| Project Phase 3: City Public Transport

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| Changes made from previous phases:

- We removed “complainee aadhar number” from the entity type COMPLAINT because it was redundant.

| Stage 1: Mapping ER to Relational Model

To map our ER diagram to a relational model:

1. We add relations for all our strong entity types.
    a. Only the simple component attributes are included for the composite attributes.
    b. The multi-valued attributes are not included for now.

    Relations added along with their simple attributes: MODE OF TRANSPORT, VEHICLE, DRIVER, CONDUCTOR, STATION, PASSENGER, LANDMARK, ADMIN OFFICER, SERVICE STAFF, COMPLAINT

2. We add relations for all our weak entity types.
    a. Only the simple component attributes are included for the composite attributes.
    b. The primary key attribute of the relation that corresponds to the owner entity type is included as foreign key attribute of each of these relations.

    Relations added along with their simple attributes: TICKET, LUGGAGE
    Foreign keys added to these relations: C_Aadhar (for both), P_Aadhar(for both), V_RegNo

3. We have no 1:1 binary relationship so nothing has to be taken care of for that.

4. We map the binary 1:N relationship types using foreign key approach. Let R be the relationship type and let S be the entity type on the N side and T be the other entity type.
    a. We add the primary key of relation T to relation S.

   Some examples of foreign key connections shown: Admin_Aadhar in CONDUCTOR to Aadhar Card Number in ADMIN OFFICER, P_Aadhar in LUGGAGE to Aadhar Card Number in PASSENGER.

5. We map the binary M:N relationship types by creating relationship relations.
    a. We create a new relation for each of the binary M:N relationship types.
    b. We include the primary keys of the relations representing the participating entity types as foreign key attributes in the new relation.

   Relations added: WORKS_WITH, ACCOMPANIES, MAINTAINS, IS_NEAR
   Foreign keys added: Pass1 in WORKS_WITH, S_Name in IS_NEAR, etc.

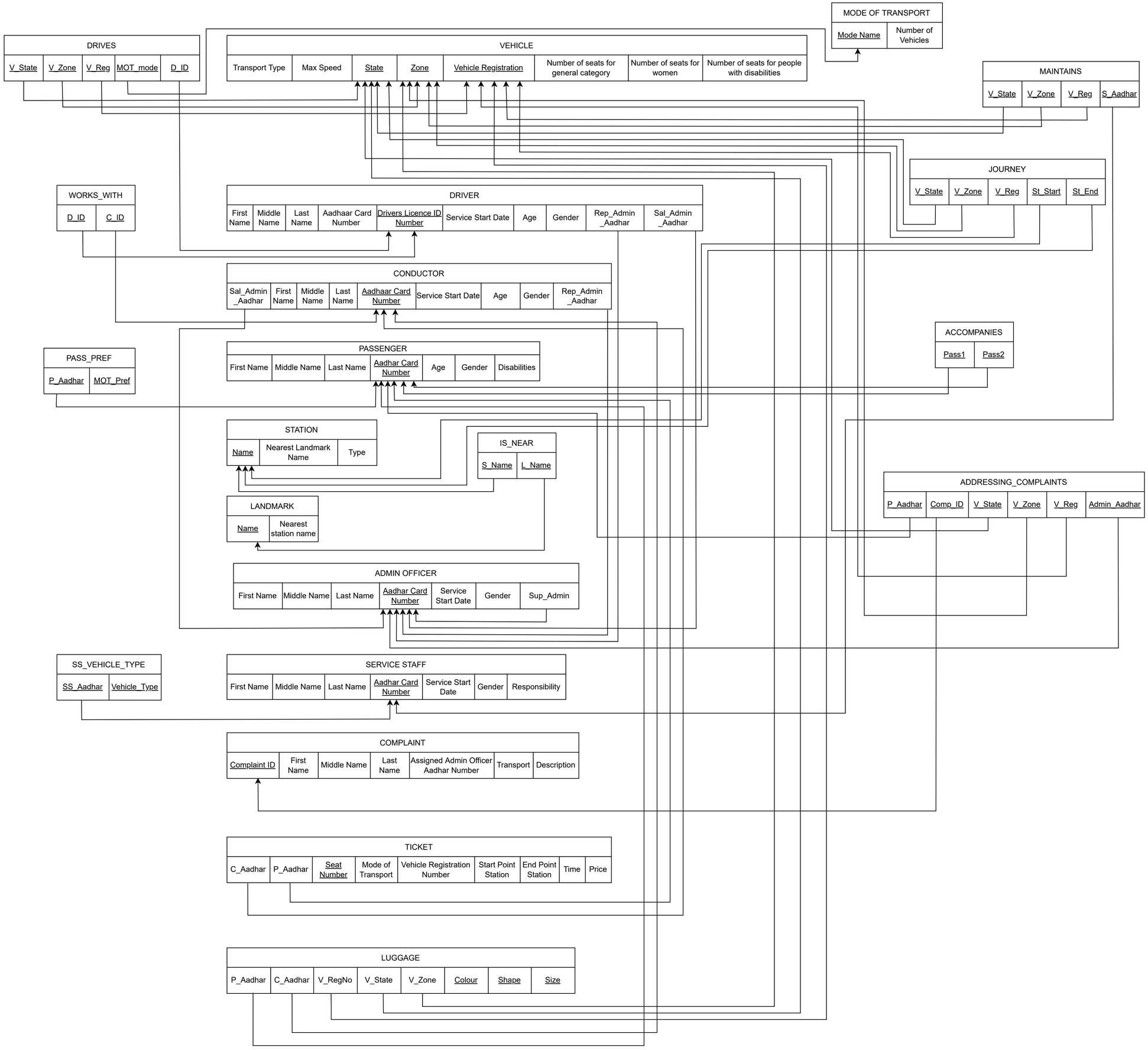
6. We map multi-valued attributes by creating a relation for each. Each relation will contain:
    a. The corresponding multi-valued attribute
    b. As foreign key, the primary key of the relation representing the entity type that contains the multi-valued attribute

   Relations added: PASS_PREF, SS_VEHICLE_TYPE
   Foreign keys added: MOT_Pref in PASS_PREF, SS_Aadhar in SS_VEHICLE_TYPE, etc.

7. We map n-ary (n>2) relationship types by creating a relation for each relationship.
    a. The primary keys of the relations representing the participating entity types.

   Relations added: DRIVES, JOURNEY, ADDRESSING_COMPLAINTS
   Foreign keys added: MOT_Mode in DRIVES, St_End in JOURNEY, etc.

SNAPSHOT OF THE RELATIONAL MODEL IS INCLUDED IN THE NEXT PAGE


MODE OF TRANSPORT
Mode Name
Number of Vehicles
DRIVES
V_State
V_Zone
V_Reg
MOT_mode
D_ID
VEHICLE
Transport Type
Max Speed
State
Zone
Vehicle Registration
Number of seats for general category
Number of seats for women
Number of seats for people with disabilities
MAINTAINS
V_State
V_Zone
V_Reg
S_Aadhar
JOURNEY
V_State
V_Zone
V_Reg
St_Start
St_End
WORKS_WITH
D_ID
C_ID
DRIVER
First Name
Middle Name
Last Name
Aadhaar Card Number
Drivers Licence ID Number
Service Start Date
Age
Gender
Rep_Admin _Aadhar
Sal_Admin _Aadhar
CONDUCTOR
Sal_Admin _Aadhar
First Name
Middle Name
Last Name
Aadhaar Card Number
Service Start Date
Age
Gender
Rep_Admin _Aadhar
ACCOMPANIES
Pass1
Pass2
PASS_PREF
P_Aadhar
MOT_Pref
PASSENGER
First Name
Middle Name
Last Name
Aadhar Card Number
Age
Gender
Disabilities
STATION
Name
Nearest Landmark Name
Type
IS_NEAR
S_Name
L_Name
ADDRESSING_COMPLAINTS
P_Aadhar
Comp_ID
V_State
V_Zone
V_Reg
Admin_Aadhar
LANDMARK
Name
Nearest station name
ADMIN OFFICER
First Name
Middle Name
Last Name
Aadhar Card Number
Service Start Date
Gender
Sup_Admin
SS_VEHICLE_TYPE
SS_Aadhar
Vehicle_Type
SERVICE STAFF
First Name
Middle Name
Last Name
Aadhar Card Number
Service Start Date
Gender
Responsibility
COMPLAINT
Complaint ID
First Name
Middle Name
Last Name
Assigned Admin Officer Aadhar Number
Transport
Description
TICKET
C_Aadhar
P_Aadhar
Seat Number
Mode of Transport
Vehicle Registration Number
Start Point Station
End Point Station
Time
Price
LUGGAGE
P_Aadhar
C_Aadhar
V_RegNo
V_State
V_Zone
Colour
Shape
Size

| Stage 2: Relational Model to 1NF

There was no need for us to explicitly change anything in the relational model diagram in the previous page for it to be 1NF since there are no multivalued, composite or nested attributes remaining after the first stage itself. Reduction of composite attributes to their lowest atomic, adding relations for multi-valued attributes, etc were all done in the first stage itself, as mentioned in the steps there.

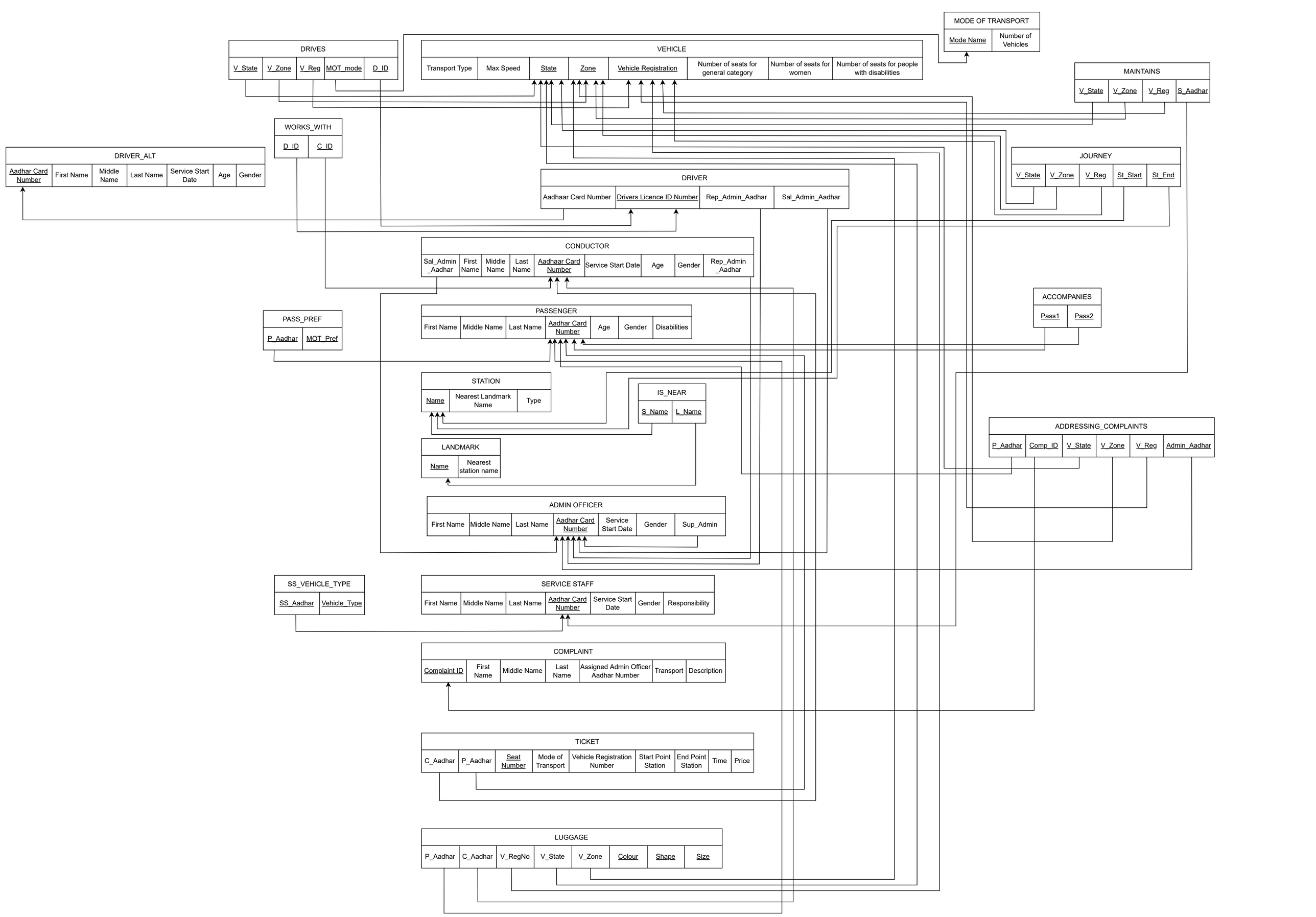
| Stage 3: 1NF Relational Model to 2NF

There was no need for us to explicitly change anything in the relational model diagram in the previous page for it to be 2NF since in the 2NF form, every non-prime attribute in a relation is fully functionally dependent on the primary key and in our relational model, there is no non-prime attribute that does not have functional dependency on the respective primary key.

| Stage 4: 2NF Relational Model to 3NF

The DRIVER relation in the 2NF form violates the 3NF rules. In DRIVER, the values of First Name, Middle name, Last Name, Service Start Date, Age and Gender are functionally dependent on Aadhar Card Number (i.e. if Aadhar Card Number changes, it is possible that the values of the mentioned attributes may change). This creates a transitive dependency.
So, to make it 3NF, we create a new relation DRIVER_ALT with Aadhar Card Number as the primary key and the Aadhar Card Number attribute in the original DRIVER relation becomes the foreign key pointing to the primary key of the new relation DRIVER_ALT. All the attributes which were functionally dependant on Aadhar Card Number originally, i.e First Name, Middle name, Last Name, Service Start Date, Age and Gender, are now attributes only of the new relation DRIVER_ALT.

SNAPSHOT OF 3NF RELATIONAL MODEL IS INCLUDED IN THE NEXT PAGE


MODE OF TRANSPORT
Mode Name
Number of Vehicles
DRIVES
V_State
V_Zone
V_Reg
MOT_mode
D_ID
VEHICLE
Transport Type
Max Speed
State
Zone
Vehicle Registration
Number of seats for general category
Number of seats for women
Number of seats for people with disabilities
MAINTAINS
V_State
V_Zone
V_Reg
S_Aadhar
WORKS_WITH
D_ID
C_ID
DRIVER_ALT
Aadhar Card Number
First Name
Middle Name
Last Name
Service Start Date
Age
Gender
JOURNEY
V_State
V_Zone
V_Reg
St_Start
St_End
DRIVER
Aadhaar Card Number
Drivers Licence ID Number
Rep_Admin_Aadhar
Sal_Admin_Aadhar
CONDUCTOR
Sal_Admin_Aadhar
First Name
Middle Name
Last Name
Aadhaar Card Number
Service Start Date
Age
Gender
Rep_Admin_Aadhar
ACCOMPANIES
Pass1
Pass2
PASS_PREF
P_Aadhar
MOT_Pref
PASSENGER
First Name
Middle Name
Last Name
Aadhar Card Number
Age
Gender
Disabilities
STATION
Name
Nearest Landmark Name
Type
IS_NEAR
S_Name
L_Name
ADDRESSING_COMPLAINTS
P_Aadhar
Comp_ID
V_State
V_Zone
V_Reg
Admin_Aadhar
LANDMARK
Name
Nearest station name
ADMIN OFFICER
First Name
Middle Name
Last Name
Aadhar Card Number
Service Start Date
Gender
Sup_Admin
SS_VEHICLE_TYPE
SS_Aadhar
Vehicle_Type
SERVICE STAFF
First Name
Middle Name
Last Name
Aadhar Card Number
Service Start Date
Gender
Responsibility
COMPLAINT
Complaint ID
First Name
Middle Name
Last Name
Assigned Admin Officer Aadhar Number
Transport
Description
TICKET
C_Aadhar
P_Aadhar
Seat Number
Mode of Transport
Vehicle Registration Number
Start Point Station
End Point Station
Time
Price
LUGGAGE
P_Aadhar
C_Aadhar
V_RegNo
V_State
V_Zone
Colour
Shape
Size