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Database Design and Insights for E.T. Transportation

Introduction:

E.T. Transportation, a Canadian asset-based company founded in 2005, specializes in providing reliable transportation and logistics services across Canada and the U.S. With operational bases in Ontario and New Brunswick, the company manages over 25,000 shipments annually using a fleet of 100 trucks and 200 trailers. This article outlines the database design project undertaken to enhance the company's logistical operations, focusing on data accuracy, fleet utilization, and operational excellence.

Mission:

The mission of this project is to develop a scalable and efficient database system for E.T. Transport. This system aims to ensure data accuracy, optimize fleet utilization, and support operational excellence to improve logistics performance.

Objectives:

- **Reduce Fleet Downtime:** Implement data-driven maintenance schedules to minimize vehicle downtime, targeting a reduction of 15%.
- **Increase Fleet Utilization:** Optimize operations to improve fleet utilization from 75% to 85%.
- **Improve On-Time Delivery:** Enhance delivery performance to increase on-time deliveries from 90% to 95%.
- **Reduce Operating Costs per Mile:** Achieve a 10% reduction in cost per mile through better route optimization.
- **Enhance Data Accuracy:** Implement validation rules to reduce data errors by 20%.
- **Improve Customer Satisfaction Scores:** Increase customer satisfaction scores by 10% through feedback analysis.

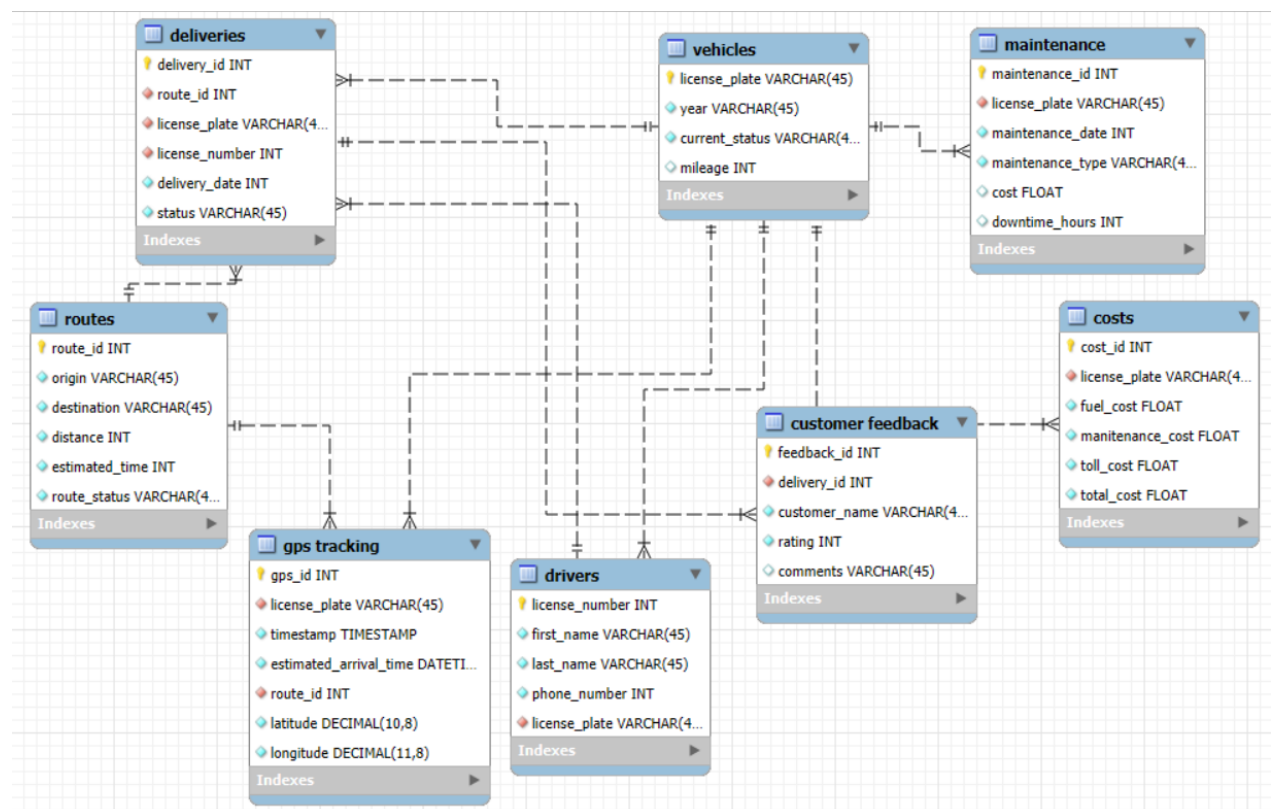
Database Design:

Database design is crucial for any logistics company as it directly impacts operational efficiency and decision-making processes. A well-designed database ensures seamless data flow, accurate reporting, and effective management of resources.

Importance of Database Design:

1. **Data Integrity:** Ensures that all data entered into the system is accurate and consistent.
2. **Efficiency:** Facilitates quick access to data, improving response times for queries.
3. **Scalability:** Allows the system to grow with the company's needs without significant redesign.
4. **Security:** Protects sensitive information through controlled access and permissions.

E.T. Transportation Database Design:



Entities and Tables Information:

Vehicles Table:

- **License_plate (Primary Key):** Vehicle registration number.
- **Current Status:** Current status (Active, In Maintenance, Retired).
- **Mileage:** Current mileage of the vehicle.
- **Year:** Year of manufacture.

Drivers Table:

- **License_number (Primary Key):** Unique ID for each driver.
- **First_name:** Driver's first name.
- **Last_name:** Driver's last name.
- **Phone_number:** Contact number.
- **License_plate (Foreign Key):** Vehicle currently assigned to the driver.

Maintenance Table:

- **Maintenance_ID (Primary Key):** Unique ID for each maintenance record.
- **License_plate (Foreign Key):** Vehicle undergoing maintenance.
- **Maintenance Date:** Date of maintenance.
- **Maintenance type:** Type of maintenance (Scheduled, Emergency).
- **Cost:** Cost of maintenance.
- **Downtime Hours:** Hours of downtime for the vehicle.

Routes Table:

- **Route_ID (Primary Key):** Unique ID for each route.
- **Origin:** Starting location of the route.
- **Destination:** End location of the route.
- **Distance:** Distance in miles or kilometers.
- **Estimated_time:** Estimated time for the trip.
- **Route_status:** Current status (Active, Completed, Delayed).

Deliveries Table:

- **Delivery_ID (Primary Key):** Unique ID for each delivery.
- **Route_ID (Foreign Key):** Route associated with the delivery.
- **License_plate (Foreign Key):** Vehicle used for the delivery.
- **License_number (Foreign Key):** Driver responsible for the delivery.
- **Delivery_date:** Date of the delivery.
- **Status:** Status of delivery (Pending, Delivered, Delayed).

Customer Feedback Table:

- **Feedback_ID (Primary Key):** Unique ID for feedback.
- **Delivery ID (Foreign Key):** Delivery associated with the feedback.
- **Customer_name:** Name of the customer.
- **Rating:** Customer rating (1 to 5 stars).
- **Comments:** Additional feedback comments.

Costs Table:

- **Cost_ID (Primary Key):** Unique ID for each cost entry.
- **License_plate (Foreign Key):** Vehicle associated with the cost.
- **Fuel_cost:** Cost of fuel.
- **Maintenance_cost:** Cost of maintenance.
- **Toll_cost:** Toll charges incurred.
- **Total_cost:** Total operational cost for the trip or route.

GPS Tracking Table:

- **GPS_ID (Primary Key):** Unique ID for GPS data.
- **License_plate (Foreign Key):** Vehicle being tracked.
- **Timestamp:** Date and time of the GPS update.
- **Estimated_arrival_time:** Estimated arrival time at the destination based on current conditions.
- **Route_ID (Foreign Key):** Routes associated with tracking.
- **Latitude:** Coordinates for GPS tracking.
- **Longitude:** Coordinates for GPS tracking.

Importance of Table Design for E.T. Transport

The table design in the database for E.T. Transport is crucial for several reasons, each contributing to the overall efficiency and effectiveness of the company's operations. Here's why the chosen tables and their configurations are important:

1. Vehicles Table

- **Purpose:** This table stores essential information about each vehicle in the fleet, such as registration numbers, status, mileage, and year of manufacture.
- **Importance:**
 - **Fleet Management:** Helps in tracking the status and usage of each vehicle, enabling efficient fleet management.
 - **Maintenance Scheduling:** Allows for proactive maintenance planning based on mileage and vehicle age, reducing downtime.

2. Drivers Table

- **Purpose:** Contains details about drivers, including their unique license numbers, names, contact information, and assigned vehicles.
- **Importance:**
 - **Driver Assignment:** Ensures that each driver is correctly assigned to a vehicle, facilitating accountability and operational efficiency.
 - **Contact Information:** Provides quick access to driver contact details for communication and coordination.

3. Maintenance Table

- **Purpose:** Records maintenance activities for vehicles, capturing details like maintenance type, cost, and downtime.
- **Importance:**
 - **Cost Management:** Tracks maintenance costs to help manage expenses and budget forecasting.
 - **Downtime Analysis:** Helps in analyzing vehicle downtime to improve scheduling and reduce operational disruptions.

4. Routes Table

- **Purpose:** Details each transportation route, including origin, destination, distance, estimated time, and status.
- **Importance:**

- **Route Optimization:** Facilitates analysis of routes to optimize travel times and reduce fuel consumption.
- **Performance Tracking:** Monitors route status to ensure timely deliveries and identify potential delays.

5. Deliveries Table

- **Purpose:** Tracks deliveries made by linking them to routes, vehicles, and drivers.
- **Importance:**
 - **Delivery Management:** Provides a comprehensive view of delivery operations to ensure efficiency and customer satisfaction.
 - **Performance Metrics:** Enables tracking of delivery performance metrics such as on-time delivery rates.

6. Customer Feedback Table

- **Purpose:** Captures customer feedback on deliveries, including ratings and comments.
- **Importance:**
 - **Service Improvement:** Offers insights into customer satisfaction levels and areas needing improvement.
 - **Quality Assurance:** Helps maintain high service quality by addressing customer concerns promptly.

7. Costs Table

- **Purpose:** Monitors operational costs associated with each vehicle trip or route.
- **Importance:**
 - **Expense Tracking:** Provides detailed insights into various cost components like fuel and tolls to manage operating expenses effectively.
 - **Profitability Analysis:** Assists in analyzing the profitability of routes by comparing costs against revenue.

8. GPS Tracking Table

- **Purpose:** Provides real-time tracking of vehicles using GPS data.
- **Importance:**
 - **Real-Time Monitoring:** Enables real-time monitoring of vehicle locations to enhance route management and security.

- **Arrival Estimation:** Improves accuracy in estimating arrival times at destinations based on current conditions.

Each table plays a vital role in ensuring that E.T. Transport's database system supports its mission of optimizing logistics performance through accurate data management and operational insights. This structured approach allows the company to maintain high standards of service delivery while continuously improving its operations.

Appendices:

Appendix A: Table Dictionary

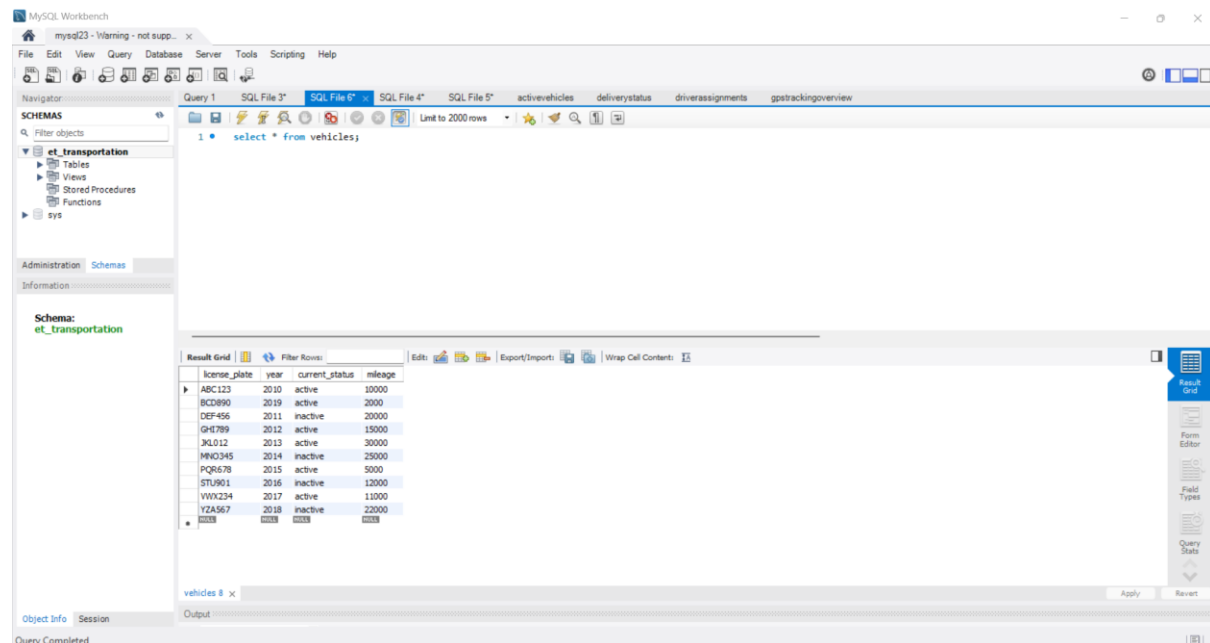
Table Name	Primary Key	Foreign Keys	Description
Vehicles	License_plate	None	Stores information about each vehicle in the fleet, including its status, mileage, and year of manufacture.
Drivers	License_number	License_plate	Contains details about drivers, including their names, contact information, and the vehicle they are currently assigned to.
Maintenance	Maintenance_ID	License_plate	Records maintenance activities for vehicles, including type, cost, and downtime hours.
Routes	Route_ID	None	Details each transportation route, including origin, destination, distance, estimated time, and status.
Deliveries	Delivery_ID	Route_ID, License_plate, License_number	Tracks deliveries made by the company, linking them to routes, vehicles, and drivers. Includes delivery date and status.
Customer Feedback	Feedback_ID	Delivery_ID	Captures customer feedback on deliveries, including ratings and comments.
Costs	Cost_ID	License_plate	Monitors operational costs associated with each vehicle trip or route, such as fuel and maintenance costs.
GPS Tracking	GPS_ID	License_plate, Route_ID	Provides real-time tracking of vehicles using GPS data, including timestamps and geographical coordinates.

This table dictionary provides a comprehensive overview of the database structure designed for E.T. Transport. It includes all necessary tables along with their primary keys and foreign keys to ensure data integrity and efficient operations management within the company.

Appendix B: Queries and Joins

SQL Syntax: `select * from vehicles;`

OUTPUT:



Result Grid				
Filter Rows:				
	license_plate	year	current_status	mileage
▶	ABC123	2010	active	10000
	BCD890	2019	active	2000
	DEF456	2011	inactive	20000
	GHI789	2012	active	15000
	JKL012	2013	active	30000
	MNO345	2014	inactive	25000
	PQR678	2015	active	5000
	STU901	2016	inactive	12000
	VWX234	2017	active	11000
	YZA567	2018	inactive	22000
✱	NULL	NULL	NULL	NULL

This query fetches everything from the vehicles table, as we can see in the output. On the left section the database and all the tables can also be noticed.

SQL Syntax:

SELECT

Routes.Route_ID,
Routes.Origin,
Routes.Destination,
COUNT(Deliveries.Delivery_ID) AS Total_Deliveries,
SUM(Costs.Total_cost) AS Total_Cost,
AVG(Customer_Feedback.Rating) AS Average_Rating,
CONCAT(Drivers.First_name, ' ', Drivers.Last_name) AS Driver_Name

FROM

Deliveries

JOIN

Routes ON Deliveries.Route_ID = Routes.Route_ID

JOIN

Drivers ON Deliveries.License_number = Drivers.License_number

LEFT JOIN

Costs ON Deliveries.License_plate = Costs.License_plate

LEFT JOIN

Customer_Feedback ON Deliveries.Delivery_ID = Customer_Feedback.Delivery_ID

WHERE

Routes.Route_status = 'Completed'

GROUP BY

Routes.Route_ID, Drivers.First_name, Drivers.Last_name

ORDER BY

Total_Cost DESC;

OUTPUT:

The screenshot shows the MySQL Workbench interface. The SQL editor contains the following query:

```

1  SELECT
2      Routes.Route_ID,
3      Routes.Origin,
4      Routes.Destination,
5      COUNT(Deliveries.Delivery_ID) AS Total_Deliveries,
6      SUM(Costs.Total_cost) AS Total_Cost,
7      AVG(Customer_Feedback.Rating) AS Average_Rating,
8      CONCAT(Drivers.First_name, ' ', Drivers.Last_name) AS Driver_Name
9  FROM
10     Deliveries
11 JOIN
12     Routes ON Deliveries.Route_ID = Routes.Route_ID
13 JOIN
14     Drivers ON Deliveries.license_number = Drivers.license_number
15 LEFT JOIN Costs ON Deliveries.license_plate = Costs.license_plate
16 LEFT JOIN Customer_Feedback ON Deliveries.Delivery_ID = Customer_Feedback.Delivery_ID
17 WHERE Routes.Route_status = 'Completed'
18 GROUP BY Routes.Route_ID, Drivers.First_name, Drivers.Last_name
19 ORDER BY
20     Total_Cost DESC;

```

The Results tab shows the following data:

Route_ID	Origin	Destination	Total_Deliveries	Total_Cost	Average_Rating	Driver_Name
5	Seattle	San Francisco	1	350	2.0000	John5 Doe5
2	Chicago	Houston	1	195	4.0000	John2 Doe2

	Route_ID	Origin	Destination	Total_Deliveries	Total_Cost	Average_Rating	Driver_Name
▶	5	Seattle	San Francisco	1	350	2.0000	John5 Doe5
	2	Chicago	Houston	1	195	4.0000	John2 Doe2

Explanation:

- **Purpose:** This query provides a summary of completed routes, including the total number of deliveries, total cost, average customer rating, and the driver responsible for the deliveries.
- **Tables Involved:**
 - **Routes:** Provides details about each route.
 - **Deliveries:** Links deliveries to routes and drivers.
 - **Drivers:** Supplies driver information.
 - **Costs:** Offers cost data related to vehicle operations.
 - **Customer Feedback:** Contains customer ratings for deliveries.
- **Key Features:**
 - **Aggregation Functions:** Uses COUNT() to count deliveries, SUM() to calculate total costs, and AVG() to find average customer ratings.
 - **String Concatenation:** Combines first and last names of drivers for a full name display.

- **Filtering:** Focuses on routes with a status of 'Completed'.
- **Grouping:** Groups results by route ID and driver name to consolidate data for each route-driver combination.
- **Ordering:** Sorts results by total cost in descending order to highlight the most expensive routes.

This query is practical because it provides valuable insights into operational efficiency, cost management, and customer satisfaction—all critical metrics for improving logistics performance at E.T. Transport.

Conclusion:

The database design project for E.T. Transport has successfully addressed key operational challenges by creating a robust system that enhances data accuracy, optimizes fleet utilization, and supports operational excellence. By implementing a comprehensive set of tables and relationships, this database provides a solid foundation for managing logistics operations efficiently. The insights gained from this project demonstrate the potential for improved on-time delivery rates, reduced operating costs, and enhanced customer satisfaction. This work not only supports E.T. Transport's strategic goals but also sets the stage for future innovations in logistics management.

Learning Outcomes:

- **Technical Proficiency:** Developed advanced skills in SQL and database design, including creating complex queries that integrate data from multiple sources to provide actionable insights.
- **Problem-Solving:** Overcame challenges related to data integration and validation, ensuring that the database system is both reliable and scalable.
- **Collaboration:** Worked effectively within a team to gather requirements, design the database schema, and implement solutions that meet business objectives.
- **Analytical Thinking:** Applied data analysis techniques to evaluate fleet performance and customer feedback, driving continuous improvement in service delivery.

Future Work:

Looking ahead, there are several opportunities to expand this project:

- **Predictive Analytics:** Incorporate machine learning algorithms to predict maintenance needs and optimize route planning.
- **Integration with IoT Devices:** Use real-time data from IoT devices for more accurate tracking and monitoring of vehicle conditions.
- **Enhanced Reporting Tools:** Develop dashboards and visualization tools to provide stakeholders with real-time insights into logistics operations.

Call to Action:

I invite you to explore my GitHub repository for more projects that showcase my skills in database design and data analysis. Your feedback is invaluable as I continue to refine my work and explore new opportunities in data-driven solutions. Feel free to reach out for collaboration or discussions on how we can leverage technology to transform logistics management.