Epam

Aziz Berkan Hosgül

Subway(Metro)

# 1-Business Description

## 1.1 Business background:

Metro (Subway) systems are critical urban transportation infrastructures that require efficient management of stations, trains, schedules, employees, ticketing, and maintenance. A structured database is essential for handling large volumes of data and ensuring smooth operations.

## 1.2 Problems. Current Situation:

* Lack of real-time tracking for train schedules and station status.
* Inefficient management of employee assignments and train operations.
* Limited historical data for maintenance and infrastructure repairs.
* Manual or outdated ticketing systems leading to revenue loss.
* Difficulty in managing promotions and discount systems for passengers.

## 1.3 the Benefits of implementing a database. Project Vision:

* Centralized database for real-time access to train schedules, stations, and operations.
* Automated tracking of maintenance activities to prevent downtime.
* Secure ticketing system with digital records of purchases and promotions.
* Enhanced efficiency in employee scheduling and resource allocation.
* Data-driven decision-making for route optimization and passenger satisfaction.

# 2-Model description

## 2.1-Definitions & Acronyms:

* **DWH** - Data Warehouse
* **ETL** - Extract, Transform, Load
* **PK** - Primary Key
* **FK** - Foreign Key

## 2.2- Logical Scheme

The following tables form the core of the Subway (Metro) Management System:

1. **Stations** - Stores information about metro stations.
2. **Lines** - Represents subway lines with associated details.
3. **Routes** - Many-to-many relationship between stations and lines.
4. **Schedules** - Details of train schedules per line and station.
5. **Trains** - Stores train-related information.
6. **Train\_Operations** - Assigns trains to lines at specific times.
7. **Employees** - Stores employee details for operational roles.
8. **Employee\_Assignments** - Links employees to their assigned schedules.
9. **Tickets** - Ticket types, prices, and discount details.
10. **Passengers** - Registered passengers for ticketing and digital tracking.
11. **Tickets\_Purchased** - Records ticket purchases and transactions.
12. **Infrastructure** - Information on tunnels, tracks, and stations.
13. **Maintenance** - Tracks maintenance records for infrastructure.
14. **Repairs** - Details of repair logs and responsible teams.
15. **Promotions** - Stores discount offers and promotional campaigns

## 2.3-Objects

#### **Stations**

Stores information about all metro stations, including their unique IDs, names, locations, and opening dates.

#### **Stations Table**

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Station\_ID | Unique station identifier | INT (PK) |
| Name | Station name | VARCHAR(100) |
| Location | GPS coordinates/address | TEXT |
| Open\_Date | Date station was opened | DATE |

#### **Lines**

Represents the different subway lines, each uniquely identified, along with their names, colors, and operators.

#### **Lines Table**

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Line\_ID | Unique line identifier | INT (PK) |
| Name | Name of the metro line | VARCHAR(100) |
| Color | Line color representation | VARCHAR(20) |
| Operator | Organization operating the line | VARCHAR(100) |

#### **Routes**

Defines the many-to-many relationship between subway stations and lines, specifying their order along the route.

#### **Routes Table**

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Route\_ID | Unique route identifier | INT (PK) |
| Station\_ID | Associated station ID | INT (FK) |
| Line\_ID | Associated line ID | INT (FK) |
| Sequence | Order of stations in the route | INT |

#### **Schedules Table**

Manages the timetable for trains, detailing departure and arrival times per station and line.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Operation\_ID | Unique operation ID | INT (PK) |
| Line\_ID | Associated line ID | INT (FK) |
| Station\_ID | Associated station ID | INT (FK) |
| Arrival\_Time | Scheduled arrival time | TIME |
| Departure\_Time | Scheduled departure time | TIME |

#### **Trains Table**

Contains information on individual train units, including their models, passenger capacity, and assigned lines.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Train\_ID | Unique train identifier | INT (PK) |
| Model | Train model name | VARCHAR(100) |
| Capacity | Maximum passenger capacity | INT |
| Line\_ID | Line that train operates on | INT (FK) |

#### **Train\_Operations Table**

Tracks train operations, specifying which train runs on which line, including departure and arrival times.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Operation\_ID | Unique operation ID | INT (PK) |
| Train\_ID | Train assigned to the operation | INT (FK) |
| Line\_ID | Line associated with the train | INT (FK) |
| Time\_Assigned | Time of assignment | DATETIME |

#### **Employees Table**

Stores details about subway personnel, such as train operators, maintenance staff, and station employees.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Employee\_ID | Unique employee identifier | INT (PK) |
| Name | Employee name | VARCHAR(100) |
| Role | Employee role (e.g., Driver) | VARCHAR(50) |
| Hire\_Date | Date of employment | DATE |

#### **Employee\_Assignments Table**

Manages employee schedules, defining their roles and work shifts across different train operations.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Assignment\_ID | Unique assignment identifier | INT (PK) |
| Employee\_ID | Assigned employee ID | INT (FK) |
| Operation\_ID | Assigned schedule operation | INT (FK) |

**Tickets Table**

Defines different ticket types, their prices, and applicable discounts.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Ticket\_ID | Unique ticket identifier | INT (PK) |
| Type | Ticket type (e.g., single, monthly) | VARCHAR(50) |
| Price | Ticket price | DECIMAL(5,2) |

#### **Passengers Table**

Stores registered passenger details for tracking ticket purchases and digital ticketing.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Passenger\_ID | Unique passenger identifier | INT (PK) |
| Name | Passenger name | VARCHAR(100) |
| Contact\_Info | Contact details | TEXT |

#### **Tickets\_Purchased Table**

Tracks all ticket transactions, linking passengers to their purchased tickets and recording the date of purchase.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Purchase\_ID | Unique purchase ID | INT (PK) |
| Passenger\_ID | Associated passenger ID | INT (FK) |
| Ticket\_ID | Purchased ticket ID | INT (FK) |
| Purchase\_Date | Date of purchase | DATE |

#### **Infrastructure Table**

Maintains records of subway infrastructure components, such as tunnels, tracks, and stations.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Infra\_ID | Unique infrastructure ID | INT (PK) |
| Type | Type of infrastructure (e.g., tunnel, track) | VARCHAR(50) |
| Location | Location details | TEXT |

#### **Maintenance Table**

Logs scheduled maintenance activities for subway infrastructure to ensure operational efficiency.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Maintenance\_ID | Unique maintenance record ID | INT (PK) |
| Infra\_ID | Infrastructure being maintained | INT (FK) |
| Description | Details of maintenance | TEXT |
| Date | Date of maintenance | DATE |

#### **Repairs Table**

Records repair activities on subway infrastructure, including details of the issue and responsible teams.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Repair\_ID | Unique repair record ID | INT (PK) |
| Infra\_ID | Associated infrastructure ID | INT (FK) |
| Description | Repair details | TEXT |
| Date | Date of repair | DATE |

#### **Promotions Table**

Stores information on promotional campaigns and discounts applied to ticket sales.

|  |  |  |
| --- | --- | --- |
| **Field Name** | **Description** | **Data Type** |
| Promotion\_ID | Unique promotion ID | INT (PK) |
| Discount | Discount percentage or amount | DECIMAL(5,2) |
| Start\_Date | Promotion start date | DATE |
| End\_Date | Promotion end date | DATE |

### **Primary Keys (PK)**

The following fields uniquely identify records in each table:

* **Stations** → Station\_ID (PK)
* **Lines** → Line\_ID (PK)
* **Routes** → Route\_ID (PK)
* **Schedules** → Operation\_ID (PK)
* **Trains** → Train\_ID (PK)
* **Train\_Operations** → Operation\_ID (PK)
* **Employees** → Employee\_ID (PK)
* **Employee\_Assignments** → Assignment\_ID (PK) (Add if missing)
* **Tickets** → Ticket\_ID (PK)
* **Passengers** → Passenger\_ID (PK)
* **Tickets\_Purchased** → Purchase\_ID (PK)
* **Infrastructure** → Infra\_ID (PK)
* **Maintenance** → Maintenance\_ID (PK)
* **Repairs** → Repair\_ID (PK) (Add if missing)
* **Promotions** → Promotion\_ID (PK) (Add if missing)

### **Foreign Keys (FK)**

The following fields establish relationships between tables:

* **Routes** → Station\_ID (FK), Line\_ID (FK)
* **Trains** → Line\_ID (FK)
* **Train\_Operations** → Train\_ID (FK), Line\_ID (FK)
* **Employee\_Assignments** → Employee\_ID (FK), Operation\_ID (FK)
* **Tickets\_Purchased** → Passenger\_ID (FK), Ticket\_ID (FK)
* **Maintenance** → Infra\_ID (FK)
* **Repairs** → Infra\_ID (FK)

### **2.4 Comments on Table Relationships**

* **Routes** represent the many-to-many relationship between **Stations** and **Lines**.
* **Employee\_Assignments** manages employee schedules across operations.
* **Tickets\_Purchased** links **Passengers** to **Tickets**, tracking purchases.
* **Maintenance** tracks upkeep for **Infrastructure**.
* **Repairs** logs fixes performed on **Infrastructure**.