Railway Database Management Project

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by

Pranav Hande, Arjun Wakade, Harsh Shah

220953124, 220953174, 220953224

Under the guidance of

Dr. V Sivakumar (Lab Faculty 1)
Associate Professor
Department of I&CT
Manipal Institute of Technology
Manipal, Karnataka, India

Mrs. Veena K M (Lab faculty 2)
Assistant Professor – Senior Scale
Department of I&CT
Manipal Institute of Technology
Manipal, Karnataka, India

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Unit of MAHE, Manipal

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ABSTRACT

Railway Database Management System is a comprehensive software solution designed to streamline railway booking for users who want to book tickets, view available tickets, view future tickets and other features.

User Features:

- **Registe**r: Users can register be entering details such as name, age, user id, gender, email, and phone number.
- **Login:** Users can login their account after registering with the help of their username and password.
- **Reset Password: Users can change the password of their accounts if they forget it.**
- **View Train Schedule:** Users can view the available train timings and train stations of different trains.
- **Book Train Ticket:** User can book ticket according to needs, by selecting date, train number, class and by making payment.
- **Viewing Transaction History:** User can view all previous transaction history
- **Updating Profile:** User can update/change personal details as per requirement

ACM Taxonomy Terms

- Information Systems [Database Management Systems]
- Software and it's engineering
- Applied computing

UN Sustainable Development Goals

1. **Goal 7: Affordable and Clean Energy:** Rail transport can be powered by clean energy sources such as electricity, thereby reducing reliance on fossil fuels and promoting the use of renewable energy for transportation.
2. **Goal 8: Decent Work and Economic Growth:** The development and operation of railways create employment opportunities and stimulate economic growth, particularly in sectors such as manufacturing, construction, and transportation services.
3. **Goal 9: Industry, Innovation, and Infrastructure:** Investing in railway infrastructure and modernizing rail systems can foster innovation and improve infrastructure, enhancing connectivity and accessibility within and between regions.
4. **Goal 12: Responsible Consumption and Production:** Rail transport generally consumes less energy and resources per passenger kilometer compared to air travel, contributing to more responsible consumption and production patterns.

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List of Tables

User: user_id → user_name, gender, age, email, phone

Login: (user_id, password) → user_name, gender, age, email, phone

Passenger: PNR → p_name, p_phone

Waiting_list: PNR → train_no

Ticket_status: PNR → reservation_status

Transaction_history: transaction_id → amount, status, PNR

Seat_reservation: train_no → status

Train: train_no → train_name, source, destination

Platform: (station_id, p_no, train_no) → arr_time, dep_time

Station: station_id → station_name, city

Journey: train_no → station_id

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Abbreviations

- NF- Normalization Form
- BCNF- Boyce Codd Normalization Form
- SQL- Structured Query Language
- ERD- Entity Relationship Diagram
- ACID- Atomicity, Consistency, Isolation, and Durability
- DBMS- Database Management System
- UI- User Interface

Introduction

Introduction

A database is an organized collection of data which can use a database system such as NoSQL to manage and access data. Relational database management systems such as SQL Plus are often used in order to handle complex queries, maintain ACID properties, and support relationships between data through foreign keys. DBMS provide facilities for concurrency control, backup and recovery, and efficient query processing. Nowadays cloud based database systems like MongoDB are popular.

1.1 Two Tier Architecture

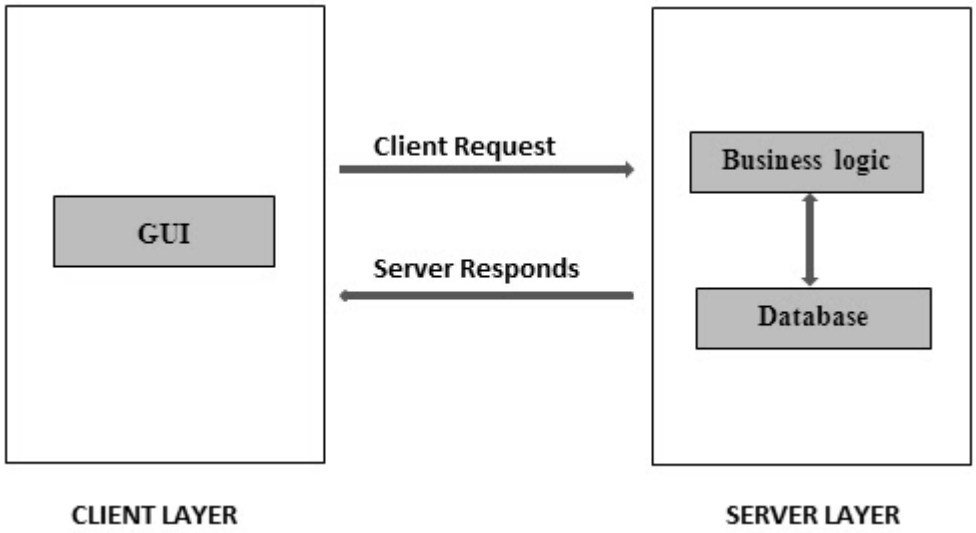


Figure 1.1: Two Tier Architecture

A two-tier architecture for software consists of:

1. **Client Tier (Presentation Tier):** This tier is the user tier for the software. Includes GUI for ease of use. Provides highest level of abstraction. Helps user access necessary data without knowledge of

2. **Server Tier (Data Tier):** This tier has the lowest level of data abstraction. This tier is responsible for managing data and logic of application. Performs necessary tasks of data storage, retrieval, and manipulation.

At it's core the client tier deals with how information is presented to user while server tier handles processing and storage of data.

Literature Survey / Background

Literature Survey:

- **Evolution of Database Technologies:** The Literature discusses change in Database Management System (DBMS) over time. Applications have shifted from traditional relational databases to advanced systems like NoSQL, NewSQL and MongoDB. These highlights changing needs of the industry.
- **Railway Management Systems:** The design & implementation of database for railway systems is essential for train scheduling and managing passenger data. These systems seek to standardize and streamline the process by using Oracle Database.
- **Challenges and Solutions:** Challenges include timetable coordination, concurrency, operational efficiency, and customer satisfaction. These challenges are tackled by integrating scheduling, ticketing, and other passenger services in a single integrated platform.

Background

The background of a railway database management system is influenced by technological advancements and market needs. Its purpose is to optimize operational processes, elevate passenger satisfaction, and establish a resilient infrastructure for handling the intricate data involved in railway operations.

Objectives / Problem Statement

Objectives:

Automatic Timetable Management: To make a system which automatically maintains the railway timetable, with minimal human help.

Enhance Data Management: Establish a centralized database infrastructure capable of efficiently handling diverse railway data, including schedules, ticketing information, passenger records, and maintenance logs.

Automating Payment Systems: To make a system which verifies online payment for ticket fees done by user using methods like net-banking, UPI and credit/debit card.

Improve Decision-Making: Utilize advanced analytics and data processing techniques to analyze various aspects of railway operations, such as passenger traffic patterns, route utilization, and equipment maintenance schedules.

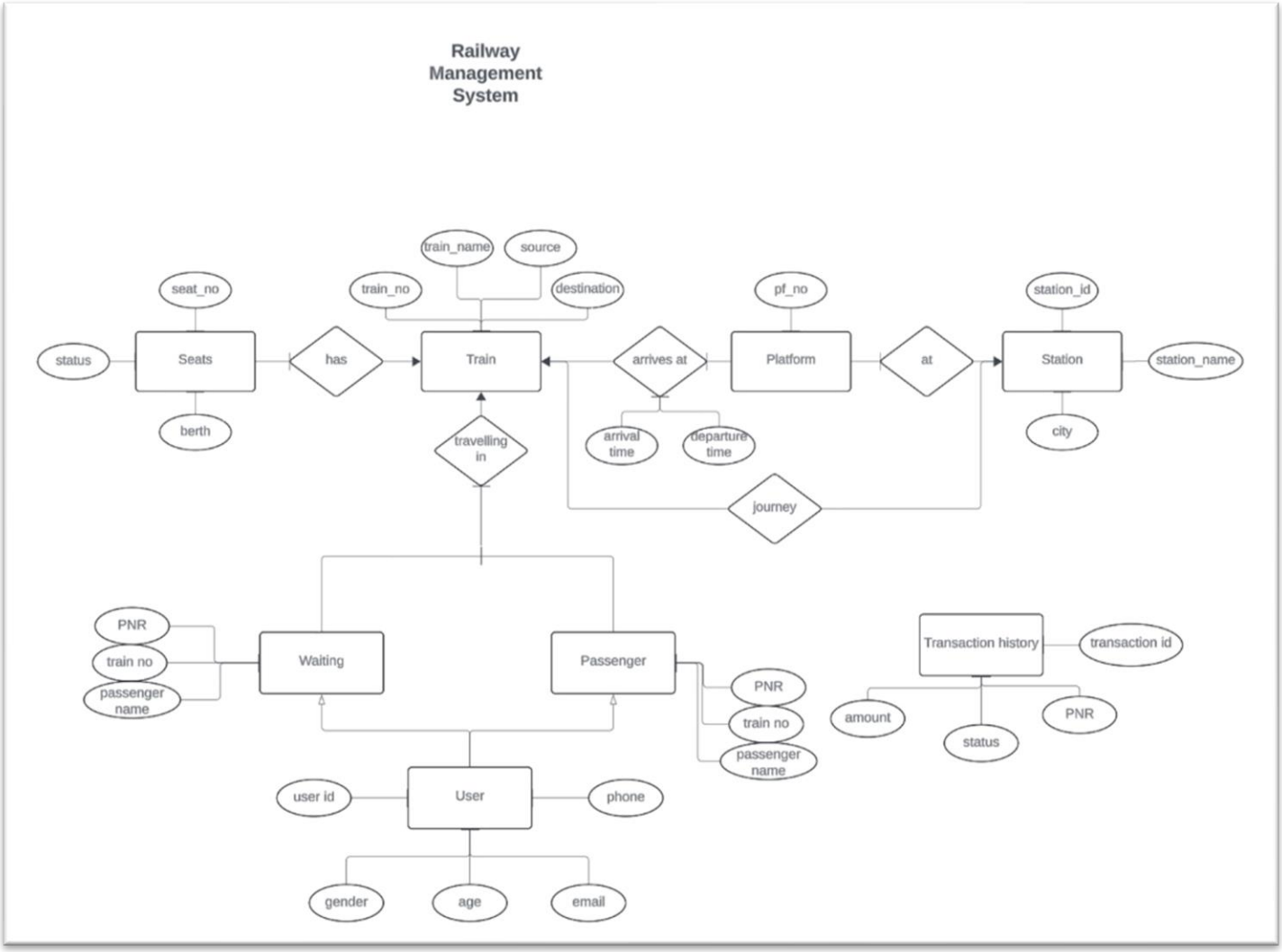
Problem Statement:

Like many other businesses, railways face difficulties with manual inventory systems. Manual tasks, such keeping track of train timetables, handling ticketing procedures, and keeping records, can result in errors, inefficiencies, and data loss during unanticipated situations like disasters. It is more difficult to create thorough performance reports when paper-based systems are used since they are more sophisticated and prone to errors.

Thus, a computerized system designed to improve overall management efficiency, minimize errors, and streamline railway operations is needed.

Data Design

ER Diagram:



ER MODEL

NORMALISATION

Universal Relations:

R {user_id, password, user_name, gemder ,age, email, phone, pnr, pa_id, p_id, p_name, p_phone, train_no, train_name, seat_no, berth, reservation_status, source, destination, station_id, station_name, city , pf_no, arr_time, dep_time, transaction_id, amount, transaction_status, }

Functional Dependencies:

train_no ➔ train_name, source, destination

station_id ➔ station_name, city

pnr ➔ pa_name, train_no, train_name, station_id, station_name, pf_no, source, destination, seat_no, journey_date, reservation_status

{pa_id, pnr}➔ pa_name, gender, phone_no

transaction_id ➔ amount, transaction_status

user_id ➔ username, email, phone_no, gender, age, password

{train_no, seat} ➔ reservation_status, berth

{station_id,pf_no} ➔ arr_time, dep_time

Closure:

- {train_no}+ = {train_no, train_name, source, destination}
- {station_id}+ = {station_id, station_name, city}
- {user_id}+ = {user_id, username, email, phone_no, gender, age, password}
- {pnr}+ = {pnr, pa_id, pa_name, train_no, train_name, station_id, station_name, pf_no, source, destination, seat_no, journey_date, reservation_status, pa_name, gender, phone_no}
- {station_id, pf_no} ➔ arr_time, dep_time

{station_id}+ = {station_id, station_name, city}

{pf_no}+ = {pf_no}

{station_id, pf_no}+ = {station_id, pf_no, arr_time, dep_time}

- {train_no, seat} ➔ reservation_status, berth

{train_no}+ = {train_no, train_name, source, destination}

{seat}+ = {seat}

{train_no, seat}+ = {train_no, seat, reservation_status, berth}

Normalising to First Normal Form (1NF):

A relational schema R is in first normal form if the domains of all attributes if R are atomic, i.e it disallows composite attributes, multivalued attributes, and nested relations.

R1 {user_id, password, user_name, gender ,age, email, phone, pnr, train_no, train_name, reservation_status, source, destination, station_id, station_name, city, transaction_id, amount, transaction_status, }

R2 {pnr, pa_id, pa_name, pa_phone, seat_no, berth }

R3 {station_id, pf_no, arr_time, dep_time}

Normalizing to Second Normal Form (2NF):

2NF is based on the concept of Full Functional Dependency.

A relation schema R is in 2NF if it is in 1NF form and every non-prime attribute A in R is fully functionally dependent on the primary key of R.

In R1, we observe the existence of some partial functional dependencies. We see that the attributes are fully functionally dependent on the primary keys (candidate keys) user_id, train_no

,pa_id, transaction_id, pnr, & station_id respectively. So as to preserve the integrity of the second normal form we decompose R1 into the following relations.

R1_A {user_id, user_name, email, phone_no, age, password}

R1_B {pa_id, pa_name, pa_phone}

R1_C {pnr, train_no, train_name, seat_no, station_id,station_name, reservation_status}

R1_D {train_no, train_name,source, destination}

R1_E {station_id, station_name, city}

R1_F {transaction_id, amount, transaction_status}

R2 {pa_id, pa_name, pa_phone}

R3 { pf_no, arr_time, dep_time}

Normalising to Third Normal Form (3NF):

A relation is in the third normal form, if there is no transitive dependency for non-prime attributes as well as it is in the second normal form. A relation is in 3NF if at least one of the following conditions holds in every non-trivial functional dependency X –> Y.

- X is a super key.
- Y is a prime attribute (each element of Y is part of some candidate key).

R1 {user_id, password}

R2 { user_id, user_name, email, phone_no, age}

R3 { pnr, pa_id, train_no, seat_no, station_id, reservation_status}

R4 {train_no, train_name, source, destination}

R5 {station_id, station_name, city}

R6 {transaction_id, amount, transaction_status}

R7 {pa_id, pa_name, pa_phone}

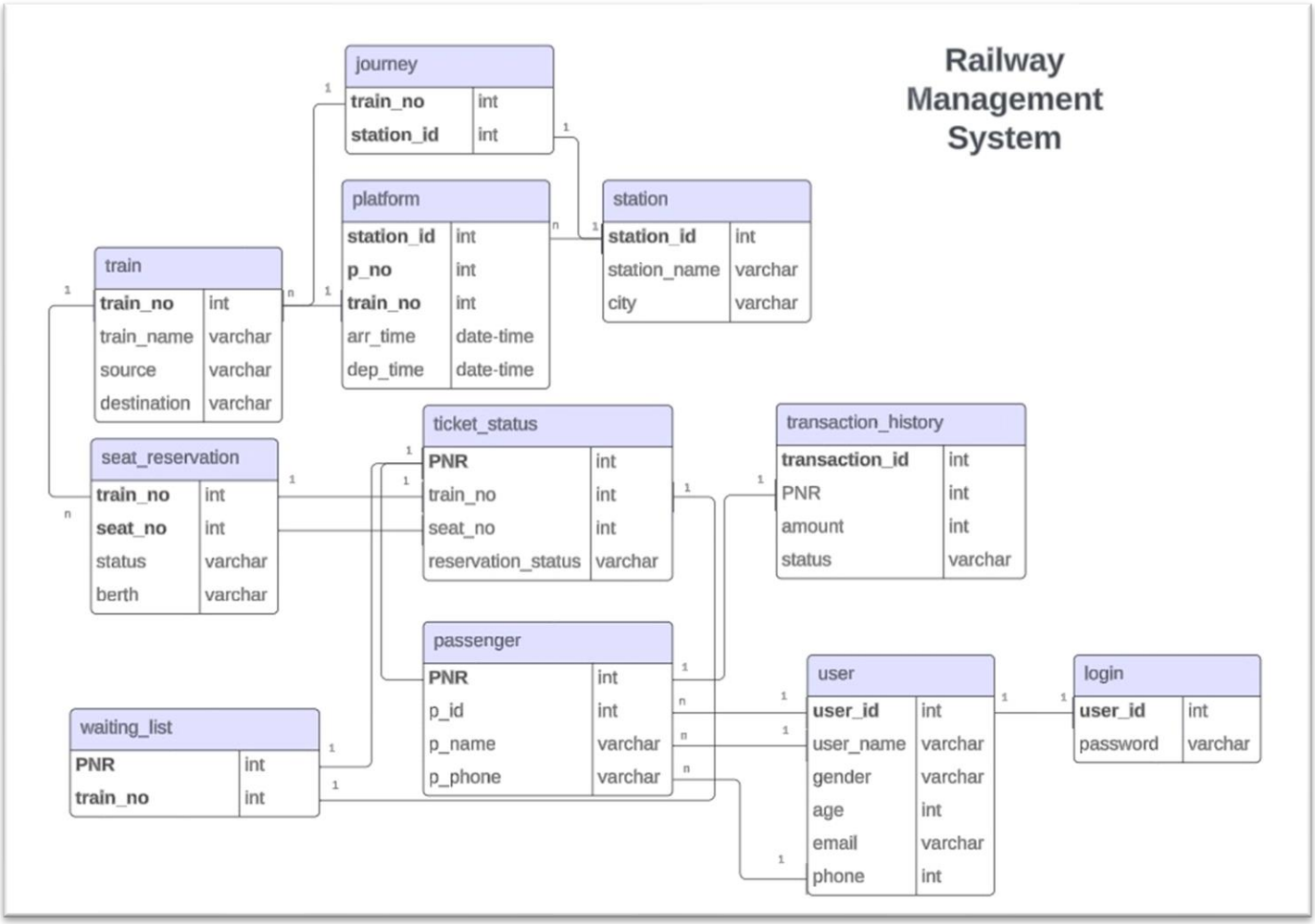
R8 {station_id, pf_no, arr_time, dep_time}

Normalizing to Boyce-Codd Normal Form (BCNF):

A relation is in BCNF if every determinant is a candidate key. In the decomposed relations, each relation has a primary key, and all non-prime attributes are fully functionally dependent on the primary key.

Therefore, the decomposed relations are in BCNF.

Schema Diagram:



Methodology

1. **Requirement Analysis:**
    - Gather and analyze the requirements of railways management to understand the necessary features and design of database management system.
2. **System Design:**
    - Design a GUI (graphical user interface) for ease of use using VC# and Windows Forms for managing Railway Database Management
    - Create an Entity-Relationship Diagram (ERD) to model the database schema, defining entities, attributes, and relationships.
3. **Database Implementation:**
    - Set up the Oracle Database to store and manage the Railways Database data.
    - Define tables, constraints, and relationships based on the ERD.
    - Implement stored procedures and triggers for data manipulation and business logic
4. **Application Development:**
    - Develop the application logic in C# to interact with the database.
    - Use Oracle.DataAccess.Client for database connectivity and operations.

Results:

The Railway Management System has been successfully implemented, leading to significant improvements in the efficiency and management of railway operations. The system effectively handles various aspects such as scheduling, ticketing, train management, passenger information, and maintenance, providing real-time access to critical data for efficient decision-making and resource utilization. Key outcomes include enhanced operational efficiency, reduced downtime, improved passenger experience, and streamlined maintenance processes. The system's user-friendly interface and intuitive design contribute to its successful adoption among railway staff, marking a pivotal advancement in the digital transformation of railway operations.

Conclusion:

The Railway Management System represents an essential development in the railway industry, signifying a major leap in its digital transformation journey. The system's capabilities in managing scheduling, ticketing, passenger information, and maintenance in real-time contribute significantly to improved decision-making and resource allocation. Its user-friendly interface and

minimal training requirements facilitate seamless integration and adoption among railway personnel and passengers.

The Railway Management System holds immense potential for further enhancements and advancements. Integration of advanced analytics and predictive algorithms can aid in predicting travel demand, optimizing scheduling, and enhancing passenger experiences. Linking the system with online booking platforms can cater to the needs of modern travellers, while incorporating sustainability metrics can contribute to reducing environmental impact. Hosting a common database online can facilitate collaboration and data sharing across multiple railway stations, leading to a more comprehensive analysis of railway operations and performance.

Future Work:

- **Advanced Analytics and Predictive Algorithms:** Integrate advanced analytics and machine learning algorithms to predict travel demand, optimize scheduling, and improve resource allocation.

- **Online Booking and E-Ticketing:** Enhance the system to support online booking and e-ticketing services, catering to the needs of modern travellers and improving customer convenience.

- **Mobile App Development:** Develop a mobile application for passengers to access services, receive updates, and manage bookings conveniently from their smartphones.

- **Regulatory Compliance:** Ensure compliance with regulatory requirements, industry standards, and safety protocols to maintain operational integrity and customer trust.

References:

S. R. Patel, J. Choudhary, and G. Patil, “Revolution of Database Management System: A literature Survey,” International Journal of Engineering Trends and Technology, vol. 71, no. 7, pp. 189–200, Jul. 2023, doi 10.14445/22315381/ijett-v71i7p218.

Study of Management Information System of Railway Permanent Way Safety Risks and Comprehensive Evaluation

https://www.researchgate.net/publication/271881970_Study_of_Management_Information_System_of_Railway_Permanent_Way_Safety_Risks_and_Comprehensive_Evaluation