Fleet Vehicle Management
Group Number #2

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Stage II

Problem Statement

The College of New Jersey has a goal of becoming Net Zero by 2040 and it is our goal to alter the fleet vehicle management in order to help the college get closer to its goal. To become Net Zero, the college must completely negate the amount of greenhouse gasses produced. While 2040 may seem a long way out, in reality if TCNJ would like to achieve their goals of becoming Net Zero in 2040, actions must be taken soon. The College of New Jersey has over 100 fleet vehicles in operation that are used around campus to support its staff. Some of the uses of the vehicles include maintenance vehicles for the TCNJ maintenance crew, police cars, vans for athletic teams, as well as golf carts that are used by different organizations and events on campus. Since most of these vehicles are engine powered and are fueled by gasoline, this can add up to a lot of money being spent on operating these vehicles. Not only that, but these vehicles are contributing to TCNJ's greenhouse gas emissions. Our proposal to change this is to build a model that allows the user to compare and contrast the differences between vehicles in the model to determine what the overall effects of the change would have on the fleet vehicles.

Objective

The objective of our model is to build a user-friendly interface that gives the user control to execute commands that bring up a vehicle of his own wishes that would then provide the user with information regarding the vehicle's cost and emission data. This model would allow administrators to have complete control of the different vehicles and could compare on the database. For example, the user could request to compare the cost and emission data of one of TCNJ's Ford F450's with a Ram 1500, easily comparing side by side the different expected costs and the effects on the environment. The database will be able to store thousands of vehicle information, allowing the user to find the most optimal group of vehicles to make up the fleet vehicle management at TCNJ.

Desired End Product

The desired end product is a database that uses the FIFO method to replace the old vehicles with new vehicles. The database will also allow for the admin to manually choose a specific vehicle to replace if they would like to. The database will have specific dropdowns where the admin can select the year, make, and model of vehicles. Once a certain vehicle is selected, the admin will then be able to access numerous data about the vehicle, such as how many miles per gallon the vehicle gets, how much emissions it releases, the life expectancy, etc. This is important because the admin will be able to see if the vehicle is environmentally friendly as well as when it is time for a vehicle to be retired, and what type of vehicle would be the best replacement. Obviously, different departments will need different vehicles to complete their tasks, so this database will help find the best replacement. Non admins will be able to access the database as well, and view important statistics regarding the vehicle fleet's impact on the environment.

Research and Data

Being able to look at the entire workings of TCNJ's Fleet Vehicle Management System would've been the best option to make decisions for TCNJ's fleet. However, with the data we've been given, we can make informed decisions as well. The research we plan to conduct involves, primarily, the Vehicle Fleet CAB spreadsheet as that is where our base information on TCNJ's

fleet comes from. Researching this topic and possible improvements will lead to us asking questions such as: What vehicles are currently in the fleet, what fuel source do said vehicles use and how costly is it, financially and environmentally. Also, the chance of looking at any previously proposed and trying to integrate any relevant information and suggestions.

As for the Data we will be including, it sits along the same lines of our research questions. Taken into account will be several factors like the initial cost of purchasing the vehicle and the maintenance costs for repairs, tires, battery, transmission, and the like. Perhaps one of the most significant data entries will be the fuel type, usage, cost, and environmental effects.

Other Similar Systems / Approaches That Exist

Colleges use many similar systems and there are other approaches that exist that are similar to ours. One method that some colleges use is a sort of GPS fleet tracking system. Fleet management software such as this ensures that vehicles are where they are supposed to be and serve their correct purpose. This is similar to our idea because we want to only use vehicles that are helping our campus and decrease the amount of money spent on maintenance. This idea prioritizes that vehicles are doing what they were purchased to do; however, our idea focuses more on reducing the number of fleet vehicles by retiring vehicles that were purchased before 2006.

Many college campuses have on site maintenance facilities to keep their fleet vehicles running properly. Smart maintenance is something that is becoming more popular. Features such as Zubie Smart Maintenance allow fleet managers to track vehicles, schedule maintenance, and pay for maintenance and vehicle expenses. This helps keep track of each vehicle's service requirements. There already is an existing system for fleet vehicle management at TCNJ. They have started to utilize golf carts more and the fleet vehicle excel illustrates that TCNJ has future plans to buy more electric vehicles. Our module will add to this by retiring vehicles that were purchased prior to 2006 and overall reducing the number of fleet vehicles at TCNJ.

Possible Alternate Applications

With our approach, it is suggested that when it is time to replace vehicles, it is done so by electric vehicles. This would include cars, trucks, and even golf carts. It is believed that while there may be an initial cost at hand, this would lead to cost-efficiency and more sustainability in the future. The creation of this database will allow for TCNJ to use the same techniques when trying to determine what else at the college needs to be replaced. This could range from a variety of items such as technology, buildings, classroom materials, etc.

Performance

The database will contain the records of every fleet vehicle used by TCNJ. The GUI will have boxes to fill out the year, make, and model of the new vehicle being added to the fleet. The database will suggest the oldest vehicle on file to be replaced, but the user will be able to choose any other vehicle in the fleet if need be. The database will also display statistics such as the percentage of electric vehicles in the fleet, as well as any other attributes found useful for improving TCNJ's carbon footprint. Overall, the database will serve as easy access to information regarding the college's fleet vehicles and how they affect the environment.

Security

In terms of security, repositories created on GitHub will be restricted to private instead of public visibility. Making a repository private eliminates an open source project, where the source code cannot be modified and changed by anyone for any other purpose. Since the repositories will be in private visibility, all the files related to the project will only be accessed by the group members and all the modifications and updates of the source code will only be viewed by the shared members, which makes it safe and secure. After the project is completed and departed from Github to the TCNJ facilities, we will ensure that the user interface (software) is restricted to TCNJ users only. If restriction is possible to implement through database queries, then we will proceed with this proposal. Otherwise, we have to restrict access through the source code we develop. Therefore, no unauthorized users can access the database or retrieve the information.

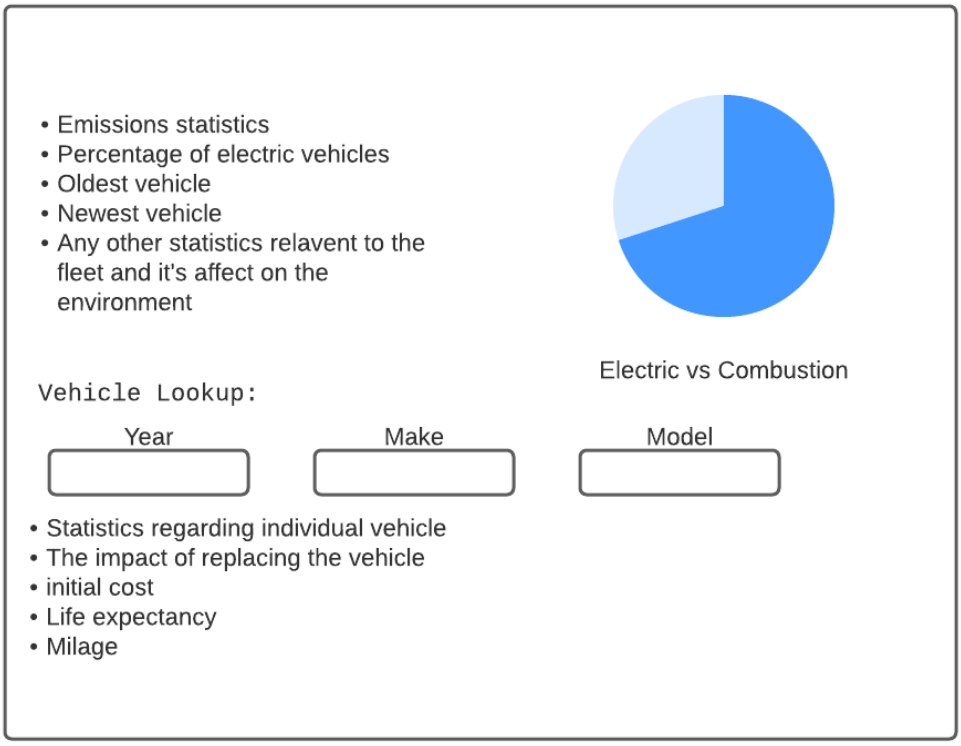
Backup and Recovery

For each portion of our project, we will be uploading our information to the open-source application known as GitHub. In the case that our information is damaged or destroyed, it is important for there to be a backup in order to recover whatever is lost. Therefore, we also plan on uploading all of our codes and overall information to alternative open source platforms. Examples of these include GitLab and Google Cloud Source Repositories. This would allow for the group to recover any lost information without having to start entirely over from the beginning of the process.

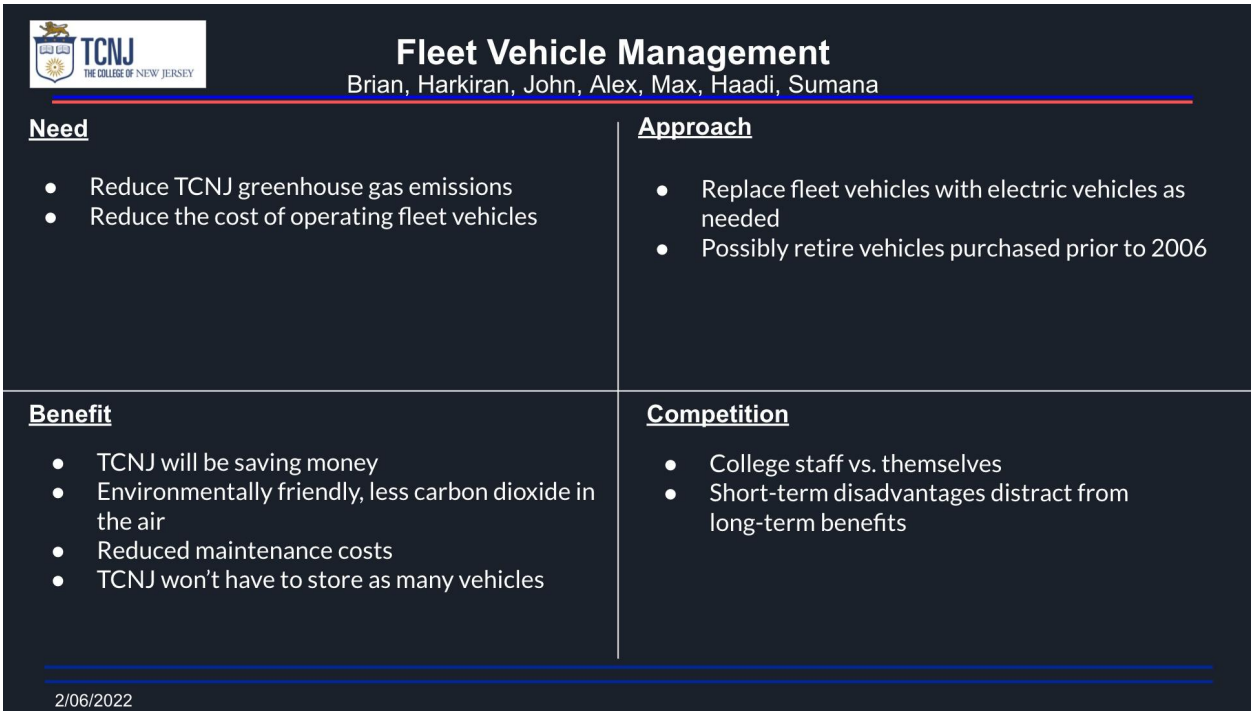
Technology and Concepts:

For the Fleet Vehicle Management project, some of the database concepts that will be used are Entity-Relationship diagrams. An ER diagram is a visual representation that displays the relationships between several entities, also known as tables, in the database. Each entity has specific characteristics, known as attributes, that will store the information about a particular entity. For instance, in our project, a vehicle is an entity; the attributes are color, license number, manufacturing date, etc., An ERD diagram tool- Lucidchart, will be used to construct the ER diagrams to showcase the design of our database application. Also, PostgreSQL database will serve as a platform to write SQL queries. With the use of these queries, data stored in the database can be accessed and manipulated with the use of SQL commands as per the requirements. As for the implementation of the web-based interface, the Python programming language will be used to integrate all the SQL queries into user-interface. As the sample Flask code is already being provided, we will use it as a sample to write the Python programming language to develop the web application.

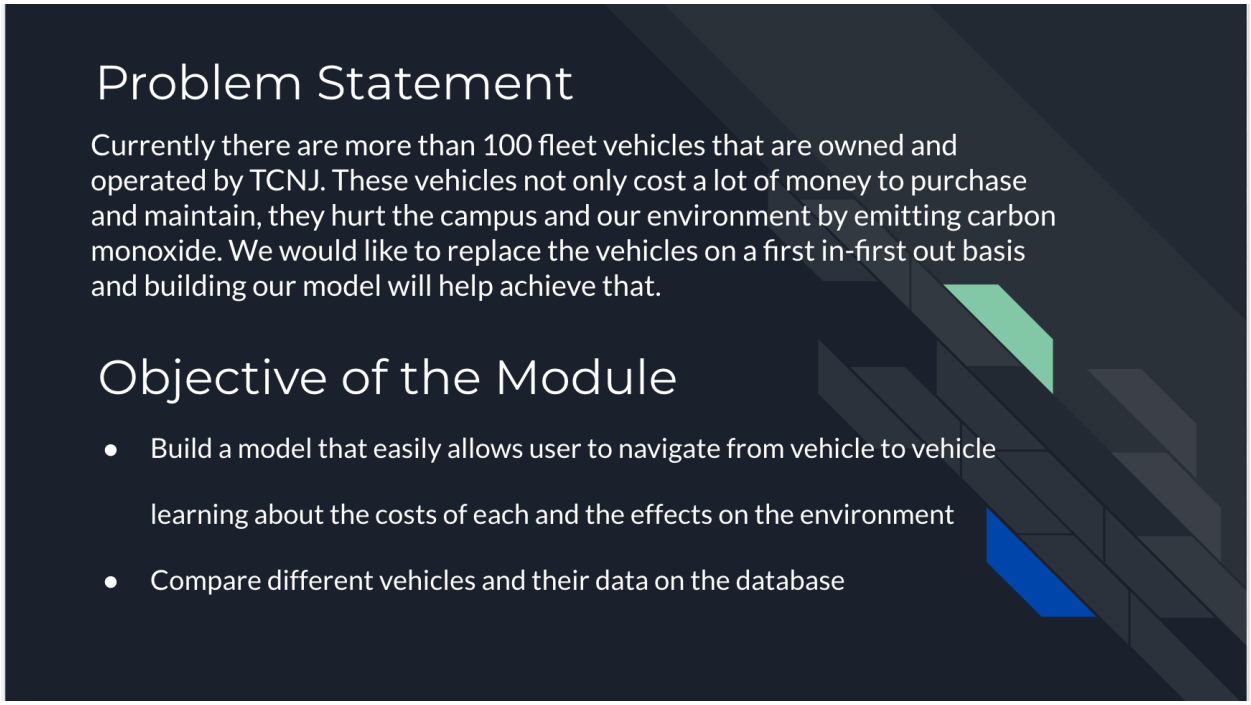
Diagrammatic Representation



QuadChart


TCNJ
THE COLLEGE OF NEW JERSEY
Fleet Vehicle Management
Brian, Harkiran, John, Alex, Max, Haadi, Sumana
Need
Reduce TCNJ greenhouse gas emissions
Reduce the cost of operating fleet vehicles
Approach
Replace fleet vehicles with electric vehicles as needed
Possibly retire vehicles purchased prior to 2006
Benefit
TCNJ will be saving money
Environmentally friendly, less carbon dioxide in the air
Reduced maintenance costs
TCNJ won't have to store as many vehicles
Competition
College staff vs. themselves
Short-term disadvantages distract from long-term benefits
2/06/2022

Stage II: PowerPoint



Desired End Product and Importance

- Database that uses FIFO method to replace vehicles
- Also gives option to manually choose which vehicle to replace
- Once a vehicle is selected, user can access numerous data, such as how many miles per gallon, the amount of emissions released, life expectancy, etc.
- Important because user can see if a vehicle is environmentally friendly
- Also shows when a vehicle should be retired, and what type of vehicle would be the best replacement

Research and Data

We will Research all of, but not limited to, the following:

- Vehicle Fleet CAB spreadsheet
  - What vehicles make up TCNJ's fleet
  - How old those vehicles are
- What methods are used to manage said fleet
- How other universities/colleges manage their on-campus fleet
- What vehicles are the most common
- What they are used for
- What vehicles are cheaper than others
- How big of a difference fuel makes
- What fleet vehicles may be unnecessary
- Any previously proposed, viable, solutions
- etc.

The Data we will take into consideration:

- The year / make / model
- How much it (fleet vehicle) costs to buy and maintain
  - Initial cost
  - Annual depreciation
  - Financial incentives
  - Fuel source and cost
  - Maintenance cost
  - Repairs
  - Tire replacement
  - Battery replacement
  - Insurance cost
- Emissions

Similar Systems / Approaches

- Some colleges manage their fleets by using some sort of GPS fleet tracking system
- Colleges have on site maintenance facilities
- Features like Zubie Smart Maintenance are used to track, schedule, and pay for vehicle maintenance
- TCNJ already has golf carts on campus and future plans to switch to using more electric vehicles

Possible Alternate Applications

- When it comes time to replace vehicles, do so by going electric
  - Cars, trucks, & golf carts
  - More cost effective and more sustainable
    - Reduce carbon emissions and overall cost for maintenance
- Same application can be used to replace other parts of TCNJ
  - Buildings, classroom materials, technology, etc.

Performance

- By retiring all fleet vehicles from 2006 and older, we are greatly reducing TCNJ's carbon footprint as well as annual vehicle costs.
- Newer vehicles are more technologically advanced and produce less emissions.
- The money saved by this reduction could help out other school projects, or go back into fleet management.

Backup and Recovery

- Upload our codes and overall information to GitHub
- As a backup, also upload to alternative open source platforms
  - GitLab
  - Google Cloud Source Repositories
- Recover from these backup sources if needed

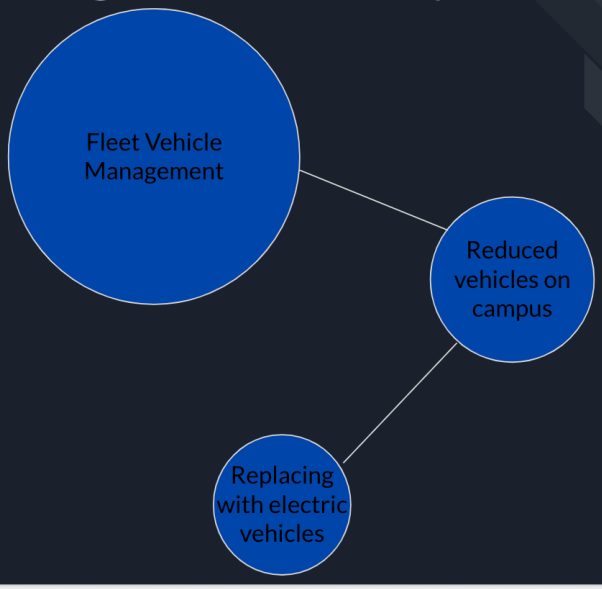
Security

- Restrict access to a repository on GitHub
  - Maintain private repositories
  - Eliminate an open source project

Technologies and Database Concepts

- An Entity-Relationship diagrams to specify relationships among several entities
  - Graphical representation of the relationships
  - ERD diagram tool- Lucidchart
- PostgreSQL database
  - Uses SQL queries to retrieve and manipulate data
- Use Python to integrate queries into UI

Diagrammatic Representation



TCNJ THE COLLEGE OF NEW JERSEY

Fleet Vehicle Management

Brian, Harkiran, John, Alex, Max, Haadi, Sumana

Need

- Reduce TCNJ greenhouse gas emissions
- Reduce the cost of operating fleet vehicles

Approach

- Replace fleet vehicles with electric vehicles as needed
- Possibly retire vehicles purchased prior to 2006

Benefit

- TCNJ will be saving money
- Environmentally friendly, less carbon dioxide in the air
- Reduced maintenance costs
- TCNJ won't have to store as many vehicles

Competition

- College staff vs. themselves
- Short-term disadvantages distract from long-term benefits

2/06/2022

Stage III

Problem Statement

A main goal of The College of New Jersey is to become Net Zero by 2040. With that said there are a few parts of the college which can be modified in order to become more sustainable as a campus community. More specifically, the problem which we will be focusing on surrounds the idea of fleet vehicle management. One aspect is ways to reduce the amount of greenhouse gasses produced on campus. Many of the vehicles which the college has on campus include vehicles for the maintenance crew, police cars, and more. These vehicles are essential, but we hope to build a model which allows the user to compare and contrast the differences between vehicle models so that we can effectively and efficiently determine whether these vehicles are truly needed on campus or if we can find better solutions to promote sustainability.

Objective

The objective of our model is to build a user friendly interface that allows users to compare and contrast key differences between the fleet vehicles on campus. This model would allow administrators to have control regarding the characteristics of the fleet vehicles and compare a variety of factors of each vehicle. In addition, the database will be able to store thousands of pieces of information regarding the vehicles information so the user can find the most optimal group of vehicles to make up the fleet vehicle management at TCNJ.

Data

The data that our database requires to operate can be broken down into three categories. The first category is the vehicle identifiers, which is what each vehicle has the most general data. Data that would be required for this category include the vehicle year, the make of the vehicle, as well as the vehicle model. This data allows us to easily group the types of vehicles together based on their general information. The next category that is necessary for our database is related to vehicle costs. In order to determine the most efficient and cost effective vehicle fleet, there needs to be data showing the cost of the vehicle, as this is relevant information when evaluating a vehicle. Some costs for each vehicle that our database will include are initial cost, annual depreciation, financial incentives, maintenance costs as well as insurance costs. By including these costs in our database, it will give the user a lot of information to evaluate and decide the vehicle that will be most cost effective. The third category of data that our database will include is emissions. This category will show each vehicle's C02 emission rates per mile, showcasing the effects that each vehicle has on the environment. By including all of this data in our model, the user will have sufficient information to decide the changes that should be made to the fleet vehicle setup.

End Goal

The end goal of this database is to use the FIFO method to help the user determine when the appropriate time to replace a vehicle is and assist the user in determining which vehicles to replace first. The database will provide key information on vehicles within the fleet such as types, the vehicles costs and emission rates. With all of the vehicle information on the database, it will be easy to compare between two vehicles' information, which will save the user time comparing multiple vehicles. The database will also allow the user to easily determine which vehicles are helping TCNJ reach their goal of becoming net zero by 2040, since they can track the emission rates per mile of the current vehicles and analyze which vehicles have the best and worst emission rates. The end goal of the database is to provide the user with all of the information necessary about the fleet vehicles in order to allow TCNJ to get a better understanding of their management of the vehicles.

Inputs and Outputs

When a user wishes to use the database, all they have to input into the database is the information pertaining to the specific vehicle or vehicles that they are interested in. The user is able to input multiple vehicles into the database at the same time so that they can compare the outputs. Users must input the make, model, and year of the fleet vehicle that they are searching for. For example, a user could input a 2005 Dodge Caravan into the database.

In return, the database will show various information about the vehicle. Some of the outputs include gallons of fuel, insurance cost, maintenance number, mileage, life expectancy, emission data, initial cost, vin number, engine type and department name of the fleet vehicle that the user inputs into the database. These outputs are all extremely important because they help users find the most environmentally friendly vehicles and from that information they can then determine which vehicles need to be retired and which vehicles should serve as the replacement vehicles. The outputs will allow the user to compare different fleet vehicles' expected costs and their effects on the environment. From all of this information, users will be able to determine the most optimal group of vehicles to make up the fleet vehicle management at TCNJ.

User Interface

The User Interface, by definition, is "the point of human-computer interaction and communication in a device". Our user interface will be a menu-driven interface. In the user interface, there will be a drop down menu where the user can select the make, model, and year to find a specific type of vehicle. Once the make, model, and year of a vehicle are put in, there will be a "submit" button which the user would click. After that,

all information regarding that car will be displayed, such as emission data, VIN number, the department the vehicle belongs to, engine type, insurance cost, initial cost, life expectancy, etc. Based on the information that was retrieved by the user interface, the user can decide which electric car would be best to purchase.

ER Diagram:

The ER diagram contains several entities such as Vehicle, Department, Engine, and General Maintenance. Among these entities, some of them are classified as strong and weak entities. For example, a “vehicle” is a strong entity as its existence does not depend on any other entities. Every strong entity has a primary key as it is used to uniquely identify that tuple in a given relation. Since a “vehicle” entity is labeled as a strong entity, it has a primary key called “VIN number” to identify each car uniquely. The attributes of the Vehicle entity are year, make, model, mileage, life_expectancy, emission_data, initia_cost, and VIN. General_Maintance entity is also a strong entity and its attributes are maintenance_number, insurance_cost, and gallons_of_fuel. Another strong entity is Department and its primary key is Dname. The weak entity in the ER is General_Maintance entity. The attribute for the Engine entity is engine_type.

The relationship between two strong entities is represented by a diamond symbol. The relationship between one strong entity and a weak entity set is shown by a double diamond symbol. For instance, the relationship between Vehicle and Engine entities has a single diamond symbol; whereas, the Vehicle and General_Maintance entity sets have a double diamond symbol.

The ER diagram also contains subclass and superclass relations. A subclass is a class derived from the superclass and inherits all the properties of the superclass. For instance, Van_Passenger, Van_Cargo, Pick-UpTruck_lightduty, Passenger_Vehicle, Public_Safety_Vehicle, etc., are all subclasses of the superclass Vehicle. They all inherit common attributes from Vehicle such as year, make, model, mileage, emission data, vehicle index, life expectancy, etc.,

The ER also contains a disjointness constraint that is symbolized as “d”. The disjointness constraint states that all subclasses of the specialization must be disjoint. This constraint is relevant to our ER diagram because it indicates that a Van_Passenger cannot be a Low_Speed_Utility or Paasenger_Vehicle cannot be a Van_Cargo.

The ER diagram has a cardinality of 1:1 between Vehicle and Engine entities because each vehicle can only have one engine and each engine can only be owned by one vehicle. Another cardinality of 1: N is between Vehicle and Department entities; each vehicle is owned by only one department, and each department owns multiple vehicles. There is a 1:N cardinality between Vehicle and General_maintanance entity because each vehicle requires several maintenance; multiple maintenance are required to only one vehicle.

The Vehicle entity has total participation because every vehicle has an engine. On the other hand, the Engine entity also has a partial participation constraint because there might exist spare engines not currently installed in a vehicle. Additionally, the Department entity has total participation because each department manages a vehicle. The total participation between Vehicle entity and disjointness constraint indicates that all vehicles belong to at least one of the categories of the subclasses. All the total participation constraints are shown by a double line; partial participation constraint is shown by a single line

The subset sign denoted as “U” in ER specifies all the subtypes such as van_passenger, van_cargo, passenger_vehicle, reduction, low_speed_untility, public_safety_vehivle, pickup_truck_light duty, and pickup_truck_heavy duty are all the subsets of the supertype Vehicle.

Relational Schema:

1. The *GM_Vin_Number* attribute in the GENERAL_MAINTENANCE table is a foreign key connecting it to the *Vin_Number* attribute in the VEHICLE table (primary key)
2. The *V_Engine_Type* attribute in the VEHICLE table is a foreign key connecting it to the *Engine_Type* attribute in the ENGINE table (primary key)
3. The *Dept_Name* attribute in the VEHICLE table is a foreign key connecting it to the *Dname* attribute in the DEPARTMENT table (primary key)

Estimates:

Database Size: Since there are currently 97 fleet vehicles logged on the fleet vehicle spreadsheet, there will be a total of 97 fleet vehicle entries in the database.
Searches: We will need 2 to 3 searches because we will be joining multiple tables.

Stage III PowerPoint

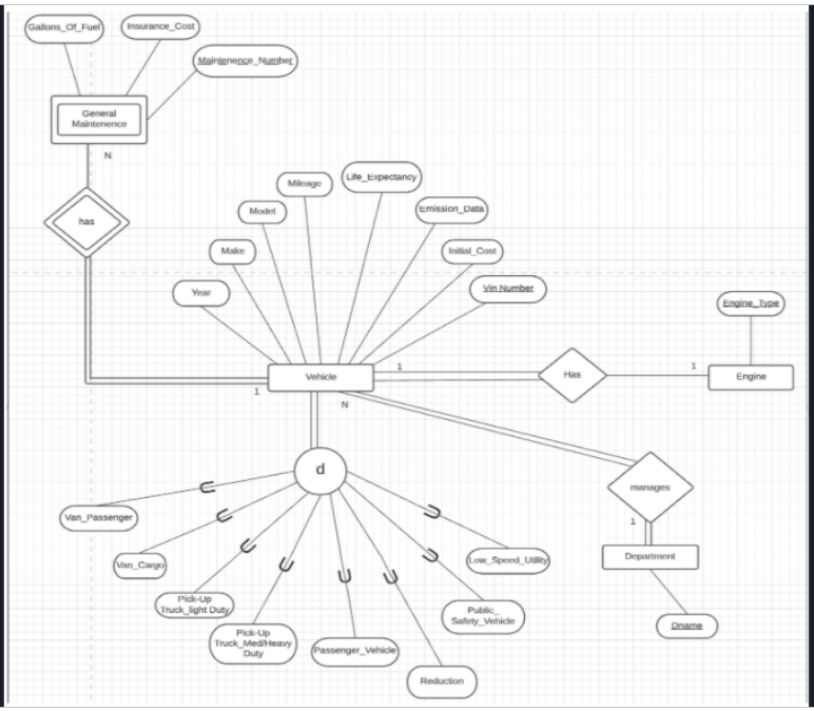
Review of Scope - Harkiran & Brian

- Problem Statement:
  - Alter fleet vehicle management through replacement or reduction in order to assist TCNJ to become Net Zero by 2040
- Objective:
  - Build a user friendly interface that allows the user to compare and contrast key differences between the fleet vehicles on campus
- Data:
  - Vehicle year, make and model
  - Vehicle costs
    - Initial cost
    - Annual Depreciation
    - Financial Incentives
    - Maintenance Cost
    - Insurance
  - Emissions
- End Goal:
  - Database that shows key information on individual vehicles in the fleet and helps user decide if vehicle should be replaced

Review of Specifications

- Inputs
  - Make and model of the vehicle
  - Vehicle Year
    - Example: 2005 Dodge Caravan
- Outputs
  - Data about the vehicle
    - Gallons of fuel, insurance cost, maintenance number, mileage, life expectancy, emission data, initial cost, vin number, engine type and department name
    - These outputs will allow the user to compare different fleet vehicles' expected costs and their effects on the environment and help determine the most optimal group of vehicles to make up the fleet vehicle management at TCNJ
- User interface
  - Menu-driven interface
    - User will have drop down where they input the make, model, and year of vehicle they are looking for
  - Once done, user will click "submit"
  - After submitting, the user will be able to see the vehicle's information
    - Can see the vehicle's emission data, VIN number, the department the vehicle belongs to, engine type, insurance cost, initial cost, life expectancy, etc.

ER Diagram



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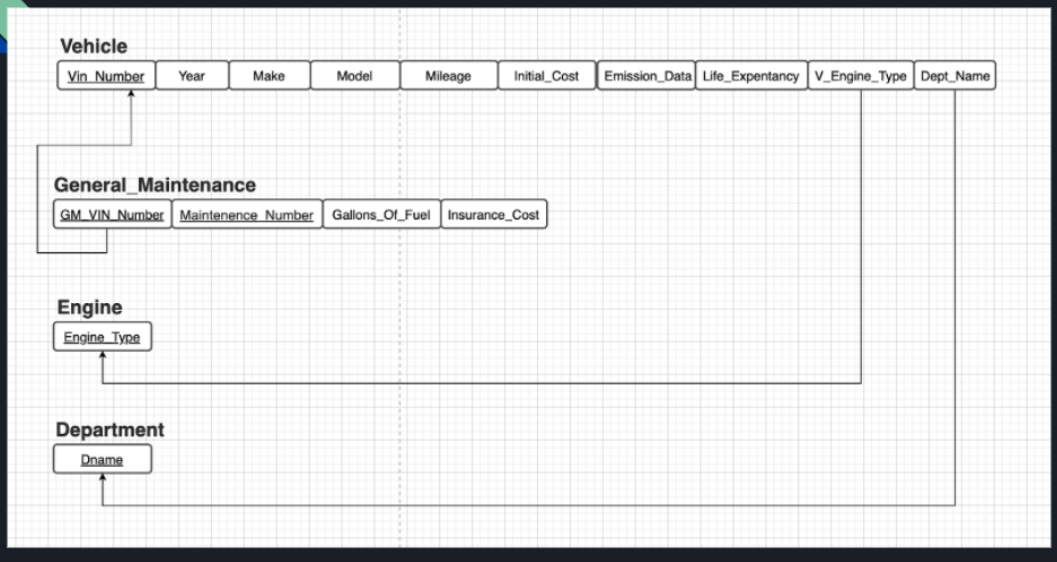

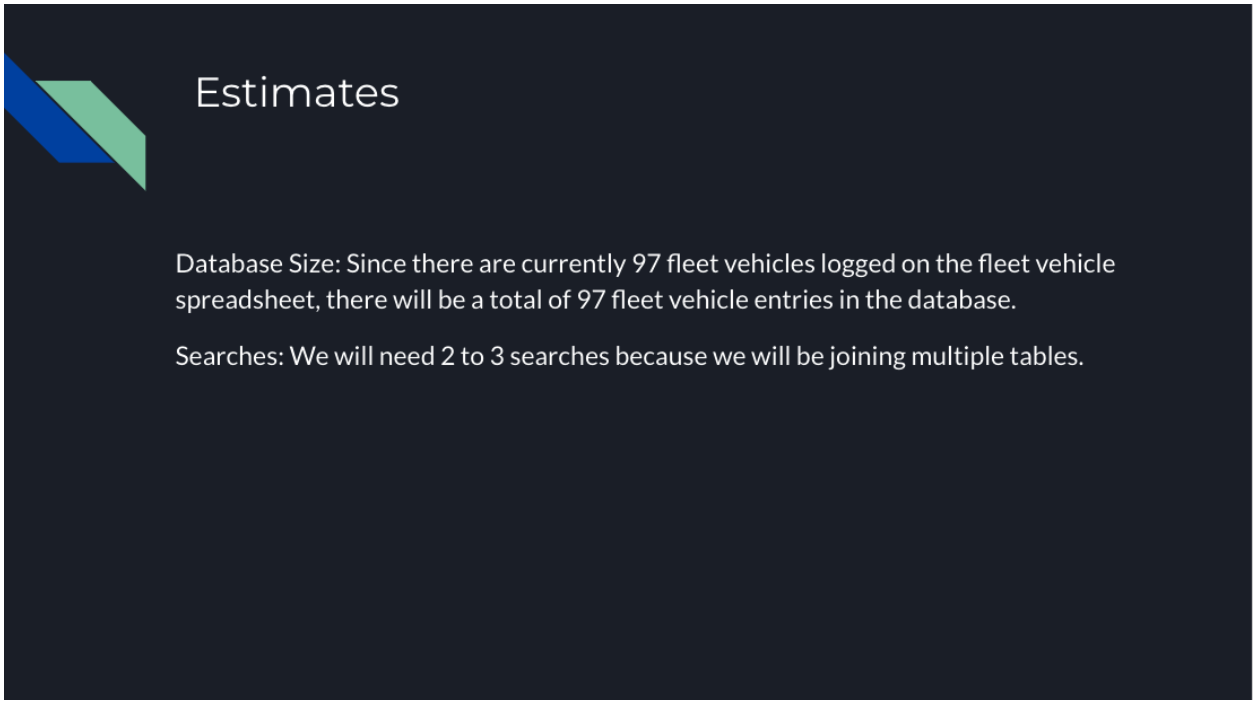
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