Automated Print Shop System with AI

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Session 2020 – 2024

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Second Deliverable for Object Oriented Approach

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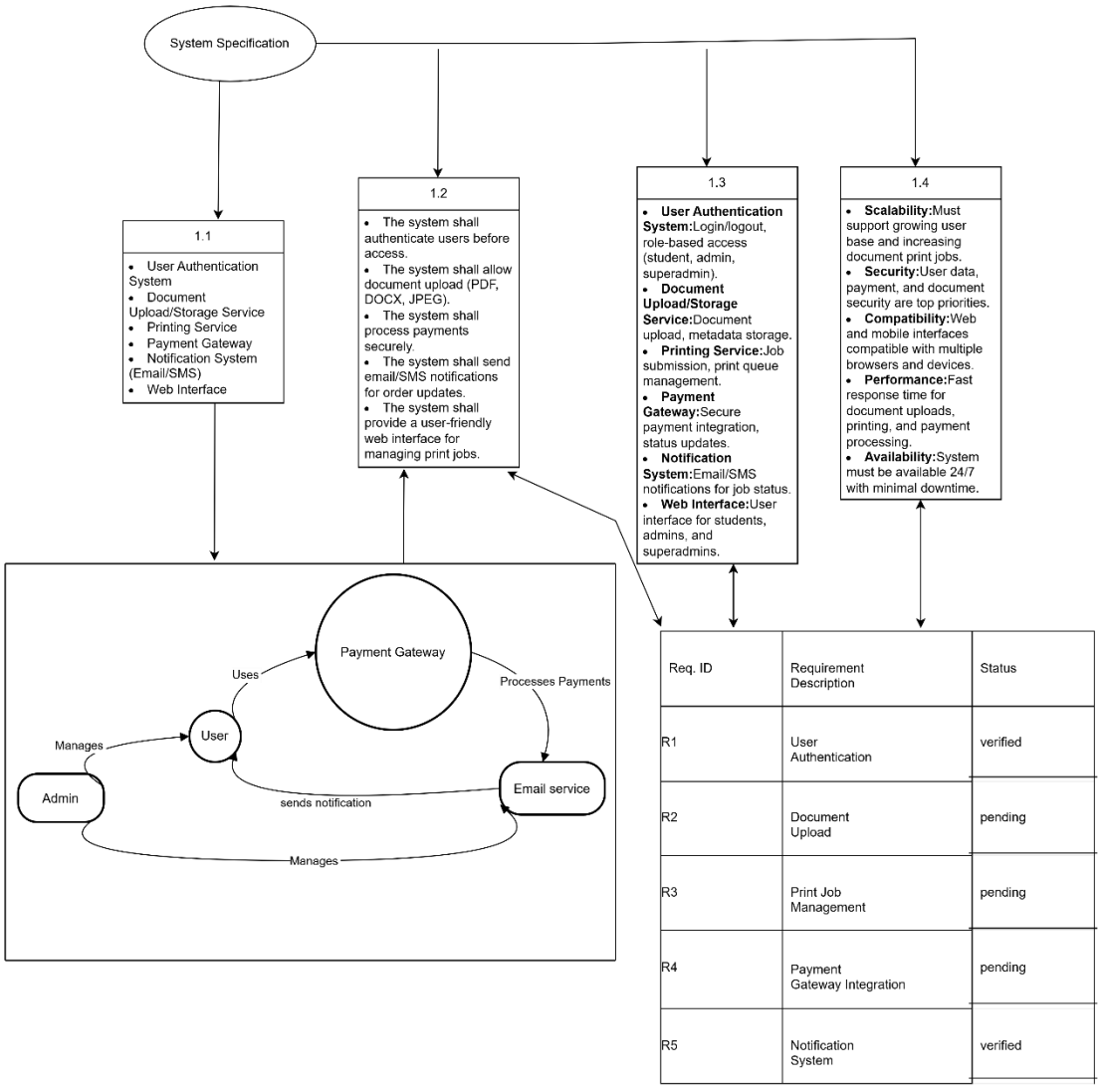
2.1 Introduction

The **requirements engineering process** for the **Automated Print Shop System** ensures that the system aligns with user needs and business objectives. It involves gathering, structuring, and validating requirements to develop a solution that meets expectations. The process includes analyzing system functionalities such as user authentication, document handling, AI job distribution, and role-based access control.

Requirements Engineering Process

- **Requirements elicitation:** Gathering input from stakeholders (students, staff, admins) to define the system's core features, such as document upload and job distribution.
- **Requirements analysis and negotiation:** Analyzing requirements to prioritize based on user needs, performance, and feasibility.
- **Requirements specification:** Defining clear functional specifications for document management, user roles, and print job monitoring.
- **System modeling:** Creating models (ERD, DFD) to visually represent system interactions and backend processes.
- **Requirements validation:** Ensuring requirements are met through feedback, testing, and system checks.
- **Requirements management:** Tracking and adjusting requirements throughout the project lifecycle.



Here, the requirements specification for the **Automated Print Shop System** focuses on defining the operational and functional aspects of the system. The specification is developed through the following steps:

- **Identify External Interfaces:** Determine the interaction points between users (students, staff, admins), external payment gateways, and notification systems (Email/SMS).
- **Development of Context Diagram:** Create a diagram to represent the system's high-level interactions with external entities like users, printers, and databases.
- **Capture "Shall Statements":** Document functional requirements, such as "The system shall allow users to upload documents securely," or "The system shall notify users via email after successful printing."
- **Allocate Requirements:** Assign responsibilities to system components, such as the authentication system, payment gateway, and printing service.

- **Prioritize Requirements:** Categorize requirements into must-have (e.g., user authentication) and optional features (e.g., advanced analytics for admins).
- **Development of Requirements Traceability Matrix:** Map each requirement to its corresponding design, implementation, and testing phase to ensure complete coverage and traceability.

2.1.1 Systems Specifications

The following are the clauses that must be included while describing the system specifications.

Introduction

The **Automated Print Shop System** focuses on digitizing and automating the printing processes in educational institutions. The system aims to streamline print requests, reduce manual errors, and provide a centralized platform for students and staff. It integrates advanced AI-based load distribution and efficient document handling to enhance the overall printing experience.

Existing System

Currently, the printing process in most institutions is manual and time-consuming. Students often face delays due to long queues, lack of transparency, and limited monitoring options. Print shop staff struggle with inefficient task allocation and payment management, leading to operational bottlenecks..

Organizational Chart

The organizational structure includes three key roles:

- **Admin:** Manages specific print shop operations.
- **Students:** Submit print requests and monitor status.

Scope of the System

The **Automated Print Shop System** is designed to handle document uploads, secure payments, and real-time monitoring within the boundaries of university campuses. The project scope excludes external print shops or commercial operations. **Summary of Requirements (Initial Requirements)**

The system must address the following high-level requirements.

- Secure user authentication for all roles.
- Document upload and storage with status tracking.
- Payment processing through integrated gateways.
- AI-based load balancing for efficient task distribution.
- Real-time notifications (via Email/SMS) for job updates.

2.1.2. Identifying External Entities

The identification of external entities for the **Automated Print Shop System** involves two phases:

a. Over Specify Entities from Abstract

From the abstract, key entities are identified based on the problem description.

b. Perform Refinement

Entities are refined based on the system's business logic. The main entities include:

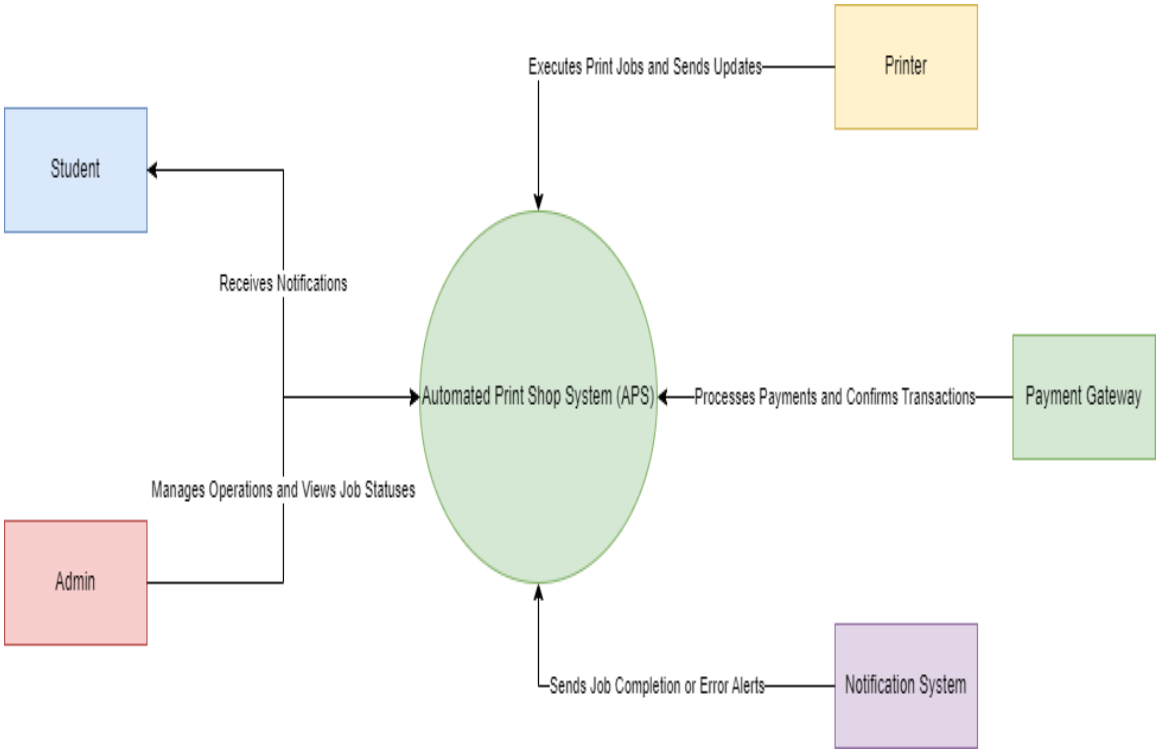
- **Student (User):** Submits print requests, uploads documents, and makes payments.
- **Admin:** Manages system operations, including job approvals and printer monitoring.
- **Printer:** Executes print jobs and updates job status.
- **AI Module:** Allocates jobs to printers and estimates completion times.
- **Payment Gateway:** Processes payments securely.
- **Notification System:** Sends job status updates and alerts via email/SMS.

2.1.3. Context Level Data Flow Diagram

For the **Automated Print Shop System**, the context-level DFD represents the entire system as a single process, labeled **0**. External entities include **Student**, **Admin**, **Printer**, **Payment Gateway**, **AI Module**, and **Notification System**, with the major data flows being:

- **Student:** Submits documents and receives notifications.
- **Admin:** Manages operations and views job statuses.
- **Printer:** Executes print jobs and sends job status updates.
- **Payment Gateway:** Processes payments and confirms transactions.
- **Notification System:** Sends job completion or error alerts.

Example:



2.1.4. Capture "shall" Statements

The functional requirements of the **Automated Print Shop System** include:

- The system **shall** allow students to upload documents for printing.
- The system **shall** enable admins to manage printer allocations and monitor jobs.
- The system **shall** estimate job completion time using the AI module.
- The system **shall** notify students of job status through email or SMS.
- The system **shall** securely process payments via the payment gateway.

2.1.5. Allocate Requirements

The functional requirements are allocated to use cases:

- **Document Upload:** Handled by the Student entity.
- **AI-Based Allocation:** Managed by the AI Module.
- **Job Monitoring:** Admin oversees the system processes.
- **Notifications:** Implemented via the Notification System.
- **Payment Processing:** Supported by the Payment Gateway.

2.1.6. Prioritize Requirements

1. **High Priority**

- These are the essential requirements that the system cannot function without. They directly impact the core functionality of the system.

Examples:

- **User Authentication** (Ensures that only authorized users can access the system)
- **Document Upload and Storage** (Critical for handling user print jobs)
- **Payment Gateway Integration** (Vital for transaction processing)

2. **Medium Priority**

- These are important features but not critical for the initial functioning of the system. They enhance the user experience but can be implemented after core features.

Examples:

- **Notification System** (To inform users about job statuses)
- **Admin Dashboard** (Allows admins to manage the system effectively)

3. **Low Priority**

- These features are nice-to-have but do not significantly impact the system's main objectives. They can be implemented if time and resources permit.

Examples:

- **Advanced AI for Job Distribution** (Could be developed in future iterations)

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2.1.7. Requirements Trace-ability Matrix

The requirements trace-ability matrix is a table used to trace project life cycle activities and work products to the project requirements the matrix will trace requirements from identification through implementation and verification.

Req. ID	Requirement Description	Status
R1	User Authentication	verified
R2	Document Upload	pending
R3	Print Job Management	pending
R4	Payment Gateway Integration	pending
R5	Notification System	verified

2.2. Example

Here is an example to explain all the above.

2.2.1. Introduction

The Automated Print Shop System (APS) is designed to streamline and automate the printing services for universities. APS aims to provide students with a seamless online platform for submitting and managing print jobs while enabling staff at print shops to efficiently process and track these orders. APS will allow students to upload documents for printing, track their orders in real-time, and make payments via a secure payment gateway. The print shop staff will have a backend system that manages all print orders, maintains inventory of printing resources, and handles customer support. The system will also provide detailed analytics to help the print shop staff manage operations efficiently. APS will offer a 24x7 online service for document printing and other related services, enhancing the overall experience for students and university staff.

2.2.2. Existing System

The current system used by the print shops is largely manual. Students submit physical documents or send them to the print shop via email. The print shop staff manually process these orders, track inventory, and handle payments through cash or bank transactions. There is no centralized system for managing print orders, and the staff rely on paper records, making the process slow and inefficient.

Business Organization

The APS will automate three main business areas:

1. **Document Printing**
    - Students upload documents through the APS interface.
    - Print jobs are processed by the print shop and completed by staff.

2. **Payment and Account Management**
    - The APS integrates a secure online payment system.
    - Students make payments for print jobs through various methods (credit card, PayPal, etc.).
    - Transaction history is stored and accessible to both students and staff.

3. **Inventory and Resource Management**
    - The APS tracks the availability of resources such as paper, ink, and printing machines.
    - Print shop staff are notified when inventory levels are low.

Departments/Offices Facilitating Business Services:

1. **Printing Services Department**

- Handles the document printing tasks, ensuring that students' print jobs are processed promptly.

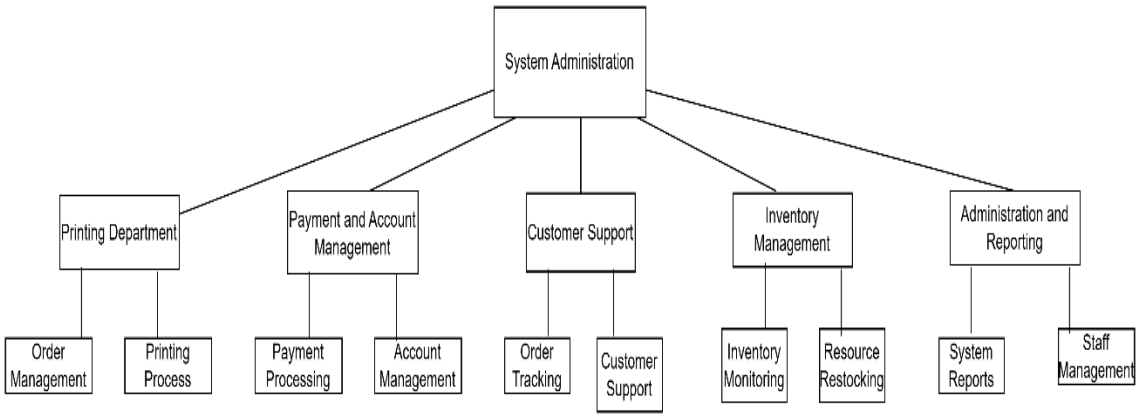
2. **Account Management Office**
    - Handles user accounts, transaction records, and payment processing.

3. **Customer Support & Order Management**
    - Provides customer support for students, answering inquiries and helping with order tracking.

4. **Inventory Management**
    - Tracks and manages the stock of printing materials and other resources required for printing.

5. **Administrative Office**
    - Manages internal processes including reports, employee records, and overall system performance.

Business Organization Chart



2.2.3. Scope of the System

The **Automated Print Shop System** is divided into three phases for gradual implementation and efficiency. These phases ensure that each key area of the business is automated and streamlined.

Phase I

Phase I focuses on setting up core functionalities required to run the basic operations of the print shop system. The following business areas are included:

1. **Customer Account Management:**
- Creating and managing user accounts for customers, including login credentials and usage tracking.

2. **Order Management:**
- Handling customer orders for printing services, including order placement, processing, and delivery tracking.

3. **Print Job Management:**
- Managing the details of the printing jobs, including file uploads, job status, and print scheduling.

Phase II

Phase II involves the complete automation of the back-end processes necessary to run the print shop. It includes the integration of the following business areas:

- **Payment and Account Management:**
  - Processing payments for print jobs, handling invoicing, and tracking financial transactions.

- **Inventory and Resource Management:**
  - Managing inventory of print materials, such as paper, ink, and other supplies.

- **CRM (Customer Relationship Management):**
  - Managing customer interactions, feedback, and support services.

- **Reporting and Analytics (MIS):**
  - Generating reports on print job statistics, customer activity, and operational performance.

Phase III

Phase III expands the system to include all remaining components needed for the comprehensive automation of the print shop system. This phase will address:

1. **Employee Management (HRM and Payroll):**

- Automating employee management, including payroll, schedules, and HR functionalities.

2. **Marketing and Promotion:**
- Handling promotional campaigns, customer engagement, and marketing strategies to increase sales and awareness.

4. **Full Integration:**
- The final integration of all modules into a cohesive and fully automated system, ensuring seamless operations across all areas of the print shop.

This document focuses solely on **Phase I** of the **Automated Print Shop System (APS)**. Further phases will be developed as outlined in the above scope.

2.2.4. Summary of Requirements (Initial Requirements)

The purposed system must fulfill following requirements as follow

2.2.4.1. Print Job Department Requirements

Order Management

1. **Customer Registration:**
- Only registered customers can place print job orders. Customers must be able to register in the system by requesting registration. There will be two types of registration: **normal** and **privileged**. During registration, customers will need to provide personal details, organizational information, authorizer details, and payment information.
- All registration requests will be reviewed by the **Customer Account Administrator (CAA)**, who will have the authority to accept, reject, or temporarily waive requests based on the provided credentials.
- Once the registration request is accepted, a login ID, password, and role will be assigned to the customer and sent via email.
- Customers will also have the ability to update their records (e.g., personal details, shipping information, or payment method). Updates will also be reviewed by the **CAA**, who can accept or reject the changes.
- Customers can view their personal details and the **CAA** can search and view the details of all registered customers.

2. **Placing Orders:**
- Both **registered** and **privileged** customers will be able to place print job orders. When placing an order, customers will need to provide their **customer ID**, personal

details, shipping information, and a list of items (print jobs), including quantity and payment details.

- Customers can choose their preferred payment method: either **cash** or **credit card**. An **invoice** will be generated with a breakdown of the print jobs, including pricing, discounts, sales tax, and the total amount.
- Customers will receive a **confirmation receipt** after completing the order.
- Customers can also check the **status of their orders** by providing the **Order Number**.
- **Privileged customers** may update their orders if the orders have not yet been shipped. They can request updates to shipping addresses or adjust quantities of print jobs.
- If the privileged customer wishes to cancel an order, they can submit a request, which will be processed by the **Order Administrator** (OA).
- The **OA** will review and either accept, reject, or waive requests for updates or cancellations.

3. Action List Mechanism:

- The system will implement an **Action List** mechanism for better communication, notifications, and control.
- When an order update or customer detail change request is submitted, an action event will be generated for the corresponding administrator. These actions may be initiated by the **Order Operator** or by the customer's request for updates.
- The corresponding administrator will have an **Action List** containing pending actions, which they must review and process accordingly. Once actions are processed or if the action is simply a notification, the administrator can delete these actions from the list.
- The **System Admin** will configure the Action List by adding new action events and removing obsolete events from the system.

4. Shipping Orders:

The **Shipping Department** will handle the shipment of the print jobs. Once an order has been processed and invoiced, the shipping department will be responsible for shipping the corresponding print jobs to the customer's specified address.

2.4.2.2. Print Job Inventory

This department handles the addition, searching, and updating of print materials and supplies. Whenever new printing supplies (such as paper, ink, etc.) arrive, the Inventory Administrator updates the stock in the system. They can also add new items to the inventory and modify the details of existing print materials. The administrator has the ability to view and search the complete inventory of printing materials.

2.4.2.3. Customer Order Management Requirements

This department handles customer interaction and order processing related to printing services.

Printing Order Center:

- Deals with customer registration and order management for print jobs.
- Customers can register on the platform and receive a print job card for tracking their printing needs.
- Customers can also place orders for specific print jobs and request modifications or cancellations of their orders before printing begins.

2.4.2.3. Print Job Distribution

This department is responsible for managing print jobs that are ready for printing. It ensures efficient load distribution of print jobs to different printers based on the AI algorithm to optimize printing times and resources.

2.2.5. Identifying External Entities

Based on the **Automated Print Shop System**, the identification of external entities is done in two phases.

Over Specify Entities from Abstract

From system description, the following external entities can be identified:

- Customer (student/staff)
- Print Job Order
- Printer
- Print Material Inventory
- Payment (Payment via university accounts or credit/debit cards)
- AI Load Distribution System
- Admin (for managing orders, payments, and inventory)

Perform Refinement

After refining the entities based on the business logic, the more relevant entities in your system would be:

- Customer (student or staff placing print orders)
- Print Material Inventory (paper, ink, etc.)
- AI Load Distribution System (for distributing print jobs to printers)
- Order Management System (tracking print jobs and status updates)
- Payment Gateway (for processing print job payments)
- Admin (handling order processing, inventory, and payment management)

2.2.6. Capture "shall" Statements

Para #	Initial Requirements
1.0	A **customer** "shall" place a print order for documents
1.0	A **customer** "shall" register himself to the system.
1.0	The system "shall" provide two types of registration process: **normal** and **privileged**
1.0	**Admin** "shall" accept, reject, and temporarily waive registration requests based on provided credentials.
1.0	A **customer** "shall" login to the system and can change their password.
1.0	The system "shall" update the **customer's** registration request.
1.0	The system "shall" process different types of updates such as updating personal/shipping details, upgrading from normal to privileged customer, or modifying payment methodology.
1.0	A **customer** "shall" view their details for verification purposes.
1.0	**Admin** "shall" accept, reject, and temporarily waive requests based on the provided credentials.
1.0	The system "shall" search and retrieve any customer details.
2.0	Both registered and privileged **customers** "shall" place orders for print jobs.
2.0	**Customer** "shall" make payment either through university account funds, cash, or credit/debit card.
2.0	The system "shall" generate invoices, confirmation receipts, and process the print order.
2.0	**Customer** "shall" view the status of their orders by providing the **Order Number**.
2.0	**Privileged customers** "shall" place requests to update their orders if the jobs are not yet processed or printed.
2.0	**Privileged customer** "shall" place requests to cancel orders. All these update and cancellation requests "shall" be viewed by the **Order Administrator** for approval or rejection.
3.0	An **action event** "shall" be generated for the corresponding administrator when a request for updating orders or customer details is made.
3.0	The corresponding **administrator** "shall" view their Action List containing different pending actions and process them accordingly.

3.0	Once action processing is completed or if the action is just a notification, the **administrator** "shall" delete these actions from the Action List.

2.2.7. Allocate Requirements

Para #	Initial Requirements	Use Case Name
1.0	A **customer** "will" place an order for print jobs.	UC_Place_Print_Order
1.0	A **customer** "shall" register himself to the system.	UC_Registration_Request
1.0	The system "shall" provide two types of registration process: normal and privileged.	UC_Place_Registration_Request
1.0	**Admin** "shall" accept, reject, and temporarily waive registration requests based on provided credentials.	UC_Process_Customer_Request
1.0	A **customer** "shall" login to the system and can change their password.	UC_Login
1.0	The system "shall" update the **customer's** registration request.	UC_Update_Request
1.0	The system "shall" process different types of updates (e.g., updating personal/shipping details, upgrading status from normal to privileged customer, or updating payment methods).	UC_Change_Status
1.0	A **customer** "shall" view their details for verification purposes.	UC_View_Customer_Details
1.0	The system "shall" search and retrieve any **customer** details	UC_Search_Customer
1.0	**Admin** "shall" accept, reject, and temporarily waive requests based on the provided credentials.	UC_Accept_Customer_Request UC_Reject_Customer_Request UC_View_Customer_Request
2.0	Both registered and privileged **customers** "will" order for print jobs.	UC_Place_Print_Order_Privileged

2.0	**Customer** "will" make payment either through university account funds, cash, or credit/debit card.	UC_Pay_For_Print_Order
2.0	The system "will" generate invoice, confirmation receipt, and process the print order.	UC_Invoice_Generation,
2.0	**Customer** "shall" view the status of their orders by providing the **Order Number**.	UC_Search_Print_Order_Status
2.0	**Privileged customers** "shall" place requests to update their orders if the print jobs are not yet processed or printed.	UC_Update_Print_Order
2.0	**Privileged customers** "shall" place requests to cancel their orders. These requests "shall" be reviewed by the **Order Administrator** to accept, reject, or waive them.	UC_Change_Payment_Details, UC_Change_Print_Order_Status, UC_Change_Personal_Details
3.0	The system "shall" generate an action event for the corresponding **administrator** when a request is placed for updating orders or customer details.	UC_Create_Action_Event
3.0	The corresponding **administrator** "shall" view their Action List containing different pending actions and process them.	UC_View_Action_List

2.2.8. Priorities Requirements

Para #	Rank	Initial Requirements	Use Case ID	Use Case Name
1.0	Highest	A customer “will” place order for goods	UC_1	UC_PlaceOrder

1.0	Highest	A customer "shall" register himself to the system	UC_2	UC_Registration_Request
2.0	Highest	Customer "will" make payment either through cash or through a credit card	UC_3	UC_Pay_For_Order
2.0	Highest	System "will" generate invoice, confirmation receipt and finally will place order	UC_4	UC_Invoice_Generation,
2.0	Medium	Both registered and privileged customers "will"order for goods.	UC_5	UC_Place_Order_Privleged
1.0	Medium	The system "shall" provide two types of registration process, normal and privileged	UC_6	UC_Place_Order_Request
3.0	Medium	The System "shall" generate an action event for a corresponding administrator when a request is placed for updating of orders or customer details etc	UC_7	UC_Create_Action

1.0	Medium	CA “shall”accept, reject and temporarily waive the requests on the basis of credentials provided.	UC_8 UC_9 UC_10	UC_Accept_Customer_Request UC_Reject_Customer_Request UC_View_Customer_Request
1.0	Medium	System “shall” update the customers Request	UC_11	UC_Update_Request
1.0	Medium	The system "shall" process different types of updates (e.g., updating personal/shipping details, upgrading status from normal to privileged, or updating payment methods).	UC_12 UC_13 UC_14	UC_Change_Payment_Details, UC_Change_Status, UC_Change_Personal_Details
1.0	Medium	A **customer** "shall" view their details for verification purposes	UC_15	UC_View_Customer_Details
1.0	Medium	The system "shall" search and retrieve any **customer** details.	UC_16	UC_Search_Customer
2.0	Medium	**Customer** "shall" view the status of their orders by	UC_17	UC_Search_Print_Order_Status

		providing the **Order Number**.		
2.0	Medium	**Privileged customers** "shall" place requests to update their orders if the print jobs are not yet processed or printed.	UC_18	UC_Update_Print_Order
2.0	Medium	**Privileged customers** "shall" place requests to cancel their orders. These requests "shall" be reviewed by the **Order Administrator** to accept, reject, or waive them.	UC_19 UC_20 UC_21	UC_View_All_Print_Orders, UC_Manage_Print_Order
1.0	Lowest	A **customer** "shall" login to the system and can change their password.	UC_22 UC_23	UC_Login,
3.0	Lowest	The corresponding **administrator** "shall" view their Action List containing different pending actions and process them.	UC_24	UC_View_Action_List
3.0	Lowest	When action processing is completed, or if	UC_25	UC_Delete_Action

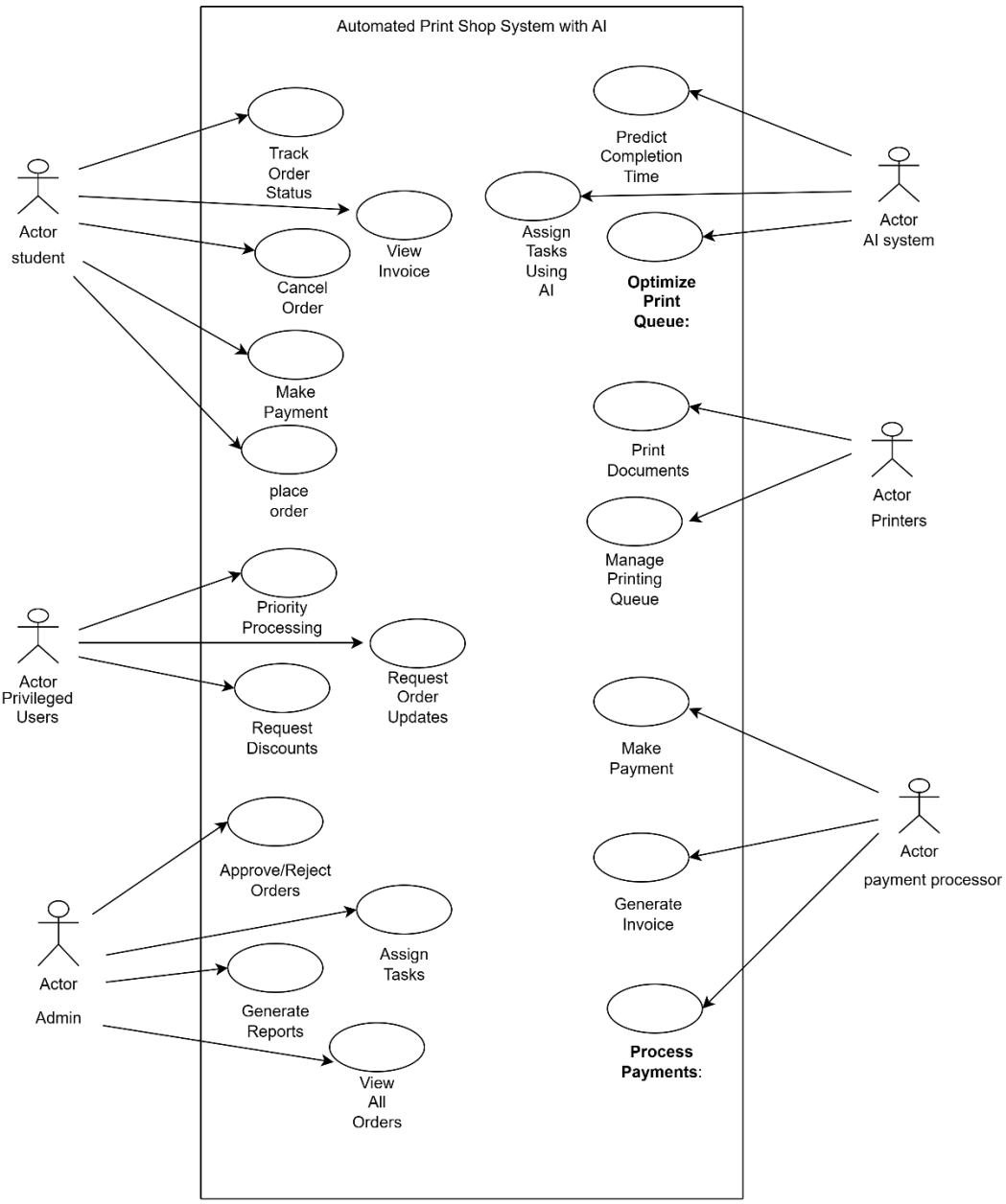
		the action is just a notification message, the **administrator** "shall" delete these actions from the action list.		

2.2.9. Requirements Traceability Matrix

Sr#	Para #	System Specification Text	Build	Use Case Name	Category
1	1.0	A customer "will" place order for goods	B1	UC_Place_Order	Functional
2	1.0	A customer "shall" register himself to the system	B1	UC_Registration_Request	Functional
3	1.0	The system "shall" provide two types of registration process, normal and privileged	B1	UC_PlaceOrderRequest, UC_PlaceCustomerRequest	Functional
4	1.0	CA "shall"accept, reject and temporarily waive the requests on the basis of credentials provided.	B1	UC_Accept_Customer_Request UC_Reject_Customer_Request UC_View_Customer_Request	Business
5	1.0	A customer "shall" login to the system and can change his password	B1	UC_Login,	Functional
6	1.0	System "shall" update the customers Request	B1	UC_Update_Request	Functional

7	1.0	System "shall" process different types of updating e.g. updating of his personal/shipping details, or upgrading of his status from registered to privileged customer, or updating of his payment methodology	B1	UC_Change_Payment_Details, UC_Change_Status, UC_Change_Personal_Details	Functional
8	1.0	A customer "shall" view his details for verification purposes	B1	UC_View_Customer_Details	Functional
9	1.0	System "shall" search any customer details	B1	UC_SearchCustomer	Functional
10	2.0	Both registered and privileged customers "will"order for goods.	B1	UC_Place_Order_Privellged	Functional
11	2.0	Customer "will" make payment; either through cash or through a credit card	B1	UC_Pay_For_Order	Business
12	2.0	System "will" generate invoice, confirmation receipt and finally will place order	B1	UC_Invoice_Generation	Business

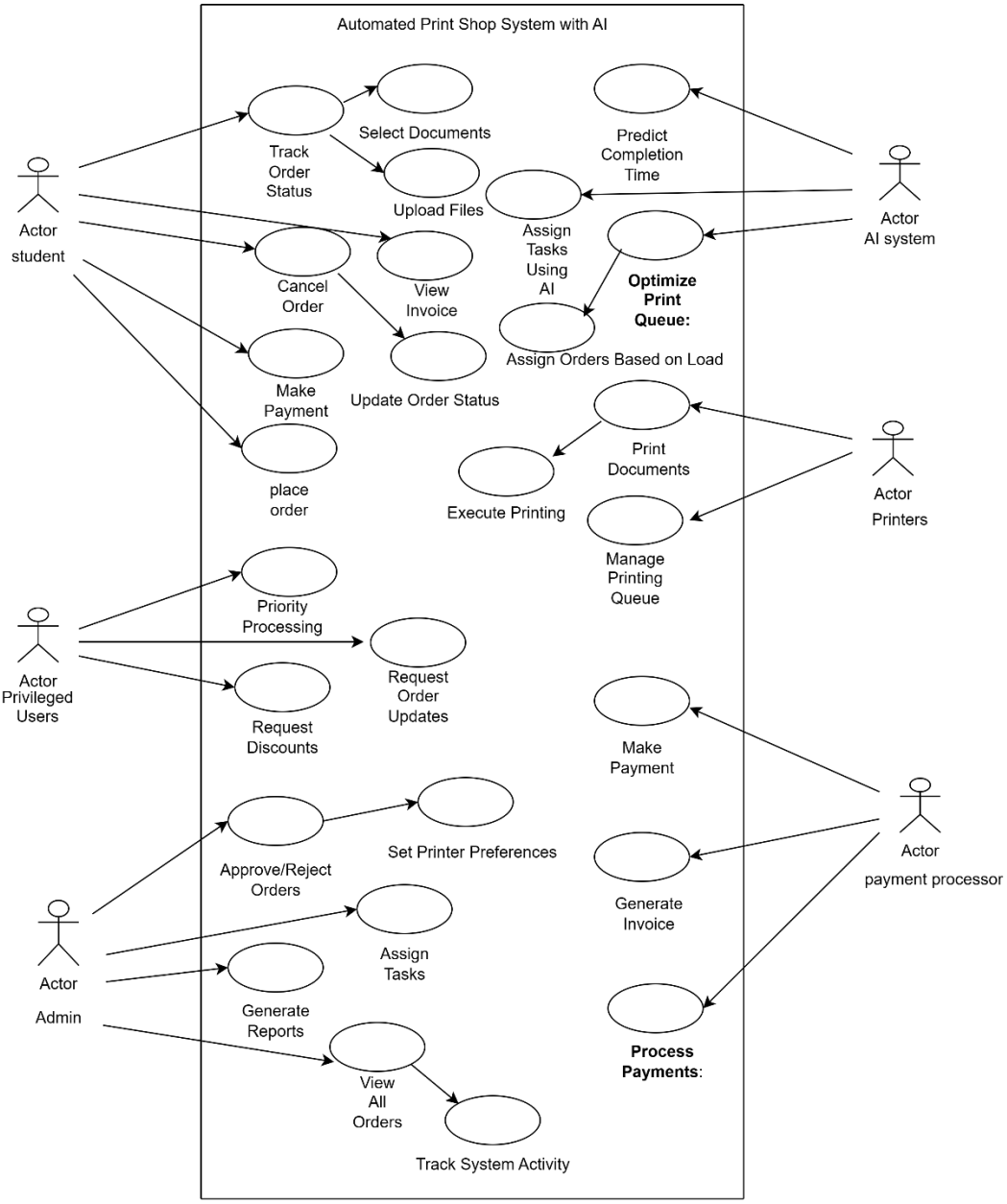
2.2.10. High Level Use case Diagram



2.2.11. Analysis Level Use Case Diagram

Analysis level use case diagram is actually the explanation of high level use case diagram. In this diagram high level use cases are expanded in a way that exhibit how high level use cases will reach to their functionality. Two types of relationships are used in this diagram. Which are

- Extend
- Include



2.2.12. Use case Description

1. Place Order (Customer)

- **Brief Description**:
  The customer places an order for printing services by selecting documents, specifying print settings, and submitting the order. Once the order is confirmed, the system generates a confirmation.

- **Preconditions**:
  - Customer is logged into the system.
  - Customer has a valid document for printing.
  - The system is connected and ready to process the request.

- **Basic Flow**:

1. The customer logs in.
2. The customer uploads documents.
3. The customer selects print options (e.g., color, number of copies).
4. The customer confirms the order and initiates the payment.

- **Alternate Flows**:
  - If the document is not found, the customer is prompted to upload the document again.
  - If the payment fails, the system asks the customer to retry payment.

- **Post Conditions**:
  - Order is placed in the system.
  - The customer is notified of the order status or payment failure.

2. Payment Processing (Customer)

- **Brief Description**:
  The customer pays for the printing order using an integrated payment system.

- **Preconditions**:
  - The customer has placed an order.
  - The customer has selected a payment method.
- **Basic Flow**:

1. The customer selects the payment method (e.g., credit card, online payment).
2. The system processes the payment and sends a confirmation.

- **Alternate Flows**:
  - Payment fails: customer is prompted to retry.

- **Post Conditions**:
  - Successful payment confirmation is received.
  - Payment is recorded in the system.

3. Order Processing (Print Shop Staff)

- **Brief Description**:
  The print shop staff processes the order once the payment is confirmed. The documents are printed and prepared for delivery.

- **Preconditions**:
  - The payment has been successfully processed.
  - The print shop staff has received the order details.

- **Basic Flow**:

1. The print shop staff accesses the order.
2. The staff processes the print job by printing the documents according to the specifications.
3. The order is packaged and prepared for delivery.

- **Alternate Flows**:
  - If there is an issue with the print quality, staff reprocesses the order.

- **Post Conditions**:
  - The order is ready for delivery or pickup.

4. Track Order (Customer)

- **Brief Description**:
  The customer can track the status of their order, including whether it is being processed or if it's ready for pickup.
- **Preconditions**:
  - The customer has placed an order.

- **Basic Flow**:

1. The customer logs into the system.
2. The customer views the status of their order.

- **Alternate Flows**:
  - If there is no order in the system, the customer is informed of the error.

- **Post Conditions**:
  - The customer is updated with the latest status of their order.

5. Admin: Manage Orders (Admin)

- **Brief Description**:
  The admin oversees all orders, manages status updates, and ensures smooth operation.

- **Preconditions**:
  - Admin is logged into the system.

- **Basic Flow**:

1. Admin accesses the order management section.
2. Admin updates the status of orders as needed.
3. Admin can view, edit, or cancel orders.

- **Alternate Flows**:
  - If there is an error, the admin receives an alert to fix it.

- **Post Conditions**:
  - The admin has updated the system with the latest order statuses.

6. Staff: Manage Print Jobs (Print Shop Staff)

- **Brief Description**:
  The print shop staff can access and manage print jobs.

- **Preconditions**:
  - Staff is logged in.
  - Orders have been placed and are pending processing.

- **Basic Flow**:

1. Staff accesses the job queue.
2. Staff starts the print job.
3. Print jobs are completed and prepared for delivery.

- **Alternate Flows**:
  - If there is an issue with the print job (e.g., paper jam, ink shortage), the print job is paused and staff is notified.

- **Post Conditions**:
  - Print job is completed or needs reprocessing.

7. Admin: Manage Payments (Admin)

- **Brief Description**:
  Admin can manage payments, verify payments, and handle discrepancies.

- **Preconditions**:
  - Admin is logged in.
  - Payments have been initiated by customers.

- **Basic Flow**:

1. Admin reviews payment statuses.
2. Admin resolves payment issues or approves payments.

- **Alternate Flows**:
  - If payment fails, the admin notifies the customer to retry.

- **Post Conditions**:
  - Payments are properly processed and updated in the system.

8. AI-Based Load Distribution (AI System)

- **Brief Description**:
- The AI system distributes printing jobs to ensure the efficient use of available resources (e.g., printers, paper).

- **Preconditions**:
  - Orders are placed and ready to be processed.
  - Printers are available.

- **Basic Flow**:

1. The AI system receives the print job queue.
2. The system distributes jobs based on available resources and printer load.

- **Alternate Flows**:
  - If the system detects high demand, it may delay certain print jobs.

- **Post Conditions**:
  - The printing workload is efficiently distributed across available printers.

9. Printers: Print Document (Printers)

- **Brief Description**:
  Printers execute the print jobs assigned to them.

- **Preconditions**:
  - The printer has received a print job from the system.

- **Basic Flow**:

1. Printer receives a print job from the system.
2. Printer prints the documents according to the specifications.

- **Alternate Flows**:
  - If the printer runs out of paper or encounters a malfunction, the print job is paused.
- **Post Conditions**:
  - The document is printed and ready for delivery.

Chapter 3 Design Document

3.1. Introduction

The Design Document outlines the architecture and components of the Automated Print Shop System (APS), ensuring an efficient design and implementation approach. This chapter includes diagrams, sequence interactions, and detailed modeling to translate system requirements into actionable designs. The aim is to provide a clear blueprint for developers, stakeholders, and testers.

1. **Domain Model**: Represents the key entities and their relationships within the system.
2. **System Sequence Diagram**: Illustrates the sequence of interactions between external actors and the system.
3. **Sequence Diagram**: Captures the order of object interactions in specific use cases.
4. **Collaboration Diagram**: Explains the relationships and message flows between objects.
5. **Operation Contracts**: Defines state changes resulting from system operations.
6. **Design Class Diagram**: Details the classes, attributes, and methods in the system.
7. **State Transition Diagram**: Tracks transitions between different system states.
8. **Data Model**: Provides a relational representation of system entities and their relationships.

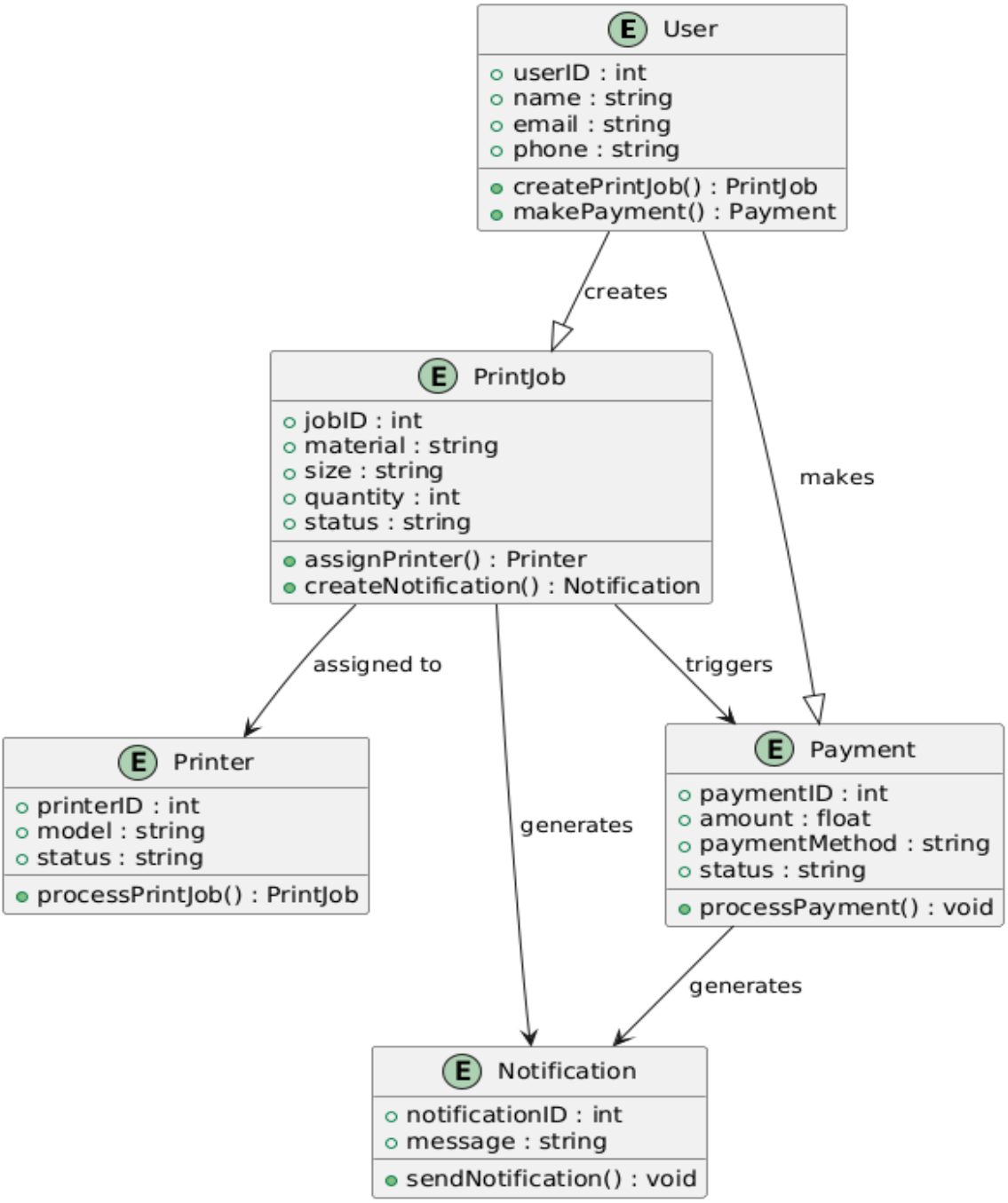
Now we discuss these artifacts one by one as follows.

3.2. Domain Model

Domain modeling represents the high-level entities and their relationships in the Automated Print Shop System. It identifies critical components such as Users, PrintJobs, Printers, Payments, and Notifications. The domain model provides the structural framework that guides development, ensuring consistent communication and design.

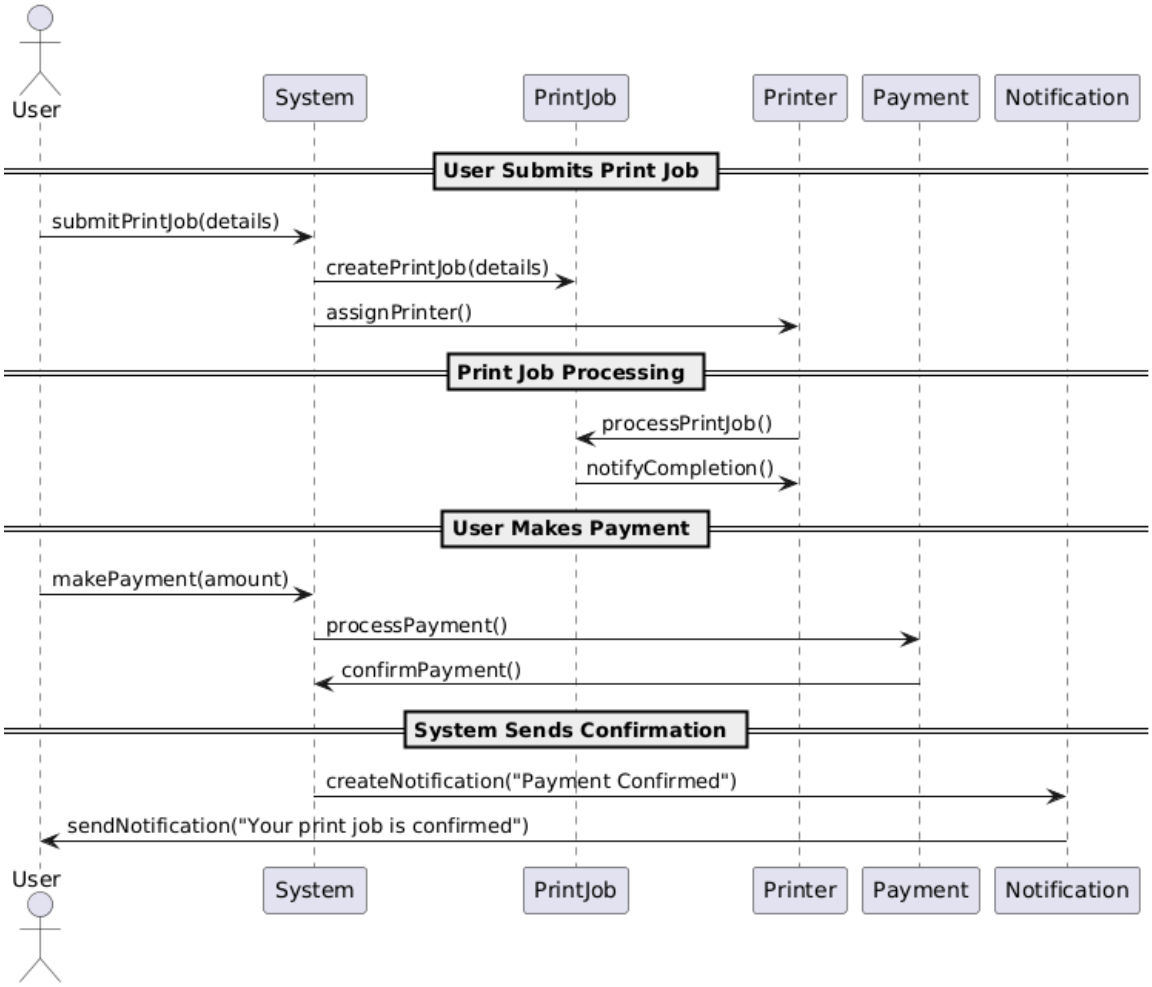
- Definition of scope for the domain
- Information or objects
- Features or use cases, including factors that lead to variation
- Operational/behavioral characteristics

A product line definition will describe the domains necessary to build systems in the product line.



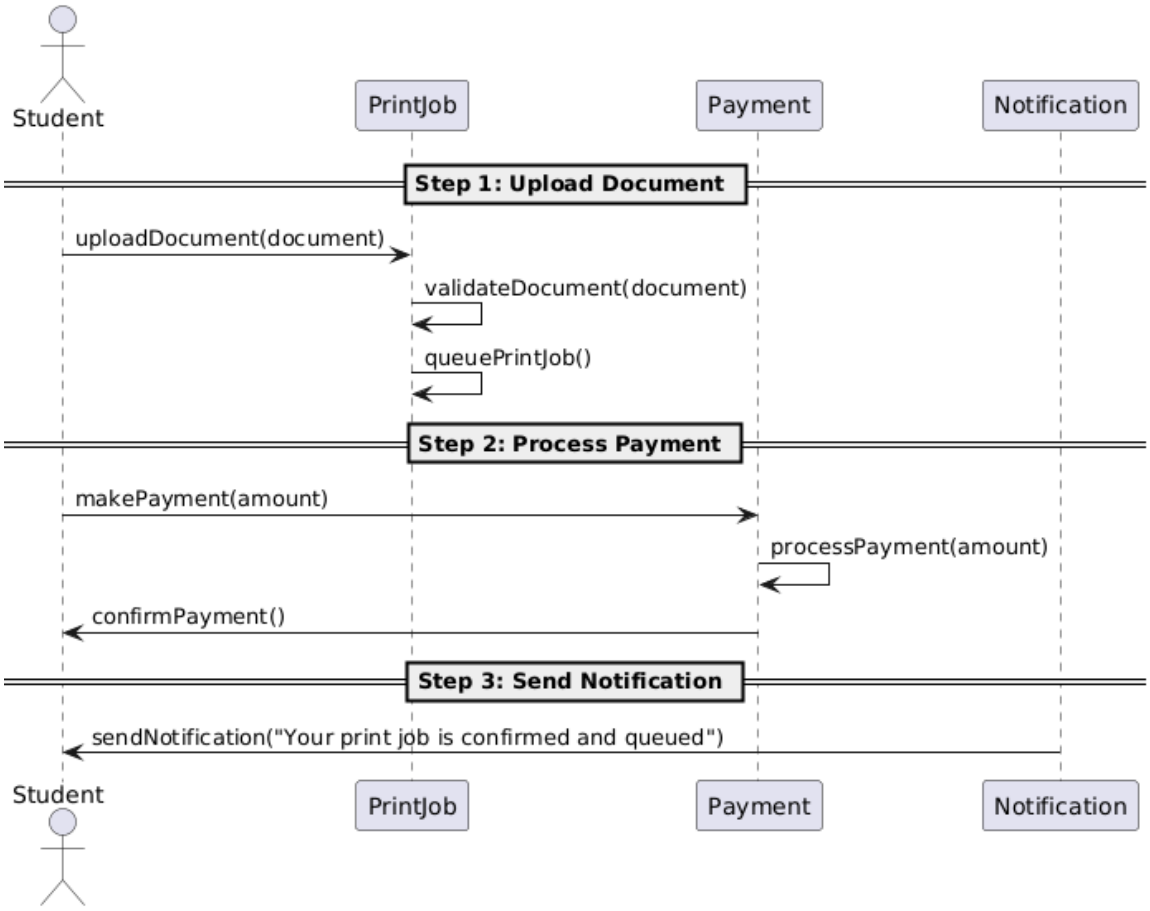
3.3. System Sequence Diagram

System Sequence Diagrams illustrate the sequence of interactions between external actors and the system for specific use cases. For example, a sequence diagram might show how a student submits a document, the system processes the request, and a confirmation is sent.



3.4. Sequence Diagram

Sequence diagrams offer a detailed depiction of how objects interact in a specific use case. They show the sequential flow of messages between system components, capturing the dynamic behavior during operations.



3.4.1. Defining a Sequence Diagram

A sequence diagram visualizes the interactions between objects in a specific scenario. It defines the sequence of messages exchanged among various entities.

3.4.2. Basic Sequence Diagram Symbols and Notations

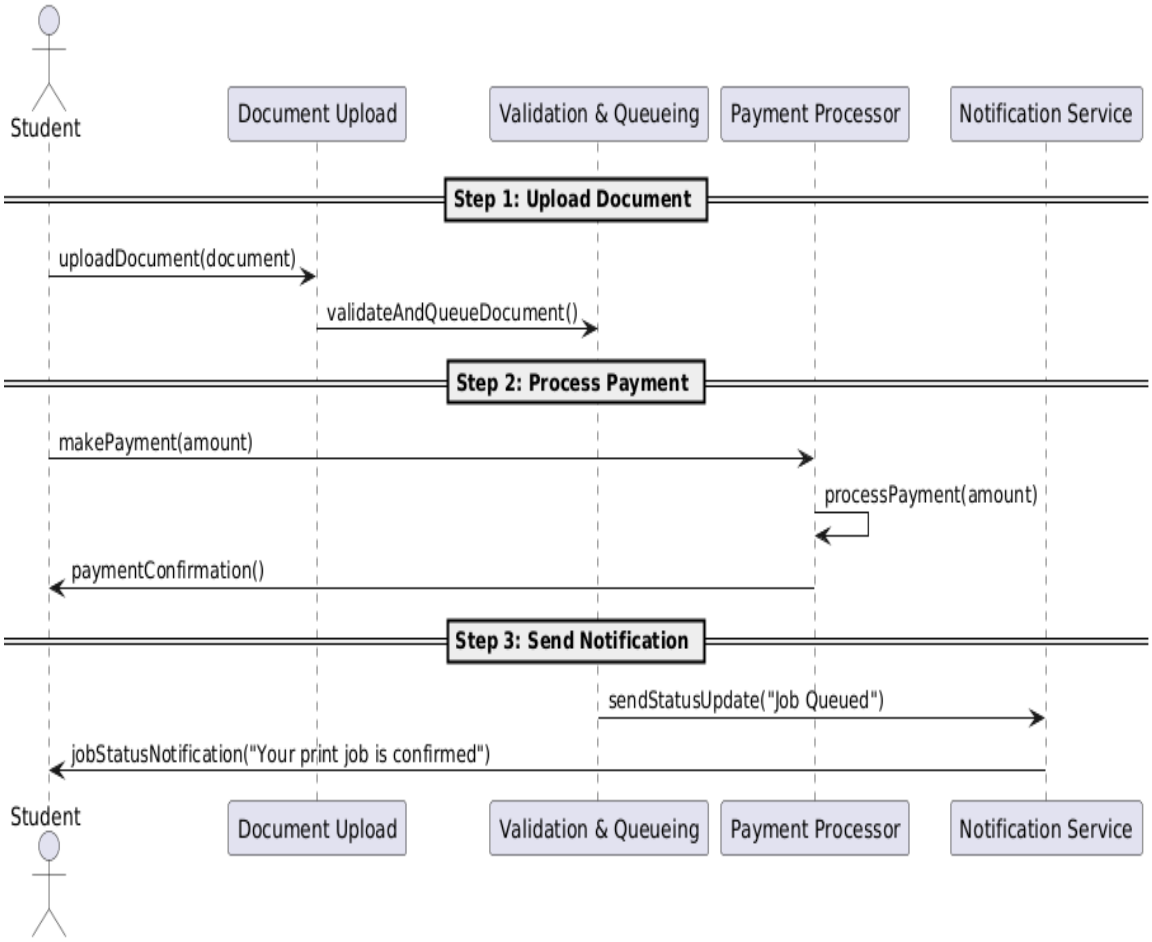
Key symbols and notations include:

- **Actors**: External entities (e.g., Student, Admin).
- **Lifelines**: Represent entities involved in the sequence.
- **Messages**: Arrows representing communication between objects.
- **Activation Bars**: Indicate the time taken for a process.

3.4.3. Example

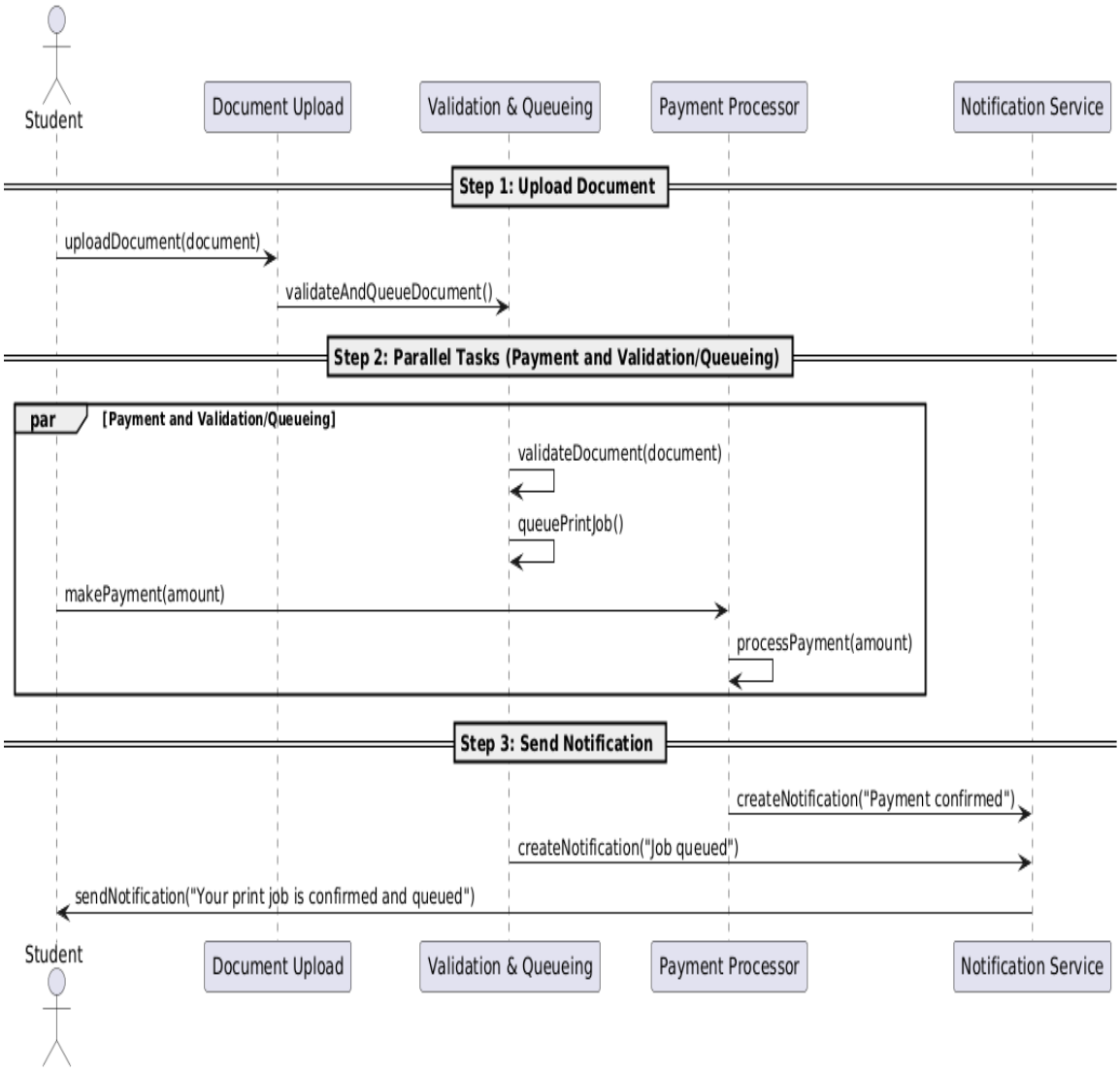
A sequence diagram for the "Print Job Submission" use case might include:

1. Student uploads a document.
2. The system validates and queues the document.
3. Payment is processed.
4. Notifications are sent about job status.



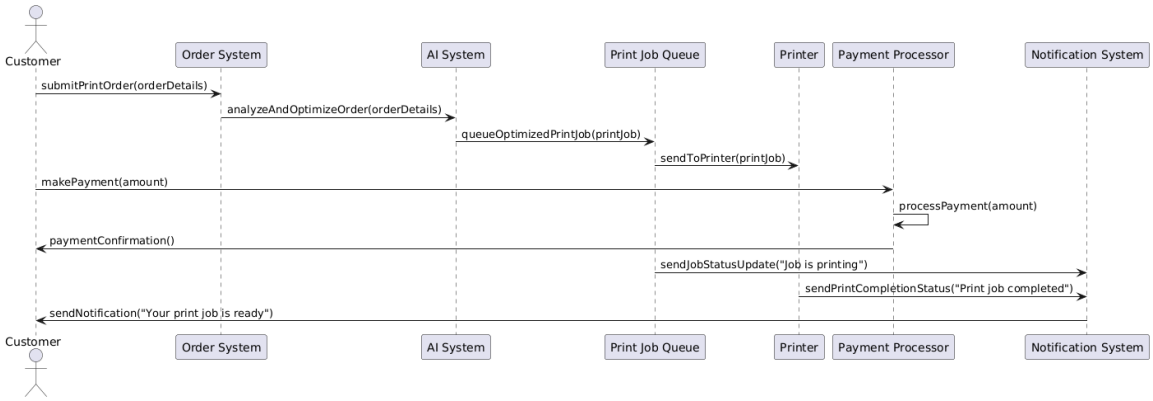
3.4.4. Distributing Control Flow in Sequence Diagrams

Control flow distribution ensures that tasks like printing and payment processing are handled in parallel wherever possible, minimizing delays.



3.5. Collaboration Diagram

Collaboration diagrams emphasize the structural organization of objects, showing their relationships and interactions.



3.5.1. Contents of Collaboration Diagrams

Key contents include:

- **Objects**: Represent entities in the system (e.g., Printer, Payment Gateway).
- **Links**: Connections between objects for communication.
- **Messages**: Define the order of interactions.

3.5.2. Constructs of Collaboration Diagram

Constructs include:

- Object roles defining their functions.
- Links showing communication paths.
- Sequential messages for process flow.

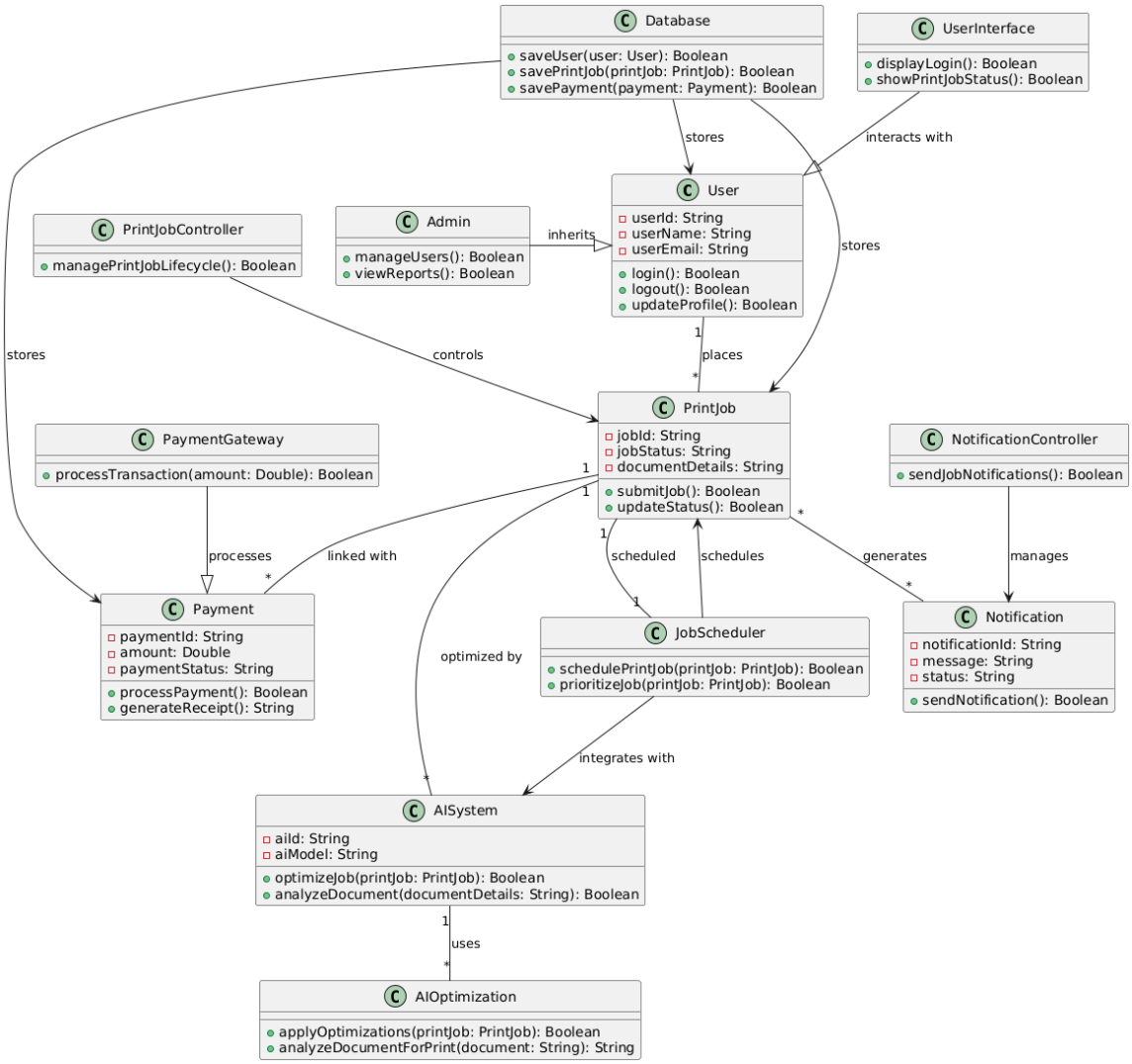
3.6.Operation Contracts

Operation	**Preconditions**	**Postconditions**	**State Transition**
Submit Print Job	Customer logged in, document ready for upload	Print job created, enters **Pending** state	No Job → Pending
Validate and Queue Print Job	Print job in **Pending** state, valid document format	Print job validated, enters **Queued** state	Pending → Queued
Optimize Print Job (AI)	Print job in **Queued** state, AI system available	Print job optimized, enters **Optimized** state	Queued → Optimized

Process Payment	Customer entered payment info, print job in **Queued** or **Optimized** state	Payment processed, print job enters **Paid** state	Queued → Paid, Optimized → Paid
Print Job Completion	Print job in **Paid** state, printer available	Print job printed, enters **Completed** state	Paid → Completed
Notify Customer	Print job in **Paid** state, printer available	Customer notified with job status	No change in print job state

3.7. Design Class Diagram

The Design Class Diagram outlines the static structure of the system, showcasing classes, their attributes, methods, and interconnections.



3.7.1. Create Initial Design Classes

Initial design classes include:

- **User**: Represents students, admins, and staff.
- **PrintJob**: Contains document details and statuses.
- **Payment**: Manages transaction records.
- **Notification**: Sends updates about job progress.

3.7.2. Designing Boundary Classes

Boundary classes act as interfaces with external systems. Examples include:

- **User Interface**: Handles user interactions.
- **Payment Gateway**: Processes transactions.

3.7.3. Designing Entity Classes

Entity classes represent core data elements, such as:

- **User**: Stores user data.
- **PrintJob**: Tracks job details and statuses.
- **Payment**: Logs transactions.

3.7.4. Designing Control Classes

Control classes manage process flows, such as:

- **PrintJob Controller**: Manages the lifecycle of print jobs.
- **Notification Controller**: Handles communication processes.

3.7.5. Identify Persistent Classes

Persistent classes store long-term data, including:

- **User** and **PrintJob** classes mapped to database tables.

3.7.6. Define Class Visibility

Class visibility ensures proper encapsulation:

- **Public**: Accessible methods for external interaction.
- **Private**: Internal attributes for data integrity.
- **Protected**: Limited access for inheritance.

3.7.7. Design Class Relationships

Relationships include:

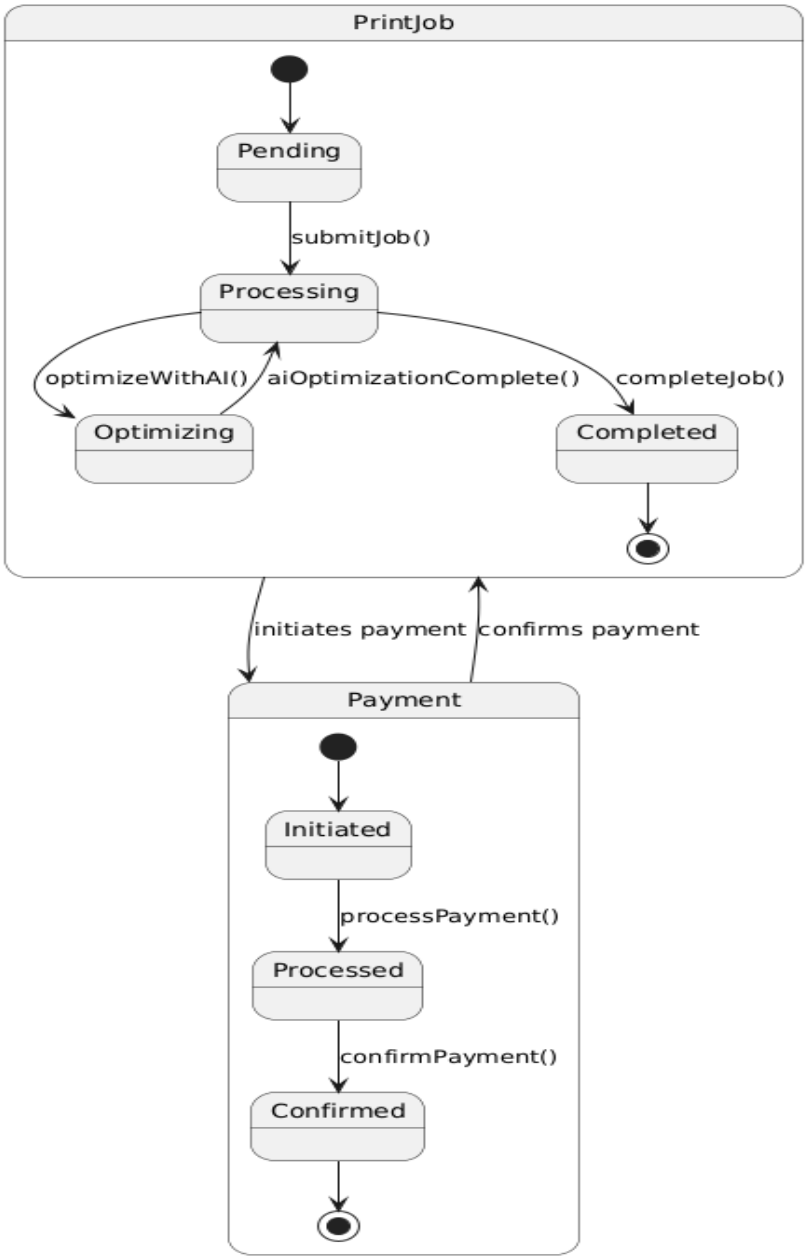
- **Association**: User places Print Jobs.

- **Inheritance**: Admin inherits from User.
- **Aggregation**: A Notification aggregates multiple messages.

3.8. State Chart Diagram

State chart diagrams represent object states, such as:

1. **PrintJob** states: Pending → Processing → Completed.
2. **Payment** states: Initiated → Processed → Confirmed.



3.9. Data Model

The data model defines the logical organization of data:

- **User Table**: Stores user information.
- **PrintJob Table**: Tracks job details.
- **Payment Table**: Logs payment records.