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

Software Engineering (CO3001)

A smart printing service for students at HCMUT

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Software Requirements Specification

for

A smart printing service for students at HCMUT

Version 10.0 approved

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Name	Date	Reason For Changes	Version
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Sequence	11.10	Update complete sequence diagram	4.0
Class	12.10	Update complete class diagram	5.0
MVP-1 UI	19.10	Update complete MVP1 user interface	6.0
Layered	20.10	Update complete layered architecture	7.0
Component	21.10	Update complete component diagram	8.0
Usability	3.11	Complete survey	9.0
Implementation	20.11	Complete coding	10.0

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1. Requirement elicitation (1.1, 1.2)

1.1 Domain Context

Currently, the printing needs of university students in Vietnam in general and students of Ho Chi Minh City University of Technology in particular are increasing. Hard copies of learning materials are becoming increasingly useful in the learning process of students. However, with the traditional method of providing printing services through printing shops, there are still some problems such as:

- Students may have to travel a long distance to get to the printing shops.
- Printing requests can only be sent to the printing shop, then students have to wait for the request to be completed.
- The number of students is much larger than the number of printing shops, so students may have to wait in line for a long time if there are many printing requests.
- Customizing the printing format can be difficult when communicating between students and printing shop owners.
- It is not guaranteed that information in printed documents will not be disclosed when sent to the printing shop.
- Sending files to the printing shop through many different platforms can cause errors, making it difficult to manage.
- Printing services often do not have a price list and do not have invoices, so students cannot manage their spending on printing services.

The Student Smart Printing Service at HCMUT (HCM-SSPS) is designed to allow students at HCMUT to print documents through a network of printers distributed across the university's campus. This system includes various objects such printers, students, documents, printing logs, Student Printing Service Officer (SPSO) and BKPay. Each printer is identified by its ID, brand, model, and location. Students can select a printer, upload documents, and configure settings such as paper size, pages, number of copies. The system ensures students can only print within their allocated page balance, with an option to purchase additional pages through BKPay. Every print's work is logged, including student's ID, printer ID, file name, print times and pages printed, allowing students and SPSO to track usage. The SPSO manages system configurations, such as default page allocations per semester, permitted file types, and printer availability. The system ensures that all users are authenticated through the HCMUT_SSO service and provides access via both web-based and mobile apps.

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1.2 Stakeholders and Needs

- Students
    - Description: are primary users of the system. They upload documents, select printers, configure print jobs, manage print page balances and view their printing history.
    - Needs: Need a reliable, easy to use system to upload, manage, and print their documents on campus, as well as the ability to track their print usage and manage their print quota. They also require access to a payment option, such as BKPay, to purchase additional print pages if necessary. Additionally, they require a user-friendly interface accessible via both web and mobile platforms.
- Student Printing Service Officer (SPSO)
    - Description: Is the manager and monitor all printing activities of the students and in the system. They are also responsible for the system's configuration, printer, file types permission.
    - Needs: Need tools to manage and monitor all printers, configure system settings (e.g., default print quotas, permitted file types), view detailed print logs, and generate reports on system usage. They also require features to add, enable, or disable printers and access historical data on printing activities.
- HCMUT Administration
    - Description: Is responsible for overseeing the system's overall functionality and alignment with institutional policies.
    - Needs to oversee the entire system, ensuring that the printing service operates efficiently, cost efficiency and optimal resource allocation, while having access to data for decision-making regarding printing allowances and infrastructure improvements. They rely on data-driven insights from the system to assess its performance and adapt policies accordingly, ensuring the service meets the needs of both students and the university at large.
- BKPay
    - Description: Is the university's online payment system, allowing students to buy additional printing pages. BKPay's primary role is to facilitate smooth, secure transactions when students purchase additional printing pages.
    - Needs: Needs seamless integration with the HCMUT_SSPS to handle online payments for students purchasing additional printing pages. They require reliable transaction processing, accurate accounting, and payments from students.
- IT system management department

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  - Description: Is the service provider of the software and other relating technologies for printing and printing management. They ensure smooth technical operation of the system.
  - Needs: Is responsible for maintaining system performance, ensuring integration with the HCMUT_SSO for secure user authentication, and supporting the web-based and mobile platforms to ensure smooth access for students and staff.
- Printer provider
  - Description: They provide printers to support the SPSO service.
  - Needs: Provide printers as soon as possible. The printers must ensure to have quality and quaranty. Also, informations about the printer's ID, name, model must be provided to ensure maintainance.
- Guests
  - Description: They can view the overall usage of the system and decide whether to purchase an account or not.
  - Needs: View some basic features of the system. Ask for help from the HCMUT Administration to whether purchase an account or use the system for free trial.

1.3 Benefits of the System

- Students
  - For students, the system offers a convenient and flexible way to print documents on campus, track their print usage, and easily purchase additional pages when needed. The ability to manage print settings and logs through both web and mobile apps enhances their printing experience.
- Student Printing Service Officer (SPSO)
  - For the Student Printing Service Officer (SPSO), the system simplifies printer management by providing tools to monitor printer status, configure system settings, and generate automatic monthly and yearly reports. It also enables detailed oversight of student print activities, helping to ensure efficient resource allocation and printer availability.
- For HCMUT Administration
  - They can benefit from resource optimization, as they can optimize the use of printers across the campus, ensuring resources are used efficiently, and data-driven decisions, as they can analyze printing trends to make informed

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decisions about printer allocation and student allowances, leading to cost efficiency..

- For BKPay
  - They benefit from increased transaction volume as students purchase additional pages, as they can make payments through BKPay, with seamless integration ensuring smooth, reliable payment processing and financial tracking
- For the IT system management department
  - The system streamlines administrative tasks by integrating with HCMUT_SSO for secure authentication, automating report generation, and reducing the need for manual intervention in managing print services. This creates a smoother operational flow, improves service reliability, and provides data-driven insights for future improvements.
- Printer provider
  - They provide good and quality printers that are useful and easy to use for connecting with the servers. This can increase the performance of the system by enhancing more about stability, user interface, and usage.
- Guests
  - Can decide whether to use the system, and use the basic features of the system. Contact info is also helpful in creating an account for better features.

1.4 Functional Requirements

1.4.1 Guest Side

- Main page view
  - Guests can view the home page and some remarkable features.
  - Manual script of how to use the page and how to purchase to use a printer.
- Contact for account
  - Contact SPSO to provide an account to use the printer.
- Limited actions
  - Guests doesn’t have as much permission as students or SPSO guidances.

1.4.2 Student Side

- Sign in
  - Students can sign in and view personal informations, including their HCMUT_SSPS account, quota, printing history and logs, …
- Printer option

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  - Choose printer at required location, choose printing paper size, pages, one/doubled-sided, number of copies, …
  - Choose time to receive printed document.
- Viewing action history
  - By signing in to the system, a student can view their printing log for a time period together with a summary of number of printed pages for each page size.
  - The log must include the student's ID, printer ID, model, short description, location, and the printed document information, including pages, one/doubled-sided, size, quota sent.
- Purchasing quota
  - Each semester, the university give each student a default number of A4-size papers for printing. If need more, student has to purchase quota.
  - Students are allowed to buy some more using the feature Buy Printing Pages of the system and pay the amount through some online payment system (BKPay).

1.4.3 SSPS System

- Issue quota
  - At each semester's begin, the system issues each studen with a default number of quota to use.
  - Add more quota for a student if he/she had already purchase more quota via payment system (BKPay).
- Document uploader
  - The system allow students to upload files (with specific tile type) to the system and perform printing.
  - Announce the quota needed and view whether the student can print. Show printing locations available, and predicted received time.
- Notification
  - Send notification to student whenever the printing is done. Announce total of quota
- Logging uses information
  - For each student, at each use time, the system must log out the printing actions, including student ID, printer ID, file name, printing start and end time, number of pages for each page size.
  - Allow SPSO to view printing history (log) of all student for a time period (date to date) and for all or some printers.
- Limiting student's usage

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- If a student has no more quota, the system does not allow the student to print more papers, unless he/she purchase more quota through a payment system (BKPay).

1.4.4 SPSO Side

- Manage users
  - SPSO can view user's information, including their sign-in actions, printing logs, number of quota left.
- Manage printers
  - Add, disable, enable a printer.
- Mange configuration
  - Changing the default number of pages, the dates that the system will give the default number of pages to all students, the permitted file types accepted by the system.
- Printing report
  - Reports of the using of the printing system are generated automatically at the end of eachmonth and each year and are stored in the system.

1.4.5 Authentication

- Via HCMUT_SSO
  - Every sign-in actions must be made via HCMUT_SSO.

1.4.6 Payment

- Via BKPay
  - Every quota purchase actions must be done via a payment system, specificly BKPay

1.5 Non- Functional Requirements

1.5.1 Performance

- The system should handle multiple simultaneous printing requests without significant delay. More specifically, 1000 requests a time.
- Response time from receiving request to getting response should not exceed 5 seconds.
- Payment responses success should be in an interval of 30 seconds.

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- Must allow at most least 5000 users without having issues with performance.
- Logs and reports should be generated promptly, even with large amounts of data.

1.5.2 Scalability

- The system should support increasing numbers of students, printers, and documents as the university expands.
- System must be available in at least 95% of work time, not including maintenance. The work time is from 6 a.m to 9 p.m.

1.5.3 Security

- Authentication must be done securely using the HCMUT_SSO.
- Sensitive information like student IDs, printing history, and payment transactions must be protected from unauthorized access.
- Only authorized account may view their information.

1.5.4 Reliability

- The system must ensure reliable document upload, printer selection, and printing processes.
- Printing services must be operational with minimal downtime.
- No errors or data loss during uploading files and printing.

1.5.5 Maintainability

- The system should be designed to allow easy updates, such as changes in printer configurations or quota rules.
- Clear documentation and error logging should be implemented for troubleshooting.

1.5.6 Usability

- SPSO guidance can have enough skills to use system after 2 hours of training.
- Students should be capable of using the system after 30 minutes of training via tutorial.
- The web and mobile interfaces must be user-friendly for both students and SPSO, with intuitive navigation and clear instructions.
- The system can be used while using wifi institution with the ping is less than 100ms at all working time.

1.5.7 Data Retention and Integrity

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- Logs, reports, and printing data must be stored accurately and security according to university policy.
- Monthly and yearly reports must not lose data integrity even over long periods of operation.

1.5.8 Compatibility

- The system should support all modern browsers and mobile platforms in any electrical device such as laptop, smartphone. It works in any OS including Windows, Linux, macOS, iOS, and Android. The system is a website that can work in various browsers like Chrome, Edge, CocCoc, Safari.
- Uploaded document files must be compatible with a predefined set of printers and formats.

1.5.9 Availability

- The system should ensure high availability for both web and mobile platforms, with minimal downtime.

1.5.10 Compliance

- The system must comply with university data privacy and security policies, including encryption standards where applicable.

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2. Use-case Diagrams (1.3)

2.1 Use-case Diagram for the Whole System

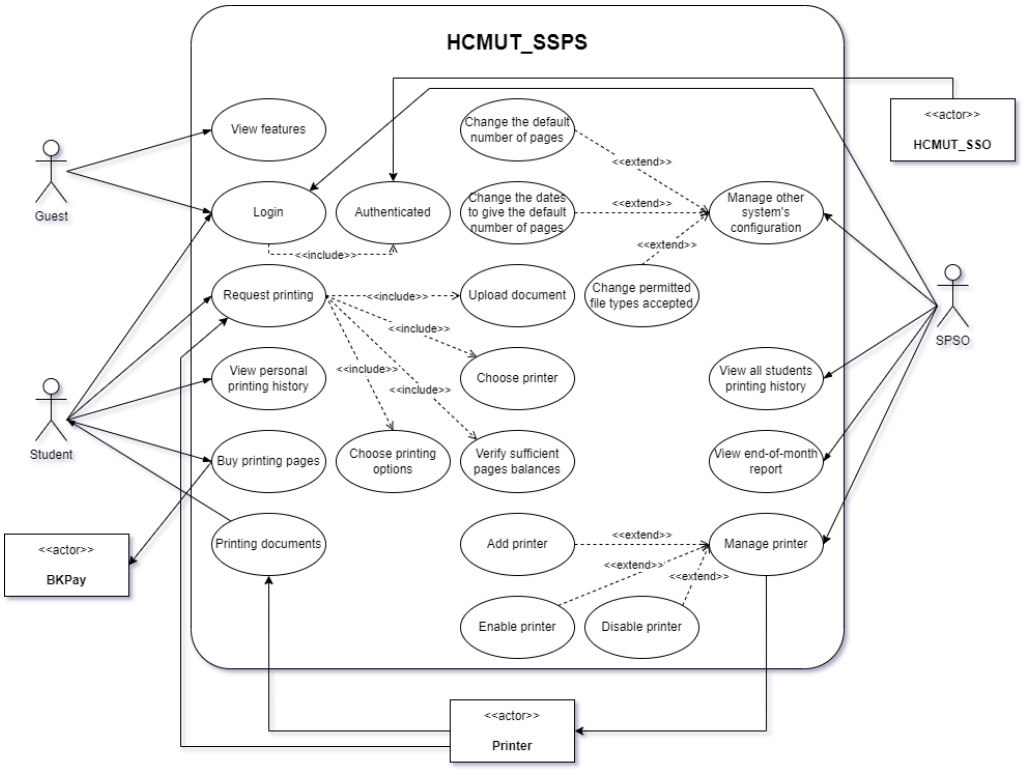

Figure: Use-case Diagram for the Whole System

2.2 Use-case Diagram for Request Printing Module

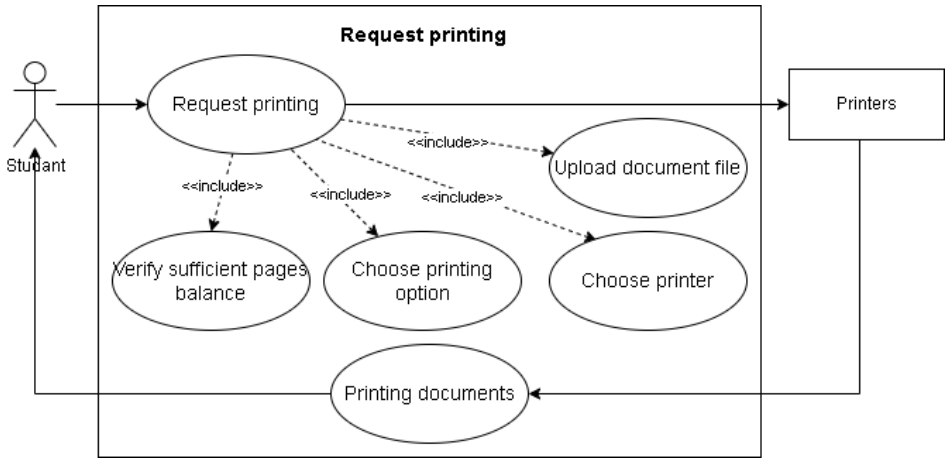

Figure: Use-case Diagram for Request Printing Module

2.3 The Details of Usecases in every Modules

1. Usecase Request printing

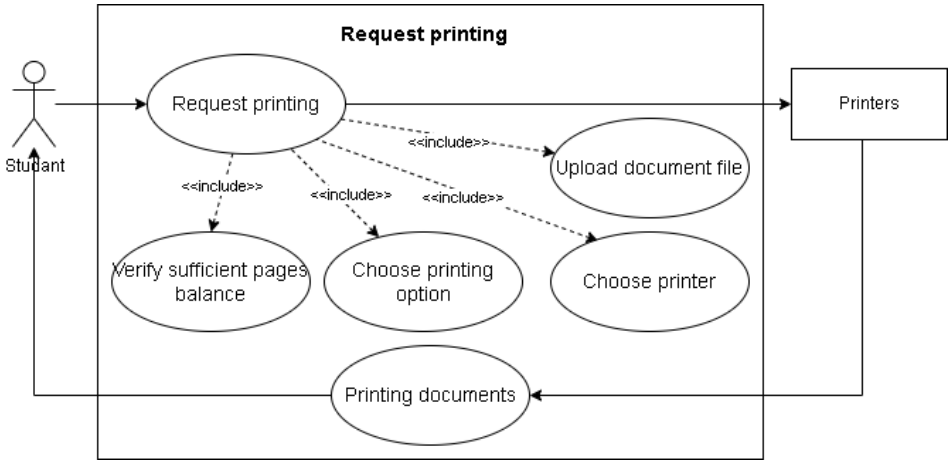

Figure: Usecase Request printing

Use case ID and Name	UC1 Request printing

Created by	Phan Quang Minh
Date created	22/9/2024
Actors	Students, HCMUT_SSPS and printers.
Description	The student uploads their document file, chooses a printer, configures printing options, and submit the print job
Trigger	The student requests to print a document
Preconditions	1. The student connects to the Internet. 2. The student is authenticated via HCMUT_SSO. 3. The student has sufficient printing page balance. 4. The printer is available
Postconditions	1. The document is printed successfully 2. The student's page balance is updated based on the pages used 3. The printing log is updated
Normal Flow	1. The student logs into the HCMUT_SSPS. 2. The student requests to print a document 3. The student uploads the document. 4. The student selects a printer 5. The student configures the print options (paper size, total number of pages, sigle or double sided, number of copies) 6. The system verifies the student's page balance 7. If the student has sufficient balance, the system sends the document to the selected printer. 8. The printer prints the document. 9. The student's page balance is reduced based on the print job. 10. The printing log is updated.

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Alternative Flow	3.1 The student can remove the file if he/she doesn't want to print anymore. 4.1 The student can upload the configuration file that he/she has already created in which he/she doesn't need to set the configuration again.
Exceptions	2.1 If the student uploads a file type that is not supported, the system will inform the student and cancel the file. 2.2 If the student uploads a file that is too large, exceeds accepting space, the system will also cancel that file and notify the student. 4.1 If the printer is offline or unavailable, the system will inform the student and the student can select another printer. 8.1 If the print job fails in mid-process, the system will log the error and inform the student, allow them to retry printing after resolving the error.

2. Usecase View personal printing history

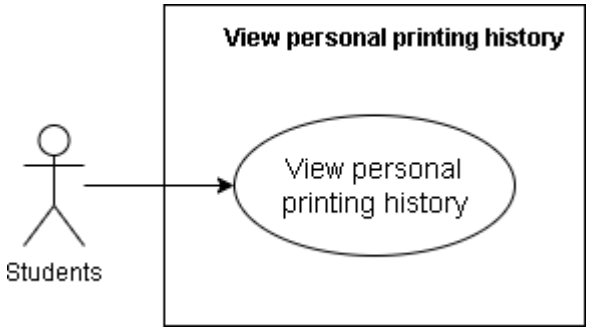

Figure: Usecase View personal printing history

ID and Name	UC2 View personal printing history
Created by	Phan Quang Minh
Date created	22/09/2024
Actors	Students, HCMUT_SSPS

Description	The student views his/her personal printing history for a selected period, including details such as print times, number of pages printed, page size summaries and printer used.
Trigger	The student requests to view his/her printing history
Preconditions	1. The student connects to the Internet. 2. The student is authenticated via HCMUT_SSO 3. The system contains log data for the previous print works. 4. The student has already done some print jobs.
Postconditions	1. The student's personal printing history is displayed 2. The request is logged for auditing purposes.
Normal flow	1. The student logs into HCMUT_SSPS. 2. The student navigates to "View Personal Printing History" option 3. The student selects a time period for which they want to view their printing history. 4. The system displays a list of print jobs, including details such as date, time, printer used, number of pages, and printing options (single/double sided,…) 5. The system shows a summary of pages printed for each page size (e.g., A4, A3).
Alternative flow	3.1 If no print job is done for the selected period, the printer will inform the student that there are no print jobs in the chosen period of time, then student can choose another time period.
Exceptions	3.2 If the student selects an invalid time range, The system will prompt the student to enter a valid time range. 4.1 If the system fails to retrieve log data, the system will notify the error to the student and prompt them to try again later.

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3. Usecase Buy more printing pages

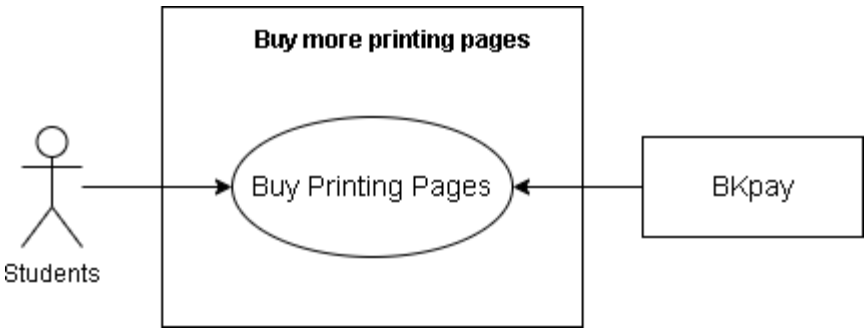

Figure: Usecase Buy more printing pages

ID and Name	UC3 Buy printing pages
Created by	Phan Quang Minh
Date created	22/09/2023
Actors	Students, HCMUT_SSPS, BKPay
Description	The student purchases additional printing pages through HCMUT_SSPS system by making an online payment via the BKPay payment system. The system updates the student's page balance once the transaction is successful.
Trigger	The student initiates the process to buy additional printing pages
Precondition	1. The student connects to the Internet 2. The student is authenticated via HCMUT_SSO 3. The student has access to a valid payment method through BKPay 4. The student has insufficient page balance
Postconditions	1. The student's page balance is updated with the purchased page 2. The transaction is recorded in the system

Normal flow	1. The student logs into HCMUT_SSPS. 2. The student navigates to "Buy Printing Pages" option. 3. The student selects the number of pages to buy. 4. The system redirects the student to BKPay payment portal. 5. The student enters payment information and confirms transaction. 6. BKPay processes the payment and sends confirmation to HCMUT_SSPS. 7. HCMUT_SSPS updates the student's page balance. 8. The payment is both logged in payment and printing systems. 9. The student is notified of the successful purchase.
Alternative flow	5.1 The student chooses payment method through credit/debit card: 5.1.1 The system prompts enter student to enter card number and CVV 5.1.2 The student confirms transaction. 5.2 The student chooses payment method through Internet Banking: 5.2.1 The system prompts student to choose bank services. 5.2.2 The student confirms transaction. 5.3 The student chooses payment method through Momo E-waller: 5.3.1 The system creates a QR code 5.3.2 The student scans the QR code to confirm transaction,
Exceptions	4.1 If the payment service is down, the system will inform the student and tell them to retry later. 5.4 If the payment information is incorrect, the system will inform the student to correct his/her payment information and retry the transaction. 5.5 If there is insufficient fund in the student's payment account, the system will inform the student to either retry or try another payment methods.

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4. Usecase Login

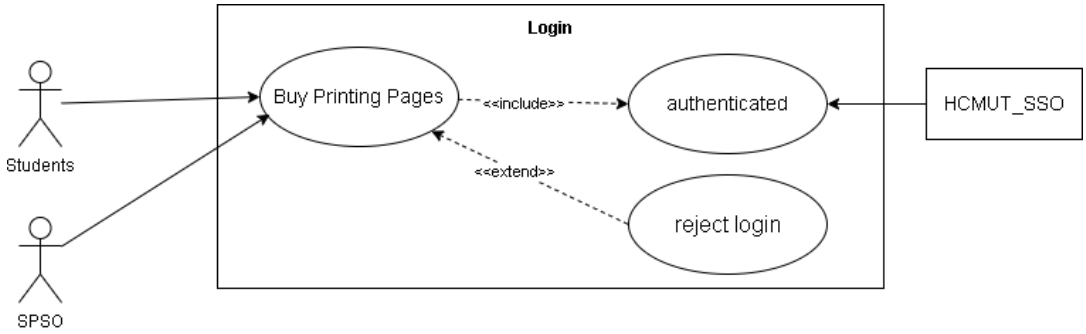

Figure: Usecase Login

ID and Name	UC4 Login
Created by	Phan Quang Minh
Date created	22/09/2023
Actors	Student, HCMUT_SSO, SPSO, HCMUT_SSPS
Description	The student or SPSO logs into the HCMUT_SSPS using their credentials authenticated by the HCMUT_SSO system.
Trigger	The student or SPSO wants to access HCMUT_SSPS
Preconditions	1. The user (student or SPSO) has valid logic information. 2. HCMUT_SSO is operational
Postconditions	1, The user is authenticated and granted access to HCMUT_SSPS 2. The user can perform actions based on their roles.
Normal flow	1. The user opens the HCMUT_SSPS login page. 2. The user enters their username and password. 3. HCMUT_SSO verifies the login information.

	4. If they are correct, HCMUT_SSO confirms the authentication to HCMUT_SSPS. 5. The system grants the user access to the platform based on their role (student or SPSO).
Alternative flow	2.1 If the user forgets their password: 2.1.1 The system provides a link to reset the password via HCMUT_SSO. 2.1.2 The user follows the password reset process and retries the login.
Exceptions	1.1 HCMUT_SSO service is down: 1.1.1 The system informs the user that the authentication service is unavailable. 1.1.2 The user cannot log in until the service is restored. 2.2 Invalid login information: 2.2.1 HCMUT_SSO rejects the login request. 2.2.2 The system notifies the user of the failed login attempt and prompts them to retry.

5. Usecase Manage Printer

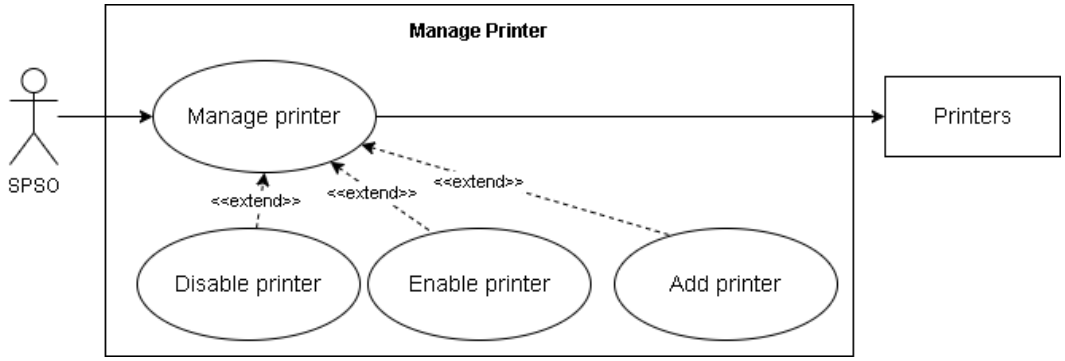

Figure: Usecase Manage Printers

ID and Name:	UC5 Manage printers		
Created By:		Dated Created:	
Primary Actors:	SPSO	Secondary Actors:	Printer
Description:	The SPSO can control the Printers by choosing which ones to apply		

	changes. The change could range form add, enable to disable printers.
Trigger:	SPSO indicate that they want to change printers' setting
Precondition:	PRE-1: User identity has been authenticated PRE-2: User is authorized to change printers setting PRE-3: Printers is connected to the system
Postcondition:	POST-1: Changes are record in the database POST-2: Changes are sent to the corresponding printers
Normal flow:	**1.0 Choose "Enable Printer" option** 1. User select the "Enable Printer" option 2. System displays a list of disable printers 3. User select printers from the list or search them up via search bar then press enable 4. System record to the history then signal the corresponding printers
Alternative flow:	**1.1 Choose "Disable Printers" option** 1. User select the "Disable Printers" option 2. System displays a list of printers that currently active 3. User select printers from the list or search them up via search bar then press disable 4. System record to the history then signal the corresponding printers
Alternative flow:	**1.2 Choose "Add Printers" option** 1. User select the "Add Printers" option 2. User fill in the new printer information to the system 3. System establish connection to the newly added printer 4. System record to the history then add new printer to the database
Exception flow:	3.0.1 If the system cannot find the printer via search bar, the system notifies the user about the situation then ask users to input again 3.0.2 If the system cannot find the printer via search bar, the system notifies the user about the situation then ask users to input again

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6. Usecase Manage System's configuration

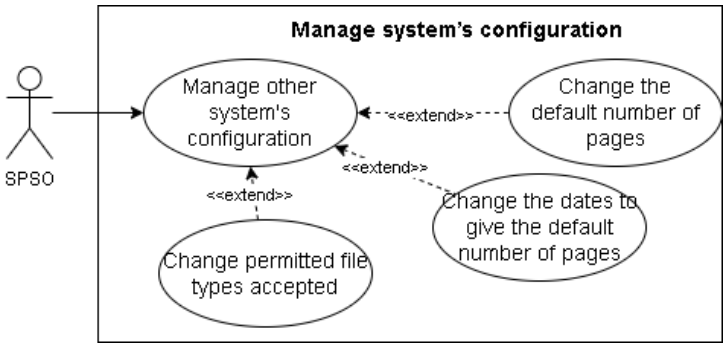

Figure: Usecase Manage System's configuration

ID and Name:	UC6 Manage system's configuration		
Created By:		Dated Created:	
Primary Actors:	SPSO		
Description:	The SPSO specify which system's configuration to apply changes, which could be either the default number of pages, the dates to give the default number of pages or permitted file types accepted. The system will change to fit the desired config		
Trigger:	SPSO indicate that they want to change system's configuration		
Precondition:	PRE-1: User identity has been authenticated PRE-2: User is authorized to change system's configuration PRE-3: System is currently online		
Postcondition:	POST-1: Changes are record in the database POST-2: system change correspondingly		
Normal flow:	**1.0 Choose "Change default number of pages" option** 1. User select the "Change default number of pages" option 2. System displays the current default number of pages 3. User input the new default number 4. System record to the history then execute the change		
Alternative flow:	**1.0 Choose "Change reset cycle" option** 1. User select the "Change reset cycle" option 2. System displays the current reset cycle 3. User input the new reset cycle 4. System record to the history then execute the change		
Exception flow:	**1.2 Choose "Change permitted file types" option** 1. User select the "Change permitted file types" option		

	2. System displays a list of file types that currently permitted to use 3. User change the setting 4. System records the change and apply it to the setting

7. Usecase View all student's printing history

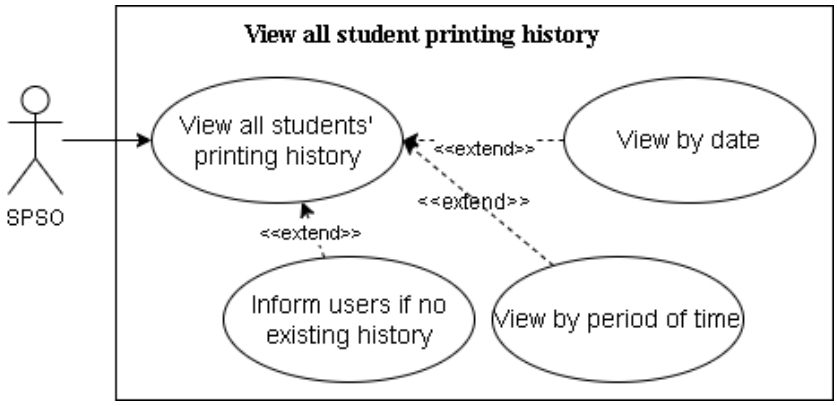

Figure: Usecase View all student's printing history

ID and Name:	UC7 View all student printing history		
Created By:		Dated Created:	
Primary Actors:	SPSO		
Description:	The SPSO can view the all students printing history by enter which period of time or date and the system will display all data that relate to that given time.		
Trigger:	SPSO indicate that they want to change system's configuration		
Precondition:	PRE-1: User identity has been authenticated PRE-2: User is authorized to change system's configuration PRE-3: System is currently online		
Postcondition:	POST-1: system display the list of printing history of all students		
Normal flow:	1. User select the "view Printing History of all students" option 2. User input the desire date or the period of time 3. System displays all printing history during the given date or period of time		
Exception flow:	3.1 If there were no student printing during that period of time, date or there were no printer exist during that period of time yet then the system will inform the users about it then ask user to try another one.		

8. Usecase View printing report

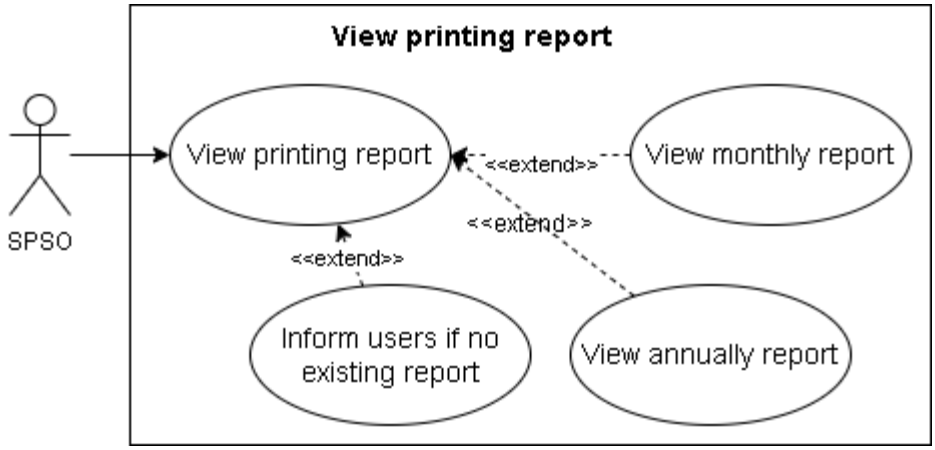

Figure: Usecase View printing report

ID and Name:	UC8 View printing report		
Created By:		Dated Created:	
Primary Actors:	SPSO		
Description:	The SPSO can view the printing report which is automatically generate at the end of each month or at the end of each year		
Trigger:	SPSO indicate that they want to view the report		
Precondition:	PRE-1: User identity has been authenticated PRE-2: User is authorized to change system's configuration PRE-3: System is currently online		
Postcondition:	POST-1: system display the list of printing report		
Normal flow:	1. User select the "View Printing Report" option 2. System displays the list of report that either currently generated or from the previous period of time 3. User search which reports to view 4. System displays the chosen report		
Exception flow:	1.1 If there were no printing report during that period of time, date then the system will inform the users about it and exit		

2.1. Activity Diagram

2.1.1. Guest

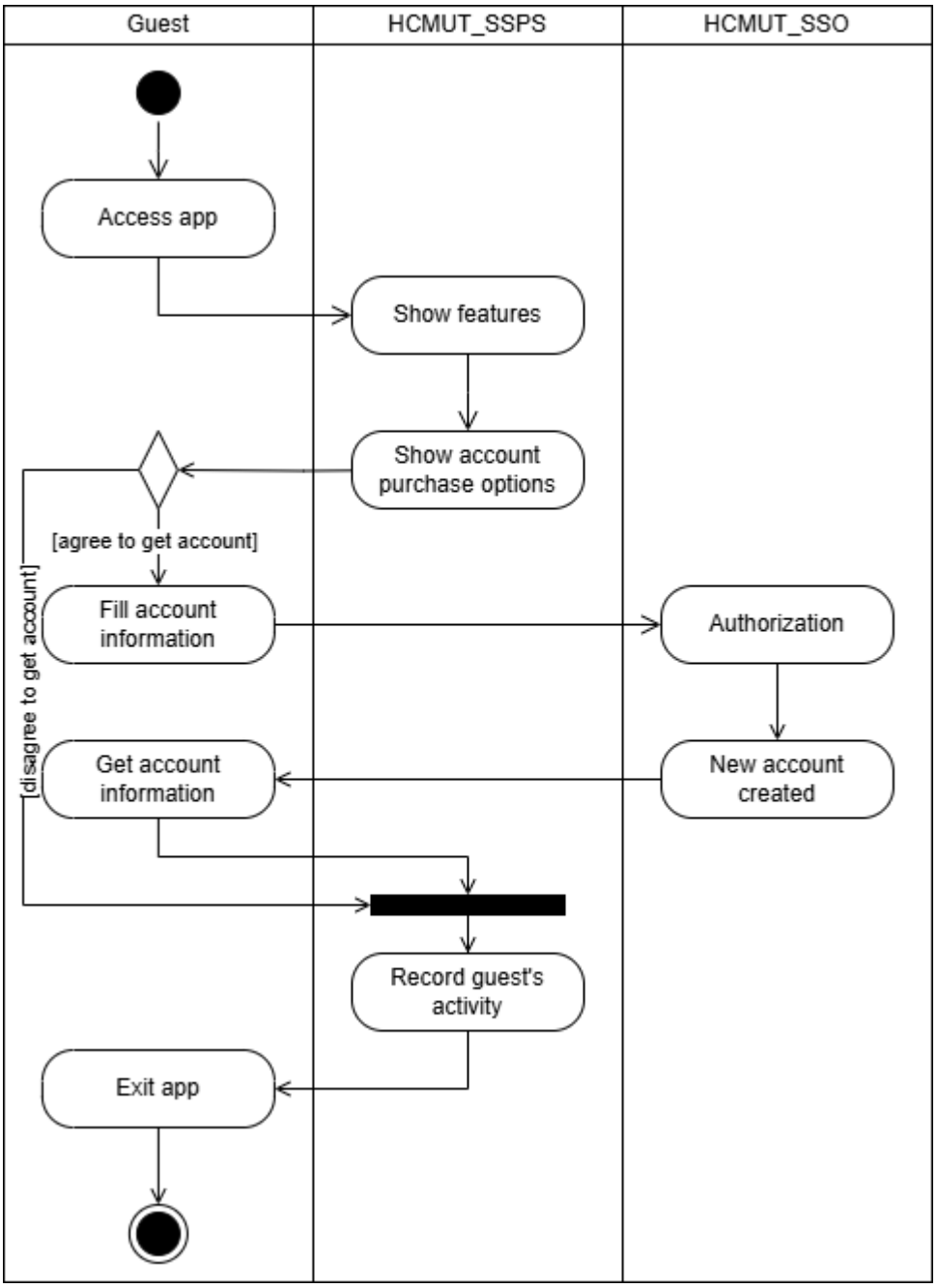

Figure: Activity Diagram Guest

`

2.1.2. Login

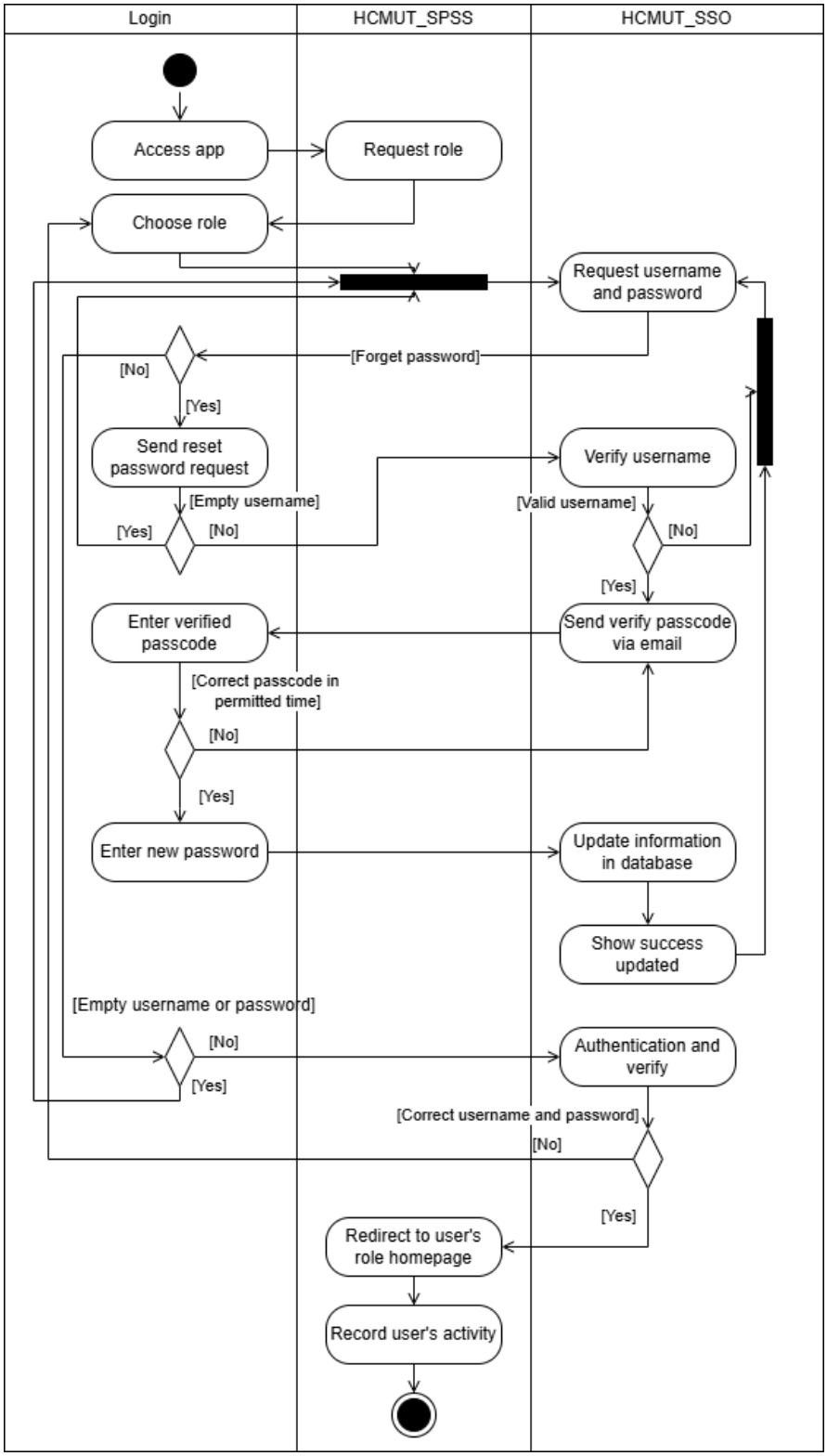

Figure: Activity Diagram Login

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2.1.3. Printing

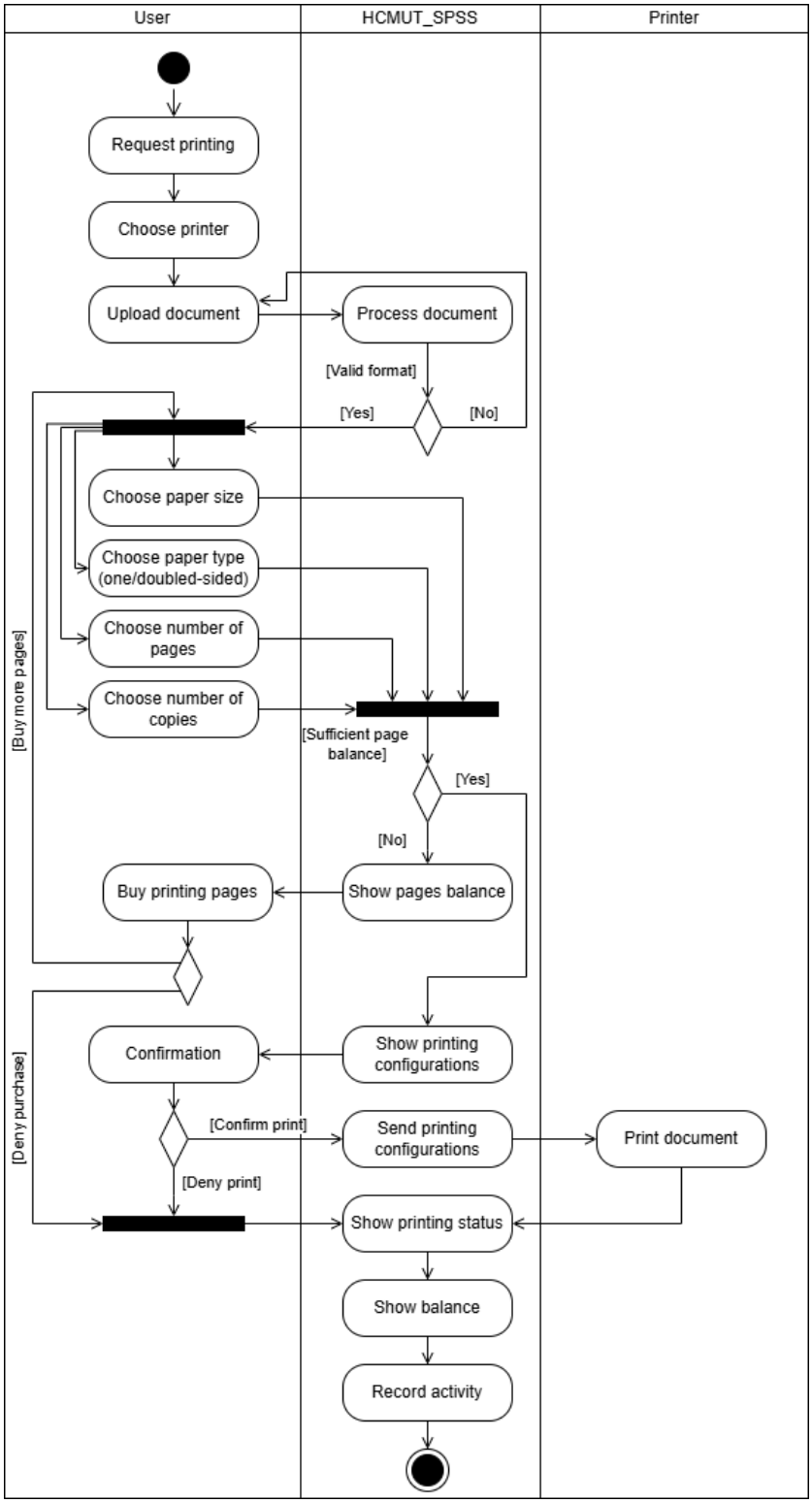

Figure: Activity Diagram Printing

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2.1.4. Payment

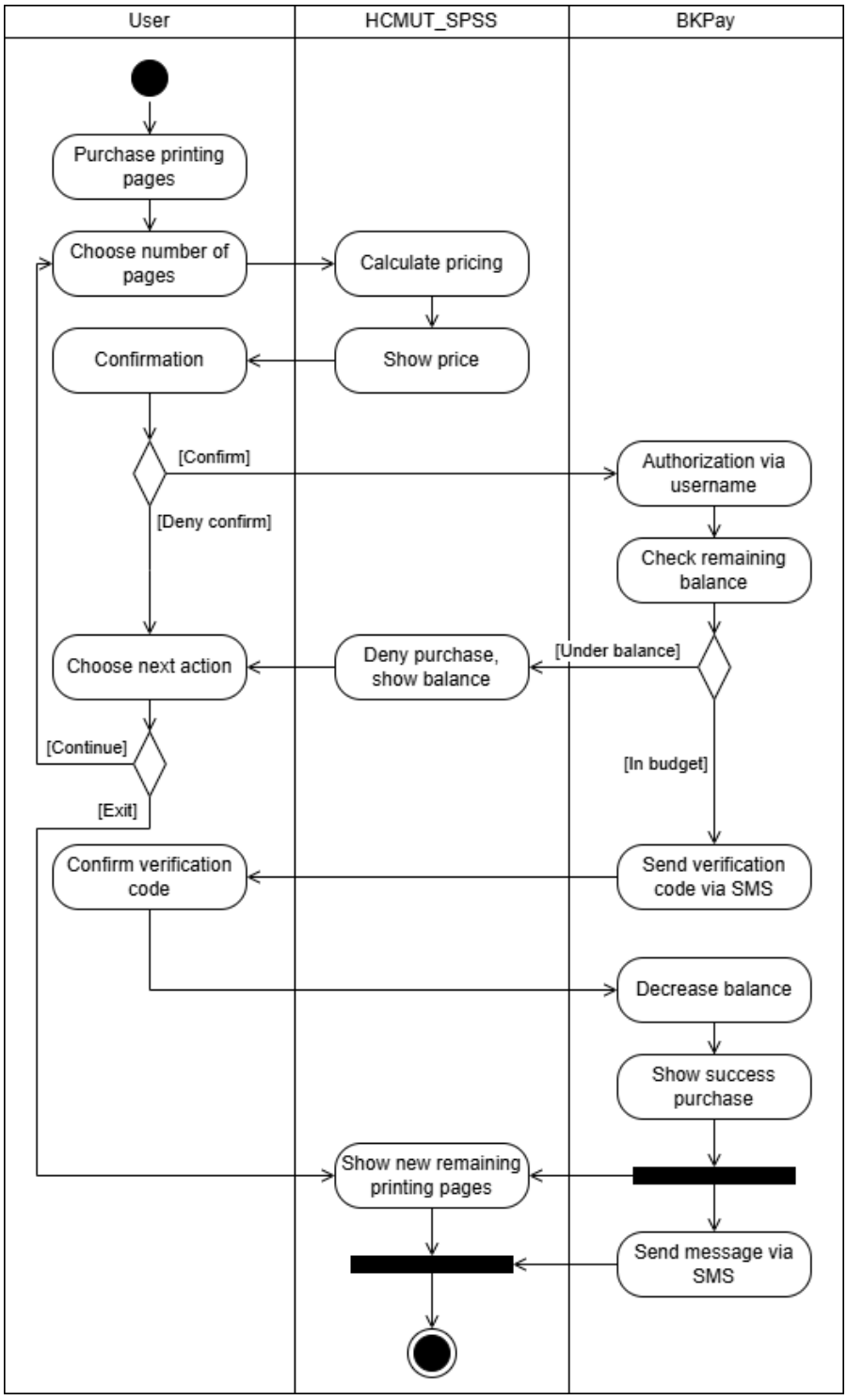

Figure: Activity Diagram Payment

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2.1.5. Manage

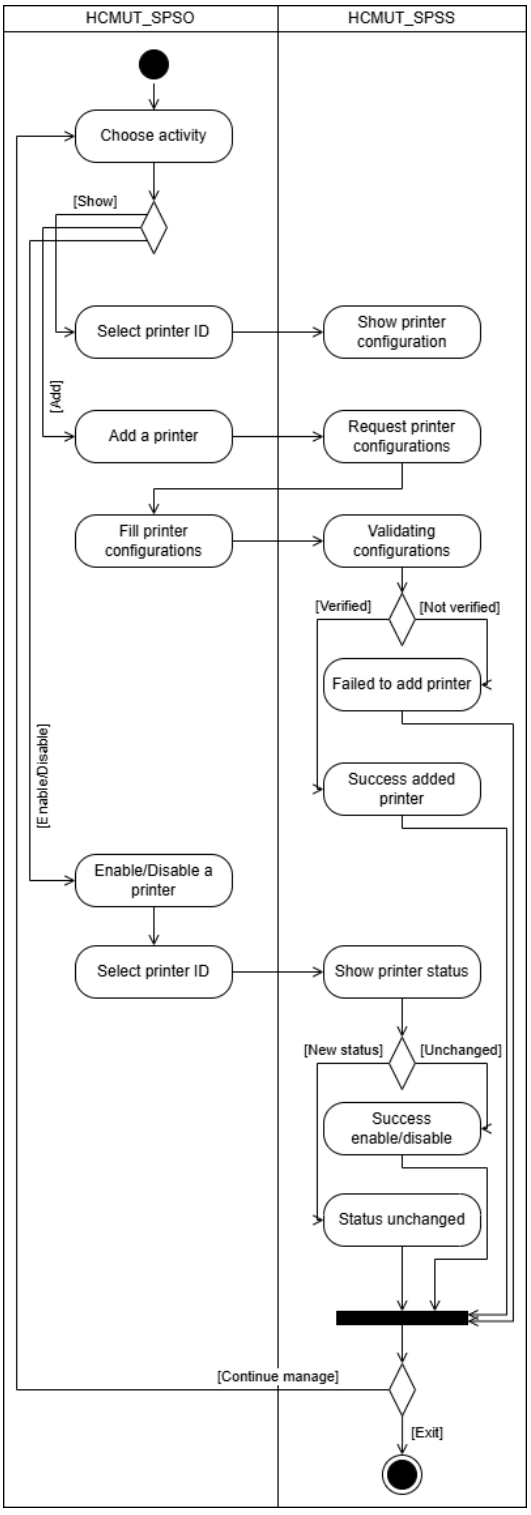

Figure: Activity Diagram Manage

`

2.1.6. Configuration

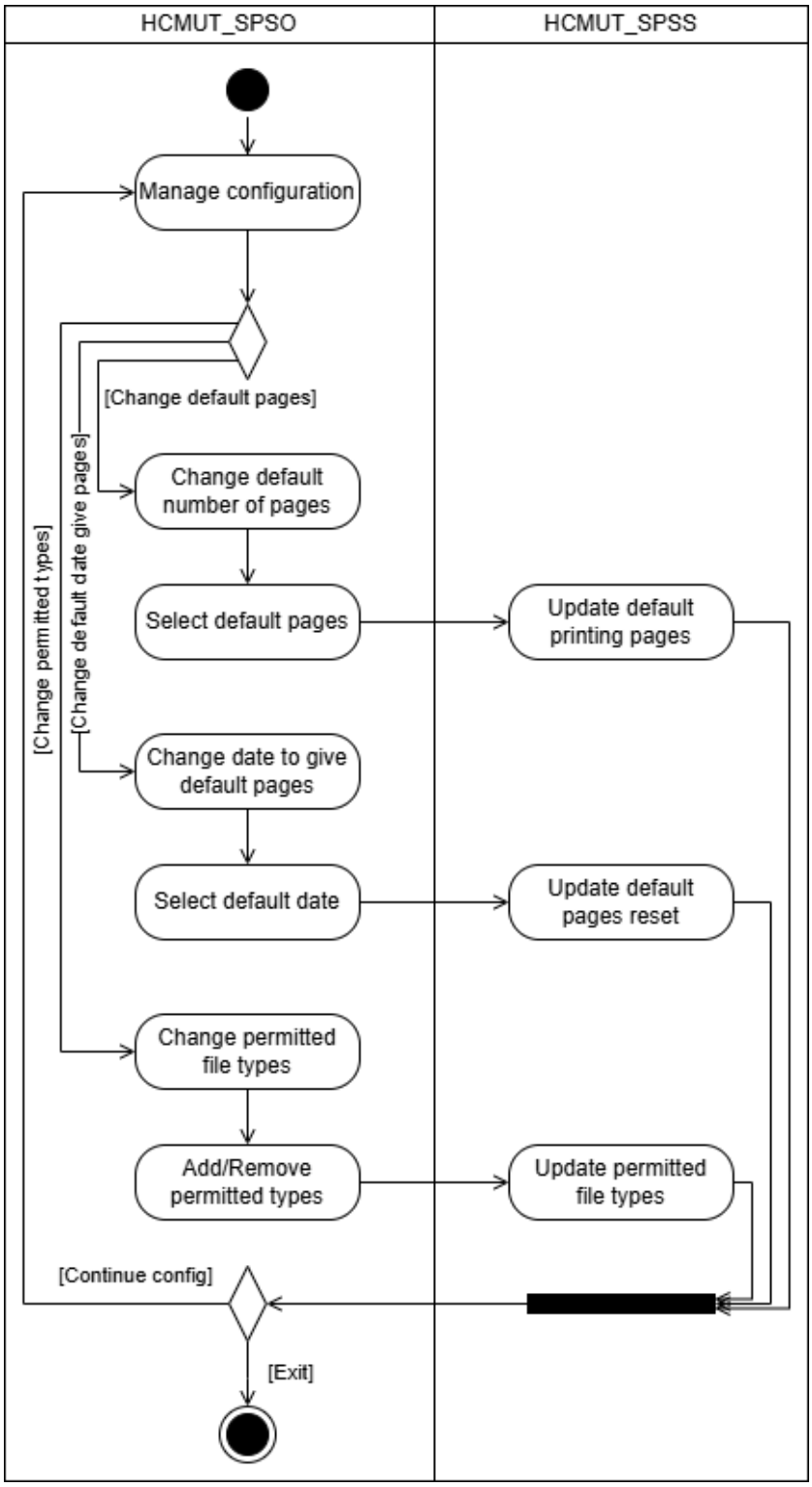

Figure: Activity Diagram Configuration

`

2.2. Sequence Diagram

2.2.1. Login

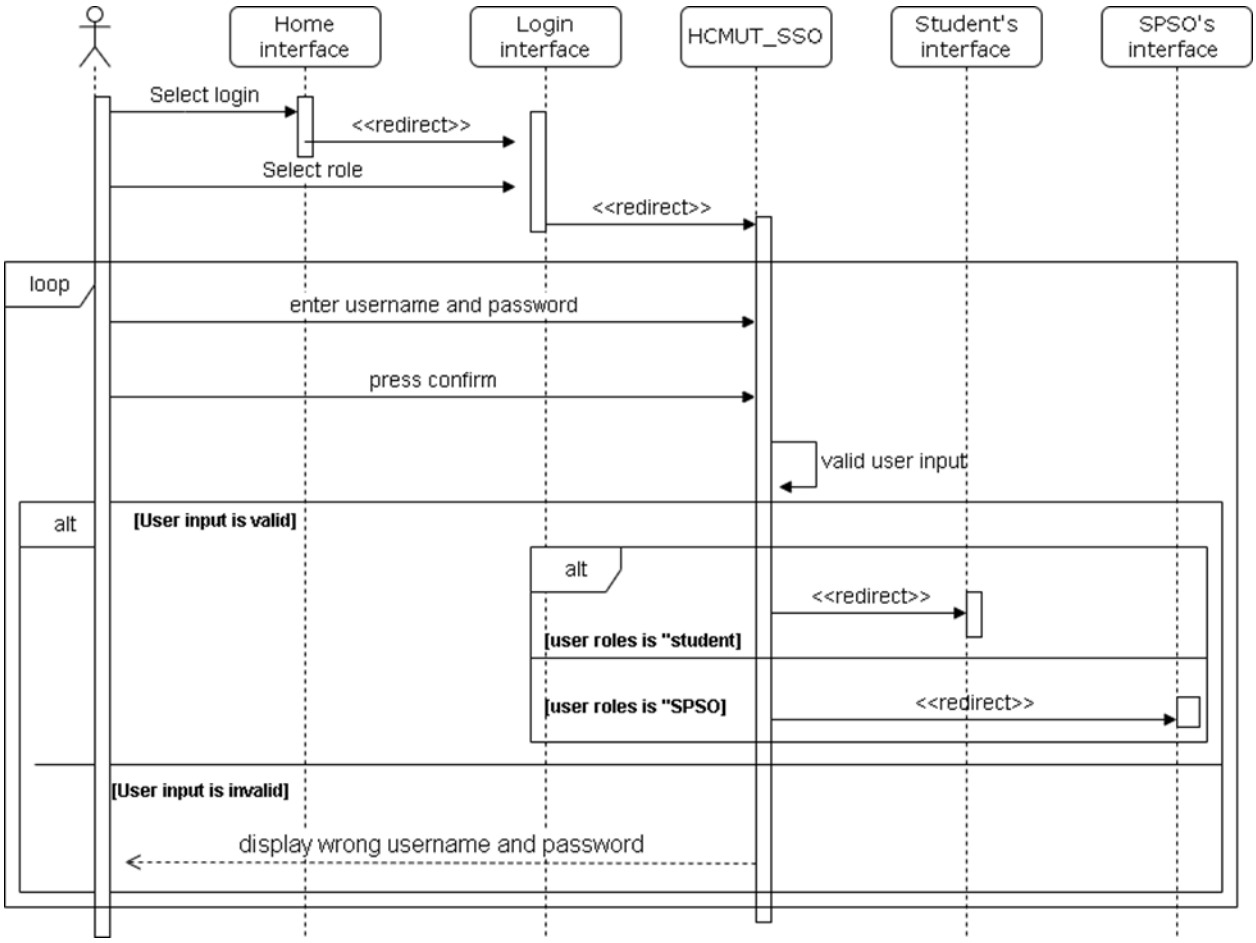

Figure: Sequence Diagram Login

Description

Login feature is used by users, either by student or SPSO, to access their printing account and utilize its feature. This feature helps the system to filter between guest, students and staff members; give administration to the rightful managers. Starting from the home page, after users select login, they are requested choose between students and SPSO then input username and password. If the given username and password is invalid or not match any account in the database, the interface will notify the user and they are allowed to try again. Otherwise the website will redirect to the interface that in respected to their role.

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2.2.2. Printing request

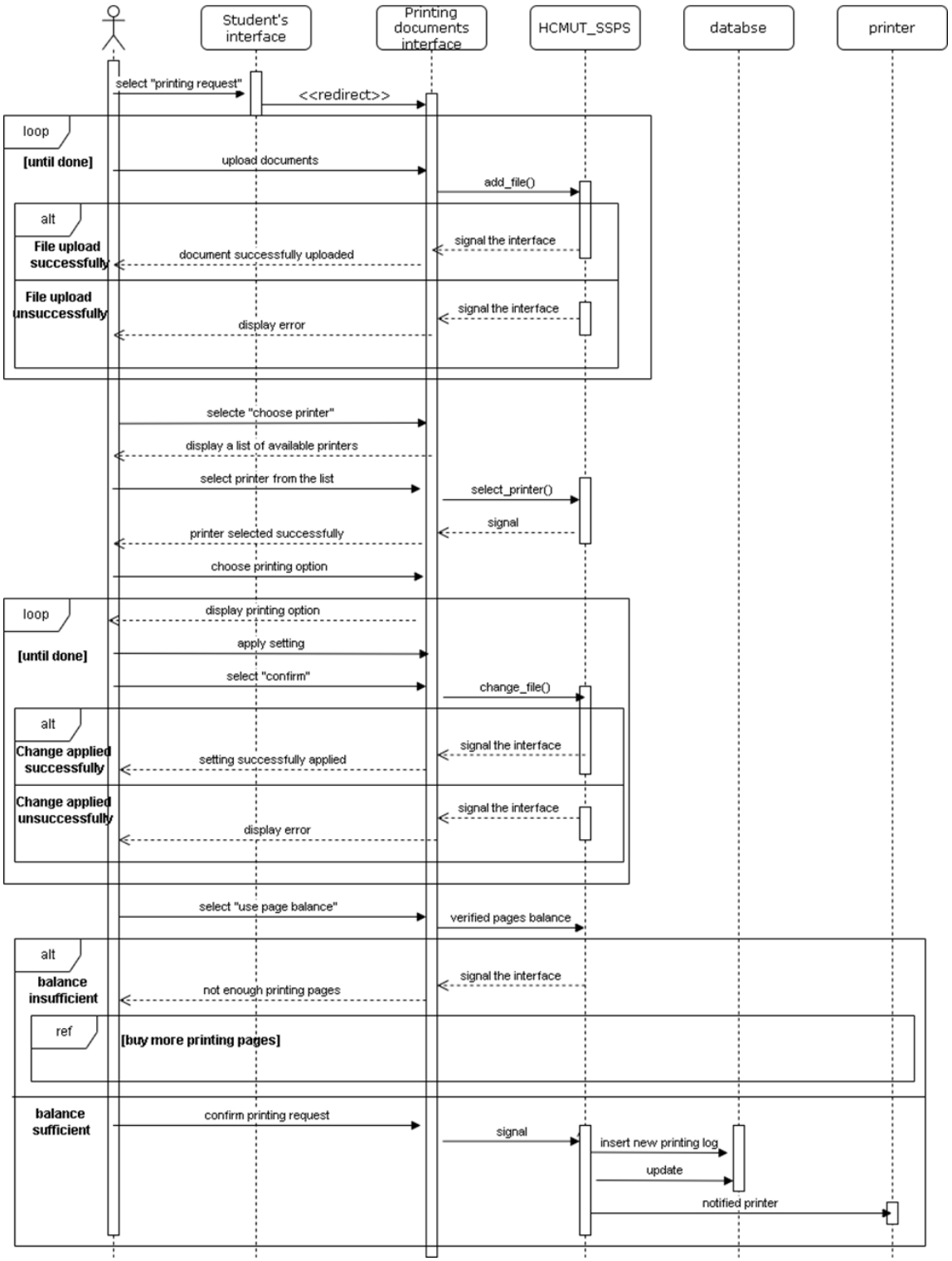

Figure: Sequence Diagram Printing request

Description

This is one of the most important features in the system. It allows student to print document base on their account balance. Once they select the printing option, they are directed to the printing document interface which consist of a number of steps before printing request can be sent. Firstly, they need to successfully upload document to the system, any fail attempt, maybe by weak connection, or wrong name, will be required to try again. Secondly, a printer much be chosen to send the printing request. List of available printers is presented to the users from which they can choose. Third, the student can choose what setting to apply to the document, either going with the default setting or customize freely base on which the available option in the interface. If for some reason the printing option is not suitable to the document then the interface will notify so. Finally, the system needs to verified sufficient pages balance in other to proceed to the next phase, unless they have enough balance, they have to by more in the bk_pay, the sequence of which will be display later. But if they have enough, then after they confirm the printing request the system will record their request to the database for future inspection and report. The request itself will be sent to the printer and be proceed there.

2.2.3 Buy Printing Pages

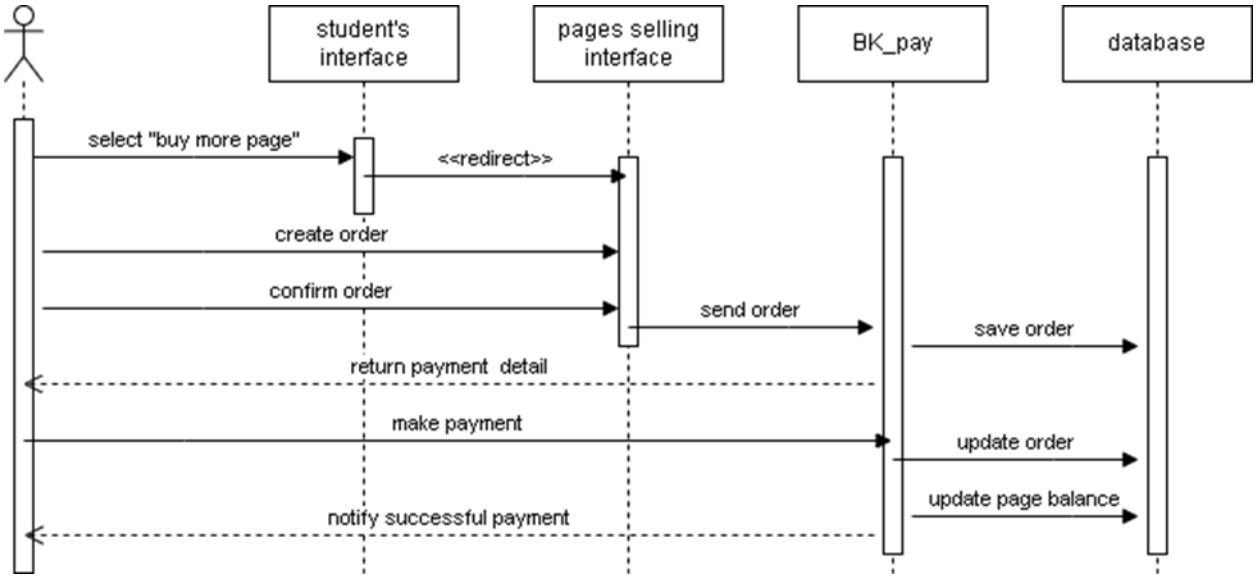

Figure: Buy Printing Page Sequence Diagram

Description

The feature help student extends their page limit. At the page selling interface, after the student create order and confirm it, they will be send to BK_pay system, at which the process of payment will begin. When the payment is done, BK_pay will update the status of the order to the database as well as update the page balance to the student account. The student will also receive a notification indicate that their payment is successful and that their page is updated.

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2.2.4. Manage Printers

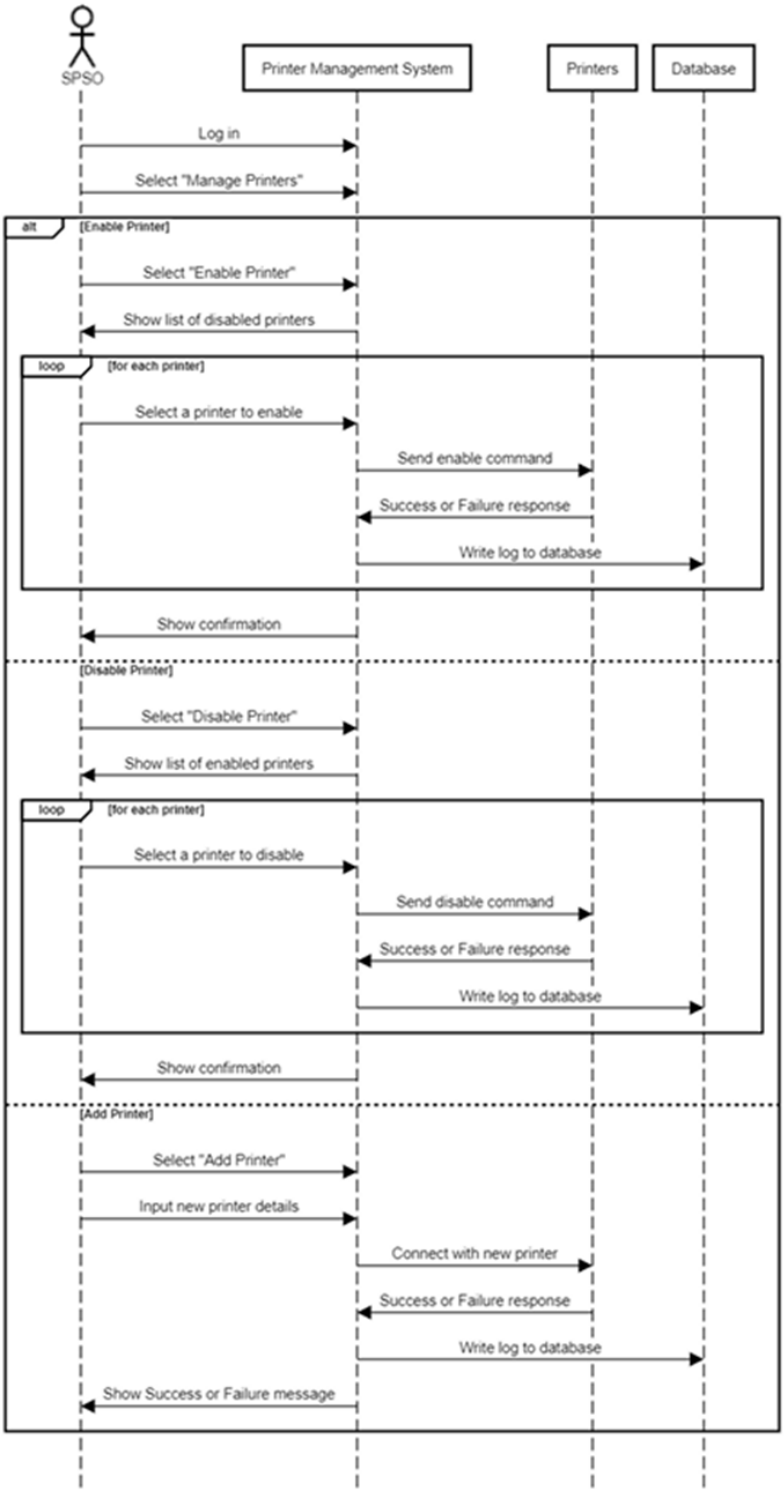

Figure: Manage Printers Sequence Diagram

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Description

The sequence diagram describes Printer Management System which can be controlled by SPSO. SPSO can control the printers by selecting which printer to apply the change such as adding, enable, and disable the printer. User can logs in, select "Manage Printers" and perform one of three functions: - Enable printer: Selects the printer from the disabled list, sends the enable command, logs it and receives the result. - Disable printer: Selects the printer from the enabled list, sends the disable command, logs it and receives the result. - Add printer: Enters the new printer information, connects the printer, and logs the result. Each functions ends with logging to the database and displaying a message to the user.

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2.2.5. Configuration Management System

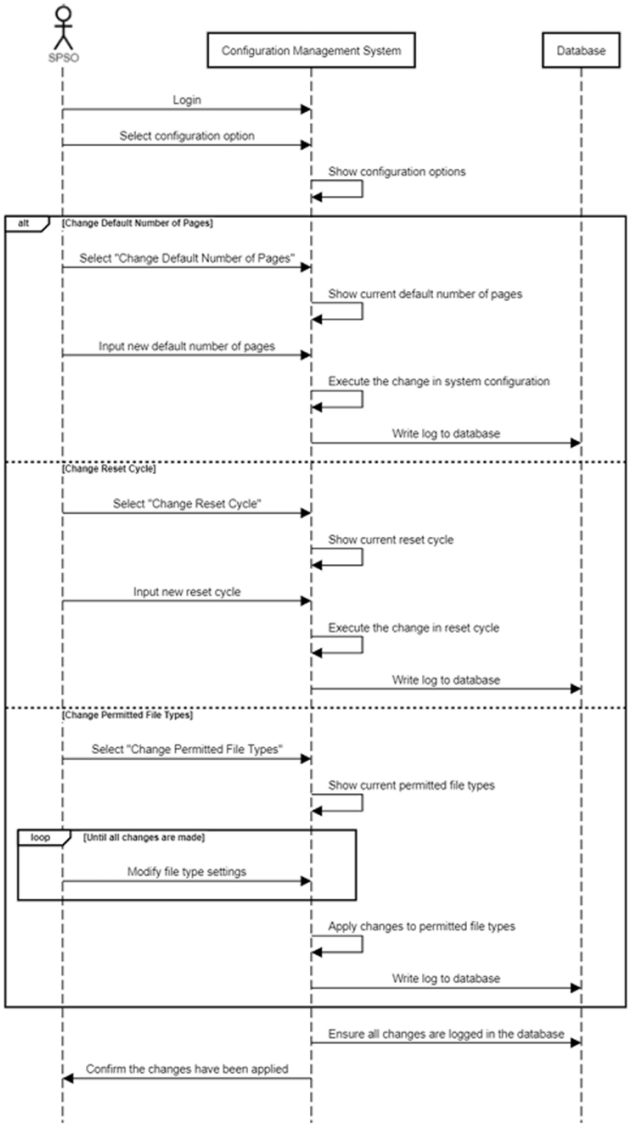

Figure: Sequence Diagram Configuration Management System

Description

SPSO can change system configurations such as default page number, reset cycle, or permitted file types. The system will change based on the new configuration. Preconditions include the user being authenticated, having permission to change the configuration, and the system being online. After the change, the changes are logged to the database and the system applies the change accordingly.

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2.3. Class Diagram

2.3.1. Login, Printing and Log

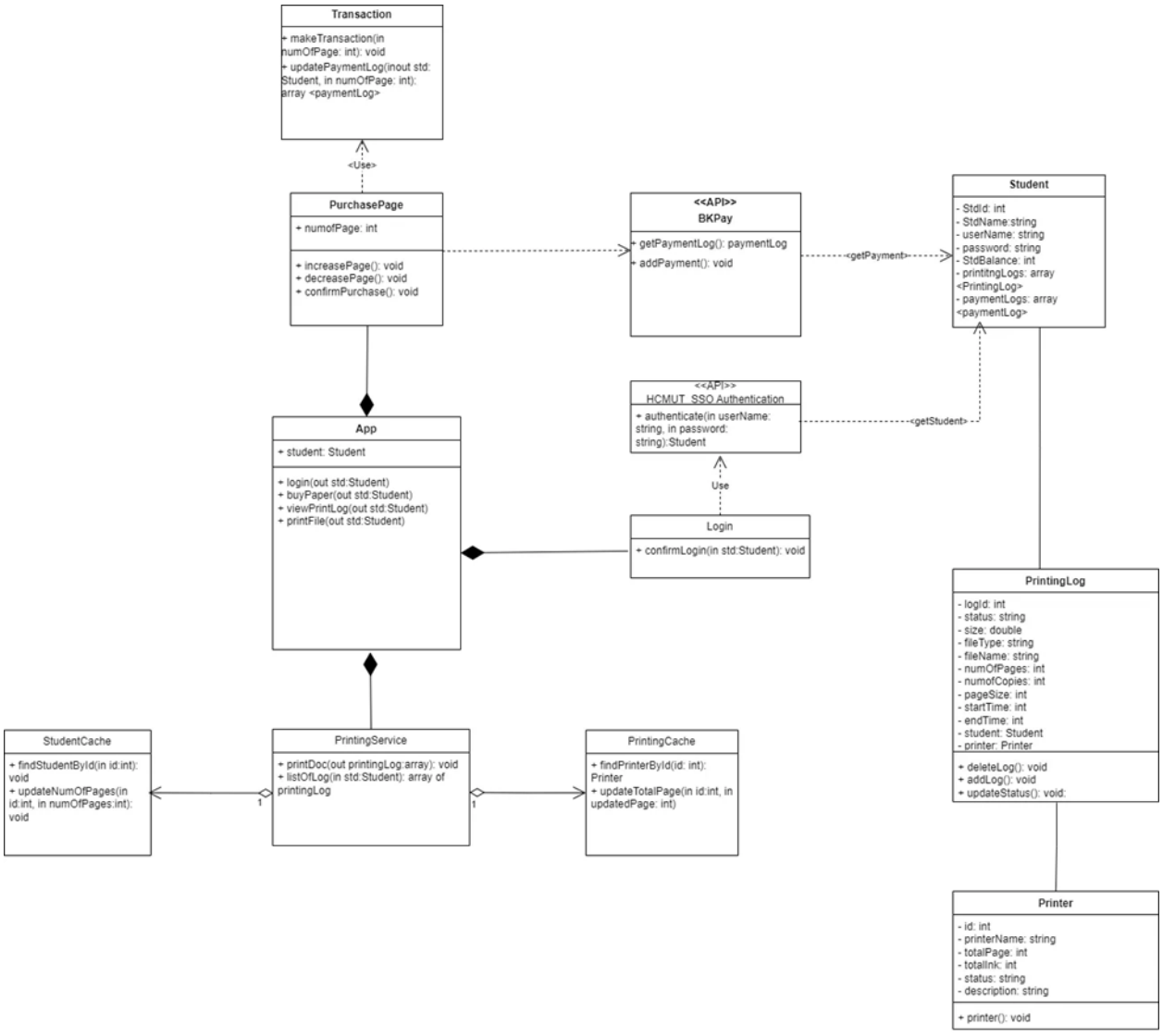

Figure: Class Diagram Login, Printing and Log

2.3.2. Management and Configuration

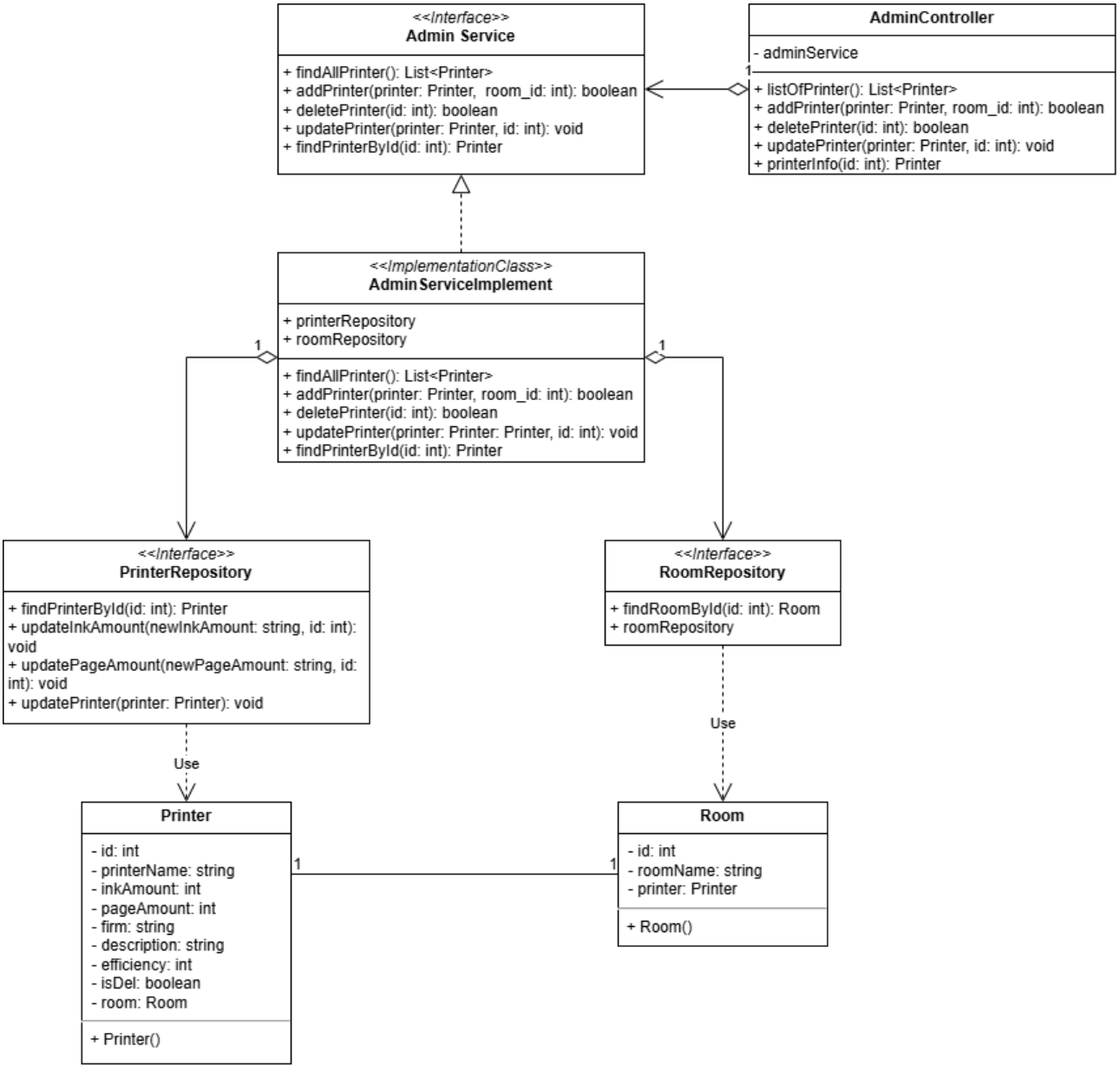

Figure: Class DiagramManagement and Configuration

2.4. MVP 1 User Interface

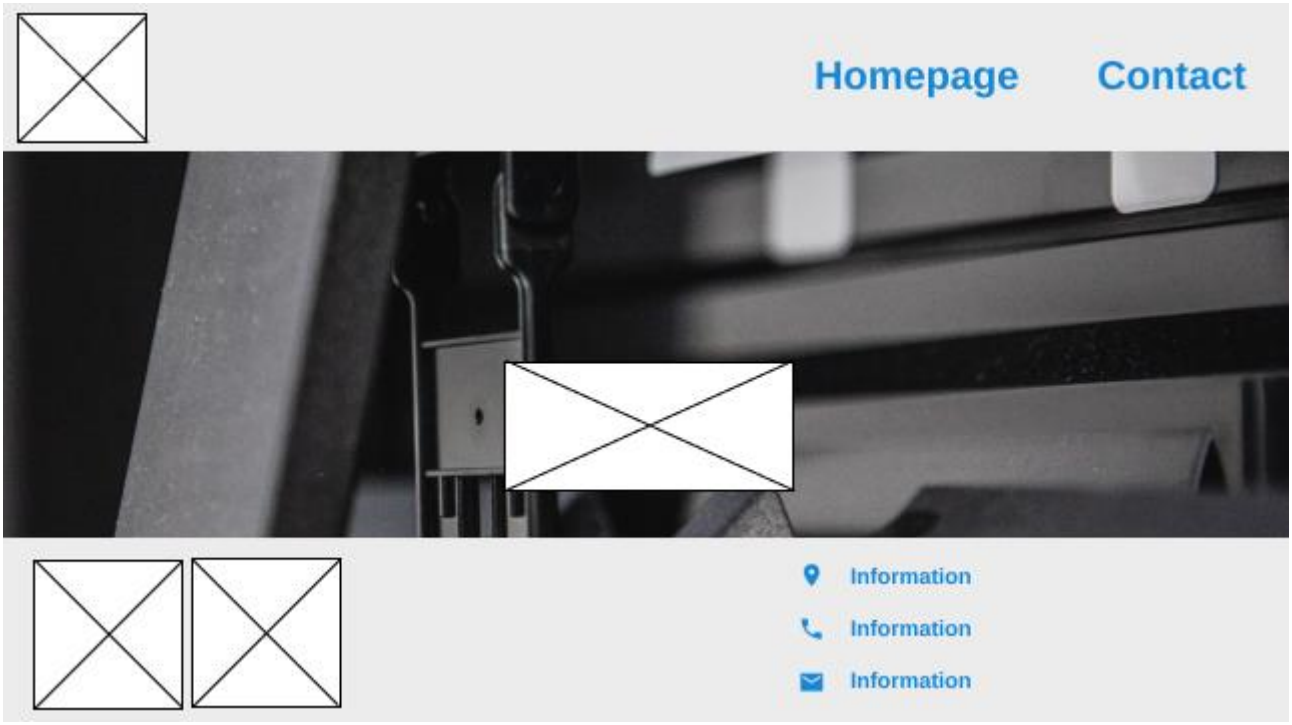

Figure:Homepage and login

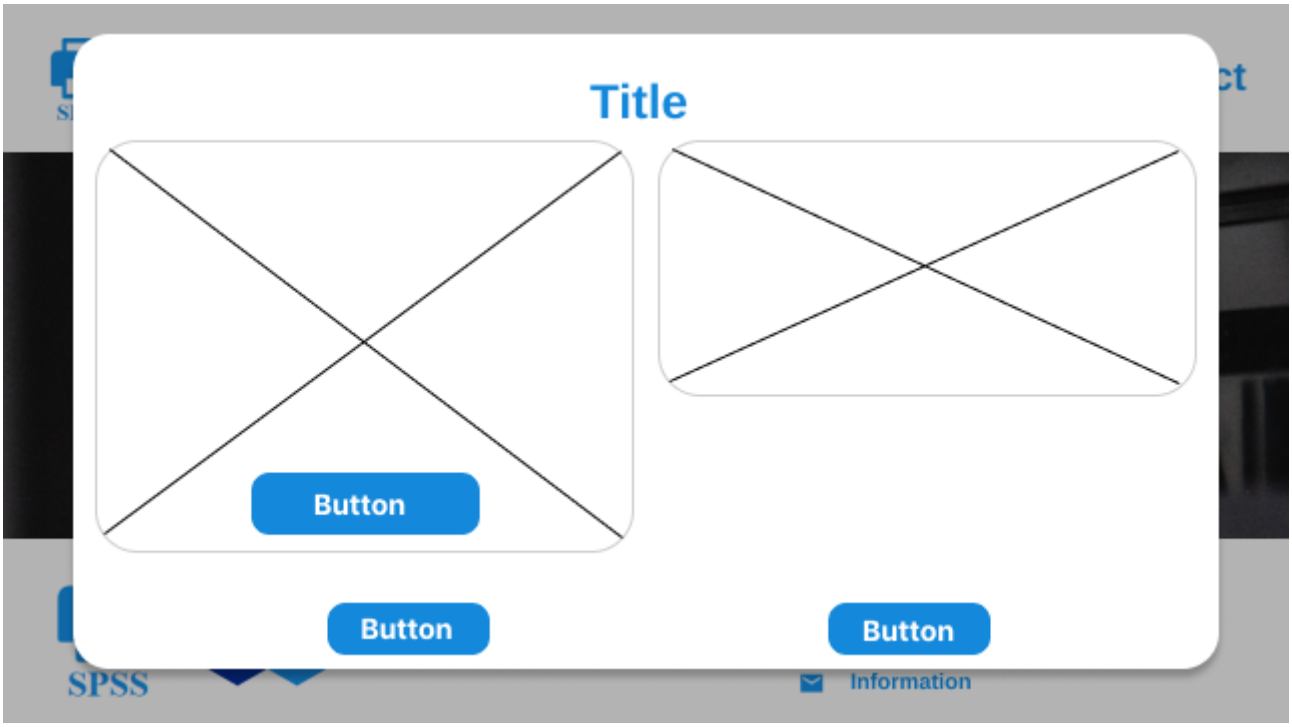

Figure:Buying printing pages

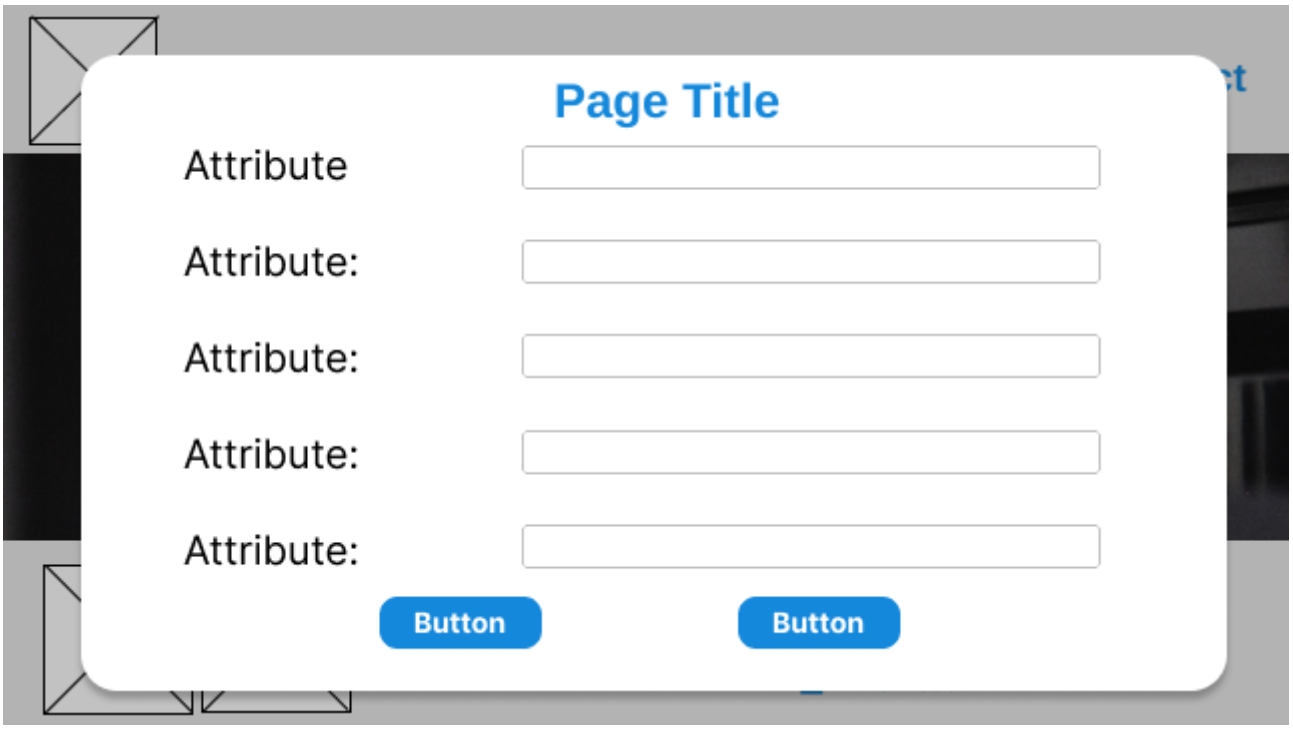

Figure:Add printers

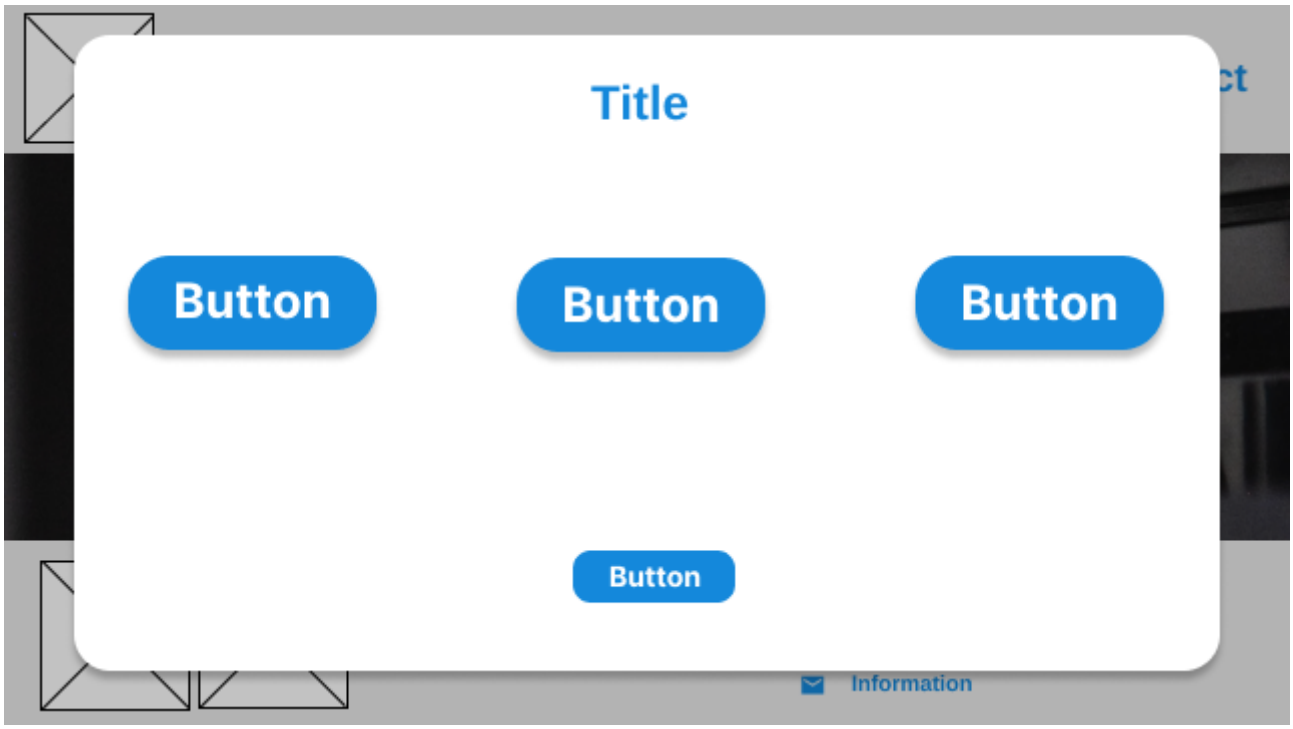

Figure: Printer options

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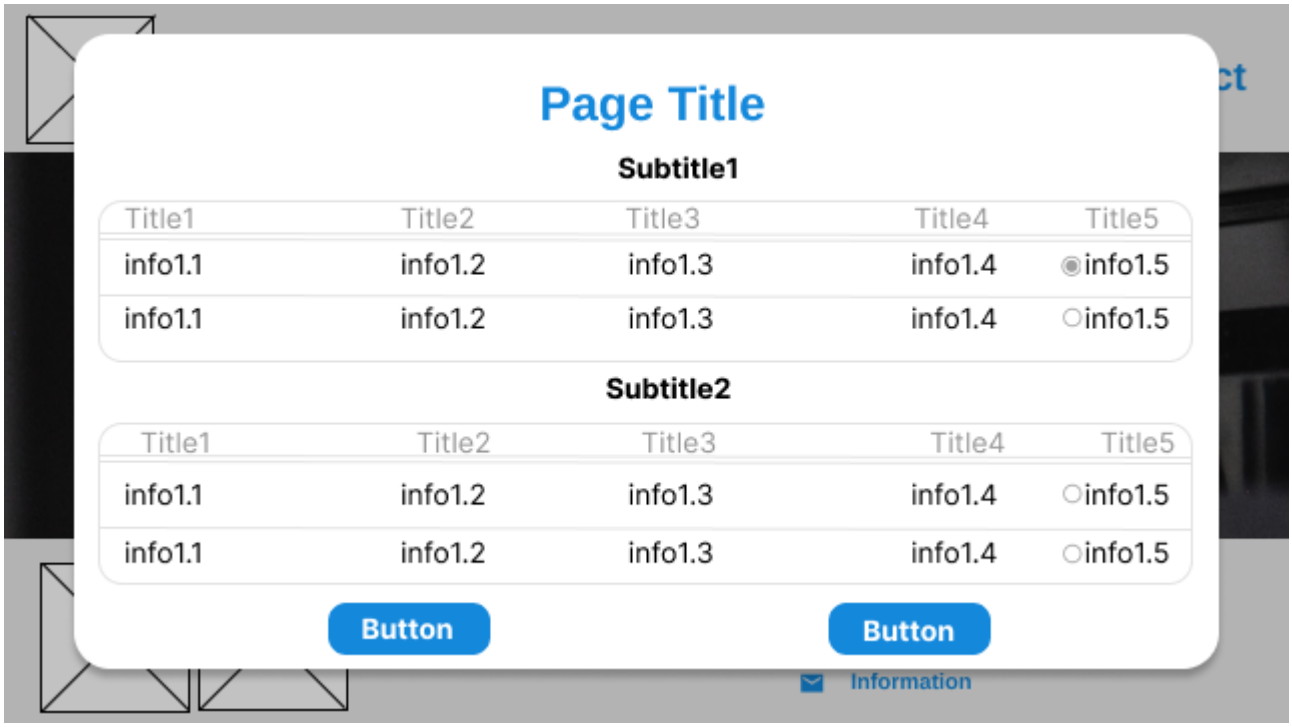

Figure: Choose printer

3. Layered Architecture

3.1.1. Layered Architecture

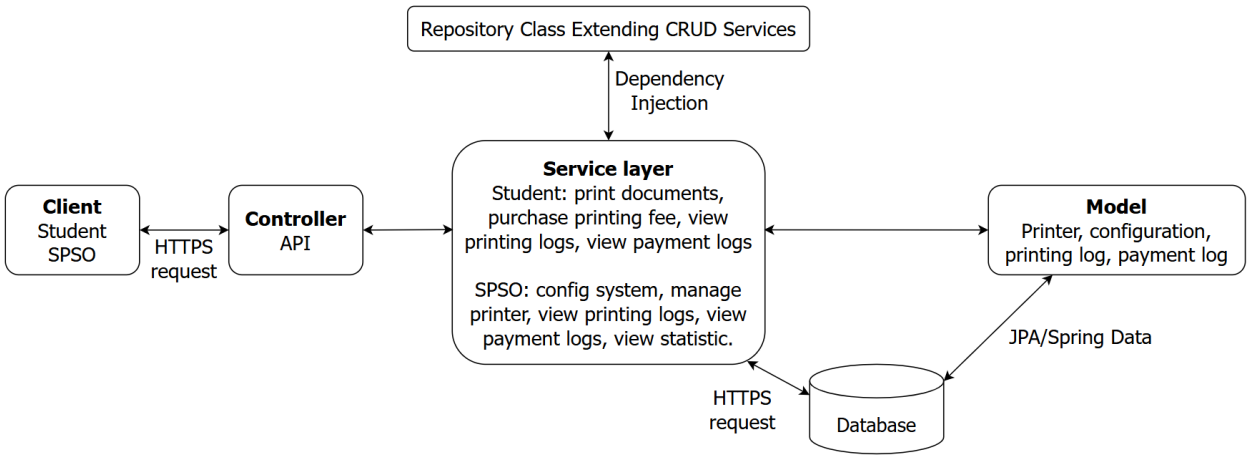

Figure: MVC Layered Architecture

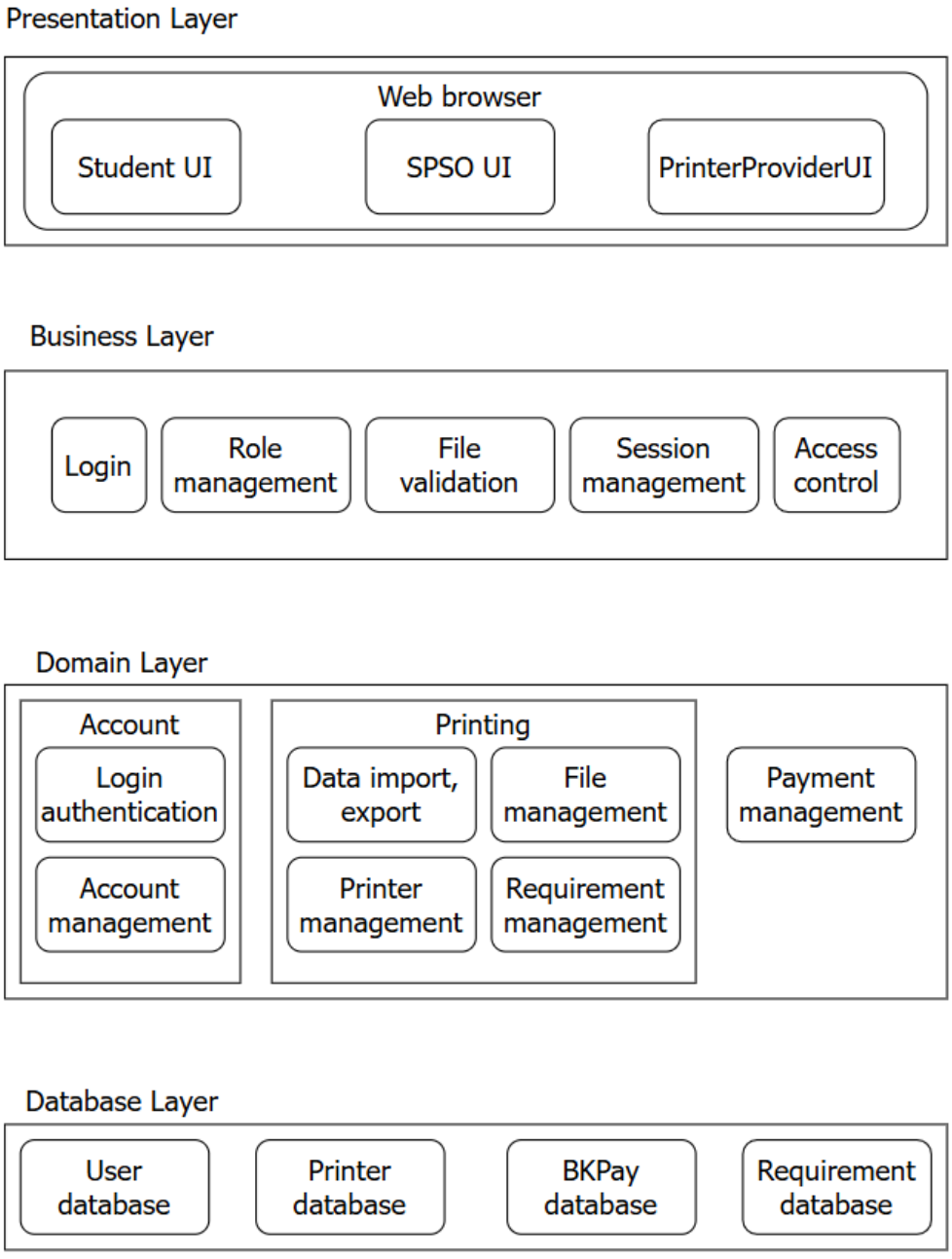

Figure: Layered Architecture

3.1.2. Layered architecture diagram

a. Presentation Layer:

Components:

- Student UI
- SPSO UI
- PrinterProviderUI

Description: The Presentation Layer is responsible for the user interface and provides access points for different types of users. Each UI is designed for the specific needs of the user roles:

- Student UI: Create a user interface that attracts students and help them to easily upload documents, manage their printing quotas, and review their printing history.
- SPSO UI: Provide a user interface that Student Printing Service Officers can manage printers, view printing logs, configure printing policies, and access system reports.
- PrinterProvider UI: Create a user interface for printer administrators to manage and maintain printers.

Dependencies: The Presentation layer relies on the Business Layer for basis functions like login, file validation, session management, and access control.

b. Business Layer:

Components:

- Login
- Role Checking
- File Validation
- Session Management
- Access Control
- Page Quota Management

Description: The Business Layer is responsible for processing user requests, enforcing business rules, and managing user access and sessions. This layer provides some of the most important services in the program such as:

- Login: Handles user authentication requests, working closely with the Domain Layer's Login Authentication component.
- Role Checking: Provide appropriate permissions to each user to perform their actions and protect the unauthorized access to crictical permissions and data.
- File Validation: Ensures that uploaded documents meet system requirements, such as allowed file types and file size.

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- Session Management: Maintains user sessions securely to ensure system performance and prevent unauthorized access.
- Access Control: Restricts access to system components based on user roles.
- Page Quota Management: Manages the printing quota for each student, ensuring that they cannot exceed their page limits.

Dependencies: The Business Layer collabration with the Domain Layer to provide core services like Account Management, File Management, and Payment Management.

c. Domain Layer:

Components:

- Account Management:
  - Login Authentication
  - Account Management
- Printing:
  - Data Import/Export
  - File Management
  - Printer Management
  - Requirement Management
- Payment Management

Description: The Domain Layer encapsulates the main business logic and core operations of the system. This layer manages data and processes that is necessary for the printing service:

- Login Authentication: Verifies user credentials during login and manages secure access.
- Account Management: Maintains user account information, including profile, quotas and account balances.
- Data Import/Export: Manages the import and export of data to and from the system, supporting file uploads and download functions.
- File Management: Handles operations related to uploaded files, including storage and format checking.
- Printer Management: Manages the printing system, including their status and configurations.
- Requirement Management: Allows SPSO officers to set and update application requirements, such as allowable file types and page quotas.
- Payment Management: Manages all transactions relating to purchasing additional pages, and interact with the external BKPay payment system.

Dependencies: The Domain Layer communicates directly with the Database Layer to store and retrieve data related to users, printers, payment records, and system configurations.

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d. Database Layer:

Components:

- User Database
- Printer Database
- BKPay Database
- Requirement Database
- File Database

Description: The Database Layer is used for data storage and retrieval. It holds persistent data for the system's operations and supports CRUD (Create, Read, Update, Delete) operations for the following components:

- User Database: Stores user information, including profile, credentials, role, and printing quota details.
- Printer Database: Contains printer details information such as ID, location, status, and configurations.
- BKPay Database: Manages payment records for any purchase procedure of students.
- Requirement Database: Stores system configuration and requirements, such as page quotas and file type restrictions.
- File Database: Store any files uploaded by students such as document for printing.
- Dependencies: This layer is associated with Domain Layer to read and write data essential for the system's functionality.

3.1.3. Description for Architecture Decision

1. Presentation Strategy

The presentation layer of HCMUT_SSPS will use a web interface that support mobile view to provide accessibility and comfortable use for students, SPSO officers, and printer providers With simple and familiar layout, user-friendly interface, students could browse the website easily without the need for guide or tutorial. The user interface will be developed using HTML, CSS, and JavaScript, and will be accessible through any standard web browser.

Key Reasons for this Strategy:

- User Accessibility: Students, SPSO officers, and printer providers can access the system from any device with a web browser.
- Consistency: A single, responsive web interface ensures consistent user experience across devices.

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- Scalability: Web-based interfaces are easier to update and scale as the system grows or new features are added.

2. Data Storage Approach

The HCMUT_SSPS system will use a relational database model with MySQL as the database management system (DBMS).

Reasons for Choosing MySQL:

- Ease of Use and Configuration: MySQL provides a straightforward setup process, making it a practical choice for application development.
- Scalability and Flexibility: MySQL offers the ability to scale database operations to handle increasing numbers of students and print logs.
- Large Support Community: MySQL has a well-established community, offering abundant resources for troubleshooting and development.

Database Structure:

- User Database: Stores information about users, including students and SPSO officers.
- Printer Database: Contains details about each printer, such as location and status.
- BKPay Database: Manages transactions related to the purchase of printing pages by students.
- Requirement Database: Maintains information on system requirements and settings.
- File Database: Stores document information and printing logs.

3. API Management:

Effective API management is crucial for ensuring smooth interactions between the printing web/app, user accounts, and the university's existing infrastructure. A good API architecture would allow for easy integration with authentication services, payment gateways, and print queue management systems.

To support system functionality, HCMUT_SSPS uses two types of APIs: internal and external.

- Internal API:
  - Printer API: Developed internally, this API manages document printing requests by handling printer-specific operations. This API ensures smooth interaction between the system and the printers on campus, allowing for document processing, printing, and status monitoring.
- External APIs:
  - Apero CAS Authentication API: Used for authenticating users, including students and SPSO officers, by integrating with the university's Central Authentication Service (CAS) system.

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- BKPay Payment API: Supports the "Buy Printing Pages" feature, allowing students to purchase additional pages using the university's BKPay payment platform.

API Strategy:

- Internal APIs allow for better control and customization of printer operations specific to HCMUT's requirements.
- External APIs ensure integration with university-wide services, enhancing user experience and enabling secure authentication and payment processes.

3.2. Component Architecture

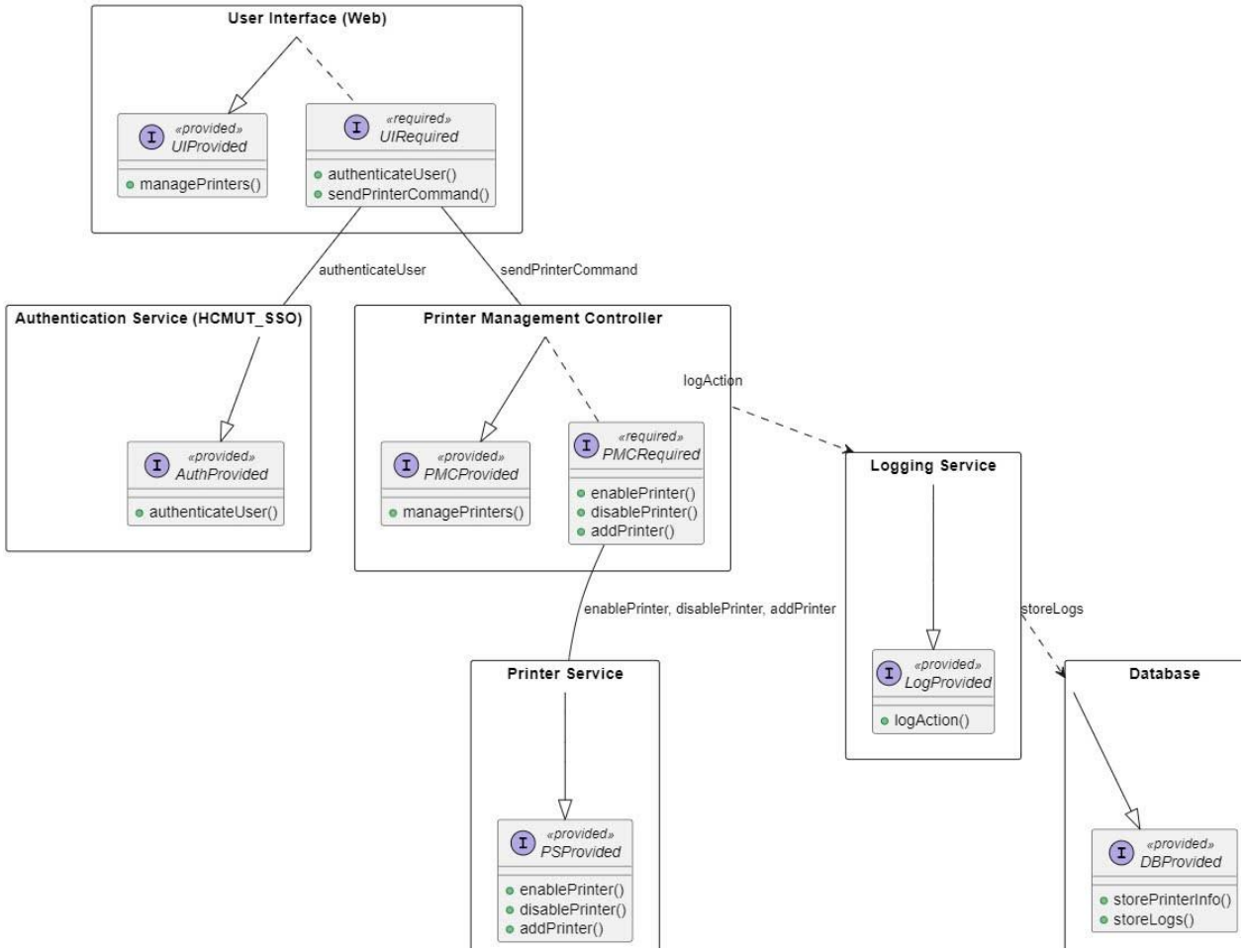

Figure: Component Architecture

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This component diagram focuses specifically on the **Printer Management** process. It depicts how different components interact with one another to manage printers, authenticate users, and log activities within the system.

At the center of the system is the User Interface (Web) component, which serves as the entry point for users to interact with the printing service. The user interface provides functionalities such as managing printers (managePrinters()). However, before executing any operations, it requires authentication (authenticateUser()), which is handled by the Authentication Service (HCMUT_SSO). This ensures that only authorized users can proceed. The user interface also allows sending printer-related commands (sendPrinterCommand()) to manage the printers effectively.

The Printer Service is the component that directly interacts with the physical printers. It takes the commands provided by the printer management controller and implements them on the actual devices, ensuring printers are enabled, disabled, or added as needed. This component is critical for handling the direct manipulation of hardware to ensure printers operate according to system requests.

Meanwhile, every action performed within the system, whether it be managing a printer or executing a print job, is logged by the Logging Service. This service ensures that all actions related to printer management are properly recorded (logAction()). The logs are then stored in the Database, providing an auditable trail of all system activities. The database component manages persistent storage, allowing printer configurations (storePrinterInfo()) and logs (storeLogs()) to be saved securely for future reference or reporting purposes.

4.1 & 4.2. Version Control

Below is the link to the github repository:

thaiquangphat/Student-Smart-Printing-Service

4.3. Usability Testing

4.3.1. Overview

All members of the team developing the smart student printing system SPSS have conducted a usability test using Figma prototype given in the following link:

https://www.figma.com/design/sFBTaCKqfDYrBK5csP3R8v/hcmut-spss

`

The testing session took place in person with the participation of all members, including the chairperson (team leader) and the secretary. During the session, the team recorded solutions, task completion rates, comments, overall evaluations, questions, and feedback from all members.

4.3.2. Members and their role

Name	Role
Thai Quang Phat	Chairperson/Leader/Member
Phan Quang Minh	Serectary/Member
Phan Quang Nhân	Member
Phung Gia Minh Khoi	Member
Thai Quang Du	Member

Table. Team members and their role

4.3.3. Testing Method

The team leader gathered all members through a group message to arrange a face-to-face meeting for the testing session. All members arrived on time as scheduled. The testing session was divided into multiple phases, each lasting about 30 minutes and focusing on a specific part of the system.

During each phase, the team leader explained the testing process and required members to fill out a questionnaire related to tasks aligned with the scenarios. Each member was tasked with reviewing the scenarios and interacting with the application to achieve the scenario's objectives.

After completing each task, the team leader asked members to rate the user interface on a 5-point scale, ranging from "Strongly Disagree" to "Strongly Agree." Post-task evaluation factors included:

- Ease of finding information on the application
- Flexibility in interactions
- Accuracy in predicting which part of the application contains specific information

Once the final task was completed, the team leader asked members to evaluate the overall system using the same 5-point scale, with the following factors:

- Ease of use
- Frequency of use

`

- Learnability (how easily users can learn to use the application)
- Supportability (how easily users can find information)
- Visual appeal (how engaging the interface design is, encouraging exploration)
- Content quality (how captivating the website's content is for users)
- Website layout

Additionally, the team leader requested members to answer the following questions:

- Which part of the application do they like the most?
- Which part of the application do they like the least?
- Suggestions for improving the application

4.3.4 Testing Scenario

The testing participants will attempt to perform the following tasks:

- Successfully register for a printing service.
- Fail to register for a printing service due to a lack of printing pages, purchase new pages, and then successfully register for the printing service again.
- View the printing history of a student on printer H6-501.
- Search for and edit the information of a printer located in building A4.
- Check the paper and ink status of the printer in building A3.
- Disable the operation of a printer at Campus 2.
- View the monthly activity frequency of printers.

4.3.5. Task Results

4.3.5.1. Percentage Completion

Name	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
Thai Quang Phat	x	x	x	x	x	x	x
Phan Quang Minh	x	x	x	x	x	x	x
Phan Quang Nhan	x	x	x	x	x	x	x
Phung Gia Minh Khoi	x	x	x	x	x	x	x
Thai Quang Du	x	x	x	x	x	x	x
Percentage	100%	100%	100%	100%	100%	100%	100%

Table. Percentage Completion

`

4.3.5.2. Evaluating Tasks Based on Factors

Scoring are from 1 to 5. Here are the average scores of the members

Task	Info Accessibility	Interaction Flexibility	Prediction Accuracy	Average
1	3	4	4	3.67
2	5	5	3	4.33
3	4	3	4	3.67
4	3	3	5	3.67
5	4	4	5	4.33
6	5	4	3	4.00
7	3	3	4	3.33

Table. Evaluating Tasks Based on Factors

4.3.5.3. Result Summary

Task	Completion percentage (%)	Errors encoutered	Satisfaction level
1	100%	0	3.67
2	100%	0	4.33
3	100%	0	3.67
4	100%	0	3.67
5	100%	0	4.33
6	100%	0	4.00
7	100%	0	3.33

Table. Result Summary

4.3.5.4. User Experience


PHIẾU KHẢO SÁT TRẢI NGHIỆM NGƯỜI DÙNG VỚI HỆ THỐNG IN ẤN THÔNG MINH TẠI HCMUT (SPSS)

Chào mọi người, chúng mình là nhóm 12, đến từ lớp CC01. Hiện tại chúng mình đang thực hiện đề tài xây dựng một hệ thống quản lý in ấn thông minh tại HCMUT (Student Smart Printing Service).

Bên dưới đây là các hình ảnh hệ thống của chúng mình, chúng mình rất mong nhận được một số góp ý của các bạn để hệ thống của chúng mình được hoàn thiện hơn. Chúng mình cảm ơn các bạn rất nhiều

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* Biểu thị câu hỏi bắt buộc

Figure. Survey form

To better understand how accessible our website is to the majority of students, we conducted a survey to gather their feedback. Students were asked to rate the following features on a scale of 1 to 5:

1. Homepage
2. Login page
3. Student's services
4. Select documents to print
5. Choose printer
6. Configure paper
7. View printing history
8. View purchasing history

Our survey reached to a total of 16 students, with results summarize as below

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Major

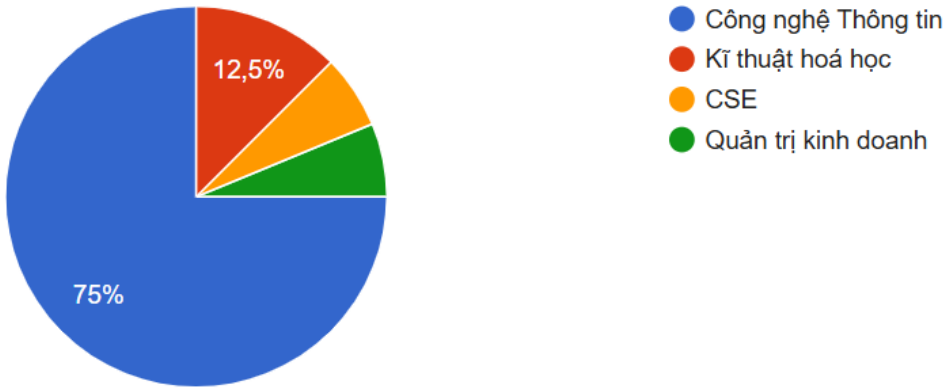

Figure. The number of students attempted the survey

The majority of students who attended the survey are professioned in information technology (IT), this can be seen as a non benefit since we need feedbacks from students who doesn't have much knowledge of software engineering, only then we can have more general feedbacks.

We will now show our results on all pages, and then give a overall summary.

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Homepage

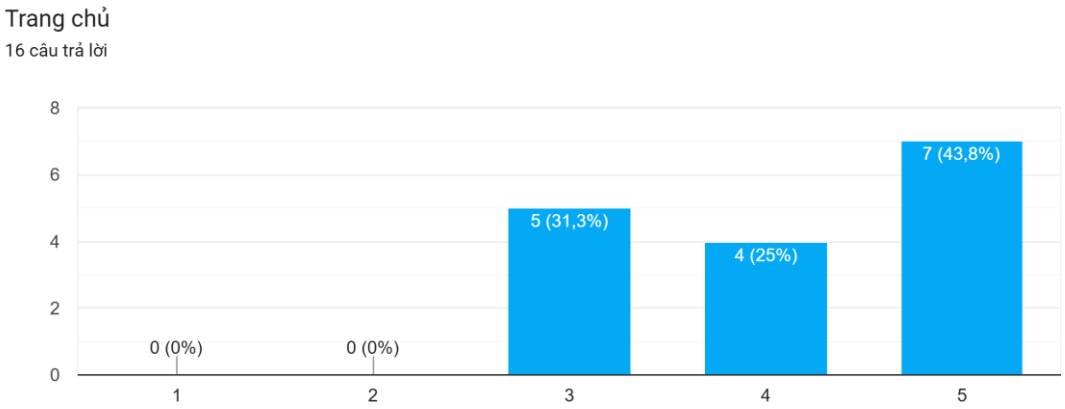

Figure: Scoring of the homepage

Login page

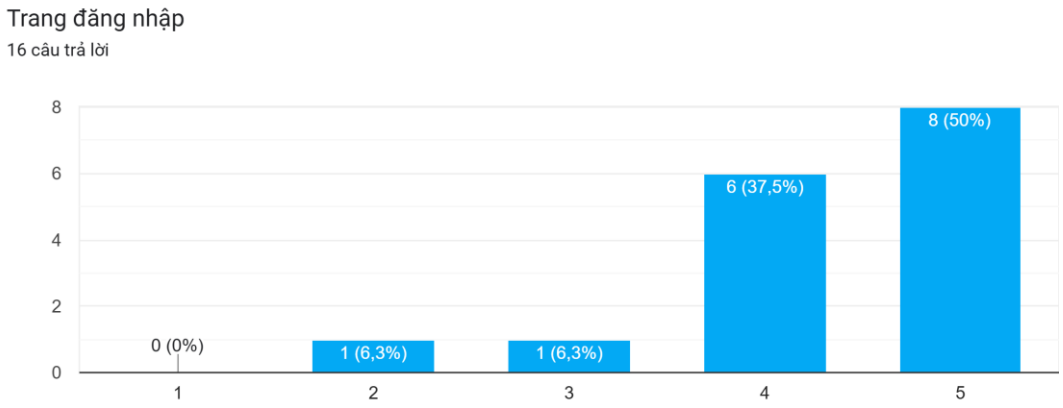

Figure: Scoring of the login page

Student services

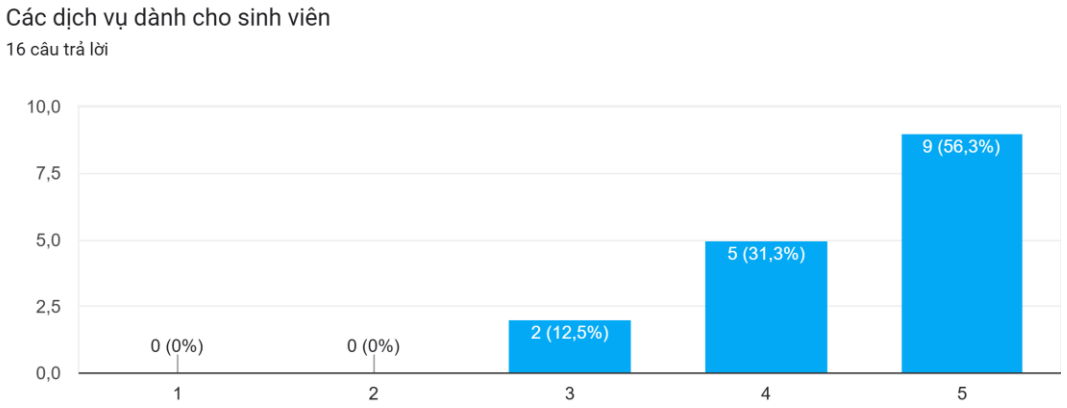

Figure: Scoring of the student services

Select documents to print

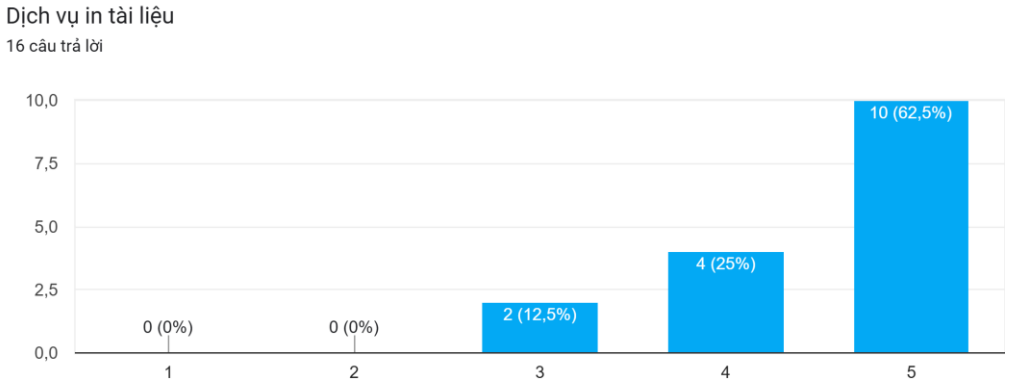

Figure: Scoring of selecting documents

Choose printer

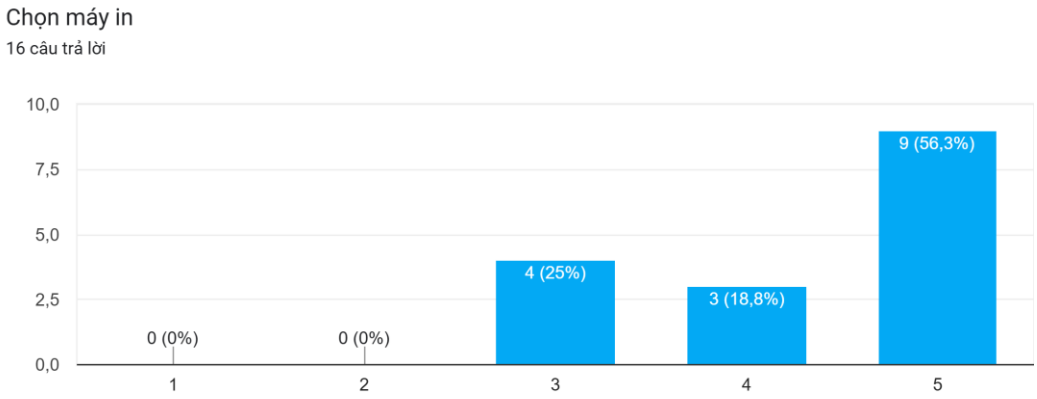

Figure: Scoring of choose printer

Configure paper

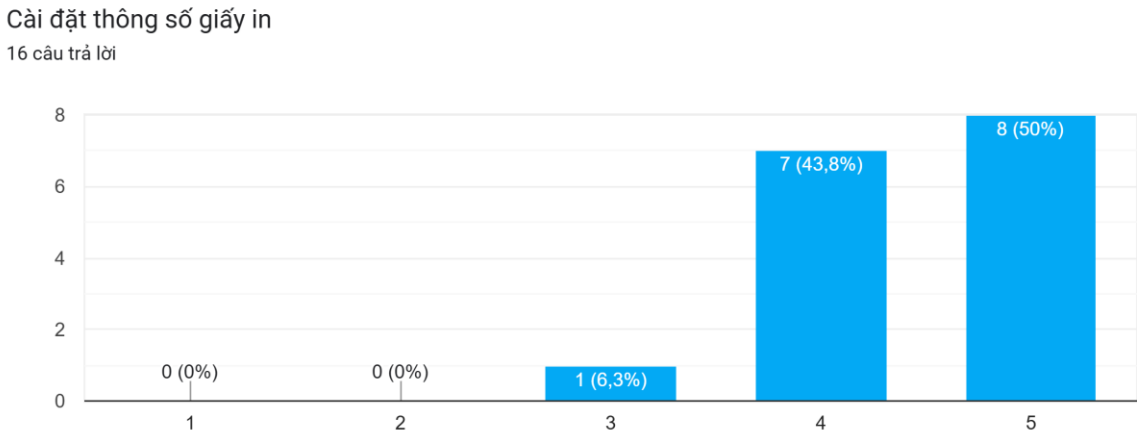

Figure: Scoring of configure paper

View printing history

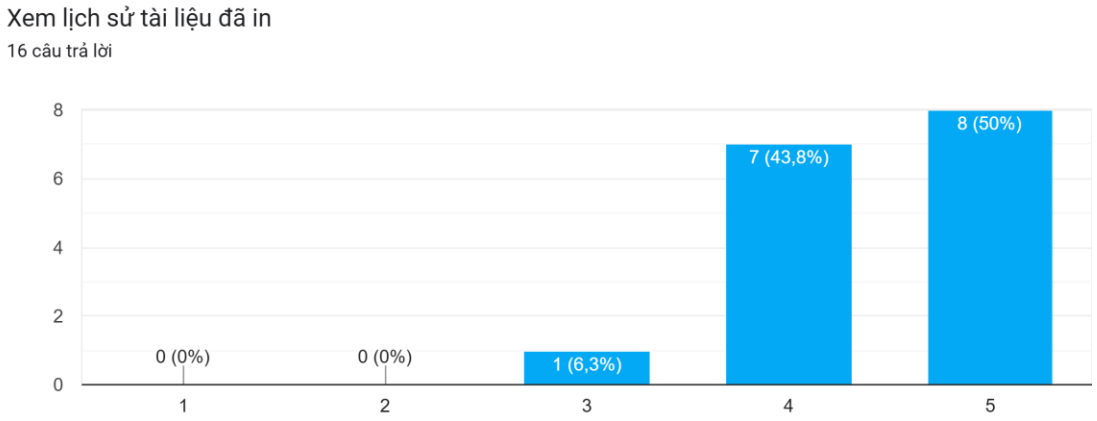

Figure: Scoring of view printing history

View purchase history

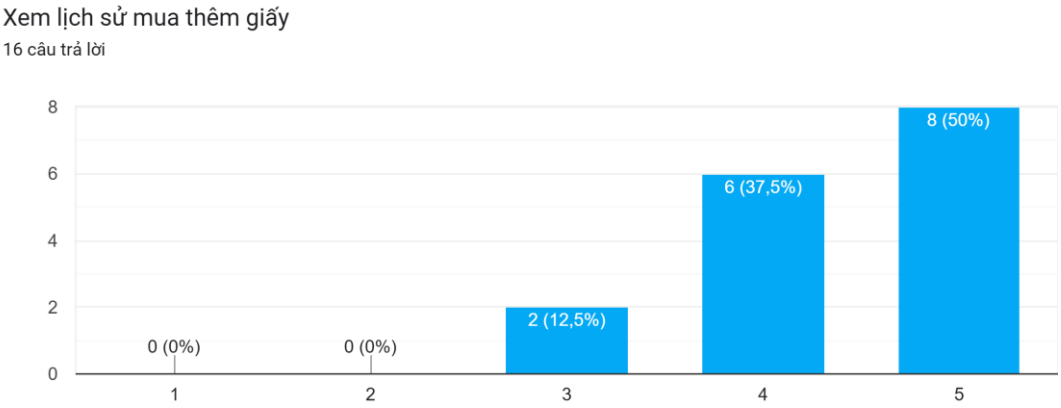

Figure: Scoring of view purchase history

Summary comment

Having observe the results above, we get to the conclusion below

1. Our service fits to the majority of studen't interest. This is a good sign since it can atract many students to use it.

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2. Out of the features above, it can be seen that the student's favorite are in the printing feature, which is the main feature of our system.
3. The only feature which got a scoring of 2, is the login page, which also appears to be the feature which students do not pay much interest. This shows that our login page needs improvement.

4.3.5.5. Personal Opinion

The following table shows each member's favourite and least favorable feature of the system.

Name	**Favourite**	**Least favorite**
Thai Quang Phat	Select documents	Statistic page
Phan Quang Minh	Printer table	View history
Phan Quang Nhan	Printing history	Configure printing
Phung Gia Minh Khoi	Homepage	Current balance
Thai Quang Du	Configure paper	Buy printing pages

4.3.5.6. Suggestion for Improvement

Feature	**Reason**	**Priority**
Statistics of printing for each printer	To have a better visualization of the printing process	Medium
Search filter for each history	Students can easily access to their required printing log	Medium

5. Implementation

The source code and all notes about the technologies used, installation instructions, and usage can be found in the following GitHub link:

thaiquangphat/Student-Smart-Printing-Service

References

[1] Sommerville, I. (2016). Software Engineering 10th Edition. Boston: Pearson Education Limited.
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