DUTCHESS COUNTY BUS TRANSPORTATION SYSTEM

MSCS_542L_256_23S

The Four-Ce

Marist College School of Computer Science and Mathematics

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PROJECT REPORT OF DUTCHESS COUNTY BUS TRANSPORTATION SYSTEM

Team Name

The Four-Ce

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DESCRIPTION OF TEAM MEMBERS

1. Sindhuja Ravikanth

I attained my bachelor's degree in computer science from Keshav Memorial Institute of Technology in 2022. I worked as a Software Developer in TCP Wave for 1 year 9 months. I have come to Marist College for my master's degree in computer science. I am proficient in Java, MySQL, and JavaScript. I am here to develop my skills and develop better products.

2. Shanmukha Chowdary Nalla

I graduated from the Indian Institute of Technology Design and Manufacturing, Jabalpur in the year 2022. I started working in the software field in the 7th semester at Merkle Company as an Analyst and then as a Salesforce Marketing Cloud Developer till June 2023. I am a Certified Salesforce Marketing Cloud Developer, Email Specialist, and Machine Learning Engineer. I chose this course because it helps me enhance my skillset in data management which is always handy.

3. Gaurav Bapurao Sherla

I am an aspiring AWS and ML developer. I want to make the world a better place by empowering technology with the help of AI, especially in the mining sector. Where many lives are lost while mining ore from hundreds of feet beneath the earth, I have worked as an ML developer for a startup where I gained some useful insights with the help of this course I will be able to get in-depth practical knowledge about DBMS and this would help me enhance my knowledge, which can help me boost my skills for my future growth.

4. Katipally Chanakya Vardhan Reddy

I am Katipally Chanakya Vardhan Reddy, a Computer Science graduate from Methodist College of Engineering and Technology. Currently, I'm pursuing my Master's in MSCS with a focus on cloud computing at Marist College. I excel in Python, C, and C++ and have a strong background in problem-solving.

INTRODUCTION

In an era defined by rapid urbanization and increased reliance on public transportation, the Dutchess County Bus Transportation System (DCBTS) stands as a vital lifeline for the residents of Dutchess County, New York. The DCBTS is an essential part of the daily lives of countless commuters, offering a means to connect with their destinations efficiently and sustainably. However, in a world where technological advancements are reshaping how we interact with the world around us, it is imperative that our public transportation system evolves in tandem.

The objective of this project Is to propel the DCBTS Into the future by revolutionizing its digital presence and user experience. With the advent of the Information Age, accessibility to transportation information is crucial, and the current DCBTS app, while functional, requires a comprehensive overhaul to meet the needs and expectations of modern commuters.

The primary aim of this project is to develop a user-friendly DCBTS application that caters to a diverse range of users. This includes commuters seeking to efficiently plan their journeys, tourists exploring the county, and an administrator with specialized privileges to manage and optimize the system.

In this project, we are planning to simplify the process of planning daily commutes via DCPT buses for all individuals which would be user-friendly to the users of all the age groups above 10 years. With the help of our project model, we want to cater our services to our users by providing them with enough data in a simplified format. Our user interface will provide the users with a menu where they can put in their source and destination locations and all the bus routes and buses in respect to their search will be displayed. Which can help them keep track of their bus timings and changes of any kind in the bus schedule. The users can also mark their favorite routes and buses which they mostly use for their commute and can keep track of them without any inconvenience.

PROJECT OBJECTIVES

The following should be supported by the system:

- The application should be able to prompt the commuters for the login details and allow them to change credentials with proper authentication.
- The application should allow the administrator to make changes in the user records.
- The application should provide the capability for the users or administrator to modify their contact information and profile changes with proper authentication.
- Users should be able to access information about their bus routes and buses at any point in time.
- The administrator should have access to the user's credentials through a valid process.
- The administrator should be able to make changes in the commuting-related data.
- The application should have the capability to access separate login databases like commuter login and administrator login. So that they can access their respective data and use the application based on their requirements.

REVIEW

Dutchess County Public Transportation (DCPT) [1]

- This app is based on the whole public transportation system of Dutchess County.
- The app shows the live tracking of buses around Dutchess County.
- The buses are identified by their bus numbers with which people can identify which bus would be comfortable to board based on their schedule.
- The app also shows the user's live location, so that the user can identify which bus is the nearest to them.
- This app shows buses in a map form.

NYC Transit: MTA Subway & Bus [2]

- This app is based on the Subways and Buses of New York.
- This app shows the best ways to get from a source to a destination around New York.
- It saves different locations as favorites.

Moovit [3]

- This app is based on all types of transport in many countries worldwide.
- It shows directions from one place to another and suggests quicker ways to get from a source to a destination irrespective of the transit type.

MERITS

- The DCBTS helps everyone to search for a route from source to destination and plan their day based on the time estimation of the buses in Dutchess County.
- This application shows all the stops between the source and destination.
- This application will keep track of days when the buses will not be available like public holidays.
- This application will support multiple users including an Administrator.
- This application will also show the bus fare by taking into consideration the user's age.

GITHUB REPOSITORY

https://github.com/SindhujaRavikanth2001/DBMS_Project

ENTITY RELATIONSHIP MODEL (ER MODEL)

An Entity Relationship (ER) Diagram is a type of flowchart that illustrates how “entities” such as people, objects, or concepts relate to each other within a system. ER Diagrams are most often used to design or debug relational databases in the fields of software engineering, business information systems, education, and research.

We have used ERDPlus to create the ER diagram. ERDPlus is an open-source software modeling tool that supports the UML (Unified Modeling Language) framework for system and software modeling.

Entities	Attributes
User	UserID, FirstName, LastName, DOB, Email, PhoneNumber, Username, Password
Admin	AdminID, Username, Password, Email, PhoneNumber, EmployeeID
Bus	BusID, BusNumber, Capacity, LicensePlateNumber, BusType
Ticket Type	TicketTypeID, TypeName, Price, ValidityPeriod, Description, UserID
Payment	PaymentID, Amount, UserID, TicketTypeID, PaymentDate
Reservation	ReservationID, PaymentID, BusID, ReservationDate, NumberOfReservations
Bus Route	RouteID, StartLocation, EndLocation, BusID
Route Stop Sequence	StopSequenceID, RouteID, StopID, NumberofStops, ArrivalTime
Employee	EmployeeID, DepartmentID, FirstName, LastName, Position
Department	DepartmentID, DepartmentName, Location

Schedule	ScheduleID, BusID, RouteID, DayFlag, DepartureTime, ArrivalTime
Bus Stop	StopID, StopName, Location
Notification	NotificationID, Message, DateAndTime, UserID, AdminID, ReservationID
Holidays	HolidayID, HolidayDate, Description, NotificationID

ENTITY RELATIONSHIP DIAGRAM

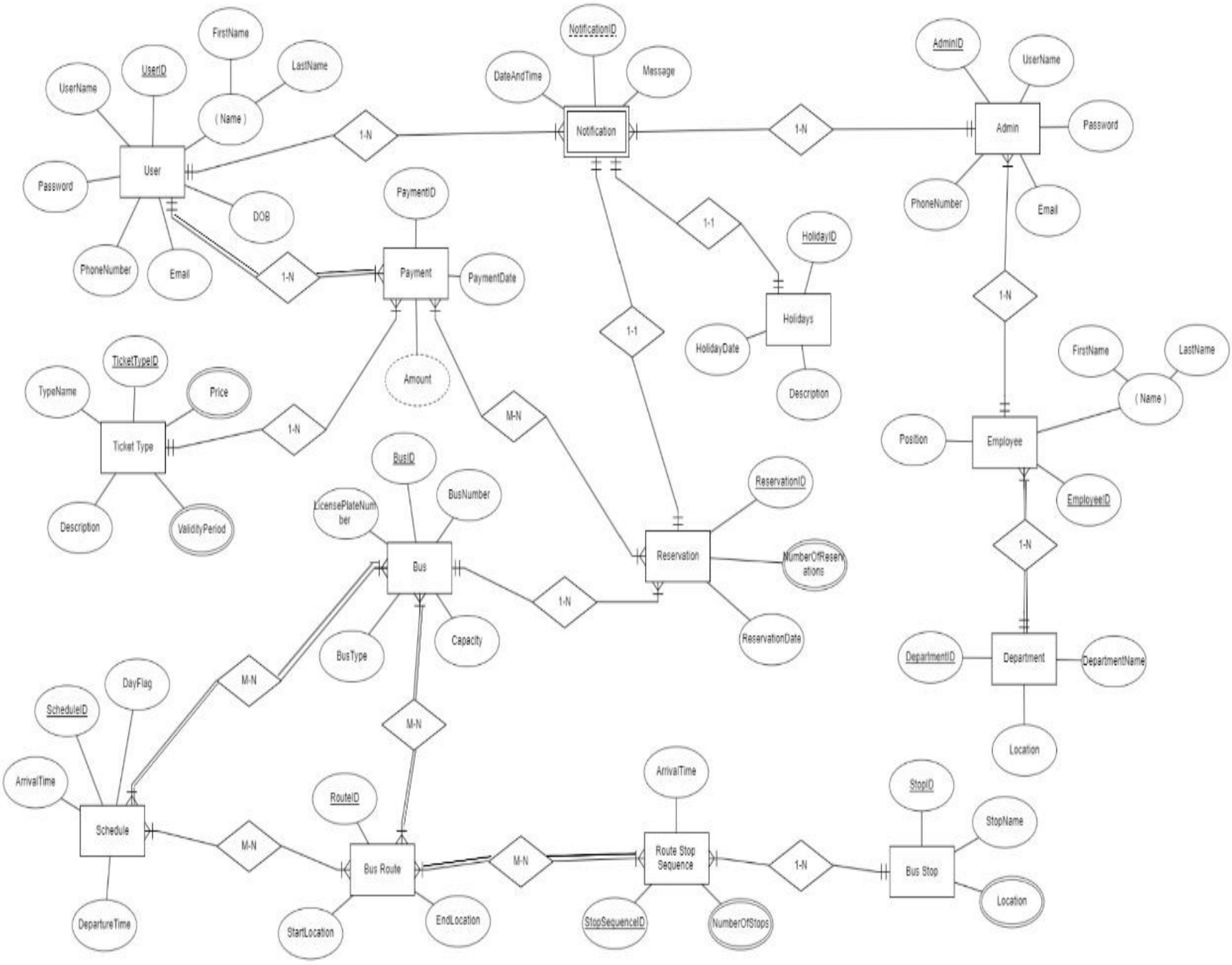

Figure 1 Entity Relationship Diagram

IMPLEMENTATION OF ER DIAGRAM

Entities and Attributes:

Entity: User

Description: A table to describe the passengers in the Dutchess County Bus Transportation System.

Attributes:

UserID – A unique identifier to identify each user. (Primary Key)

FirstName – First name of the user.

LastName – Last name of the user.

DOB – The date of birth of the user.

Email – E-mail ID of the user.

PhoneNumber – The contact number of the user.

Username – The username of the user with which they want to login.

Password – Password of the user.

Entity: Admin

Description: A table to describe the administrators who handle all the changes in the DCBTS.

Attributes:

AdminID – A unique identifier to identify each admin. (Primary Key)

Username – The username of the admin with which they want to login.

Password – The password of the admin.

Email – E-mail ID of the admin.

PhoneNumber – The contact number of the admin.

EmployeeID – The employee identifier of the admin.

Entity: Bus

Description: A table to describe all the properties of a bus.

Attributes:

BusID – A unique identifier to identify each bus. (Primary Key)

BusNumber – A designated bus number to identify the route of the bus.

Capacity – The seating capacity of the bus.

LicensePlateNumber – The license plate number of the bus.

BusType – The type of the bus. E.g.: Coach

Entity: Ticket Type
Description: A table to describe the type of each ticket.
Attributes:
TicketTypeID – A unique identifier to identify each ticket type. (Primary Key)
TypeName – Type name of the ticket. E.g.: Student ticket
Price – Price of the ticket.
ValidityPeriod – Validity period of the ticket.
Description – A description to explain which ticket applies to what age group.
UserID – (Foreign Key) to relate ticket type and user.

Entity: Payment
Description: A table to describe the payments for tickets.
Attributes:
PaymentID – A unique identifier for each payment. (Primary Key)
Amount – Amount paid in the payment.
UserID – Identifier of the user who made the payment. (Foreign Key)
TicketTypeID – Identifier of the ticket type for which the payment has been made. (Foreign Key)
PaymentDate – The date on which the payment is made.

Entity: Reservation
Description: A table to describe all the seating reservations on the bus.
Attributes:
ReservationID – A unique identifier for each reservation. (Primary Key)
PaymentID – Payment identifier with which the seating reservation was made. (Foreign Key)
BusID – Identifier of the bus on which the reservation is made. (Foreign Key)
ReservationDate – The date for which the reservation is made.
NumberOfReservations – No. of reservations that have been made.

Entity: Bus Route

Description: A table to describe all the bus routes in the Dutchess County Bus Transportation System.

Attributes:

RouteID – A unique identifier to identify each route. (Primary Key)

StartLocation – Start location of the route.

EndLocation – End location of the route.

BusID – Identifier of the bus that will go on that route. (Foreign Key)

Entity: Route Stop Sequence

Description: A table to describe the route stop sequence from a source to a destination.

Attributes:

StopSequenceID – A unique identifier to identify a route stop sequence. (Primary Key)

RouteID – Route identifier to which the stop sequence is associated. (Foreign Key)

StopID – Identifier of every stop in the stop sequence. (Foreign Key)

NumberofStops – No. of stops in the route sequence.

ArrivalTime – The time at which the destination will arrive.

Entity: Employee

Description: A table to describe all the employees employed in the DCBTS.

Attributes:

EmployeeID – A unique identifier to identify each employee. (Primary Key)

DepartmentID – Identifier of the department in which the employee is employed. (Foreign Key)

FirstName – First name of the employee.

LastName – Last name of the employee.

Position – Designation of the employee.

Entity: Department

Description: A table to describe all the departments in the DCBTS.

Attributes:

DepartmentID – A unique identifier to identify each department. (Primary Key)

DepartmentName – Name of the department.

Location – Location of the department.

Entity: Schedule

Description: A table to describe the bus schedule.

Attributes:

ScheduleID – An identifier to identify a schedule. (Primary Key)

BusID – Identifier of the bus. (Foreign Key)

RouteID – Identifier of the routes. (Foreign Key)

DayFlag – Flag to identify the day of week.

DepartureTime – Time when the bus departs.

ArrivalTime – Time when the bus arrives.

Entity: Bus Stop

Description: A table to describe all the bus stops in DCBTS.

Attributes:

StopID – A unique identifier to identify each stop. (Primary Key)

StopName – The name of the stop.

Location – The location of the stop.

Entity: Notification

Description: A table to describe all the notifications that address festivals and other holidays.

Attributes:

NotificationID – A unique identifier to identify each notification. (Primary Key)

HolidayID – Identifier of the holiday to which the notification is associated. (Foreign Key)

ReservationID – Identifier of the reservation which will trigger a notification. (Foreign Key)

Message – Message content of the notification.

DateAndTime – Date and Time of when the notification will be displayed.

UserID – The identifier of the user who would see the notification. (Foreign Key)

AdminID – The identifier of the admin who would create the notification. (Foreign Key)

Entity: Holidays

Description: A table to describe the holidays during which the buses will not be available.

Attributes:

HolidayID – A unique identifier to identify each holiday. (Primary Key)

HolidayDate – The date on which the holiday falls.

Description – Description of the holiday.

NotificationID – Identifier of the notification that will display the about this holiday. (Foreign Key)

Multivalued Attributes:

- In the Ticket Type table, Price and ValidityPeriod can have multiple attributes.
- In the Route Stop Sequence table, the NumberofStops attribute is multi-valued as it indicates the count of stops on a route.
- In the Reservation table, the NumberOfReservations attribute is multi-valued.

Composite Attributes:

- In the User and Employee table, we have User's name and Employee's name which will be a combination of FirstName and LastName.

Derived Attributes:

- In the Payment table, the Amount attribute can be derived from the Price in the Ticket Type.

Weak entity:

- Notification: The "Notification" entity is a weak entity because it relies on either "Admin" or "User" for its existence.

Strong entity:

- Bus, Bus Route, Ticket Type, User, Bus Stop, Schedule, Holidays, Route stop sequence, Payment, Reservation, Employee, and Department are strong entities that do not depend on any other entities for their existence or identity.

Participations:

Total Participation:

- Each payment must be associated with a user, indicating total participation.
- Each department should be associated with Employee, indicating total participation.
- Each route stop sequence should be associated with bus stop, indicating total participation.
- Each bus can be associated with many routes in different schedules same vice versa, which indicates Bus, Route, Schedule a total participation.

Partial Participation:

- Users may or may not have associated records in other tables.
- Not all administrators need to have associated employee records.
- Not all holidays may have associated notification records.
- Bus may or may not be associated with reservation.
- Not all notifications need to be associated with User and Admin.
- Not all reservations may be associated with notification records.

Cardinality Ratios:

1-N Cardinality Ratio:

- User: One user can make multiple payments (1-N cardinality).
- Notification: One admin or user can have multiple notifications (1-N cardinality).
- Payment: One user can make multiple payments (1-N cardinality).
- Reservation: One user can make multiple reservations (1-N cardinality).
- Employee: One department can have multiple employees (1-N cardinality).
- BusStop: Each bus stop can be involved with multiple route stop sequence (1-N cardinality).

1-1 Cardinality Ratio:

- Reservation: Each reservation is associated with one notification (1-1 cardinality).
- Holidays: Each holiday is associated with one notification (1-1 cardinality).

M-N Cardinality Ratio:

- Route stop sequence: Many routes can have many stops.
- Bus: Multiple buses can be associated with multiple routes.
- Payment: multiple payments lead to multiple reservations.
- Schedule: Different schedules linked to available buses.

ENHANCED ENTITY RELATIONSHIP MODEL (EER MODEL)

EER Diagram, also abbreviated as Enhanced Entity-relationship diagram, helps us create and maintain detailed databases through high-level models and tools. In addition, they are developed on the basic ER diagrams and are its extended version.

EER Diagrams basically help in creating and maintaining excellent databases with the help of smart and efficient techniques. It is a visual representation of the plan or the overall outlook of the database you intend to create.

We have used MySQL Workbench to create the EER diagram. Enhanced Entity-Relationship (EER) diagrams are an essential part of the modeling interface in MySQL Workbench. EER diagrams provide a visual representation of the relationships among the tables in our model.

When the application became complex, the traditional ER model was not enough to draw a sophisticated diagram. Therefore, the ER model was developed further. It is known as the Enhanced ER diagram. There are three concepts added to the existing ER model in the Enhanced ER diagram (EER). Those are generalization, specialization, and aggregation. In generalization, the lower-level entities can be combined to produce a higher-level entity. Specialization is the opposite of generalization. In specialization, the high-level entities can be divided into lower-level entities. Aggregation is a process when the relation between two entities is treated as a single entity.

Additionally, it includes the concepts of a subclass and superclass (Is-a). Furthermore, it introduces the concept of a union type or category, which represents a collection of objects that is the union of objects of different entity types. The EER model also includes EER diagrams which are conceptual models that accurately represent the requirements of complex databases.

ENHANCED ENTITY RELATIONSHIP DIAGRAM

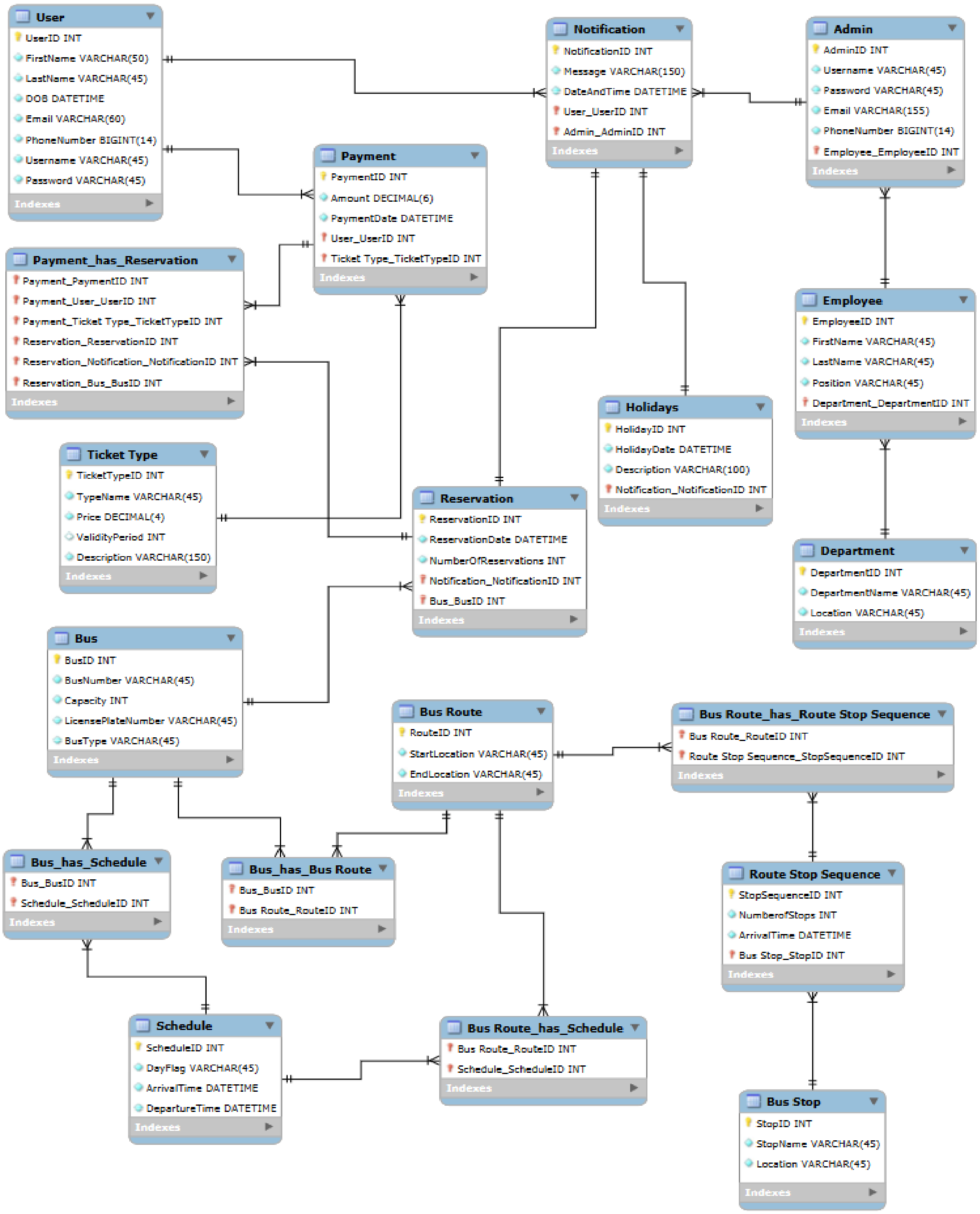

Figure 2 Enhanced Entity Relationship Diagram

IMPLEMENTATION OF EER

This Enhanced Entity Relationship (EER) diagram offers a comprehensive model for a complex system comprising essential entities, including payment, employee, admin, ticket type, time, date, last name, department, name, and Sunday Bus schedules. Each entity plays a distinctive role within the database structure. Payment, for instance, is intricately connected to a specific ticket type, employee, and date, ensuring precise payment records. Meanwhile, employees and admins are associated with departments and identified by their First name and Last name, forming the backbone of personnel management.

Ticket types are uniquely defined by their names and prices, preventing any duplications, while time and date entities offer precise temporal and date-based representations. Names act as versatile identifiers across various domains, connecting entities within the system. Additionally, Sunday schedules are distinctly linked to a department, date, and time for efficient planning.

The relationships between these entities are systematically outlined, ensuring data integrity and retrieval efficiency. For example, strict associations like payments being tied to one ticket type, employee, and date eliminate any chances of duplicate payments. This design not only safeguards data but also streamlines data retrieval, making it easier to extract meaningful information from the database.

In conclusion, this well-designed EER diagram offers an efficient model for the system's organization. It ensures data integrity, enhances data retrieval performance, and provides clarity, making it a valuable tool for managing and organizing complex data structures within the described system.

REFERENCES

1. Dutchess County Public Transportation Application.
2. NYC Transit: MTA Subway and Bus.
3. Moovit.