VIETNAM NATIONAL UNIVERSITY, HO CHI MINH CITY
UNIVERSITY OF TECHNOLOGY
FACULTY OF COMPUTER SCIENCE AND ENGINEERING

SOFTWARE ENGINEERING (CO3001)

Assignment

A smart printing service for students at HCMUT

Task 1: Requirement Elicitation

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1 Requirement Elicitation

1.1 Domain Context

The Student Smart Printing Service (HCMUT_SSPS) project operates within the context of a university campus environment, influenced by various stakeholders and elements. This domain context comprises the following components:

1. **University Environment**
    - **Academic Departments:** The university includes multiple academic departments, each with unique printing requirements related to coursework, research, and administrative tasks.
    - **Students:** Students from diverse academic backgrounds have varying printing needs, such as assignments, research papers, and administrative documents.
    - **Student Printing Service Officer (SPSO):** The SPSO is responsible for managing and configuring the printing system. They set policies, manage printers, and resolve service-related issues.
    - **University Administration:** The university administration provides oversight and resources for the project to enhance campus services and ensure efficient operations.
    - **Facilities Management:** Personnel responsible for the physical installation and maintenance of printers in various campus locations to ensure hardware functionality.
    - **Finance Department:** The finance department plays a role in budgeting for the project, particularly regarding the online payment system and financial transactions.
2. **Technological Environment**
    - **Information Technology (IT) Department:** The university's IT department oversees the technical implementation and maintenance of the printing system, ensuring security, reliability, and availability.
    - **Online Payment System Provider:** Integration with an online payment system (e.g., BKPay) is a critical aspect of the project, enabling students to purchase additional printing pages seamlessly.
    - **HCMUT_SSO Authentication Service:** User authentication is managed by the HCMUT_SSO authentication service, ensuring secure access to the printing system.
    - **Web and Mobile App Development:** Developers are responsible for creating user-friendly web and mobile interfaces to facilitate access to the printing service.
3. **Legal and Compliance**
    - **Legal Department:** The university's legal department reviews contracts, agreements, and terms of service related to the printing system, online payment integration, and compliance with data protection and privacy regulations.
    - **Compliance and Data Privacy Authorities:** Depending on the university's location and applicable regulations, compliance and data privacy authorities may need to be consulted to ensure that the system complies with legal requirements regarding student data and privacy.
4. **External Services and Standards**
    - **Printer Manufacturers or Suppliers:** If the university contracts with specific printer manufacturers or suppliers, they are stakeholders with an interest in the project's success.

This domain context provides a comprehensive overview of the factors and stakeholders influencing the Student Smart Printing Service (HCMUT_SSPS) project. Understanding this context is essential for effectively designing, developing, and deploying the system to meet the diverse needs of the university community while ensuring compliance and security.

1.2 Stakeholders

1. **Students:**
   - **Needs:**
     - Convenient and efficient printing services for coursework, assignments, and research.
     - Clear information on available printing credits and costs.
     - Easy access to printing history for tracking usage.
   - **Benefits from HCMUT_SSPS:**
     - Convenient access to on-campus student budget-friendly printing services.
     - Transparency in printing credit usage and costs, allowing better budget management.
     - Easy access to printing history for tracking usage, aiding in academic planning.
     - Reduced waiting times and improved efficiency in the printing process.
2. **Student Printing Service Officer (SPSO)**
   - **Needs:**
     - Tools to configure and manage the printing system efficiently.
     - Access to usage data and reports for monitoring and policy adjustments.
   - **Benefits from HCMUT_SSPS:**
     - Streamlined management of printers and system configurations, reducing administrative workload.
     - Access to detailed usage logs and reports for informed decision-making and policy adjustments.
     - Improved user satisfaction with the printing service due to efficient management.
3. **University Administration**
   - **Needs:**
     - Improved campus services for students.
     - Efficient resource allocation and cost control.
   - **Benefits from HCMUT_SSPS:**
     - Enhanced campus services contribute to a positive student experience and improved university reputation.
     - Data-driven insights from reports support optimized resource allocation and cost control.
     - Efficient management of the printing system aligns with the university's commitment to excellence.
4. **Facilities Management:**
   - **Needs:**
     - Well-maintained printing hardware for reliable service.
   - **Benefits from HCMUT_SSPS:**
     - Efficient maintenance and monitoring of printing hardware, reducing downtime and maintenance costs.
     - Reliable printing service contributes to a smoother campus operation and student satisfaction.

5. **Finance Department:**
   - **Needs:**
     - Budget oversight and financial control for the printing service.
   - **Benefits from HCMUT_SSPS:**
     - Accurate tracking of printing-related finances ensures transparent financial management.
     - Integration with an online payment system streamlines financial transactions and minimizes errors.
     - Better control over printing-related expenses and revenue.
6. **IT Department:**
   - **Needs:**
     - Secure and reliable technical implementation of the printing system.
     - Scalability to accommodate growing user and resource demands.
   - **Benefits from HCMUT_SSPS:**
     - Secure and reliable technical implementation of the printing system enhances the university's IT infrastructure.
     - Scalability accommodates growing user and resource demands without major disruptions.
     - Reduced technical issues and increased system reliability.
7. **Online Payment System Provider:**
   - **Needs:**
     - Integration with the university's printing system for financial transactions.
   - **Benefits from HCMUT_SSPS:**
     - Integration with the printing system expands the payment system's user base, increasing revenue.
     - Contribution to seamless financial transactions for printing services enhances user experience.
8. **HCMUT_SSO Authentication Service:**
   - **Needs:**
     - Secure and seamless integration with the printing system.
   - **Benefits from HCMUT_SSPS:**
     - Enhanced security and authentication for system access, reducing the risk of unauthorized access.
     - Seamless user experience with single sign-on simplifies access for all users.
9. **Web and Mobile App Developers:**
   - **Needs:**
     - Clear requirements and guidelines for system interfaces.
   - **Benefits from HCMUT_SSPS:**
     - Well-defined requirements and design ensure the development of user-friendly interfaces.

  - Contribution to a positive user experience, increasing user satisfaction and usability.

10. **Legal Department and Compliance Authorities:**
    - **Needs:**
      - Compliance with legal and data privacy regulations.
    - **Benefits from HCMUT_SSPS:**
      - Ensuring that the system complies with relevant laws and regulations protects the university from legal risks.
      - Protecting student data and privacy strengthens the university's ethical standing and reputation.
11. **Printer Manufacturers or Suppliers:**
    - **Needs:**
      - Successful implementation and utilization of their printing hardware.
    - **Benefits from HCMUT_SSPS:**
      - Increased utilization of their printing hardware on campus leads to higher sales and potential long-term partnerships with the university.
      - Expansion of their presence in the university's printing ecosystem.

By addressing the needs of these stakeholders, the Student Smart Printing Service (HCMUT_SSPS) can provide a range of benefits, including improved user experience, efficient management, financial control, and compliance with legal. These benefits contribute to a more effective and user-friendly printing service within the university environment.

1.3 Functional Requirements

1. **User Authentication:**
   - Users must be authenticated through the HCMUT_SSO authentication service before accessing the system.
2. **Print Job Submission:**
   - Students should be able to upload documents for printing.
   - Students can select a printer from the available options.
   - Students can specify printing properties such as paper size, single/double-sided, number of copies, and page range.
   - Supported file types for printing must be limited and configurable by the SPSO.
3. **Printing Credits and Payments:**
   - The system should maintain a record of students' available printing credits.
   - Students can purchase additional printing pages through the online payment system (e.g., BKPay).
   - The system should deduct the appropriate amount from a student's account when they print.
4. **Logging and Reporting:**
   - The system must log printing actions, including student ID, printer ID, file name, start and end times, and the number of pages for each page size.
   - Generate automatic monthly and yearly usage reports for the SPSO.
   - Provide a summary of the number of printed pages for each page size.
5. **Printer Management:**
   - The SPSO should be able to add, enable, and disable printers in the system.
   - Ensure that printers' details (ID, brand, model, description, location) are configurable.
6. **System Configuration Management:**
   - The SPSO can configure system parameters such as the default number of pages allocated to students, allocation dates, and permitted file types.
   - These configurations should be easily adjustable.
7. **Viewing and Managing Printing History:**
   - The SPSO can view the printing history (logs) of all students or a specific student for a specified time period.
   - The SPSO can view the printing history (logs) of all printers or a some printers.
   - Students can view their own printing history.
8. **Reports Generation:**
   - Automatic generation of end-of-month and end-of-year reports for usage statistics.
   - Reports should be stored within the system and accessible to the SPSO.

9. **Support for A3 Printing:**
    - Ensure that one A3 page is equivalent to two A4 pages when deducting from students' account balances.
10. **User Support:**
    - Provide user support and a helpdesk for addressing user inquiries and issues related to the system.

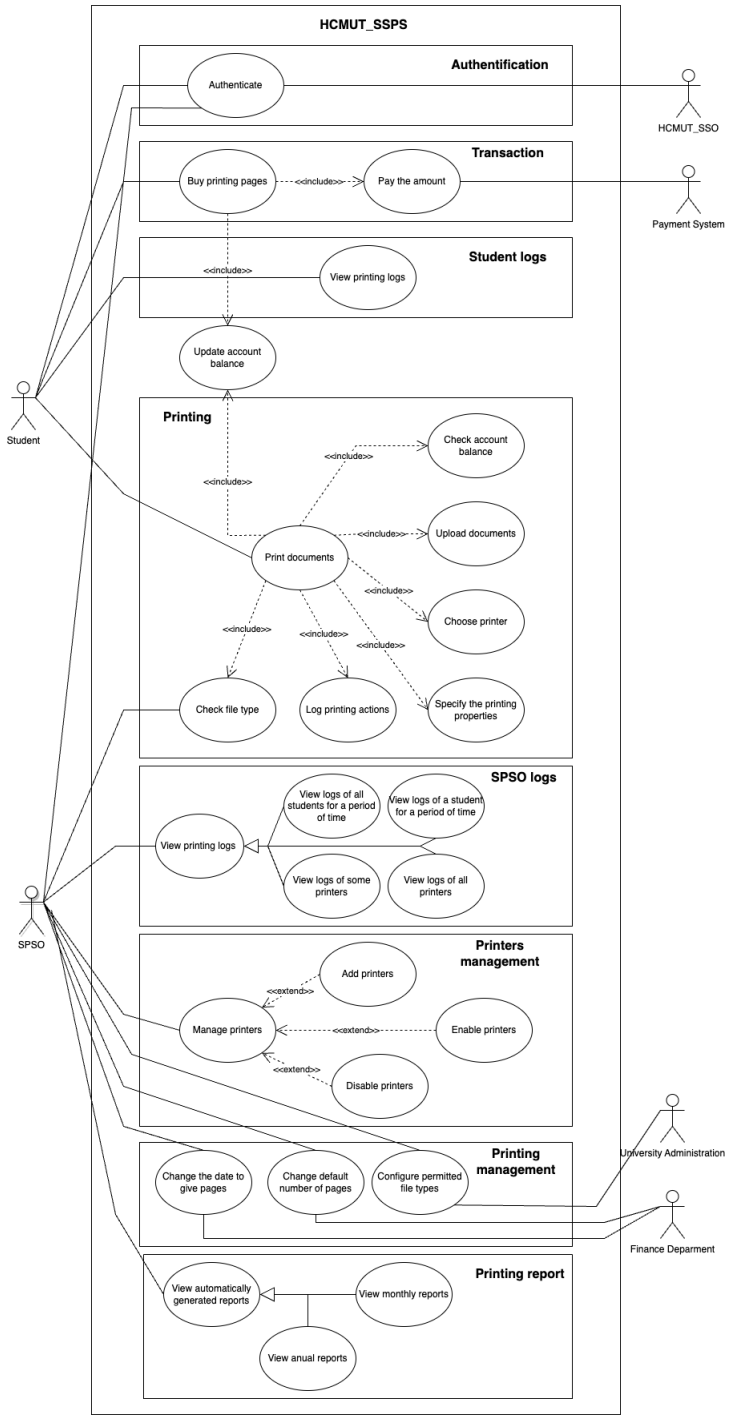
1.4 Non-Functional Requirements

1. **Performance:**
    - The system should provide efficient and responsive performance even during peak usage times.
2. **Security:**
    - Ensure robust data security to protect sensitive student information and printing logs.
    - Implement secure authentication and authorization mechanisms.
    - Regularly conduct security audits and updates.
3. **Reliability and Availability:**
    - Maintain high system availability to ensure students can print when needed.
    - Implement backup and disaster recovery mechanisms to prevent data loss.
4. **Scalability:**
    - The system should be designed to accommodate a growing number of users, printers, and printing requests.
5. **Usability and Accessibility:**
    - The user interface (both web-based and mobile) should be intuitive and accessible to users with disabilities.
    - Ensure compatibility with common web browsers and mobile devices.
6. **Compliance and Data Privacy:**
    - Comply with relevant data privacy regulations (e.g., GDPR, HIPAA) and university policies regarding student data.
    - Maintain data retention and deletion policies.
7. **Integration:**
    - Seamlessly integrate with the HCMUT_SSO authentication service and the online payment system (e.g., BKPay).
    - Support future integration with other university systems if necessary.
8. **Error Handling and Logging:**
    - Implement robust error handling mechanisms and log errors for troubleshooting.
    - Log system events for monitoring and auditing purposes.

9. **Compliance with Standards:**
   - Follow industry best practices and coding standards for software development.
   - Ensure compliance with web and mobile app development standards.

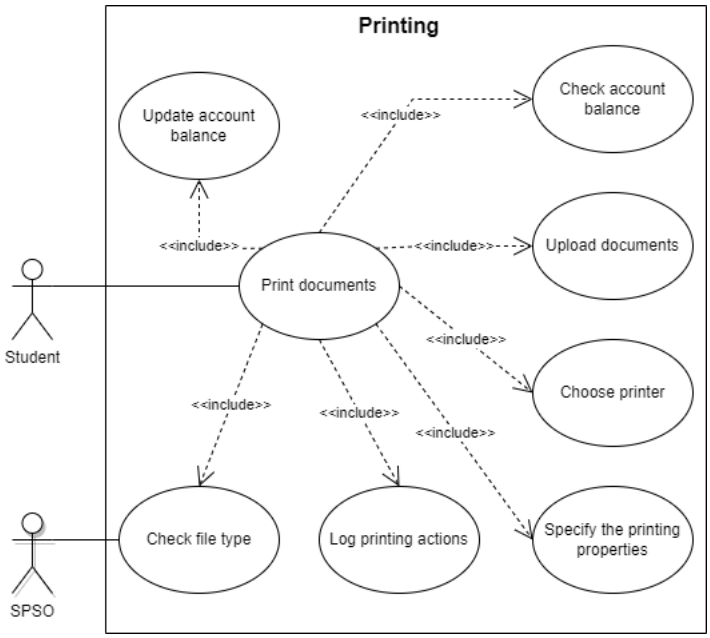
1.5 Use-case Diagram

1.5.1 System Use-case Diagram



1.5.2 Printing Module

1.5.2.a Use-case Diagram

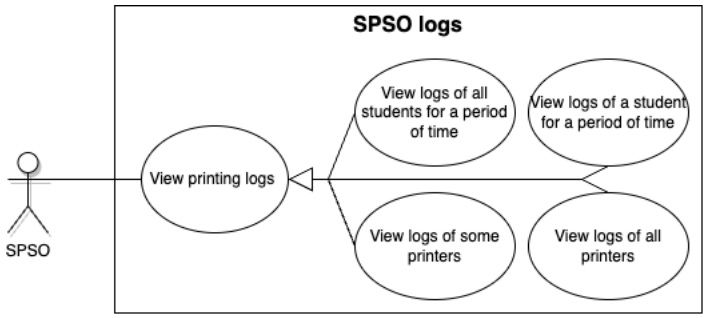


1.5.2.b Use-case Diagram Description

Use-case Name	Print documents
Actor(s)	Students, SPSO
Description	Students can print documents.
Pre-condition(s)	Students have authenticated successfully.
Post-condition(s)	1. Students can print documents successfully. 2. Printing actions are logged.
Trigger	Students click the "Printing" option button.
Normal flow	1. Students navigate to the functional menu. 2. Students choose the printing option. 3. Students upload the documents. 4. Based on the information from SPSO, verify that the document formats are compatible. 5. Students choose the printer to print. 6. Students specify the printing properties. 7. Students click the confirmation "Print" button. 8. The system checks the account balance is sufficient. 9. The system deducts a needed amount of balance from the account. 10. The system adds the printing actions to log activity. 11. Documents are printed.
Alternative flow	No alternative flow.
Exception flow	4a. The system verifies the document formats are not compatible and shows notice. 4a1. Students choose the cancel printing option (Use-case stops). 4a2. Students choose the retry printing option (Use-case continues at step 3). 4b. The system verifies the account balance is not sufficient and shows notice. 4b1. Students choose the cancel printing option (Use-case stops).

1.5.3 SPSO logs Module

1.5.3.a Use-case Diagram



1.5.3.b Use-case Diagram Description

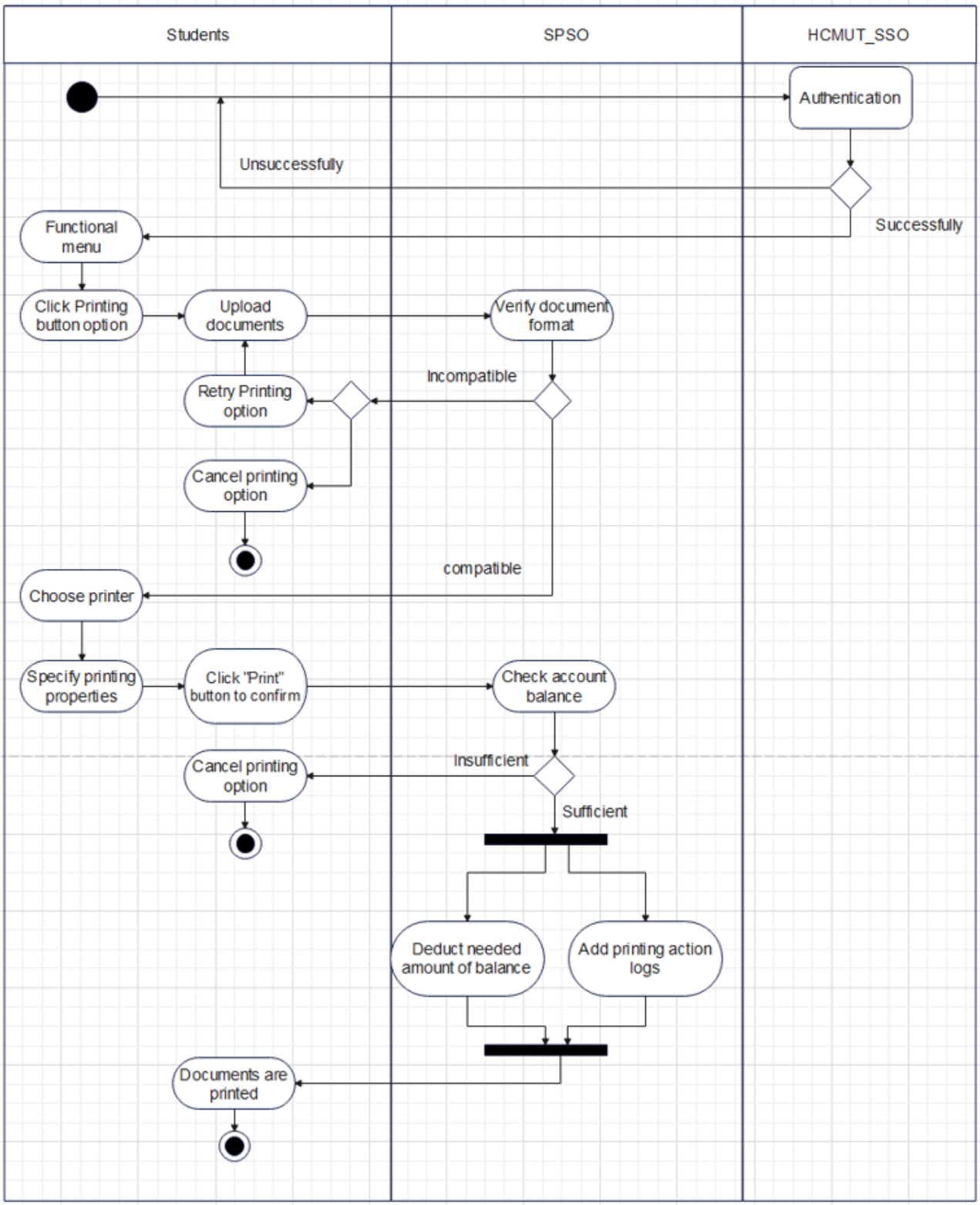
Use-case Name	View printing logs
Actor(s)	SPSO
Description	SPSO can view the action printing logs.
Pre-condition(s)	SPSO have authenticated successfully.
Post-condition(s)	The corresponding logs are shown.
Trigger	SPSO click the "View logs" option button.
Normal flow	1. SPSO navigates to the functional menu. 2. SPSO chooses the view logs option. 3. SPSO chooses which printing history to show. 4. SPSO chooses the time period. 5. Printing history is shown.
Alternative flow	3a. SPSO chooses to view from all students (Use-case continues at step 4). 3b. SPSO chooses to view from a student. 3b1. SPSO enters the student ID (Use-case continues at step 4). 3c. SPSO chooses to view from all printers (Use-case continues at step 4). 3d. SPSO chooses to view from some printers. 3d1. SPSO chooses some printers (Use-case continues at step 4).
Exception flow	No exception flow.

2 System Modelling

2.1 Activity Diagram

2.1.1 Printing module

2.1.1.a Activity diagram



2.1.1.b Activity diagram description

Title	Activity Diagram for Document Printing Process
Purpose	Illustrates the steps involved in the document printing process
Scope	Interaction between students and the printing system for document printing.
Actor(s)	Students, SPSO, and HCMUT_SSO
Key Activities	Activities covered in the diagram are user authentication, navigating to the printing menu, document upload, and printing.
Flow of control	The control flows from user authentication to selecting the printing option, document upload, specifying printing properties, checking account balance, and finally, document printing.
Trigger	The process is triggered when a student clicks the "Printing" option.

2.1.2 SPSO logs module

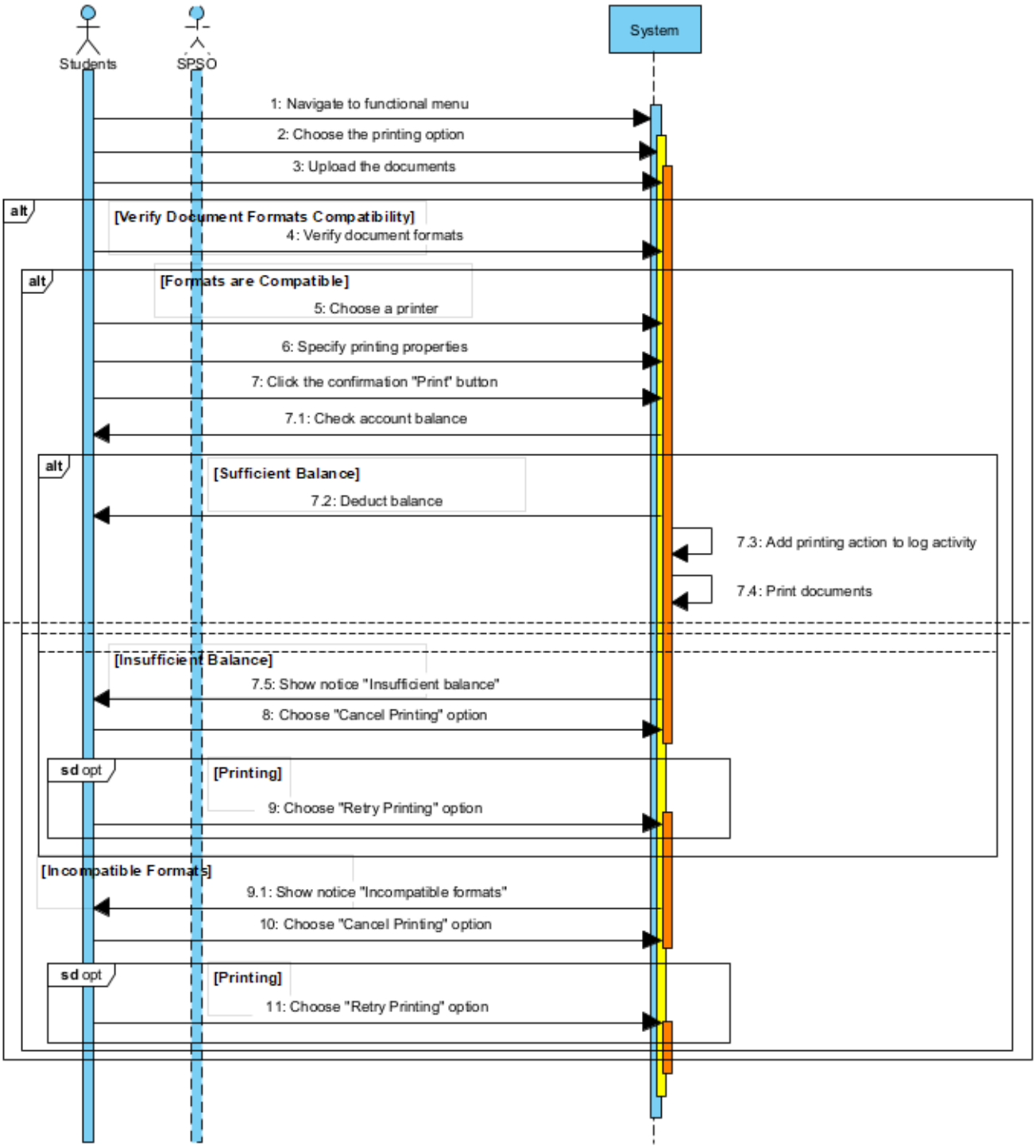
2.1.2.a Activity diagram

2.1.2.b Activity diagram description

Title	Activity Diagram for SPSO logs
Purpose	To illustrate the steps involved in logging the document printing process
Scope	Interaction between the SPSO and the document printing system
Actor(s)	SPSO
Key Activities	1. Choosing which printing history to show 2. Choosing the time period 3. Showing the printing history
Flow of control	1. SPSO navigates to the functional menu. 2. SPSO chooses the view logs option. 3. SPSO chooses which printing history to show. 4. SPSO chooses the time period. 5. Printing history is shown.
Trigger	The process is triggered when SPSO click the "View logs" option button.

2.2 Sequence Diagram for Printing documents and View Printing logs

2.2.1 Sequence Diagram for Printing documents



2.2.2 Diagram description

This sequence diagram illustrates the interaction and flow of activities for the "Print Documents" use case involving the actors, Students, and the System, including exception handling for incompatible document formats and insufficient account balances.

- Students Navigate to Functional Menu: Students initiate the process by navigating to the functional menu within the system.

- Choose the Printing Option: Students select the "Printing" option within the menu.

- Upload the Documents: Students upload the documents to be printed. Verify Document Formats Compatibility: The system verifies if the document formats are compatible.

- Formats are Compatible: If the document formats are compatible, Students choose a printer, specify printing properties, and confirm the print request.

- Check Account Balance: The system checks whether the student's account balance is sufficient.

- Sufficient Balance: If the balance is sufficient, the system deducts the required amount, adds printing actions to the log activity, and prints the documents.

- End: The document printing process is successfully completed.

- Incompatible Formats: If the system detects that the document formats are not compatible with the selected printer:

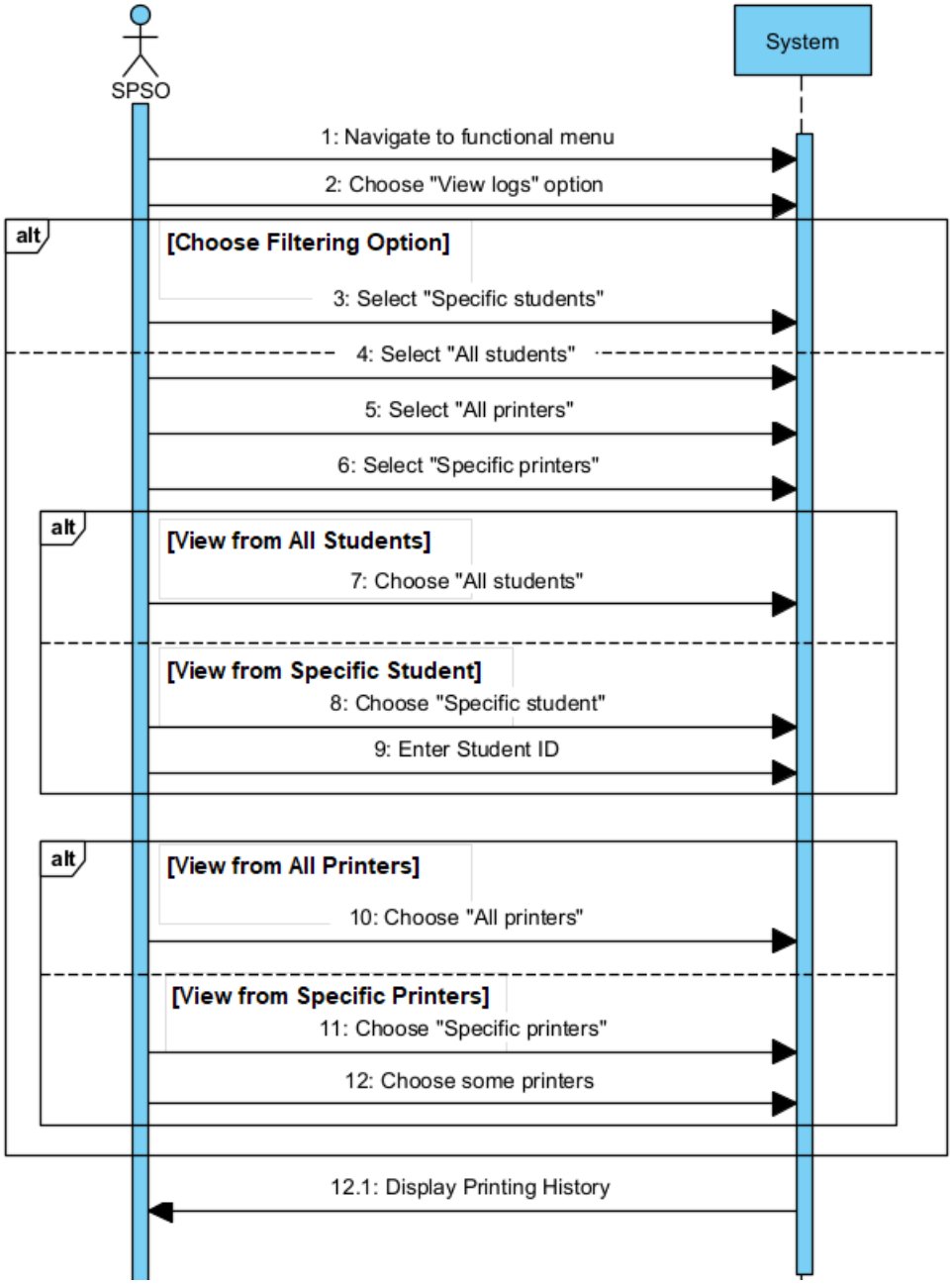
- A notice is shown to the students.
- Students can cancel the printing (use case stops) or retry the printing process (use case continues at step 3).

- Insufficient Balance: If the system finds that the student's account balance is insufficient:

- A notice is shown to the students regarding the insufficient balance.
- Students can cancel the printing (use case stops).

This sequence diagram visually represents the interactions between the actors and the system during the "Print Documents" use case. It highlights the main flow of activities and how the system handles exceptions related to document formats and account balances.

2.2.3 Sequence Diagram for View Printing logs



2.2.4 Diagram description

This sequence diagram represents the interaction between (SPSO) and the system for viewing printing logs. The primary objective is to allow the SPSO to view the printing logs, with various options for filtering the displayed information. The key steps and interactions in the sequence diagram are as follows:

- SPSO Navigation: The SPSO starts the process by navigating to the functional menu within the system.

- Selecting "View Logs": SPSO chooses the "View logs" option from the menu, initiating viewing printing logs.

- Choosing Filtering Options: SPSO has various filtering options, including viewing logs from all students, a specific student, all printers, or specific printers. The choice made here directs the flow of the sequence:

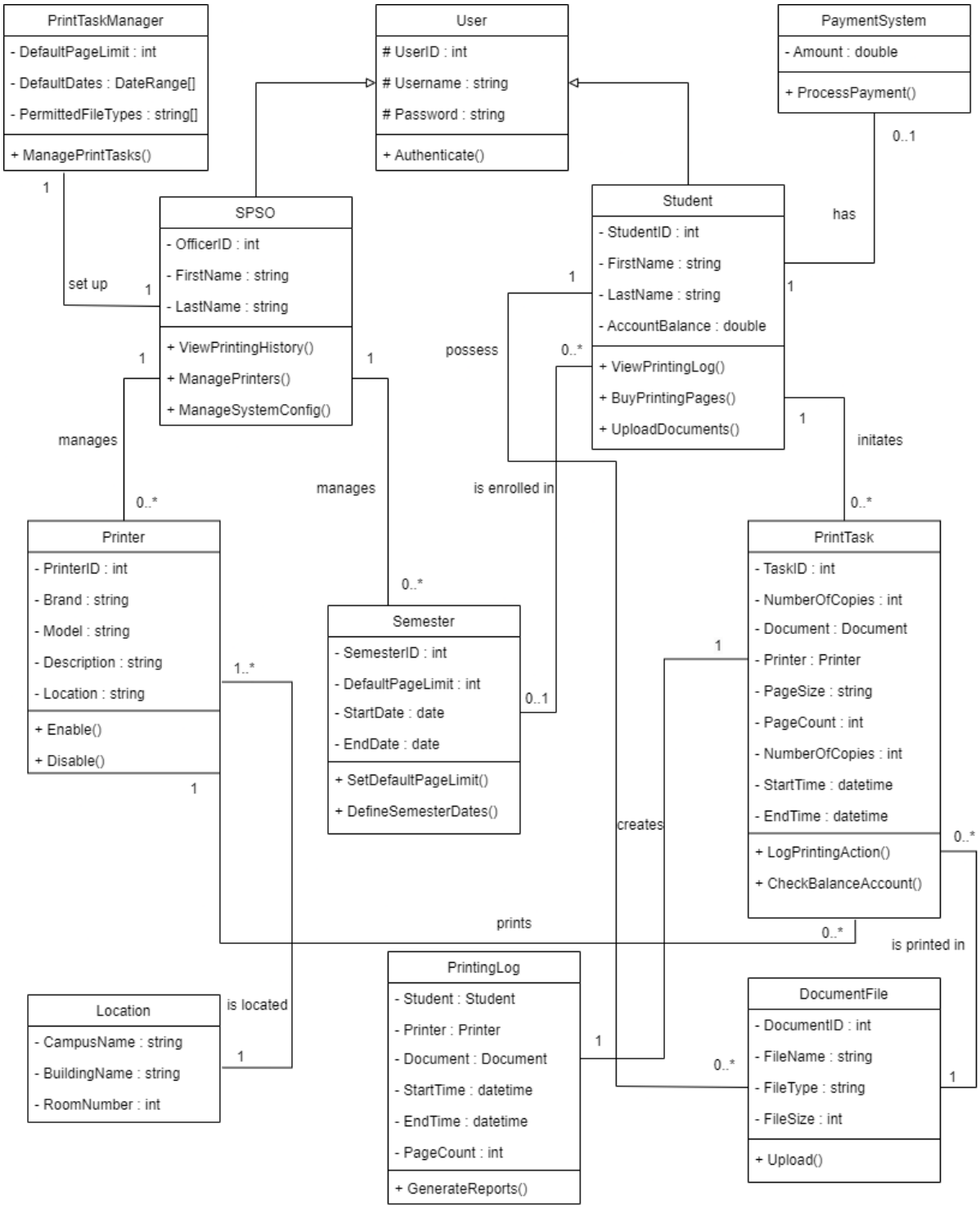
- If "All students" is selected, the system displays logs from all students.
- If a "Specific student" is selected, the SPSO enters the student's ID, and the system displays logs for that student.
- If "All printers" is chosen, logs from all printers are displayed.
- If "Specific printers" are selected, the SPSO chooses specific printers, and the system displays logs for those printers.

- Display Printing History: The system then displays the printing history based on the selected filtering options, showing the relevant logs to the SPSO.

This sequence diagram outlines the flow of interactions and choices within the "View Printing Logs" module, ensuring that SPSO can access and filter printing logs according to their preferences. It provides a structured view of the steps involved in this process.

2.3 Class Diagram

2.3.1 Class diagram



2.3.2 Diagram description

The class diagram for the printing system at HCMUT illustrates the system's core components and their interconnections, providing a visual representation of the system's main functions.

- The system has two main types of users: students and SPSOs. Students can submit print tasks,

enroll in a semester, or use a Payment System, while SPSOs can manage printers and the Print Task Manager.

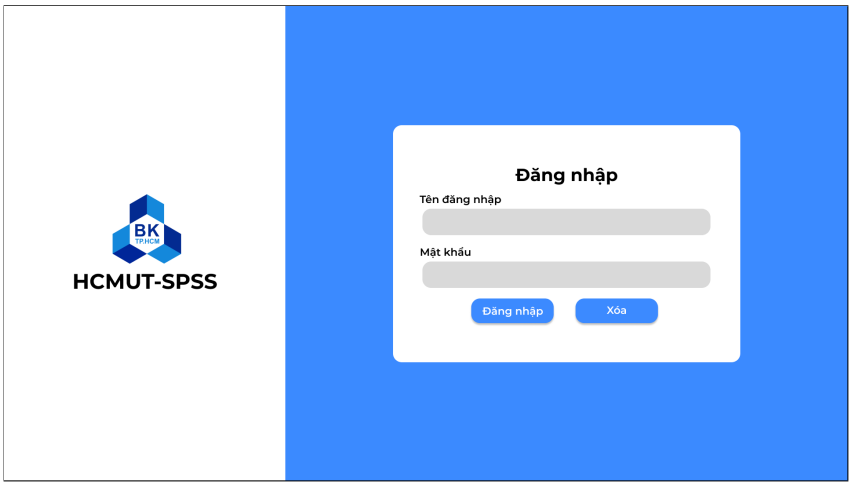
- When a user submits a print task, the system checks their account balance to ensure they have enough credit. The system sends the print task to the printer if the user has enough credit. The print task includes information such as the document, the printer to print it on, and the number of copies to print.
- The printer prints the document and sends a notification back to the system when the print job is complete. The system then updates the user's account balance and adds an entry to the printing log.
- The printing log is a record of all print tasks that have been submitted to the system. It includes information such as the user who submitted the task, the printer on which the document was printed, and the number of printed pages.
- SPSOs can also manage the printers in the system. They can add new printers, remove old printers, and set printer settings, such as the default page limit and the types of documents printed on each printer.

The class diagram also shows the relationships between the different classes. For example, the User class has a zero-to-many relationship with the PrintTask class, meaning that a single user can submit multiple print tasks. The Printer class has a zero-to-many relationship with the PrintTask class, meaning a single printer can be used for multiple print tasks.

2.4 MVP

2.4.1 Login

When entering the system, users must log in to enable the system to authenticate whether they are students, teachers, or members of SPSO.



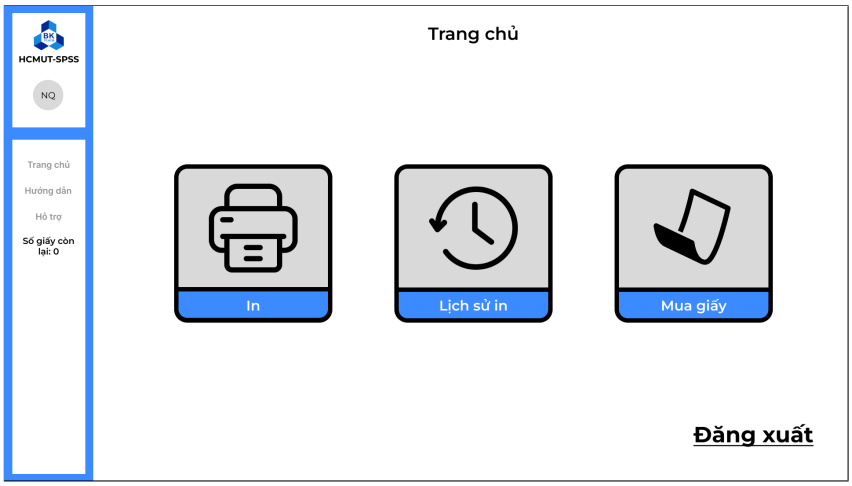
2.4.2 Student Application

When successfully logged in as students, users will be redirected to the main page of HCMUT-SPSS in the student application.

1. **Main page**

   In our implementation, we have prioritized user-friendliness and a lightweight user interface to

ensure efficient page rendering. The main page features a navigation bar with options to return to the home page and access instructions and support. It includes an indicator that displays the remaining number of papers for the user. There will also be a "Đăng xuất" button for logging out of the system.

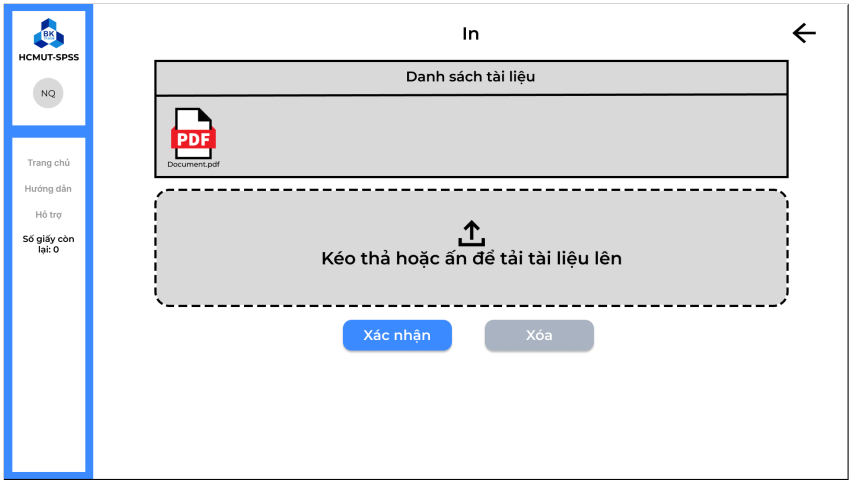


From the main page, we will have three main flows:

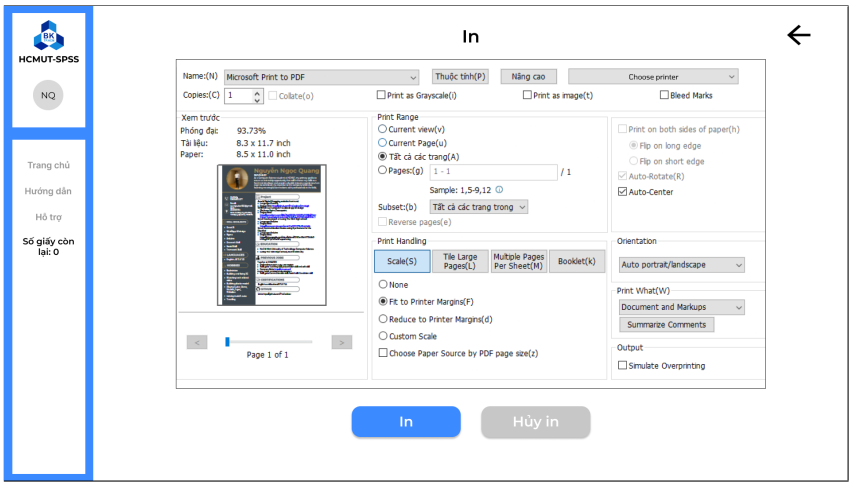
- Print document
- View printing log(history)
- Buy more paper

2. **Print**

Upon clicking the "In" button, users will be directed to the Print page to proceed with printing. On this page, users can upload multiple files or documents for printing.

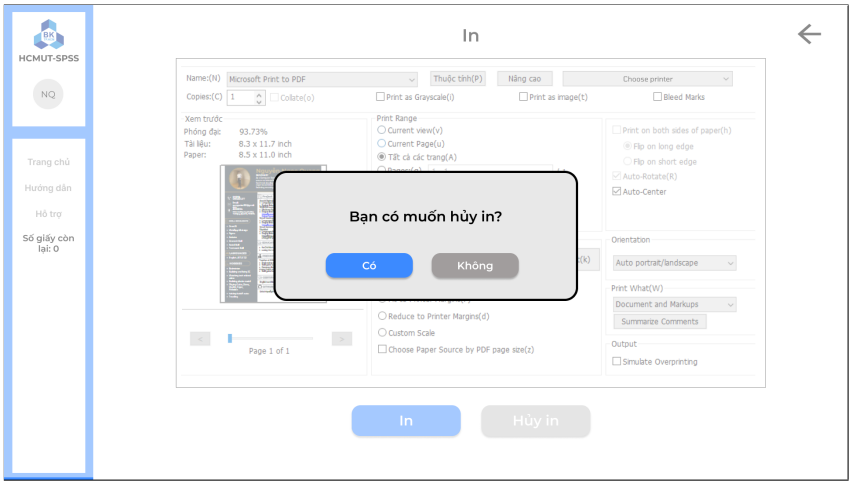


By clicking the "Xóa" button, all documents in the document list will be promptly cleared. Conversely, when users select "Xác nhận" they will be redirected to the Printing Action page to proceed with the print job.



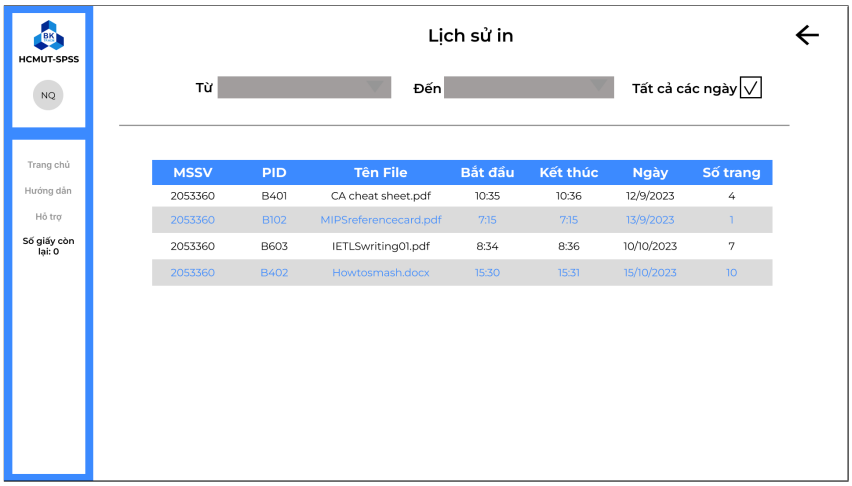
Users are presented with various customizable options within the Printing Action page. These include specifying the desired number of copies, the number of pages to be printed, selecting between one-sided or two-sided printing, and choosing from various other standard printing features. Furthermore, users have the flexibility to opt for their preferred printer located in a convenient location on the campus.

Upon clicking the "In" button, the system will promptly initiate printing the user's files and documents using their selected printer. A message prompt will confirm their action if users exit or return to the main page by clicking "Hủy in" or the "Trang chủ" button in the navigation bar.



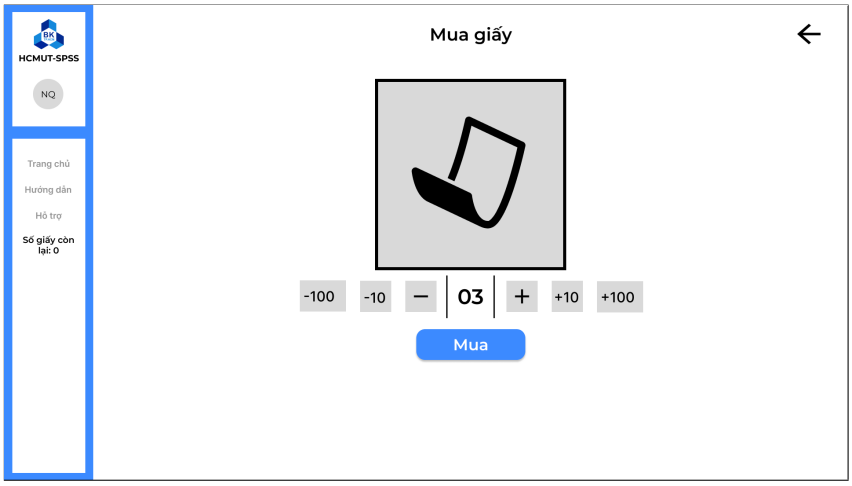
If the user chooses "Có" the print will be discarded, and the user will be redirected to the main page.
If the user chooses "Không" the print will continue.

3. **View printing log**
   By selecting the "Lịch sử in" button, users will be seamlessly directed to the printing history page. Here, they can conveniently access a comprehensive record of their previous printing actions in a period or for all records, including all relevant information and details. If the "Tất cả các ngày" box is ticked, the edit time fields are disabled. Otherwise, they can be edited by clicking the drop-down event with the calendar to choose the date.



There will be a table with all details of printing history: **ID, PID(Printer ID), Filename, Start time, End time, Date, Number of pages**.

4. **Buy more paper**
   When clicking "Mua giấy" the user will be redirected to the buy paper page.

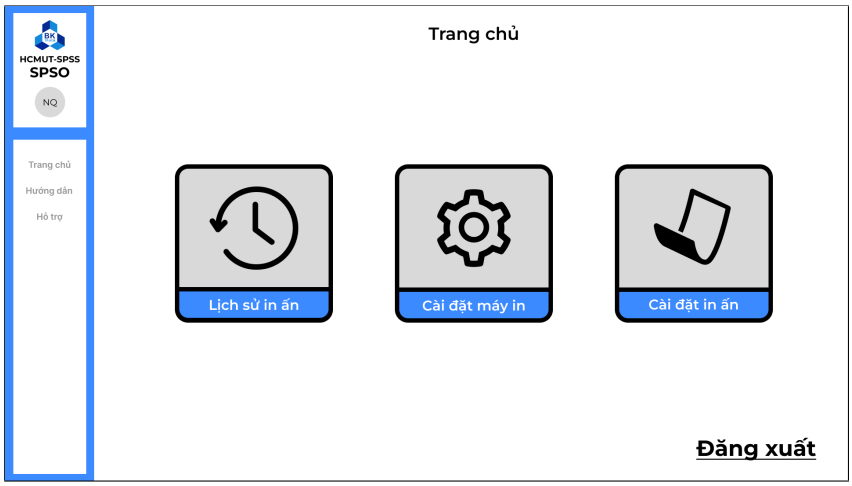


The application will feature three distinct button types for user interaction. The initial button, denoted by "+," is designed to increment the paper count by one. Conversely, the "-" button serves the purpose of decreasing the current paper count by one. Additionally, the application will allow users to purchase paper bundles, featuring two variants: "+ 10" to acquire ten papers and "+ 100" to purchase a hundred papers. Each addition option will have a corresponding subtraction button: "- 10" and "- 100". This structured approach ensures users have a comprehensive and user-friendly interface to manage their paper quantities.
After clicking "Mua" the user will be redirected to the main page, and another tab will open and redirect to the BKPAY system, where the user will pay for the paper they just purchased.

2.4.3 SPSO Application

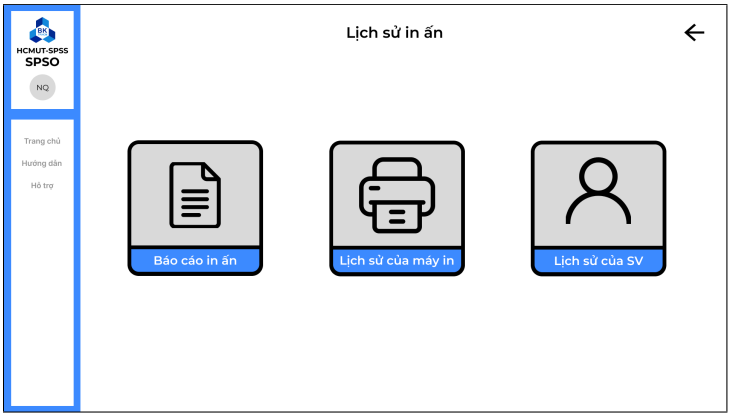
When successfully logged in as SPSO members, users will be redirected to the main page of HCMUT-SPSS in the SPSO application.

1. **Main page**
   On the main page of the SPSO application, there are three main functions: Printing history (Lịch sử in ấn), Printer settings (Cài đặt máy in), and Printing settings (Cài đặt in ấn).



2. **Printing history**

   In the Printing history option, users can view three types of printing records: Printing summary (Báo cáo in ấn), Printer records (Lịch sử của máy in), and Student records (Lịch sử của SV).



- **Printing summary**

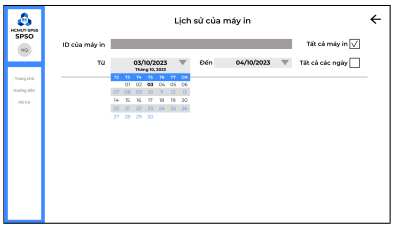
  Here, the user can view automatically generated monthly and annual reports. A monthly report can be viewed, and the "Tháng" text field can be edited if the "BC tháng" box is ticked. Otherwise, an annual report is viewed.

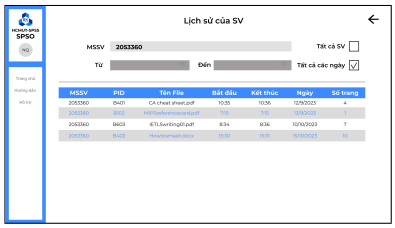
- **Printer records**

  For the printer records, the user can view the report corresponding to all printers or some printers' IDs in a time range or for all records.

- **Student records**

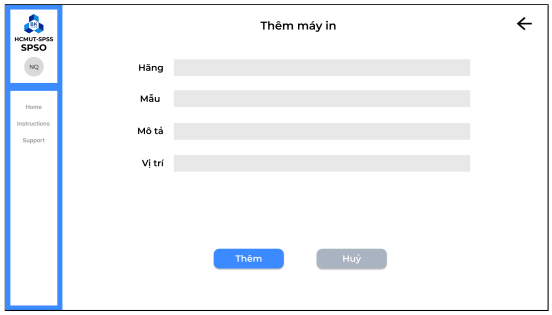
  For the student records, the user can view the report corresponding to all students or some students' IDs in a time range or for all records.

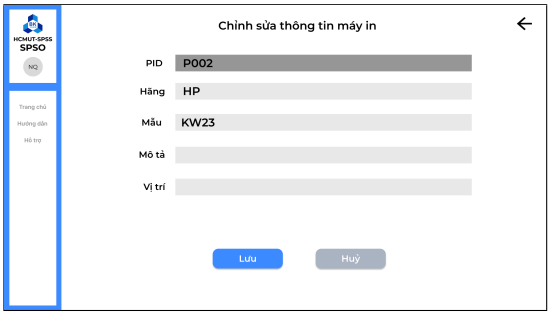




3. **Printer settings**

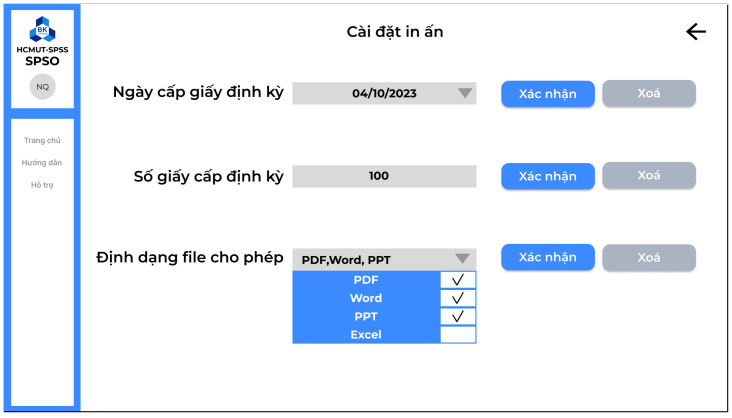
In the Printer settings, a list of all printers is shown with printers' information: PID, Manufacturer (Hãng), Model (Mẫu), Description (Mô tả), Location (Vị trí). The user can add a new printer by clicking the "Thêm máy in" text and turn the printer on or off by ticking the box in the "Kích hoạt" column. To edit the printer's information, the user clicks the "Pen" icon next to that printer. Click the "Áp dụng" button to apply all changes and the "Huỷ" button to cancel all changes.





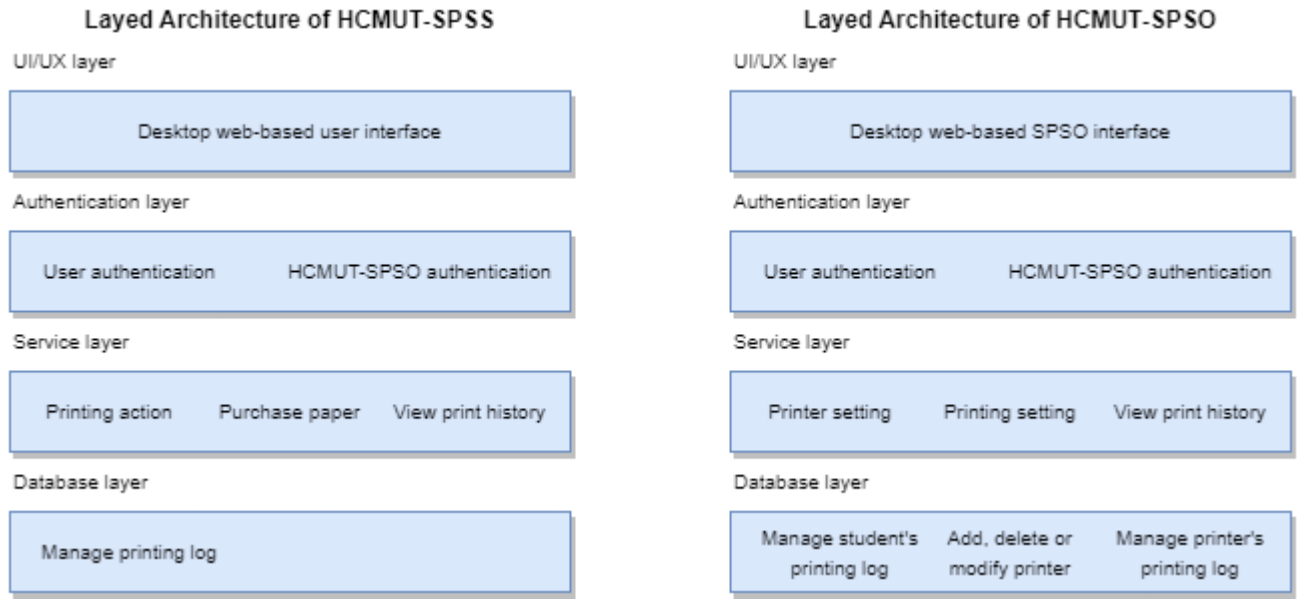
4. **Printing settings**

The user can use the Printing settings option to edit the date to give papers to all students and the number of papers to provide. They can also edit the permitted file types that can be printed by choosing the listed file types the systems give. Click the "Xác nhận" button to apply all changes and the "Xoá" button to cancel all changes.



3 Architecture

3.1 Layed architecture Diagram



3.1.1 Diagram description

The layered architecture diagrams for HCMUT-SPSS and HCMUT-SPSO are depicted above. The SPSS architecture is marginally simpler than SPSO, with the first two layers, UI/UX and Authentication, remaining the same. In the service layer, SPSS offers three actions: Printing action, View printing log, and Purchase paper. However, only managing printing logs involves the database layer. SPSO, on the other hand, requires three management services: Printer setting, Printing setting, and View print history. All of these actions necessitate database interaction..

3.2 Presentation

Figma visualizes our UI in the above section. First, when they click on the system website, the authentication service will check whether the user is a student or teacher, or an officer of HCMUT-SPSO. After that, the user will be redirected to their corresponding page. Students/teachers will log in to the user page, and SPSO officers will log into the admin page.
In the user section, there will be 3 big buttons in the middle section: "In", "Lịch sử in" and "Mua giấy" and 1 vertical navigation bar to navigate to Home, Instruction, or Support, there is also a logout button. From here 3, flows will happen:

- The printing page will have a list of documents and an upload section so user can drag or upload their document, after they confirm, they will be redirected to the main printing page, where they can decide whether they proceed the printing or cancel and go back to home page.
- A table displays the history page, the table will have information about ID, PID, filename, printing start, printing end, date, and pages. Users can also filter the date if they want.
- The buy paper page will display a purchase section, users can buy paper in bundles if they want to. After clicking buy, the user will be redirected to BKPAY.

On the SPSO admin page, the layout is pretty much the same as the user page, the button name on the homepage will change to: "Lịch sử in ấn", "Cài đặt máy in" and "Cài đặt in ấn". There will be 3 flows after clicking "Lịch sử in ấn" which are printing reports, printer history, and student history.

- In the printing report, a table will be displayed with the same information as the printing history on the user page. SPSO officer can view all of the student that uses the printer, the filter will also be there.
- In printer history, the same table will be displayed. Here, the admin can enter the printer ID to search for the printer. The filter will be included.
- In Student history, it's the same thing as printer history except for a change in a search method here, the admin can type in student ID to search.

The other 2 flows on the SPSO page are the Printer setting and the Printing setting

- With printer setting, admin can add, edit, or enable/disable printer, an input box including brand, model, description, and location will appear so that admin can add. For editing the printer, the printer ID will appear and the rest will be the same.
- In the printing setting, there will be an option for choosing the date of authorization, the number of papers every user can have, and the format they can print.

3.3 Data Storage

The data storage approach within the layered architecture of the Student Smart Printing Service (HCMUT_SSPS) is a critical element that underpins the system's functionality, security, and scalability. In the layered architecture, data storage is managed systematically, with distinct layers dedicated to specific data-related tasks. The backbone of the data storage approach is a robust Relational Database Management System (RDBMS), which plays a central role in the system's data management strategy.

3.3.1 Relational Database Management System (RDBMS)

The HCMUT_SSPS relies on an RDBMS to organize and manage its data. This relational database system is chosen for its ability to store data in structured tables, where data elements are organized in rows and columns. Each table represents a specific data entity, such as user profiles, printing logs, configuration settings, and financial transactions. The relational model allows for efficient querying and retrieval of data, making it well-suited for complex data relationships and reporting needs.

3.3.2 Structured Data

The RDBMS enforces a structured approach to data storage, ensuring that data is organized, consistent, and easily accessible. For example, user profiles are stored in a user table, and printing logs are stored in a separate log table. This structured organization simplifies data retrieval and reporting processes.

3.3.3 Data Integrity and Security

Data integrity is a top priority for the HCMUT_SSPS. The RDBMS enforces data integrity constraints, ensuring that data remains accurate and consistent. For instance, the system may impose constraints to validate that printing logs are associated with valid user accounts and printers. Additionally, the RDBMS provides security measures such as access control, encryption, and audit trails to safeguard sensitive information.

3.3.4 Scalability and Performance

The choice of an RDBMS allows the system to scale as the user base and data volume grow. The system can efficiently handle increasing data loads, providing reliable performance. Scalability is crucial to accommodate the printing needs of a large university with many students and multiple campuses.

3.3.5 Backup and Redundancy

To ensure data availability and disaster recovery capabilities, the HCMUT_SSPS implements regular data backups and redundancy mechanisms. Backups are performed to capture changes to the data over time and provide recovery points in case of data loss. Redundancy strategies may involve replicating data to multiple locations to prevent data loss due to hardware failures.

In conclusion, the data storage approach within the layered architecture of HCMUT_SSPS utilizes a robust RDBMS to manage structured data efficiently. It enforces data integrity, implements security measures, and ensures scalability and performance. With a focus on structured data models and security, this approach serves as the foundation for reliable and efficient data management within the printing system, contributing to a seamless user experience and the system's overall success.

3.4 External services and APIs

To create a robust and secure Smart Printing Service that integrates seamlessly with the HCMUT's existing systems and infrastructure, a comprehensive approach to API integration is necessary.

- Firstly, the plan is to connect with the university's IT team to integrate the student authentication system. This involves a technical discussion to access their authentication API, ensuring we align with their security measures. Students will then be able to log in to the HCMUT SSPS using their university credentials, which maintains security and simplifies the login process. For understanding the integration process, the OAuth 2.0 Authorization Framework provides essential information.[1]

- Once we have IT approval, we'll secure the necessary API keys or tokens. These keys are a secure handshake between our service and the university's system, ensuring only authorized users can access the printing services. It's critical to manage these keys properly to protect student information. Guidelines on securing and managing API keys are available in resources like API Keys — A Guide to Securing and Using Them.[2]

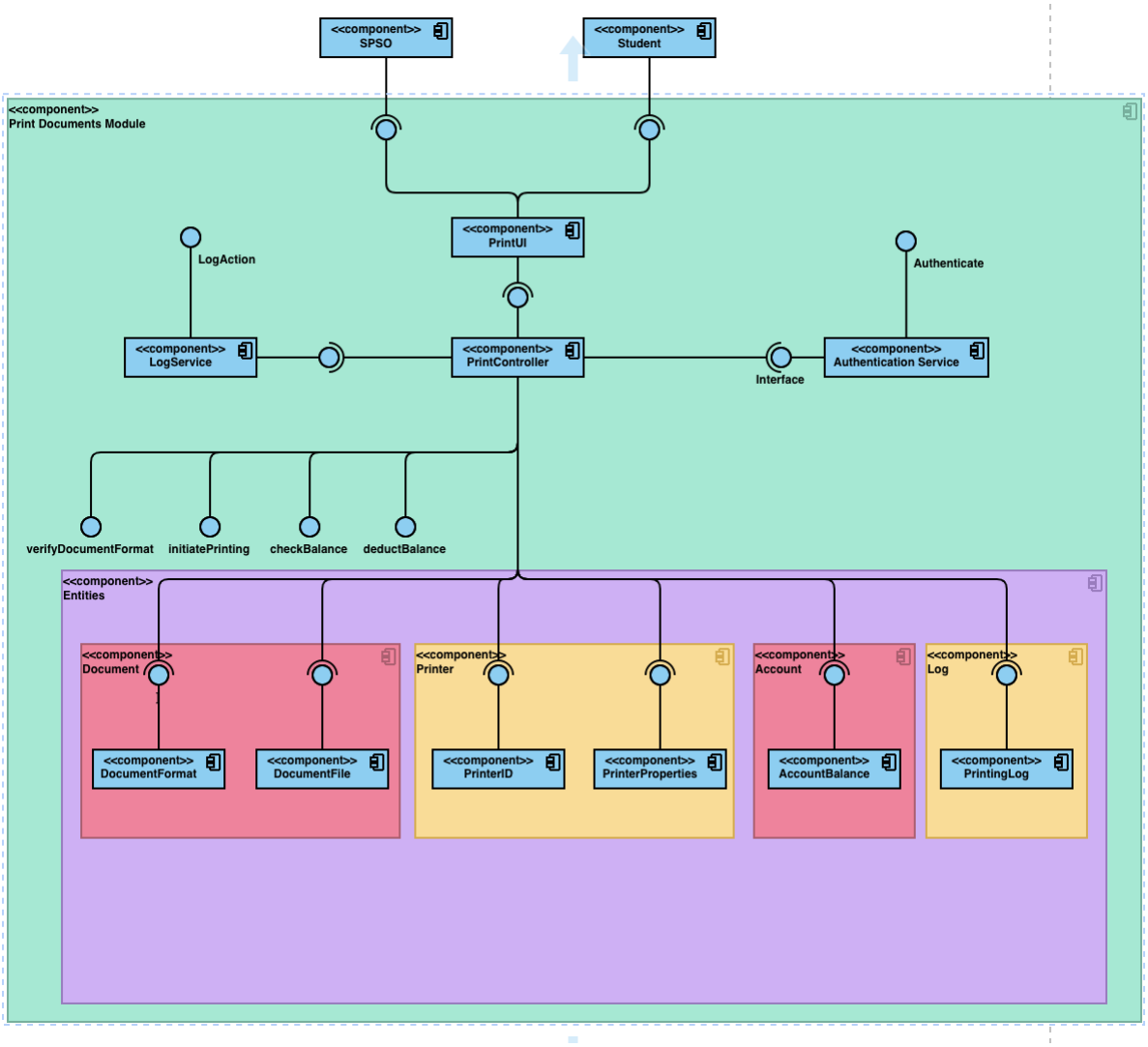
- We want to set up a special secure link that connects our Smart Printing Service directly to BKPAY. This means when students need to add more paper, they can pay through a safe system. We can think of a protected bridge between the student's account and BKPAY where their payment information travels safely, hidden from prying eyes. To build this bridge, we follow instructions from BKPAY designed to keep everything locked tight.

- Finally, our goal is to establish a direct line of communication with printers around the campus. This starts by identifying if the printers support a standard API such as Internet Printing Protocol for sending print jobs and managing printer status. To understand how IPP works, Internet Printing Protocol offers a comprehensive overview.[3]After confirming API support, the next phase is to integrate this into HCMUT SSPS, which will allow direct management of printing tasks. This process must be carefully coded to ensure smooth operation and immediate response to print jobs.

3.5 Component Diagram for important modules

3.5.1 Component Diagram for Printing documents

3.5.1.a Component Diagram



3.5.1.b Diagram description

This component diagram should offer a high-level but detailed overview of how the "Print Documents" module is architecturally structured.

Components:

- AuthenticationService: This component is tasked with user authentication. Its background color is specifically set to distinguish its role in security.
- LogService: This component handles the logging of print actions, including any necessary storage and retrieval.
- PrintController: This serves as the orchestrator of the printing process. It interacts with multiple services and entities to coordinate the flow of actions.

- PrintUI: This is the user interface component through which the users (both Students and SPSO) interact with the system.

Entity Packages:

- Document: Contains two components, DocumentFormat and DocumentFile, to represent the attributes of the document being printed.
- Printer: Includes PrinterID and PrinterProperties components that hold printer-specific data.
- Account: Consists of a single component, AccountBalance, which keeps track of the user's account balance for printing.
- Log: Comprises the PrintingLog component to store log entries related to print actions.

Interfaces:

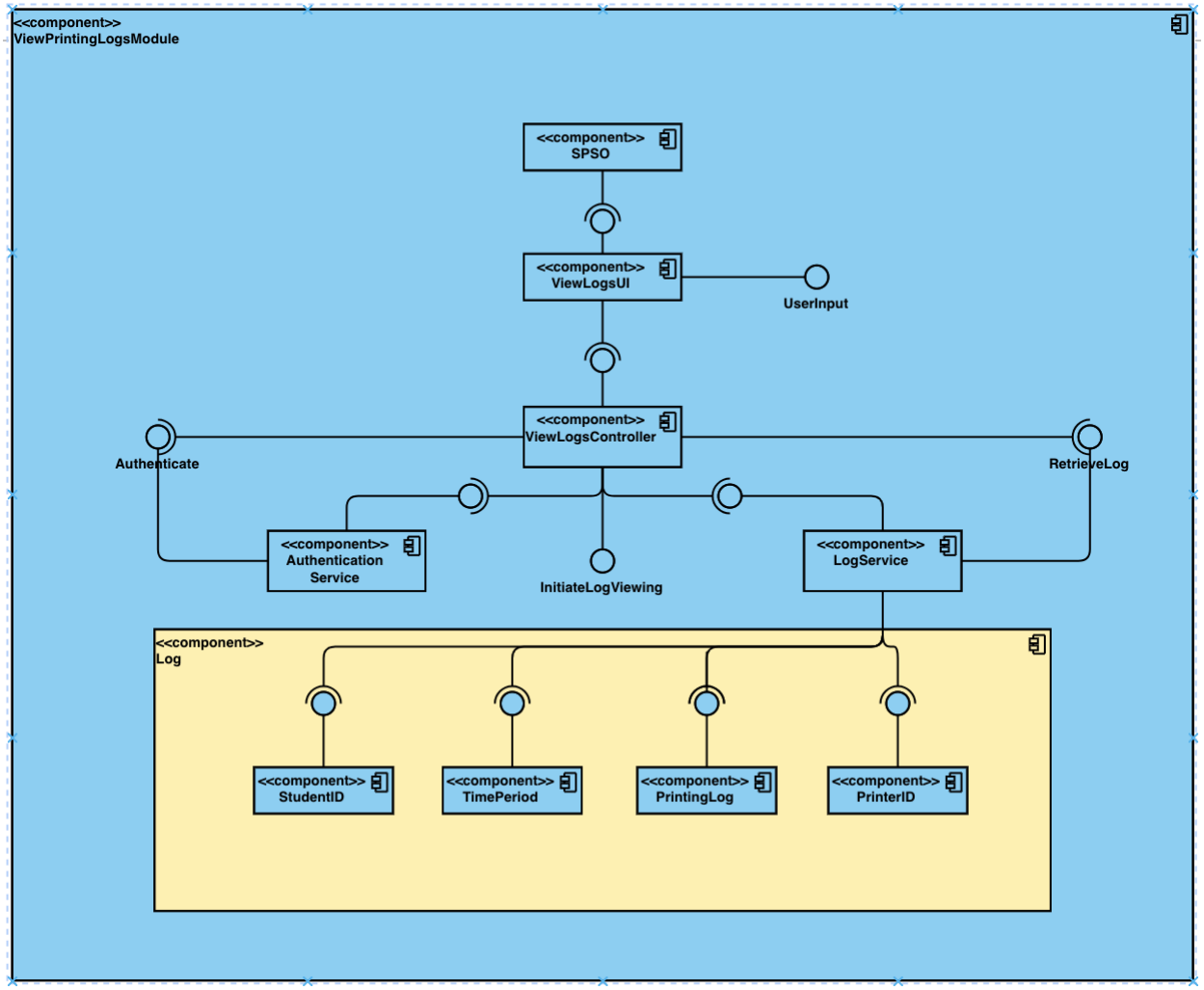
- verifyDocumentFormat: Verifies the uploaded document format.
- authenticate: Handles the user authentication process.
- initiatePrinting: Kicks off the actual printing procedure.
- logAction: Logs the printing action to a log.
- checkBalance: Checks the balance in the user account.
- deductBalance: Deducts the balance from the user account upon successful printing.

Relationships:

- Students and SPSO - PrintUI: Students and SPSO interact with the system through the PrintUI. They are the end-users of the system and hence have a "uses" relationship with the UI component.
- PrintUI - PrintController: The UI delegates user actions to the PrintController, indicating a "uses" relationship.
- PrintController - AuthenticationService and LogService: The PrintController requires the AuthenticationService for user authentication and LogService for logging print actions. Both are marked by a "uses" relationship.
- Interfaces and Components: Various "provides" and "requires" relationships exist between the interfaces and the components that implement or consume them. For instance, AuthenticationService provides the authenticate interface, which PrintController requires.
- Entities and PrintController: The PrintController interacts with the various entities (DocumentFormat, DocumentFile, PrinterID, PrinterProperties, AccountBalance, and PrintingLog) to fulfill its responsibilities.

3.5.2 Component Diagram for View Printing logs

3.5.2.a Component Diagram



3.5.2.b Diagram description

This system module is particularly designed to facilitate SPSO in viewing the logs of printing actions.

The system is comprised of the following components:

- AuthenticationService: This component is responsible for ensuring that the SPSO is authenticated.
- LogService: Manages the retrieval and perhaps storage of various logs.
- ViewLogsController: Acts as an intermediary between the UI and the backend services.
- ViewLogsUI: The user interface that the SPSO interacts with.
- Log: This is a sub-package that contains entities like PrintingLog, TimePeriod, StudentID, and PrinterID.

The system also defines several interfaces:

- retrieveLogs: Likely used for retrieving log information.
- authenticate: Utilized for authentication processes.
- initiateLogViewing: Possibly used to initiate the process of viewing logs.
- userInput: Likely takes input from the user via the UI.

The relationships between the various components and interfaces are designed to delineate responsibilities and data flow within the system.

- SPSO uses ViewLogsUI: Indicates that the SPSO interacts with the user interface.
- ViewLogsUI uses ViewLogsController: Suggests that the UI sends user inputs to the controller.
- ViewLogsController uses LogService and AuthenticationService: The controller uses these services to fetch log data and authenticate the SPSO, respectively.
- LogService connects to the entities in the Log package: Indicates that this service interacts with these entities to fulfill its role.

The system also defines several interfaces:

- Provided interfaces define "a set of public attributes and operations that must be provided by the classes that implement a given interface".
- Required interfaces define "a set of public attributes and operations that are required by the classes that depend upon a given interface".
- Components can be "wired" together using to form subsystems, with the use of a ball-and-socket joint.

The normal flow indicates that an authenticated SPSO can navigate through a functional menu to select a specific type of printing history, choose a time period, and then view it. Alternative flows allow the SPSO to filter logs by student or printer. Overall, the diagram serves as a high-level architectural overview for developers, analysts, or other stakeholders interested in understanding how the "View Printing Logs" functionality is designed and implemented.

References

[1] Oauth. https://oauth.net/2/. Accessed: 2023-10-31.

[2] Authenticate by using api keys. https://cloud.google.com/docs/authentication/api-keys. Accessed: 2023-10-31.

[3] How to use the internet printing protocol. https://www.pwg.org/ipp/ippguide.html. Accessed: 2023-10-31.