Technical paper for full-stack E-commerce website development project using React, Node.js and MySQL

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Abstract. I am hereby presenting a technical paper on design and implementation of a full-stack e-commerce website development project using latest technologies like React for frontend, supported by Node.js & Express for Backend and database from MySQL. Website tested for various functions and found to be responsive and robust.

I INTRODUCTION

The extensive use of E-commerce platforms in our day-to-day lives sparked my interest in studying and understanding the front-end, back-end, and database to develop this user-friendly full-stack e-commerce website which offers user registration, login, cart management, delivery & order instructions, session management and payment gateway. Key learnings and future enhancements elaborately explained in this paper.

II RELATED WORKS

Efficiency of an E-Commerce Web Application with MERN Stack and Modern Tools (October 2022) [6]

C.M. K De Silva, A. S De Silva, K.A. I Maduwantha, D.A.I.U Dewpura, D.I. De Silva and R.R.P De Zoysa

https://ijemr.vandanapublications.com/index.php/j/article/view/928/803

We referred many articles and found article [6] as a Related work. Both, aforesaid article [6] and our project, has used React for Frontend and Node.js for Backend. User authentication, Cart management, Product display and Checkout are similar in Article [6] and our project.

Article [6] backend uses MongoDB whereas I have used MySQL which allowed me to use structured schema for users, sessions, orders and payment details. Further my project integrates Razorpay for real-time payment processing and verifies payments through cryptographic signature validation, whereas in article [6] this capability not addressed.

III FRAMEWORKS AND PROGRAMMING LANGUAGES

- React [1] framework & CSS language for front-end
- Node.js [2] & Express [3] for Back end
- MySQL Workbench [4] for Database

IV SYSTEM ARCHITECTURE

Three key components namely the Front end, Back end and Database of this web application system are illustrated in Figure 1 having System architecture which is enclosed herewith.

System components described as follows:

A. Front End

React framework [1] frontend layer provides a user-friendly, dynamic & responsive interface. Product data are fetched from API.

Frontend communicates seamlessly with the Backend through HTTP requests to API endpoints.

Front end includes User registration, Login & Log-out process, Form validation & Error handling, Visual representation & other details for products, Cart operations, Ordering & Delivery instructions, and Payment Gateway.
Figure 2 to 11 having Snapshots of Frontend pages are enclosed herewith for ready reference.

B. Back End

Node.js [2] and Express [3] frameworks handle HTTP requests and facilitate communication between the front end, server, and database.

Back-end frameworks provide User authentication & authorization, Session management, Database operation, and Password encryption.
Figure 12 having Schema design of backend enclosed herewith for ready reference.

C. Database
User information, Session data, and Shopping cart data are stored using the My SQL Workbench [4] database system. The database includes the following tables:

- User table (User ID, User Name, Password, Full Name, Email, Phone)
- Session table (Session ID, Expires, Cookie data)
- Cart table (Cart ID, User ID, Product ID, Quantity)
- Order table (User ID, Order ID, Cart data, Total amount, Order instructions, Delivery instructions, Payment ID, Payment status, Delivery address)

V IMPLEMENTATION & USAGE

A. User Registration
Easy to use Front end form captures details fed by Users like Full Name, Password, Email address, and Phone number.
Refer enclosed Fig. 3 having snapshot of this frontend page.

B. User Login Process

- User fills User name & Password in front end Login form
- The back end crosschecks credentials fed by the user from the database.
- Password verification is done by bycrpt [5] comparison.

Refer enclosed Fig. 4 having snapshot of this frontend page.

C. Session management

- Upon successful authentication session is created and a Session ID is assigned to each session using an HTTP cookie.
- Session with its ID stored in the Session table.
- User name with the Hello prefix is displayed upon session storage.
- When a user gives the Logout command session is destroyed.

Fig. 12 having Session management code snippets attached for ready reference.

D. Shopping cart
Enables continuous storage of product information selected by the user across various sessions.

- Add to cart
- Check user authentication, Facilitate the addition and updation of products in the cart.
- Assign order Quantity to items in the cart
- Allows to modify quantify which is 1 by default.
- Remove the item from the cart.
- Updation of Prices as per the quantity of items in the cart.
- No access to the Cart after the session is destroyed.

Refer enclosed Fig. 5 & 6 having snapshots of these frontend pages.

E. Order & Delivery instructions
Frontend form enables the user to Type in customized user order instructions like Gift wrap, Fragile, Include bill with consignment, and the User fills in the Delivery address along with customized delivery instructions like Leave at the security desk, Call upon arrival, etc.

- Upon clicking the Proceed to pay button, filled-in user inputs are captured in the frontend and sent to the backend, for generating Order ID and saving Order & Delivery instructions.

Refer enclosed Fig. 7 & 8 having snapshots of these frontend pages.

F. Payment Gateway
Enables secured and real-time Payment using Razorpay payment gateway.

- Upon clicking the Checkout Now button, a post request is sent to the backend to refer Order ID and create a Razorpay order for the total cart amount.
- Subsequently, Frontend displays the Razorpay checkout widget using the Order ID.
- Upon receipt of payment instructions from the user, Razorpay sends the Payment ID and Transaction signature to the frontend and for backend verification.
- Upon successful payment Razorpay via post requests informs the backend to save full order data including Payment ID.
- Simultaneously Razorpay post requests inform frontend to display the Payment successful message.

Refer enclosed Fig. 9 & 10 having snapshots of these frontend pages.
Fig. 13 having Razor Payment Gateway Integration code snippets attached for ready reference.

VI LEARNINGS

A. Frontend learnings

- Use of Function based components in React [1]
- Use of Hooks functions (Custom Hook & Inbuilt hook)
- Create a context that acts like a Cloud where all pages will share the same Cart data
- Incorporated Filter function which creates a new array containing only those items that did not match the condition.
- Implemented Webkit CSS function for Media queries.
- Created Media responsiveness (1553 pixels, 1386 pixels, 1112 pixels, 600 pixels).
- Added responsive navigation.
- Created Dynamic slider for Landing page
- Added Out of stock / Added to cart Pop-ups

B. Backend learnings

- Used Express session for website to store data across multiple HTTP requests
- Used CORs (Cross-origin requests)
- Established secure Session management using express-session with MySQL
- Implemented password hashing with bcrypt for secure user authentication
- Designed APIs for login, registration, cart operations, and order management
- Connected MySQL database with Express for dynamic CRUD operations
- Cross-Origin Resource Sharing (CORS) for communication between frontend and backend
- Built a Razorpay integration for secure and dynamic payment processing
- Verified payments using cryptographic signature validation on the backend
- Stored complete order metadata (cart items, payment info, instructions) upon successful payment
- Added robust error handling and validation for user sessions and database interactions

VII TESTING

- Manually tested user authentication flows (login, logout, registration) across different user roles.
- Stimulated various cart operations (add, remove, update quantity) to check state consistency
- Checked Session persistence using browser dev tools and cookie inspection
- Validated Razorpay payment flow using test keys and monitored success/failure redirections
- Ensured proper form validation.
- Browser resize and mobile emulation tools used for testing responsiveness and UI behaviors.

VIII RESULTS & CONCLUSION

Satisfactorily achieved the development of full stack eCommerce website using the latest technologies like React [1], Node.js [2], Express [3], and MySQL workbench [4].

IX FUTURE ENHANCEMENTS

- Customer feedback
- Goods return & refund policy
- Complete Backend panel

X ACKNOWLEDGEMENTS

The author thankfully acknowledges guidance and contribution of his mentor Ms. Monali Tayade at M/s. Fermion Infotech Pvt. Ltd., Vashi, Navi Mumbai, India. Email address: monalit@fermion.in.

REFERENCES

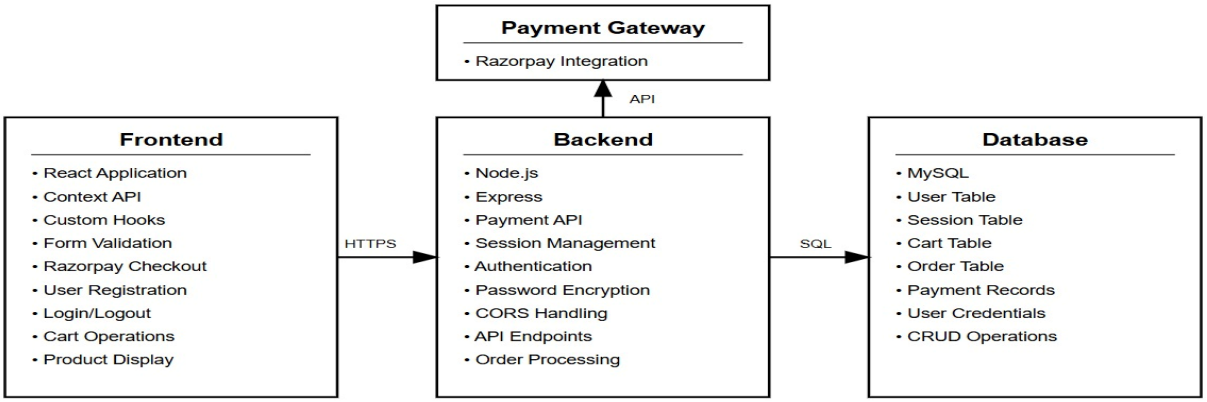
[1] React: JavaScript library by Meta (Facebook) https://reactjs.org.
[2] Node.js, Node.js Foundation: Cross-platform JavaScript runtime environment. https://nodejs.org.
[3] Express: Minimal & flexible Node.js web application framework. https://expressjs.com.
[4] MySQL: Open source database by Oracle Corporation. https://dev.mysql.com.
[5] bcrypt: Node package manager (npm) used in Node.js for securely hashing passwords. https://www.npmjs.com/package/bcrypt.
[6] Efficiency of an E-Commerce Web Application with MERN Stack and Modern Tools (October 2022). C.M. K De Silva, A. S De Silva, K.A. I Maduwantha, D.A.I.U Dewpura, D.I. De Silva and R.R.P De Zoysa.

XII ANNEXURE

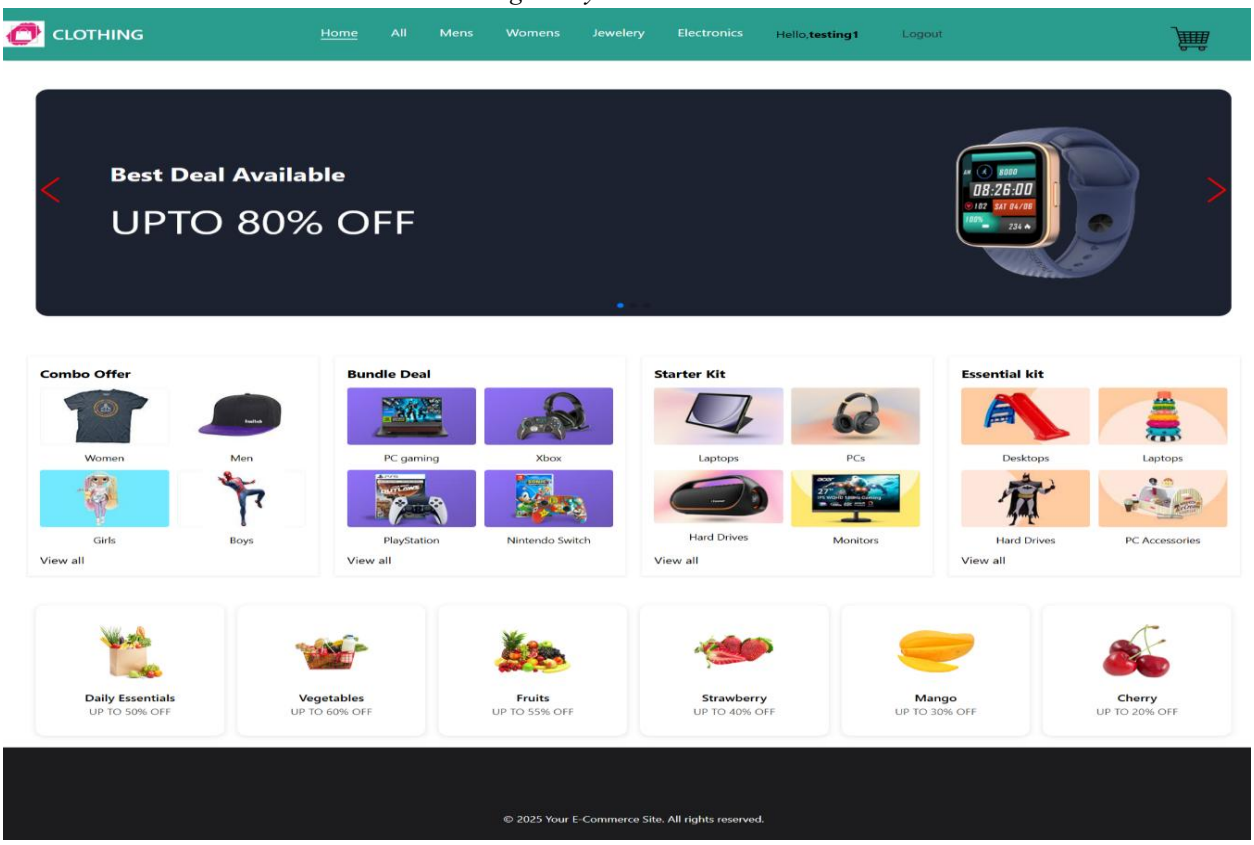
Following System architecture, Snapshots of the Frontend pages, Backend design schema and Code snippets enclosed:

Fig. 1 System architecture
Fig. 2 Website Landing page.
Fig. 3 User registration page
Fig. 4 User Login page
Fig. 5 Product display page
Fig. 6 Cart page
Fig. 7 Checkout / Ordering page
Fig. 8 Delivery Instruction page
Fig. 9 Payment gateway page
Fig. 10 Payment success page
Fig. 11 Schema design of backend
Fig. 12 Session management code snippet
Fig. 13 Razorpay Payment integration code snippet

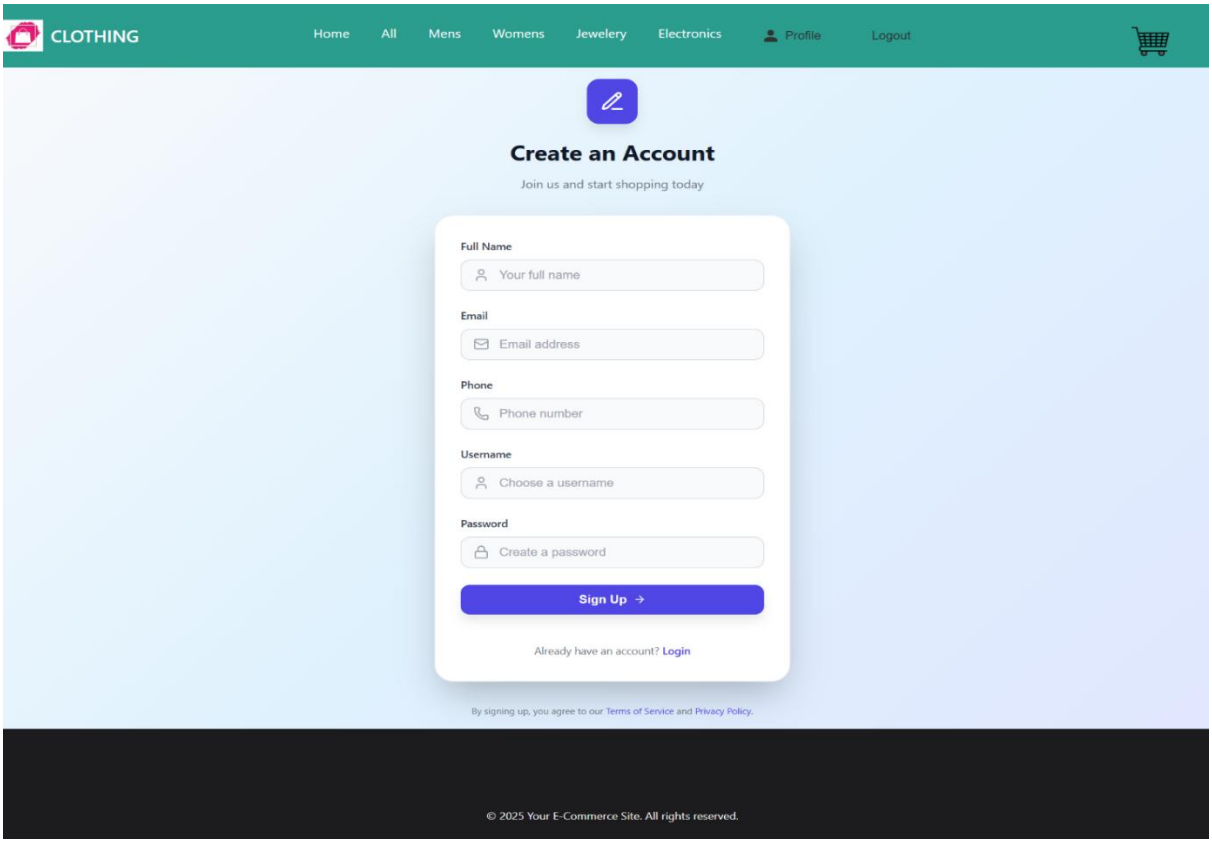
Annexure: System architecture, Frontend pages, Backend design schema and Code snippets



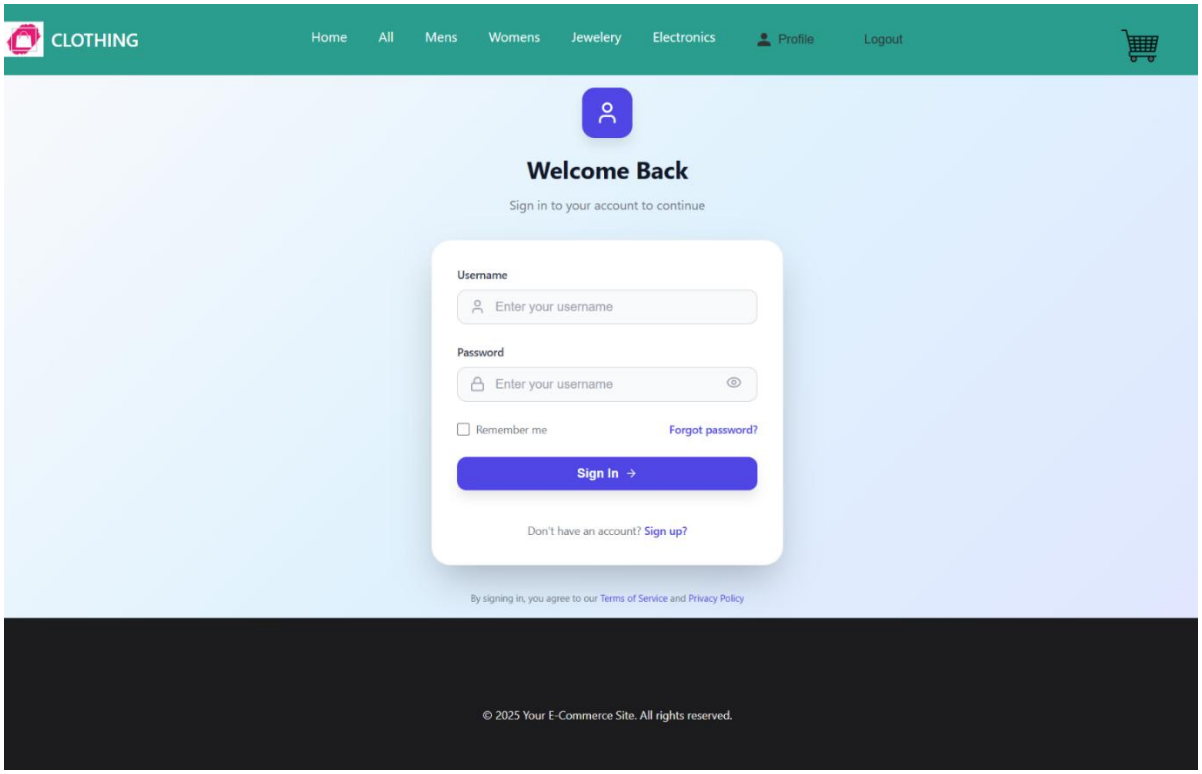
"Fig. 1" System architecture



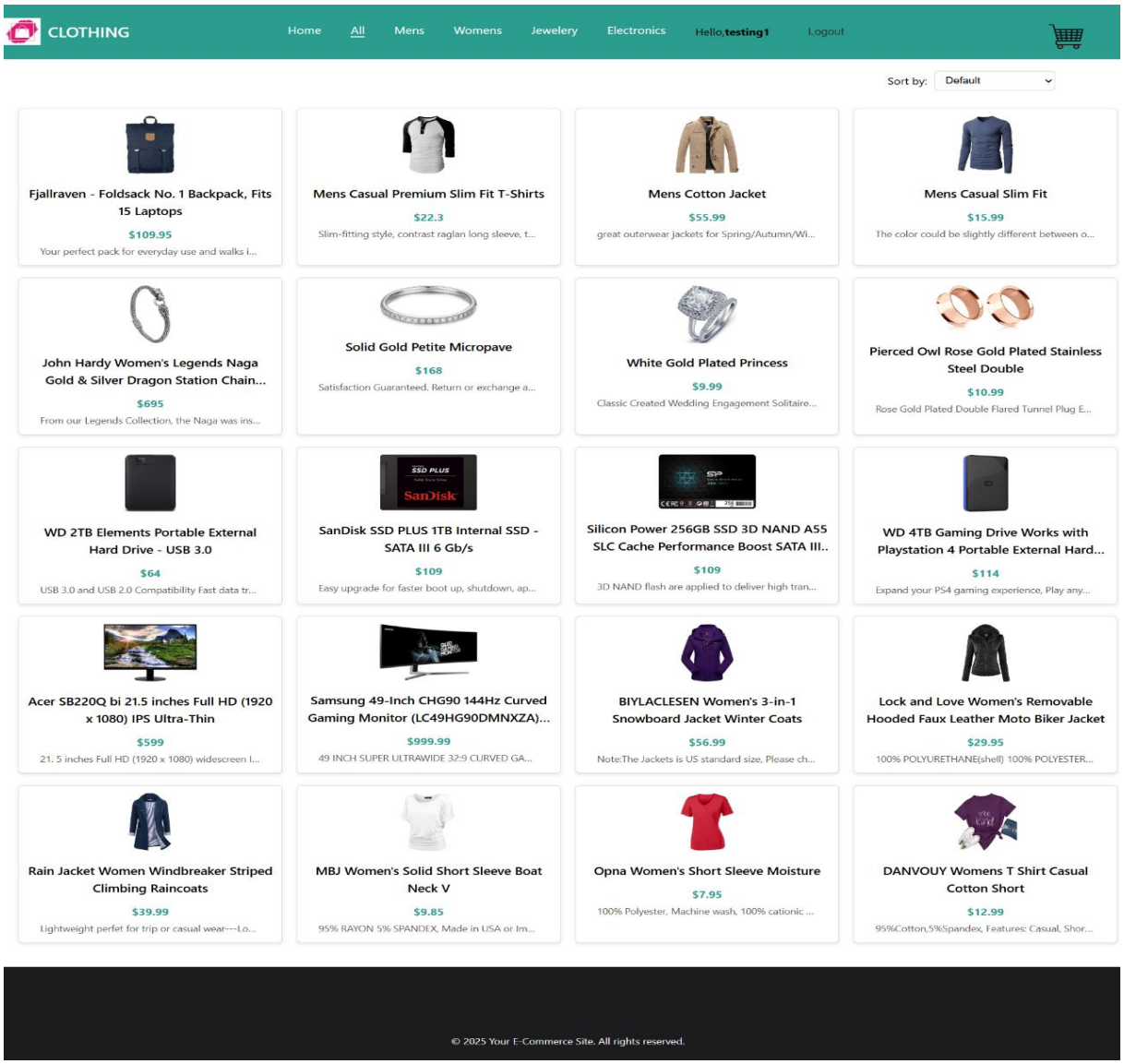
"Fig. 2" Website landing page



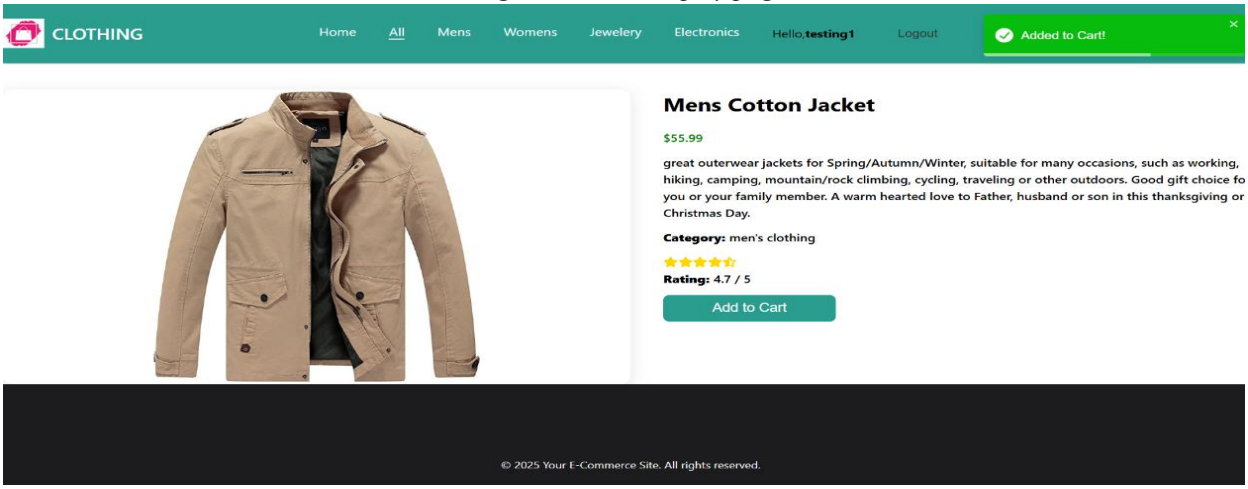
"Fig. 3" User registration page



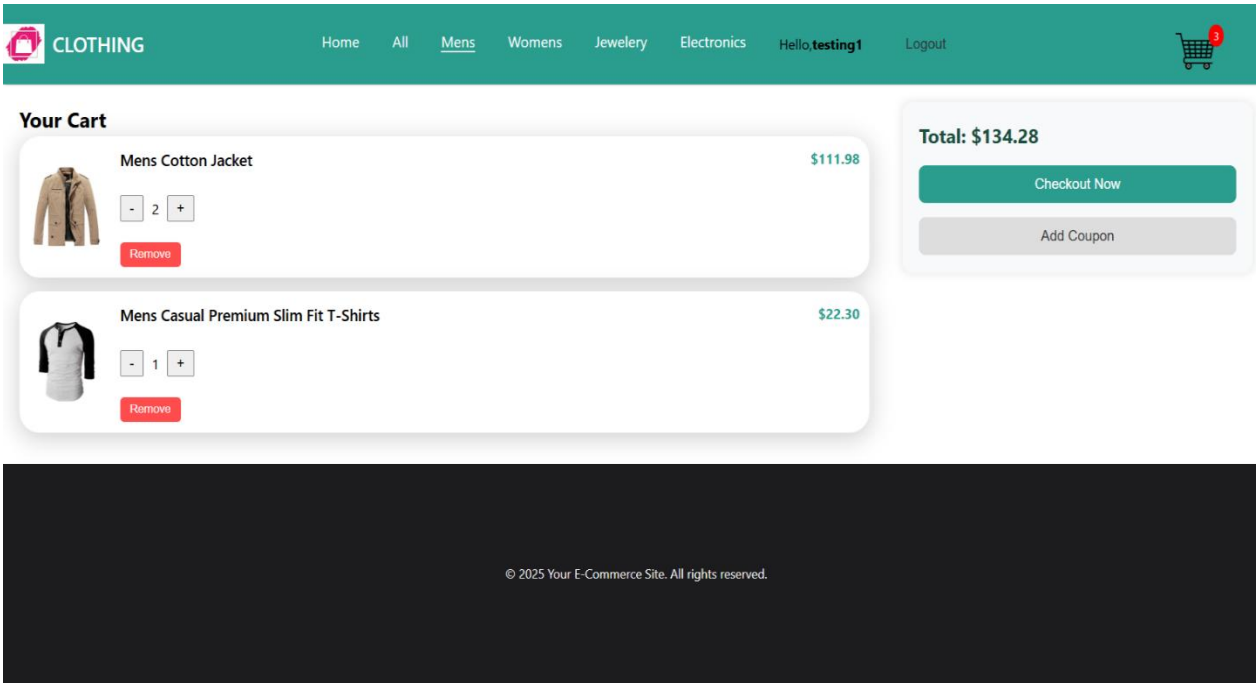
"Fig. 4" User login page



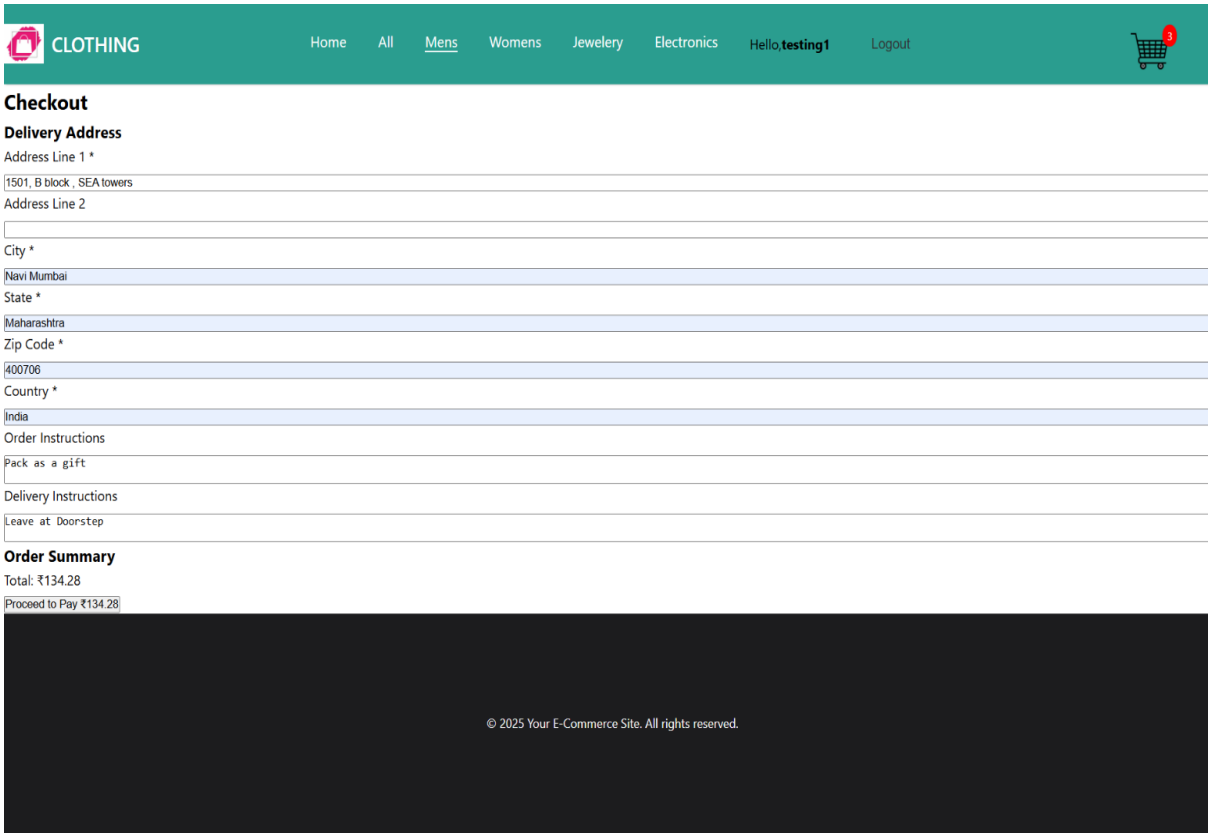
"Fig. 5" Product display page



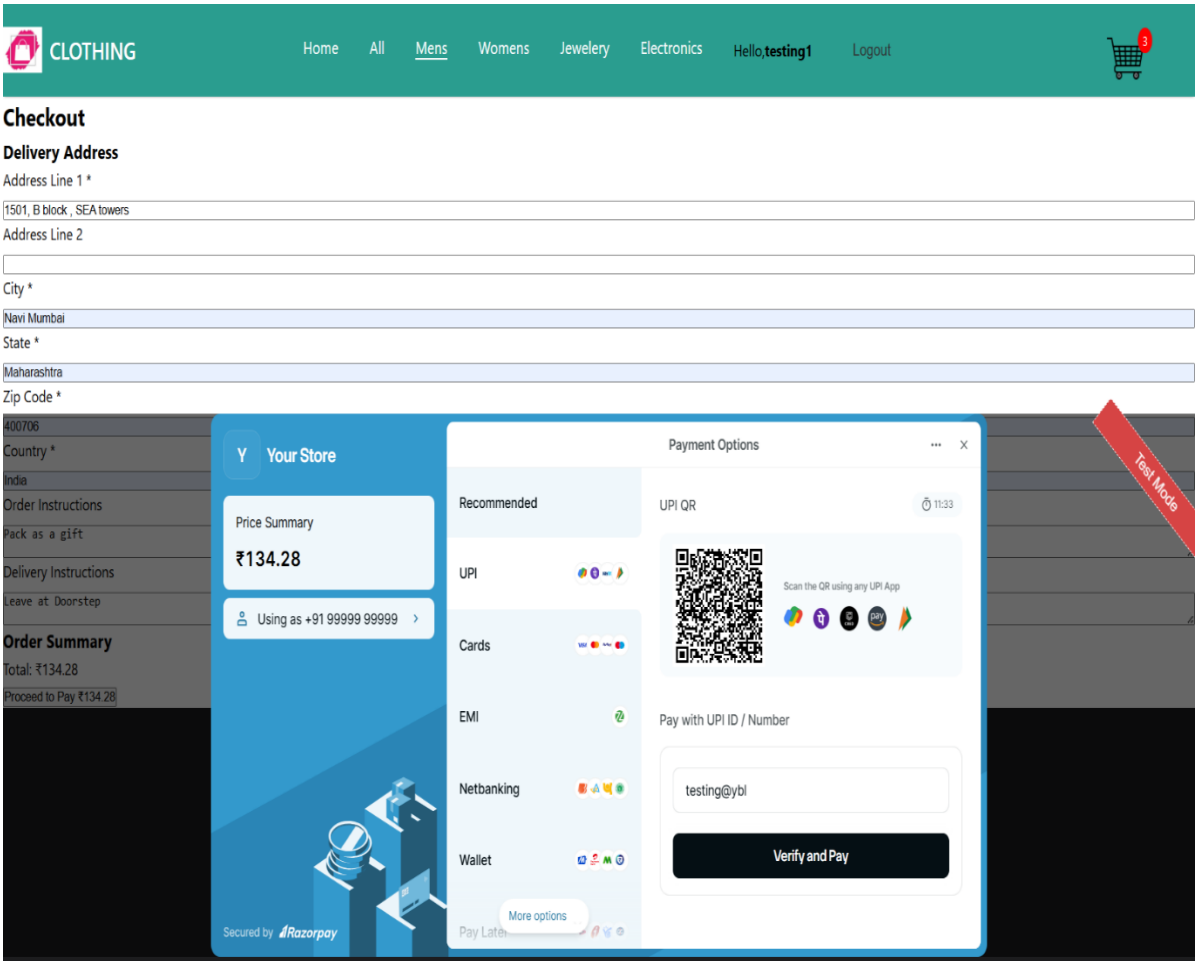
"Fig. 6" Cart page



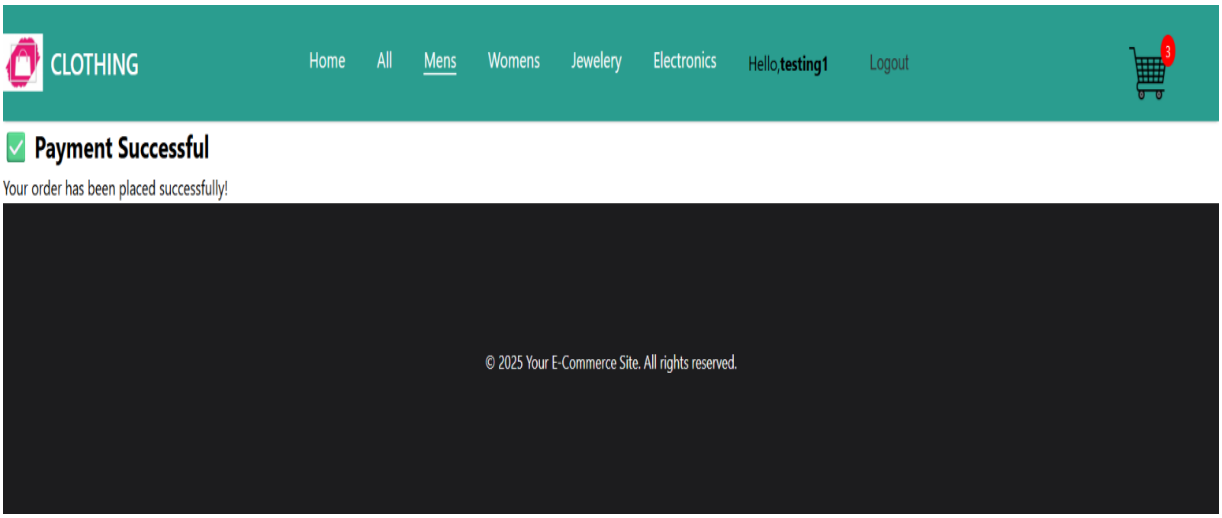
"Fig.7" Checkout Ordering page



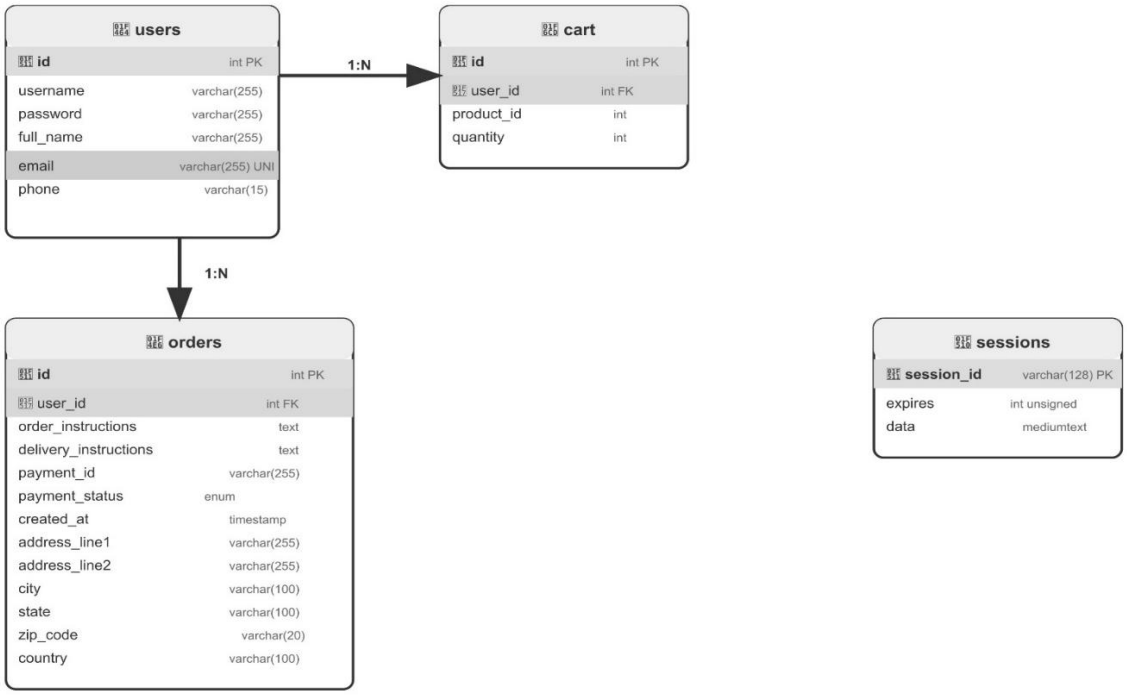
"Fig. 8" Delivery instructions page



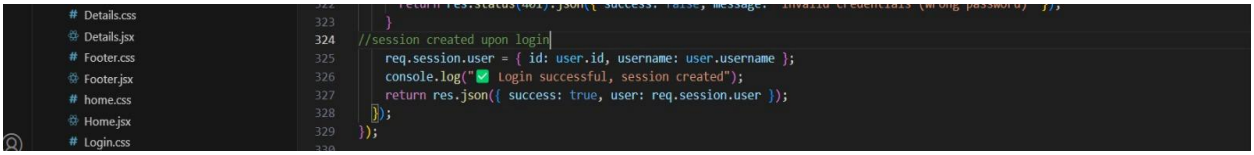
"Fig. 9" Payment Gateway page



"Fig. 10" Payment success page



"Fig. 11" Schema design of backend



```
const express = require('express');
const session = require('express-session');
const mysql = require('mysql2');
const MySQLStore = require('express-mysql-session')(session);

const cors = require('cors');
const bcrypt = require('bcrypt');
const nodemailer = require('nodemailer');
const Razorpay = require('razorpay');
const app = express();
const PORT = 5000;
const crypto = require('crypto');

const db = mysql.createConnection({
  host: 'localhost',
  user: 'root',
  password: 'Aditya',
  database: 'ecommerce'
});

const sessionStore = new MySQLStore({}, db.promise());
app.use(express.json()); // built-in JSON parser

//cors
app.use(cors({
  origin: 'http://localhost:3000',
  credentials: true
}));

//session setup
app.use(session({
  secret: 'secretKey123',
  resave: false,
  saveUninitialized: false,
  store: sessionStore,
  cookie: { secure: false }
```

"Fig. 12" Session management Code snippets

```
app.post('/create-order', async (req, res) => {
  try {
    console.log("📥 Received /create-order body:", req.body);
    console.log("👤 Session user:", req.session.user);

    // Check if user is logged in
    if (!req.session.user) {
      console.log("❌ User not logged in");
      return res.status(403).json({ error: "User not logged in" });
    }

    if (!req.body || typeof req.body.amount === 'undefined') {
      console.log("❌ Bad Request: Missing amount in body");
      return res.status(400).json({ error: "Amount is required" });
    }

    const { amount } = req.body;

    if (amount <= 0) {
      console.log("❌ Invalid amount:", amount);
      return res.status(400).json({ error: "Amount must be greater than 0" });
    }

    const options = {
      amount: Math.round(amount * 100), // Convert to paise
      currency: 'INR',
      receipt: `rcpt_${Date.now()}_${req.session.user.id}`
    };

    console.log("🛠 Creating Razorpay order with options:", options);
    const order = await razorpay.orders.create(options);
    console.log("✅ Razorpay Order Created:", order);

    res.json(order);

  } catch (err) {
    console.error("❌ Razorpay order creation failed:", err);
    res.status(500).json({
      error: "Failed to create order",
      details: err.message
    });
  }
});
```

```
Details.jsx
Footer.css
Footer.jsx
home.css
Home.jsx
Login.css
Login.jsx
OUTLINE
```

```
79  });
80
81  //razorpay
82  // Razorpay instance
83  const razorpay = new Razorpay({
84    key_id: 'rzp_test_o08YVZwKcCbv9M',
85    key_secret: 'Kk7Sp1T1mDRiFU4Px2hBNWsR'
86  });
```

"Fig. 13" Razorpay Payment Gateway Integration code snippets