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UNIVERSITY OF TECHNOLOGY  
FACULTY OF COMPUTER SCIENCE AND TECHNOLOGY



## SOFTWARE ENGINEERING (CO3001)

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### ASSIGNMENT

### A smart printing service for students at HCMUT

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# 1 Requirement elicitation

## 1.1 Domain Context

### 1.1.1 Problems

Along with the digitization of electronic lectures, lecturers at Ho Chi Minh City of Technology (HCMUT) usually tend to upload materials such as textbooks and presentation slides onto the LMS (Learning Management System) for students to preview and print out to follow and take notes during direct lectures. The large campus size, combined with the scattered placement of printers, makes printing become difficult and time-consuming. Generally, when printing outside the university, students may encounter the following issues:

- It takes time to visit printing facilities, wait in line, and the long geographical distances are not suitable for urgent situations. With traditional printing methods, students need to go to print shops, send their files, and wait for the printing process, not to mention the time spent waiting for their turn.
- The prices and print quality are not transparent or consistent. With constantly fluctuating prices, students may unknowingly end up paying more than the standard rate. Even when print errors are not the student's fault, the cost is often still included in the printing fee.
- It's hard to keep track of printed materials. With a large number of documents printed during thesis, project, or scientific research phases, students struggle to manage their printed documents.
- For documents with high intellectual property value, such as scientific research, students face the potential risk of intellectual property theft.
- There's also a risk of exposing personal information, such as social media accounts, phone numbers, addresses, . . . , when students log in to retrieve data saved on cloud platforms.

### 1.1.2 Solution

The Student Smart Printing Service (HCMUT\_SSPPS) is designed to address these issues, particularly as follow:

- **Centralized Printer Access & Document Upload:** Students can upload documents to a centralized system and select printers across campus, eliminating the need for external print shops and saving time.

- **Customizable Print Settings & Real-time Status:** Students can choose print preferences like paper size, print range, single/double-sided options, . . . , while viewing the real-time status of each printer.
- **Printing Log, History & Summary:** The system logs all print activities, allows students to view their printing history, and provides the summary of pages printed by paper size.
- **Prepaid Balance & Payment Integration:** Students receive a default page allocation each semester and can purchase additional pages through BKPay, with automatic balance adjustments based on paper size.
- **Printer & System Management by SPSO:** The SPSO manages printers, adjusts system settings like page allocations and file types, and views automatic monthly/annual reports for system usage.

## 1.2 Stakeholders and Needs

### 1.2.1 Students

- **Description:** Primary users of the printing system, responsible for uploading documents and managing their print tasks.
- **Needs:** Quick, convenient access to printers, customizable print options, ability to manage printing history and balance, and secure handling of personal and intellectual property.

### 1.2.2 Student Printing Service Officer (SPSO):

- **Description:** Responsible for managing the printing infrastructure, printers, and system configurations.
- **Needs:** Efficient tools to add/disable printers, adjust system settings (file types, page allocations), view detailed print logs, and generate usage reports.

### 1.2.3 University Administrators:

- **Description:** Oversee the overall functioning of the printing system and ensure it aligns with university policies and budget.
- **Needs:** Assurance that the system is efficient, cost-effective, and supports sustainability goals like reducing paper waste.



#### 1.2.4 IT Support/Technical Team:

- **Description:** Handle the technical infrastructure of the printing system, ensuring uptime and security.
- **Needs:** Robust, scalable system architecture, regular updates, and maintenance to ensure seamless operation and security.

#### 1.2.5 BKPay System Administrators:

- **Description:** Manage the online payment system that integrates with the printing service for purchasing additional pages.
- **Needs:** Secure, reliable integration with the printing system, and smooth transaction processing for students.

#### 1.2.6 HCMUT\_SSO Authentication Service Administrators:

- **Description:** Oversee the authentication service that ensures secure access to the printing system.
- **Needs:** Secure, efficient user authentication to prevent unauthorized access while providing smooth login experiences.

#### 1.2.7 Printer Manufacturers/Suppliers:

- **Description:** Provide and maintain the printers used in the system.
- **Needs:** Ensure printers are compatible with the system, reliable, and easily serviceable when issues arise.

#### 1.2.8 Faculty and Staff (optional Users):

- **Description:** May occasionally use the system for administrative or teaching-related printing needs.
- **Needs:** Access to the system with similar ease and functionality as students, with the ability to print documents efficiently.

## **1.3 Benefits of the System**

### **1.3.1 Students**

The system provides a convenient, centralized printing solution that saves time and effort, as well as offering customizable print settings, secure handling of personal documents, and easy management of printing history and balance. It also reduces risks associated with external printing services, such as cost variability and data security issues.

### **1.3.2 Student Printing Service Officer (SPSO):**

Printer management and system configuration are simplified with a user-friendly interface, enables efficient oversight of print logs and usage statistics. The system also facilitates better control over printer resources and settings, and automates report generation for easier monitoring and analysis.

### **1.3.3 University Administrators:**

The system ensures efficient use of resources and aligns with budgetary and sustainability goals, from that it provides a streamlined, cost-effective solution that improves operational efficiency. Also, it supports better decision-making through detailed usage reports and system performance data.

### **1.3.4 IT Support/Technical Team:**

The team benefits from a robust and scalable system architecture that is easier to maintain and secure. The complexity of managing multiple standalone printers and supports proactive maintenance and troubleshooting is also reduced through centralized monitoring.

### **1.3.5 BKPay System Administrators:**

In addition to ensuring reliable processing of payments for additional printing pages, enhancing user satisfaction and system reliability, the system facilitates seamless and secure integration with the printing system for handling transactions.

### **1.3.6 HCMUT\_SSO Authentication Service Administrators:**

The system integrates smoothly with the authentication system, ensuring secure access and preventing unauthorized use, besides enhancing user experience by providing a secure and efficient login process.

### 1.3.7 Printer Manufacturers/Suppliers:

The system help the suppliers gain access to a large, consistent user base within the university. Also, it ensures printers are used efficiently and are well-maintained, leading to fewer service issues and improved customer satisfaction.

### 1.3.8 Faculty and Staff (optional Users):

The system provides a reliable and convenient printing solution for administrative and teaching needs. Everyone has easy access to printing services with consistent quality and reduced hassle, similar to the benefits experienced by students.

## 1.4 Functional Requirements

### 1.4.1 Students

- Login/logout
- Accessing and viewing personal information
- Uploading a file from his own device into the system
- Choosing printer to print
- Specifying the printing properties such as paper size, pages (of the file) to be printed, one/double-sided, number of copies, etc
- Checking whether the printed document is done and knowing the estimated day for receiving the document
- Viewing and searching the printing log for a period time
- Buying more paper if need

### 1.4.2 Student Printing Service Officer (SPSO)

- Login/logout
- Viewing the printing history (log) of all students or a student for a time period (date to date) and for all or some printers
- Accessing and viewing properties of all printers
- Configuring system such as changing the default number of pages of each student, providing date of default pages, specifying the permitted file types



- Add/enable/disable printer
- Viewing monthly & annual reports of system

### 1.4.3 The Printing System

- Connecting to printers, sending requests to them to print documents
- Logging all activities of students
- Automatically publishing monthly & annual reports
- Using HCMUT\_SSO Authentication in login step
- Creating invoices in BKPay System and returning more papers for student when the invoice is payed

### 1.4.4 Printer

- Receiving requests from the printing system to print documents

## 1.5 Non-Functional Requirements

Non-functional requirements, as the name suggests, are requirements that are not directly concerned with the specific services delivered by the system to its users. These non-functional requirements usually specify or constrain characteristics of the system as a whole. They may relate to emergent system properties such as reliability, response time, and memory use. Alternatively, they may define constraints on the system implementation, such as the capabilities of I/O devices or the data representations used in interfaces with other systems. In SPSS, we have non-functional requirements:

- Product requirement:
  - **Usability:** The system should be easy to use by student, faculty and staff. The system shall provide an intuitive, multilingual and accessible interface for both web and mobile users
  - **Efficiency:**
    - \* **Performance:** The system shall support 10000 concurrent users with a response time under 5 seconds
    - \* **Space:** The system shall support a maximum file upload size of 100MB per document with configurable file type restrictions

- **Dependability:** The system shall implement regular data backups and error tracking, ensuring all print requests are completed successfully or providing clear notifications and resolution guidance in case of failure.
- **Security:** All users must be authenticated through HCMUT\_SSO authentication service and all data must be encrypted and logged for security and auditing purposes
- Organizational requirement:
  - **Environmental:** The system shall be compatible with web browsers and mobile operating systems, including iOS and Android
  - **Operational:** The system should be available 24/7, with scheduled maintenance restricted to off-peak hours, and should allow administrators to easily manage printers, file types and configurations through a user-friendly interface
  - **Development:** The system should be developed using a modular architecture to allow for easy future upgrades and feature additions and integration with university services like BKPay and HCMUT\_SSO authentication service
- External requirement:
  - **Regulatory:** The system shall comply with university data protection policies and any applicable local or international data protection laws
  - **Ethical:** The system must ensure fair access to printing resources for all students, including those with disabilities
  - **Legislative:**
    - \* **Accounting:** All financial transactions such as buy more printing, shall comply with university accounting standards and provide complete records for auditing
    - \* **Safety:** The system must protect student data by prevent unauthorized access and maintain comprehensive logs for auditing

## 2 Use-case Diagrams

### 2.1 Actors

ID	Actor	Description
1	User	General system user
2	Student	Use the printing system
3	SPSO	Manage the printing system
4	Printer	Printing system
5	HCMUT_SSO	User authentication system
6	BKPay System	Online payment system

Table 1: Actors involve in the system

### 2.2 Main Usecase branches

Usecase ID	Usecase Name	Description
UC-1	Login/Logout	Users login/logout the system.
UC-2	View printing logs	Student view his/her printing logs.
UC-3	Print documents	Student use the printing system to print documents.
UC-4	Buy pages	Student use BKPay system to buy new pages.
UC-5	Manage printers	SPSO manage all the printers.
UC-6	View all printing logs	SPSO view all printing logs of all students.
UC-7	Manage configuration	SPSO manage the system configurations.
UC-8	View monthly report	SPSO view the monthly report of the system operation.

Table 2: Main Usecase branches of the system

## 2.3 Use-case Diagram for the whole System

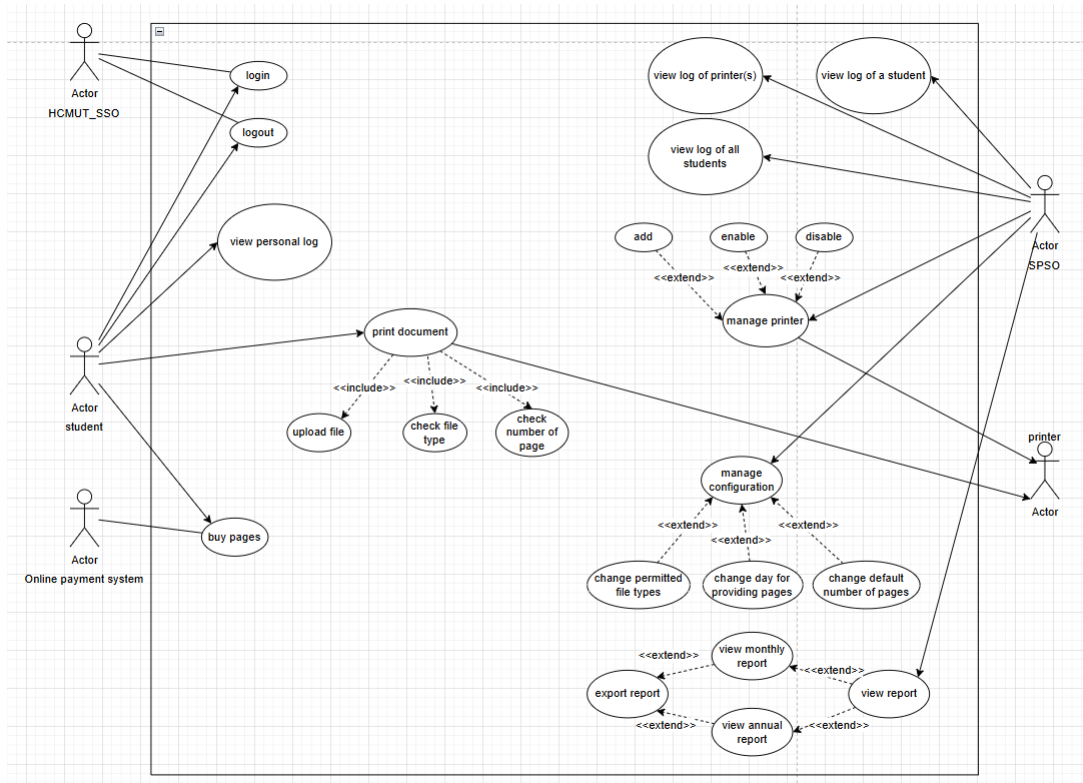


Figure 1: Use case diagram of whole system

## 2.4 Use-case Diagram for the "View printing logs" Module

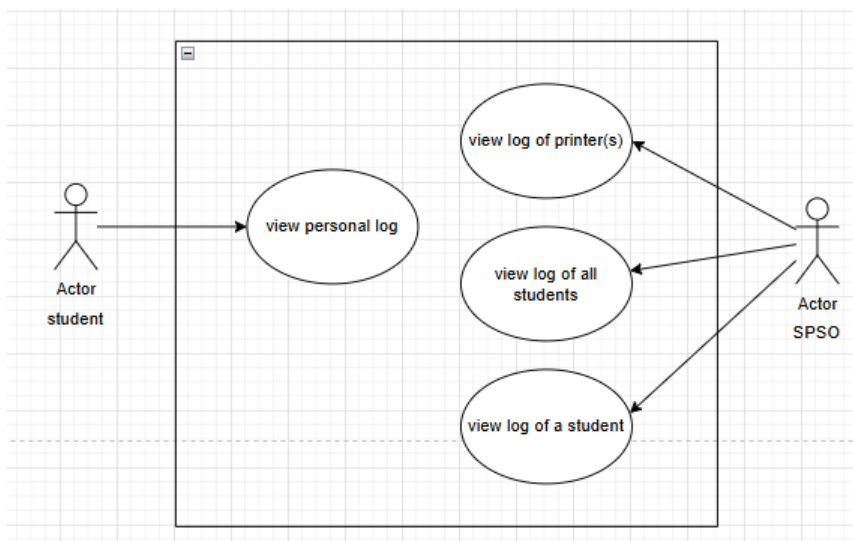


Figure 2: Use case diagram of view printing logs module

## 2.5 The Details of Use-cases in the "View printing logs" Module

Use-case Table 1: View logs of all students.

<b>Use-case ID</b>	UC-6-1
<b>Use-case name</b>	View logs of all students
<b>Created by</b>	Đỗ Hoàng Quân
<b>Date created</b>	28/9/2024
<b>Actor</b>	Student Printing Service Officer (SPSO)
<b>Description</b>	SPSO can view the printing logs for all students, and be able to filter by date, printer or student ID. Logs include details such as student ID, printer ID, file name, printed time, and number of pages printed.
<b>Trigger</b>	The SPSO wants to monitors printing usage for administrative purposes, analyze the operation or generate a report, and needs to revise the logs.
<b>Preconditions</b>	1. The SPSO must be authenticated through the HCMUT_SSO authentication system. 2. Printing logs must exist in the system.
<b>Postconditions</b>	1. The SPSO is able to view all printing logs and apply filters such as time period, student ID, or specific printers. 2. Logs can be exported or reviewed for future reference.
<b>Normal flow</b>	1. SPSO selects the "View printing log" button on the home page. 2. SPSO chooses a period time for searching 3. The system will display the information of all printing logs, with details of student ID, number of papers remaining, and number of printed papers appropriate to the specific paper size. 4. The SPSO can export the logs, or take further actions such as apply filters or view information for a specific printing action.
<b>Alternate flows</b>	1a. If there's an error retrieving logs (e.g., network or server issues), the system displays an error message. <b>3. Extension points:</b> 3a. If SPSO also types student_ID in search box, the system will return logs of a specific student (UC-6-2). 3b. If SPSO select (a) specific printer(s), the system will return logs of chosen printer(s) (UC-6-3).
<b>Exceptions</b>	2a. Connection issues may prevent the display of database (logs). 2b. SPSO session timeout, requiring re-login to continue the process.

Table 3: Use-case specification of view all printing logs



**Use-case Table 2:** View printing log of specific student(s).

<b>Use-case ID</b>	UC-6-2
<b>Created by</b>	Hồ Quốc Đạt
<b>Date created</b>	26/09/2024
<b>Use-case name</b>	View log of specific student
<b>Actor</b>	Student Printing Service Officer (SPSO)
<b>Description</b>	The SPSO searches and views a printing log of a specific student based on the student ID
<b>Trigger</b>	The SPSO user want to view the printing history to check manually for user's paper usage.
<b>Preconditions</b>	1. The User has authenticated successfully by the HCMUT_SSO 2. The User's account must belong to SPSO
<b>Postconditions</b>	System will display the printing log of specific student with appropriate student ID
<b>Normal flow</b>	1. SPSO select the "View printing log" button on the home page. 2. SPSO chooses a period time for searching 3. The SPSO will tick the option "Sort by student ID" and enter the student ID to be searched for. 4. HCMUT_SSPS will direct the user to the search page 5. The system will display the information of the student whose ID matches the entered ID with details of student ID, number of papers remaining, and number of printed papers appropriate to the specific paper size.
<b>Alternate flows</b>	<b>Alternate 1:</b> 5a. The user can modify another student ID to search for another student's log
<b>Exceptions</b>	<b>Exception 1:</b> 3a. If user enter an invalid student ID then the system will pop up an error message and require user to reenter the student ID 3b. If the system can't connect to database then the system will require user to reload page.
<b>Notes and issues</b>	

Table 4: Use-case specification of view log for a specific student

Use-case Table 3: View printing log of printer(s).

Use-case ID	UC-6-3
Created by	Hồ Quốc Đạt
Date created	26/09/2024
Use-case name	View specific printer(s)' log.
Trigger	The SPSO wants to view the usage of paper in a time range of some printers so that the SPSO can analyze and prepare papers for future usage.
Actor	Student Printing Service Officer (SPSO), printer.
Description	The SPSO searches and views the printing log of some specific printers.
Preconditions	1. User has authenticated successfully by the HCMUT_SSO. 2. User's account must belong to SPSO.
Postconditions	The system will display the printing log of students who print documents on some specific printers during the selected time range.
Normal flow	1. SPSO select the "View printing log" button on the home page. 2. HCMUT_SSPO will direct the user to the search page. 3. The system will ask SPSO to choose the printers that they want to view log. 4. The SPSO specifies the printer(s) that they want. 5. The SPSO will select the start day and the end day to be searched for. 6. The system will display the information of the student who prints documents on the specified printers during the selected time with details of student ID, number of papers remaining, and number of printed papers appropriate to the specific paper size.
Alternate flows	<b>Alternate 1:</b> 3a. The user can combine with another sorting option (Sorted by student ID or by printer). <b>Alternate 2:</b> 4a. The user can change the time to search for another time range.
Exceptions	<b>Exception 1:</b> 3a. If the user enters an invalid date (invalid start, end day, invalid format), the system will send a warning notification and require the user to reenter the time range. 3b. If the system can't connect to database then the system will require user to reload page.

Table 5: Use-case specification of view log for a specific time range

Use-case Table 4: View personal log.

Use-case ID	UC-6-4
Created by	Đinh Xuân Quyết
Date created	26/09/2024
Use-case name	View personal log.
Trigger	Student requests to view their own printing history.
Actor	Student.
Description	Students can view a printing history, namely date, time of printing, and number of pages of each time printed within a specific period.
Preconditions	1. The student already log into system. 2. The system manages the database of printing history
Postconditions	The printing page history is displayed for the actor's specified time range.
Normal flow	1. The user logs into the system using HCMUT_SSO. 2. The user navigates to the View Printing History feature. 3. The user selects the "View Printed Page Summary" option from dashboard. 4. The system prompts the actor to enter a date range. 5. The actor enters the desired date range. 6. The system calculates and displays the total number of printed pages, categorized by page size (A4, A3) for the specified period.
Alternate flows	<b>Alternate 1:</b> at step 3 3a. The user uses the default option from dashboard. Continue step 4 in normal flow.
Exceptions	<b>Exception 1:</b> at step 6 6a. If the system experiences a timeout due to a large amount of data or slow server response, system presents a page saying that request time out. <b>Exception 2:</b> at step 6 6b. If there is no printing activity for the selected period, system presents a page saying that no data was found.

Table 6: Use-case specification of view personal log



## 3 System Modeling

### 3.1 Activity Diagram

#### 3.1.1 View all Printing logs

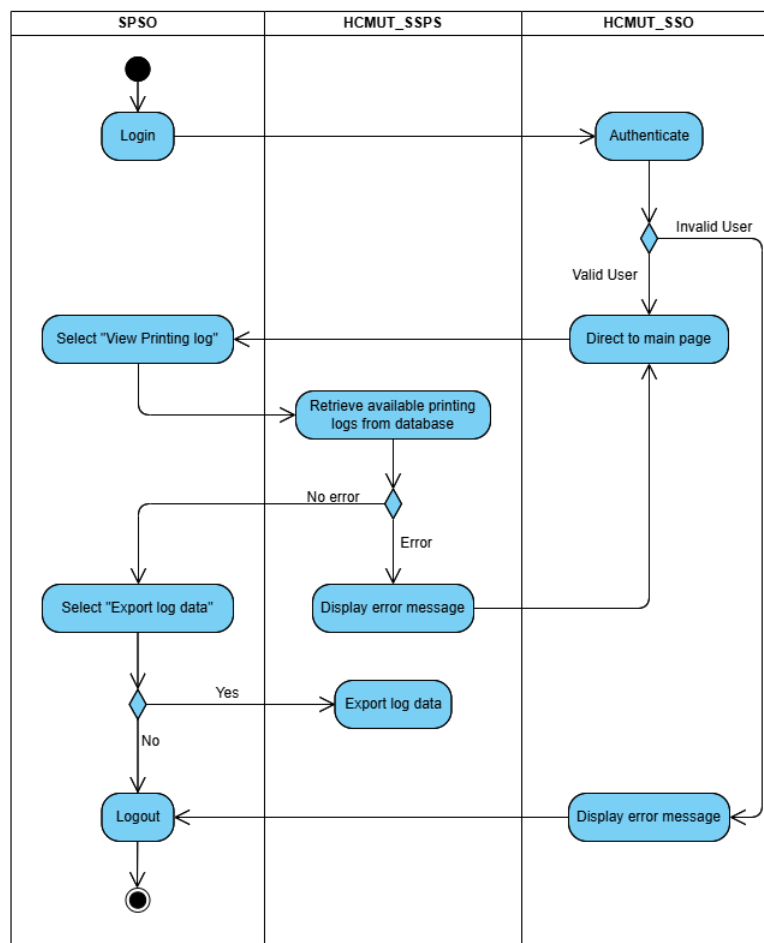


Figure 3: Activity Diagram - View all Printing logs

Link Google Drive: [https://drive.google.com/file/d/1JEwd\\_ljIh96lsOP6knJoNPHmMKpOebIg/view?usp=drive\\_link](https://drive.google.com/file/d/1JEwd_ljIh96lsOP6knJoNPHmMKpOebIg/view?usp=drive_link)

This activity diagram represents the "View All Printing Logs" use case for the HCMUT Smart Printing Service. It involves three actors: SPSO, HCMUT\_SSPS, and HCMUT\_SSO. The process starts with the SPSO logging into the system, while HCMUT\_SSO authenticates the user. If the authentication is valid, the SPSO can proceed to view the printing logs by selecting the "View Printing Log" option. HCMUT\_SSPS retrieves the logs from the database, and if there are no errors, the SPSO can choose to export the log data. If an error occurs during

data retrieval, an error message is displayed. Once the task is complete, the SPSO logs out of the system.

### 3.1.2 View log of a specific student

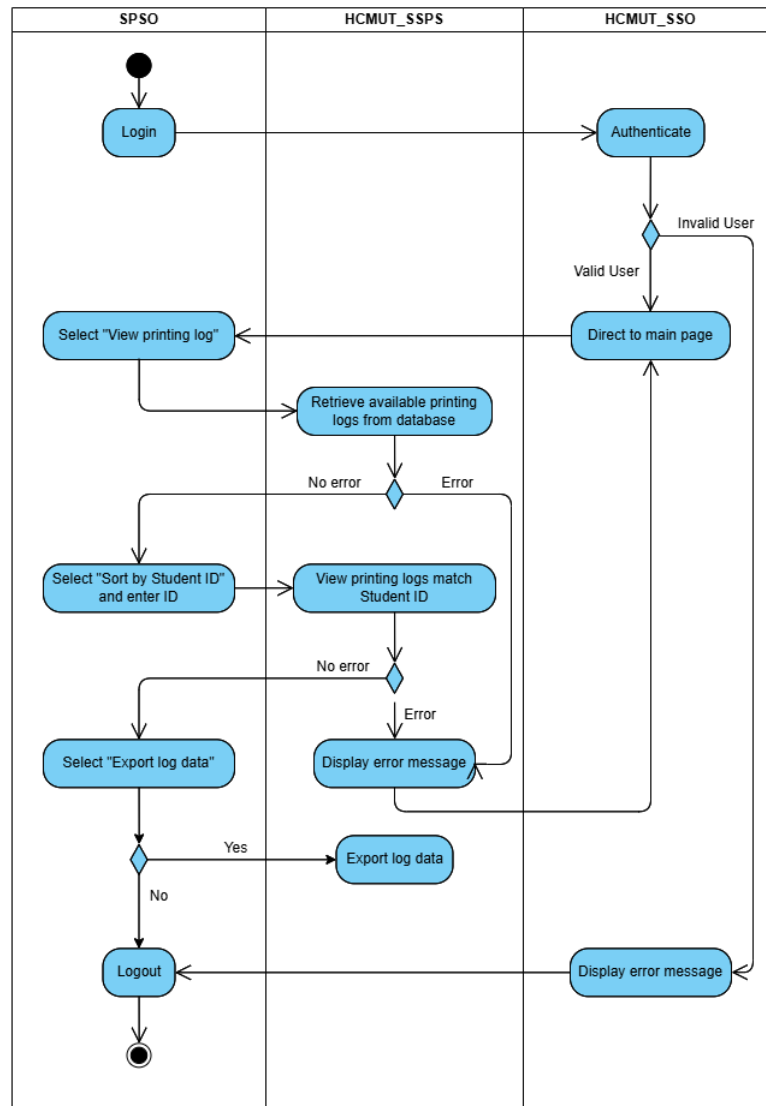


Figure 4: Activity Diagram - View log of a specific student

Link Google Drive: [https://drive.google.com/file/d/1YgdroG\\_1iXo2-IhA0zA5vbS0ot54DBQq/view?usp=drive\\_link](https://drive.google.com/file/d/1YgdroG_1iXo2-IhA0zA5vbS0ot54DBQq/view?usp=drive_link)

This activity diagram illustrates the "View Printing logs of a specific Student" use case in the HCMUT Smart Printing Service system. It involves three actors: SPSO, HCMUT\_SSPS, and HCMUT\_SSO. The process begins with the SPSO logging in, followed by authentication through HCMUT\_SSO. If the user is valid, he/she are directed to the main page. The SPSO

selects the "View Printing Log" option, and the system retrieves the logs from the database. To view logs of a specific student, the SPSO enters the Student ID, and the system fetches the relevant logs. If the logs match the entered ID, they are displayed; otherwise, an error message is shown. The SPSO can then choose to export the logs or log out. Any errors during the process will also trigger error messages.

### 3.1.3 View specific printer(s)' log

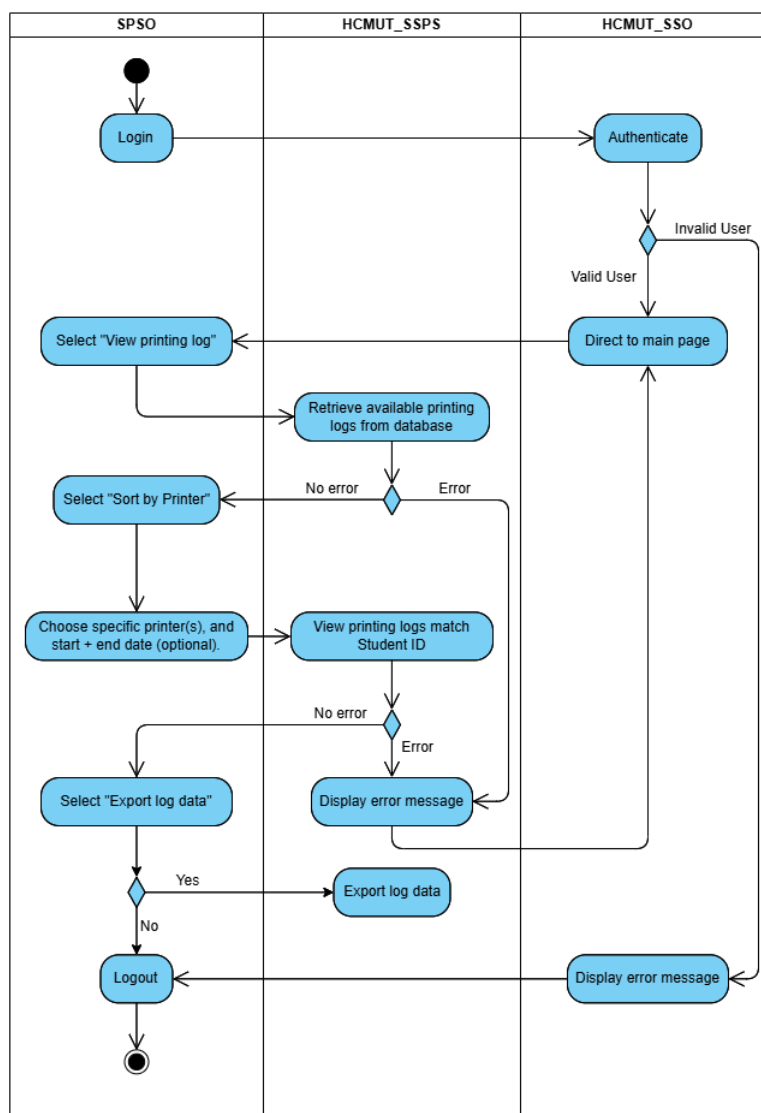


Figure 5: Activity Diagram - View specific printer(s)' log

Link Google Drive: [https://drive.google.com/file/d/10gq4jqog\\_dhDYZsTuTBaV0pCD\\_xxssB4/view?usp=drive\\_link](https://drive.google.com/file/d/10gq4jqog_dhDYZsTuTBaV0pCD_xxssB4/view?usp=drive_link)

This activity diagram represents the use case "View specific printer(s)' log" in the HCMUT

Smart Printing Service system. The process starts with the SPSO logging in, followed by user authentication through HCMUT\_SSO. Once authenticated, the SPSO selects the option to view the printing logs, which prompts the system (HCMUT\_SSPS) to retrieve available logs from the database. The SPSO can then sort logs by selecting specific printers and optionally specifying a date range. The system filters and displays the logs that match the criteria. If there are errors during retrieval, the system displays an error message. Finally, the SPSO has the option to export the log data or log out.

### 3.1.4 View personal log

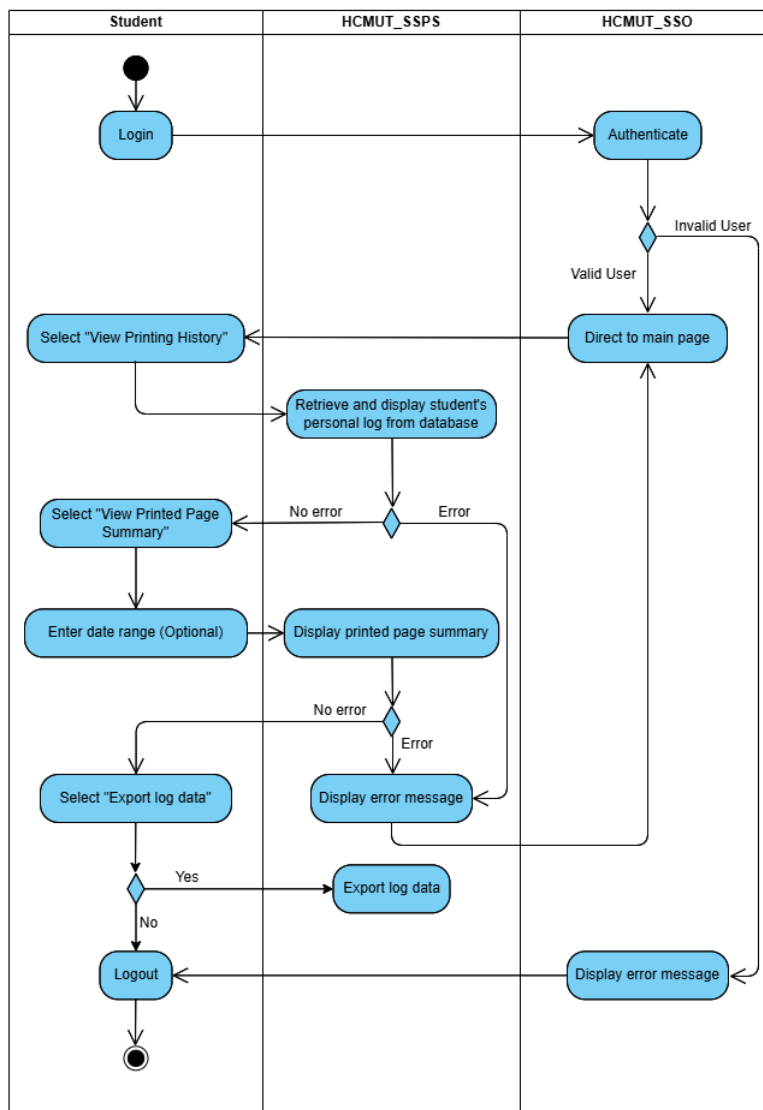


Figure 6: Activity Diagram - View personal log

Link Google Drive: [https://drive.google.com/file/d/10gpokqHvB-KbdB4GzQVnpu3PVg8Cwhkj/view?usp=drive\\_link](https://drive.google.com/file/d/10gpokqHvB-KbdB4GzQVnpu3PVg8Cwhkj/view?usp=drive_link)

This activity diagram represents the use case "View personal log" for a student in the HCMUT Smart Printing Service system. The student begins by logging in, after which the HCMUT\_SSO authenticates the user. If authenticated, the student selects the option to view his/her printing history, and the system retrieves the student's personal printing log from the database. The student can then choose to view a summary of printed pages, optionally specifying a date range. If there are no errors, the log is displayed; otherwise, an error message is shown. The student also has the option to export the log data before logging out.

## 3.2 Sequence diagram

### 3.2.1 Use case: view logs of all students

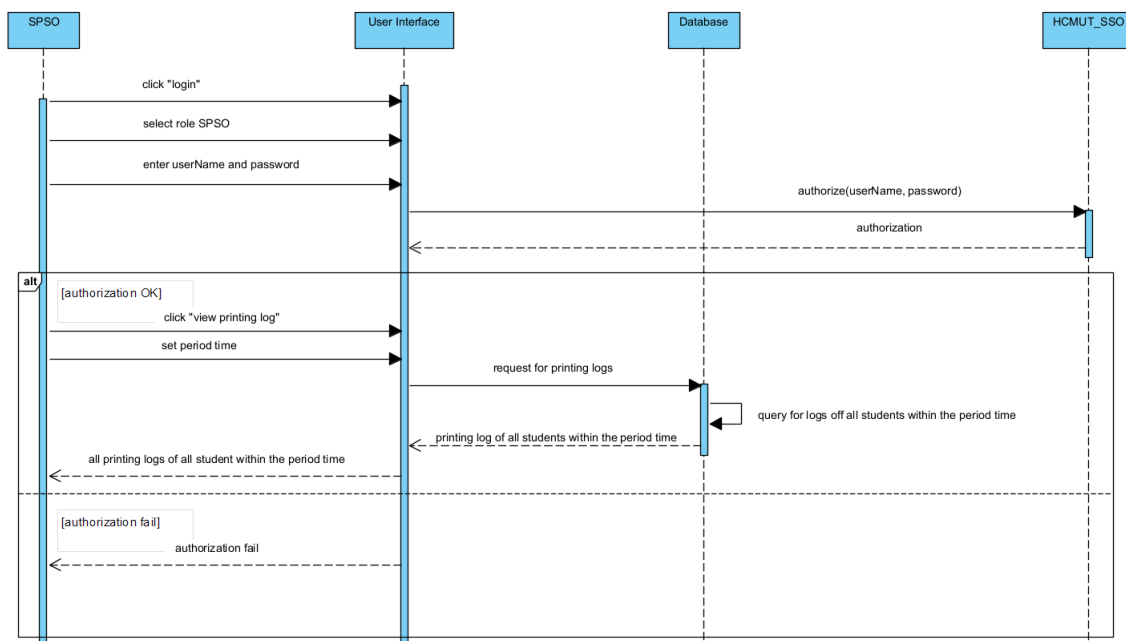


Figure 7: Sequence diagram - view all logs of all students

This sequence diagram represents the use case "view logs of all students". Only SPSO is authorized to do it. First, SPSO needs to log in. If the authorization fails, system will returns a message indicating that. Otherwise, SPSO needs to choose the "view printing log" feature. Then, system prompts SPSO to set period time for searching. System redirects this filter to database for querying and return the result.

### 3.2.2 Use case: view logs of specific student

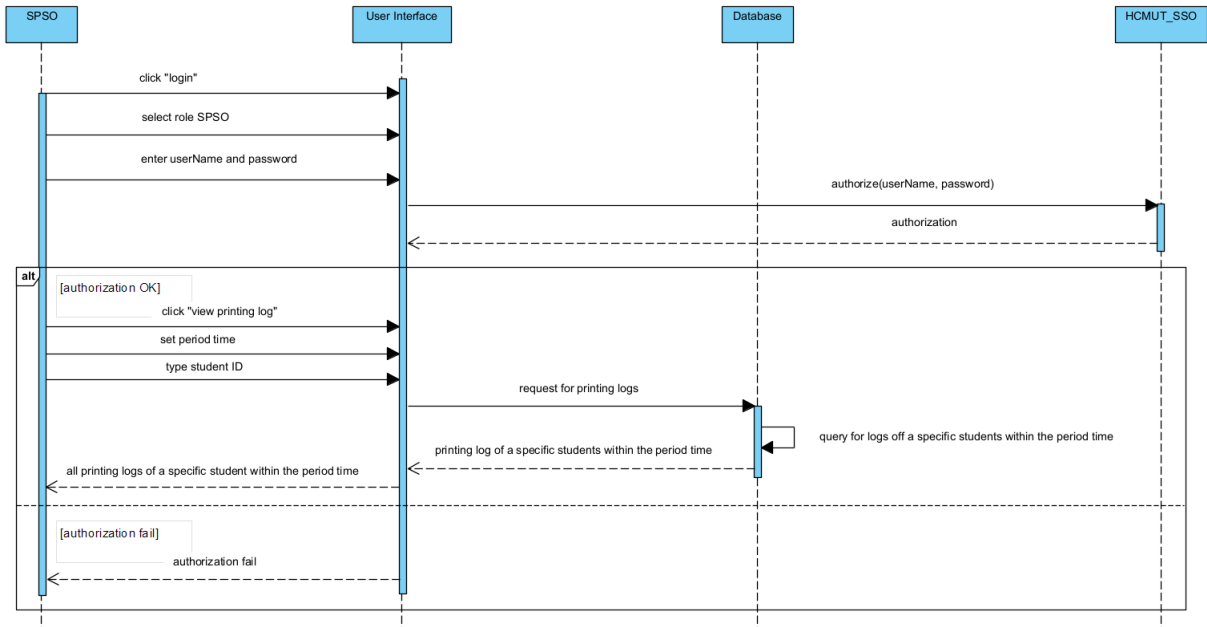


Figure 8: Sequence diagram - view log of specific student

This sequence diagram represents the use case "view logs of all students". Only SPSO is authorized to do it. First, SPSO needs to log in. If the authorization fails, the system will return a message indicating that. Otherwise, SPSO needs to choose the "view printing log" feature. Then, the system prompts SPSO to set a period of time and specific student ID for searching. If SPSO doesn't set student ID for searching, the system will interpret that SPSO wants to view printing logs of all students within the period of time. Then, the system redirects this filter to database for querying and return the result.

### 3.3 Class diagram

#### View printing log module

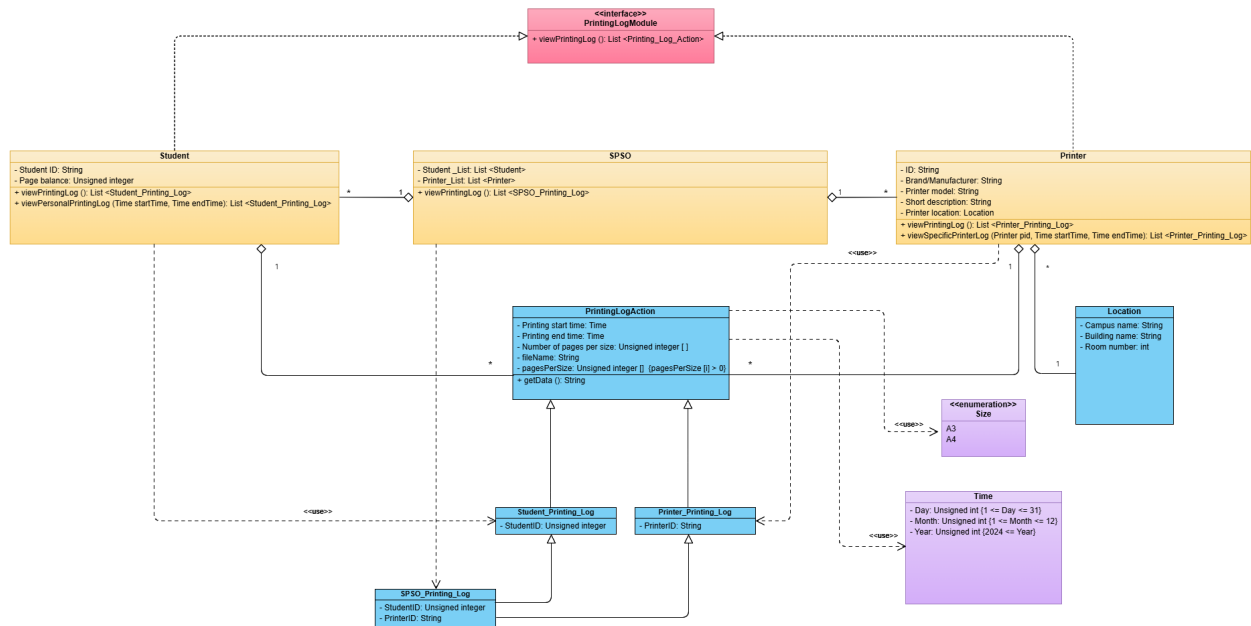


Figure 9: Class Diagram - View printing log module

### 3.4 User Interface

#### *MVP 1 - UI for desktop-view printing logs*

In this task, the team used Adobe Illustrator 2022 to design the interface for basic actions of view printing logs module.

Specifically, the Illustrator implementation can be found at the following [link](#)



### 3.4.1 Homepage

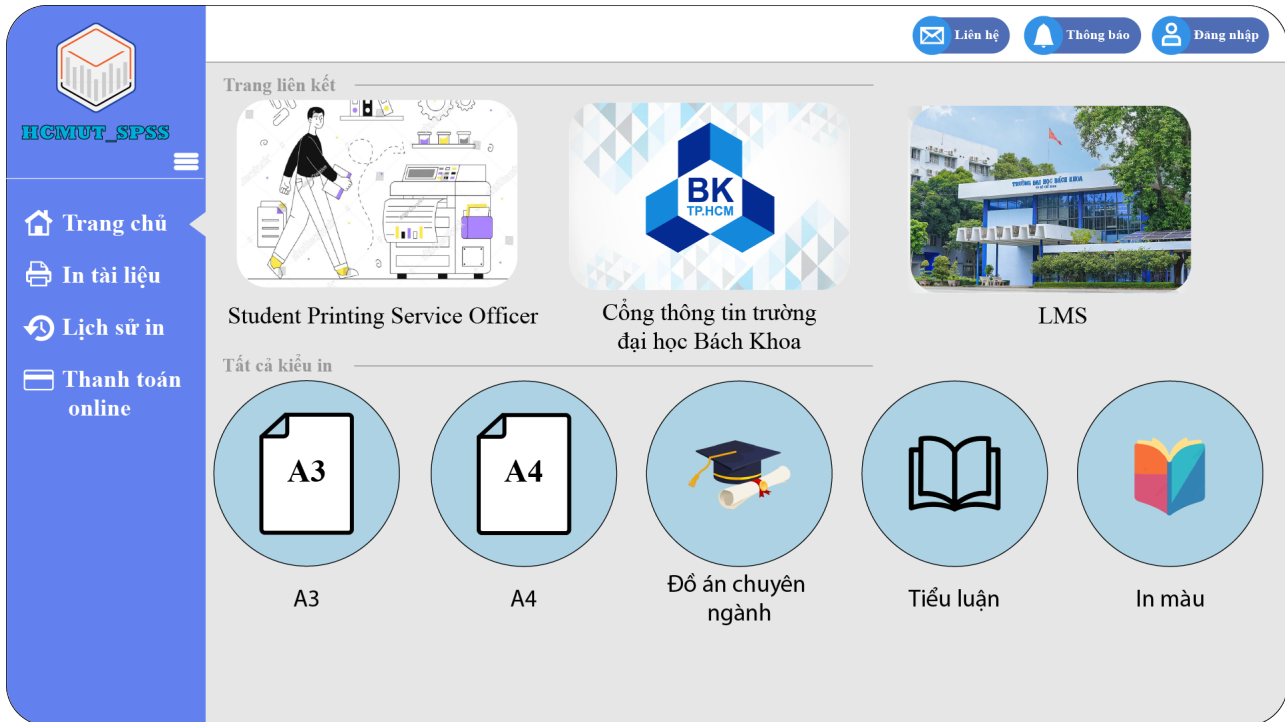


Figure 10: UI Homepage of desktop view

The main components of the system's homepage:

1. **Header:** Representing the main information of the homepage
  - Contact: Navigate to contact the admin team
  - Message: Display notifications for users
  - Log in: Navigate to login page
2. **Navigation Menu:** Display the navigation dashboard between pages
  - Homepage: Display the main page at the start of the website
  - Print: Navigate to the printing page
  - Printing log: Navigate to the printing log
  - Payment: Navigate to the payment page
3. **Main Board:** Display the main function of the website



### 3.4.2 Login Page

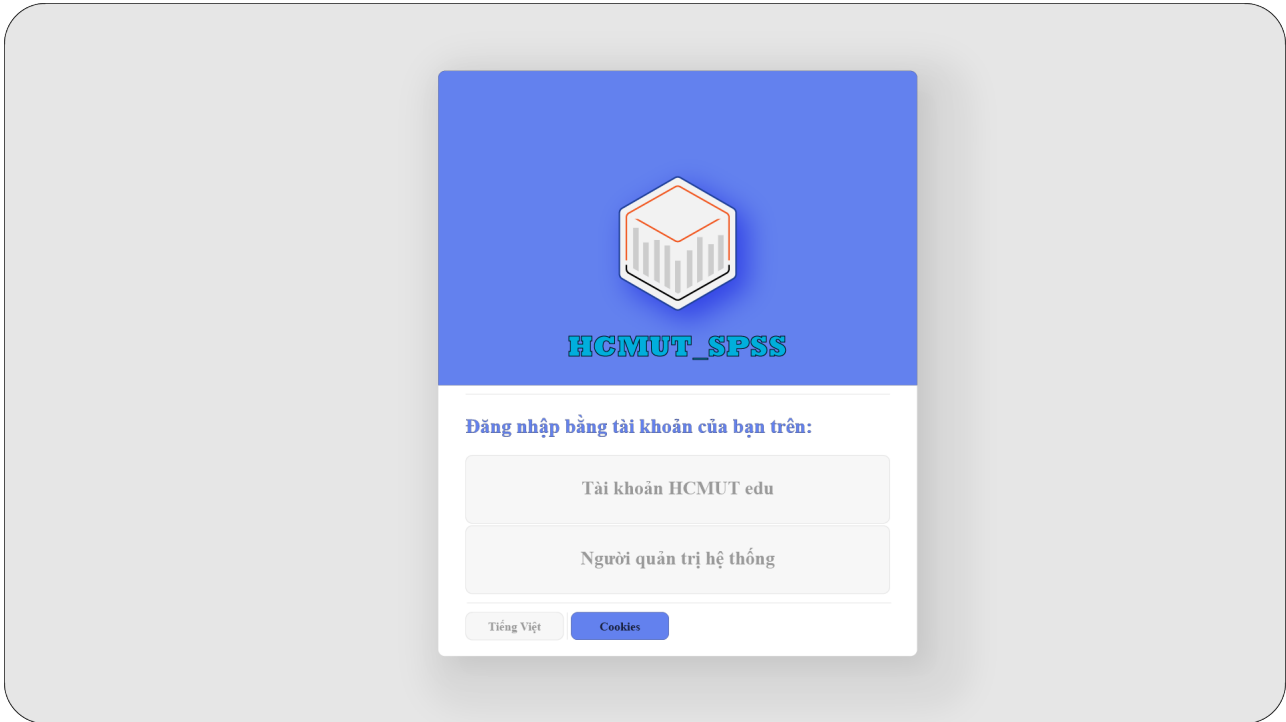


Figure 11: UI for the log in page

The login page of the system has two login options with the following fields:

- User field: Login to the user's edu account. When clicked, the website will redirect to the authentication service for the user
- Admin field: Login to the admin account. When clicked, the website will redirect to the authentication service for the admin.

### 3.4.3 HCMUT\_SSO Authentication Service

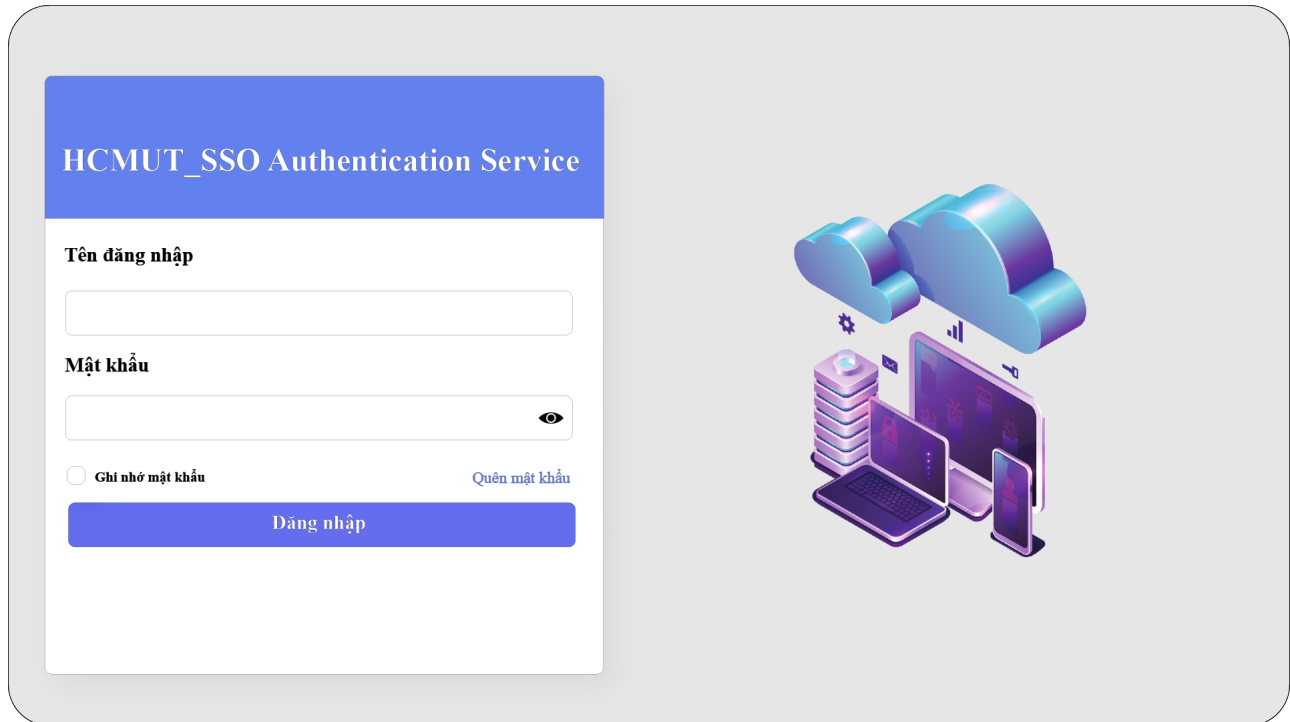


Figure 12: UI for the user authentication service

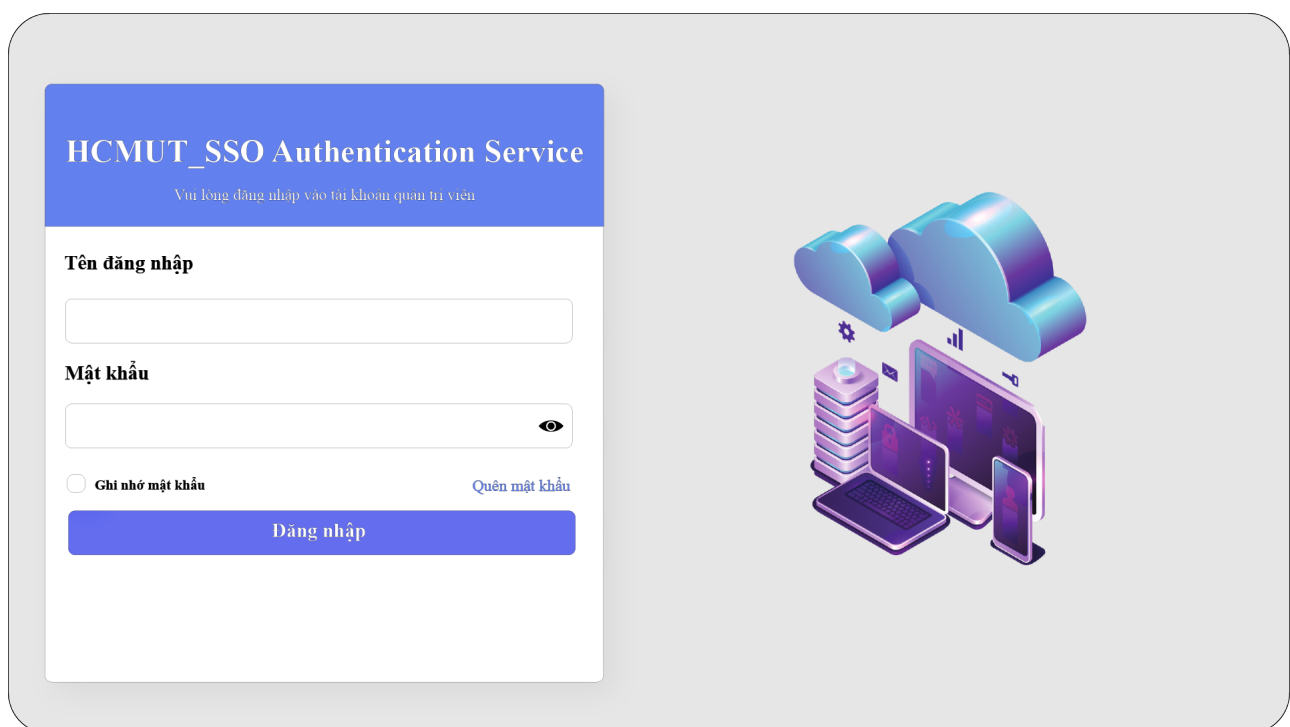


Figure 13: UI for the admin authentication service



- **Pagination:** navigate through multiple pages of printing tasks
- **Export Button:** export the data displayed in the table for further analysis or record-keeping

### 3.4.5 The User's Filter in the Printing Log

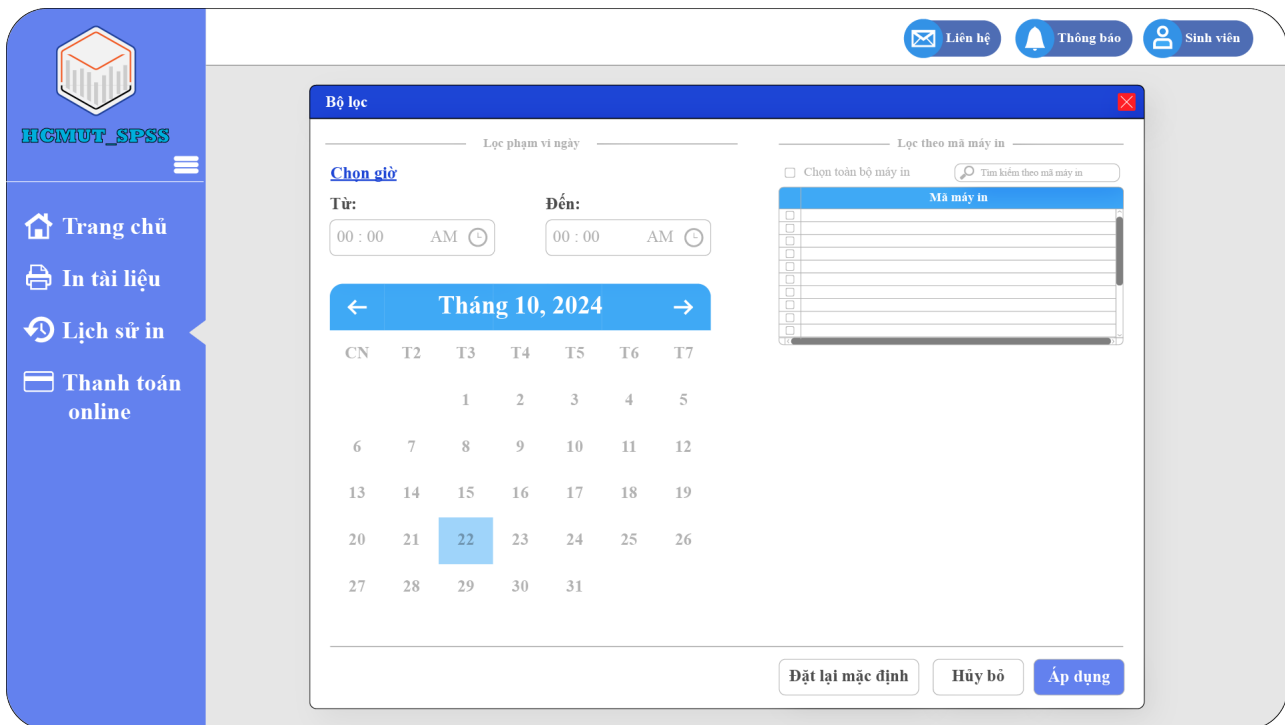


Figure 15: UI for the user filters attributes in the view printing log

- **Date Selection:** Users can select a start time and an end time for filtering the printing tasks. The date fields are labeled "Start" and "End," with a calendar icon for easy date selection.
- **Calendar Display:** A monthly calendar view (October 2024) is displayed, allowing users to visually choose dates for filtering.
- **Filter by Printer Code:** There is an option represent "view specific printer(s) log" with a search box where users can enter or search for specific printer codes.
- **Reset and Apply Buttons:** At the bottom of the filter interface, users can find buttons to:
  - Reset to Default: Clears the filters and resets to the original view.
  - Cancel: Exits the filter window without applying changes.
  - Apply: Applies the selected filters to the displayed data.

### 3.4.6 Admin Viewing Printing Log

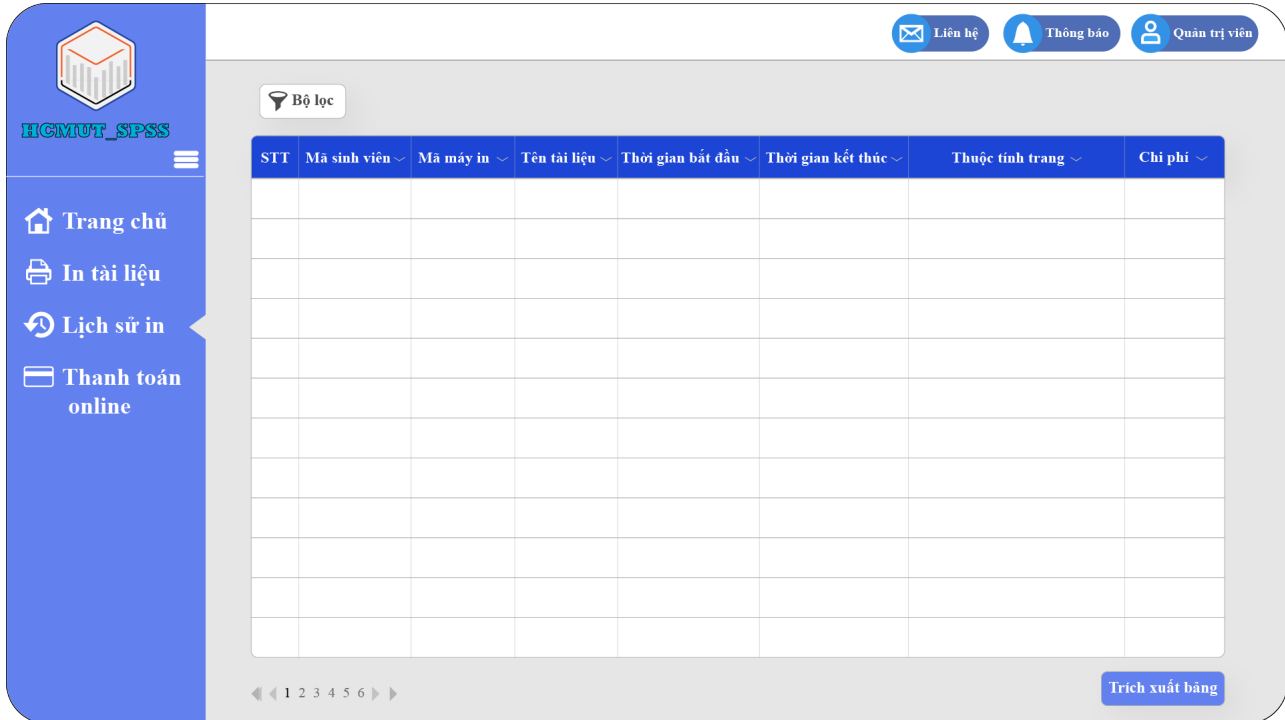


Figure 16: UI for the admin view printing log

- **Filter Option:** A Filter button is available at the top right of the sidebar and open the filter page.
- **Main Content Area:** Display a table with headers for various attributes:
  - Serial Number
  - Student ID
  - Printer Code
  - Document Name
  - Start Time
  - End Time
  - Status Attribute
  - Cost
- **Export Button:** allow users to export the data displayed in the table

### 3.4.7 The Admin's Filter in the Printing Log

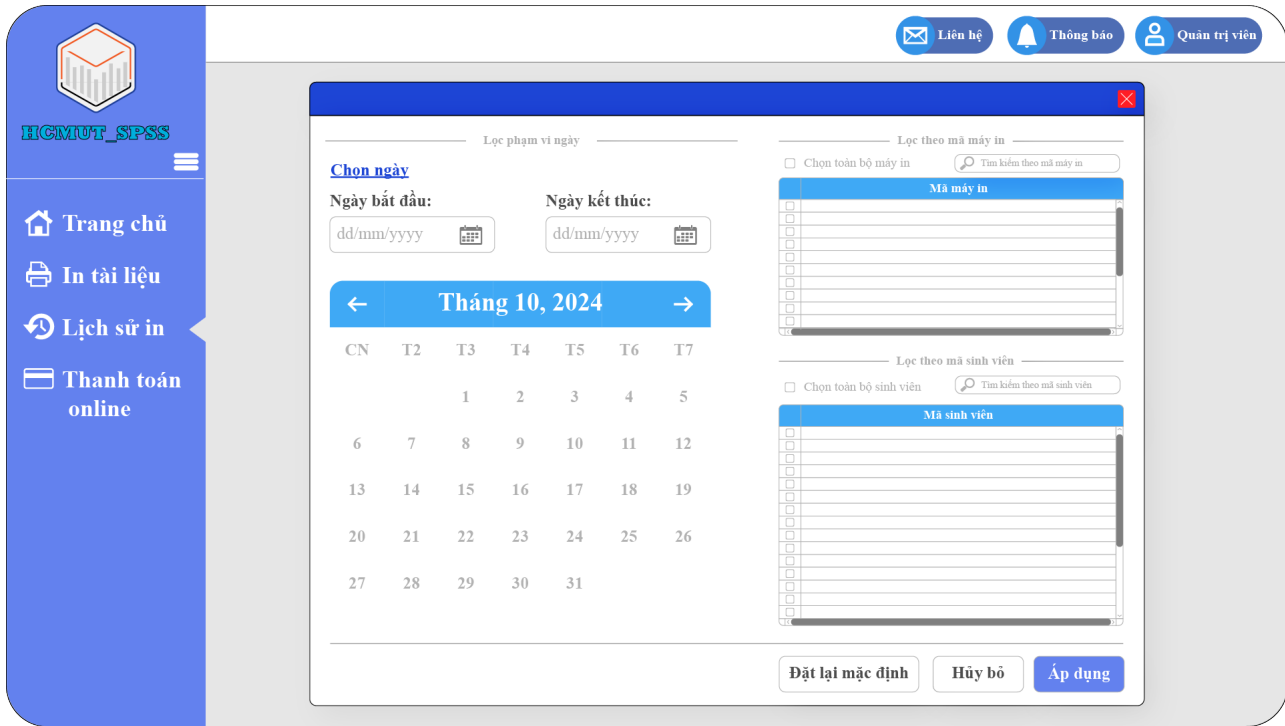


Figure 17: UI for the admin filters attributes in the view printing log

- **Date Selection:** Users can select a start date and an end date for filtering the printing tasks. The date fields are labeled "Start Date" and "End Date," with a calendar icon for easy date selection.
- **Calendar Display:** A monthly calendar view (October 2024) is displayed, allowing users to visually choose dates for filtering.
- **Filter by Printer Code:** There is an option represent "view specific printer(s) log" with a search box where users can enter or search for specific printer codes.
- **Filter by Student ID:** Another filter option is available for student identification, represent "view log of a specific student", which also includes a search feature for finding specific student IDs.
- **Reset and Apply Buttons:** At the bottom of the filter interface, users can find buttons to:
  - Reset to Default: Clears the filters and resets to the original view.
  - Cancel: Exits the filter window without applying changes.
  - Apply: Applies the selected filters to the displayed data.

## 4 Architecture Design

### 4.1 Layered Architecture

#### 4.1.1 Deployment Diagram

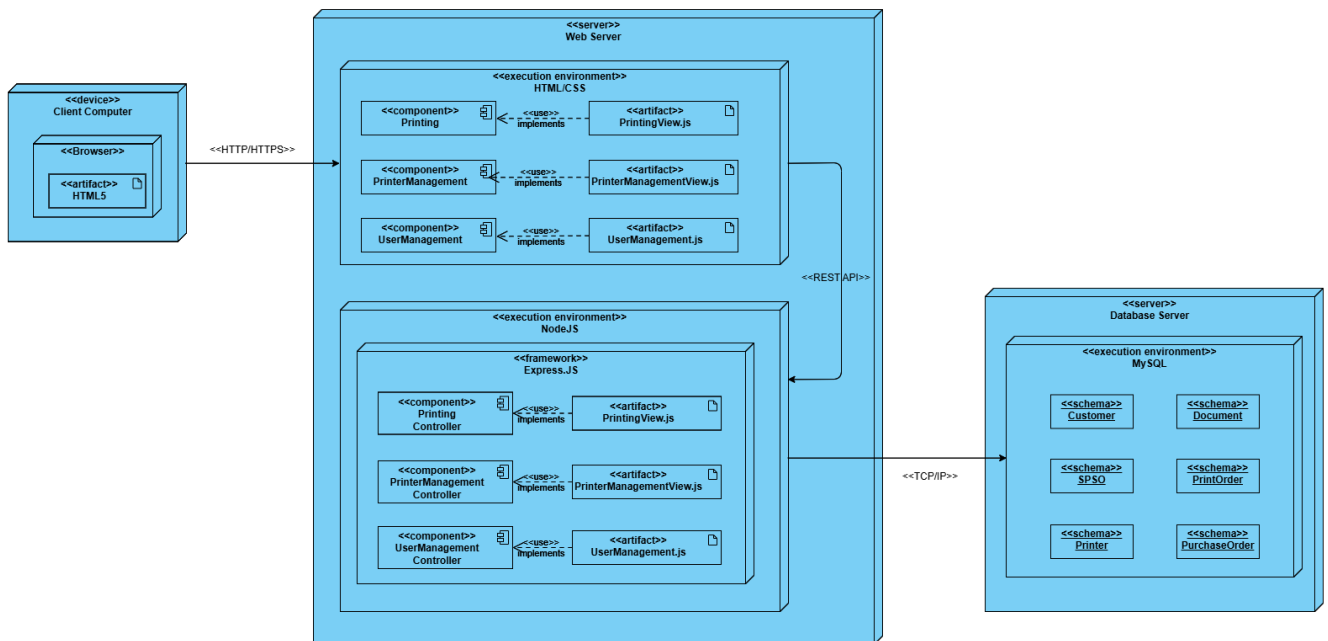


Figure 18: Deployment Diagram

- The **Client** server will connect to the **Server** via the HTTPS protocol. The data received from the Server includes files that render the user interface, which will be displayed on the user's web browser (Client) through an embedded HTML5 reader.
- The **Server** hosts the execution environment for the system's core functional modules. The back-end execution environment is based on **Node.js**, using the **Express.js** framework, which comprises three main components. The front-end execution environment is based on **ReactJS**, also consisting of three main components. Each component will be implemented using corresponding JavaScript source files. The front-end and back-end communicate via **REST APIs** to update, display the interface, and handle user interactions and responses.
- The **Server** connects to the **Database Server** via the **TCP/IP** protocol to retrieve data for display or to update data whenever the user interacts with the application. After the data is updated, it is transmitted back through TCP/IP to the Server and then to the Client to refresh the interface.

- The **Database Server** uses the relational database system **MySQL**, which stores information in structured tables with defined relationships.

Link Google Drive: [https://drive.google.com/file/d/1C7SJ\\_AIPC6stXJ4Lvh3VMpSige1FwSad/view?usp=sharing](https://drive.google.com/file/d/1C7SJ_AIPC6stXJ4Lvh3VMpSige1FwSad/view?usp=sharing)

#### 4.1.2 Presentation Strategy

This layer forms the foundation of our system architecture. Our approach prioritizes simplicity, ease of use, and an optimal user experience. To achieve these goals, we will implement a range of modern technologies and methodologies:

- **Front-End Library and Framework:** We use front-end technology like React, which allows us to build responsive and efficient interfaces that enhance user interactivity.
- **Responsive Design:** Our system is designed to support various devices used by students and faculty, ensuring compatibility with different screen sizes and device types. Flexible forms and adaptable UI components will deliver a seamless experience on desktops, mobile devices, and tablets.
- **User-Friendly Features:** We emphasize intuitive design elements such as easily accessible buttons, forms, and menus to ensure even first-time users can navigate the system without difficulty.

By using React for our interface development, along with a responsive and user-centered design, we aim to create an engaging and functional interface for the HCMUT-SSPS system that integrates effectively with the system's layered architecture.

#### 4.1.3 Data Storage Approach

In our layered architecture, the database forms the bottom layer and is responsible for storing and managing all application data. This layer will handle key operations such as searching, inserting, updating, and deleting records through a database management system. For the Smart Printing Service project, we have chosen a layered architecture with a relational database layer powered by MySQL, where data is organized in tables and interconnected relationships.

For the Smart Printing Service system, several essential entities are required:

- **Customer:** Stores information about users, including Customer ID (student/staff ID), Full Name, Username (Unique), Password, Type (Student or Staff), Email, Balance (the number of pages available, measured in A4 pages), and Last Usage Date.



- **SPSO (Smart Printing System Operator):** Includes attributes such as SPSO ID, Full Name, Username (Unique), Password, Birthdate, Email, Phone Number, and Last Usage Date.
- **Printer:** Contains details such as Printer ID, Printer Name, Brand, Model, Description, Location (Campus, Building, Room), and Status.
- **Document:** Records information like Document ID, Document Name, File Format, and Number of Pages.
- **Print Order:** Includes attributes such as Order ID, Print Configuration (Orientation, Paper Size, Side Type, Pages per Side, Scale), Start Time, End Time, Status, and Pages Used.
- **Purchase Order:** Contains attributes such as Transaction ID, Transaction Time, Pages Purchased, Purchase Price, and Status.
- **Feedback:** Consists of attributes such as Feedback ID, Title, Content, and Rating.

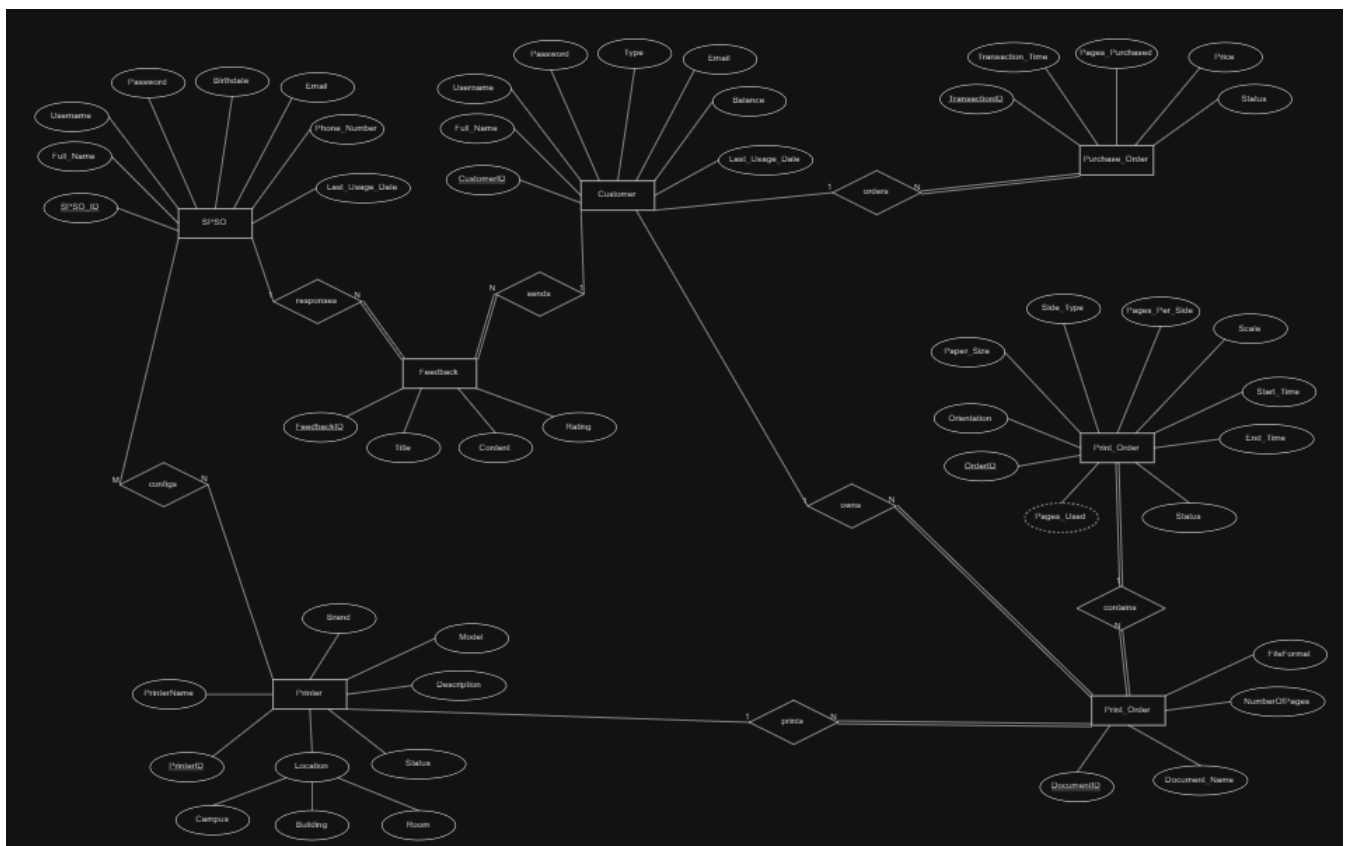


Figure 19: HCMUT-SSPS ERD Diagram

Link Google Drive: <https://drive.google.com/file/d/1Vjrr2oP09ByxqbSaC4xGKXd8urZ4ySwW/view?usp=sharing>

#### 4.1.4 API Management

The API (Application Programming Interface) is a set of methods and protocols that allow applications and libraries to connect and interact with each other. APIs facilitate access to commonly used functions, enabling data exchange between applications. The APIs designed for the HCMUT Smart Printing Service System (HCMUT-SSPS) include:

- **Security and Authentication API:** Ensures secure communication and printing operations by providing authentication methods through HCMUT-SSO and controlling access rights for SPSO.
- **Input Data Formatting and Processing API:** Allows the application to send input data (such as print files, images, or text) to the automated printing system and ensures that this data meets specific formatting and quality requirements.
- **Print Job Management API:** Provides methods to create, manage, and track printing jobs. This may include scheduling print jobs, monitoring job statuses, checking available print pages, and canceling print jobs.
- **Custom Print Template API:** Allows for the creation and management of custom print templates, enabling dynamic print template generation based on specific user needs.
- **Printer Control API:** Enables the application to interact with and control printers directly.
- **Reporting and Analytics API:** Provides data on completed print jobs, print time, page counts, and other relevant information for tracking and reporting on printing activities.
- **Payment API:** Enables payment transactions for document printing and page purchases through BKPay.

## 4.2 Component diagram

We draw Component diagram for this module.

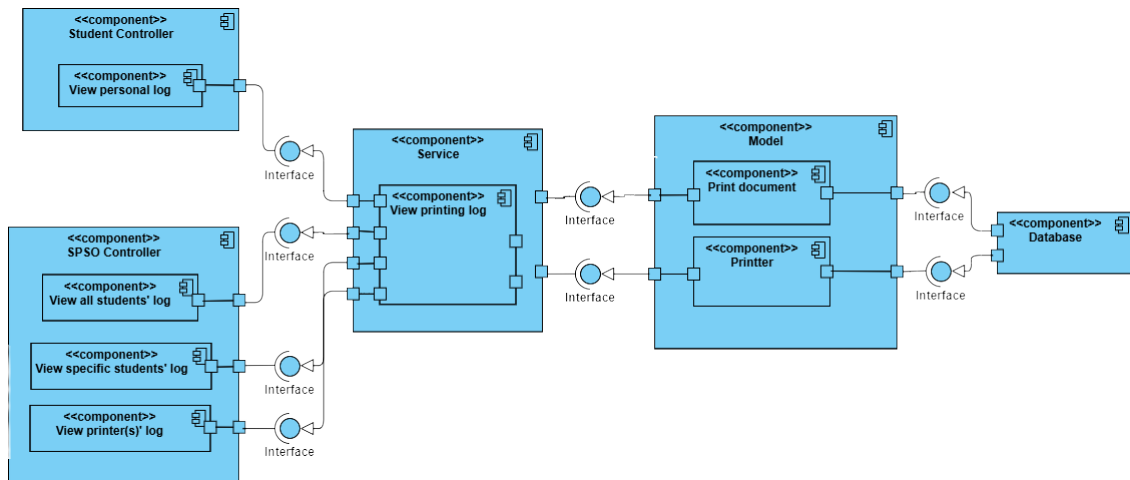


Figure 20: HCMUT-SSPS Component Diagram

The diagram illustrates a system architecture with several key components and their interactions:

- **Student Controller:** Manages student-related operations, including viewing personal logs.
- **SPSO Controller:** Handles specific tasks related to the SPB module.
- **Service Layer:** Acts as an intermediary, processing requests and coordinating between controllers and models.
- **Model:** Represents the data structure and business logic.
- **Printer:** Manages printing tasks and logs.
- **Database:** Stores all the data for the system.

Arrows indicate the flow of data and control between these components, with interfaces labeled to show specific interaction points.

## 5 Implementation - Sprint 1

### 5.1 Setting up Repository with GitHub

Repository link on GitHub: [https://github.com/minhduongts13/BTL\\_CNPM](https://github.com/minhduongts13/BTL_CNPM)

### 5.2 Adding Documents

All commits in the uploading and setting up repository phase:

```
PS D:\BTL\BTL_CNPM\BTL_CNPM> git add *
PS D:\BTL\BTL_CNPM\BTL_CNPM> git commit -m "Set up, upload diagrams and mockups"
[main 221f58a] Set up, upload diagrams and mockups
28 files changed, 0 insertions(+), 0 deletions(-)
create mode 100644 diagram/Component.png
create mode 100644 diagram/Dashboard.png
create mode 100644 diagram/Deployment Diagram.png
create mode 100644 diagram/Login.png
create mode 100644 diagram/SPSO_filter.png
create mode 100644 diagram/SPSO_log.png
create mode 100644 diagram/SSO Authentication service.png
create mode 100644 diagram/Seq diagram_view all logs.png
create mode 100644 diagram/Seq diagram_view log of a student.png
create mode 100644 diagram/Seq diagram_3.png
create mode 100644 diagram/Student_filter.png
create mode 100644 diagram/Student_log.png
create mode 100644 diagram/Use case of Whole system.png
create mode 100644 diagram/View log of a specific student.png
create mode 100644 diagram/View logs of all students.png
create mode 100644 diagram/View personal log.png
create mode 100644 diagram/View specific printer(s)' log.png
create mode 100644 diagram/classDiagram.png
create mode 100644 diagram/moduleDiagram.png
create mode 100644 diagram/sequenceDiagram.s1.png
create mode 100644 mock up/Admin_authentication.png
create mode 100644 mock up/Dashboard.png
create mode 100644 mock up/Login.png
create mode 100644 mock up/SPSO_filter.png
create mode 100644 mock up/SPSO_log.png
create mode 100644 mock up/SSO Authentication service.png
create mode 100644 mock up/Student_filter.png
create mode 100644 mock up/Student_log.png
PS D:\BTL\BTL_CNPM\BTL_CNPM> git push -u origin main
Enumerating objects: 26, done.
Counting objects: 100% (26/26), done.
Delta compression using up to 16 threads
Compressing objects: 100% (25/25), done.
Writing objects: 100% (25/25), 2.13 MiB | 1.37 MiB/s, done.
Total 25 (delta 0), reused 0 (delta 0), pack-reused 0
To https://github.com/minhduongts13/BTL_CNPM
 4f431e4..221f58a main -> main
```

Figure 21: All commits in the uploading documents phase

### 5.3 Conducting Usability Test

#### 5.3.1 Definition

Usability testing is a popular UX research methodology. In a usability-testing session, a researcher (called a “facilitator” or a “moderator”) asks a participant to perform tasks, usually using one or more specific user interfaces. While the participant completes each task, the researcher observes the participant’s behavior and listens for feedback.

## Usability Testing: Flow of Information



Figure 22: Usability testing

### 5.3.2 Usability testing goal

To retrieve better result, we must take a look at the goal of usability test in software development. Briefly, usability testing primary goal includes:

- Check whether the product meets the user's demand.
- Study of user behavior, collecting user insights to continue developing products.
- Check the understandable of program, whether the program is easy to use without training or not.

### 5.3.3 Recruit participants

To prepare for the test we will choose 5 participants who are currently studying different majors at HCMUT. Participants taking test must be a real user of a relevant printing service or having a demand of printing documents.

## Reason of choosing participants

- We consider choosing students whose background are not familiar with IT technique, to receive a better performance. Students who study in information technology usually tend to accept easily the system fault then it would cause bad affection to our overall testing result.
- The number of participants should be a small group (Recommended up to 5). Taking survey on a large number of participants will result to overlap the feedback. This would lead to waste of time and money.

### 5.3.4 Define tasks

In this test, assume that we need to test for x main modules - Sign in, print document and search printing log history respectively. The task used for the test must be realistic - perform mostly used action that real user might do. Task must also be understandable, it could be specific or very ended. To follow up above principle, we have define class table as below:

No	Description
0	Log in SPSS with wrong password.
1	Log in SPSS with correct password.
2	Try to upload a document, configure and send for printing in printing section.
3	Navigate to printing log section to view self printing log.
4	Search for printing log based on a false information printer ID
5	Search for printing log based on given printer ID

Table 7: Task table for usability testing

### 5.3.5 Test strategy

Before diving into choosing specific method, usability testing fall within different types of research. Testing strategy are divided into 3 types:

- **Qualitative** vs **Quantitative** test.
- **Remote** vs **In-person** test.
- **Moderated** vs **Unmoderated** test.

Qualitative	Quantitative
Offers descriptive insights into user experiences, motivations, and emotions.	Provide measurement, numerical key metrics about users such as task completion times, error rates, and user satisfaction ratings.
Data is collected by observing user' interactions and reactions	Data is indirectly recorded while participants complete the tasks.

Table 8: Qualitative vs Quantitative method

Our team have define a benchmark for the overall result, which can be easily observe through data so we expect the test be focus on the percentage of success tasks, the overall satisfaction points of participants then our team decided to conduct the **quantitative** test beside of qualitative test.

Remote	In-person
The test will be held when the participants not stay at the same location with the office or moderator	Test will be held directly with participants - in a controlled environment.
Suitable for both moderated and unmoderated testing, more accessible and have a lower cost than in-person test	Can directly observe participants' behavior, including nonverbal cues and reactions.

Table 9: Remote vs In-person method

In this test, because our participants are all students (Who don't have much time), and we want to lower the cost → We will choose remote method.

Moderated	Unmoderated
Test will be taken under observation of moderator.	Participants can take test with out being supervisor by anyone.
Allow moderator to check if participants misunderstand the task, this help the collected data is more reliable.	Allow user to be more natural to do tasks, this help to simulate much more likely to reality environment.
More suitable for qualitative test when the test is expected to gather information about user experiences, motivations and emotions.	Suitable for quantitative test when the test is focus on measurements, numerical key, and help to lower the cost when it does need to involve large-sample studies.

Table 10: Moderated vs Unmoderated method

Because our usability test will use remote method then we will choose the unmoderated method in order to simulate a testing environment identical to realistic environment.

### 5.3.6 Conduct test

Participants will be given a google form to fill in, in this form, we will divide into three main parts (Sign in tasks, Printing tasks and View printing log tasks), participants will be asked to do the listed tasks in the form.

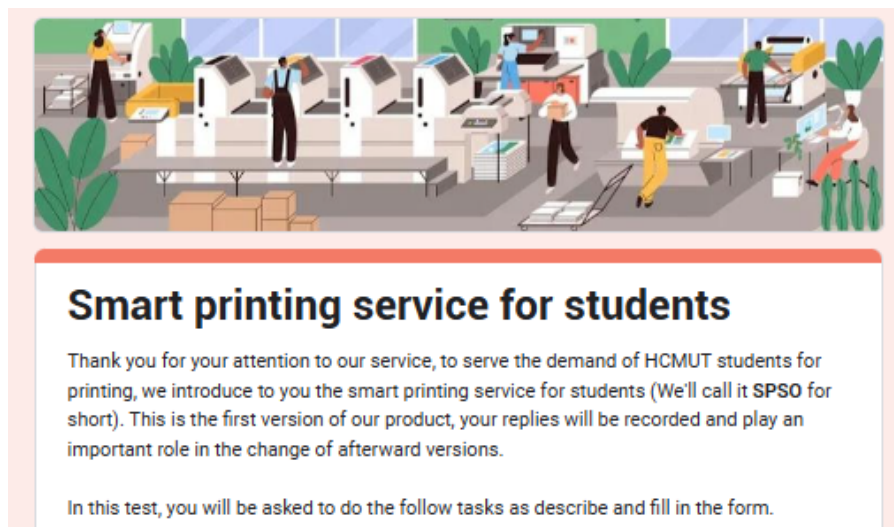


Figure 23: Usability testing introduce form

Group task 1: Sign in tasks  
Student's account for testing:  
Email: abc@hcmut.edu.vn  
Password: abc123

Task 1: Please log in the service system with the wrong account information and record your time to find, fill in information and receive error message (Time must be a number and is required to be in second format). \*

Câu trả lời của bạn

Task 2: Do you find task 1 is easy to do \*

☐ Yes

☐ No

Task 3: Please log in to the service system with the correct account information \* and record your time to find, fill in information and log in successfully (Time must be a number and is required to be in second format).

Câu trả lời của bạn

Figure 24: Login tasks





Group task 2: Printing tasks

Task 1: Please move to printing section for uploading the documents and record the time till it open printing page. (Time must be a number and be in second format). \*

Câu trả lời của bạn

Task 2 (Relevated to task 1): Navigate to printing section. Do you find it easy? \*

Yes

No

Figure 25: Printing tasks

Group task 3: View printing log tasks

Printer ID: pr1

Task 1: Open printing log after login successfully. Please record the time you do the task. \*

Câu trả lời của bạn

Task 2: Enter a printer ID to find the printing log. Please record the time you do the task. \*

Câu trả lời của bạn

Task 3: Enter an incorrect printer ID. Now the message will be send to you. Please close the message and find for another printer ID. Record your task time \*

Câu trả lời của bạn

Figure 26: View printing log tasks

5.3.7 Research results

Form_Responses1					
Dấu thời gian	Task 1: Please log in the service system with	Task 2: Do you find task 1 is easy to do	Task 3: Please log in to the service system w	Task 1: Please move to printing section for ur	Task 2 (Relevated to task 1): Navigate to print
15/11/2024 10:12:09	30	Yes	13	16	Yes
15/11/2024 10:18:47	42	Yes	35	12	Yes
15/11/2024 10:46:47	38	Yes	26	11	Yes
15/11/2024 11:13:03	22	Yes	16	18	Yes
15/11/2024 12:04:33	31	Yes	15	17	Yes

Figure 27: Response table

Task 1: Open printing log after login successf	Task 2: Enter a printer ID to find the printing l	Task 3: Enter an incorrect printer ID. Now the
8	7	84
5	7	58
12	12	89
8	9	64
10	7	64

Figure 28: Response table

Satisfaction point	Time (Seconds)	Task	Average time (Seconds)
Task 1.2	5	Task 1.1	32.6
Task 2.2	5	Task 1.3	21
Overall average	5	Task 2.1	14.8
		Task 3.1	8.6
		Task 3.2	8.4
		Task 3.3	71.8
		Overall average	26.2

Figure 29: Overall points

Benchmark	Expected (Seconds)	Completion rate (%)
Overall satisfaction points	5	100
Overall average time	30	114,5038168

Figure 30: Benchmark

We can observe easily that most of the tasks, task time is neatly the same between 5 users. This mean, without training, all participants need to take the same time to use the system. In comparison with the proposed satisfaction points, the research results show that participants all feel it easy to use the system. This fact can be see through at the completion rate of overall satisfaction points reach 100% overall average points reach 5 points out of 5.

Another benchmark that we want to research is the time each task perform. We have set this to 30 seconds for each task, then the average time participants need to do task only 26.2 seconds which is 114% faster than we expected. The first result has shown that our system has worked really well.