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Research Paper

Online Hotel Booking System: A Secure Three-Tier Web Platform for Direct Room Reservation and Administrative Analytics

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Abstract*—Direct hotel reservation remains difficult for many small and mid-sized properties that depend on telephone calls, walk-in registers, spreadsheets, or high-commission online travel agencies. This paper presents a complete web-based Online Hotel Booking System that supports hotel discovery, city/name search, room-availability viewing, date-based reservation, automatic price calculation, simulated payment, booking-history management, and administrative analytics. The implementation follows a three-tier client-server architecture: a responsive HTML5/CSS3/JavaScript presentation layer, a Node.js/Express REST application layer, and a MySQL relational data layer. Six core tables—users, admin, hotels, rooms, bookings, and payments—are connected through foreign keys. JWT-based authentication, role-based authorization, bcrypt password hashing, parameterized queries, and one-hour token expiry secure customer and administrator operations. The project report records API responses below 300 ms under normal load, page rendering below 1.5 s, indexed MySQL lookups below 50 ms, successful handling of concurrent booking tests, and safe rejection of SQL-injection attempts. The resulting platform provides a commission-free and modifiable booking channel for hotels while demonstrating a practical full-stack architecture suitable for academic study and low-cost deployment.

Keywords*—hotel booking, room reservation, Node.js, Express.js, MySQL, REST API, JWT, role-based access control, web application.

I. INTRODUCTION

The hotel and tourism sector requires reservation channels that are transparent, continuously available, and simple to operate. Manual registers and telephone bookings force customers to depend on front-desk staff for availability and pricing, while spreadsheet records do not provide a public booking interface. Online travel agencies improve discovery but commonly charge substantial commissions and control much of the customer relationship. A direct hotel-owned system can reduce these dependencies while preserving access to customer and transaction data [1]–[4].

The proposed Online Hotel Booking System is a standalone browser-based platform developed for visitors, registered users, and administrators. Visitors can search and inspect hotels without authentication. Registered users can select rooms and dates, calculate the payable amount, complete a simulated payment, view their profiles, and examine booking history. Administrators use a separate login and a dashboard that displays revenue, bookings, users, hotels, and rooms, together with hotel-management functions.

A. Motivation and Problem Statement

Small hotels often face a choice between fragmented manual procedures and complex commercial platforms. Manual operation produces delayed confirmation, poor occupancy visibility, duplicate-entry risk, and weak historical reporting. Commercial property-management systems may be feature-rich but require licensing, configuration, and trained staff. The project therefore focuses on a lightweight direct-booking portal that is understandable, deployable on ordinary hosting, and built entirely with widely available technologies.

B. Objectives and Contributions

The principal objectives are to automate hotel discovery and reservation, maintain real-time room records, secure role-specific functions, preserve relational data integrity, and expose a responsive interface across desktop and mobile screens. The contributions include a three-tier architecture, modular Express controllers, six-table MySQL schema, automatic date-based pricing, simulated multi-method payment, user booking history, an analytics-oriented administrator dashboard, and a security design based on JWT, bcrypt, and parameterized SQL.

II. RELATED WORK

A. Reservation and Distribution Models

Traditional reservation channels depend on telephone communication, walk-in requests, faxed forms, or manual ledgers. Online travel agencies introduced large searchable catalogs, reviews, and immediate booking, but their intermediation cost and ownership of customer communication can weaken direct hotel relationships [1]–[5]. Commercial property-management systems mainly optimize internal activities such as front-desk work, housekeeping, billing, and reporting; a customer-facing booking engine may require additional modules.

B. Web-Based Booking Systems

Modern reservation platforms increasingly use API-driven architectures so that browser or mobile clients can share a common backend. Node.js is suited to I/O-bound workloads, Express provides lightweight routing and

middleware, and MySQL provides ACID transactions and foreign-key constraints for structured booking records [6]–[12]. Stateless JWT authentication allows the server to validate identity without maintaining a separate session table, while bcrypt protects stored credentials through adaptive hashing [13]–[16].

C. Comparative Analysis and Research Gap

Table I. Comparison of major hotel-booking approaches

Approach	Cost / commission	Main characteristic
Phone / walk-in	No platform fee	Manual, slow, no real-time customer view.
Online travel agency	About 15–30% commission	Large reach but limited customer-data control.
Commercial PMS	License and setup cost	Powerful internal operations; complex for small hotels.
Open-source PMS	No commission	Highly customizable but may require technical staff.
Proposed system	No commission	Direct, lightweight, role-based and fully modifiable.

The identified gap is a complete but technically transparent system that connects relational schema design, REST APIs, customer-facing pages, payment flow, role separation, and administrative analytics in one compact implementation. Many academic prototypes stop at static interfaces, whereas enterprise products hide the underlying architecture. The proposed work maintains a small set of auditable modules and uses only free components.

III. PROPOSED SYSTEM AND METHODOLOGY

A. Three-Tier Architecture

The architecture shown in Fig. 1 separates presentation, application, and data responsibilities. The presentation tier includes hotel listing, hotel details, booking, payment, profile, admin-login, and admin-dashboard pages. The application tier contains auth, hotel, room, booking, payment, and admin controllers behind an Express REST API. JWT middleware and role checks guard protected routes. The data tier contains users, admin, hotels, rooms, bookings, and payments tables connected through foreign keys.

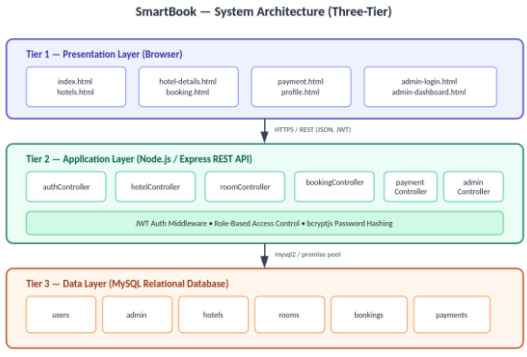


Fig. 1. Three-tier System Architecture

Separating tiers supports maintainability and testing. Frontend styling can change without altering relational rules, and controller logic can evolve without redesigning every page. A MySQL connection pool with promise support handles concurrent requests, while environment variables isolate database credentials and token secrets from source code.

The browser communicates with the application layer through HTTPS and JSON-based REST calls. Public endpoints provide hotel discovery, while protected endpoints require a bearer token. The API layer validates request bodies before invoking controller logic and returns consistent status codes for success, client errors, authorization failures, missing resources, and unexpected database errors. This interface boundary also makes a future mobile application possible without duplicating the business rules.

B. Object and Database Model

The class model in Fig. 2 captures the principal entities and their multiplicities. A hotel owns multiple rooms; a user may create multiple bookings; each booking references one hotel and one room; and a payment belongs to one booking. The administrator is intentionally independent of customer accounts so that management credentials and permissions can be controlled separately.

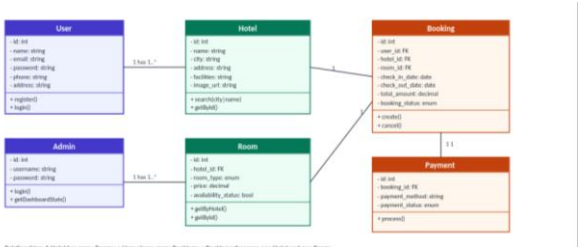


Fig. 2. Class diagram

The relational design mirrors these associations through primary and foreign keys. Unique email constraints prevent duplicate customer identities, hotel_id connects rooms to their property, and booking_id connects payment status to the reservation lifecycle. Timestamps provide an audit trail for registration, booking creation, and payment processing. Normalized tables avoid repeated hotel and user information inside each reservation record.

C. Functional Modules

Authentication module**.** Registration collects name, email, phone, address, and password. Duplicate emails are rejected, passwords are hashed with ten bcrypt salt rounds, and successful login issues a one-hour JWT containing the user identifier and role.

Hotel and room modules. Hotel endpoints return all properties, perform case-insensitive search by name or city, and retrieve individual hotel details. Room endpoints return types, nightly prices, images, and availability for the selected property.

Booking and payment modules. An authenticated user selects check-in and check-out dates. A Pending booking is created, payment is simulated using Credit Card, Debit Card, or UPI/Net Banking, and successful payment records a transaction and changes the booking status to Confirmed. User-owned bookings can later be cancelled.

Administrative module. A separate administrator token protects the dashboard and hotel-management endpoints. Parallel COUNT and SUM queries produce the displayed totals for revenue, bookings, users, hotels, and rooms.

D. Booking Computation and Data Integrity

Let d_in and d_out denote check-in and check-out dates, P the room price per night, and N the number of chargeable

nights. The browser validates that check-out occurs after check-in and computes:

$$N = d_out - d_in \quad (1)$$

$$\text{Total Amount} = N \times P \quad (2)$$

The booking table stores user_id, hotel_id, room_id, both dates, total_amount, booking_status, and creation time. Foreign keys connect bookings to valid users, hotels, and rooms; payments reference a valid booking. This design prevents orphan transaction records and supports enriched booking-history queries through relational JOIN operations.

E. Security and Reliability Design

Passwords are never stored in plain text, and authenticated requests carry bearer tokens that expire after one hour. Parameterized mysql2 queries prevent input strings from being interpreted as executable SQL. Ownership checks prevent one user from cancelling another user's booking. Missing hotels and rooms produce controlled 404 responses, while database failures are caught and returned as server errors without exposing sensitive configuration.

The current implementation uses an availability flag and booking status to reduce conflict risk. A production version should additionally protect the final room-allocation operation with a database transaction and row-level lock or atomic conditional update. This would ensure that two customers cannot confirm the same room when requests arrive at nearly the same time [17]–[20].

IV. IMPLEMENTATION AND RESULTS

A. Technology Stack and Development Process

The backend was implemented with Node.js 18.x, Express 4.x, mysql2 promise-based connections, jsonwebtoken, bcryptjs, and dotenv. The interface uses semantic HTML5, CSS variables, reusable component styles, responsive grids, and vanilla JavaScript fetch calls. Development proceeded module by module: schema and connection pool, authentication, hotels and rooms, booking and payment, frontend integration, and administrative analytics. Postman was used to validate endpoints before end-to-end browser testing.

B. Interface and Operational Outputs

The implementation interface is branded SmartBook in the project screenshots. Fig. 2 summarizes three representative outputs: searchable hotel cards, the date-based booking screen with automatic total calculation, and the administrator dashboard. The full report also includes hotel details, payment simulation, profile information, and booking-status history.

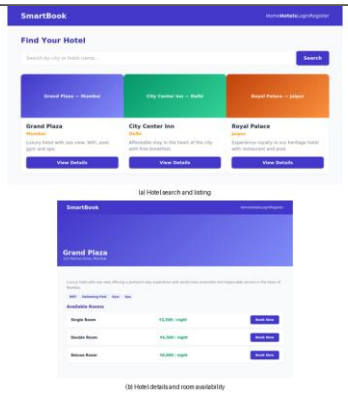


Fig. 3. Hotel discovery and room-availability

The discovery pages give an unauthenticated visitor immediate access to hotel names, cities, descriptions, facilities, room types, prices, and availability. Search is performed through a case-insensitive SQL LIKE operation on both hotel name and city. Selecting a property triggers a second API request for the room inventory associated with that hotel.

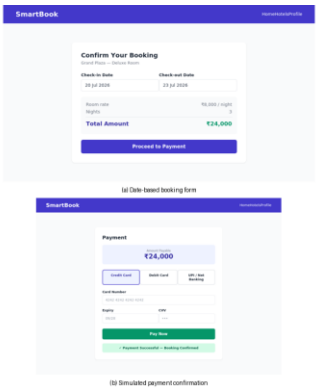


Fig. 4. Date selection, amount calculation, and simulated payment outputs.

The booking screen validates the date interval, calculates the number of nights, and shows the payable amount before the user continues. The payment screen clearly identifies the operation as a simulation and supports card, debit-card, and UPI/Net Banking choices. Successful submission inserts the payment record and updates the corresponding reservation from Pending to Confirmed.

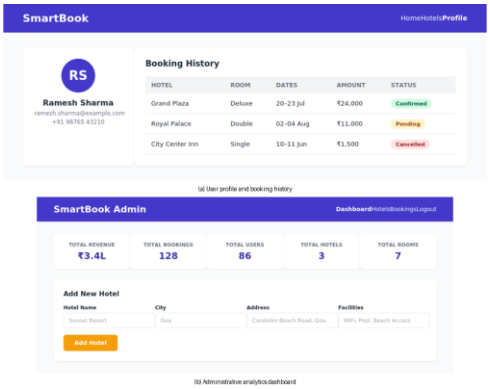


Fig. 5. Booking history and administrative analytics outputs.

The profile page combines personal information with a booking-history table containing hotel, room, dates, amount, and status. The administrator dashboard demonstrates the operational summary with 128 bookings, 86 users, three hotels, seven rooms, and reported revenue of ₹3.4 lakh in the seeded demonstration records. Status

badges distinguish Pending, Confirmed, and Cancelled reservations.

C. Evaluation Methodology

Testing was conducted in stages. Individual API endpoints were first exercised independently, followed by integrated browser workflows for registration, login, hotel search, hotel-details retrieval, booking creation, amount calculation, payment confirmation, booking history, cancellation, administrator login, dashboard statistics, and hotel creation. Security checks included invalid passwords, expired JWTs, unauthorized cancellation, and a manual SQL-injection attempt.

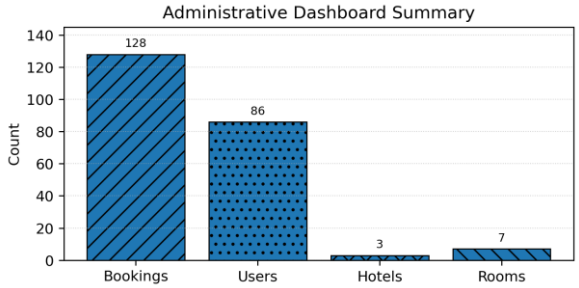


Fig. 6. Four administrative counters reported by the demonstration dashboard.

Table II. Observed implementation and performance results

Metric	Observation
API response time	Under 300 ms for normal-load endpoints.
Page load time	Under 1.5 s for the implemented pages.
Indexed database query	Under 50 ms for reported lookups.
Concurrent booking check	No race condition observed; sequential processing maintained.
Authentication security	JWT expiry enforced at one hour; SQL-injection attempt failed safely.

D. Discussion of Results

All documented functional scenarios produced the expected output. Under the reported normal-load environment, API endpoints responded in less than 300 ms, pages became interactive in less than 1.5 s, and indexed database queries completed in less than 50 ms. The concurrent booking test did not reveal a race condition, and authentication controls correctly rejected expired tokens and injection-style input. These results satisfy the project's stated performance objective of API responses below 500 ms and page loads below two seconds.

The system's strengths are direct commission-free reservation, clear separation of three user roles, complete booking-state visibility, and modular controller design. The relational schema is sufficient for the present scope and can be extended with reviews, promotions, hotel chains, or additional room attributes. The responsive interface and limited dependency set reduce deployment cost and make the system appropriate for small hotels and academic demonstrations.

E. Limitations, Threats to Validity, and Future Scope

The evaluation used a development environment and a small seeded database. Payment is simulated, so real gateway latency, failed transactions, refunds, chargebacks, and webhook verification were not measured. The report does not evaluate hundreds of hotels or thousands of simultaneous customers, and the current availability mechanism requires stronger transactional protection before production use. Security testing was limited to manual checks rather than professional penetration testing.

Future enhancement should integrate Razorpay, Stripe, or PayPal; send email and SMS confirmations; add reviews and ratings; expose advanced city, facility, and price filters; support multiple languages and currencies; add promotions and discount codes; provide mobile applications; enable cloud image storage; and deploy behind HTTPS with automated backups and monitoring. Analytics can be extended with occupancy rate and average daily rate:

$$\text{Occupancy Rate} = (\text{Booked Room Nights} / \text{Available Room Nights}) \times 100\% \quad (3)$$

$$\text{ADR} = \text{Room Revenue} / \text{Rooms Sold} \quad (4)$$

A production roadmap should also include database transactions for confirmation, idempotency keys for payment requests, rate limiting, refresh-token management, audit logging, automated unit and integration tests, accessibility evaluation, and containerized deployment. These measures would preserve the prototype's simplicity while improving reliability, security, and operational visibility.

F. Module-Level Verification and Maintainability

Authentication was verified for successful registration, duplicate-email rejection, correct and incorrect passwords, token generation, token expiry, and protected profile retrieval. Hotel verification covered complete listing, city/name filtering, valid and invalid identifiers, and associated room retrieval. Reservation verification covered date validation, amount calculation, Pending creation, confirmation after payment, user-specific history, ownership checks, and cancellation.

Administrative verification included separate login, protected dashboard access, aggregate COUNT and SUM queries, and addition of a new hotel. The controller-per-domain organization limits the effect of changes: modifying payment logic does not require editing hotel search, and changing a hotel card does not alter database queries. This modularity supports regression testing and future team-based development.

G. Deployment Considerations

For a low-cost deployment, the browser files, Express application, and MySQL database may run on one virtual private server. A scalable deployment can separate static files behind a content-delivery network, run the API under a process manager or container platform, and use a managed MySQL service with automated backups. HTTPS should terminate at a reverse proxy, and production secrets should be supplied by a secure environment or secret manager rather than committed to the repository.

Operational monitoring should record API latency, database errors, authentication failures, payment state transitions, cancellation events, and room-allocation conflicts. Health-check endpoints, structured logs, alert thresholds, and periodic backup restoration tests are necessary before real guests depend on the platform. Database indexes on hotel city/name, room hotel_id, booking user_id, and payment booking_id will remain important as data volume grows.

H. Requirements Traceability

The implementation can be traced directly to the functional requirements stated in the project report. Public browsing and search satisfy the visitor requirements; registration, login, profile access, booking, payment,

history, and cancellation satisfy the registered-user requirements; and the separate admin login, dashboard counters, and hotel creation satisfy the administrator requirements. This traceability is important because it shows that each visible interface has a corresponding API operation and persistent data structure rather than existing only as a static prototype.

Non-functional requirements are also reflected in the design. Performance is supported by asynchronous Node.js execution, connection pooling, indexed lookups, and small JSON responses. Usability is supported by descriptive forms, automatic price calculation, status badges, and responsive layouts. Reliability is supported by persistent MySQL records and foreign-key relationships. Portability follows from the use of platform-neutral web standards and environment-based configuration. Maintainability follows from controller separation and reusable CSS components.

I. API Organization and Request Lifecycle

A typical request begins in the browser when the user submits a search, authentication, booking, or management action. JavaScript serializes the required values, attaches a JWT for protected operations, and sends the request to the Express server. Routing middleware selects the responsible controller. The controller validates the inputs, invokes a parameterized MySQL query, interprets the result, and returns a JSON response with an appropriate HTTP status. The browser then updates only the affected interface region instead of reimplementing business rules in the page.

Authentication routes manage registration, login, and profile retrieval. Hotel routes provide listing, search, detail, and creation functions. Room routes expose the inventory belonging to one property. Booking routes create reservations, retrieve user history, and cancel owned records. Payment routes create transaction records and confirm bookings. Admin routes return aggregate statistics. This resource-oriented organization keeps endpoint intent clear and simplifies Postman verification, logging, and future API documentation.

J. Data Management and Analytical Reporting

The six-table data dictionary provides enough information to reconstruct the complete transaction. The users table identifies the customer; hotels and rooms identify the property and selected inventory; bookings store the reservation interval, amount, and status; payments store method, status, and transaction date; and the admin table isolates management credentials. Because descriptive hotel and user fields are not copied into each booking, updates remain consistent and storage duplication is reduced.

The administrator counters are generated through aggregate database queries rather than hard-coded interface values. Total users, hotels, rooms, and bookings are calculated with COUNT operations, while confirmed revenue is calculated with SUM over eligible booking or payment records. This approach gives the dashboard an operational role: it summarizes the current database state and can later be extended with monthly revenue, cancellations, occupancy by property, room-type demand, and average booking value.

K. Risk Analysis and Mitigation

The project identifies concurrent booking conflict, payment-simulation confusion, SQL injection, JWT expiry, and cross-site scripting as key risks. The current prototype mitigates them through availability and status tracking, explicit simulation labels, parameterized queries, controlled token expiration, and input validation. These controls are appropriate for an academic implementation, but the risk analysis also clarifies where production hardening is required. In particular, final room confirmation should be atomic and payment callbacks should be verified cryptographically.

A second class of risk concerns operational continuity. Database credentials, JWT secrets, and administrator passwords must not be embedded in public source files. Backups should be encrypted and periodically restored in a test environment. Application logs should avoid recording passwords, full card details, or bearer tokens. Rate limiting and account lockout can reduce brute-force attempts, while content security policy and output encoding can further limit script injection. These measures extend the security foundation already present in the report.

L. User Experience, Accessibility, and Feasibility

The booking journey is intentionally linear: discover a property, inspect rooms, select dates, review the calculated amount, choose a payment method, and receive confirmation. Clear labels and status indicators reduce the need for user training. A production revision should additionally provide keyboard-visible focus, semantic form labels, sufficient color contrast, meaningful alternative text for hotel images, and error messages that explain how to correct invalid dates or missing fields. These improvements align the interface with established usability and accessibility guidance [27]–[30].

Technical feasibility is supported by mature open-source components and a modest hardware requirement. Economic feasibility follows from the absence of license fees and the ability to run on shared hosting or a small virtual server. Operational feasibility follows from role-specific screens and familiar reservation steps. Schedule feasibility is supported by modular development, allowing database, authentication, catalog, booking, payment, and administration work to be completed and tested in stages.

M. Scalability and Extension Strategy

The current three-tier design can scale vertically by increasing application and database resources, and horizontally by placing stateless API instances behind a load balancer. Static assets can move to a content-delivery network, while hotel images can move to object storage. Read-heavy hotel search can be cached, and pagination can limit result size. Database replicas can support analytics, but booking confirmation must continue to use the authoritative primary database to preserve consistency.

Extension should remain incremental. Reviews and ratings require new review entities and moderation rules; promotions require validity intervals and discount calculations; multilingual support requires externalized interface strings; real payment gateways require order identifiers, signatures, webhook processing, and idempotent state changes; and mobile clients require no new business logic if they consume the existing REST endpoints. Preserving these boundaries prevents future features from turning the system into a tightly coupled application.

V. CONCLUSION

This paper presented a secure three-tier Online Hotel Booking System that automates direct hotel discovery, room selection, date-based pricing, payment simulation, reservation tracking, and administrative management. The Node.js/Express application layer, MySQL relational schema, and responsive browser interface form a compact architecture that is easy to understand and extend. JWT authentication, bcrypt hashing, role checks, ownership validation, and parameterized SQL provide a practical security baseline.

The implemented workflow demonstrates that a small hotel can maintain a direct booking channel without depending completely on high-commission intermediaries. Reported response times, database performance, and successful functional checks show that the chosen stack meets the project's academic and prototype objectives. With real payment integration, transactional room locking, comprehensive security testing, cloud deployment, and richer guest services, the platform can evolve into a production-oriented reservation system.

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