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9876Smart CNG Reservation System: Web-Based Slot Booking And Pump Management

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Abstract: This paper presents the design and implementation of a Smart CNG Reservation System that enables users to pre-book CNG fueling slots and allows pump owners to manage station availability, subject to administrative approval. The system is developed as a Java web application using JSP and Servlets with MySQL as the backend database. It includes three modules: user, pump-owner, and administrator, each with distinct functionalities such as slot booking, pump approval, and dashboard management. Additional features such as an integrated chatbot and location-based mapping improve usability. The system reduces waiting times at CNG stations, improves pump utilization efficiency, and demonstrates scalability for urban fuel management. Future enhancements include mobile app integration and predictive slot allocation using machine learning.

***Keywords*:** CNG reservation, slot booking, JSP/Servlets, MySQL, smart fuel management, web application

I. INTRODUCTION

Compressed Natural Gas (CNG) has become a widely adopted fuel option for vehicles due to its cost-effectiveness and environmental benefits. However, the rapid increase in the number of CNG-powered vehicles has created challenges for fuel distribution. One of the primary issues faced by consumers is the long waiting time at CNG stations, which not only causes inconvenience but also contributes to fuel wastage and traffic congestion. Traditional manual booking methods at fuel stations are inefficient, lack transparency, and are prone to errors.

This project introduces a Smart CNG Reservation System that digitizes the entire booking and management process. The proposed system aims to eliminate the hassle of standing in queues by allowing users to pre-book slots for refueling. Pump owners benefit from improved management and monitoring tools, while administrators gain oversight for better regulation and system transparency.

The main objectives are:

1. To provide a user-friendly web platform for booking CNG slots in advance.
2. To empower pump owners with tools to manage availability and reservations.
3. To establish an administrative layer for approving pump stations and monitoring usage.

Through these objectives, the system addresses critical inefficiencies in the current CNG fuel distribution ecosystem.

II. Literature Review

The concept of pre-booking systems has been explored in domains such as parking, EV charging, and public transport. The base paper *"Streamline Your Drive: Pre-booking and Pre-paid Parking Slots, Locating CNG Stations & EV Charging Stations"* demonstrates the efficiency of implementing pre-booking models to reduce congestion and waiting times [1].

Similarly, the paper *"Smart EV Charger Locator and Slot Booking Manager App for Chhattisgarh"* focuses on location-based services for electric vehicle charging, highlighting the importance of mobile accessibility and real-time availability [2].

Another relevant study, *"Priority-based Pre-booking System for Electric Vehicle Charging Stations Enabling Emergency Vehicle Accessibility"*, presents a priority model that ensures critical vehicles receive preferential access [3].

While these works address EV charging and parking management, there is a noticeable research gap in the domain of CNG fuel distribution. Existing CNG stations continue to rely heavily on manual operations, leading to long queues and mismanagement. Our work fills this gap by presenting a Smart CNG Reservation System that integrates booking, pump-owner management, and administrative approval into a unified platform.

III. Problem Statement

CNG stations face challenges in managing reservations, handling demand, and maintaining transparency. Manual operations lead to:

- Long queues and user dissatisfaction.
- Poor visibility of availability.
- Pump owners struggling with slot allocation.
- Lack of oversight for administrators.

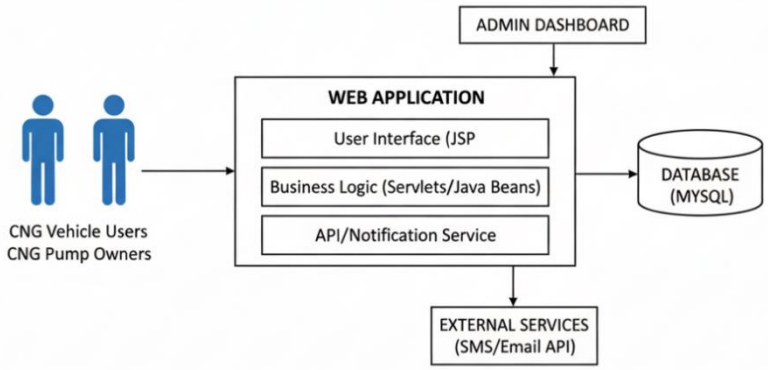
A centralized digital solution is essential to overcome these issues.

IV. Proposed System

The proposed Smart CNG Reservation System consists of three modules: User, Pump Owner, and Administrator.

- User Module: Registration, login, booking slots, viewing history, chatbot assistance, and station locator.
- Pump Owner Module: Pump registration, slot management, monitoring reservations, and analytics dashboard.
- Admin Module: Approving/rejecting pump registrations, monitoring activities, and maintaining system compliance.

The backend uses JSP/Servlets for business logic, MySQL for structured storage, and Apache Tomcat for deployment. Additional features include chatbot integration and Google Maps-based location support.



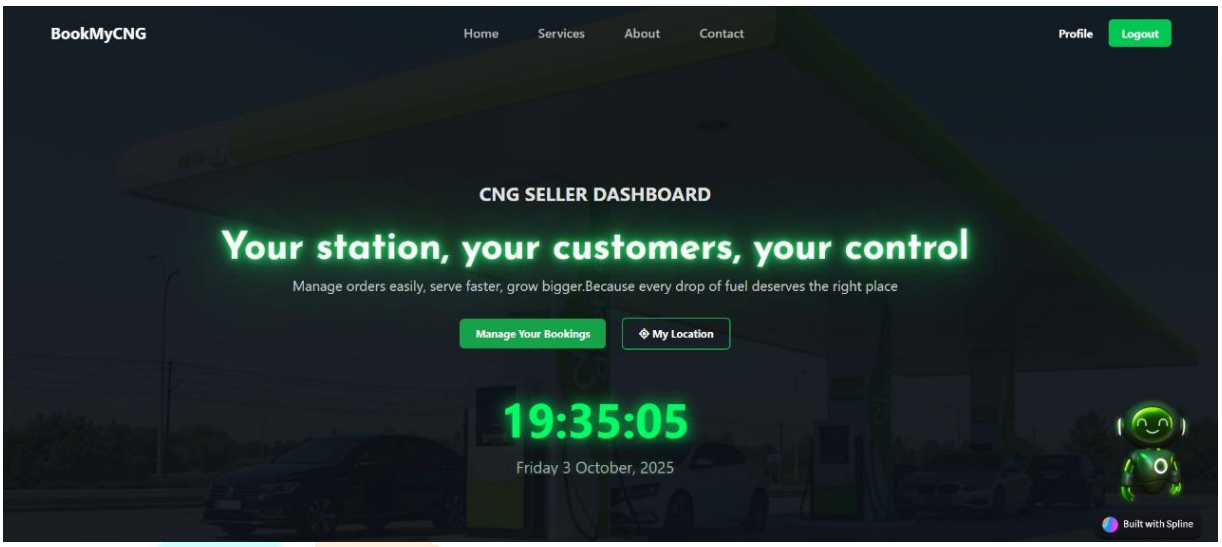
V. METHODOLOGY

The project follows the Software Development Life Cycle (SDLC) approach:

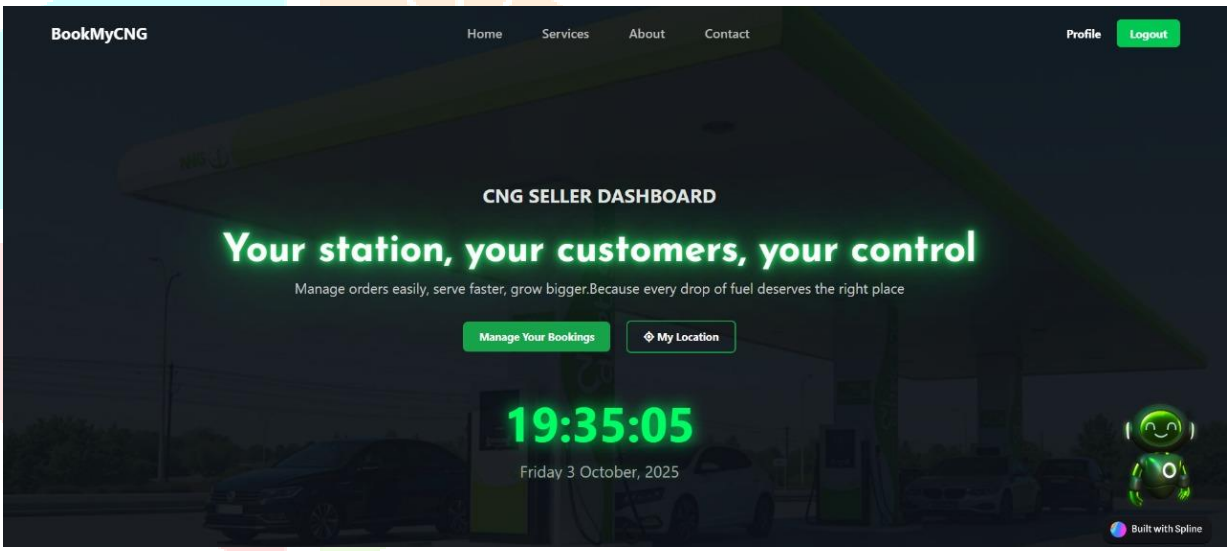
1. **Requirement Gathering** – Surveys with users, pump owners, and administrators identified key needs (slot booking, approvals, dashboards).
2. **System Design** – UML diagrams, database schema (users, pumps, admins, bookings), and UI design.
3. **Technology Stack** – Java (JSP/Servlets), MySQL, Tomcat, HTML/CSS/JS.
4. **Implementation** – Modules for login, registration, booking, dashboards, and chatbot packaged as a WAR file.
5. **Testing** – Unit testing for modules, integration testing across flows, and load testing for concurrent users.
6. **Deployment** – Apache Tomcat used for deployment; WAR ensures easy portability.
7. **Maintenance & Future Enhancements** – Mobile app, ML-driven slot prediction, Google Maps live integration

VI. RESULTS

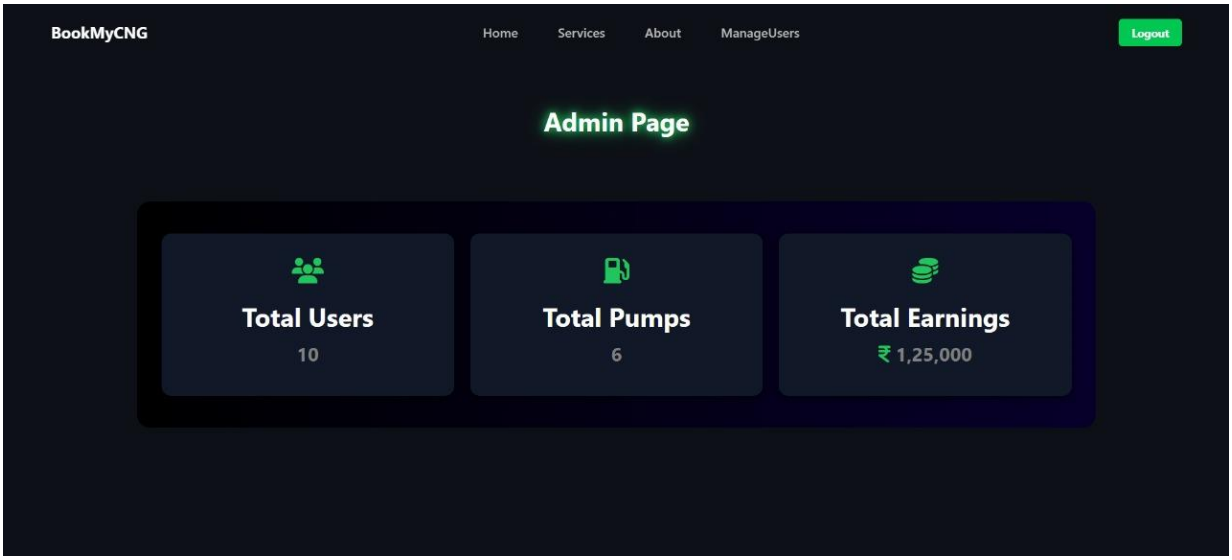
Testing shows that the system significantly reduces waiting times at CNG stations. Users can efficiently reserve slots, while pump owners maintain better control over pump utilization. The admin dashboard ensures transparency and centralized monitoring. The system proved reliable and scalable during simulated test cases.



User Dashboard



Pump Owner Dashboard



Admin Page

VII. Conclusion and Future Work

The Smart CNG Reservation System successfully achieves efficient slot booking and management for CNG stations. It enhances transparency, reduces queues, and improves customer experience.
Future improvements will include a mobile application, integration with Google Maps for live pump status, and predictive slot allocation using machine learning algorithms.

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