VIETNAM NATIONAL UNIVERSITY, HO CHI MINH CITY
HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY
Faculty of Computer Science and Engineering

Group 11 - CC01 — Assignment Report

STUDENT SMART PRINTING SERVICE

Supervisors:	Dr. Truong Tuan Anh	
Students:	Pham Nguyen Minh Hieu	2252215
	Pham Nguyen Ngoc Uyen	2252895
	Pham The Duc	2252168
	Pham Tran Dang Khoa	2252360
	Phan Khanh Nhan	2252564

Ho Chi Minh City, March 29, 2025

Name	ID	Tasks	Distribution
Pham Nguyen Minh Hieu	2252215	-**T**ask 1.1; Task 1.3; Task 2.1; Task 2.2; Task 2.3; Task 3.2; Task 4; Task 5; Front end developer.	20%
Pham Nguyen Ngoc Uyen	2252895	- **T**ask 1.2; Task 1.3; Task 2.1; Task 2.2; Task 2.4; Task 3.2; Front end developer.	20%
Pham The Duc	2252168	- **T**ask 1.1; Task 1.3; Task 2.1; Task 2.2; Task 3.1; Back end developer	20%
Pham Tran Dang Khoa	2252360	- **T**ask 1.1; Task 1.3; Task 2.1; Task 2.2; Task 3.1; Back end developer.	20%
Phan Khanh Nhan	2252564	- **T**ask 1.1; Task 1.3; Task 2.1; Task 2.2; Task 3.1; Back end developer.	20%

Contents

1 Task 1: Requirement elicitation

1.1 Task 1.1: Overall

1.1.1 Domain Context

The arrival of technology onto educational environments has altered a significant part of traditional operations, including the provision of sophisticated printing services. A smart printing service could aid learners and instructors with their varying printing demands, as well as the administrators at Ho Chi Minh City University of Technology (HCMUT). Since there is a large number of students having the need to print an extensive amount of documents on a daily basis, varied from essays to assignments, research, and projects, implementing a dedicated printing system would not only enhance printing accessibility via their devices of use, but also allow university administrators to efficiently manage resources, track usage, promoting cost control and sustainability. In this context, HCMUT-SSSP stands to modernize and streamline the printing experience, making it, potentially, an integral part of the campus infrastructure.

1.1.2 Stakeholders and Needs

Students: Students require the ability to upload and print documents at multiple campus printers, customize printing options, track their printing history and page balance, and purchase additional print credits as needed. Easy access via both web and mobile applications is essential for convenience.
SPSO (Administrator): The SPSO, responsible for managing the printing system, requires functionality to add, enable, or disable printers as needed. They need to configure system settings such as default print quotas and accepted file types while monitoring student activity and printer usage through detailed logs. Additionally, the SPSO must be able to generate and review monthly and annual reports to track system performance. Ensuring the system runs efficiently is crucial, along with integration with HCMUT's SSO for secure authentication and BKPay for managing payments and print credit purchases.
HCMUT IT Staff: Responsible for the technical upkeep of the system, HCMUT IT staff must ensure system reliability, manage uptime, and provide troubleshooting and technical support as needed.
BKPay: Seamless integration with the printing system for managing transactions, secure processing of payments for print credits, real-time updates to student accounts reflecting changes in page balance after purchases.

1.1.3 Benefits of the System

- For the SPSO, they have the ability to manage the source of data easily and supervise all the printing processes of students.
- For the students, they can save time in the process of printing their information instead of requiring the office to approve, they also can find it easy to meet the requirements from the printing service and manage their budget effectively.
- For the University, they can upgrade their reputation to show to any individual or agency outside the university.
- For Printer Manufacturer, they have the potential environment for them to sell their products as well as increase their brand image to be well-known.

- For the BKPay, they have another income from the printing service and encourage the students to use E-Payment.
- For the staff, they can gather more experience to be better and more professional when taking on other projects.

1.2 Task 1.2: Functional and Non-Functional Requirements

1.2.1 Functional Requirement

For Guests (users not logged in)

- The system provides a homepage containing general information.
- Guests can view information about the system.
- Guests can learn more about the system's key features.
- Guests can view the system's user guide.
- Guests can contact support via the contact information provided in the system.
- Guests can register to the system to become a user's services.
- Guests can log in to the system to use its services.
- The system must assign permissions to logged-in users, including students, SPSO, and machine operators.

For Students

- Students can register by their personal HCMUT's account.
- Students can log-in by their personal HCMUT's account.
- Students can access and view their personal information.
- Students can select files from their devices and upload them to the system.
- Students can choose a specific printer based on their desired location.
- Students can select a time to receive the printed document.
- The system must send email notifications to students when their print jobs are completed.
- Students have options to adjust print settings, such as page size, specific pages to print, single-sided or double-sided printing, and the number of copies.
- The system must store all printing-related information for each student, including student ID, printer ID, start and end times of printing, and the number of pages printed for each page size.
- Students can access and review information related to their previous print jobs, with the ability to filter data by time period and printer used.
- The system must allocate a certain number of printing pages to each student at the beginning of every semester.

- The system must notify students of the remaining number of pages available for use during the semester.
- Students can purchase additional print pages through an integrated electronic payment system.

For SPSO (Student Printing Service Operator)

- SPSO has access to view all students' account information.
- SPSO can access and view information about all available printers in the system.
- SPSO can add, activate, or deactivate any printer in the system.
- SPSO can manage certain system configurations, including changing the number of pages allocated to students periodically, selecting the dates for allocation, determining the file formats students are allowed to upload, and other configurations as needed.
- The system must generate monthly and yearly statistical reports, accessible only by SPSO.
- The system must notify SPS0 when equipment fails.

Authentication System (For HCMUT IT Staff)

- The system must integrate with the HCMUT-SSO authentication system.
- All user login actions must go through the HCMUT-SSO authentication system.
- Notify HCMUT-SSO if the login is successful.
- All information about the account, printing history, number of logins, number of pages, total printing cost, etc. are notified to the student's HCMUT-SSO monthly and annually.

Payment System

- The system must integrate at least one electronic payment method.
- The system must send transaction receipts to students via email.

1.2.2 Non- Functional Requirements

Usability:

- SPSO printing service staff should be able to use all system functions after 2 hours of training.
- Students should be able to use the full printing service after 30 minutes of training.

Security:

- The payment gateway must comply with PCI DSS (The Payment Card Industry Data Security Standard).
- All users must be authenticated via the HCMUT-SSO authentication service before using the system.
- Only document owners can access their stored documents in the system.

- Logged data should be read-only and not modifiable from the user interface.
- Data should be backed up monthly on the 30th and annually on 30th December.

Reliability:

- The error rate for users when performing print operations must not exceed 5%.
- System downtime should not exceed three hours per month.
- The system should be able to restore to a previous state in case of errors.

Performance:

- The system must be able to handle as much as possible print requests simultaneously.
- The response time from receiving the print request to processing it should not exceed too long (5 seconds).
- The response time from a successful payment to updating the user's balance should not exceed too long (30 seconds).
- The response time for notifications to the user's account must not be too long (5 seconds).
- The system must be scalable enough to support many simultaneous accesses while maintaining optimal performance.
- System resources should be used efficiently.

Availability:

- The system must be available ¿90% of the time during the university's working hours, excluding maintenance periods
- The system must function normally for at least ¿90% of the requests in a month.
- The average time to restore the system after a failure should not exceed 1 hours during university working hours.
- The system should be available from 6:30 A.M to 6:00 P.M on weekdays and 7:30 A.M to 4:00 P.M on weekends.
- Maintenance should be limited to no more than four times per year.

Compatibility:

- The system must support both web and mobile platforms.
- The system should be compatible with available printers.
- The system should integrate seamlessly with the payment system.
- The mobile application must support devices running Android and iOS.
- The web application must work on the latest versions of browsers such as Chrome, Firefox, Edge, Safari, CocCoc, and Opera.
- The user interface on the web platform must display well across various screen sizes (PC, tablet, phone, vertical and horizontal, etc.).

- Printing usage reports should be easily accessible.
- Common file formats (doc, docx, pdf) should be supported.
- The system should have a clean and intuitive interface with clear labeling, navigation and distinct buttons.
- A confirmation prompt should appear before submitting any action.
- Provide informative error messages and guidance to users when issues occur.

Extensibility:

- The system should be able to accommodate an additional 5000 users annually.
- The system should allow for the addition of new modules (e.g., document approval) without affecting existing data structures.
- The system should be able to accommodate an additional 5000 users annually.
- The system should allow for the addition of new modules (e.g., document approval) without affecting existing data structures.

Maintainability:

- Comprehensive documentation should be provided.
- Clear error notifications should be sent to technicians when printer issues arise.
- Regular maintenance and upgrades should be performed.

Localization:

- The system must be available in both Vietnamese and English languages.

1.3 Task 1.3: Use Case Analysis

1.3.1 Overall system

Actors

ID	Actor	Description
1	User	General system users
2	Student	Print service user
3	SPSO	System administrator
4	Printer	Printer system
5	HCMUT-SSO	User authentication system
6	Payment System - BKPay	Online payment system

Table 1: *Actors in the system*

Main use case branches

Use Case ID	Name	Description
SE2410	User Registration	Register, login and verify account
SE2411	Print Documents	Print service user
SE2412	Purchase and Payment	Students buy new printed pages
SE2413	Manage Printers	Manage printer addresses, quantity, status
SE2414	Manage Configuration	Manage printer rights, parameters and page prices
SE2415	View Printing Logs	View print history, machine usage
SE2416	View Report	View statistics

Table 2: *Actors in the system*

1.3.2 Use case diagram

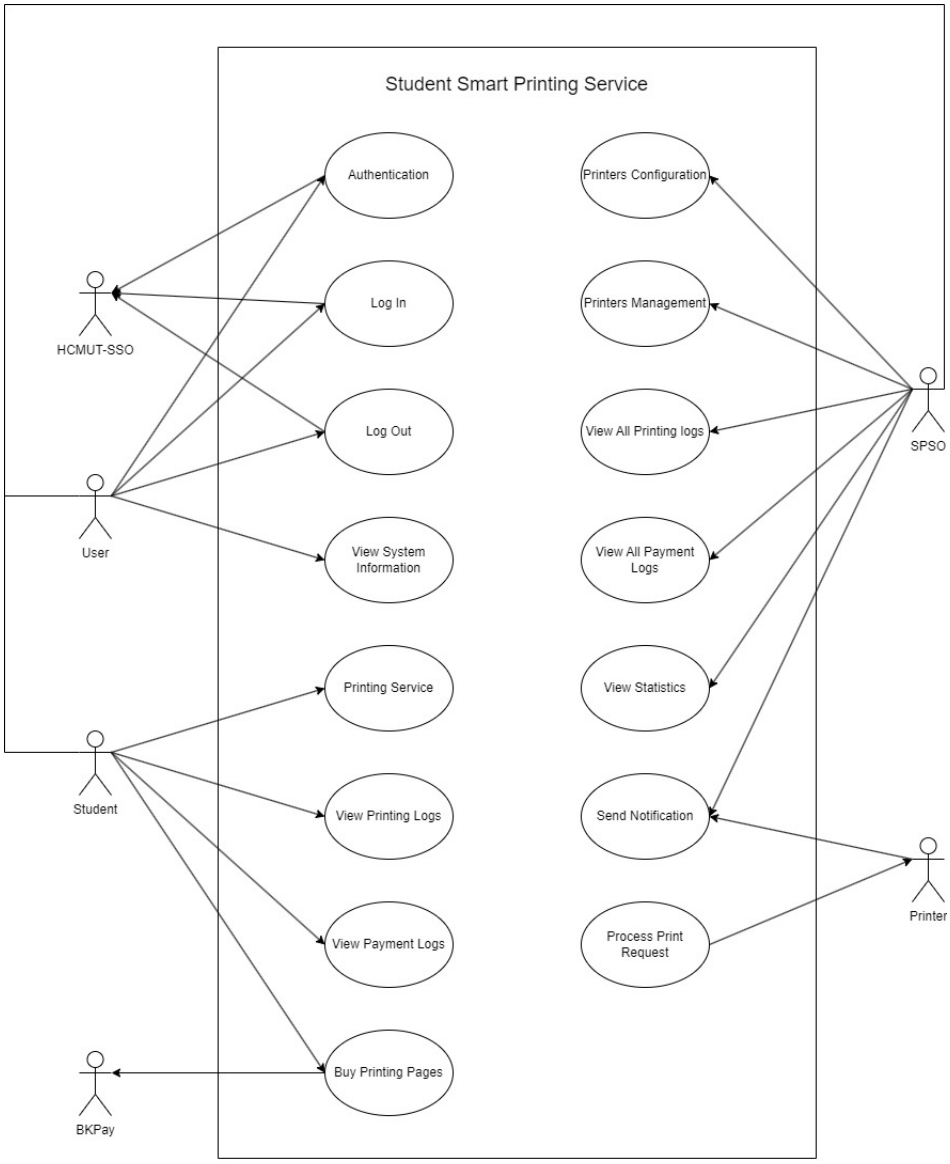

Figure 1: *Overall System Use Case*

1.3.2.a User Registration

Diagram:

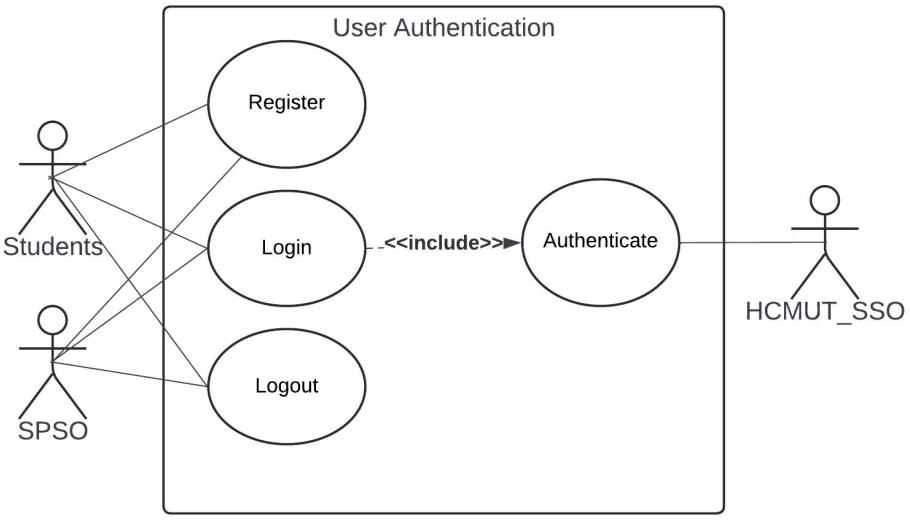

Figure 2: *User Authentication*

Description table:

Use Case ID	SE2410-1
Use Case Name	User Registration
Created By	Pham Nguyen Ngoc Uyen
Day Created	27/09/2024
Last Updated By	Pham Nguyen Ngoc Uyen
Date Last Updated	10/012/2024
Primary Actor	Students, Student Printing Service Officer
Secondary Actor	None
Description	Allows new users to create an account on the HCMUT-SSPS system.
Trigger	User selects the ”Sign up” option on the system’s homepage.

Pre-conditions	• The system is running and accessible. • The user has a valid email address. • The user has not already created an account.
Post-conditions	• A new user account is created in the system.
Normal flows	1. The system displays a registration form. 2. User enters their required information (e.g., name, email, password). 3. The system validates the input data. 4. If the validation is successful, the system creates a new user account. 5. The system sends a confirmation email to the user's registered email address. 6. The system records the registration event in the system logs. 7. The user is automatically logged in to their new account.
Alternative Flows	None
Exceptions	• 2a.If the user enters invalid data (e.g., invalid email format, weak password), the system displays an error message and prompts the user to correct the input. • 4a.If the user tries to register with an email address that is already associated with an existing account, the system displays an error message and prompts the user to log in or choose a different email address.
Notes	None

Table 3: *"Registration" use case specification*

Use Case ID	SE2410-2
Use Case Name	User Log In

Created By	Pham Nguyen Ngoc Uyen
Day Created	27/09/2024
Last Updated By	Pham Nguyen Ngoc Uyen
Date Last Updated	27/09/2024
Primary Actor	Students, Student Printing Service Officer
Secondary Actor	HCMUT-SSO
Description	Users are allowed to access by using user ID or email with password.
Trigger	User selects the "Log in" option on the system's homepage.
Pre-conditions	• Users are managed by and belongs to Ho Chi Minh City University of Technology. • User has valid username and password, registered. • System is running and accessible.
Post-conditions	• The user's session is established.
Normal flows	1. User enters their user ID/email and password. 2. The system validates the credentials with HCMUT-SSO 3. If the credentials are valid, the system establishes a session for the user. 4. The user is redirected to the main dashboard or appropriate landing page. 5. The system records the successful login attempt in the system logs.
Alternative Flows	None

Exceptions	• 2a.If the provided username or password is incorrect, the system displays an error message and prompts the user to try again • 2b.If the system cannot communicate with the HCMUT-SSO authentication service due to network problems, the login process will fail.
Notes	None

Table 4: *"Log In" use case specification*

Use Case ID	SE2410-3
Use Case Name	User Log Out
Created By	Pham Nguyen Ngoc Uyen
Day Created	27/09/2024
Last Updated By	Pham Nguyen Ngoc Uyen
Date Last Updated	10/12/2024
Primary Actor	Students, Student Printing Service Officer
Secondary Actor	None
Description	Users are allowed to exit the HCMUT-SSPS system.
Trigger	User selects the "Log out" option on the system's homepage.
Pre-conditions	• The user is currently logged in. • The system is running and accessible. • The user's session is active
Post-conditions	• The user's session is terminated.

Normal flows	1. User selects the “Log out” option. 2. The system invalidates the user’s session token. 3. The user is redirected to the login page or the system’s homepage. 4. The system records the logout event in the system logs.
Alternative Flows	None
Exceptions	None
Notes	None

Table 5: *”Log Out” use case specification*

Use Case ID	SE2410-4
Use Case Name	User Authenticate
Created By	Pham Nguyen Ngoc Uyen
Day Created	27/09/2024
Last Updated By	Pham Nguyen Ngoc Uyen
Date Last Updated	27/09/2024
Primary Actor	HCMUT-SSO
Secondary Actor	None
Description	An authentication system allows users to log in to the HCMUT-SSPS system and verify their identity.
Trigger	User selects the ”Login” option on the system’s homepage.
Pre-conditions	• The system is running and accessible. • The user has a valid username and password. • The system is integrated with the HCMUT-SSO authentication service.

Post-conditions	• The user's session is established.
Normal flows	1. User enters their user ID/email and password. 2. The system validates the credentials with HCMUT-SSO 3. If the credentials are valid, the system establishes a session for the user. 4. The user is redirected to the main dashboard or appropriate landing page. 5. The system records the successful login attempt in the system logs.
Alternative Flows	None
Exceptions	None
Notes	None

Table 6: *"User Authenticate" use case specification*

1.3.2.b Print Documents

Diagram:

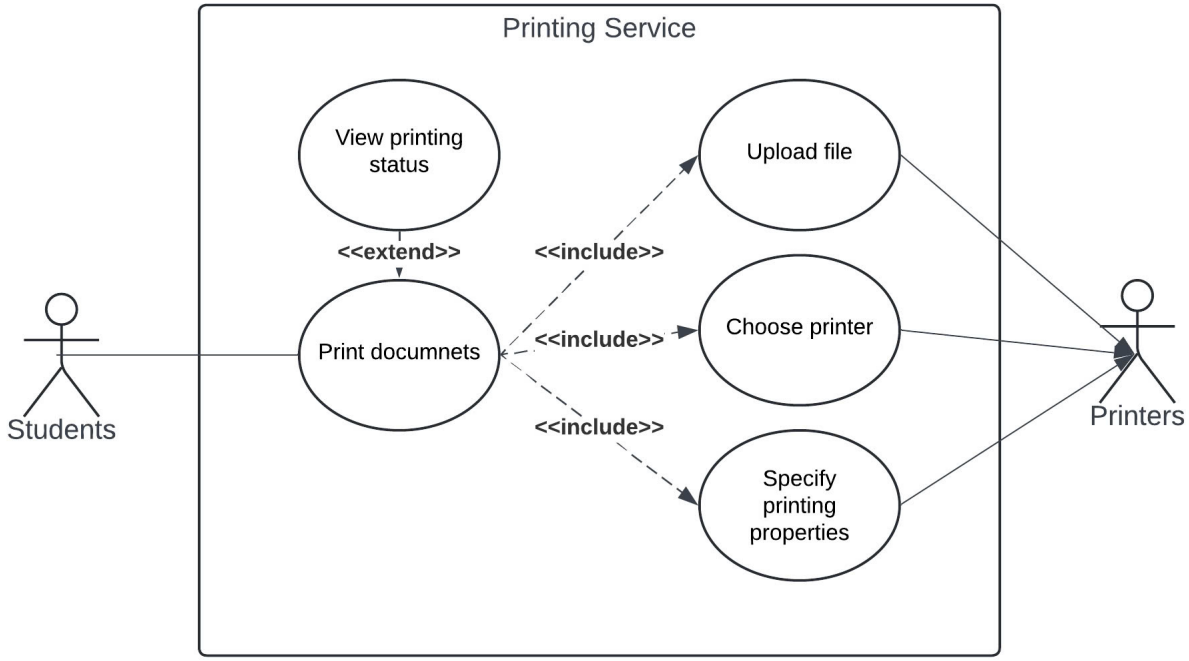

Figure 3: *Print Service*

Description table:

Use Case ID	SE2411-1
Use Case Name	Print Documents
Created By	Pham Nguyen Ngoc Uyen
Day Created	27/09/2024
Last Updated By	Pham Nguyen Ngoc Uyen
Date Last Updated	27/09/2024
Primary Actor	Students
Secondary Actor	Printers, Student Printing Service Officer

Description	Allows authorized users (Students) to upload a document file onto the system, choose a printer, and specify the printing properties such as paper size, pages (of the file) to be printed, one-/double-sided, number of copies, etc.
Trigger	• User uploads a document file to the system. • User chooses a printer. • User specifies printing properties (paper size, pages to be printed, color, number of copies, orientation, etc.) and selects the "Print" option for the uploaded document.
Pre-conditions	• The user is logged in and has the necessary permissions. • The uploaded document is a supported file type and is accessible. • A printer is selected and available. • The user has sufficient printing credits or has purchased additional printing pages.
Post-conditions	• The document is successfully printed on the selected printer.

Normal flows	1. The system displays an interface for uploading printable documents. 2. User uploads document files to the system. 3. The system verifies that the documents are supported file types and accessible. 4. The user selects one of the previously uploaded documents. 5. The system displays a preview interface before printing and adjusts the configuration for that document. 6. The user specifies the printing properties (paper size, pages, orientation, number of copies, etc.) (if necessary). 7. The user chooses the date and time to come and receive the printed copy if necessary; otherwise, the system will automatically suggest a pickup time. 8. The user confirms the request and clicks the next button. 9. The user selects an available printer. 10. The system verifies that the user has sufficient printing credits or has purchased additional pages. 11. The system displays a print confirmation interface and shows information such as: document to be printed, number of pages to print, available pages in the account, etc. 12. The user then clicks the 'Print' button to proceed. 13. The system sends the document to the selected printer for printing. 14. After finishing the printing, the system sends a completion notification to the user. 15. The system updates the user's printing balance and records the printing event in the logs.

Alternative Flows	• 2a.Users can return to the previous page by clicking the back button. • 5a.Users can delete one or more documents from the list if they have no need to print. • 6a. Users can create custom parameter sets and save them for later use, without having to re-enter the parameters each time. • 6b, 8a, 12a. Users can return to the previous page by clicking the back button.
Exceptions	• 3a. If the uploaded document is not a supported file type, the system displays an error message and prevents printing. • 3b. If a student uploads one or more files that violate the requirements (in terms of the number of files or the size exceeding the allowed limit), the system will report an error and cancel the files. • 3c. If there is an error with the document (e.g., corrupted data), the system displays an error message and prevents printing. • 10a. If the user does not have sufficient printing credits, the system displays an error message and prompts the user to purchase additional pages. • 13a. In the event of a printing error, the system will notify both the student and the SPSO.
Notes	None

Table 7: *"Print Documents" use case specification*

1.3.2.c Purchase and Payment

Diagram:

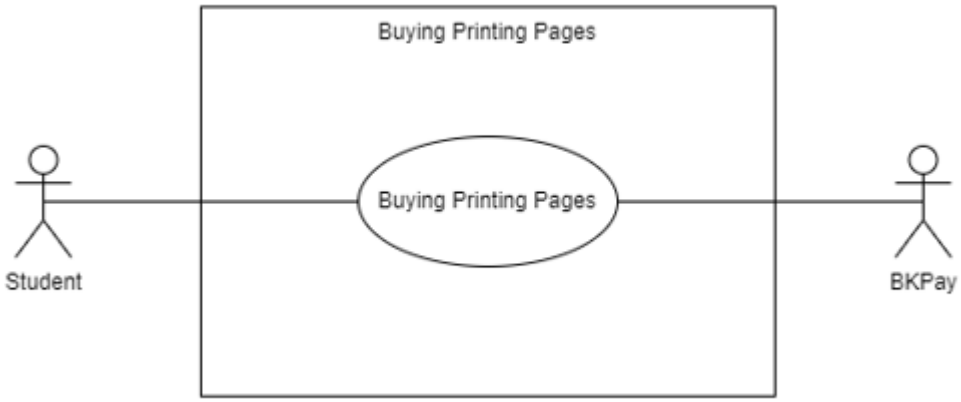

Figure 4: *User Authentication*

Description table:

Use Case ID	SE2412-1
Use Case Name	Buy Printing Pages
Created By	Phan Khanh Nhan
Day Created	27/09/2024
Last Updated By	Phan Khanh Nhan
Date Last Updated	27/09/2024
Primary Actor	Students
Secondary Actor	BKPay
Description	The student can purchase additional printing pages through an online payment system.
Trigger	The student needs to print documents but does not have enough pages.

Pre-conditions	• The system is running and accessible. • The student has logged into the system. • The logged-in account has student-level permissions. • The student's device is connected to the internet. • Bank account linking is available.
Post-conditions	• The request to purchase additional pages is successfully completed. • The number of pages in the student's account is updated.
Normal flows	1. The student accesses the page to purchase additional pages in the system. 2. The student enters the number of pages to purchase. 3. Students log in to their BKPay account. 4. The student selects a payment method. 5. The payment service confirms the payment is successful. 6. The system logs the payment transaction. 7. The system updates the student's account balance with the new page count.

Alternative Flows	• 4a.The student selects the payment method via international credit/debit card (Visa/MasterCard). • 4a1. The system creates the transaction and redirects to the payment page. • 4a2. The student enters card details. • 4a3. The student selects a payment authentication method and proceeds with payment authentication. • 4b.The student selects the payment method via MoMo e-wallet. • 4b1.The system generates a MoMo QR payment code. • 4b2.The student opens the MoMo app and scans the QR code to make the payment. • 4b3.The payment service confirms and processes the payment. • 4c.The student selects the payment method via Internet Banking. • 4c1.The student selects the bank for payment. • 4c2.The system redirects to the bank's payment page. • 4c3.The bank service confirms and processes the payment.
Exceptions	• If the student enters a number of pages less than 0, the system will display an error. • 5a.If an error occurs during the payment process, the system will notify the user of a payment failure.
Notes	None

Table 8: *"Buy Printing Pages" use case specification*

1.3.2.d Manage Printers

Diagram:

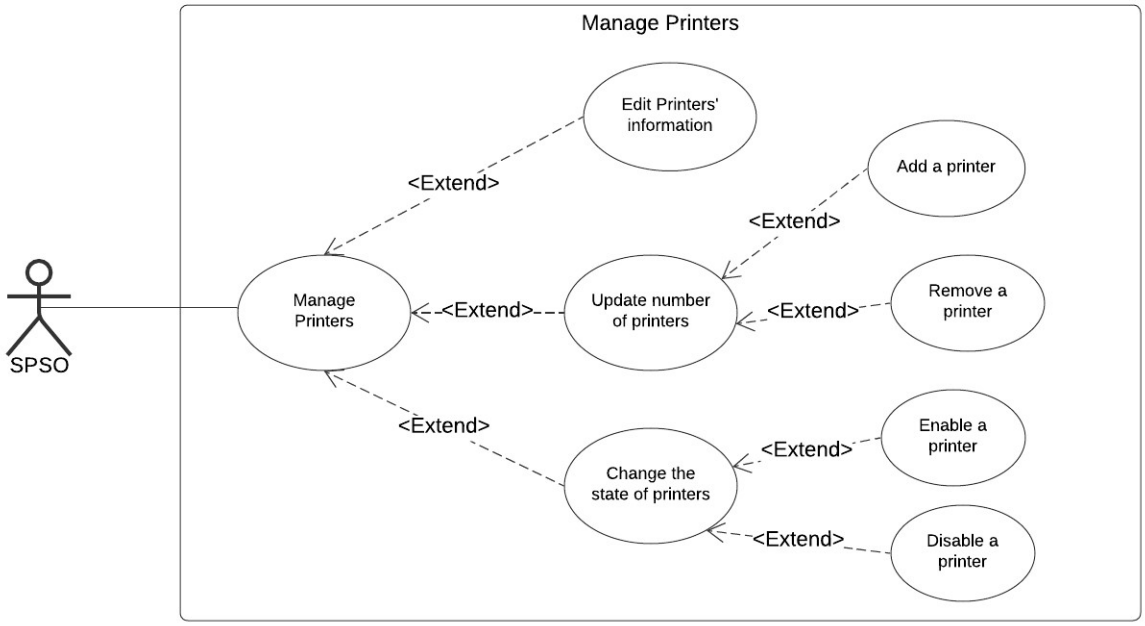

Figure 5: *Manage Printer*

Description table:

Use Case ID	SE2413-1
Use Case Name	Manage Printers
Created By	Pham The Duc
Day Created	27/09/2024
Last Updated By	Pham The Duc
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None

Description	SPSO has the right to manage printers in the system including updating printer information (e.g. ID, brand, location, etc.), applying new printers or changing printer status.
Trigger	SPSO configures settings of printers in the school campus.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet.
Post-conditions	• Successful actions in managing the printers.
Normal flows	1. After logging in sucessfully, SPSO will access to printer's management. 2. The system will show a list of action can be done with the printer to the system. 3. The SPSO will select the suitable one from the list. 4. In the selected figure will be shown in detail what can change. 5. The system will log the update time configuring.
Alternative Flows	• 2a.The system will show a list of recent applied printers. • 3a.Configure the information or status of the printers.
Exceptions	• If SPSO cannot log into the system, send an error message to SPSO.
Notes	None

Table 9: *"Printer Management" use case specification*

Use Case ID	SE2413-2
Use Case Name	Update number of printers.

Created By	Pham The Duc
Day Created	27/09/2024
Last Updated By	Pham The Duc
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO can connect the new printers or disconnect the recent applied printers in the system.
Trigger	SPSO add/remove any printer.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO now in the printers management page.
Post-conditions	• Success in updating the printers system.
Normal flows	1. SPSO chooses Update number of printers. 2. System will show a place to see the recent acepted files and add/remove type. 3. The SPSO will choose “Add” to add another printers to the system. 4. SPSO confirms the change. 5. The system updates the printers system.
Alternative Flows	• 3a.The SPSO will choose “Remove” to remove the recent applied printers.
Exceptions	• If the number of printed pages entered by SPSO is invalid, the system will report an error.

Notes	None

Table 10: *"Update number of printers specification*

Use Case ID	SE2413-3
Use Case Name	Change state of printers.
Created By	Pham The Duc
Day Created	27/09/2024
Last Updated By	Pham The Duc
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO can enable or disable any printer at any time when needed.
Trigger	SPSO changes the status of the printers.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO now in the printers management page.
Post-conditions	• Success in updating allocation time and number of pages.

Normal flows	1. SPSO chooses Change state of printer. 2. System will show a list of printers is being connected to the system. 3. SPSO starts changing the status by clicking enable or disable that printer. 4. SPSO confirms the change. 5. The system updates the status of printers.
Alternative Flows	None
Exceptions	• If the number of printed pages entered by SPSO is invalid, the system will report an error.
Notes	None

Table 11: *Change state of printers specification*

1.3.2.e Manage Configuration

Diagram:

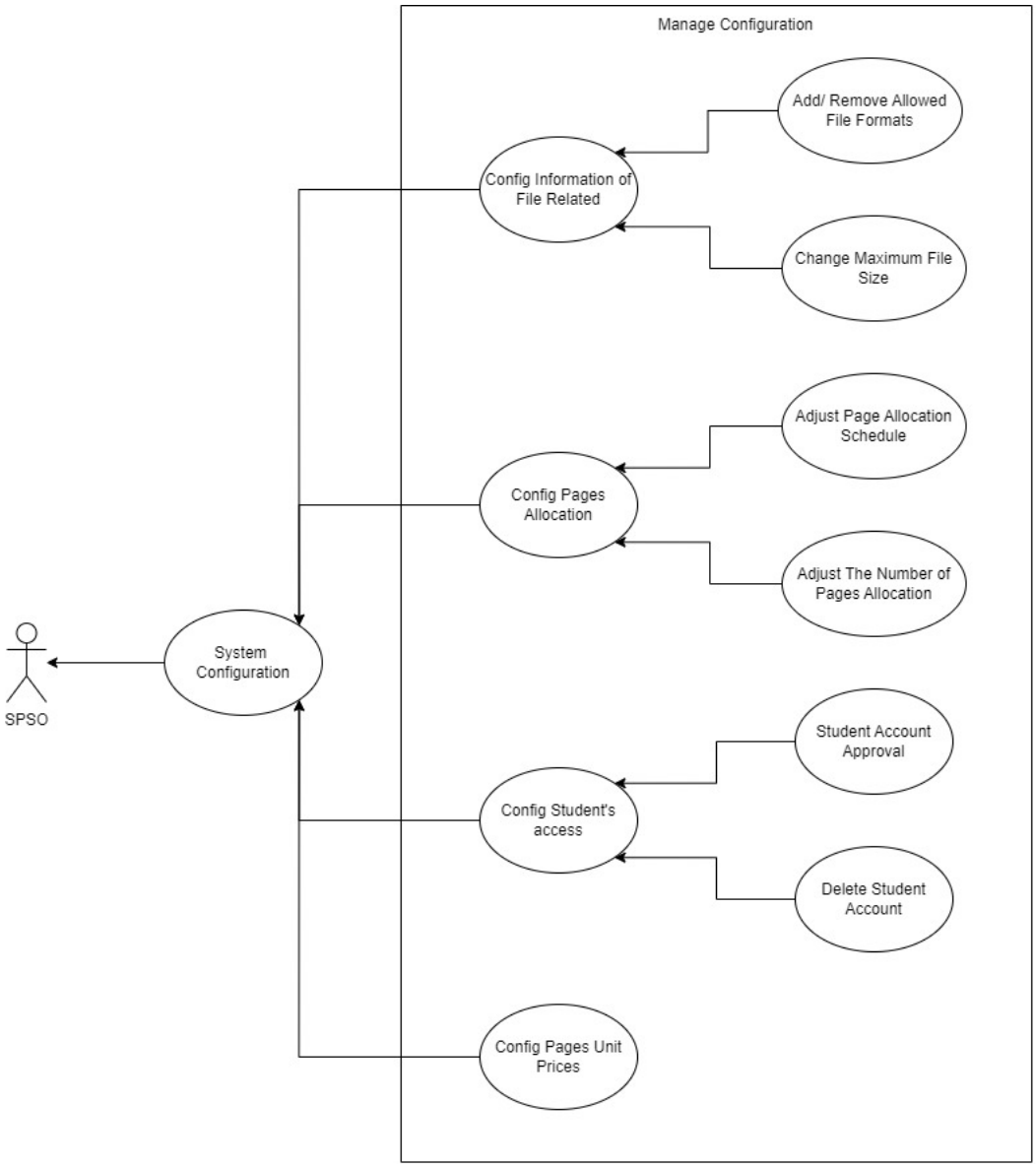

Figure 6: *Manage Configuration*

Description table:

Use Case ID	SE2414-1
Use Case Name	Manage Configurations
Created By	Pham Nguyen Minh Hieu
Day Created	27/09/2024
Last Updated By	Pham Nguyen Minh Hieu
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO can manage a number of system configurations, including assigning service access to students, changing the number of printed pages assigned to students periodically, selecting the dates for assignment, defining the file formats allowed for student uploads, and viewing overall statistics.
Trigger	SPSO configures settings of printing system.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet.
Post-conditions	• SPSO successfully performed configuration management operation.
Normal flows	1. After successful login, SPSO will access the configuration management page. 2. The system will display a list of configurations that can be changed. 3. SPSO will select the appropriate configuration from the list. 4. The system will record the configuration update time.
Alternative Flows	None

Exceptions	• If SPSO cannot log into the system, send an error message to SPSO.
Notes	None

Table 12: *"Configuration Management" use case specification*

Use Case ID	SE2414-2
Use Case Name	Adjust The Number of Pages Allocation
Created By	Pham Nguyen Minh Hieu
Day Created	27/09/2024
Last Updated By	Pham Nguyen Minh Hieu
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO can change the default print page assigned to students.
Trigger	The default number of pages allocated for printing can be changed.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO has accessed the printer management page.
Post-conditions	• The operation to change the default print page assigned to students was successful.

Normal flows	1. SPSO clicks on "Change Issued Print Pages". 2. The system displays a form to fill in the number of printed pages. 3. SPSO enters the new number of printed pages into the form. 4. SPSO confirms the change. 5. The system updates the default number of issued print pages.
Alternative Flows	None
Exceptions	• If SPSO cannot log into the system, send an error message to SPSO. • If the number of printed pages entered by SPSO is invalid, the system will report an error.
Notes	None

Table 13: *"Adjust The Number of Pages Allocation" use case specification*

Use Case ID	SE2414-3
Use Case Name	Adjust Page Allocation Schedule
Created By	Pham Nguyen Minh Hieu
Day Created	27/09/2024
Last Updated By	Pham Nguyen Minh Hieu
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO can change the date printed pages are issued to students.
Trigger	Can change the date the printed page was issued.

Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO has accessed the printer management page.
Post-conditions	• Operation to change the date of printed pages issued to students successfully.
Normal flows	1. SPSO clicks on "Change Date of Issue of Printed Page". 2. The system displays a form to fill in the date. 3. SPSO enters the new number of days in the form. 4. SPSO confirms the change. 5. The system updates the date the printed page was issued.
Alternative Flows	None
Exceptions	• If SPSO cannot log into the system, send an error message to SPSO. • If the date entered by SPSO is invalid, the system will report an error.
Notes	None

Table 14: *"Adjust Page Allocation Schedule" use case specification*

Use Case ID	SE2414-4
Use Case Name	Config Information of File Related
Created By	Pham Nguyen Minh Hieu
Day Created	27/09/2024
Last Updated By	Pham Nguyen Minh Hieu

Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO can change the format and size of files students can upload to the system.
Trigger	Can change the format and maximum file size allowed.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO has accessed the printer management page.
Post-conditions	• The operation to change the file format and the file size allowed for uploading was successful.
Normal flows	1. SPSO clicks on "Change uploaded format and size file". 2. The system displays a list of allowed format files and custom size files. 3. If SPSO wants to add a format file to the list, select "Add format". 4. If SPSO wants to delete a format file from the list, select "Delete format" in the list displayed on the screen. 5. If SPSO wants to change the size file, adjust the number. 6. SPSO confirms the change. 7. The system updates the list of format and size of files.
Alternative Flows	None
Exceptions	• If SPSO cannot log into the system, send an error message to SPSO. • If the size entered by SPSO is invalid, the system will report an error.

Notes	None

Table 15: *"Config Information of File Related" use case specification*

Use Case ID	SE2414-5
Use Case Name	Config Pages Unit Prices
Created By	Pham Nguyen Minh Hieu
Day Created	27/09/2024
Last Updated By	Pham Nguyen Minh Hieu
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO may change the price of each page that a student needs to print.
Trigger	Can change the price of each page.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO has accessed the printer management page.
Post-conditions	• The operation to change the price of a page was updated successfully.

Normal flows	1. SPSO clicks "Change currency valuation". 2. The system displays the history of currency price changes and the current currency price input box. 3. SPSO enters the amount to be changed. 4. SPSO confirms the change. 5. The system updates the new currency price and notifies the student.
Alternative Flows	None
Exceptions	• If SPSO cannot log into the system, send an error message to SPSO. • If the price entered by SPSO is invalid, the system will report an error.
Notes	None

Table 16: *"Config Price Of Each Page" use case specification*

Use Case ID	SE2414-6
Use Case Name	Config Student's access
Created By	Pham Nguyen Minh Hieu
Day Created	27/09/2024
Last Updated By	Pham Nguyen Minh Hieu
Date Last Updated	27/09/2024
Primary Actor	Student Printing Service Officer
Secondary Actor	None
Description	SPSO may change student access to services.
Trigger	Can change the accession of student.
Pre-conditions	• SPSO has logged in the system • SPSO account is an administrative account • Device must be connected to the Internet. • SPSO has accessed the printer management page.
Post-conditions	• The operation to change a student's access rights has been successfully updated.
Normal flows	1. SPSO clicks on "List of registered students". 2. SPSO selects the student to be adjusted. 3. SPSO revokes the student's access. Or 4. SPSO clicks on "List of students to be approved". 5. SPSO selects "Agree" or "Deny". 6. SPSO confirms the change. 7. The system updates the new list.
Alternative Flows	None

Exceptions	• If SPSO cannot log into the system, send an error message to SPSO.
Notes	None

Table 17: *"Config Student's access" use case specification*

1.3.2.f View Printing Logs

Diagram:

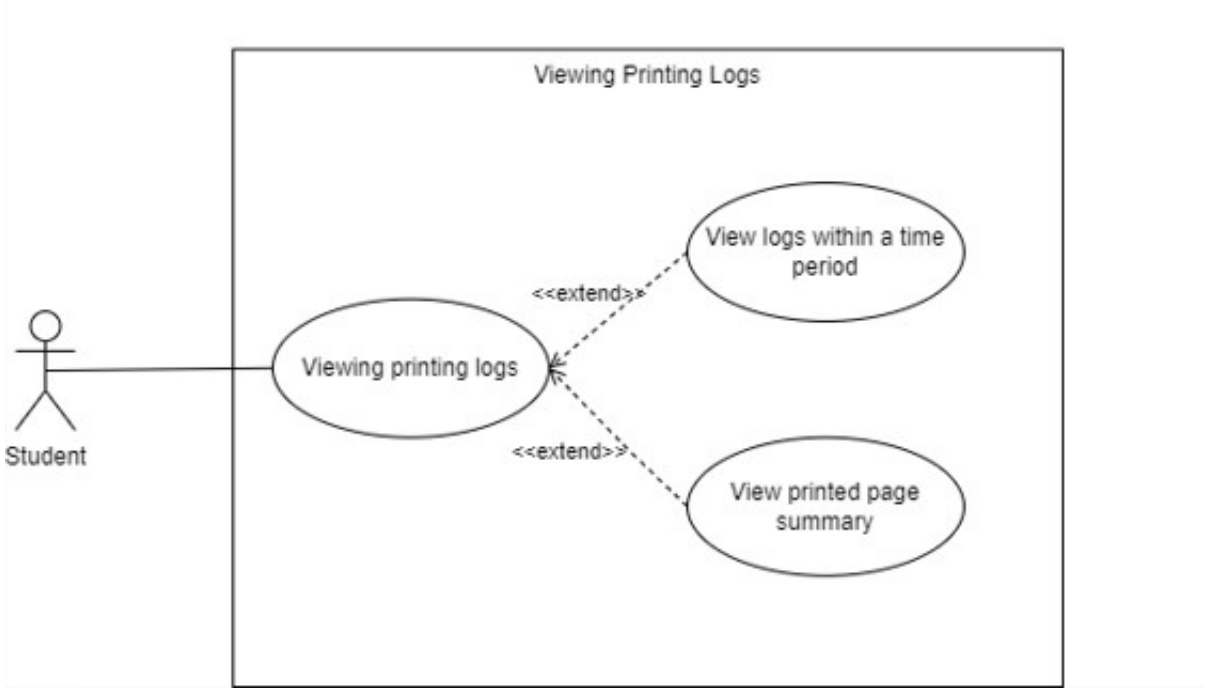

Figure 7: *View printing logs for students*

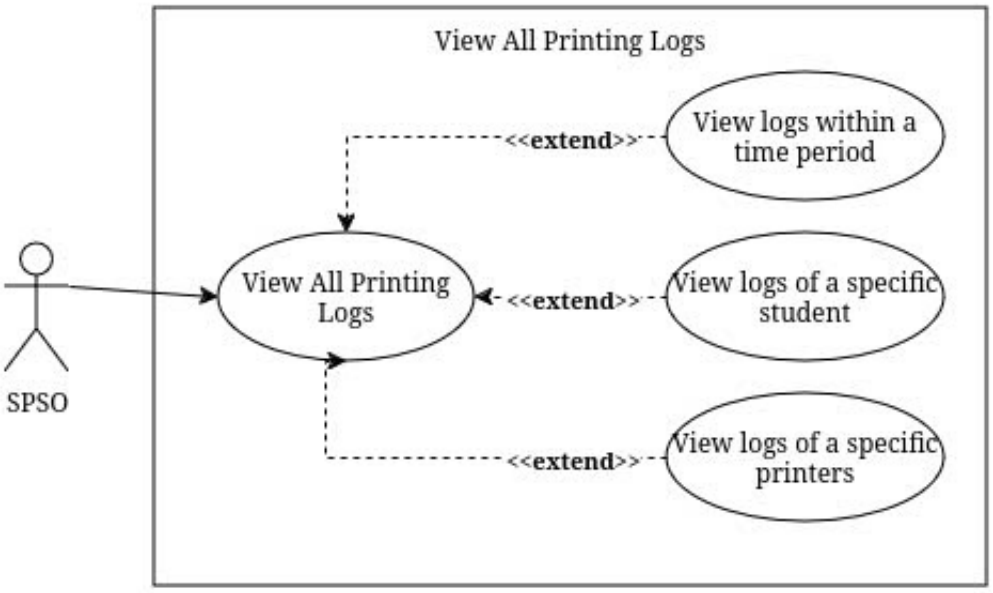

Figure 8: *View all printing logs for SPSO*

Description table:

Use Case ID	UC006-1
Use Case Name	View Printing Logs
Created By	Phan Khanh Nhan
Day Created	27/09/2024
Last Updated By	Phan Khanh Nhan
Date Last Updated	27/09/2024
Primary Actor	Students
Secondary Actor	None
Description	The student can view their print history within a specified period and sort the history by certain parameters (print date, number of pages).
Trigger	The student wants to review their previous print history.

Pre-conditions	• The system is running and accessible. • The student has logged into the system. • The logged-in account has student-level permissions. • The student's device is connected to the internet.
Post-conditions	• The action of viewing the student's print history is completed successfully.
Normal flows	1. The student accesses the print history function page. 2. The student selects a specific print transaction to view. 3. The system shows detailed information about the print transaction, including: print transaction ID, printer ID, names of printed documents, print format, number of pages for each page size, the time the print request was sent, the time the request was completed, and the status.
Alternative Flows	• 2a.The student selects a start and end date to filter print history within that period.
Exceptions	• 2a1.If the start date is after the end date, the system will display an error.
Notes	None

Table 18: *"View Printing Logs" use case specification*

Use Case ID	SE241-
Use Case Name	View All Printing Logs
Created By	Pham Tran Dang Khoa
Day Created	27/09/2024
Last Updated By	Pham Tran Dang Khoa

Date Last Updated	27/09/2024
Primary Actor	SPSO
Secondary Actor	None
Description	The SPSO can view the printing history of all students.
Trigger	The SPSO needs to review the printing history to verify information.
Pre-conditions	• The system is running and accessible. • The SPSO has logged into the system. • The SPSO account has admin privileges. • The SPSO's device is connected to the internet.
Post-conditions	• The SPSO successfully views the printing history.
Normal flows	1. The SPSO accesses the printing history page. 2. The system displays a list of completed printing activities. 3. The SPSO selects a specific printing activity. 4. The system displays detailed information related to the selected printing activity, including student ID, printer ID, file name, start and end time, and the number of pages printed for each page size.
Alternative Flows	• 3a.View logs within a time period. • 3a.View logs based on specific students. • 3a.View logs based on specific printers.
Exceptions	None
Notes	None

Table 19: *"View all printing logs" use case specification*

Use Case ID	SE241-
Use Case Name	View logs of a specific student
Created By	Pham Tran Dang Khoa
Day Created	27/09/2024
Last Updated By	Pham Tran Dang Khoa
Date Last Updated	27/09/2024
Primary Actor	SPSO
Secondary Actor	None
Description	The SPSO can view the printing history of a specific student.
Trigger	The SPSO needs to review the printing history of individual students.
Pre-conditions	• The SPSO has logged into the system. • The SPSO account has admin privileges. • The SPSO's device is connected to the internet. • The SPSO has accessed the printing history page.
Post-conditions	• The action of filtering the printing history by student is successfully completed.
Normal flows	1. The system displays an option for selecting a student. 2. The SPSO enters the student ID. 3. The SPSO clicks "Filter Results." 4. The system displays the printing activities of the selected student.
Alternative Flows	• 2a. The SPSO enters the student name, and the system searches by name.

Exceptions	If the name is invalid, the system displays an error.
Notes	None

Table 20: *"View logs of a specific student" use case specification*

Use Case ID	SE241-
Use Case Name	View logs within a time period
Created By	Pham Tran Dang Khoa
Day Created	27/09/2024
Last Updated By	Pham Tran Dang Khoa
Date Last Updated	27/09/2024
Primary Actor	SPSO
Secondary Actor	None
Description	The SPSO can view the printing history of all students that occurred within a specific time period.
Trigger	The SPSO can view the printing history of all students that occurred within a specific time period.
Pre-conditions	• The SPSO has logged into the system. • The SPSO account has admin privileges. • The SPSO's device is connected to the internet. • The SPSO has accessed the printing history page.
Post-conditions	• The action of filtering the printing history by time period is successfully completed.

Normal flows	1. The system displays options for selecting a time period. 2. The SPSO selects the start date of the desired time period. 3. The SPSO selects the end date of the desired time period. 4. The SPSO clicks "Filter Results." 5. The system filters the printing activities that occurred within the selected time period.
Alternative Flows	None
Exceptions	If the start date is after the end date, the system displays an error.
Notes	None

Table 21: *"View logs within a time period" use case specification*

Use Case ID	SE241-
Use Case Name	View logs based on specific printers
Created By	Pham Tran Dang Khoa
Day Created	27/09/2024
Last Updated By	Pham Tran Dang Khoa
Date Last Updated	27/09/2024
Primary Actor	SPSO
Secondary Actor	None
Description	The SPSO can view the printing history corresponding to one or more specific printers.
Trigger	The SPSO needs to review the printing history at certain printers.

Pre-conditions	• The SPSO has logged into the system. • The SPSO account has admin privileges. • The SPSO's device is connected to the internet. • The SPSO has accessed the printing history page.
Post-conditions	• The action of filtering the printing history by printer is successfully completed.
Normal flows	1. The system displays an option for selecting printers. 2. The SPSO enters the printer ID and clicks "Add." 3. Repeat step 2 until the SPSO clicks "Filter Results." 4. The system displays the printing activities performed at the selected printers.
Alternative Flows	• 2a. The SPSO can click "Remove" to delete a printer from the selection list.
Exceptions	None
Notes	None

Table 22: *"View logs based on specific printers" use case specification*

1.3.2.g View Printing Logs

Diagram:

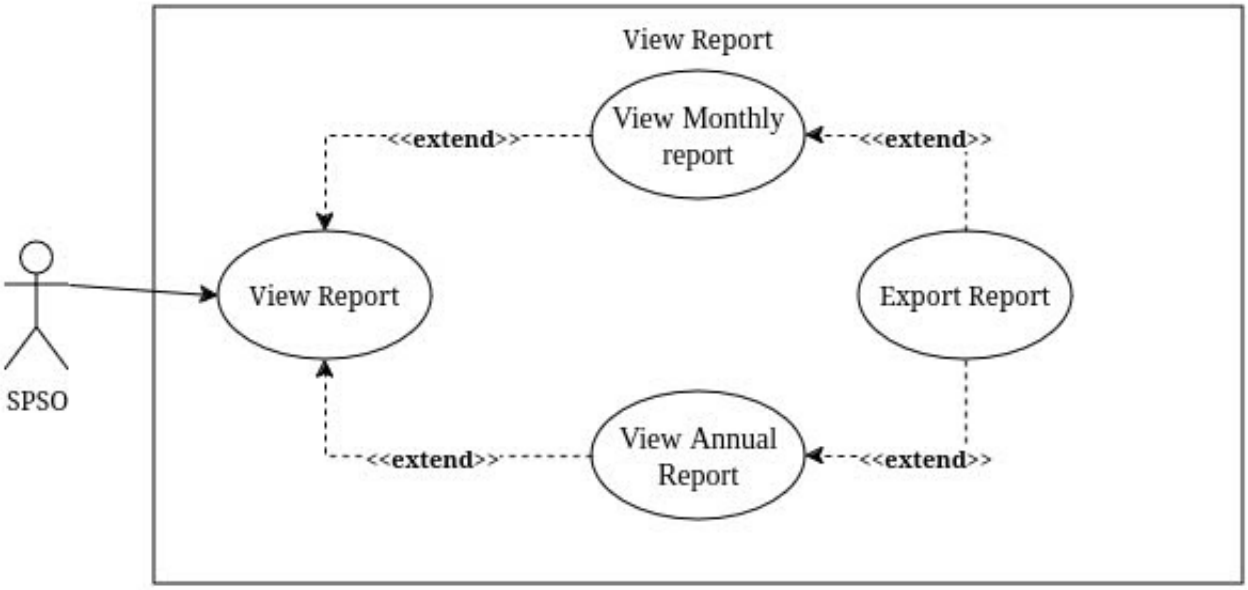

Figure 9: *View printing logs for students*

Description table:

Use Case ID	UC006-1
Use Case Name	View Report
Created By	Pham Tran Dang Khoa
Day Created	27/09/2024
Last Updated By	Pham Tran Dang Khoa
Date Last Updated	27/09/2024
Primary Actor	SPSO
Secondary Actor	None
Description	The SPSO can view a periodic statistical report by month or by year.

Trigger	The university requests to view the printing information from the system.
Pre-conditions	• The SPSO has logged into the system. • The SPSO account has admin privileges. • The SPSO's device is connected to the internet.
Post-conditions	• The SPSO successfully completes the action.
Normal flows	1. After logging into the system, the SPSO accesses the report viewing page. 2. The SPSO can select to view the report by month or by year. 3. The SPSO can choose to export the report to a file or print a hard copy of the report.
Alternative Flows	None
Exceptions	• If the SPSO logs out during the execution of this use case, the system returns to the login page. • If a system error occurs during the execution of this use case, the system displays an error message.
Notes	None

Table 23: *"View Report" use case specification*

2 Task 2: System Modelling

2.1 Task 2.1: Activity Diagram

2.1.1 Login:

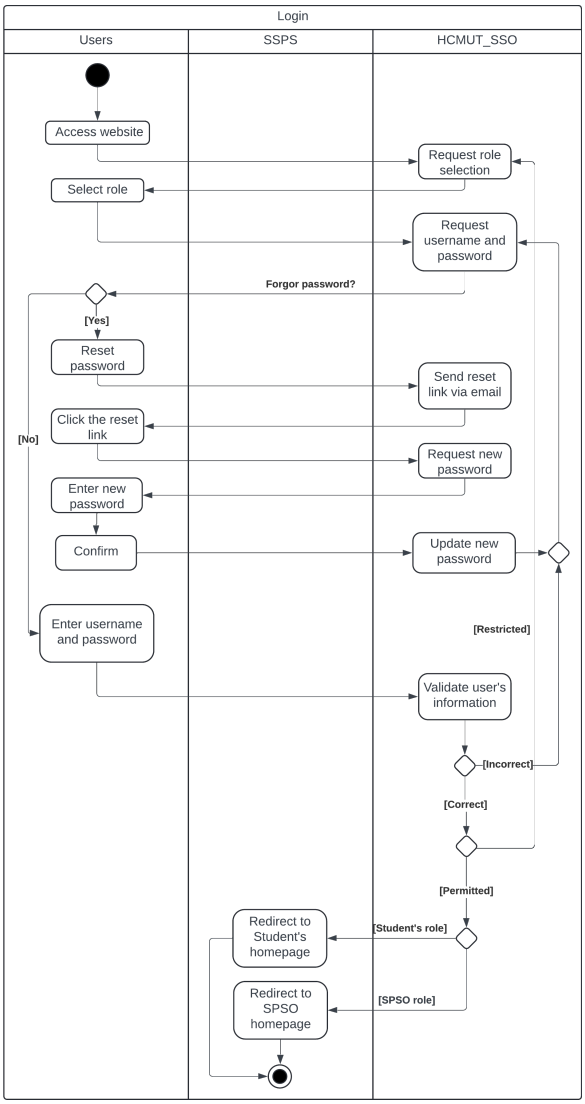

Figure 10: *Activity diagram for Login*

The login activity diagram outlines the steps involved in a user logging into the system. The process begins with the display of a login form. The users choose their roles and enter their username and password. If the users forgot their passwords, they can choose to reset passwords and the new passwords will be updated. If not, the system validates their credentials. If the credentials are correct, the user is authenticated, and a session is created. The user is then redirected to the home page. If the credentials are incorrect, an error message is displayed, and the user is prompted to try again.

2.1.2 Online Payment:

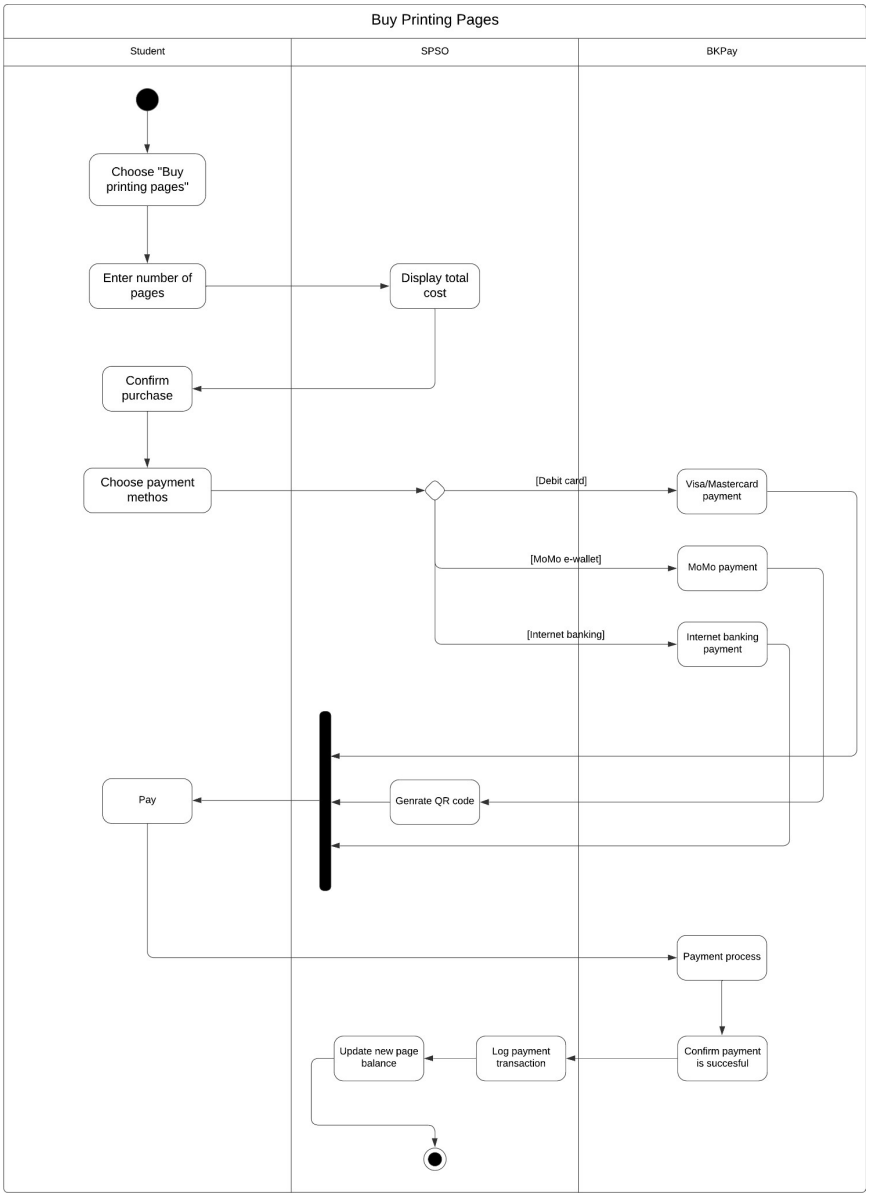

Figure 11: *Activity diagram for Online payment*

The activity diagram details the steps involved in buying printing pages. It begins with the student choosing the "Buy printing pages" option, then entering the number of pages, which leads to displaying the total cost. After confirming the purchase, the student selects a payment method, with options including debit card, MoMo e-wallet, and internet banking. The process then moves to generate a QR code for payment. Once the payment is processed successfully, the student's new page balance is updated, the transaction is logged, and a confirmation of the successful payment is provided.

2.1.3 Print Service:

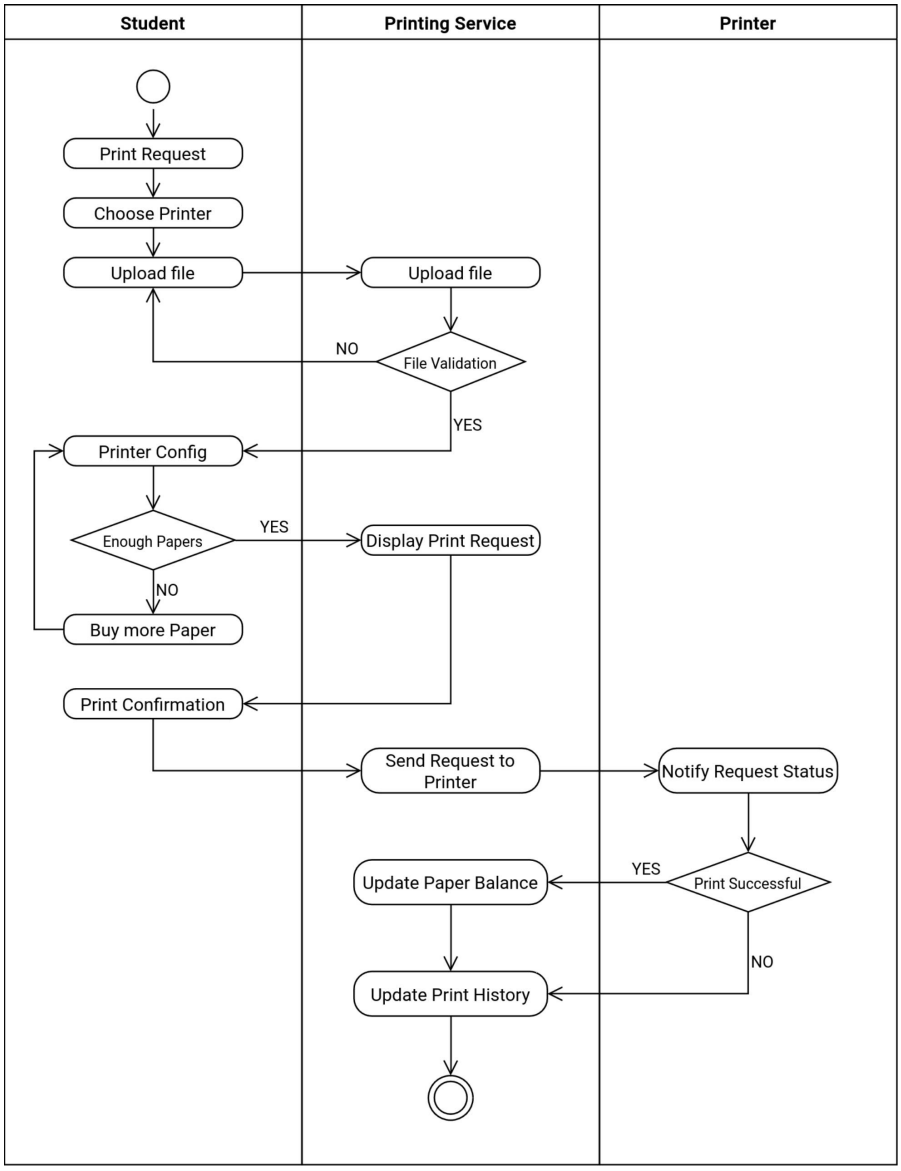

Figure 12: *Activity diagram for Printer Service*

The activity diagram outlines the steps a Student takes to complete a print request through a Printing Service. The process starts with the student selecting a printer and uploading a file. The Printing Service validates the uploaded file, and if the validation fails, the student is prompted to re-upload the file.

Once the file is validated, the system checks if there is enough paper available. If not, the student is directed to purchase more paper. If there is sufficient paper, the print request is confirmed and sent to the selected Printer. The Printer notifies the Printing Service of the print request status. If successful, the system updates the paper balance and records the print history.

2.1.4 Printer Managment:

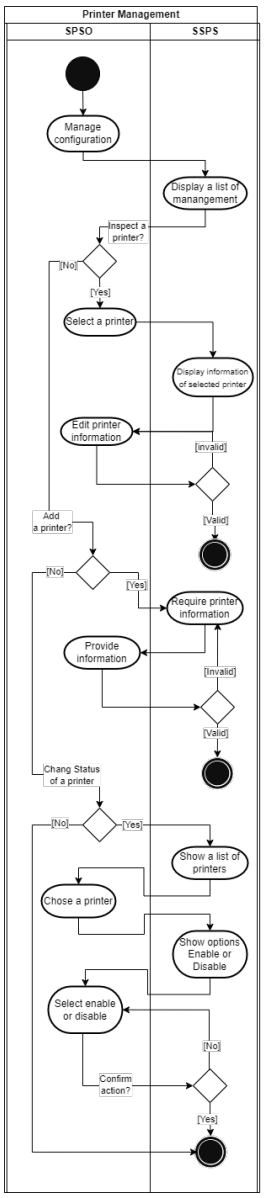

Figure 13: *Activity diagram for Printer Managment*

The diagram above shows the activity process of printer's management. Firstly, when SPSO is in the site of printer's management, the screen will display 3 categories that he can choose including Adjust the printer information, Add a new printer or Change state of a printer. When the SPSO choose to edit the printer information, he will need to select which printer need modifying and enter the new information of that printer. If the new information

is invalid, he need to enter the information again choose another printer to edit. Otherwise, if SPSO choose to add a printer, SSPS will require him to give the new printer information such as printer ID, the location, ... The SSPS will check the information validity, if it is not valid the SPSO will be required to enter the valid one. Finally, if the SPSO chooses to change the status of a printer, he will be shown a list of printers to select one and then change its status to be enable or disable. After each choice the activity will be ended by the SSPS.

2.1.5 Printer Configuration - Filetype Format - Schedule Allocation:

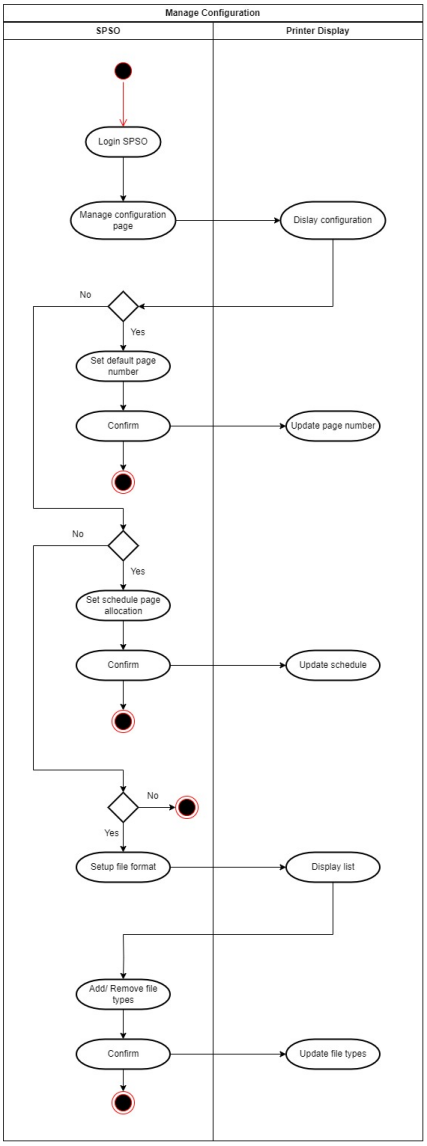

Figure 14: *Activity diagram for Filetype format - Schedule allocation*

The diagram describes the rules for editing the format of the file and resetting the page detection time. SPSO will access the printer configuration to reconfigure the necessary functions, for the purpose of adding the format file, the program will check the reasonableness before adding. For deleting the format file, the program will display a list for SPSO to delete.

For resetting the page playback time, SPSO will select a reasonable date to be allowed, including the day below 31 and the month below 12. In addition, some default pages will also be re-edited if necessary.

2.2 Task 2.2: Sequence Diagram

2.2.1 Login:

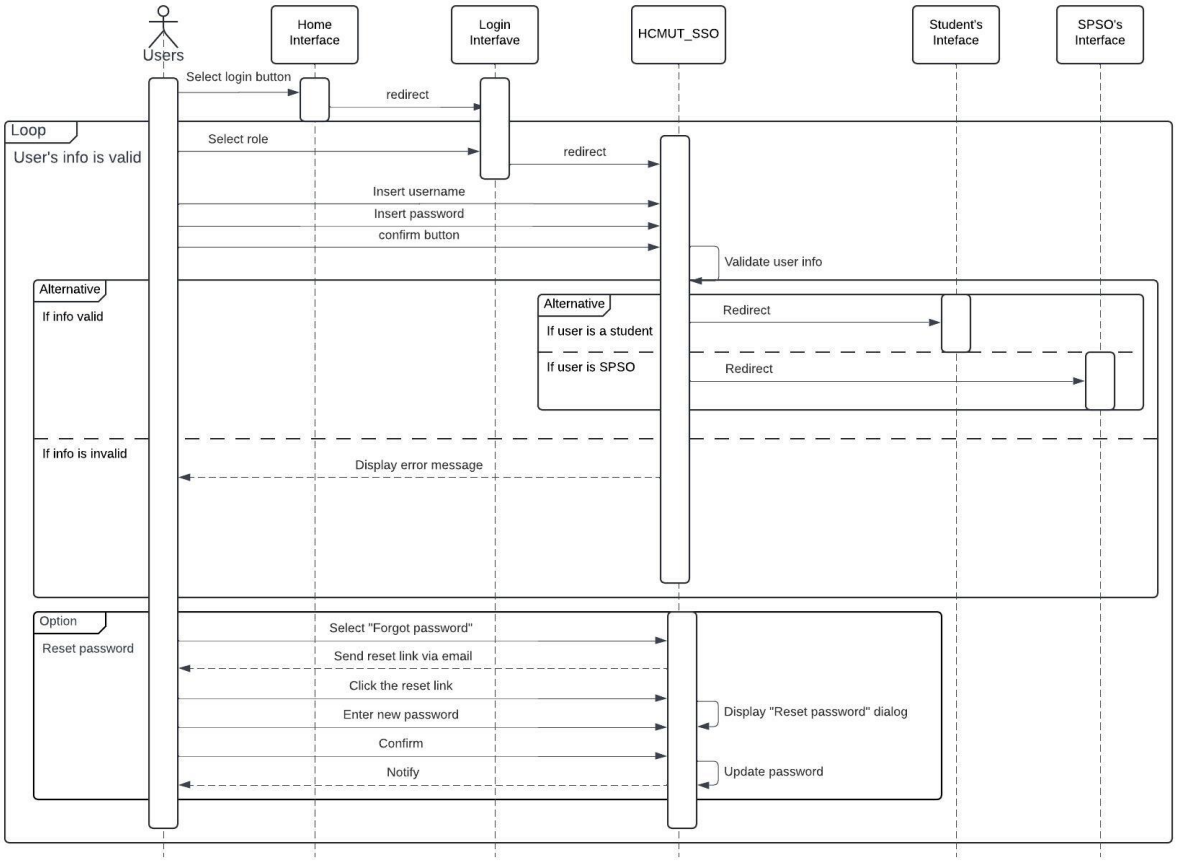

Figure 15: *Sequence diagram for Login*

The login sequence diagram illustrates the steps involved when a user attempts to log into a system. The user interface presents a login form where they choose their roles and then enter their username and password. Upon submission, the login request is sent to the authentication service (HCMUT-SSO). The authentication service validates the credentials against the stored user data in the database. If the credentials are correct, a session is created, and the user is redirected to the home page. If the credentials are incorrect, an error message is displayed, and the user is prompted to try again. There is also an option for those who forget their passwords. They will be sent a reset link via their registered emails. After entering a new password, their passwords will be updated.

2.2.2 Online Payment:

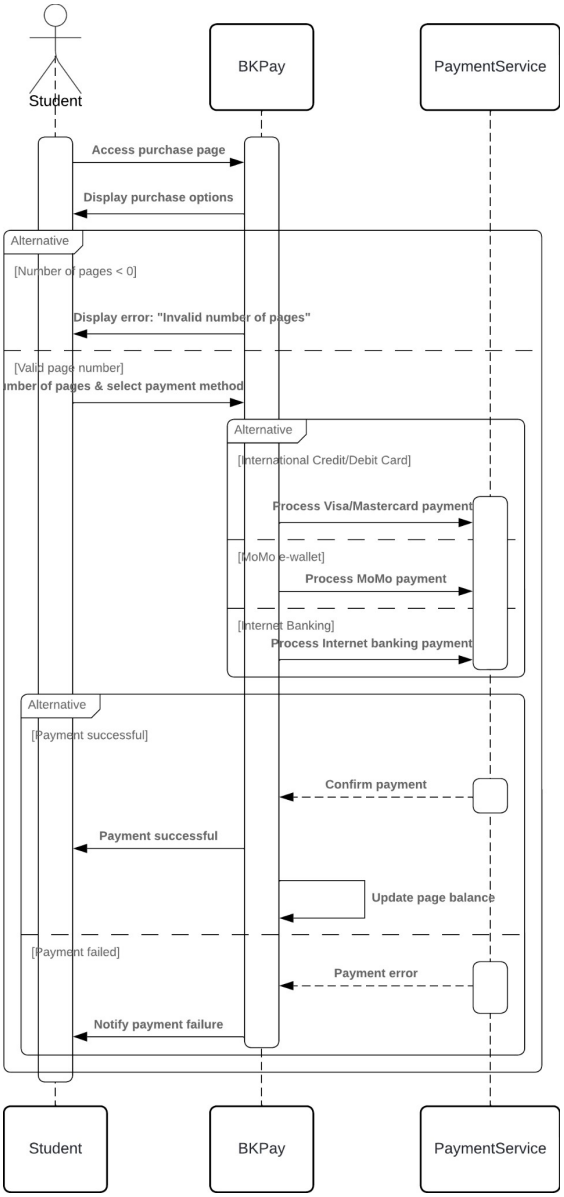

Figure 16: *Sequence diagram for Online payment*

The sequence diagram describes the process a student follows to purchase printing pages using the BKPay system. It begins with the student accessing the purchase page, where they enter the number of pages they want to buy. If the input is valid, they proceed to select a payment method. The diagram shows the alternatives available, including credit/debit card, mobile payment, and internet banking. Once a payment method is chosen, the transaction is processed through BKPay. If the payment is successful, the student's page balance is updated, and they receive a confirmation. In case of a failure, an error message is displayed.

2.2.3 Print Service:

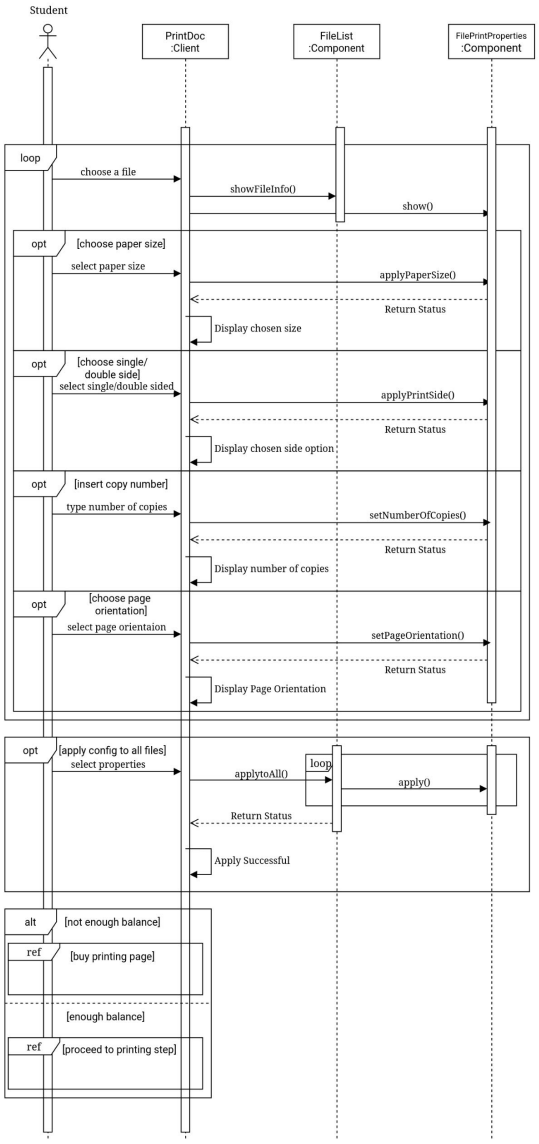

Figure 17: *Sequence diagram for Printer Service*

This sequence diagram shows how a Student interacts with the PrintDocument to configure printing properties. The student selects a file, and the file information is retrieved from FileList. They can adjust the paper size, print side (single/double), copy number, and page orientation, with each setting applied and confirmed by FilePrintProperties. The "Apply to All" option allows the student to apply these settings to all files. If the student has insufficient balance, they are directed to purchase more before continuing. Otherwise, the process proceeds to the printing step.

2.2.4 Printer Managment - Setup Status:

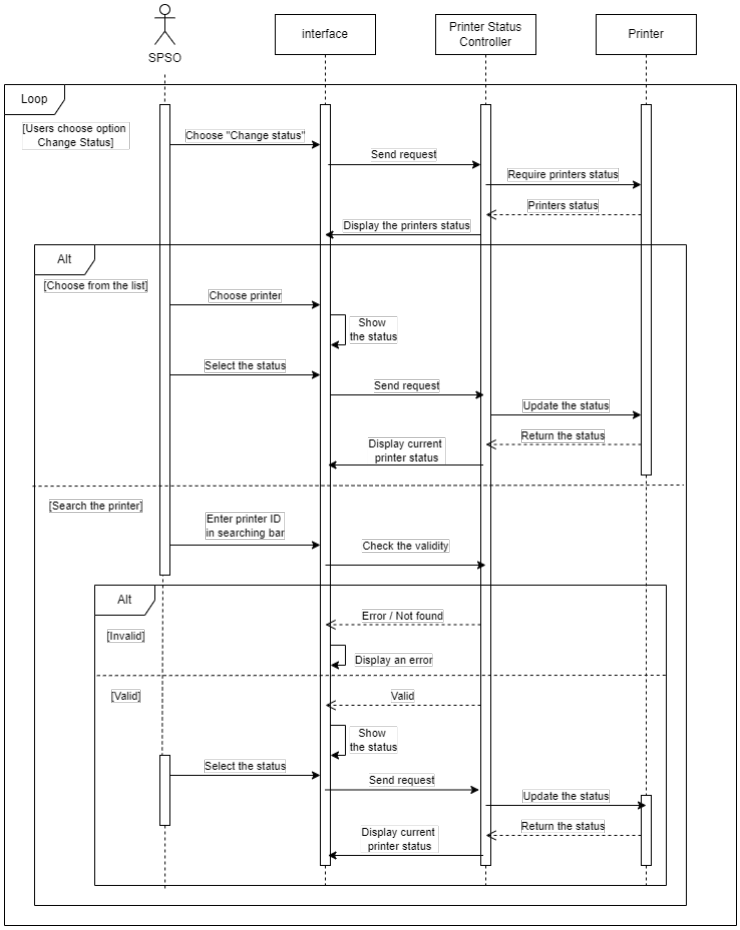

Figure 18: *Sequence diagram for Printer Managment - Setup Status*

In this diagram will show the way SPSO can change the status of a printer. After the SPSO choose “Change Status” it will send the request to the controller which will then asked printers about each of status of printers.

Then, it will display on the screen for the user to see. There are two ways the SPSO can change the status of a printer. On the one hand, the SPSO can choose to select from the list of available printers shown on the screen and then he will see the status of that printer. If he decides to change the status of that printer, it will send request to controller and the controller will update the state of that printer which will then be shown on the screen for SPSO make sure that it is completed.

On the other hand, the SPSO can enter the ID of the printer he wants to change the status. There will be two circumtances. If he enters the invalid ID, the printer status will throw an error to inform that there is no printer contain such that ID. Otherwise, if the ID is valid, it will continue the process as the SPSO choose the printer from the list. This loop will continue until the SPSO want to exit the interface.

2.2.5 Printer Configuration - Filetype Format:

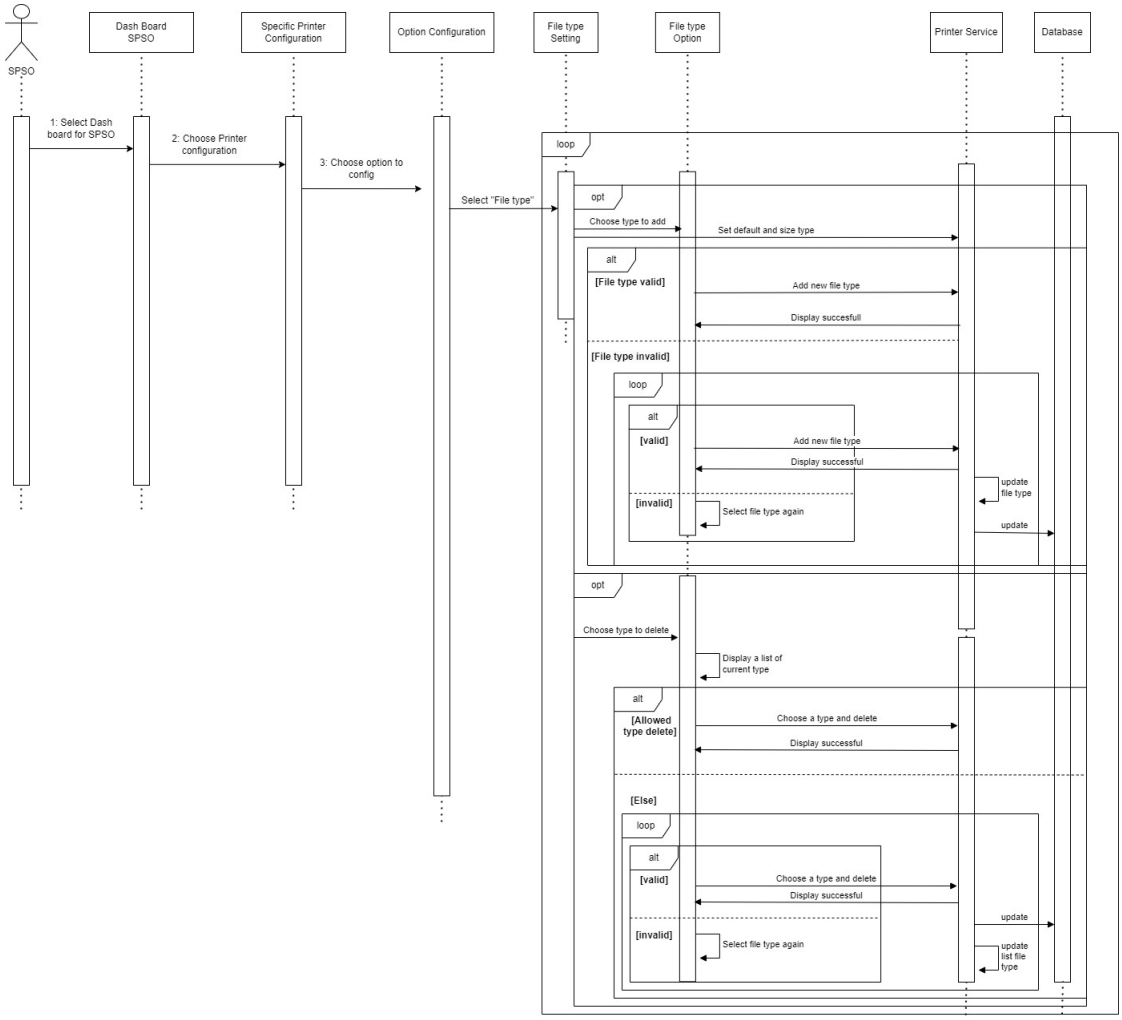

Figure 19: *Sequence diagram for Filetype format - Maxsize Config*

This diagram will show how SPSO can change the printer's file type format. After SPSO selects "File Type", it will display a page including the functions of adding file type, deleting file type, setting maximum size type.

If SPSO adds an unreasonable file format, the program will ask to add it again until it is correct, after adding, the program will update the list of current allowed formats and display it on the screen.

If SPSO wants to delete an existing file format, SPSO after clicking "select type to delete", the program will display the list of current file formats, SPSO will select the format to delete and apply. Then update the list again.

In addition, SPSO can adjust the default file format and maximum size type

2.3 Task 2.3: Class Diagram

Whole Module:

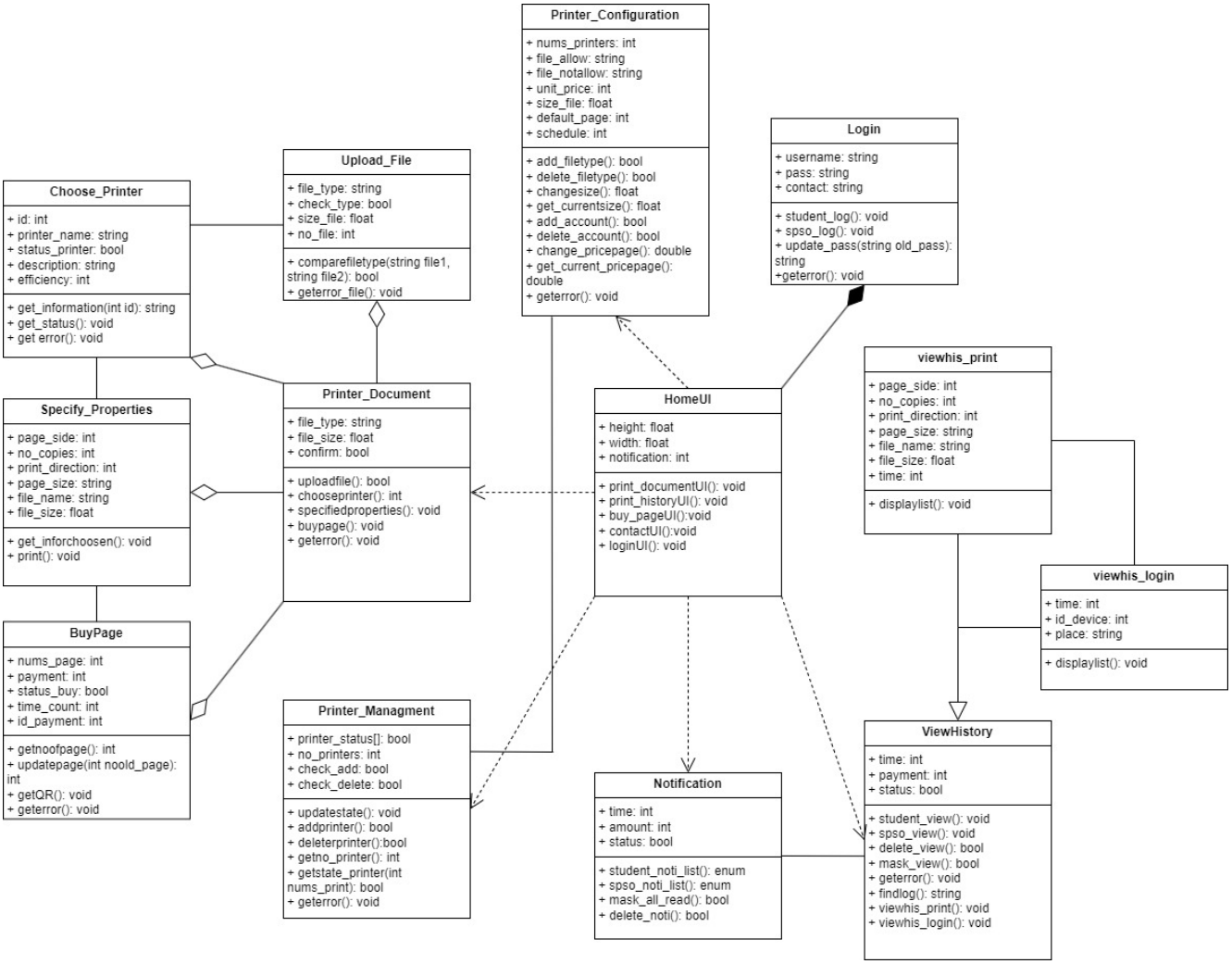

Figure 20: *Class diagram*

2.4 Task 2.4: User Interface

2.4.1 Login

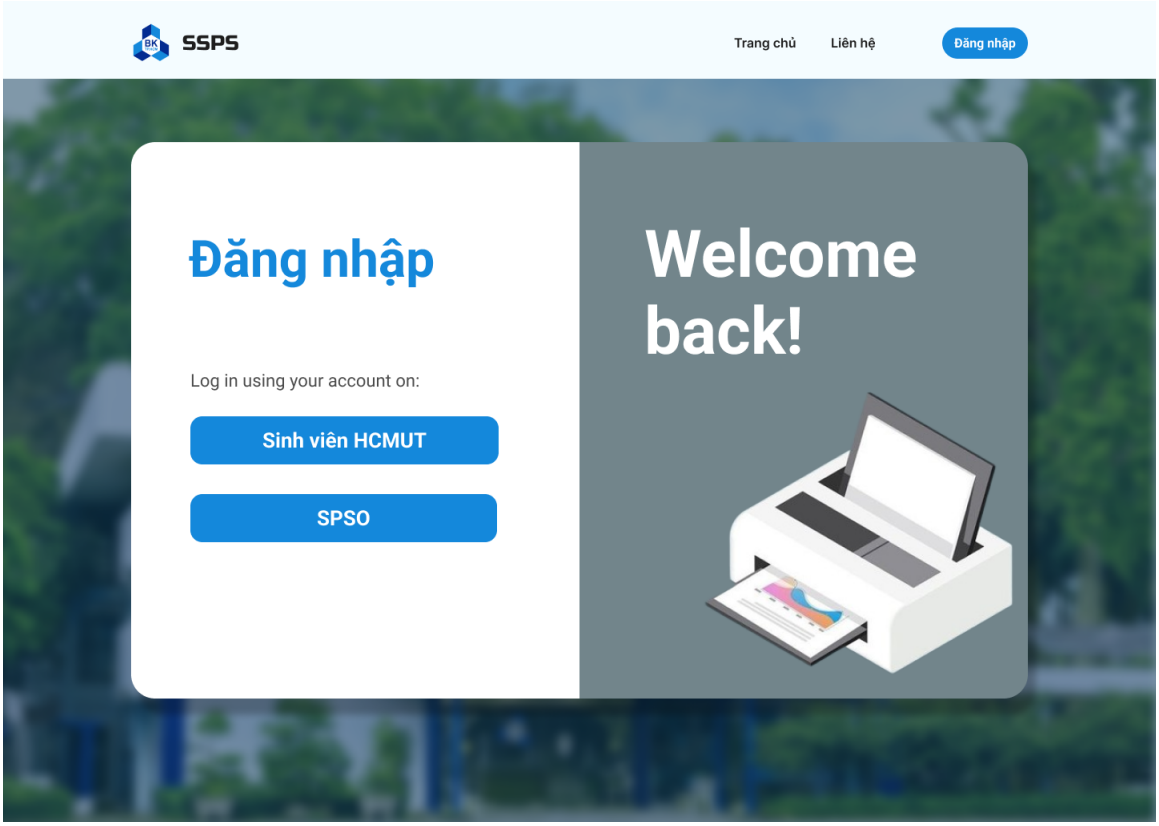

Figure 21: *Log in – Select role page*

Name	Type	Description
Main page	Button	Navigate user to the home page (for guest, if users haven't logged in yet).
Contact	Button	Navigate user to contact page.
Login	Button	Navigate user to log in session.
HCMUT Students	Button	Navigate user to log in page with student role.
SPSO	Button	Navigate user to log in page with SPSO role.

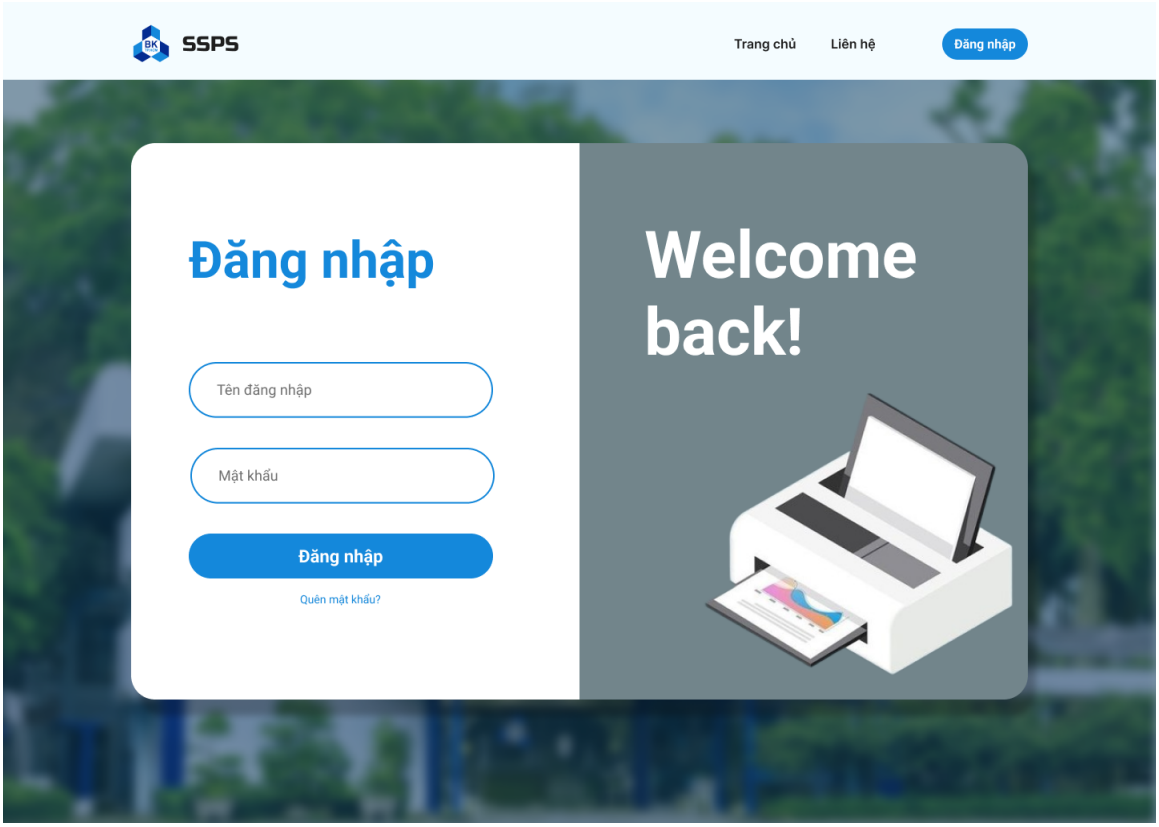

Figure 22: *Log in page*

Name	Type	Description
Main page	Button	Navigate user to the home page (for guest, if users haven't logged in yet).
Contact	Button	Navigate user to contact page.
Login (On the header)	Button	Navigate user to log in session.
Login	Button	Navigate users to their corresponding role-based homepage.
Forgot password?	Button	...

2.4.2 Printer Service

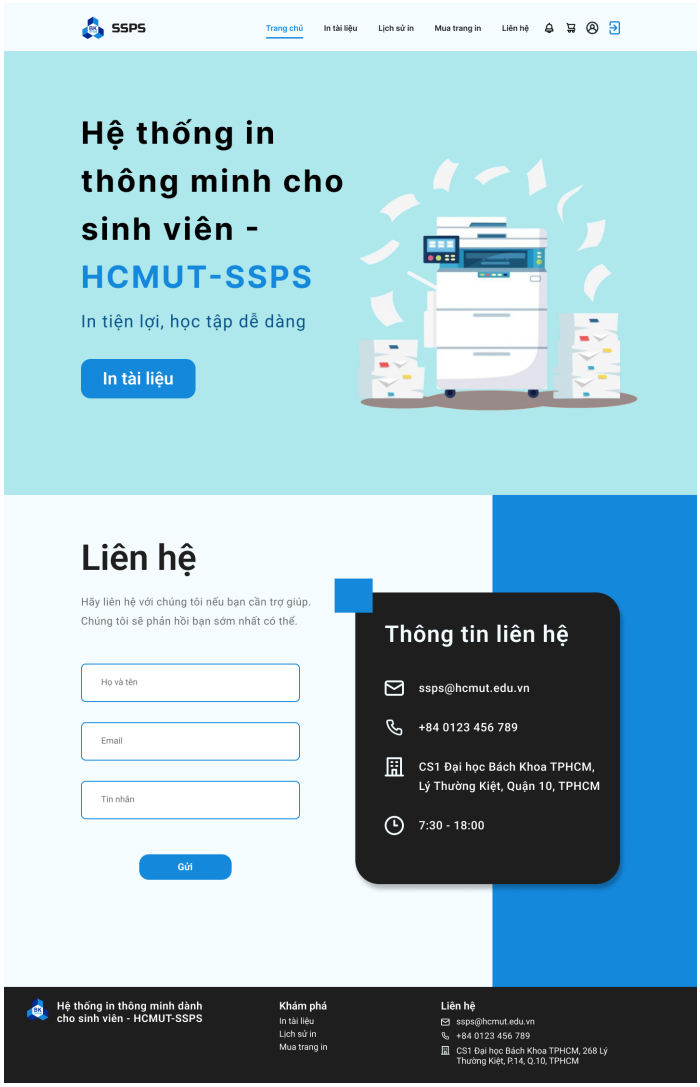

Figure 23: *Printer Service*

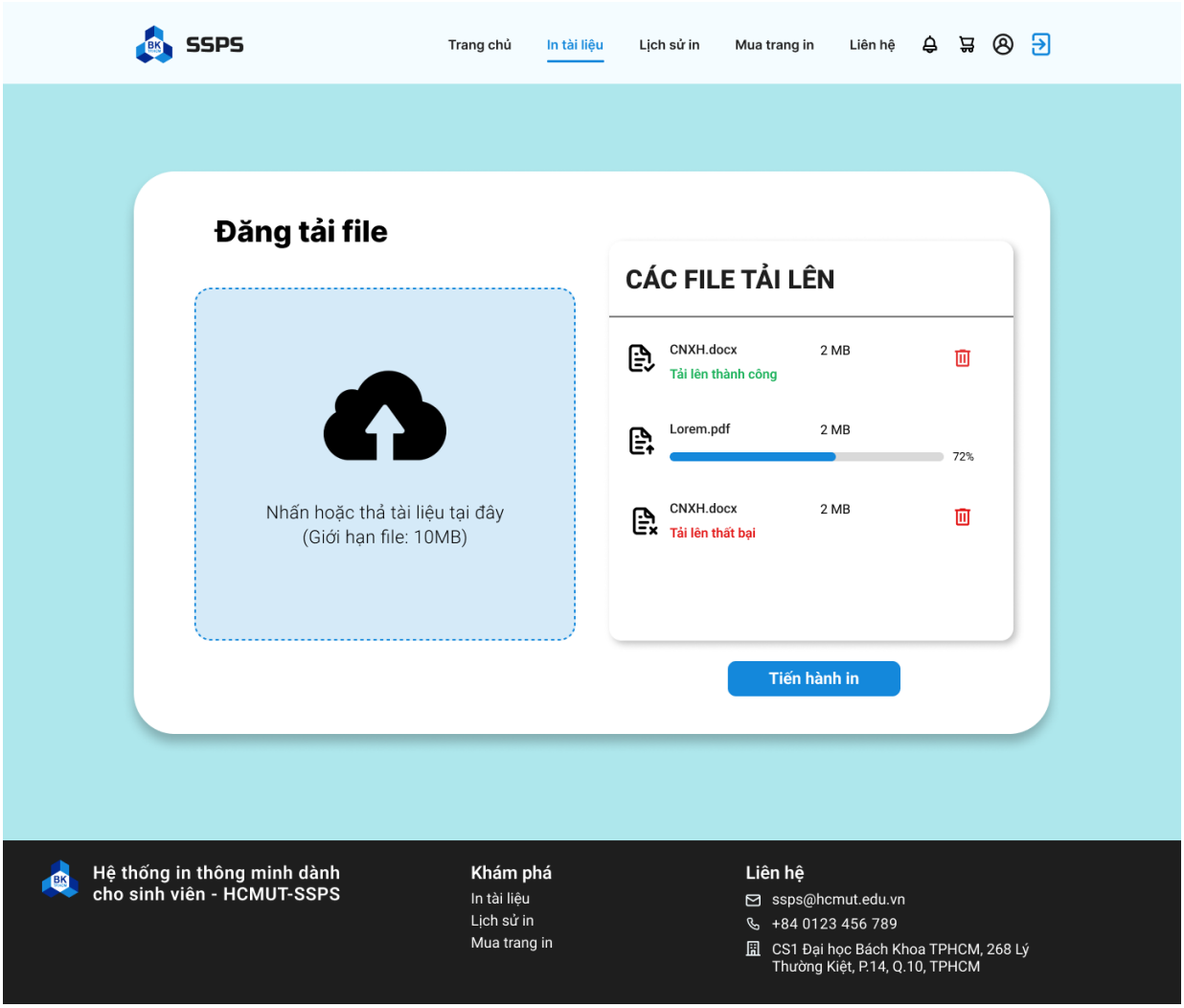

Figure 24: *Printer Service*

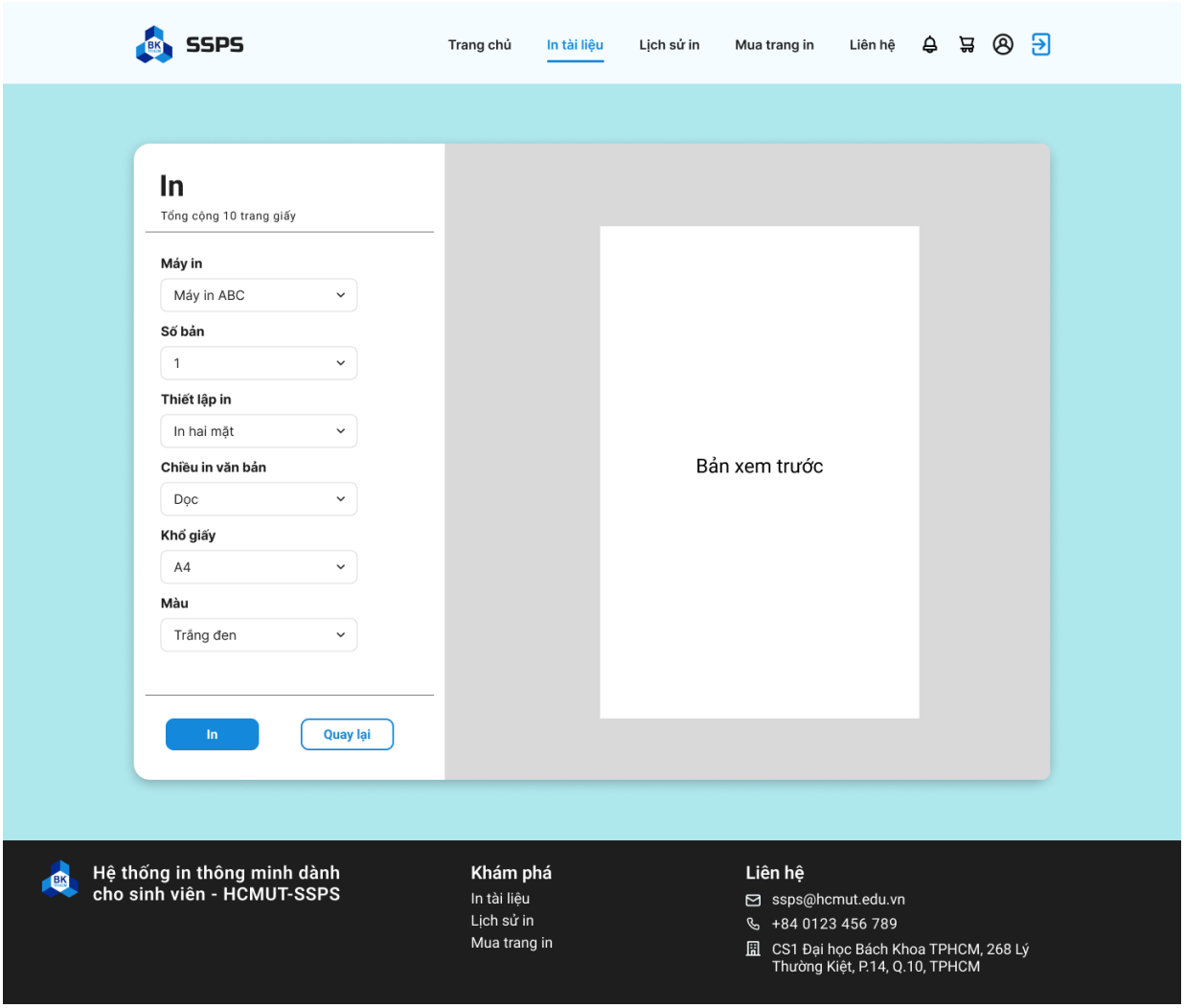

Figure 25: *Printer Service*

Name	Type	Description
Main page	Button	Navigate user to the home page (for guest, if users haven't logged in yet).
Print documents (header and hero section)	Button	Navigate user to the print documents page.
View history	Button	Navigate user to the view history page.
Buy printed pages	Button	Navigate user to the buy printing paper page.
Contact	Button	Navigate user to contact page.
Send	Button	Send students' messages to the SPSO.
Logout icon	Button	Log out.
Profile icon	Button	Navigate user to their personal information page.
Basket icon	Button	Navigate user to their cart page.
Bell icon	Button	User can receive notification.
Start print	Button	Navigate user to Print settings page.
Print	Button	Start printing and send a confirmation notification to the user.
Turn back	Button	Navigate user to Print settings page.

2.4.3 SPSO

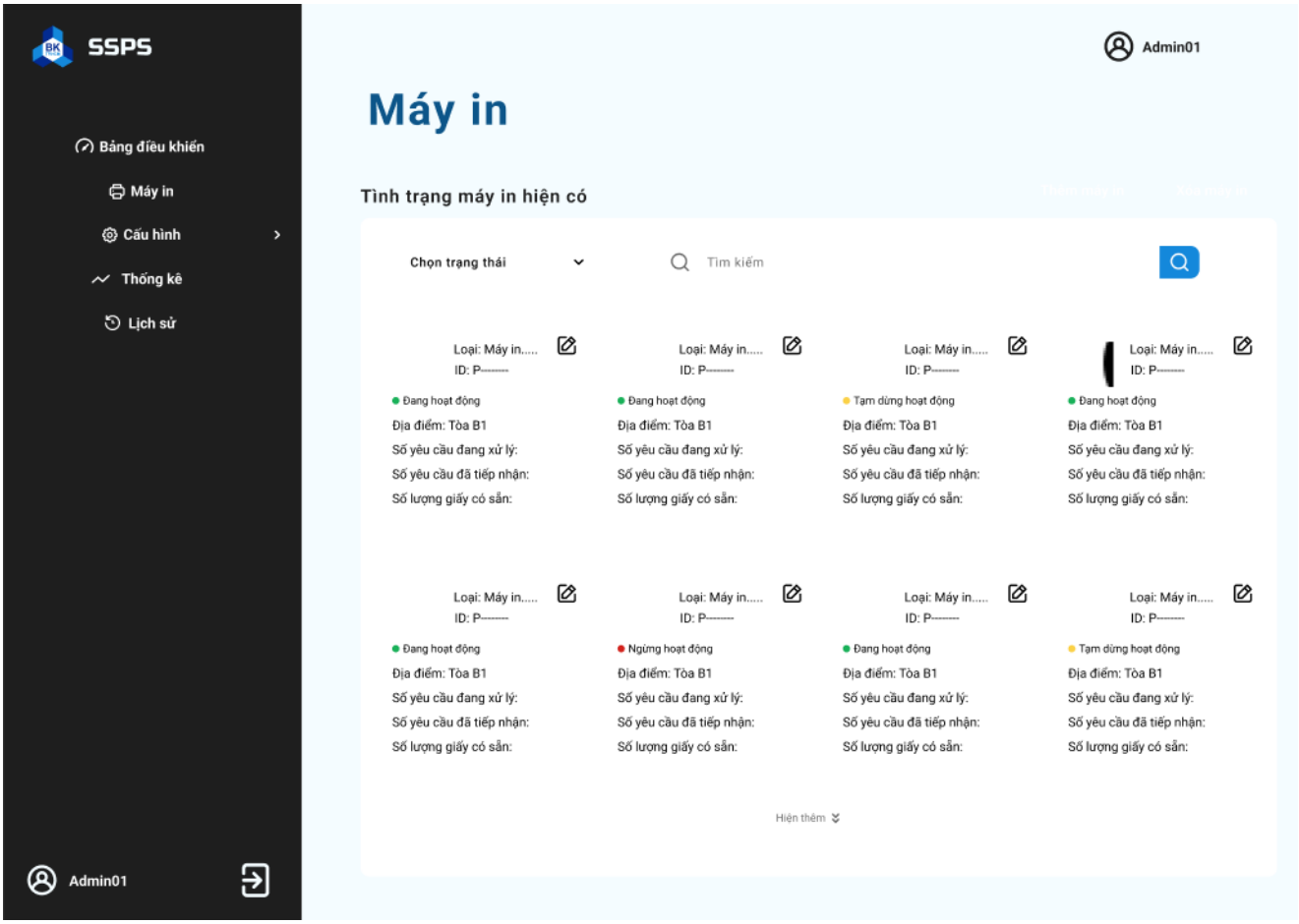

Figure 26: *SPSO Printer Management*

Image Source:
1. Printer Images
2. Printer Images
3. Icon: Uniform icon (Pluggin in Figma).
4. Logo and picture of HCMUT.

3 Task 3: Architecture design

3.1 Task 3.1: Layered Architecture

Layered architecture is a design pattern that organizes a complex system into distinct layers, each responsible for specific tasks and interfacing with adjacent layers; which suits the structure of our project. Hence, we will employ a four-layer architecture onto the building of the HCMUT-SSPS system. The four layers are, respectively:

1. **Presentation Layer**
2. **Business Logic Layer**
3. **Persistence Layer**
4. **Database Layer**

Below is a detailed description of each layer and its components.

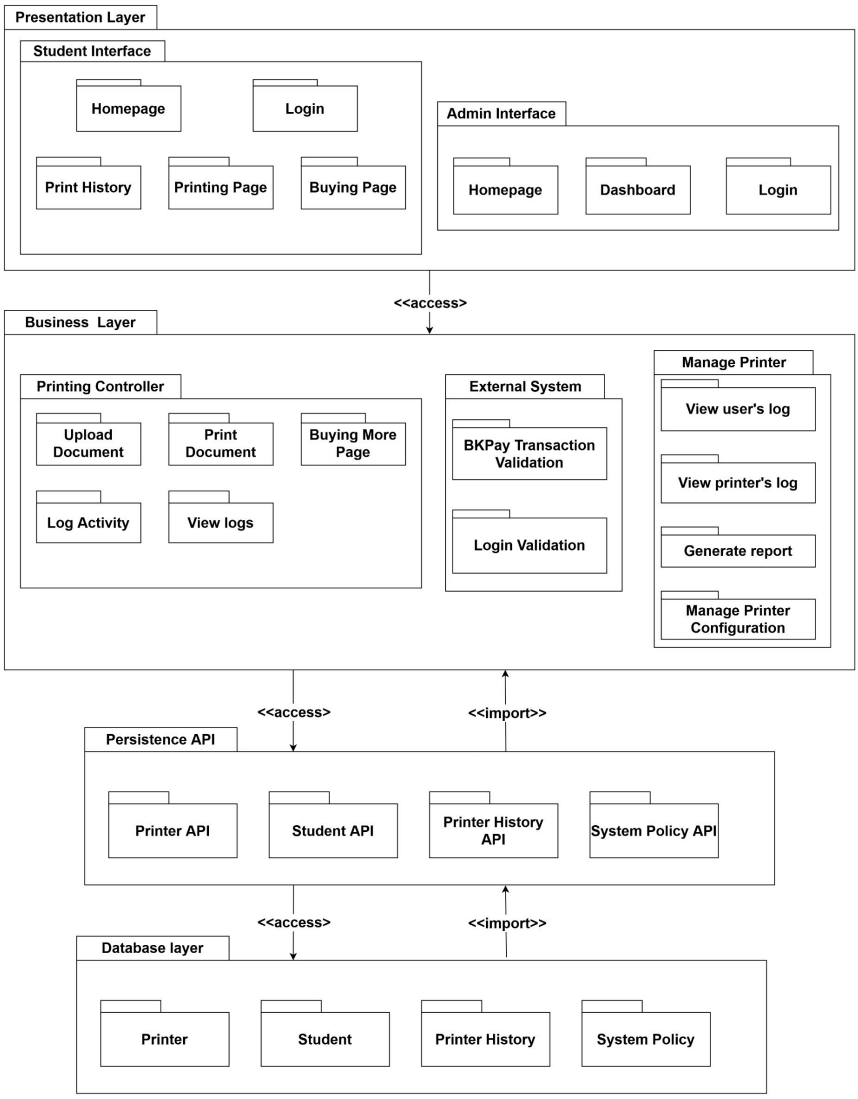

Figure 27: *Layer Architecture*

3.1.1 Presentation Layer

3.1.1.a Presentation Strategy

The Presentation Layer manages the user interface and interactions, featuring two components: the **Student Interface** and the **Administration Interface**. Both interfaces share a Home page and Login page, but each is customized for its respective user type. The Student Interface includes a Printer Location page for finding available printers, a Printing page for uploading documents and configuring print settings, and a Buying page to top up paper balance when needed. The Administration Interface provides a Dashboard page for monitoring print history, managing printer statuses, and exporting reports. Overall, this layer bridges user interactions with system functionality, enhancing service efficiency.

1. **Student Interface Pages**
    - Home page
    - Login page
    - Printer Location page
    - Printing page
    - Buying page.
2. **Administration Interface Pages**
    - Home page
    - Login page
    - Dashboard page.

3.1.1.b Business Logic Layer

The Business Logic Layer is the core of the HCMUT-SSPS system, processing requests from the Presentation Layer and interacting with the Persistence Layer to handle data operations. It is organized into three main modules:

1. **Printing Controller**
   The Printing Controller manages the core printing actions:
    - **Upload Documents:** Upon document upload, the Printing Controller uses the System Policy API to retrieve allowed file types from the database, verifying if the uploaded file format is permitted before proceeding.
    - **Print Documents:** The controller retrieves available printers via the Printer API, enabling students to select a printer and specify printing properties (e.g., paper size, print style, copies). It maintains a print job queue to handle multiple requests, updating the student's page balance and the print history in the database after each print job, using the Student and Printing History APIs.
    - **Buy Extra Pages:** When a student's page balance is insufficient, the controller calculates the cost and initiates an external payment transaction to add more pages through the online payment service.
    - **Log Activity:** The Printing Controller logs each printing job and transaction in the database through Persistence Layer APIs, ensuring accurate record-keeping for students and administrators.

- **View Logs:** The controller retrieves and displays printing and transaction logs for students and administrators by accessing the Printing History and Student APIs.

External Systems
This module integrates external services:

- **Transaction Validation:** Facilitates payments for purchasing additional pages, securely connecting to the online payment provider.
- **Login Validation:** Uses the HCMUT-SSO service to authenticate users before accessing the HCMUT-SSPS system, ensuring secure access.

2. **Manage Printers**
The Manage Printers module enables administrators to monitor and control printer configurations:

- **View User Logs:** Allows the SPSO to view the complete print history of all students by retrieving data through the Student API.
- **View Printer Logs:** Provides logs of printer usage, accessing data via the Printing History API.
- **Generate Reports**: Automatically compiles monthly and annual printer usage reports, stored in the database and accessed through the Printing History API.
- **Manage Printer Configuration:** The SPSO can add new printers, update statuses, and adjust system policies (e.g., default page limits, permitted file types). These changes are synchronized with the database via the Printer and System Policy APIs.

3.1.2 Database approach

In this project, our team decided to use a document-oriented approach. The document-oriented approach to data storage is a NoSQL method that organizes data in a semi-structured format, typically as documents in JSON, BSON, or XML format. Each document represents a complete and self-contained record that can store complex and nested data, which makes it ideal for applications with varied or evolving data structures. This approach is highly flexible, allowing each document within a collection to have its own schema, which is especially useful in applications where new fields and data types are frequently added.

Our project attempts to use the MongoDB database, which uses a document-oriented approach, provides efficient read and write operations due to their hierarchical structure, making them well-suited for real-time applications, content management systems and catalogs. They also support advanced querying, enabling developers to retrieve documents based on specific fields and conditions quickly. MongoDB's structure facilitates horizontal scalability through sharing, distributing data across multiple servers, and enabling large-scale applications to handle vast amounts of data and user load effectively. It also supports indexing, aggregation, and replication features that enhance query performance and data availability.

3.1.3 API Management

API stands for Application Programming Interface. It is a set of definitions and protocols used to build and integrate application software. APIs enable your product or service to communicate with other products and services without needing to understand their implementation details.

In this section, our group focuses on the API service which connects components within the system to transfer data from controller to the database and vice versa. It can be observed in our architecture diagram that there are 4 main object APIs corresponding to 4 objects in the database.

3.1.3.a Printer API

This object API has the following methods:

- getPrinterBrand(String ID): Retrieve the printer's brand information using the printer ID from the database.
- getPrinterName(String ID): Retrieve the printer's name information using the printer ID from the database.
- getPrinterStatus(String ID): Retrieve the printer's status information using the printer ID from the database.
- getPrinterBuilding(String ID): Retrieve the printer's building location information using the printer ID from the database.
- getPrinterRoomNumber(String ID): Retrieve the printer's room number location information using the printer ID from the database.
- getPagePrinted(String ID): Retrieve the number of pages printed by the printer using the printer ID from the database.
- addNewPrinter(Object Printer Information): Add a new printer to the database using the provided printer information.
- changePrinterStatus(String ID): Update the printer's status in the database using the printer ID.

This API will be called in some following cases:

- When a student initiates a document printing request, the Printing Document service calls the PrinterAPI to update the number of pages that have been printed.
- When the SPSO (admin) accesses the View Printer's Log, the View Printer's Log service calls the PrinterAPI to retrieve the printer's information.
- When the SPSO (admin) manages printer configurations, the Manage Printer's Configuration service calls the PrinterAPI to update the printer's status or add a new printer to the database.

3.1.3.b Student API

This object API has the following methods:

- getStudentName(String ID): Retrieve the student's name using the student ID from the database.
- getStudentEmail(String ID): Retrieve the student's email using the student ID from the database.

- getStudentFaculty(String ID): Retrieve the student's faculty information using the student ID from the database.
- addPrintingActivity(Object Printing Activity): Create a new printing activity and add it to the printing history list.
- addTransactionActivity(Object Transaction Activity): Create a new transaction activity and add it to the transaction history list.
- getPrintingTime(String ID, Integer Index): Retrieve the time of a specific printing activity using the student ID and the index of the chosen printing activity.
- getPrintingFileName(String ID, Integer Index): Retrieve the filename of a specific printing activity using the student ID and the index of the chosen printing activity.
- getPrintingPaperNumber(String ID, Integer Index): Retrieve the number of pages printed in a specific printing activity using the student ID and the index of the chosen printing activity.
- getPrintingPaperType(String ID, Integer Index): Retrieve the type of paper used in a specific printing activity (A3, A4, A5) using the student ID and the index of the chosen printing activity.
- getPrintingLocationBuilding(String ID, Integer Index): Retrieve the building location of the printer used in a specific printing activity using the student ID and the index of the chosen printing activity.
- getTransactionTime(String ID, Integer Index): Retrieve the time of a specific transaction activity using the student ID and the index of the chosen transaction activity.
- getTransactionCost(String ID, Integer Index): Retrieve the cost of a specific transaction activity using the student ID and the index of the chosen transaction activity.
- getTransactionPage(String ID, Integer Index): Retrieve the number of pages purchased in a specific transaction activity using the student ID and the index of the chosen transaction activity. By default, the paper type is A4.

This API will be called in some following cases:

- When students go to their personal account page. The controller renders all necessary information through this API.
- When students complete a printing work, this API is called in order to log printing action and transaction action into the database.

3.1.3.c Printing History API

This object API has the following methods:

- GetAllPrintingHistory: This is called when an admin wants to retrieve all printing activities in chronological order, starting from the most recent and extending to the earliest.
- AddNewPrintingHistory: This is called every time a student completes a printing activity, adding that printing activity to the database.

3.1.3.d System Policy API

This object API has the following methods:

- getDefaultPageNumber(None): Retrieve the number of pages that a student receives.
- setDefaultPageNumber(None): Change the number of pages that a student receives.
- getAllocDate(None): Retrieve the date when the system allocates the default number of pages to all students.
- setAllocDate(None): Change the date when the system allocates the default number of pages to all students.
- getMaximumPageSize(None): Retrieve the maximum size of a file that can be printed.
- setMaximumPageSize(None): Change the maximum size of a file that can be printed.
- getPermittedFile(None): Retrieve the list of all permitted types of files that can be printed.
- setPermittedFile(None): Change the list of all permitted types of files that can be printed.

This API is called when an admin wants to change the system configuration, such as:

- Changing the default number of pages allocated to students.
- Changing the dates when the system allocates the default number of pages to all students.
- Updating the list of permitted file types accepted by the system.

3.2 Task 3.2: Component Diagram

The component diagram below describes the connection of the layers in the layer architecture together.

First, we have the Presentation layer, in this layer will be the main interface where the user, here is the student and SPSO interact with the smart printing system. From the current interface components will lead to the corresponding implementation components in the Business layer.

Second is the Business layer, we have 3 different components: Printing Controller, Manage Printer Controller and External System:

1. ***Printing Controller:*** this is where the printing of documents of HCMUT students is performed, first the student will choose Print Document, here the system will let the student choose the printer and show their status. Then the student can upload the document to print if the machine is in good condition, in addition, when uploading a file, the parameters for a file to be fully uploaded will be controlled by Manage Printer Configuration in the Manage Printer Controller component. All printer usage and printing history will be recorded in the system's User log and students can review their printing history.

2. ***Manage Printer Controller:*** this is where you can edit printer status, edit fixed printing parameters, price per printed page, etc. for SPSO. All parameters will be adjusted in Manage Printer Configuration by SPSO. All editing processes will be recorded in the system's Printer log and SPSO can view the history of students using the machine as well as the history of editing printer parameters.

3. ***External System:*** includes account authentication when logging in/registering and authentication when making transactions.

The last two parts are Persistence API and Database Layer: are classes to call the necessary data when the user requests.

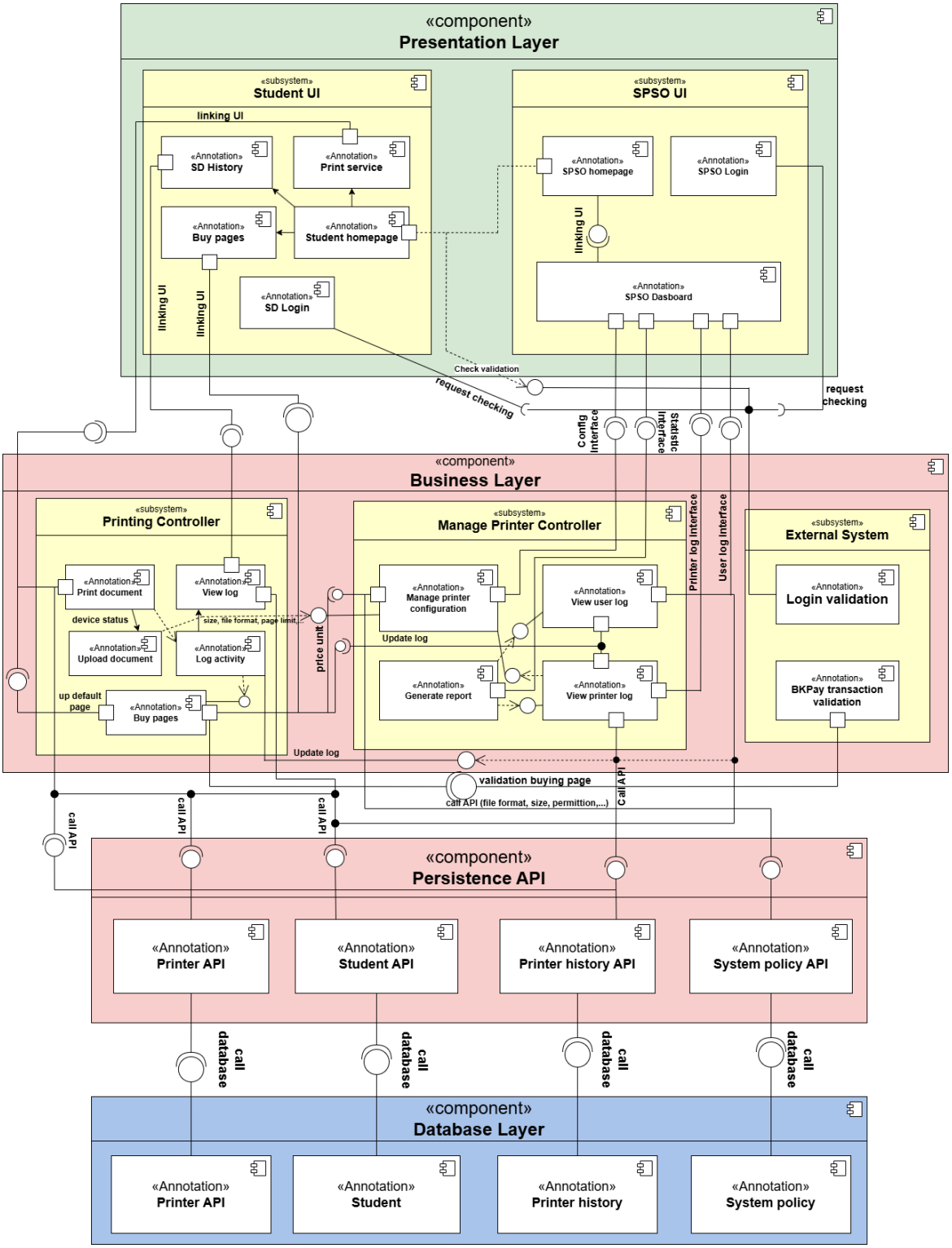

Figure 28: *Component Diagram*

4 Task 4: Implementation – Sprint 1

4.1 Github Repository

Link Github: HCMUT-SSPS-SECO11-11

4.2 Version Control

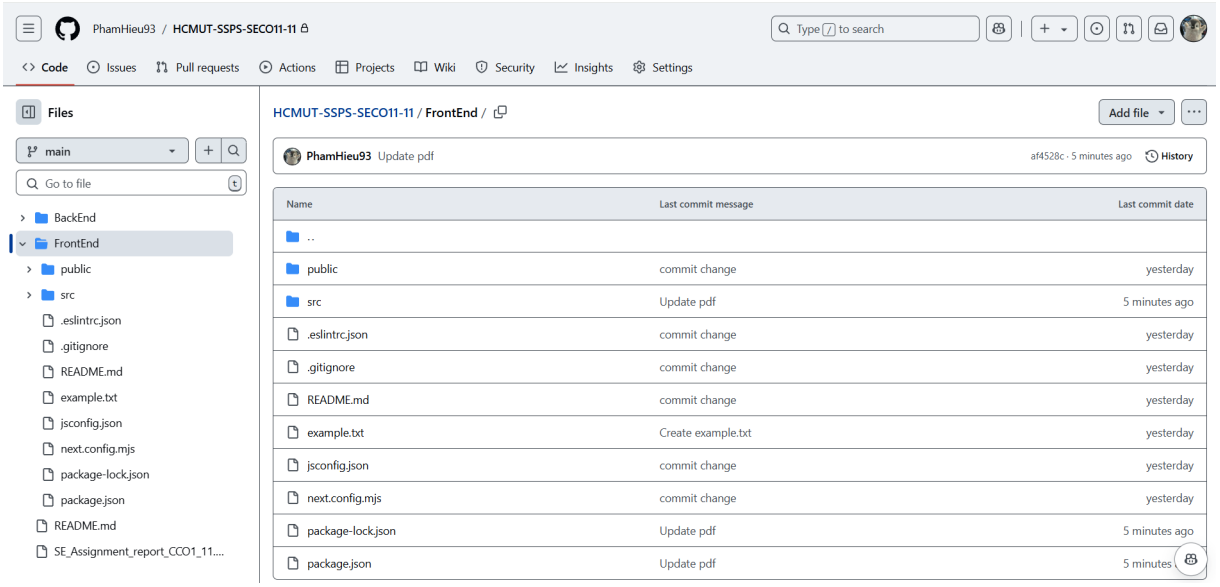

Figure 29: *Component Diagram*

4.3 Usability Testing

The SSPS printing service system development team conducted a usability testing session using the implemented Figma prototype available at the link below. We also conducted a sample of 15 people.

Link Figma: HCMUT-SSPS-SECO11-11-FIGMA

The testing session was held with the participation of all members. During the session, the team recorded solutions, task completion rates, comments, overall evaluations, questions, and feedback from all participants.

4.3.1 Recruit participants/ testers

Name	ID
Pham Nguyen Minh Hieu	2252215
Pham Nguyen Ngoc Uyen	2252895
Pham The Duc	2252168
Pham Tran Dang Khoa	2252360
Phan Khanh Nhan	2252564

4.3.2 Define tasks

Task ID	Use-Case	Description
1	Log in with Student and SPSO	Log in to the system using valid credentials (username and password). If incorrect credentials are provided, observe the error messages displayed.
2	View Student home UI	Access the home interface of student and verify that the navigation options and system status are displayed correctly.
3	Upload Document	Upload a file to the system. Check whether the system accepts the file and displays a confirmation after successful upload.
4	Specify properties	Specify document properties such as paper size, number, and orientation. Ensure all selected properties are displayed correctly.
5	Choose printer	Select an available printer from the list. Confirm that the system updates the chosen printer and provides relevant information about the printer.

6	View SPSO home UI	Access the home interface of SPSO and verify that the navigation options and system status are displayed correctly.
7	Manage printer	Add, remove, or update printers in the system. Verify that all changes reflect correctly in the printer management list.
8	Manage printer's configuration	Modify printer's configuration. Ensure the configurations are saved and applied accurately to the printer.
9	View SPSO's report	Review the detailed report about printing usage and statistic overall.
10	View Student's printing history	Review the history of using the service of student.

Table 27: *Task description for each use-cases*

4.3.3 Define test strategy

Based on the project features and budget and time constraints, our team decided to conduct testing using the following approach:

- Remotely coordinated testing: Team members sit and interact with each other. Ask other members to try out the features that the rest of the team is working on. In this case, our team used Google Meet.
- Externally evaluated testing: 15 people were selected to test the product and evaluate it collectively based on the set criteria. After using the product as described, the users will conduct the evaluation via Google form

This decision was made for the following reasons:

- Faster and more cost-effective: This strategy eliminates the need for testers to pay for travel expenses for themselves or participants. Additionally, remote testing allows both parties to schedule sessions more flexibly without logistical constraints.
- Minimize disruption to team workflow: By conducting testing remotely, team members can seamlessly integrate the testing process into their existing schedules, reducing downtime and allowing them to focus on other project tasks without having to travel or arrange a physical meeting space.

Additionally, we will use a qualitative approach. This strategy focuses on gathering detailed information and insights during the testing process, including how each user interacts with the product or service. The reason for choosing this method is that our team prioritizes user behavior and experience, making this approach more suitable for their product.

4.3.4 Conduct the test

In order to set up an online meeting for the usability testing session using Google Meet, the team leader sent group messages to every team member. Every member arrived on time for the scheduled meeting. The testing session was broken up into multiple phases, each concentrating on a different system component and lasting roughly fifteen minutes. The team leader invited the participants to complete a form with questions pertaining to the tasks described in the scenarios after explaining the testing procedure in each phase. To finish the tasks, each member was told to carefully read the task scenarios and attempt to engage with the application. A link to a website was sent to the testers for external testing so they could see how the interface worked. A Google form was included with the link, which they would review following the encounter. Following each exercise, participants evaluated the user interface using the following criteria, which ranged from "Strongly Disagree" to "Strongly Agree," on a 5-point scale:

- Visual appeal and layout design: The interface is logically structured and well-organized. Users are encouraged to explore the interface because it is visually appealing and captivating.
- Interaction flexibility: The interface can be used in a variety of ways.
- Accurate information location: Users are able to forecast with accuracy where they can locate particular information inside the interface.
- Learnability: Without guidance, users can quickly become proficient in navigating and using the interface.
- Support and assistance: Users can locate the information they require or get help with ease.

4.3.5 Evaluation results, feedback

The rating scale from 0-5 typically includes the following levels:

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree

Feedback from participant in project:
Task: Log in with Student and SPSO and View Student home UI

Criteria	Member 1	Member 2	Member 3	Member 4	Member 5
Visual appeal and layout design	5	5	5	5	5

Interaction flexibility	5	5	5	5	5
Accurate information location	3	4	3	3	3
Learnability	5	5	5	5	5
Support and assistance	5	5	5	5	5

Table 28: *Task rating for Log in with Student and SPSO and View Student home UI*

Task: Upload Document, Specify properties and Choose printer

Criteria	**Member 1**	**Member 2**	**Member 3**	**Member 4**	**Member 5**
Visual appeal and layout design	4	4	5	5	4
Interaction flexibility	5	5	5	5	5
Accurate information location	5	5	5	5	5
Learnability	4	4	3	4	3
Support and assistance	3	2	3	4	3

Table 29: *Task rating for Upload Document, Specify properties and Choose printer*

Task: View SPSO home UI, Manage printer and Manage printer's configuration

Criteria	**Member 1**	**Member 2**	**Member 3**	**Member 4**	**Member 5**
Visual appeal and layout design	4	3	5	4	5
Interaction flexibility	5	5	4	4	4

Accurate information location	3	5	5	5	4
Learnability	4	5	4	5	4
Support and assistance	4	5	4	5	5

Table 30: *Task rating for View SPSO home UI, Manage printer and Manage printer's configuration*

Task: View SPSO's report and View Student's printing history

Criteria	Member 1	Member 2	Member 3	Member 4	Member 5
Visual appeal and layout design	5	5	5	5	5
Interaction flexibility	5	5	5	5	5
Accurate information location	5	4	5	5	4
Learnability	4	5	4	5	5
Support and assistance	3	4	4	4	3

Table 31: *Task rating for View SPSO's report and View Student's printing history*

Feedback from user testing through Google form:

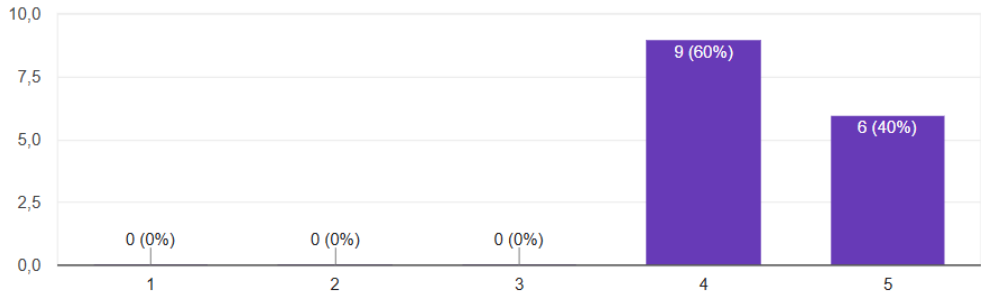

Figure 30: *Evaluate the attractiveness of the website's "Homepage" interface.*

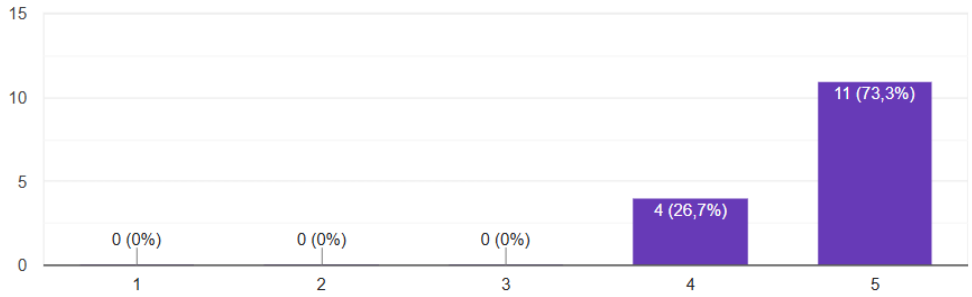

Figure 31: *Evaluate the ease of navigation (finding information or functions).*

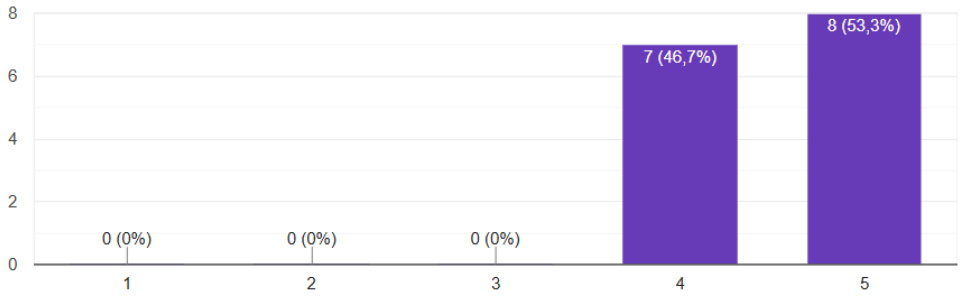

Figure 32: *Evaluate the ease of use of the print function.*

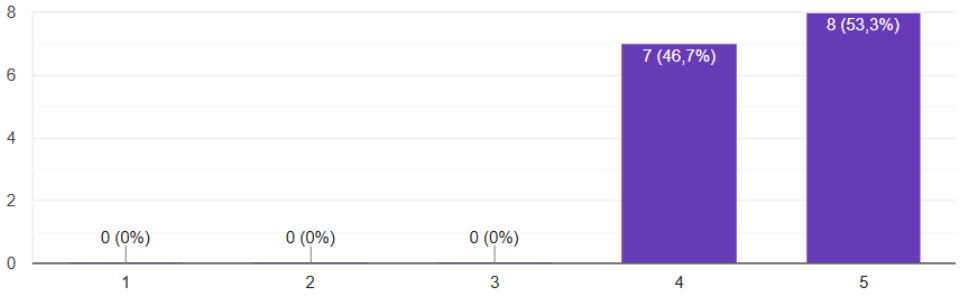

Figure 33: *Evaluate the look and feel of the "Home for Students" and "In Documents" screens.*

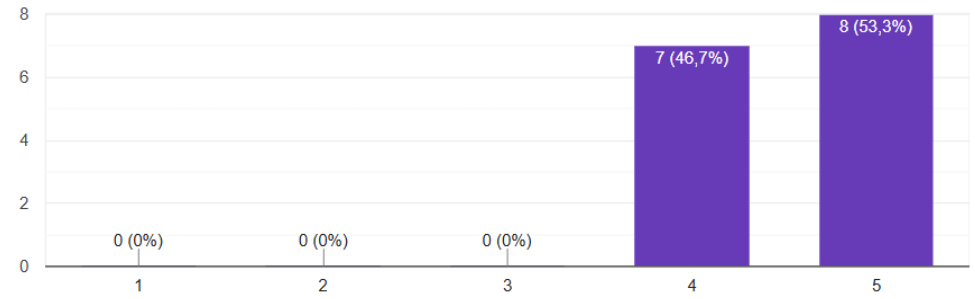

Figure 34: *Evaluate the interface of the "Buy Print Pages" screen.*

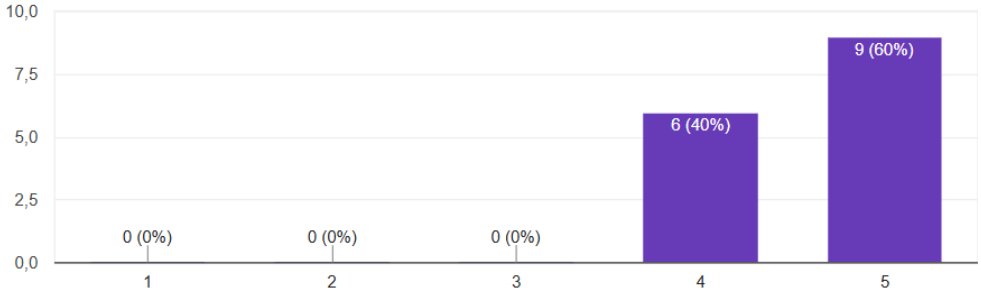

Figure 35: *Evaluate whether the content on the website meets the user's needs*

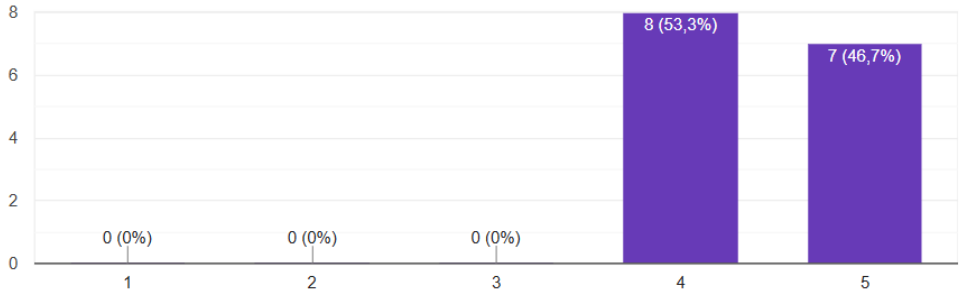

Figure 36: *Review of the ORDER of operations of the features*

4.3.6 Proposal for System Improvement

Changes	Explanation	Priority
Notify when successfully login	Need a notification when login successfully in the list of notification	Low

Button "Back previous" in Login page	Return to the page choosing "Student or SPSO" when click on wrong user	High
Showing the list in choosing printer	The printer list may be sorted and the active printers need to appear on the top	Medium
Upload multiple file	Should be 1 file each time because it can affect the calculation of the pages, the context of file	High
File Upload Feature Enhancement	Add a preview after uploading files so users can confirm the uploaded content and avoid errors	High

Table 32: *Proposal for improvement*

5 Task 5: Implementation – Sprint 2

Here are some student and spso pages our team completed for the printing system design.

5.1 5.1 Student UI

Figure 37: *Upload print document*

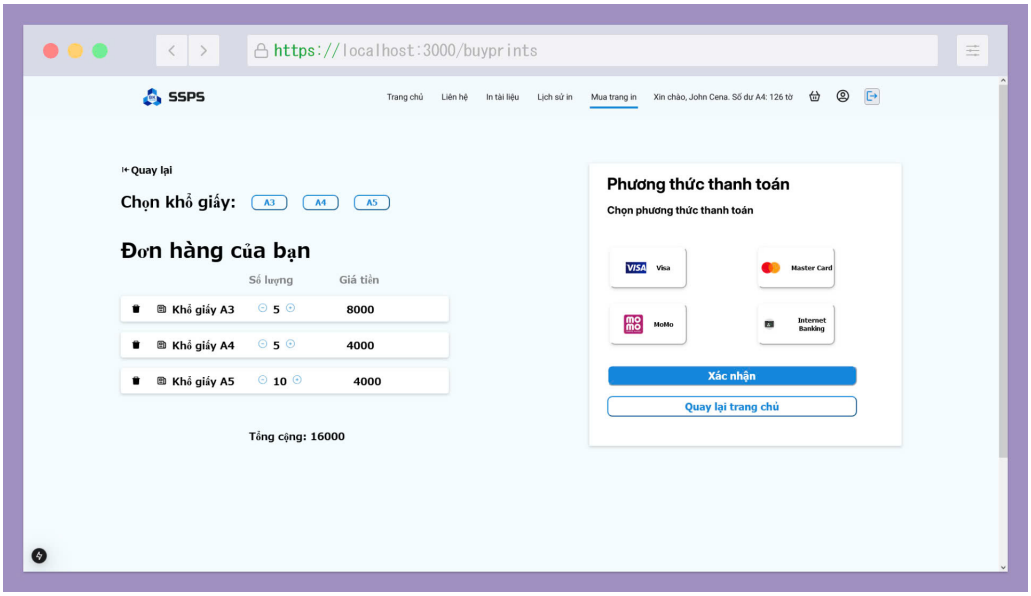

Figure 38: *Buy print page*

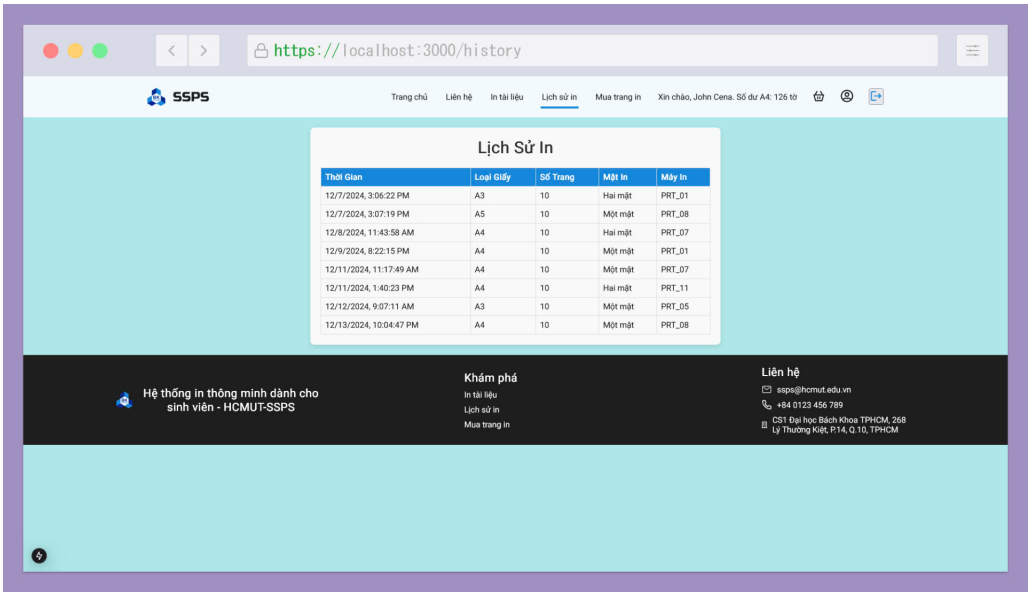

Figure 39: *Printing history of Student*

5.2 5.2 SPSO UI

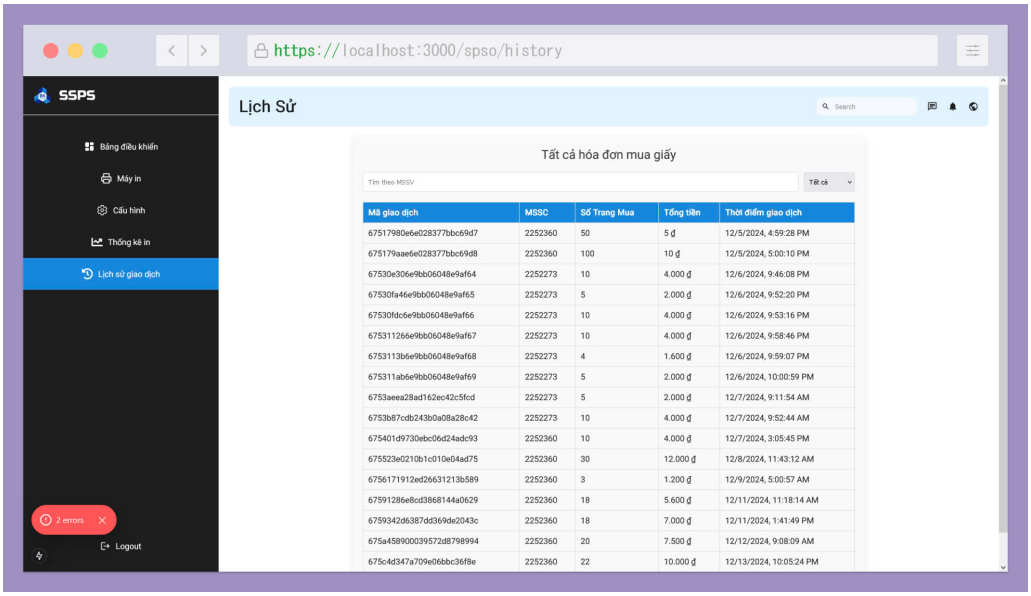

Figure 40: *Buy print history view of SPSO*

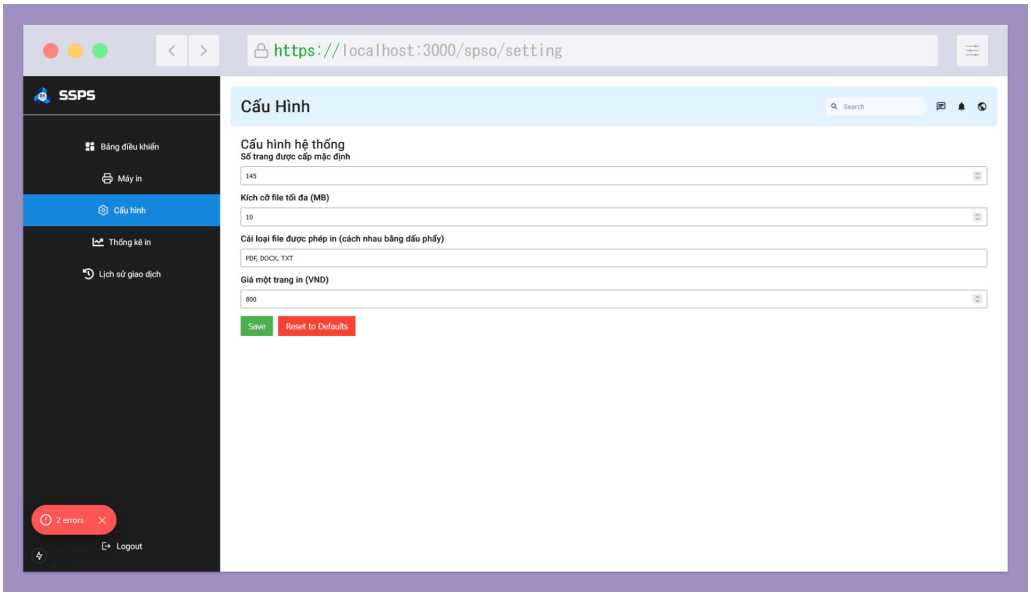

Figure 41: *Setting the initial format for printer*

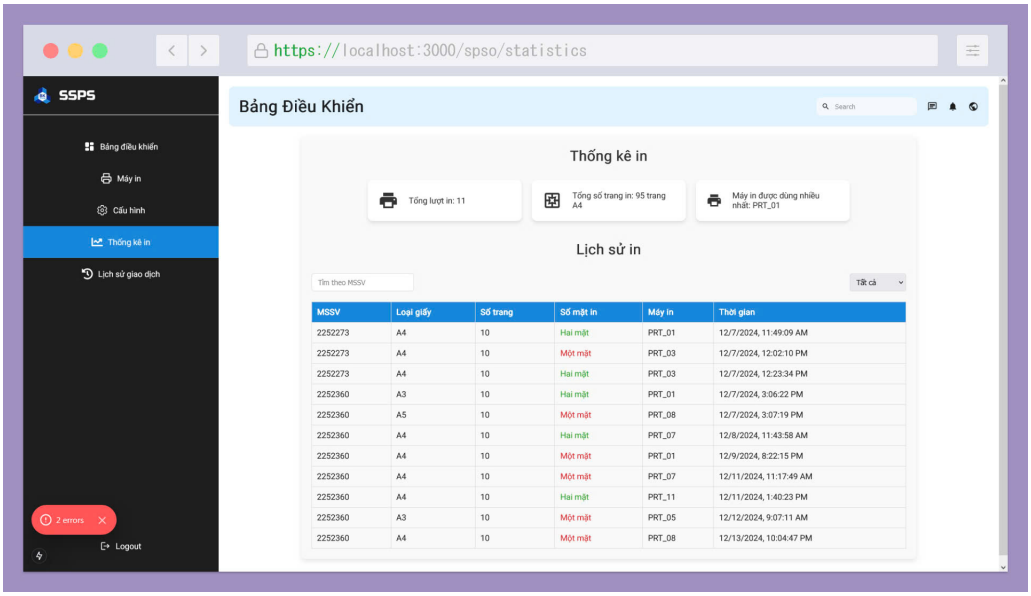

Figure 42: *Printing statistic*

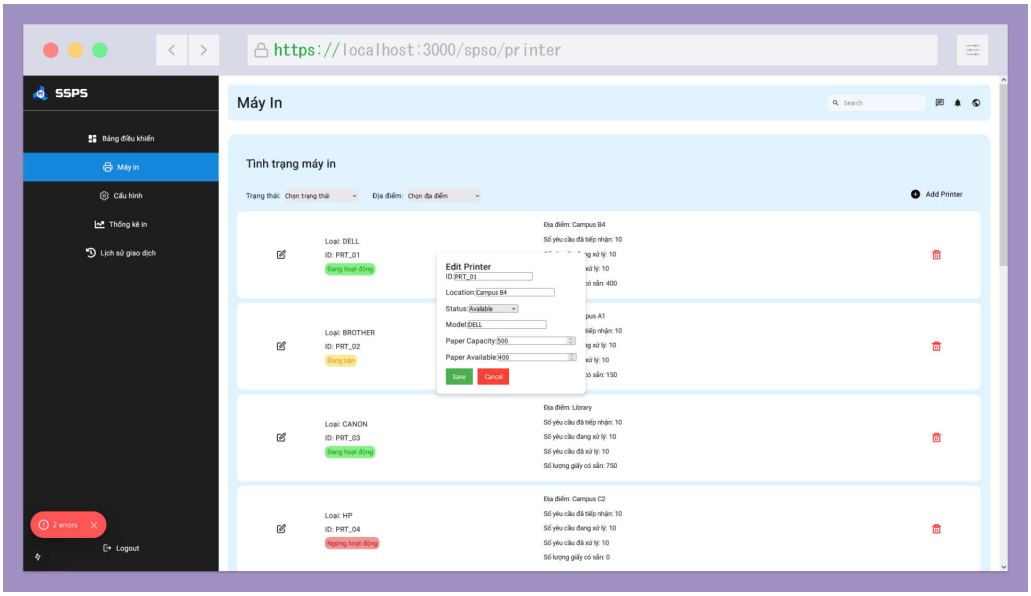

Figure 43: *Configuration printers*