

Assignment: ER Diagram Design

Smart City Public Transport Management System

DCDS Lab | Entity-Relationship Modeling

Assignment Objective

What you have to do

Read the complete Smart City Public Transport case study carefully. From the given paragraph-based description, identify the required entities, attributes, primary keys, relationships, cardinality ratios, participation constraints, and special ER modeling features. Then draw a complete ER diagram using any diagramming tool.

Important Instruction

Do not directly create SQL tables. This assignment is only for ER diagram design. The focus is on identifying the database structure from the real-world case study.

Minimum Requirement

Your ER diagram must contain **at least 8–10 meaningful entities**. You may include more entities if your design requires them.

Case Study: Smart City Public Transport System - Part 1

A smart city authority is planning to build a centralized Public Transport Management System to manage daily bus-based transportation across the city. The system will maintain information about commuters who use public transport for regular travel. A commuter may travel using a one-time ticket or may purchase a monthly, quarterly, student, senior citizen, or corporate travel pass. For every commuter, the system should store basic personal details, contact details, and travel-related preferences so that the authority can provide better services and notifications.

The city operates different categories of buses such as electric buses, CNG buses, mini buses, and air-conditioned buses. Each bus has a registration number, seating capacity, current operational status, fuel type, and assigned depot. A depot is responsible for parking, dispatching, charging or fueling, and maintaining buses assigned to it. The depot also keeps contact and capacity information for administrative planning.

Case Study: Smart City Public Transport System - Part 2

The transport network is organized through predefined routes. Each route has a route name, source point, destination point, approximate distance, and estimated travel time. A route passes through multiple bus stops, and the same bus stop may be part of multiple routes. The order of stops on a route is important because the system must know the sequence number of each stop and the distance of each stop from the starting point of the route.

Every day, the authority schedules several trips on each route. A trip represents the actual operation of a bus on a particular route on a given date and time. Each trip should store details such as trip date, start time, expected end time, actual end time, trip status, and actual distance covered. One bus is assigned to a trip at a time, but the same bus may be used for many trips on different dates or time slots.

Case Study: Smart City Public Transport System - Part 3

The authority employs different staff members such as drivers, conductors, depot managers, route supervisors, and maintenance technicians. Staff details include name, mobile number, role, salary, joining date, and license number if applicable. A driver operates a trip, and a conductor may be assigned to collect or verify tickets during the trip. A staff member may be assigned to many trips over time, but each trip must have at least one assigned driver.

Commuters can book tickets for specific trips. A ticket records the source stop, destination stop, fare amount, ticket date and time, and ticket status. Payments are recorded for tickets and passes. Payment information includes payment mode, amount, payment date and time, transaction reference, and transaction status. A ticket or pass should be considered valid only when the linked payment is successful.

Case Study: Smart City Public Transport System - Part 4

The transport department also monitors maintenance activities for buses. Whenever a bus requires inspection, repair, battery service, tyre replacement, engine work, or cleaning, a maintenance record is created. The record should store the maintenance date, issue reported, service category, service cost, technician details, and service status. A bus can have many maintenance records during its lifetime, but each maintenance record belongs to only one bus.

Commuters can submit complaints or feedback about delays, overcrowding, rude staff behavior, ticketing problems, cleanliness, bus stop conditions, route issues, and safety concerns. Feedback may be associated with a particular route, trip, bus stop, or staff member depending on the issue. The system should store feedback category, description, rating, submission date, and resolution status so that administrators can track service quality.

Case Study: Smart City Public Transport System - Part 5

The authority wants the ER diagram to support future reporting requirements. For example, administrators should be able to find how many trips were completed on a route, which buses frequently require maintenance, which depots manage the highest number of buses, which stops are part of more than one route, how many commuters purchased travel passes, and which complaint categories occur frequently.

The design should also support realistic constraints. For example, registration numbers, mobile numbers, ticket numbers, pass numbers, and payment transaction references should not repeat. Some attributes may be composite, such as commuter name or address. Some information, such as commuter age or trip duration, can be derived from other attributes. Some contact details may be multi-valued because a commuter or staff member may provide more than one contact number.

Assignment Questions: Entity and Attribute Identification

- 1 Read the case study and identify all possible entities required for the system.
- 2 Select at least **8–10 major entities** for your ER diagram.
- 3 For each entity, list meaningful attributes based on the case study.
- 4 Identify one suitable primary key for every entity.
- 5 Identify attributes that should be unique, mandatory, optional, derived, composite, or multi-valued.
- 6 Mention any assumptions you make while choosing entities and attributes.

Note

Do not copy entity names blindly. Read the story, understand the system, and decide what should become an entity, attribute, or relationship.

Assignment Questions: Relationships and Cardinalities

- 1 Identify all relationships among the entities selected by you.
- 2 Give a meaningful name to every relationship.
- 3 Specify the cardinality ratio for every relationship: **1:1**, **1:M**, or **M:N**.
- 4 Specify participation constraints wherever applicable: total or partial.
- 5 Identify the many-to-many relationship between route and bus stop and resolve it properly.
- 6 Identify whether payment should be related to ticket, pass, or both. Show your design clearly.
- 7 Identify how complaints or feedback can be connected to route, trip, bus stop, or staff.

ER Modeling Requirements

Your ER diagram must clearly include the following modeling components.

Compulsory Components

- Strong entities
- Primary key attributes
- Simple attributes
- Composite attribute
- Multi-valued attribute
- Derived attribute
- One-to-many relationship
- Many-to-many relationship

Design Features

- Associative entity for M:N
- Relationship attributes if required
- Total / partial participation
- Optional specialization for staff roles
- Meaningful relationship names
- Clean and readable layout

Case Analysis Questions

Answer the following along with your ER diagram.

- ➊ Which entity will store the order of bus stops in a route? Justify your design.
- ➋ Should Driver and Conductor be separate entities or subtypes of Staff? Justify your choice.
- ➌ Can a commuter have both a ticket and a travel pass? Show this correctly in the ER diagram.
- ➍ How will your design ensure that one bus can be used for many trips over time?
- ➎ How will your design connect a complaint to a route, trip, bus stop, or staff member?
- ➏ Which attributes can be derived in this case study? Give at least two examples.
- ➐ Write five business rules derived from your ER diagram.