**Applied Software Project Report**

By

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**A Master’s Project Report submitted to Scaler Neovarsity - Woolf in partial fulfillment of the requirements for the degree of Master of Science in Computer Science**

Month of Submission May, 2025



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**Date of Submission :** DD/MM/YYYY <Date of Submission>

**Certification**

I confirm that I have overseen / reviewed this applied project and, in my judgment, it adheres to the appropriate standards of academic presentation. I believe it satisfactorily meets the criteria, in terms of both quality and breadth, to serve as an applied project report for the attainment of Master of Science in Computer Science degree. This applied project report has been submitted to Woolf and is deemed sufficient to fulfill the prerequisites for the Master of Science in Computer Science degree.

Naman Bhalla

…………………

Project Guide / Supervisor

**DECLARATION**

I confirm that this project report, submitted to fulfill the requirements for the Master of Science in Computer Science degree, completed by me from 1st October 2024 to 31st December 2024, is the result of my own individual endeavor. The Project has been made on my own under the guidance of my supervisor with proper acknowledgement and without plagiarism. Any contributions from external sources or individuals, including the use of AI tools, are appropriately acknowledged through citation. By making this declaration, I acknowledge that any violation of this statement constitutes academic misconduct. I understand that such misconduct may lead to expulsion from the program and/or disqualification from receiving the degree.

**Ashutosh Mishra**

**<Signature of the Candidate> Date: 10 May 2025**

**ACKNOWLEDGMENT**

**I would like to express my heartfelt gratitude to my family for their unwavering support, encouragement, and belief in me throughout this journey. Their patience and understanding have been the foundation of my strength. I am deeply thankful to all the instructors and mentors at Scaler whose expert guidance, insightful feedback, and dedication to teaching have played a crucial role in shaping my skills and understanding. I also want to extend my sincere appreciation to my peers, friends, and everyone who inspired and motivated me during this program. Completing this Master's degree has been a transformative experience, and I am grateful to all who contributed to this achievement.**

**Table of Contents**

[**List of Tables 6**](#_9nnr2lniv90f)

[**List of Figures 7**](#_ju1gc9w3iuai)

[**Applied Software Project 8**](#_b4cf8683b1wd)

[Abstract 8](#_sj7c7bghlznr)

[Project Description 8](#_1z5fx61h0cc)

[Requirement Gathering 9](#_joagy45av5k0)

[Class Diagrams 9](#_nvf4h831fm8o)

[Database Schema Design 9](#_ydqs8nkbe6m9)

[Feature Development Process 11](#_p6mfl8dwb9sy)

[Deployment Flow 12](#_2mk44ad33gi)

[Technologies Used 12](#_wn68bn10ag78)

[Conclusion 13](#_4yf46wt6rx84)

[**References 14**](#_z0iyzog9l959)

## List of Tables

**(To be written sequentially as they appear in the text)**

|  |  |  |
| --- | --- | --- |
| **Table No.** | **Title** | **Page No.** |
| **1** |  |  |
| **2** |  |  |

## List of Figures

**(List of Images, Graphs, Charts sequentially as they appear in the text)**

|  |  |  |
| --- | --- | --- |
| **Figure No.** | **Title** | **Page No.** |
| **1** |  |  |
| **2** |  |  |

## **Applied Software Project**

### Abstract

### EcommApp is a full-stack, modular, and scalable e-commerce web application built using Django REST Framework (backend) and React.js (frontend), developed as part of the Scaler Neovarsity Master's degree program in Computer Science. This project aims to replicate and simplify real-world e-commerce business processes through software by integrating critical components such as user authentication, product and category management, order and cart handling, inventory tracking, payment gateway integration, and notifications. The system is architected for flexibility, maintainability, and performance. Razorpay is integrated to handle online payments securely, and Redis is employed for caching to enhance responsiveness.

### Objective

* Develop a modular backend that can handle core e-commerce operations.
* Implement clean REST APIs for frontend consumption.
* Integrate Razorpay for secure payments.
* Provide a configurable admin panel and dynamic user frontend.
* Enable caching and optimized query handling.
* Deploy using cloud infrastructure with containerization.
* Ensure secure authentication and authorization using token-based methods (JWT).
* Maintain inventory consistency and transactional integrity across services.
* Implement a scalable notification system for user communication.
* Design a database schema optimized for relational integrity and query performance.
* Ensure code maintainability and scalability through service separation and best practices.
* Facilitate API testing and documentation using Swagger/OpenAPI.

### Literature Review

The design and development of e-commerce platforms have been extensively explored in both academic and industrial domains. Research highlights the importance of modular architecture, RESTful APIs, secure authentication, and database optimization in developing scalable and maintainable systems. Microservice-based architectures are increasingly recommended for large-scale e-commerce systems to improve fault tolerance and service isolation.

Modern web development best practices emphasize decoupling the frontend and backend to allow independent scaling and deployment. Furthermore, integrating third-party services such as payment gateways, SMS/email notifications, and caching layers (like Redis) is a proven approach to enhancing system efficiency and responsiveness.

The Django REST Framework (DRF) is widely acknowledged for its simplicity, robustness, and rapid API development capability. Coupled with React.js for frontend, this combination supports a clean separation of concerns, code reuse, and fast user interfaces. This project is grounded in these proven patterns and principles.

### Market Research

India’s e-commerce market is projected to reach $200 billion by 2026, driven by increasing smartphone penetration, internet access, and digital payment adoption. Consumers today expect fast, intuitive, and secure online shopping experiences, raising the bar for performance and reliability.

Industry leaders like Amazon and Flipkart have set high standards with features such as real-time inventory updates, secure checkout, and intelligent product recommendations. Meanwhile, platforms like Shopify and WooCommerce cater to small businesses with plug-and-play e-commerce features.

EcommApp draws inspiration from both these spectrums—adopting scalable, cloud-ready backend strategies and combining them with admin configurability and modular code that could support plugins or new features in the future. This project is designed with future-readiness in mind, able to adapt to growing user demand, evolving business models, and technological advances.

### Project Description

**EcommApp** is a full-stack e-commerce platform designed to simulate real-world online retail experiences through modular, scalable, and secure backend systems. It supports user authentication, product and category management, shopping cart functionality, order processing, payment integration via Razorpay, inventory tracking, and notification delivery. The backend is developed using Django REST Framework, while the frontend uses React.js. The architecture is built with scalability, performance, and maintainability in mind, aligned with current industry standards.

The project follows agile software development practices with clearly defined phases: **Definition**, **Planning**, **Development**, and **Delivery**. This approach ensures that requirements are gathered iteratively and features are delivered incrementally, with feedback and reflection loops at each stage.

The system is also cloud-ready, containerized using Docker, and deployed on AWS to simulate real-world deployment practices, making it suitable for enterprise use cases or as a foundation for further development.

### Objectives Recap

* Build a modular backend that handles user, product, order, and payment workflows.
* Implement secure, well-documented REST APIs.
* Create a flexible admin dashboard and a responsive user-facing UI.
* Optimize performance using Redis caching and database indexing.
* Ensure scalable deployment via cloud infrastructure and containerization.

### Capstone Project Development Process



**Figure 1.1**: Project Development Process

This diagram represents the four key phases followed during the development of **EcommApp**:

* **Definition:** Project theme selection, user persona studies, and a design sprint.
* **Planning:** Backlog creation, technical setup, and project idea validation.
* **Development:** Conducted across 3 agile sprints, each ending with review and feedback.
* **Delivery:** Final project evaluation, documentation, and report preparation.

### **Requirement Gathering**

**Functional Requirement:**

The functional requirements typically cover all features and operations needed to support the buying and selling of products online.

**1. User Management**

* **User Registration**: Allow customers to create accounts.
* **User Login/Logout**: Secure authentication using username/email and password.
* **Profile Management**: Update profile info, change password, view order history.
* **Role-based Access**: Admin, customer, vendor (if multi-seller).

**2. Product Catalogue**

* **Product Listing**: Browse all products with categories, filters, and sorting.
* **Product Details**: View detailed info including price, images, stock, description.
* **Search Functionality**: Search by name, brand, category, etc.

**3. Inventory Management**

* **Stock Tracking**: Track available quantity of each product.
* **Automatic Stock Update**: Adjust inventory on order placement and return.

**4. Shopping Cart**

* **Add/Remove Items**: Add products to cart, remove or update quantity.
* **Cart Persistence**: Keep cart data even after user logs out or refreshes.
* **View Cart Summary**: Show subtotal, total, and item list.

**5. Checkout & Payment**

* **Address Selection/Entry**: Select saved shipping/billing addresses or add new.
* **Order Summary**: Show total amount, shipping cost, taxes.
* **Place Order**: Finalize purchase with confirmation.
* **Payment Gateway Integration**: Integration with Stripe, Razorpay, etc.

**6. Order Management**

* **View Orders**: Users can view past orders and their status.
* **Order Statuses**: Pending, Paid, Shipped, Delivered, Cancelled, Returned.
* **Admin Control**: View, update status, manage all orders.

**7. Shipping & Delivery**

* **Shipping Options**: Standard, Express, or by region.
* **Tracking**: Show delivery status updates if integrated with courier.

**8. Notifications**

* **Email/SMS/Push**: Notify users of order placement, shipping, delivery.
* **In-app Notifications**: For account activity or status changes (if implemented).

**9. Ratings & Reviews**

* **Customer Reviews**: Allow users to rate and review products.
* **Moderation**: Admin can manage or approve reviews.

**10. Admin Dashboard**

* **Manage Users**: View, deactivate, or promote users.
* **Manage Products**: CRUD operations on products and categories.
* **Manage Orders**: Update order status, view analytics.
* **Inventory & Sales Reports**: Track KPIs, stock, sales trends.

**11. Security**

* **Authentication & Authorization**: Secure login, JWT/session tokens.
* **Input Validation**: Prevent SQL injection, XSS, CSRF.
* **Data Encryption**: For passwords and sensitive data.

**12. Internationalization (Optional)**

* **Multi-currency Support**
* **Multi-language Support**

**Non-functional requirements (NFRs):**

Non-functional requirements (NFRs) define the **quality attributes** of the system - how it behaves under certain conditions rather than what it does.

**1. Performance & Scalability**

* **High Availability**: The app should be available 99.9% of the time.
* **Scalability**: Must handle traffic spikes (e.g., during sales or holidays).
* **Response Time**: Pages should load within 2 seconds under normal load.
* **Throughput**: Capable of processing thousands of concurrent transactions.

**2. Security**

* **Data Protection**: All sensitive user data must be encrypted (passwords, payment info).
* **Authentication & Authorization**: Secure login (JWT, OAuth2), role-based access control.
* **Compliance**: Must comply with legal standards (e.g., GDPR, PCI-DSS).
* **Input Validation**: Prevent common attacks (XSS, SQL injection, CSRF).

**3. Reliability**

* **Failover Mechanism**: Use of backups or replicas to prevent downtime.
* **Crash Recovery**: System should recover without data loss after failure.
* **Consistent Behaviour**: Actions (e.g. checkout) must complete reliably.

**4. Maintainability**

* **Modular Codebase**: Easy to update, fix, and extend features.
* **Documentation**: Code and API should be well-documented.
* **Logging & Monitoring**: Errors, transactions, and performance must be logged and monitored.

**5. Testability**

* **Unit & Integration Testing Support**: Code should be testable via automated tests.
* **Test Environment**: Maintain a staging/test environment for QA.

**6. Usability**

* **User-Friendly UI**: Clean and intuitive navigation and design.
* **Accessibility**: Supports screen readers, colour contrast, keyboard navigation.
* **Multi-device Support**: Works well on desktop, tablet, and mobile.

**7. Portability**

* **Browser Compatibility**: Chrome, Firefox, Safari, Edge, etc.
* **Cloud Deploy ability**: Can be deployed on AWS, Azure, or any cloud infrastructure.
* **Platform Agnostic**: Should work across different OS environments.

**8. Availability & Uptime**

* **24/7 Operation**: The platform should be operable at all times.
* **Downtime Notifications**: Scheduled maintenance should notify users in advance.

**9. Analytics & Reporting**

* **User Behaviour Tracking**: Integrate analytics tools (e.g., Google Analytics).
* **Business Reports**: Sales trends, user activity, conversion rate reports.

**10. Interoperability**

* **API-first Design**: Easily integrate with 3rd party services (payments, shipping, analytics).
* **Data Format Support**: JSON, XML for APIs and external data exchange.

**E-Commerce Application Architecture and Design:**

The architecture follows a microservices-based design structured into four layers:

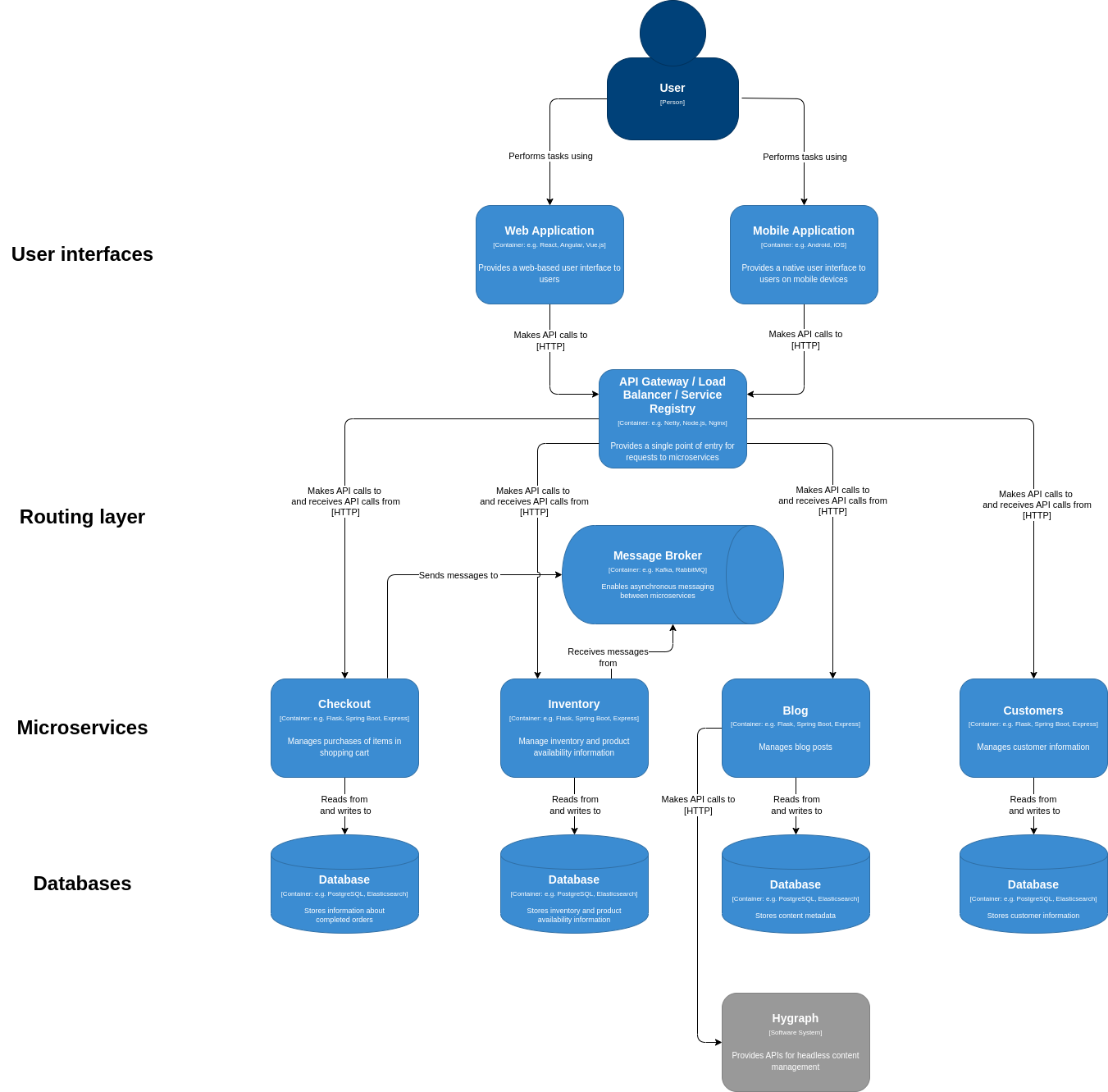
**User Interfaces:** Users interact via a Web Application or Mobile Application, which provide responsive UI experiences.

**Routing Layer:** All user requests are routed through an API Gateway / Load Balancer / Service Registry (e.g., Nginx, Kong, Spring Gateway), which acts as a single-entry point and manages routing to backend services.

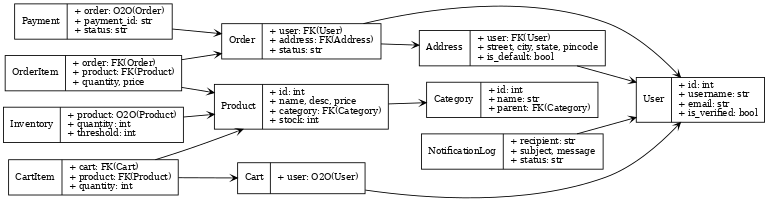
**Microservices:**

* **Users:** Manages user registration, authentication, and profile management.
* **Address:** Handles user address data used during checkout.
* **Cart:** Manages items added by users before ordering.
* **Category:** Organizes products into logical categories for easy browsing.
* **Product:** Stores product details like name, price, images, and description.
* **Inventory:** Tracks stock levels of each product.
* **Order:** Handles order creation, status tracking, and order history.
* **Payment:** Manages payment processing and transactions.
* **Notification:** Sends email or system notifications for order updates, payments, etc.

**Databases:** Each microservice uses its own dedicated database (PostgreSQL, TimescaleDB) ensuring data isolation and service autonomy. Additionally, a Hygraph headless CMS manages dynamic content like blog posts.

****

**UML Diagram:**



**Users**: Manages user registration, authentication, and profile management.

**Address**: Handles user address data used during checkout.

**Cart**: Manages items added by users before ordering.

**Category**: Organizes products into logical categories for easy browsing.

**Product**: Stores product details like name, price, images, and description.

**Inventory**: Tracks stock levels of each product.

**Order**: Handles order creation, status tracking, and order history.

**Payment**: Manages payment processing and transactions.

**Notification**: Sends email or system notifications for order updates, payments, etc.

### **Class Diagrams**

**Low Level Design (LLD):**

The low-level design breaks down each service and its components (controllers, services, entities, repositories) along with their responsibilities and relationships. This level focuses on the actual implementation blueprint, method details, and object interaction.

**Project Structure Overview:**

This project follows a modular design with the following key directories:

* backend/: Root directory for the backend application.
* services/: Contains individual Django apps for different microservices.
* shared/: Houses shared utilities and configurations.
* manage.py: Django's command-line utility for administrative tasks.

Each service within the services/ directory represents a distinct domain of the e-commerce platform, promoting separation of concerns and scalability.

**Project Structure:**

ecommapp/

│

├── backend/ # Root backend directory

│ ├── services/ # Collection of domain-specific Django apps

│ │ ├── address/ # Address microservice (user shipping addresses)

│ │ ├── cart/ # Cart management microservice

│ │ ├── category/ # Product category microservice

│ │ ├── inventory/ # Inventory and stock management

│ │ ├── notification/ # Notification (emails, messages) microservice

│ │ ├── order/ # Order and order item tracking

│ │ ├── payment/ # Payment status and transaction tracking

│ │ ├── product/ # Product information service

│ │ └── users/ # User registration and authentication

│ │

│ ├── shared/ # Common utilities, exceptions, decorators, etc.

│ │ ├── models/ # Shared base models or abstract classes

│ │ ├── utils/ # Helper functions, formatters, validators

│ │ └── constants.py # Common constants used across services

│ │

│ ├── settings/ # Django settings split into multiple files

│ │ ├── base.py # Base settings

│ │ ├── dev.py # Development settings

│ │ └── prod.py # Production settings

│ │

│ ├── urls.py # Root URL configurations (aggregates service URLs)

│ ├── wsgi.py # WSGI entry point for deployment

│ └── asgi.py # ASGI entry point (if using async features)

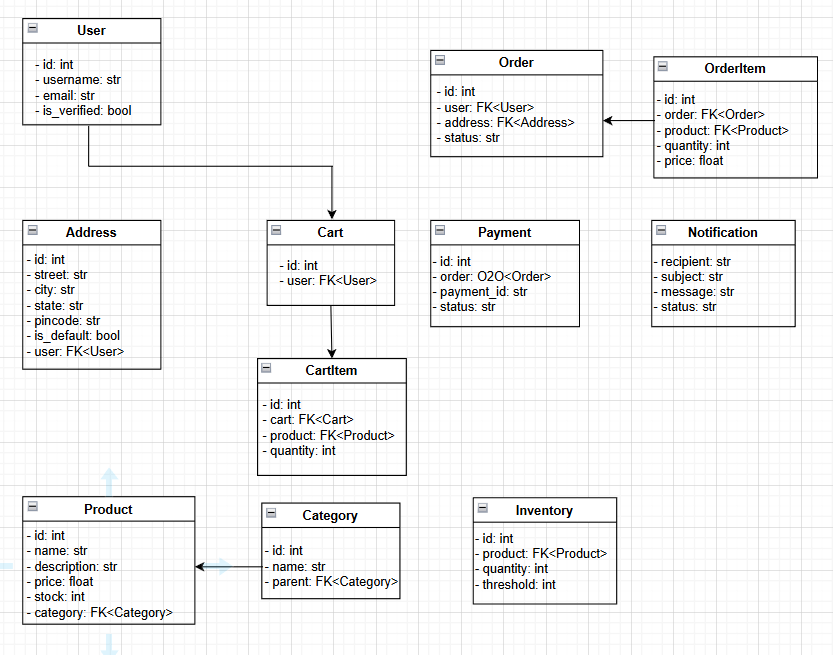
│

├── manage.py # Django’s CLI utility to manage the app

├── requirements.txt # Python dependencies

└── .venv # Environment variables (not committed to Git)

**Service Mapping:**



**Core Apps and their Responsibilities:**

**1. User Service (services/user/)**

* **Models**:
  + User: Extends Django's AbstractUser to include additional fields like is\_verified.
  + Address: Stores user addresses with fields like street, city, state, pincode, and is\_default.
* **Responsibilities**:
  + User registration and authentication.
  + Managing user profiles and addresses.

**2. Product Service (services/product/)**

* **Models**:
  + Category: Represents product categories with potential parent-child relationships.
  + Product: Contains product details such as name, description, price, stock, and a foreign key to Category.
* **Responsibilities**:
  + Managing product listings and categories.
  + Handling product-related queries.

**3. Cart Service (services/cart/)**

* **Models**:
  + Cart: Represents a user's shopping cart.
  + CartItem: Items within a cart, linking to specific products and quantities.
* **Responsibilities**:
  + Adding, updating, and removing items in the cart.
  + Calculating cart totals.

**4. Order Service (services/order/)**

* **Models**:
  + Order: Captures order details, including user, address, and status.
  + OrderItem: Represents individual items within an order.
* **Responsibilities**:
  + Processing orders from carts.
  + Managing order statuses and histories.

**5. Payment Service (services/payment/)**

* **Models**:
  + Payment: Tracks payment details linked to orders, including payment\_id and status.
* **Responsibilities**:
  + Handling payment processing and confirmations.
  + Integrating with payment gateways.

**6. Inventory Service (services/inventory/)**

* **Models**:
  + Inventory: Manages stock levels for products, including quantity and threshold.
* **Responsibilities**:
  + Tracking product stock levels.
  + Alerting when stock falls below thresholds.

**7. Notification Service (services/notification/)**

* **Models**:
  + NotificationLog: Logs notifications sent to users, including recipient, subject, message, and status.
* **Responsibilities**:
  + Sending order confirmations, shipping updates, and other user notifications.

### **Database Schema Design**

|  |  |  |
| --- | --- | --- |
| **Table** | **Fields** | **Explanation** |
| User | id (PK), username, email, is\_verified | User table holds registered user information. |
| Address | id (PK), user\_id (FK), street, city, state, pincode, is\_default | Address allows users to store multiple delivery addresses. |
| Cart | id (PK), user\_id (FK) | Cart and CartItem manage items users intend to purchase. |
| CartItem | id (PK), cart\_id (FK), product\_id (FK), quantity |
| Product | id (PK), name, desc, price, category\_id (FK), stock | Product is linked to Category and stores product information. |
| Category | id (PK), name, parent\_id (FK to Category) |
| Inventory | id (PK), product\_id (FK), quantity, threshold | Inventory tracks stock levels and threshold alerts. |
| Order | id (PK), user\_id (FK), address\_id (FK), status | Order and OrderItem capture purchase data and line items respectively. |
| OrderItem | id (PK), order\_id (FK), product\_id (FK), quantity, price |
| Payment | id (PK), order\_id (FK), payment\_id, status | Payment records payment status for orders. |
| NotificationLog | id (PK), recipient, subject, message, status | NotificationLog stores system notifications like order updates. |

**Table 1.1:** Schema Design Table

Describe the Low Level Design of the Project…

Provide class diagrams - Provide proper captions and follow the proper format for including diagrams / figures / images

**Tip** - Make images using draw.io and paste here following the guidelines for adding images / figures

### Database Schema Design

Explain the **Low Level Design** of the Project in more detail by providing the **database schema**

**design** description

Provide the schema design textually as well as diagrammatically

Sample Schema Design described textually -

“”

Tables:

Batches

* + Batch\_id
  + Name
  + Start\_month
  + Current\_instructor
  + Batch\_type\_id
  + Primary Key(Batch\_id)

Students

* + student\_id
  + name
  + graduation\_year
  + University\_name
  + email
  + Phone\_number
  + batch\_id
  + Buddy\_id
  + Primary Key(student\_id)

Classes

* Class\_id
* Name
* Date
* Time
* Instructor
* Primary Key(Class\_id)

Mentors

* + Mentor\_id
  + Name
  + Current\_company
  + Primary Key(Mentor\_id)

Mentor\_Sessions

* mentor\_session\_id
* time
* Duration
* Student\_id
* Mentor\_id
* Student\_rating
* Mentor\_rating
  + Primary Key(mentor\_session\_id)

Batches\_Classes

* + Batch\_id
  + Class\_id
  + Primary Key(Batch\_id, Class\_id)

Student\_batch\_history

* + student\_id
  + batch\_id
  + Shift\_date
  + Primary Key(student\_id, batch\_id)

Batch\_type

* + Batch\_type\_id
  + Batch\_type
  + Primary Key(Batch\_type\_id)

**Foreign Keys:**

* Batches(batch\_type\_id) refers Batch\_type(batch\_type\_id)
* Students(batch\_id) refers Batches(batch\_id)
* Mentor\_Sessions(Student\_id) refers Students(Student\_id)
* Mentor\_Sessions(Mentor\_id) refers Mentors(Mentor\_id)
* Batches\_Classes(Batch\_id) refers Batches(batch\_id)
* Batches\_Classes(student\_id) refers Students(Student\_id)
* Student\_batch\_history(student\_id) refers Students(Student\_id)
* Student\_batch\_history(batch\_id) refers Batches(batch\_id)

**Cardinality of Relations:**

* Between Batches and Batch\_type -> m:1
* Between Students and Batches -> m:1
* Between Batches and Classes -> m:m

“”

### Feature Development Process

Pick One key feature - Talk about its development process, implementation and performance optimisation / metric optimisation achieved…

For example, ‘Book a seat’ feature in developing ‘BookMyShow’ app

Elaborate the request flow to backend

* 1. API Request Payload
  2. Service which picks the request
  3. Flow of MVC architecture

Explain the performance improvement / metric optimization achieved.

For example,

* Used Cache to reduce API Response time by X seconds…
* Optimized Query Response time by using Indexing…

Benchmarking of response time without the optimisation and post the optimisation

### **Deployment Flow**

**Components Overview:**

**1. EC2 (Elastic Compute Cloud)**

* EC2 instances will host your microservices (e.g., user, product, cart, etc.).
* Each service can run on its own EC2 or in a Docker container using ECS or a container orchestrator like Kubernetes (EKS).
* You can scale EC2 instances based on load using Auto Scaling groups.

**2. VPC (Virtual Private Cloud)**

* Acts as a private network for your AWS resources.
* Public subnets host services that need internet access (e.g., API Gateway, Load Balancer).
* Private subnets contain backend services, databases, and internal components, isolated from public access.

**3. Security Groups**

* Firewall-like rules controlling inbound and outbound traffic for EC2, RDS, and other services.
* Example:
  + Web services: Allow HTTP/HTTPS (ports 80/443).
  + Database: Only allow connections from backend EC2 instances or Lambda functions.

**4. RDS (Relational Database Service)**

* Manages databases (e.g., PostgreSQL, MySQL) for persistent storage (users, products, orders).
* Automatically handles backups, patching, and replication.
* Placed in a private subnet to prevent public access, and accessed via security group rules.

**5. Cache (Amazon ElastiCache)**

* Used for session management, caching frequently accessed data (like product listings or inventory counts).
* Supports Redis and Memcached.
* Reduces database load and improves performance.

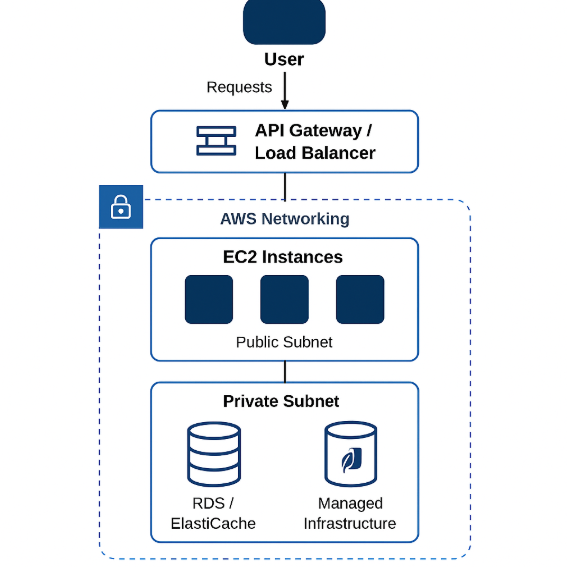
**6. Managed Infrastructure / Elastic Beanstalk**

* Ideal for simplified deployment and management.
* Automatically handles provisioning, load balancing, scaling, and monitoring.
* You just deploy code; Beanstalk manages EC2, ALB, Auto Scaling, etc., in the background.
* Suitable for non-containerized or lightly containerized apps.

**Architecture Flow:**

User -> ALB (Public Subnet) -> EC2 App Instances (Private Subnet)

-> RDS / ElastiCache (Private Subnet)



Architecture Flow of AWS

### Technologies Used

Kafka, MySQL, Springboot, Cloud etc…

* For each key technology used in building the project,
  + Detail and describe each of them
  + Elaborate how they can be used in real life
  + Provide example of real-life applications using them

Use diagrams, images to explain better

**Tip** - Use the internet to improve your project but DO NOT PLAGIARIZE - Include proper references if you are quoting articles from the internet

### Conclusion

The Conclusion should include some key points as elaborated below -

* Key Takeaways: Highlight the important concepts and technologies learned from doing the Project
* Practical Applications : Significance of technologies with their real-world applications
* Limitations : Limitations of the technologies, cost implications and suggestions for improvement

## References

Include the websites or works or the list of works referred to in a text or consulted by you for writing this report

1. Name of the Website, Date and time of referring to the Website, Name of the Author, Title/Topic
2. Author Name, Title / Topic, Research Paper Name / Book Name, Year of Publication

Format Guidelines

1. Detailed and Elaborate report of 40 pages at least is expected
2. Margins - Every page of your document must meet the margin requirements of 1.25 inches on the left and right, and 1 inch on the top and bottom.
3. Font:
   1. Style: Times New Roman,
   2. Font Size:14 (For Headings), 12 (For body text) in black colored text.
   3. All text must be the same justification, like left justified or fully justified.
4. Line Spacing:
   1. Body of the text: 1.5
   2. List of Tables/graphs/charts/bibliography: single line.
5. Alignment:
   1. Title page: Centre
   2. Chapter Heading: Centre
   3. Subheading: Left
   4. Body of the text: Justify
6. Titles: All titles and subtitles should be in bold. All tables/graphs/charts/figures should have appropriate titles.
7. Numbering of the tables, charts, graphs should be in the following fashion: Second table/graph/chart in the second chapter should be numbered as Table/graph/chart no. 2.02; where the first digit stands for chapter no. and digits after (.) stands for number of table/graph/charts in that chapter. Same numbering should be followed for all other chapters.