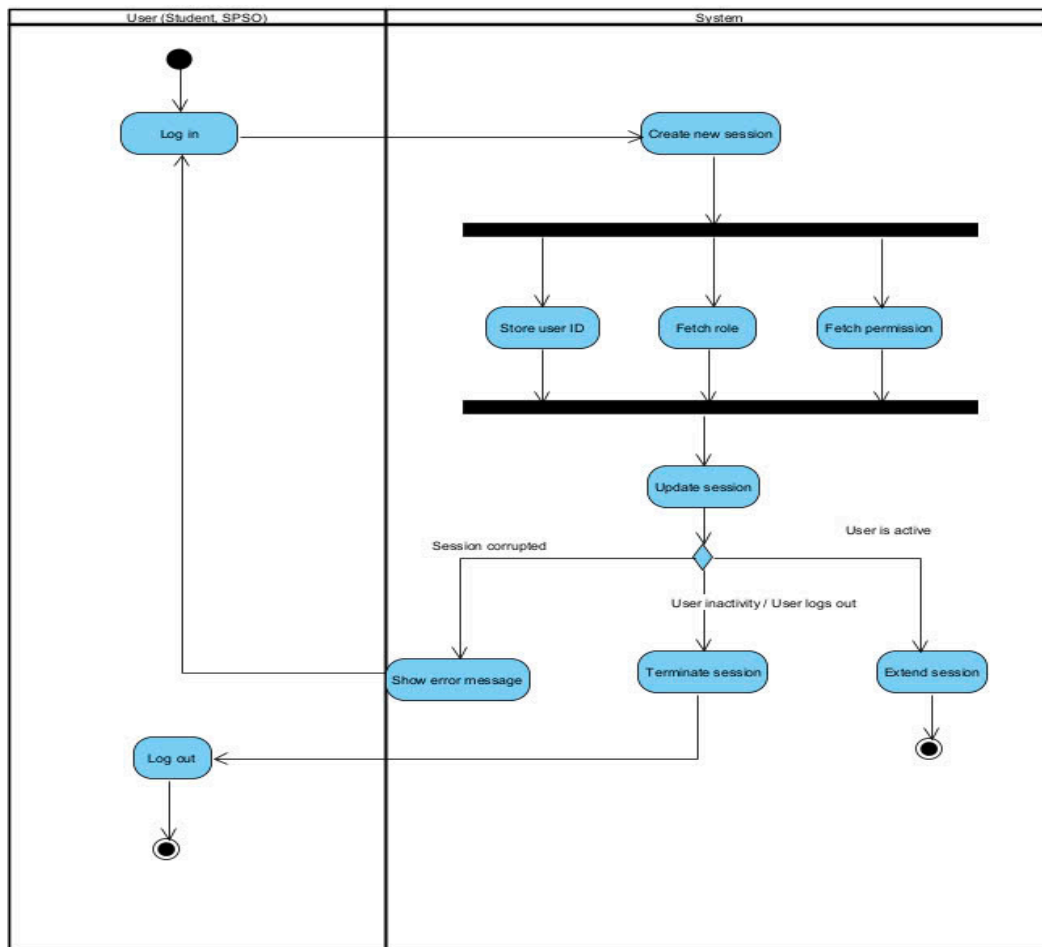
Decision Point:

If the user's permissions are sufficient, access to the feature is granted.

If permissions are insufficient, the system denies access and displays a warning message.

End: The process ends after either granting or denying access.

3.1.3 Usecase Session Management



Usecase Session Management Activity Diagram

The diagram shows the user session flow:

Log in: System creates a session, stores user ID, fetches role and permissions.

Session updates:

If corrupted: Show error.

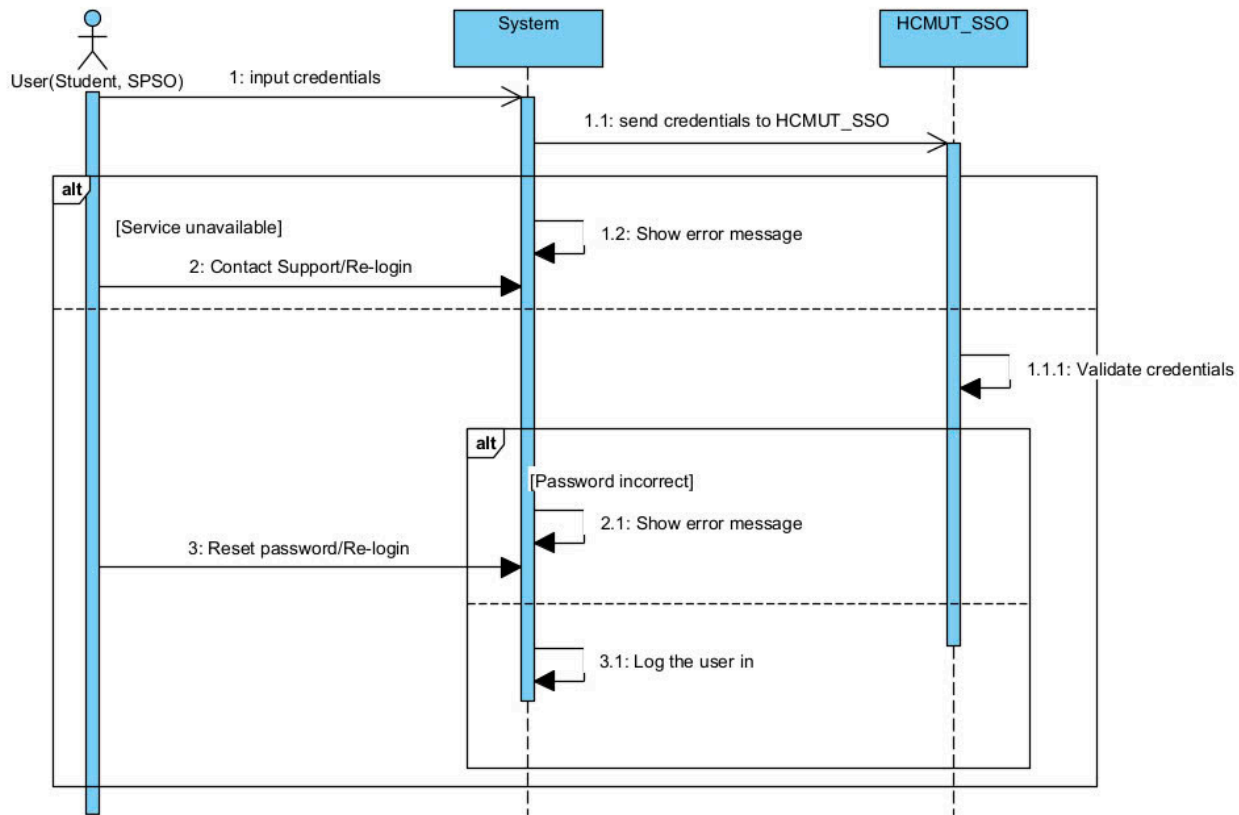
If inactive/log out: Terminate session.

If active: Extend session.

Log out ends the session.

3.2 Sequence Diagram for the Authentication and Authorization Module

3.2.1 Usecase Login



Login Sequence Diagram

This diagram represents a user login sequence flow involving the User, System, and HCMUT_SSO:

User Input:

The user provides credentials to the system.

The system sends these credentials to HCMUT_SSO for validation.

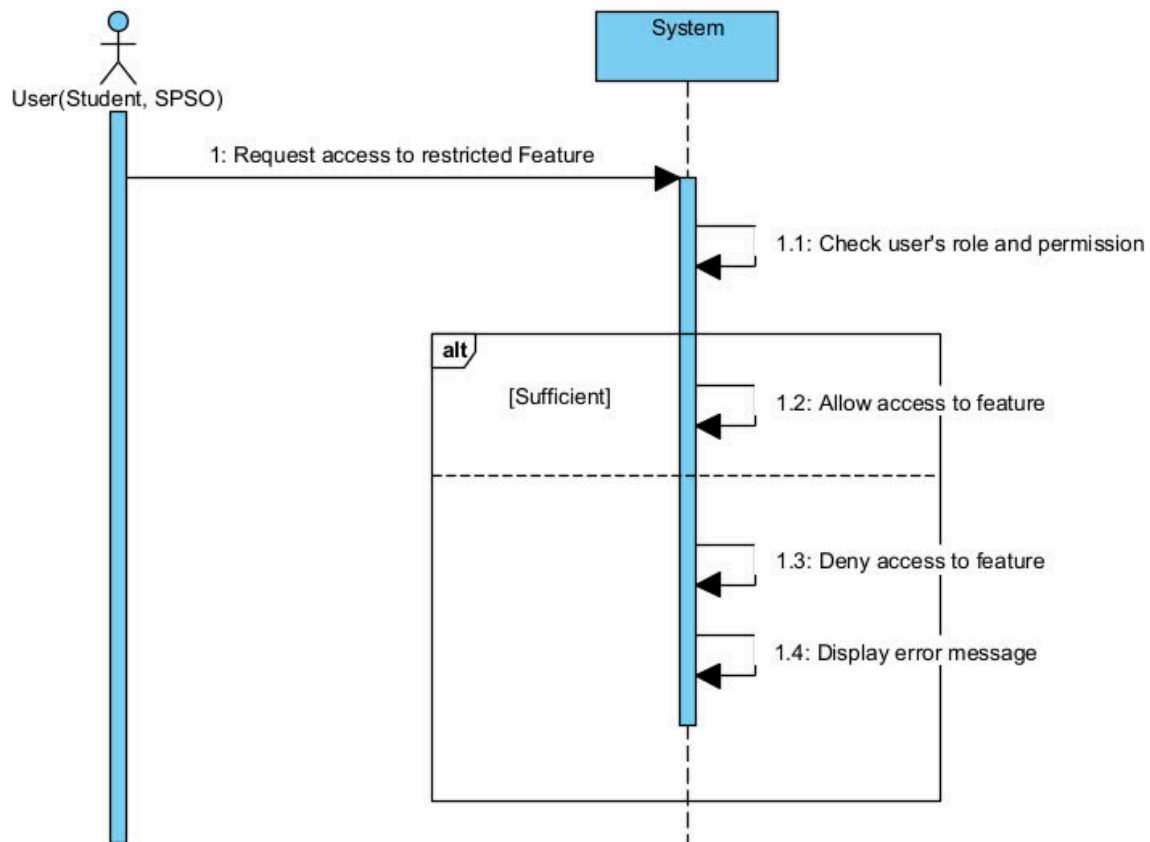
Validation Process:

If the service is unavailable → Show an error message, and the user contacts support or re-logs in.

If the password is incorrect → Show an error message, and the user resets the password or retries.

Successful Login: If credentials are valid, the user is logged into the system.

3.2.2 Usecase Check Access Permissions



Check Access Permissions Sequence Diagram

The diagram shows the restricted feature access flow:

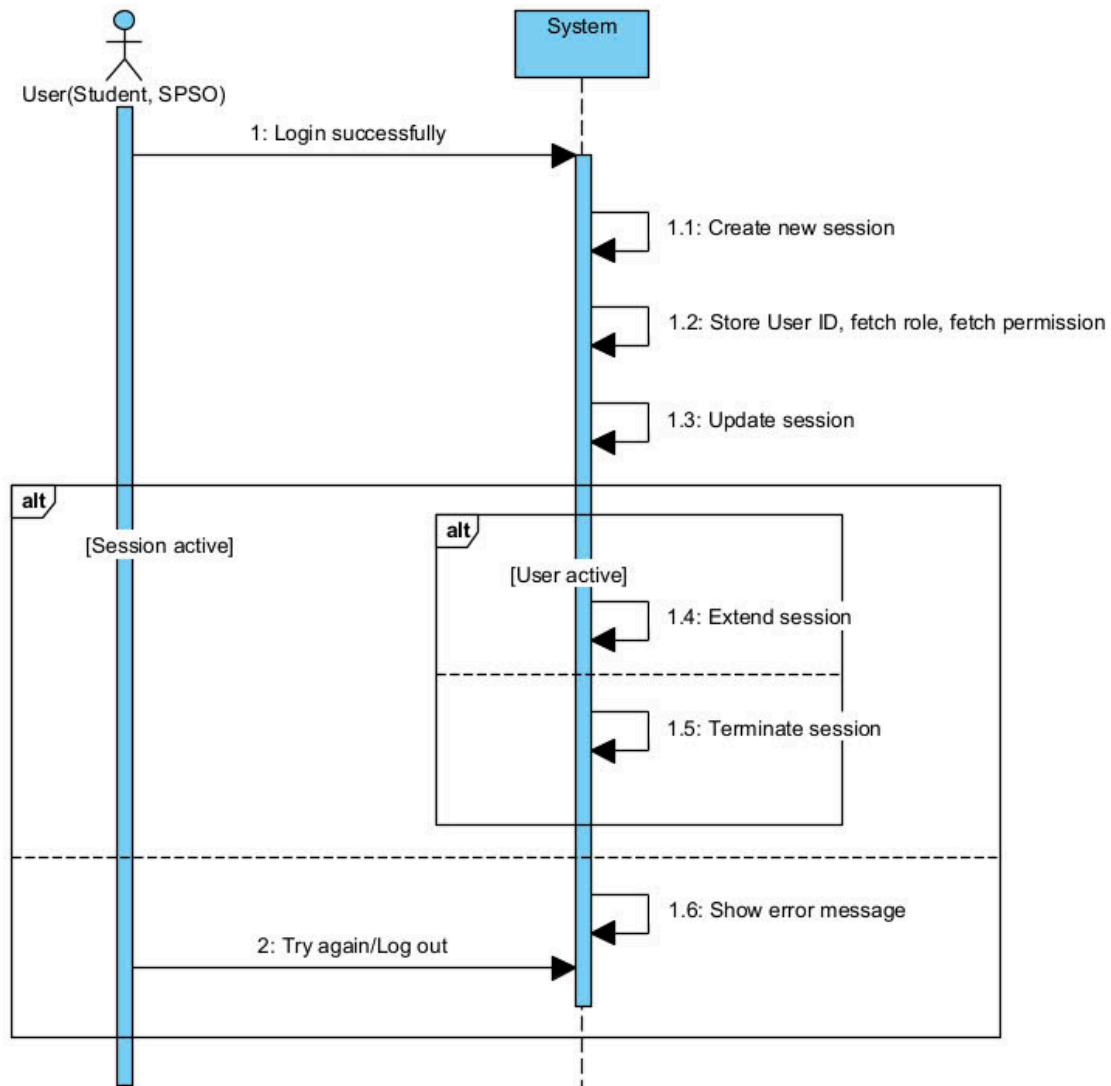
The user requests access to a restricted feature.

The system checks the user's role and permissions:

If sufficient: Allow access to the feature.

If insufficient: Deny access and display an error message.

3.3.3 Usecase Session Management



Session Management Sequence Diagram

This sequence diagram illustrates the user session management process in a system:

Successful Login: The system creates a new session. User ID, role, and permissions are stored and fetched. The session is updated.

Session Management:

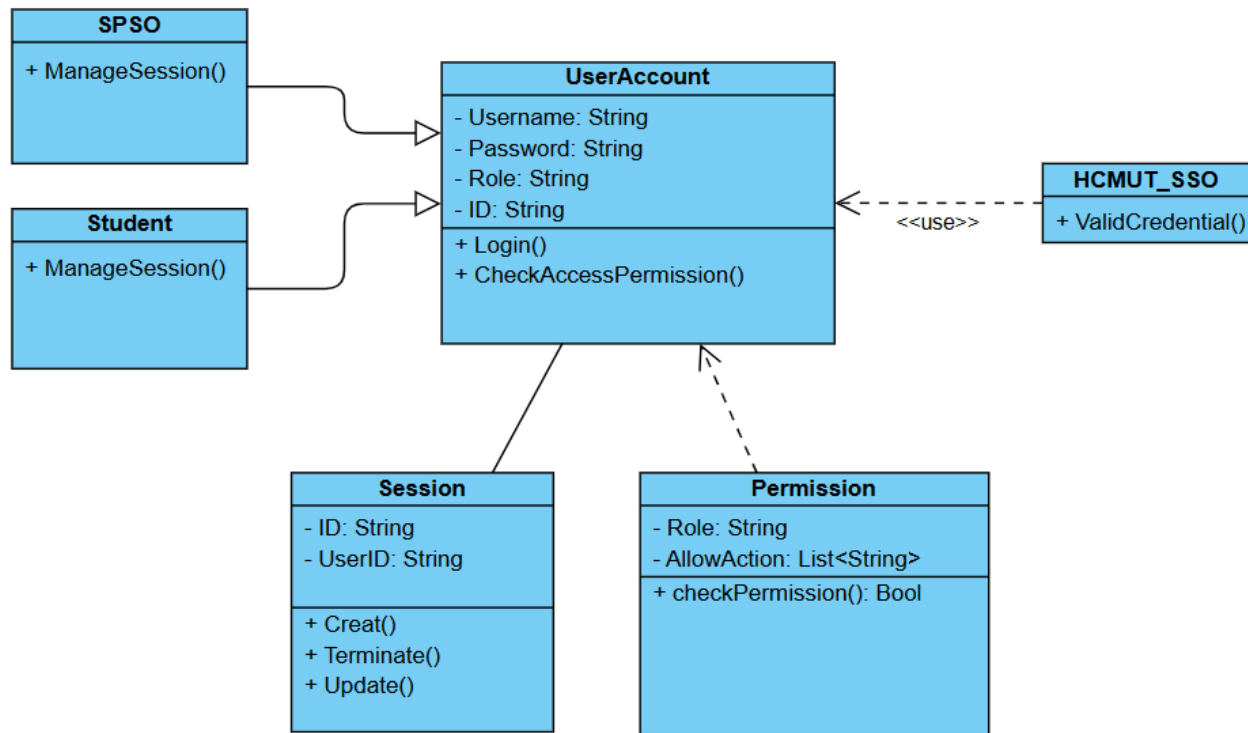
If the session is active and the user is active: Extend the session.

Optionally terminate the session. If there is an issue, the system shows an error message.

Failure Scenario:

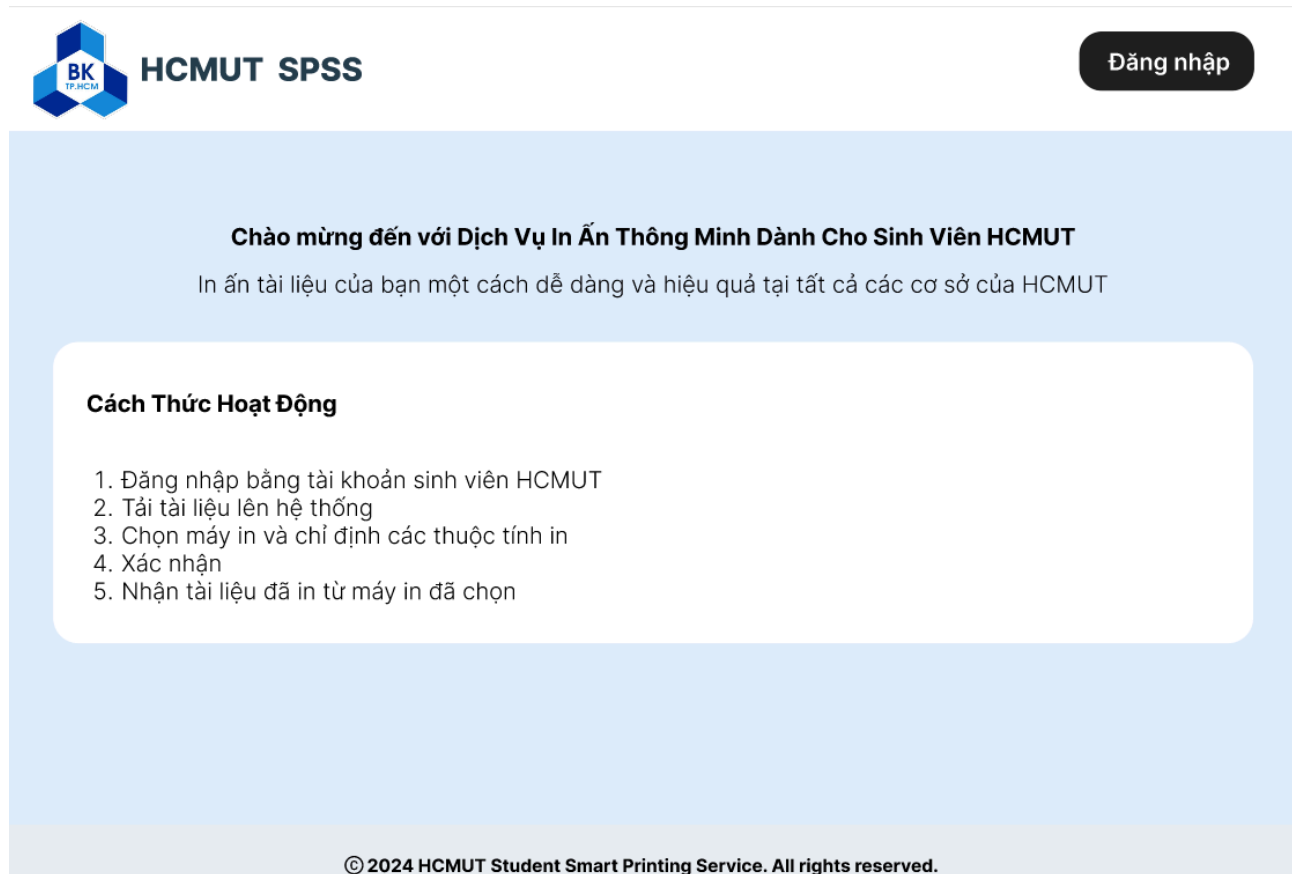
If the session is not active, the user is prompted to try again or log out.

3.3 Class Diagram for the Authentication and Authorization Module

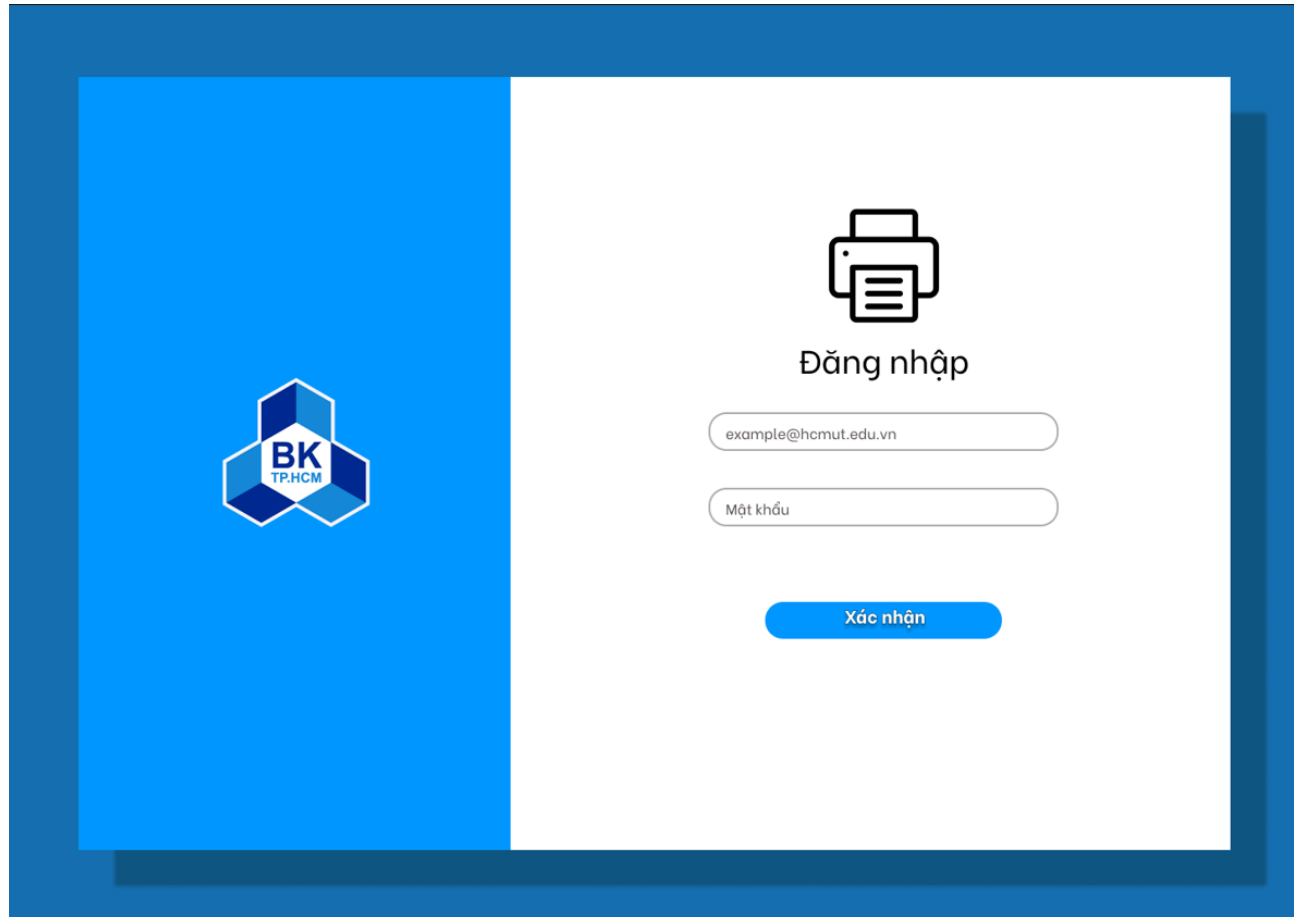


Class Diagram for the Authentication and Authorization Module


3.4 User Interface of the Authentication and Authorization Module



Landing



BK
TP.HCM



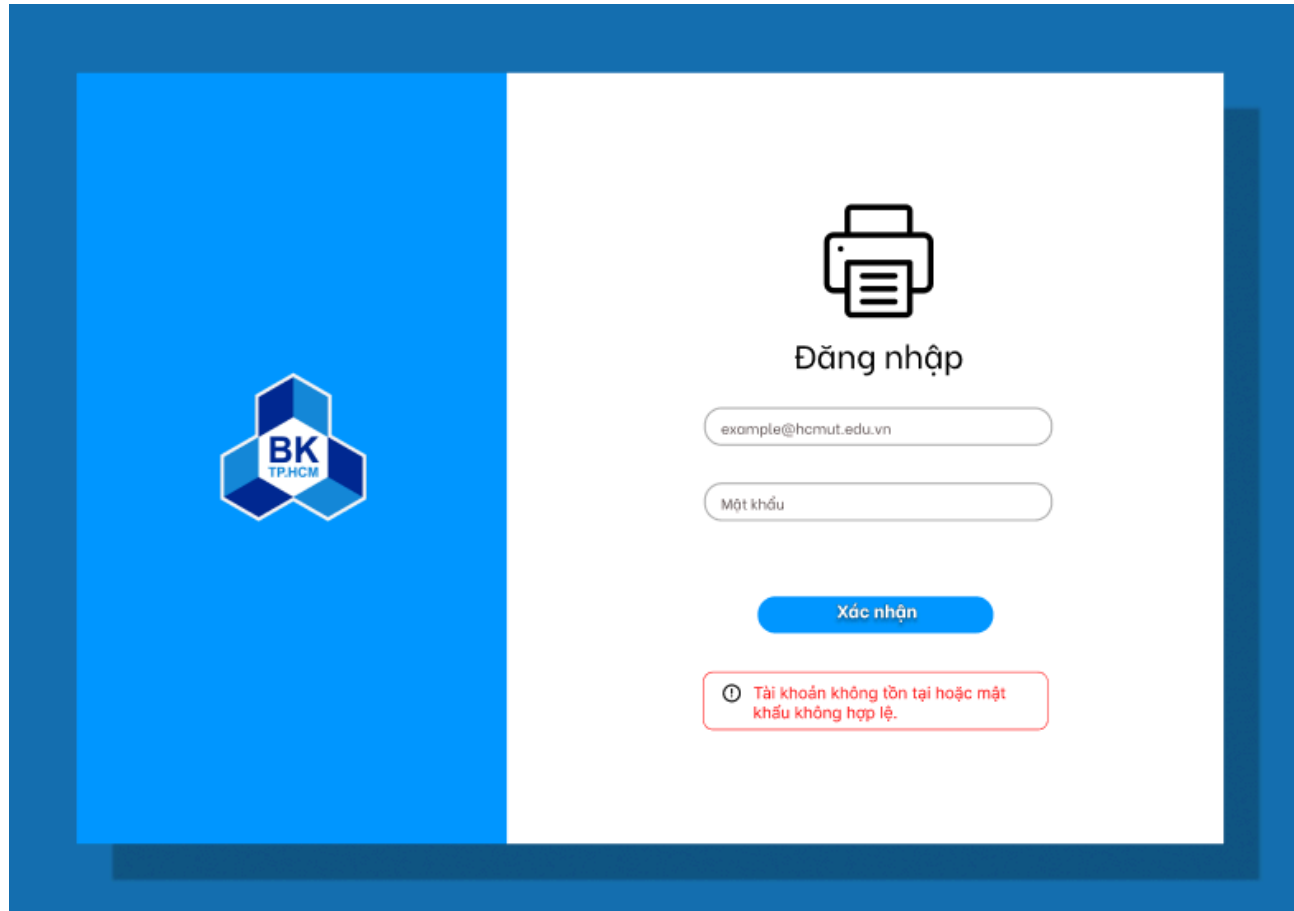
Đăng nhập

example@hcmut.edu.vn

Một khẩu


Xác nhận


Logging Screen




The image shows a login interface for BK TP.HCM. On the left, there is a blue vertical bar containing the BK TP.HCM logo, which consists of three interlocking hexagons in shades of blue and white. On the right, the background is white. At the top center, there is a printer icon. Below it, the text "Đăng nhập" (Login) is displayed. Underneath, there are two input fields: the first contains the email address "example@hcmut.edu.vn" and the second is labeled "Mật khẩu" (Password). A blue button with the text "Xác nhận" (Confirm) is positioned below the input fields. At the bottom, a red-bordered box contains a warning message: "ⓘ Tài khoản không tồn tại hoặc mật khẩu không hợp lệ." (Account does not exist or password is invalid).


Warning Message

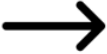
**HCMUT SPSS**

 **Nguyễn Văn A**
2252xxx



Đăng xuất

Số dư trang
25

Mua thêm

In nhanh 
Danh sách máy in
Tải tài liệu

SPSO
Quản lý hệ thống 

In gần đây **Lịch sử in**

In gần đây
 **Giải_tích1.pdf**
 **Bài_tập_lớn.doc**
Hiển thị thêm

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Screen after Login for SPSSPSO

Quản Lý Cấu Hình Hệ Thống

Định dạng tệp được chấp thuận


Chọn các loại tệp mà sinh viên được phép in.

- ☒ PDF ☒ DOCX ☐ DOC ☐ PPTX
☐ PPT ☐ XLS ☐ XLSX

Giới Hạn Số Trang In Mặc Định

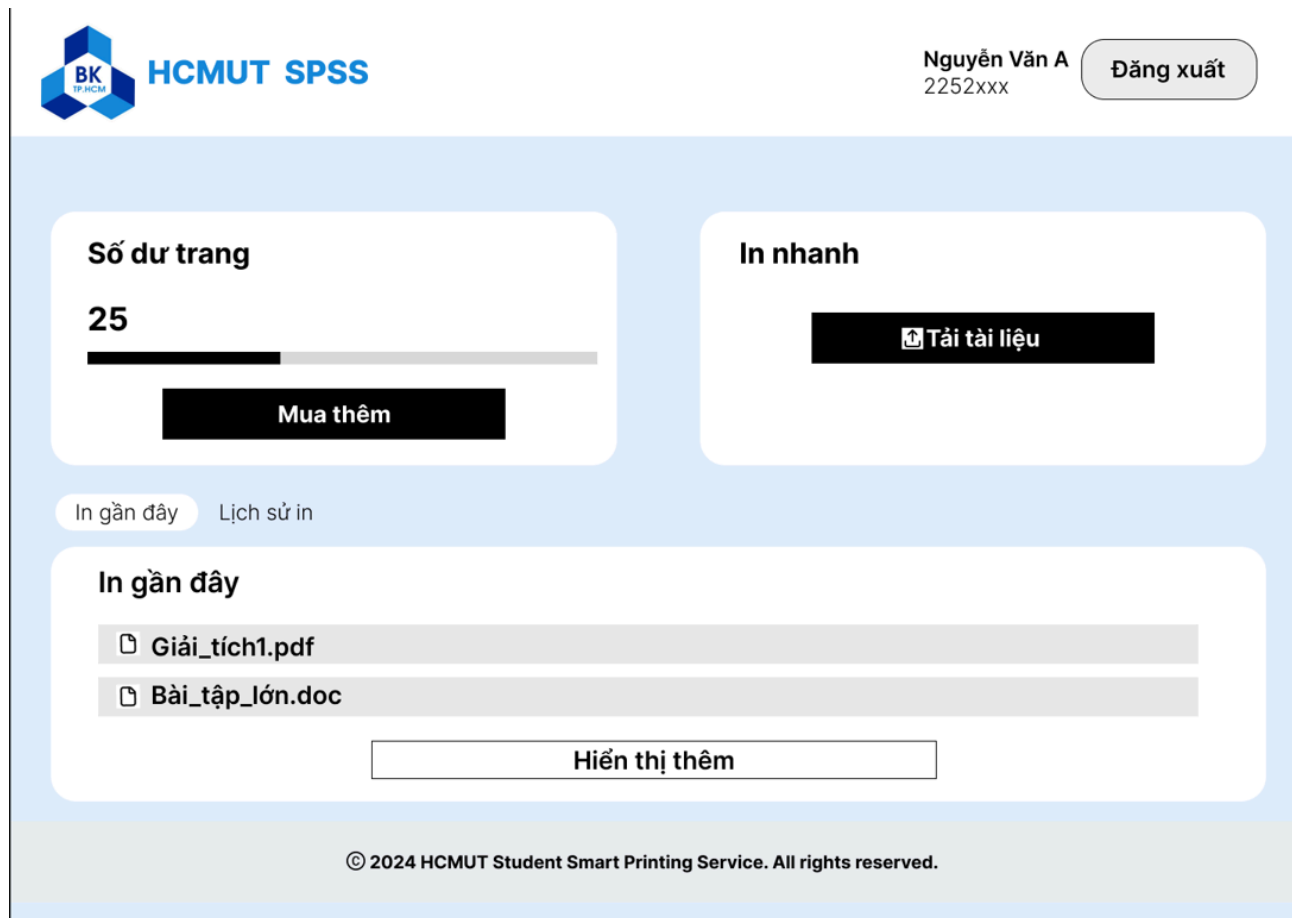
100 pages

Ngày cấp phát


 24 - 10 - 2024

Lưu thay đổi


Manage Configurations of System




Screen of Printing for students



HCMUT SPSS

Nguyễn Văn A
2252xxx

Đăng xuất



1

Administrative Building

2

Library

3

Faculty of Computer Science & Engineering

4

All International Programs / Conference Hall

5

External Relations Office / Auditorium / Computer Center

6

B1 / Faculty of Electrical - Electronic Engineering

7

B2 / Faculty of Chemical Engineering

8

B3 / Office of Postgraduate Studies

9

B4 / Faculty of Applied Science

10

B5 / Faculty of Civil Engineering

11

B6 / Faculty of Geology & Petroleum Engineering

12

B7 / Faculty of Environment

13

B8 / Faculty of Industrial Management

14

B9 / Faculty of Mechanical Engineering

15

C1 / Faculty of Materials Technology

16

C2 / Faculty of Transportation Engineering

17

C3 / National Key Labs And Research Centers / Foreign Language Center

18

Science and Technology Incubators

19

Research Center for Technology and Industrial Equipment (RECTIE)

20

National Key Lab for Digital Control and System Engineering (DCSELAB)

21

National Key Lab for Polymer and Composite Materials

22

Research and Application Center for Construction Technology (REACTEC)

23

Industrial Maintenance Training Center

24

Business Research and Training Center

25

Polymer Research Center

26

Center for Developing Information Technology and Geographic Information System (DITGIS)

27

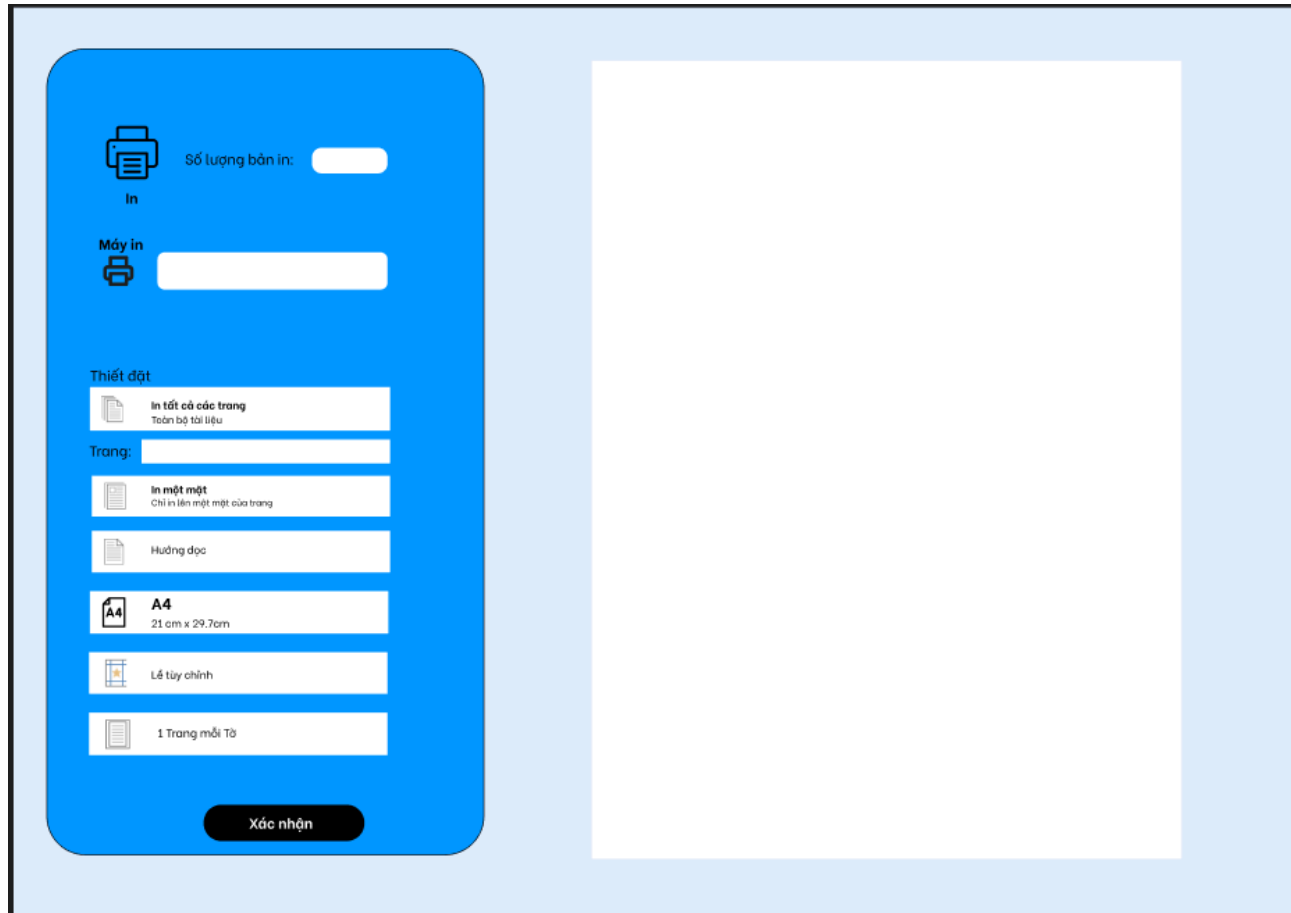
Refinery and Petrochemical Technology Research Center (RPTC)

Menu Label

Xác nhận

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Printer Location Screen



The image shows a user interface for a smart printing service. On the left, there is a blue rounded rectangle containing several settings. At the top, there is a printer icon and the text 'Số lượng bản in:' followed by a white input field. Below this is the text 'In' and another printer icon. Further down is the text 'Máy in' followed by a white input field. The section is titled 'Thiết đặt' (Settings). Below the title, there are several options, each with a document icon and a label: 'In tất cả các trang' (Print all pages) with the subtext 'Trình bày tài liệu' (Document layout), 'Trang:' (Page:), 'In một mặt' (Print one side) with the subtext 'Chỉ in lên một mặt của trang' (Only print on one side of the page), 'Hưởng dọc' (Portrait), 'A4' with the subtext '21 cm x 29,7cm', 'Lề tùy chỉnh' (Custom margins), and '1 Trang mỗi Tô' (1 page per sheet). At the bottom of the blue rectangle is a black button with the text 'Xác nhận' (Confirm). To the right of the blue rectangle is a large white rectangular area, likely for a preview of the document to be printed.

Student interface after uploading document(s)

Lịch sử in ấn

Theo thời gian:

Theo máy in:

Theo kích thước:

Ngày	Tên file	Máy in	Số tờ	Kích thước
07-12-2077	Giải_tích1.pdf	Máy in 1	3	A4

Quay về

Printing history for students with filters



HCMUT SPSS - SPSO

Quản lí A

Đăng xuất

Quản lí máy in

Quản lý danh sách máy in và trạng thái hoạt động

Quản lí máy in

Lịch sử in ấn

Tra cứu lịch sử in ấn của sinh viên

Xem lịch sử in ấn

Cấu hình hệ thống

Quản lý cấu hình hệ thống của SPSS

Cấu hình hệ thống

Báo cáo

Xem và tạo báo cáo sử dụng hệ thống

Xem báo cáo

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SPSO Dashboard

Quản Lý Máy in

Thêm máy in

ID Máy in:

Nhà sản xuất:

Địa chỉ:

Model:

Xác nhận

Quản lý máy in

Máy in 1

Máy in 2

Máy in 3

Máy in 4

Máy in 5

Máy in 6

Máy in 7

Lưu thay đổi

Tiếp tục

Printer managing

Lịch sử in ấn sinh viên

Mã số sinh viên

Thời gian



Nhật kí in ấn sinh viên

Tên file	Số trang	Thời gian bắt đầu	Thời gian kết thúc	Máy in
baitaplon.pdf	10	2023-05-15 14:30:22	2023-05-15 14:31:05	Máy in 1
doanmonhoc.docx	20	2023-05-16 10:15:30	2023-05-16 10:17:45	Máy in 2
baocaototnghiep.pptx	30	2023-05-17 09:00:10	2023-05-17 09:05:30	Máy in 3

[Xem thêm](#)

Xuất báo cáo

Tháng này



Xuất báo cáo

Student's printing log

Quản Lý Cấu Hình Hệ Thống

Định dạng tệp được chấp thuận

Chọn các loại tệp mà sinh viên được phép in.

☒ PDF

☒ DOCX

☐ DOC

☐ PPTX

☐ PPT

☐ XLS

☐ XLSX

Giới Hạn Số Trang In Mặc Định

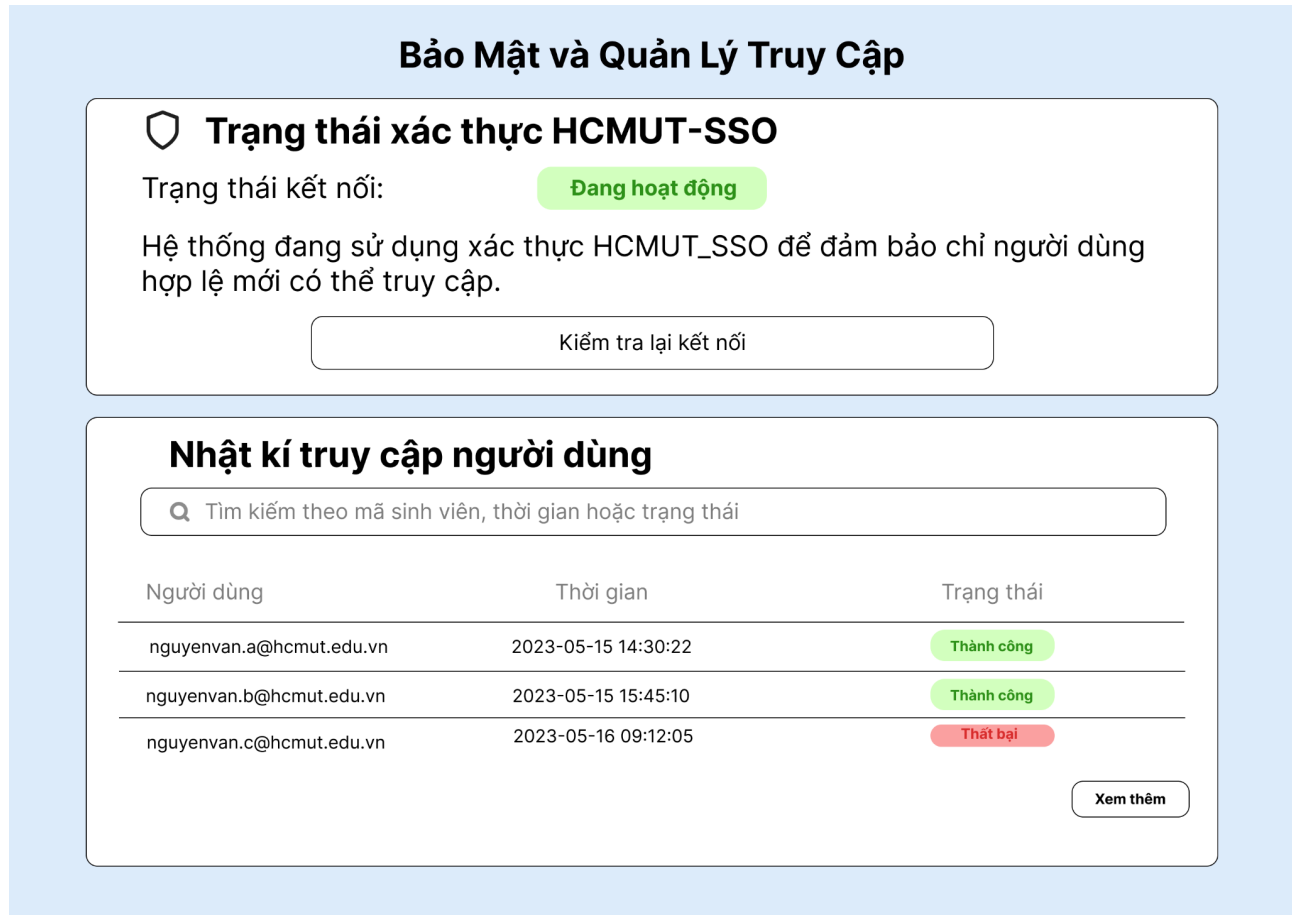
pages

Ngày cấp phát

Lưu thay đổi

Tiếp tục

System configuration managing



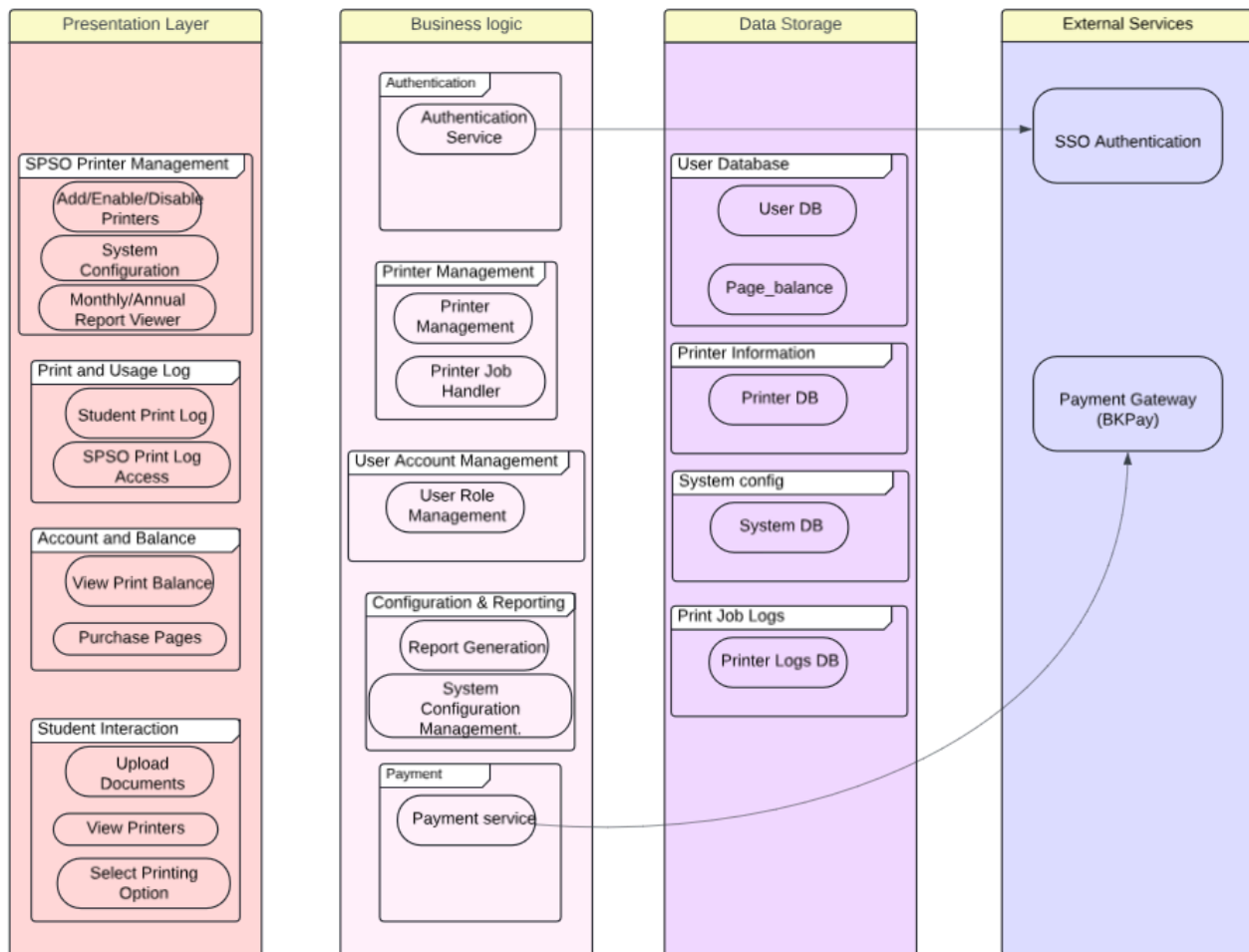
HCMUT_SSO authentication service

Our MVP1 in Figma represents the initial version of the Smart Printing Service for students at HCMUT user interface. It focuses on core functionalities, including a login screen, central dashboard, and many primary printing functionalities for students. Additionally, it offers tools for SPSO to manage the service effectively. This first version serves as a foundation for user feedback and further improvements:

<https://www.figma.com/design/T7l3DSItFWT5z1EVo3HhO5/Software-engineer?node-id=0-1&t=6dRCXtTmOxqDyd4u-1>

4. Architecture design

4.1 Layered architecture for the HCMUT-SSPS system



Presentation Strategy:

The presentation strategy for the HCMUT Smart Student Printing System (SSPS) focuses on effectively communicating the features, benefits, and value of the system to stakeholders. This strategy incorporates various presentation methods to ensure information is conveyed clearly and persuasively:

- Emphasizing the main objectives and vision of the project. Use visual slides to illustrate the overall structure of the system, including key modules such as user management, printer management, and payment system. This helps the audience quickly grasp the scope and scale of the project.

- Perform a live demonstration of the system, showing the process from login to document printing, include using an HCMUT_SSO account to log in, selecting a document to print, previewing costs, and completing the printing process. The live demo helps illustrate the system's ease of use and efficiency, while allowing viewers to better understand the user experience.
- Present the system's data analysis and reporting features using interactive charts and graphs. Demonstrate how SPSOs can monitor system usage, printing trends, and resource management. Use sample data to illustrate detailed and overview reports, emphasizing the system's capability in supporting data-driven decision-making.
- Use flow diagrams to illustrate how the system integrates with HCMUT_SSO and manages access rights. Present the implemented security measures, including data encryption, two-factor authentication, and login activity monitoring. This emphasizes the system's commitment to protecting user information and print data.
- Conclude by presenting a detailed implementation plan, using a Gantt chart to illustrate the project's key phases. Discuss the future development roadmap, including planned features and improvements. This shows the long-term vision and scalability of the system.

Advantages of This Approach:

- Comprehensive: Provides an overview of the system from multiple angles, helping the audience understand the value and functionality of HCMUT-SSPS.
- Interactive: Live demos and interactive presentations help viewers easily understand and evaluate the system.
- Data-driven: Uses data and charts to illustrate the system's efficiency and benefits, increasing persuasiveness.
- Future-oriented: Presenting the implementation plan and development roadmap shows the long-term vision of the project.

Disadvantages of This Approach:

- Time-consuming: A comprehensive presentation strategy can be time-intensive, requiring high concentration from the audience.
- Complexity: Some technical aspects may be too detailed for non-specialist audiences.
- Technology-dependent: Live demos and interactive presentations require careful preparation and may be subject to technical issues.
- Information balance: Difficulty in balancing between providing sufficient detailed information and keeping the presentation concise.

Data storage approach:

The data storage approach involves a structured setup, organizing information into distinct, hard-coded databases to balance efficiency and simplicity for simulation purposes. User information—such as usernames, emails, credentials, and page balances—is stored in User Database for easy management.

Printer-related data, including configurations and system settings, is kept in Printer Information and System Configuration databases, while Print Job Logs record printing activities to support usage tracking and reporting. To enhance performance, frequently accessed data is cached, allowing quick retrieval without repeatedly accessing the hard-coded data. This structure provides straightforward and fast access, but has limitations: hard-coded data lacks flexibility, requiring code changes for updates, and there's no data persistence after a restart. Additionally, caching can introduce inconsistencies if it becomes out of sync with the main source. The setup works well for a small-scale simulation, it would need a DBMS for a live system.

API Management:

The API management layer in the HCMUT-SSPS system is responsible for integrating and securing communications with external services such as HCMUT_SSO Authentication and BKPay Payment Gateway. This layer ensures that each service interaction is well-organized, monitored, and secure. Here's how each API is managed:

Authentication Flow with HCMUT_SSO:

When a user attempts to log in, the HCMUT-SSPS system sends a secure API request to the HCMUT_SSO service. The API management layer handles this by verifying the request format, managing retries in case of network issues, and ensuring that only validated tokens are accepted. Upon a successful response from HCMUT_SSO, the user's session is initiated within HCMUT-SSPS, allowing further interactions with system resources. This setup enforces single sign-on and keeps authentication centralized, reducing the need for redundant login mechanisms.

Payment Processing with BKPay:

For payment transactions, such as when a student buys additional printing pages, the API management layer directs requests to BKPay). The API manager validates each transaction request, sends it to BKPay, and waits for a confirmation. Once payment is confirmed, the student's account balance in the system is updated. Advantages of This Approach:

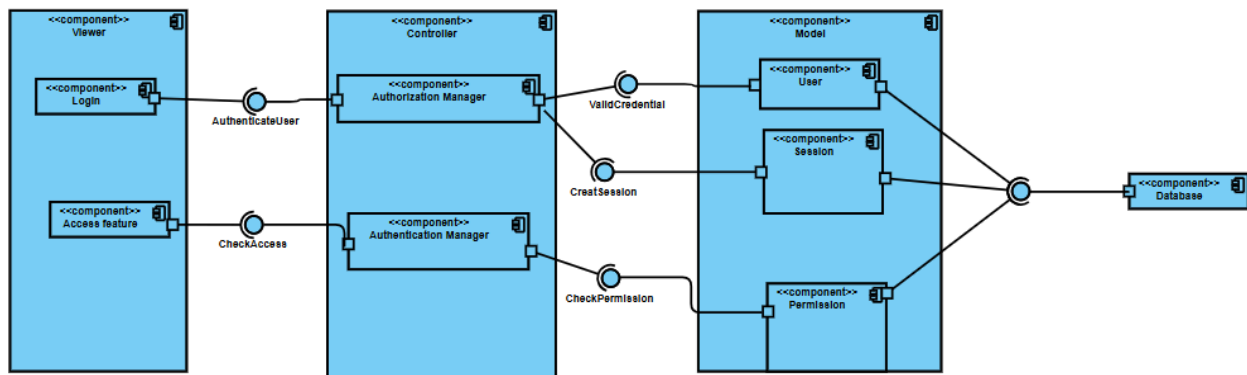
- **Modular Design:** By separating external service interactions into the API management layer, each service can be modified or replaced independently without major disruptions to the overall system. This modularity is essential for maintenance and scalability.
- **Security:** API management adds security layers, including data validation, which protect user data and prevent unauthorized access.

- **Reliability and Error Handling:** The layer includes error-handling mechanisms like automatic retries, logging failed requests, and tracking usage limits, which increase the reliability of service interactions and prevent downtime from temporary failures.

Disadvantages of This Approach:

- **Increased Complexity:** The API management layer introduces additional complexity, as it requires configuration, monitoring, and maintenance to ensure smooth operation.
- **Latency Overhead:** Additional security checks, logging, and error-handling mechanisms can introduce slight delays in response times, potentially affecting the user experience if not optimized.

4.2 Component diagram for the Authentication and Authorization Module



Component diagram

Viewer: contains two sub-components, Login and Access feature, which act as the user interface where users can log in and access system features. These components interact with the Authorization Manager and Authentication Manager in the Controller to authenticate and verify user access.

Controller: includes the Authorization Manager and Authentication Manager, responsible for handling login authentication and managing permissions. The Authorization Manager ensures that users have sufficient access rights to use certain system functions, while the Authentication Manager validates user login information.

Model: consists of three main components: User, Session, and Permission. These components manage user data, session information, and permissions within the system. Information from the

Model is accessed and updated through the Controller.

Database: stores all data related to users, permissions, and sessions. The Model directly interacts with the Database to retrieve or update necessary information.

5. Implementation – Sprint 1

5.1 Setting up an online repository

Link to github: https://github.com/Cuong111111/SE_Assignment_241.git

5.2 Adding documents, materials and folders

We have uploaded assignment related information to the repository.

- Diagram: Includes diagrams such as Class diagram, Sequence diagram, Activity diagram, use-case diagram
- Report: Updated report corresponding to tasks
- Readme

5.3 Usability Test

Project Name: Smart Printing Service for Students at HCMUT

Version: MVP 1

Conducted By: CC04-04

Date: 24/11/2024

5.3.1 Test Goals

- Evaluate the ease of use and efficiency of the MVP 1 user interface (UI).
- Identify feedback and challenges faced by users when interacting with the UI.
- Determine areas requiring improvement to enhance user experience before developing MVP 2.

5.3.1 Recruit participants/ testers

Number of Participants: 7 students currently studying at HCMUT.

Criteria for Participants:

- Regular users of campus printing services or new users unfamiliar with the system.
- Able to perform basic operations on computers.

Recruitment Method: Send invitations via email within the university.

5.3.2 Test Tasks

Participants will perform the following tasks on the HCMUT_SSPPS interface:

1. Log in using HCMUT_SSO credentials granted by the administrator.
2. Upload a document (PDF file) to be printed.
3. Configure the print settings (paper size, double-sided).
4. Select a printer at a specific campus location.
5. View their printing history.
6. Check their printing balance and purchase additional pages if required.

5.3.3 Test Strategy

Type of Test:

- **Qualitative Approach:** Focus on observing user behavior, understanding their emotions, and gathering detailed feedback about their experience.
- **Quantitative Approach:** Collect measurable data such as task completion rates, time taken to complete tasks, and error frequency.

Methodology:

- **In-person Testing:** Users will interact with the system in a controlled environment, allowing for direct observation and real-time support if necessary.
- **Pre-Test Preparation:** Ensure that participants have all necessary credentials and test materials prior to the session. Provide a brief system overview without giving detailed instructions to simulate real-world scenarios.
- **Post-Test Feedback:** Participants will complete an online survey designed to capture their satisfaction and opinions about the system.

Tools and Materials:

- **Devices:** Laptops for accessing the system.
- **Feedback Forms:** Online surveys for post-test feedback.

Environment:

- Conduct tests in a quiet and distraction-free space. Ensure stable internet connectivity for smooth testing.

Metrics to Capture:

- Task completion rates (% of users completing tasks successfully).
- Time taken for each task.
- Errors encountered (e.g., failed logins, unclear navigation).
- User satisfaction ratings (1-5 scale for ease of use, appearance, and overall experience).

5.3.4 Documenting Results

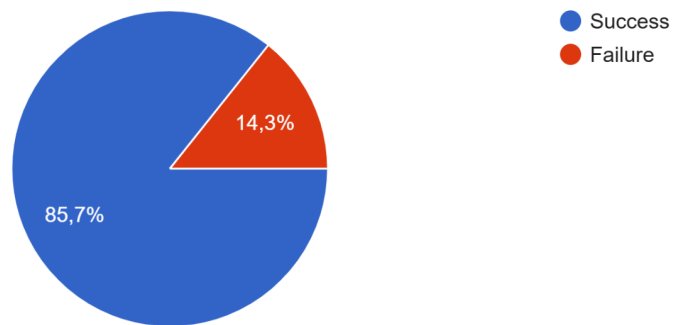
Quantitative Results:

Task	Completion Rate	Average Time (Seconds)	Error
Log in	85.7%	0.37	Incorrect password
Upload	85.7%	0.39	
Setting	100%	0.46	
Select printer	100%	0.51	
View history	71.4%	0.48	Blank space encountered
Check balance and purchase	100%	0.58	

Evaluate tasks according to factors:

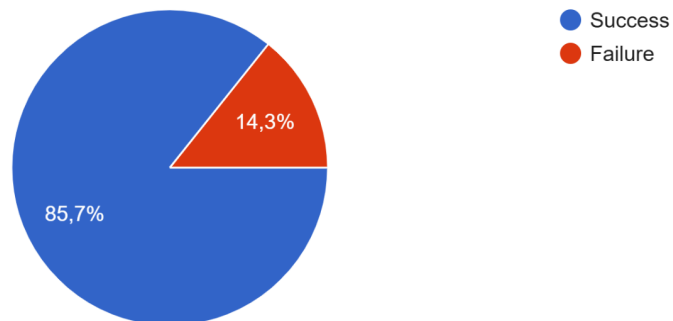
Task 1: Log in using HCMUT_SSO credentials granted by the administrator.

7 câu trả lời



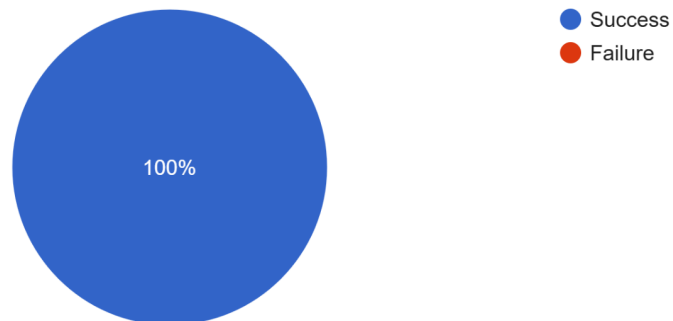
Task 2: Upload a document (PDF file) to be printed.

7 câu trả lời



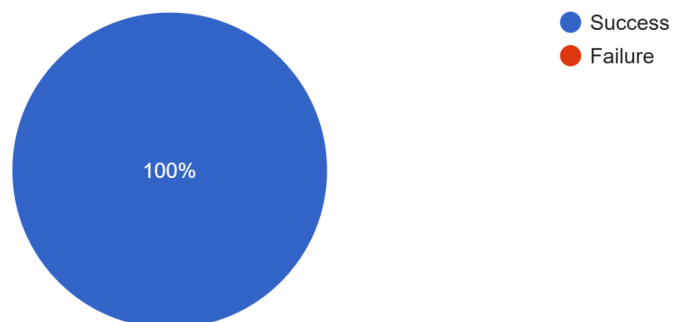
Task 3: Configure the print settings (paper size, double-sided).

7 câu trả lời



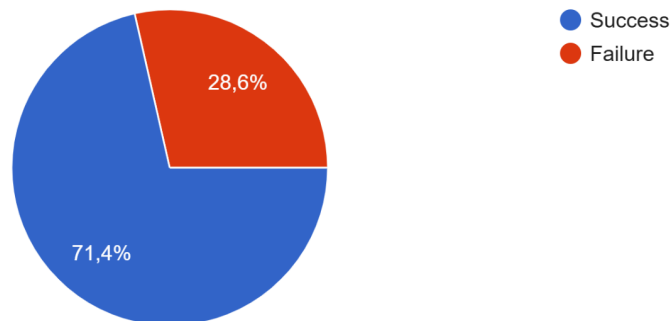
Task 4: Select a printer at a specific campus location.

7 câu trả lời



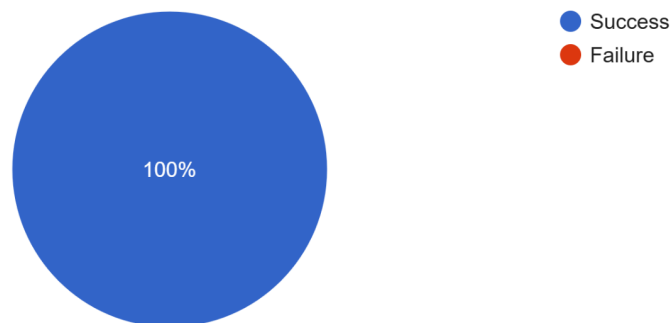
Task 5: View printing history.

7 câu trả lời



Task 6: Check printing balance and purchase additional pages if required.

7 câu trả lời

**Feedback from participants:****Positive Feedback:**

The layout was intuitive and easy to navigate.

Print configuration options were clear and straightforward.

Negative Feedback:

Missing immediate feedback after file uploads caused confusion.

Printer selection was challenging due to a lack of visual aids like maps.

Filters in the print history section were not intuitive for most users.

Updates Needed Based on Usability Test Feedback

Improve Login: Display detailed error messages (e.g., "Incorrect password" or "Account not found").

Enhance Upload Confirmation: Introduce a pop-up or message confirming a successful file upload.

Simplify Printer Selection: Add a small map or graphical representation for easier printer identification.

Refine History Filters: Include tooltips or short instructions for using filters effectively.

Increase Real-Time Feedback: Ensure actions like purchasing quotas or updating balances are immediately reflected with visual confirmation.

File Upload Module:

- Implement a confirmation dialog or notification upon successful file upload.
- Display a progress bar for large file uploads to keep users informed.

Printer Selection Module:

- Integrate a map view displaying printer locations and their statuses (e.g., "Available" or "Busy").
- Highlight the selected printer on the map for better visibility.

Print History Module:

- Add a tooltip or brief instructions explaining how to use date filters effectively.
- Ensure the filtered results are displayed prominently with clear headings (e.g., "Results for [date range]").
- Fix any issues causing blank screens when applying filters.

Quota Purchase Module:

- Add real-time balance updates after completing a purchase.
- Display a confirmation dialog showing the updated quota and a transaction summary.

General Interface Enhancements:

- Ensure all system actions (e.g., quota updates, upload success) provide immediate visual or textual feedback.
- Standardize button labels to make them more descriptive (e.g., change "OK" to "Confirm Purchase").
- Improve the color scheme and font sizes for better readability and accessibility.

6. Implementation – Sprint 2

The source code and notes on the technology used, installation and usage instructions are available in the following github link: https://github.com/Cuong111111/SE_Assignment_241.git