Fleet Vehicle Management

Group #2

Final Project Report

Harkiran Arora - arorah2@tcnj.edu

John Donegan - donegaj2@tcnj.edu

Sumana Endreddy - endreds1@tcnj.edu

Maxwell Luz - luzm1@tcnj.edu

Haadi Malik - malikh5@tcnj.edu

Alexandra Merritt- merrita4@tcnj.edu

Brian Petrovic - petrovb1@tcnj.edu

Inception: Executive Summary

Need: the important stakeholder and market need your group identified

The general need that the group has identified is the need for The College of New Jersey to reduce their emissions of greenhouse gasses and reduce the overall cost of the fleet vehicle operations. The important stakeholders that have been identified include the TCNJ administration, workers and possibly donors. The administration and workers would need to allow for the change to occur as it can have a great impact on the day to day operations of their work. In addition, donors to the college would be considered stakeholders since it is their donations which could possibly help with the funding of this overall project.

Approach: your unique and defensible approach

The idea behind our user interface was that it is simple enough for everyone to navigate and would allow the user to easily gather information that they desire. The layout of our database included more than a dozen fill in the blank style phrases that the user can view and then select from a dropdown list to fill in the phrase. Once the phrase has been filled in by the user, the model will display the corresponding information that will answer the user's question. For example, if the user is looking to figure out the total number of cars in the access control department, they can fill in the phrase that corresponds to that and the output will show the total number of cars currently in the access control department. This user interface allows the user to easily make a query and provides the solution to their request, without having to click through irrelevant information.

Benefits: the value of your product when compared to the status quo or alternatives

There are many benefits to using our database. It is different from alternatives because it allows the user to obtain important information about TCNJ's fleet vehicles and their

replacement. When the user enters the make and model of a specific vehicle they are inquiring about they in return get data such as annual emission, emission type, department name, and engine type of that specific vehicle. The ability to search for and compare annual emissions of the vehicles will help users determine which vehicles are most environmentally friendly and worth keeping around. In contrast, this may cause them to consider replacing vehicles that produce high emissions and are not good for the environment. Additionally, a user can search for the number of vehicles in a specific department. A user also has the ability to search for vehicles that were manufactured above, below, or in a specific year of the user's choice. Another important feature of our database is that it allows users to receive information about the fuel, insurance, maintenance, tire replacement, and repairs cost of a particular fleet vehicle. This can help the user to examine which vehicles are most cost effective for TCNJ. Lastly, the most unique feature of the database that really sets it apart from others is that a user can enter a make and model of a vehicle and they will be given the proposed replacement year and replacement vehicle for that fleet vehicle.

Cost: the stakeholder cost to implement, e.g would your approach replace an existing website, be an extension to an existing website, or be a separate new website?

The cost of implementing the database is extremely affordable. For example, the upfront cost of building a new website is around $200, and the cost to maintain the website is about $50 per month. The database will be a separate new website, and the only requirement to use the user interface is Virtual Machine.

Elaboration: Project Proposal and Specifications

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 the annual emissions 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

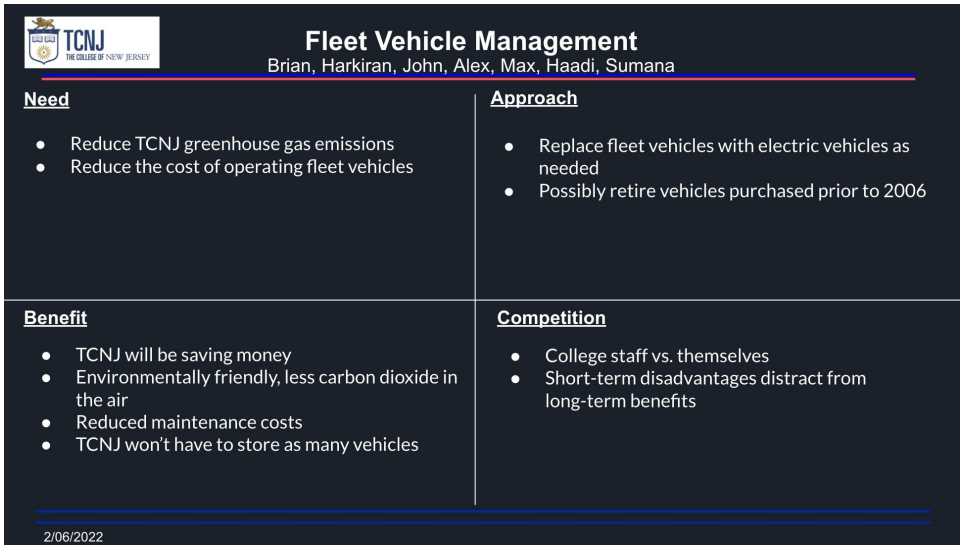
For each portion of our project, we will be uploading our information to the open-source application known as GitHub. In the case that our information is damaged or destroyed, it is important for there to be a backup in order to recover whatever is lost. Therefore, we also plan on uploading all of our 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.

Quad Chart



Stage II – Accounting Submission

What research questions are identified? Who are the stakeholders in the issues identified?

The main research questions our group will focus on are as follows: At what point should a vehicle be replaced?, Which vehicle would be the best option as a replacement?, What electric vehicles are the most cost effective to purchase? The stakeholders in the issues identified would include the TCNJ administration, workers, and possibly donors. The administration and workers would need to allow for the change to occur as it can have a great impact on the day to day operations of their work. In addition, donors to the college would be considered stakeholders since it is their donations which could possibly help with the funding of this overall project.

What financial and nonfinancial data would you incorporate in your model/database design for the identified issues?

Our database would incorporate data that showcases all of the previous vehicles and their cost as well as their emission statistics. The database will also store data on many other types of vehicles that are currently not in operation at TCNJ. Some data that will be included in the database include its initial cost, cost to fuel, depreciation rate as well as many other cost focused data points. The database would also feature data about the vehicles emission rates and other effects the vehicle has on the environment. Our model would include both financial and nonfinancial data, giving the user the power to compare and contrast between the different vehicle choices and choosing the most appropriate vehicle for TCNJ.

What is the cost object in the problem identified?

The cost object is the item in which a cost is being assigned to. Since a measurement of costs is desired for the fleet vehicles at TCNJ, these vehicles would be considered the cost object in the problem identified. We will be looking at the cost of the fleet vehicles themselves;

however, we will also be looking at other costs that are specific to each individual fleet vehicle at TCNJ. This will help us determine when vehicles should be replaced with electric vehicles, what the replacement vehicles should be so that the new vehicle can still serve the same purpose, and which electric vehicles we should purchase so that we are saving money while still reducing emissions on campus.

Can direct costs, indirect costs, fixed costs or variable costs related to the issue be identified based on the data available/provided? If yes, describe them.

Direct costs, fixed costs and variable costs can be identified based on the data provided, while indirect costs are unable to be identified based on the data we are working with. The direct costs of each vehicle include the car payment of the vehicle, as well as any maintenance costs for each vehicle. Many of the costs outlined in the data are also fixed as the cost to fuel the vehicle remains the same (may vary by a couple dollars since gas prices fluctuate) as does the costs to change the oil and to insure the vehicle. These costs remain pretty constant throughout each vehicle's lifetime which makes the costs fixed. Variable costs do exist for vehicles and they are able to be identified by our database. Variable costs that our model would include are repairments, tire replacements, and battery replacements. These costs vary from vehicle to vehicle depending on the amount of repairs that are necessary. They also vary in how often they are required which makes estimating their costs difficult to do. However not all costs will be identifiable by the model because of the lack of data that would be necessary to support their inclusion. Indirect costs would not be identified in the model because the vehicles do not have many indirect costs, and the indirect costs that exist do not have a way to be measured.

What are the cost drivers for the issues identified?

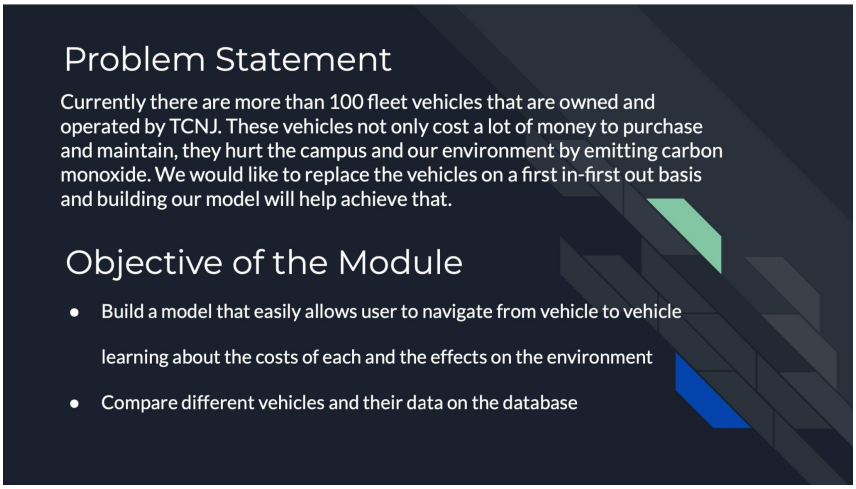
Cost drivers are activities that cause costs to occur. They are also what prompts a change in the cost of an activity. In this situation, the cost drivers would be the factors or activities that influence the costs of fleet vehicles. In our project we will be examining the cost of TCNJ vehicles and the effect they each have on the environment. Our database will allow users to see data and statistics relevant to each vehicle. Some of these variables that will be shown are the car emissions, life expectancy of the car, miles per gallon, year the vehicle was purchased, and others as these all affect the determination of when a vehicle should be replaced with an electric vehicle. In our case, the cost drivers would be things like the usage of the car/the number of miles on the car, the cost per vehicle, and depreciation because these are the activities that drive up the cost. As the activity such as the mileage on the car goes up, costs increase as well because that means more money is spent on gas. More money is also spent on maintenance because cars that are driven more typically need more repairs. Similarly, the age of a fleet vehicle is another cost driver because the older that it is, the more likely it is that TCNJ will have to spend more money on its maintenance.

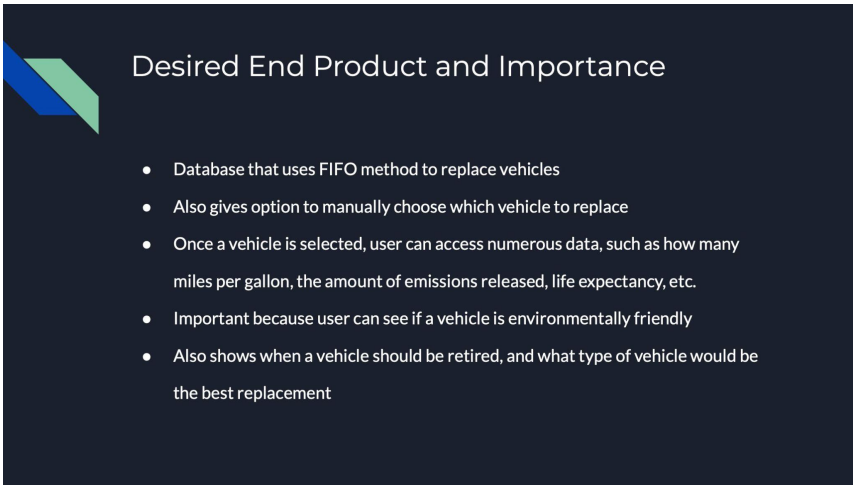
What is your plan to solve the issues identified? What do you expect to see from your end product that address the issues identified?

Our plan is to build a user-friendly database that uses the FIFO method to replace old vehicles with new vehicles. If the user chooses, they can also manually select which vehicle to replace. The database will have three dropdowns where the user can select the year, make, and model of a vehicle. Once a vehicle is selected, the user will be able to see statistics about the vehicle, such as miles per gallon, emissions released, life expectancy, etc. This allows the user to 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. Hopefully, after running vehicles through the database, it will be evident that electric vehicles are much better options than gas vehicles. By switching to electric vehicles, TCNJ would be going towards their goal of reaching carbon neutrality. TCNJ would also save money on gas, oil changes, engine repairs, etc.

Proposal Pitch Presentation





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

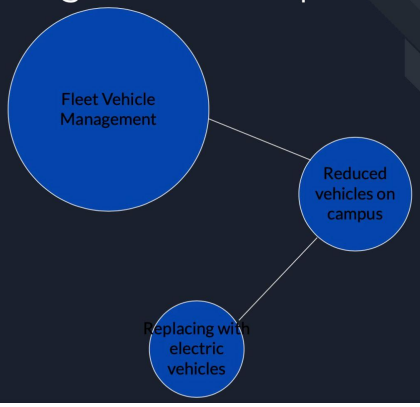
Security

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

Technologies and Database Concepts

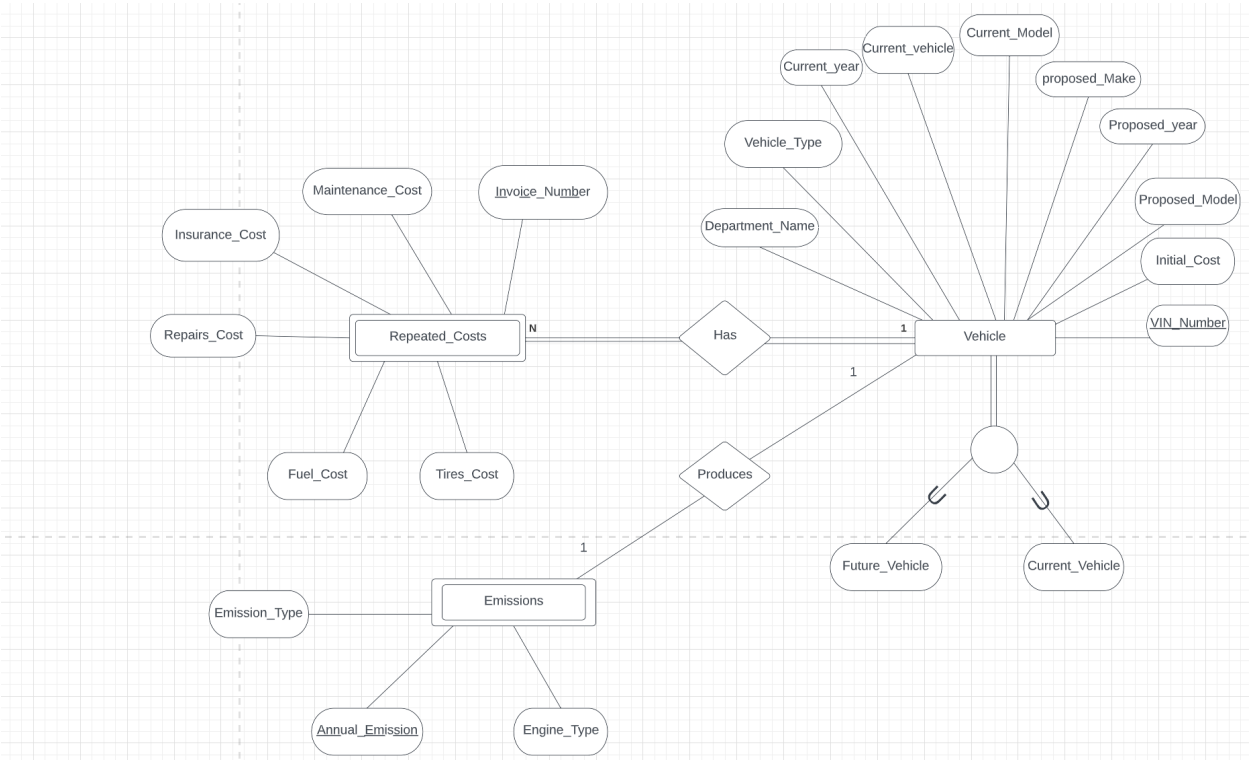
- An Entity-Relationship diagrams to specify relationships among several entities
  - Graphical representation of the relationships
  - ERD diagram tool- Lucidchart
- PostgreSQL database
  - Uses SQL queries to retrieve and manipulate data
- Use Python to integrate queries into UI

Diagrammatic Representation

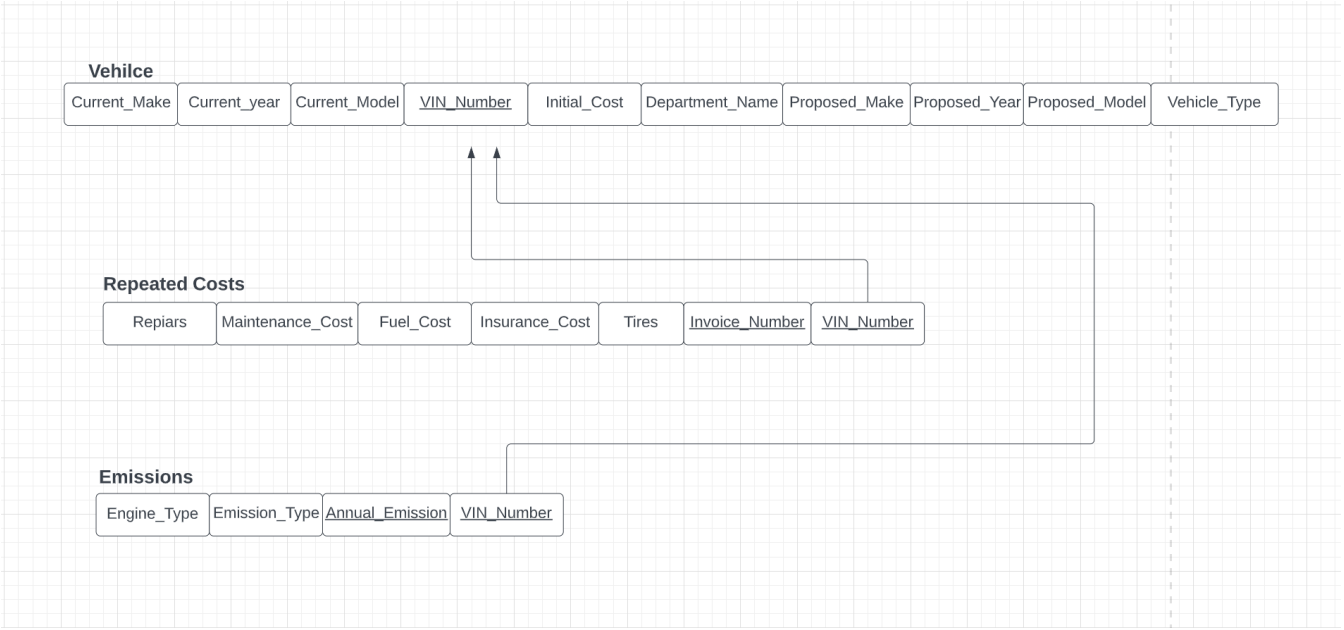


Elaboration: Design

ER Diagram



Schema



Database Model Document

The ER diagram contains several entities such as Vehicle, Emissions, and Repeated Costs. 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 Current_year, Cuurent_make, Current_model, Department_Name, future-year, future_make, future_model, vehicle_type,initia_cost, and VIN. The weak entities in the ER are Repeated_Costs and Emissions. The attributes for the Repeated_Costs entity are tires_cost, repairs-cost, fuel_cost, Insurance_cost, maintenance_cost, and invoice number

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 Emissions entities 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 current_vehicle and future_vehcile are subclasses of the superclass Vehicle. They all inherit common attributes from Vehicle such as department_name, VIN_number, and etc.,

The ER diagram has a cardinality of 1:1 between Vehicle and Emission entities because no other cardinality such as 1:N or M:N would best match the given relation between these two entities. Another cardinality of 1: N is between Vehicle and Repeated_Costs entities; each vehicle has multiple maintenance costs, repairs, and fuel costs.

The Vehicle entity has total participation because every vehicle has costs that are necessary for the functioning of the vehicle such as fuel cost, maintenance costs, etc. Likewise, the Repeated_Costs entity also has a total participation constraint because every cost (fuel, maintenance) is associated with some vehicle. Additionally, the ER contains an Emissions entity which has a partial participation. 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 Current_Vehicle and Future_Vehicle are all the subsets of the supertype Vehicle.

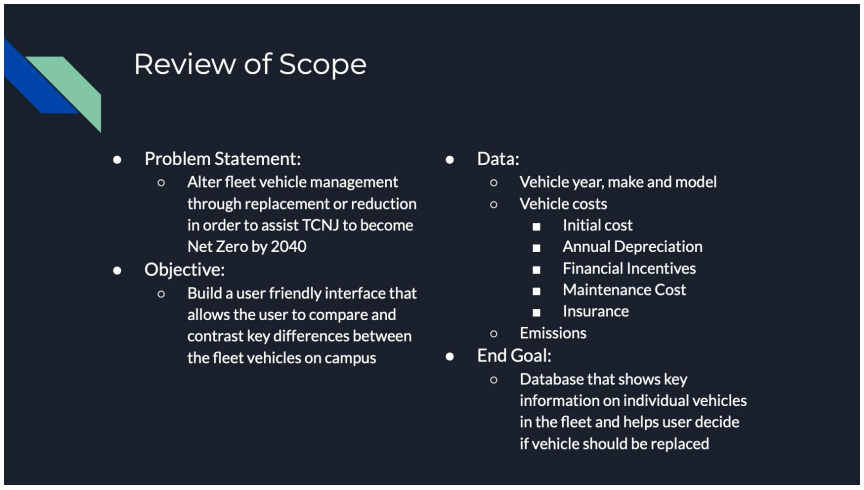
Relational Schema

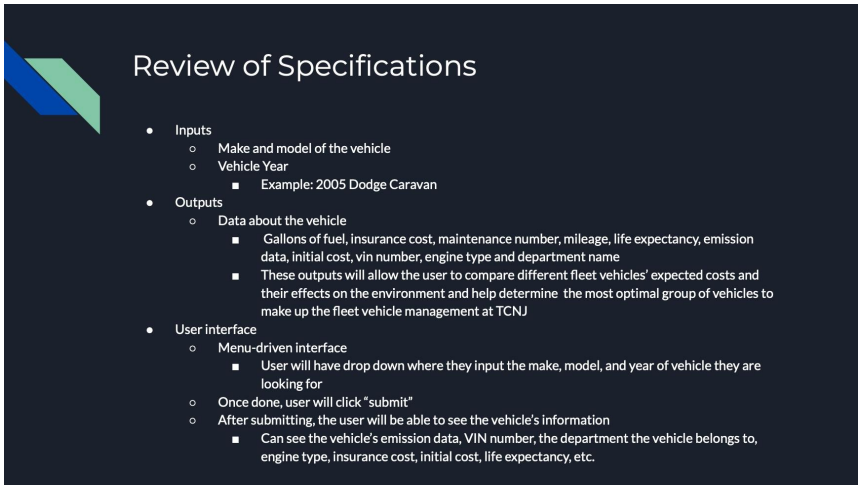
1. A relational schema contains a set of modified relational tables with its attributes. The schema can portray relationships between several tables. It also shows primary and foreign key relationships as well.
2. The *Vin_Number* attribute in the *Repeated_Costs* table is a foreign key connecting it to the *Vin_Number* attribute (primary key) in the VEHICLE table
3. The *VIN_Number* attribute in the Emissions table is a foreign key connecting it to the *VIN_Number* attribute (primary key) in the *Vehicle* table
4. The *VIN_Number* in the *Vehicle* entity is a primary key

Estimates

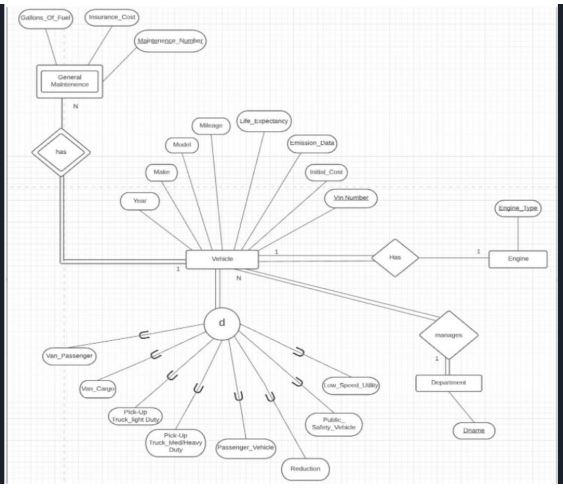
Database Size: Since there are currently 97 fleet vehicles logged on the fleet vehicle spreadsheet, there will be a total of 97 fleet vehicle entries in the database. As this is an estimated approximation, this may change in future if more data is added into the database

Mid-Semester Project Presentation





ER Diagram



Relational Schema

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 & IV – Accounting Submission

Describe and explain the requirements/components (i.e., relevant cost/financial and other data) incorporated in the entity-relationship (ER) diagram to model the database.

There are a few requirements or components incorporated in the entity-relationship (ER) diagram to model the database. To begin there is much data regarding the vehicles itself which must be collected. These include the vehicle type, current model and vehicle, initial cost, as well as the future make, year, and model. In addition, there is a requirement for data collection of the vehicle's production of emissions. This aspect can include different components such as the emission type, engine type, and annual emission. Alongside this data there are also repeated costs which must be accounted for. These components include information regarding the cost of tires, fuel, repairs, insurance, and maintenance. Financial data points such as those which are previously mentioned are important to keep track of since the database would determine if the vehicle would need replacement or removal depending on these points. For example, if there is an escalated cost of maintenance for a specific vehicle, the database can evaluate that. So, when a user enters information regarding this vehicle, the database would be able to notify the user that it would be time for a replacement or removal based on the increased cost of maintenance. This would be the same for changes in the cost of tires, fuel, repairs, and insurance. All in all, there are many components that must be accounted for in regards to both the vehicle as well as financial data associated with the fleet vehicles.

What variables or attributes are included in the model? How do you measure them?

There are three main categories of attributes that are included in the model. These categories are repeated costs, vehicle, and emissions. There are various variables that fall under the repeated costs category. These variables include insurance cost, maintenance cost, invoice

number, repairs cost, fuel cost, and tires cost. Some of the values of these costs like fuel cost, maintenance cost, insurance cost, and others are already measured and can be found under the unit impact-cost tab in the fleet vehicle excel file; however, not all of them are given to us. For the costs that are not provided in the excel we are going to have to conduct research to measure them and get an idea of what the amount of these costs will be. In conducting this research we will most likely search for the costs by entering the year, model, and make of the vehicle followed by the cost we are inquiring about. If we cannot find it we can try to search for a similar vehicle because it is likely that their costs will be similar. Emission type, annual emission, and engine type are other variables that are included in the model and are found under the emissions category. The emission type, annual emission, and emissions category of each fleet vehicle is also given to us on the vehicle fleet excel as they are already measured for us by TCNJ. Lastly, variables such as the vehicle's department name, type, current year, current name, current model, proposed make, proposed year, proposed model, initial cost, and VIN number are all included in the model. These variables are essential to the model as they make up the largest category, vehicle. Majority of the vehicle category variables are ones that are qualitative in that they can't be measured. We can find the vehicle department name, vehicle type, vehicle model, etc. in the excel sheet that was given to us by Mr. Romano. All of the variables that are included in the model will help us to determine the proposed make, year, and model that would be the best replacement for the current vehicle.

What discussion inputs do you contribute to your computer science peers in designing database model and the user interface?

While none of the accounting students have experience with web design, we are still contributing to the model by providing ideas that could elevate our model. We have been looking

at examples of models that are public and have been taking notes on what we like from each of their user interfaces as well as what we do not like. We have suggested a drop down menu where the user can place information for a vehicle that will be used to search the database and then pull up the vehicles that match the inputs. This will give the user full control to easily pull up vehicle information based on key characteristics that separate the vehicles, such as make, model and year. We also suggested that the user should be able to compare multiple vehicles at the same time, as we think this would make the model more practical for the users. It would be much easier to compare each vehicle's information if it was side by side. We also think it would be a great idea to add a picture to the database, so when a vehicle is searched up the picture is provided too. All of these suggestions would help improve the model and allow users to easily navigate the database to see the information they desire.

Do you need to incorporate any additional data/information besides the data provided to address the issues identified? If so, what is the additional data/information? Why?

The only piece of additional information the database could provide is how often the different vehicles are used. This would allow the users to see how important each vehicle is to the college as well as if non-used vehicles are able to be retired and discarded. Other than that, the database includes all other important information. It is broken up into three parts, which give a lot of information about the vehicles. The first part is "vehicle". "Vehicle" contains the background information of both current and future vehicles, such as the year, make, model, and type. It contains what department the different vehicles are in as well as the different vehicles' VIN numbers so that the vehicles are easy to find. The second part of the database is "repeated costs". This section allows the user to see the cost of tires, fuel, repairs, insurance, and general maintenance. It also gives the user invoices so the user can see previous costs. The third part is

“emissions”. This part allows the user to see how much emissions are released annually from the different vehicles as well as the type of emissions released. This section also includes the engine type of each vehicle. With all of these parts together as one, the user will have access to all the information they need when evaluating what vehicle would suit the college’s needs and budget as well as the environment best.

Elaboration: Database Design

SQL Tables:

```
CREATE TABLE Departments (
department_id int PRIMARY KEY,
department_name text UNIQUE
);
INSERT INTO Departments (department_id, department_name)
VALUES (1, 'Move_Team'), (2, 'Bldg_Services'), (3, 'Access_Control'),
(4, 'Mailing/Receiving'), (5, 'Grounds'), (6, 'Grounds_EXT'), (7, 'Grounds_SUP'),
(8, 'Grounds_Auto'), (9, 'Carpenter'), (10, 'Carpenter_Sup'), (11, 'Carpenter_Roof'),
(12, 'Const.Shop'), (13, 'Paint'), (14, 'Mason'), (15, 'Electric_Shop'),
(16, 'HVAC_Shop'), (17, 'HVAC_Shop_PH'), (18, 'Plumbing_Shop'), (19, 'Repair'),
(20, 'Information_Tech'), (21, 'Telecommunications'), (22, 'Biology'), (23, 'School_of_Ed'),
(24, 'Bonner_Center'), (25, 'Campus_PD'), (26, 'Admissions'), (27, 'Fleet_Loaner'),
(28, 'Athletics');

CREATE TABLE Vehicle_Categories (
vehicleCategory_id int PRIMARY KEY,
vehicle_category text UNIQUE
);
INSERT INTO Vehicle_Categories(vehicleCategory_id, vehicle_category)
VALUES (1, 'Pick-Up-Truck-Med./Heavy Duty'), (2, 'Van-Passenger'), (3,
'Pick-Up-Truck-LightDuty'),
```

(4, 'LowSpeed-Utility'), (5, 'Van-Cargo'), (6, 'Passenger-Vehicle'), (7, 'Public-Safety-Vehicle'), (8, 'Reduction'), (9, 'LowSpeed-Passenger'), (10, 'Retire'), (11, 'Reassigned');

```
CREATE TABLE Engine_Types (
engine_type_id int PRIMARY KEY,
engine_type VARCHAR(255)
);
INSERT INTO Engine_Types(engine_type_id, engine_type)
VALUES (1, 'ICE'), (2, 'EV'), (3, 'X'), (4, 'EV-LS'), (5, 'HYB'), (6, 'Hydro');

CREATE TABLE Model (
year int,
model VARCHAR(255),
make VARCHAR(255),
model_id int PRIMARY KEY,
proposed_year int,
future_year int,
current_vehicleCategory_id int,
proposed_vehicleCategory_id int,
future_vehicleCategory_id int,
current_engine_type_id int,
proposed_engine_type_id int,
future_engine_type_id int,
```

```
FOREIGN KEY (current_vehicleCategory_id) REFERENCES Vehicle_Categories
(vehicleCategory_id),
FOREIGN KEY (proposed_vehicleCategory_id) REFERENCES Vehicle_Categories
(vehicleCategory_id),
FOREIGN KEY (future_vehicleCategory_id) REFERENCES Vehicle_Categories
(vehicleCategory_id),
FOREIGN KEY (current_engine_type_id) REFERENCES Engine_Types (engine_type_id),
FOREIGN KEY (proposed_engine_type_id) REFERENCES Engine_Types (engine_type_id),
FOREIGN KEY (future_engine_type_id) REFERENCES Engine_Types (engine_type_id)
);
\COPY Model(year, model, make, model_id, proposed_year, future_year,
current_vehicleCategory_id, proposed_vehicleCategory_id, future_vehicleCategory_id,
current_engine_type_id, proposed_engine_type_id, future_engine_type_id) FROM
'/home/lion/Downloads/Model.csv' WITH CSV HEADER;

CREATE TABLE Vehicle (
initial_cost int,
license_plate_number VARCHAR(255) PRIMARY KEY,
model_id int,
department_id int,
FOREIGN KEY (department_id) REFERENCES Departments (department_id),
FOREIGN KEY (model_id) REFERENCES Model (model_id)
);
```

```
\COPY Vehicle(initial_cost, license_plate_number, model_id, department_id) FROM
'/home/lion/Downloads/vehicle.csv' WITH CSV HEADER;

CREATE TABLE Cost_Types (
cost_type_id int PRIMARY KEY,
cost_type_name VARCHAR(255)
);
INSERT INTO Cost_Types(cost_type_id, cost_type_name)
VALUES (1, 'tires_cost'), (2, 'insurance_cost'),
(3, 'fuel_cost'), (4, 'repairs_cost'),
(5, 'maintenance_cost');

CREATE TABLE Invoices (
invoice_number int PRIMARY KEY,
license_plate_number VARCHAR(255),
FOREIGN KEY (license_plate_number) REFERENCES Vehicle (license_plate_number)
);
\COPY Invoices(invoice_number, license_plate_number) FROM
'/home/lion/Downloads/invoices.csv' WITH CSV HEADER;
```

```
CREATE TABLE Invoice_Items (
invoice_item_id int PRIMARY KEY,
amount int,
invoice_number int,
cost_type_id int,
FOREIGN KEY (invoice_number) REFERENCES Invoices (invoice_number),
FOREIGN KEY (cost_type_id) REFERENCES Cost_Types (cost_type_id)
);
\COPY Invoice_Items(invoice_item_id, amount, invoice_number, cost_type_id) FROM
'/home/lion/Downloads/invoice item.csv' WITH CSV HEADER;

CREATE TABLE Emissions (
emission_id int PRIMARY KEY,
license_plate_number VARCHAR(255),
FOREIGN KEY (license_plate_number) REFERENCES Vehicle (license_plate_number)
);
\COPY Emissions(emission_id, license_plate_number) FROM
'/home/lion/Downloads/emissions.csv' WITH CSV HEADER;

CREATE TABLE Emission_Types (
emission_type_id int PRIMARY KEY,
emission_type_name VARCHAR(255)
);
```

```
INSERT INTO Emission_Types(emission_type_id, emission_type_name)
VALUES (1, 'C02');

CREATE TABLE Emission_Details (
emission_detail_id int PRIMARY KEY,
emission_type_id int,
emission_id int,
annual_emissions float,
FOREIGN KEY (emission_id) REFERENCES Emissions (emission_id),
FOREIGN KEY (emission_type_id) REFERENCES Emission_Types (emission_type_id)
);
\COPY Emission_Details(emission_detail_id, emission_type_id, emission_id, annual_emissions)
FROM '/home/lion/Downloads/emission details.csv' WITH CSV HEADER;
```

SQL Queries:

```
SELECT DISTINCT M.make, M.model, VC.vehicle_category
FROM Vehicle_Categories VC
JOIN Model M ON M.current_vehicleCategory_id = VC.vehicleCategory_id
WHERE M.make = 'Ford' AND M.model = 'F350 Box Truck';

SELECT M.make, M.model, VC.vehicle_category
FROM Vehicle_Categories VC
JOIN Model M ON M.proposed_vehicleCategory_id = VC.vehicleCategory_id
```

```
WHERE M.make = 'Ford' AND M.model = 'Ranger';


SELECT M.make, M.model, VC.vehicle_category
FROM Vehicle_Categories VC
JOIN Model M ON M.future_vehicleCategory_id = VC.vehicleCategory_id
WHERE M.make = 'Mazda' AND M.model = 'B3000';


SELECT COUNT(V.license_plate_number)
FROM Vehicle V
JOIN Departments D ON D.department_id = V.department_id
WHERE D.department_name = 'Move Team';


SELECT d.department_name
FROM Departments D
JOIN Vehicle V ON V.department_id = D.department_id
JOIN Model M ON M.model_id = V.model_id
WHERE M.make = 'Ford' AND M.model = 'Van';


SELECT IT.amount
FROM Vehicle V
JOIN Model M ON M.model_id = V.model_id
JOIN Invoices I ON I.license_plate_number = V.license_plate_number
JOIN Invoice_Items IT ON IT.invoice_number = I.invoice_number
```

```
JOIN Cost_Types CT ON CT.cost_type_id = IT.cost_type_id AND CT.cost_type_name =
'tires_cost'
WHERE M.make = 'Chevy' AND M.model = 'Colorado';

SELECT ED.annual_emissions
FROM Model M
JOIN Vehicle V ON V.model_id = M.model_id
JOIN Emissions E ON E.license_plate_number = V.license_plate_number
JOIN Emission_Details ED ON ED.emission_id = E.emission_id
WHERE M.make = 'Dodge' AND m.model = 'Grand Caravan';

SELECT SUM(ED.annual_emissions)
FROM Model M
JOIN Vehicle V ON V.model_id = M.model_id
JOIN Emissions E ON E.license_plate_number = V.license_plate_number
JOIN Emission_Details ED ON ED.emission_id = E.emission_id
WHERE M.make = 'Dodge';

SELECT DISTINCT ET.emission_type_name, M.make
FROM Vehicle V
JOIN Model M ON M.model_id = V.model_id
JOIN Emissions E ON E.license_plate_number = V.license_plate_number
JOIN Emission_Details ED ON ED.emission_id = E.emission_id
```

```
JOIN Emission_Types ET ON ET.emission_type_id = ED.emission_type_id
WHERE M.make = 'Ford';

SELECT DISTINCT ET.engine_type
FROM Vehicle V
JOIN Model M ON M.model_id = V.model_id
JOIN Emissions E ON E.license_plate_number = V.license_plate_number
JOIN Engine_Types ET ON ET.engine_type_id = M.current_engine_type_id
WHERE M.make = 'Ford' AND M.model = 'F450 Dump';

SELECT M.make, M.model, ET.engine_type
FROM Vehicle V
JOIN Model M ON M.model_id = V.model_id
JOIN Emissions E ON E.license_plate_number = V.license_plate_number
JOIN Engine_Types ET ON ET.engine_type_id = M.proposed_engine_type_id
WHERE M.make = 'Ford' AND M.model = 'F250';

SELECT M.make, M.model, ET.engine_type
FROM Vehicle V
JOIN Model M ON M.model_id = V.model_id
JOIN Emissions E ON E.license_plate_number = V.license_plate_number
JOIN Engine_Types ET ON ET.engine_type_id = M.future_engine_type_id
WHERE M.make = 'Ford' AND M.model = 'Aerial';
```

```
SELECT M.make, M.model, V.license_plate_number
FROM Model M
JOIN Vehicle V ON V.model_id = M.model_id
WHERE M.year < 2018;

SELECT M.make, M.model, V.license_plate_number
FROM Model M
JOIN Vehicle V ON V.model_id = M.model_id
WHERE M.year > 2015;

SELECT M.make, M.model, V.license_plate_number
FROM Model M
JOIN Vehicle V ON V.model_id = M.model_id
WHERE M.year = 2009;
```

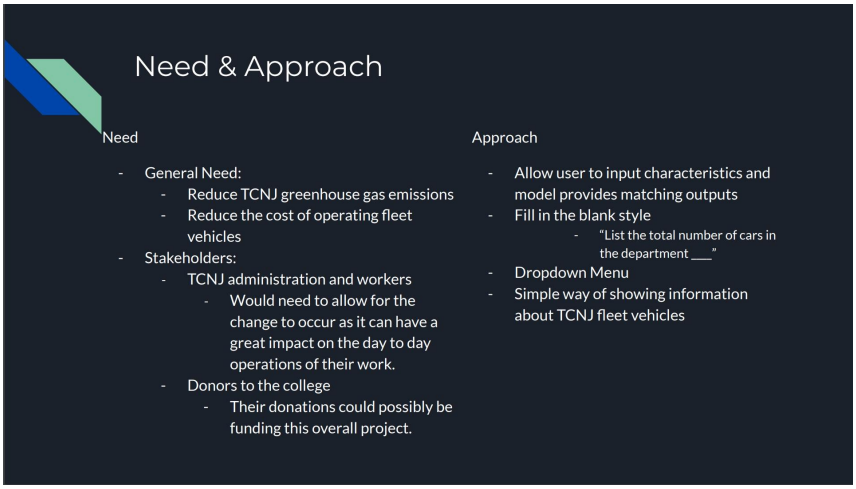
Transition: Maintenance

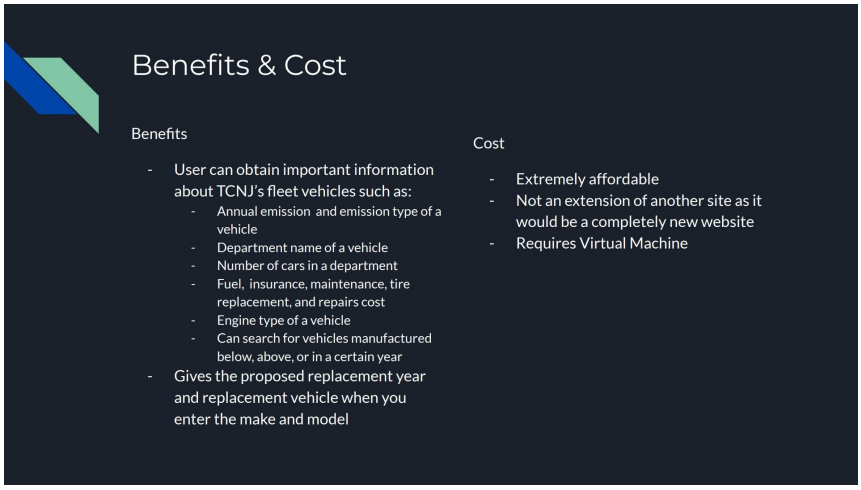
Private Repository URL:

https://github.com/TCNJ-degoodj/cab-project-01-2

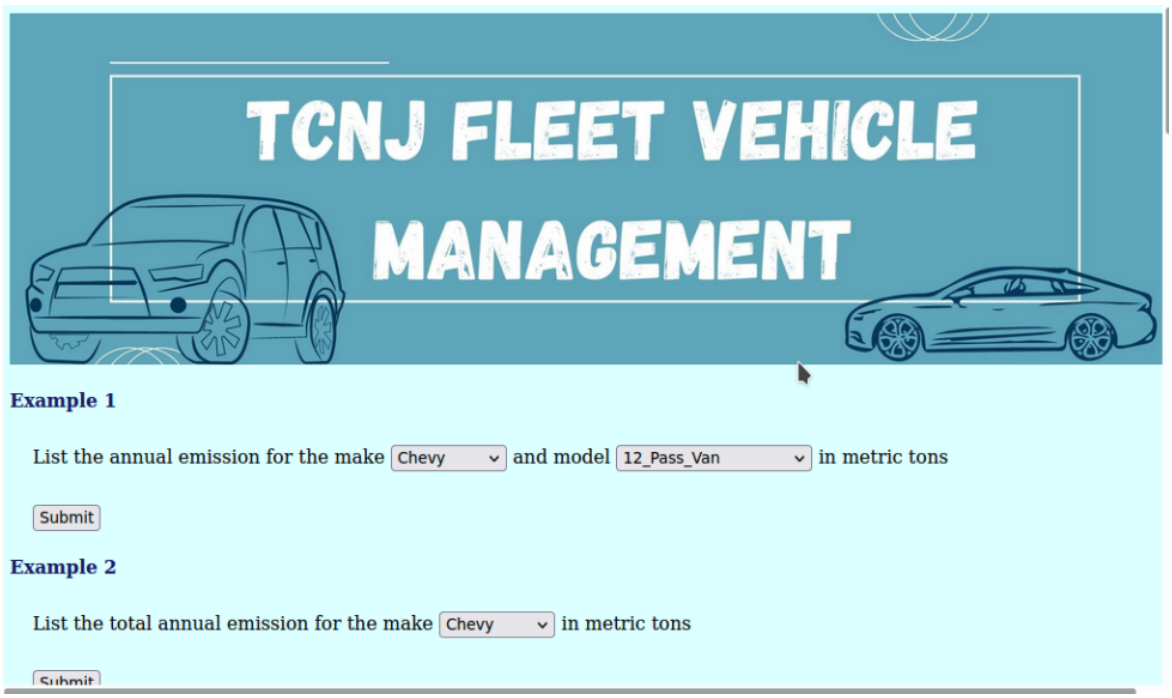
Final Project Demonstration

Final Presentation Slides





User Interface



Example 3

List the emission type for all the (make) Chevy cars

Submit

Example 4

List the proposed and future replacement year for the make Chevy and model 12_Pass_Van

Submit

Example 5

List the vehicle with lower annual emission 265 - LYA 265 - LYA

Submit

Example 6

List the annual (cost type) fuel_cost for all the (make) Chevy and model 12_Pass_Van

Submit

Example 7

List the total number of cars in the department Access_Control

Submit

Example 8

Provide the department name to which the make Chevy and model 12_Pass_Van belongs to

Submit

Example 9

List the current vehicle category for the make Chevy and model 12_Pass_Van

Submit

Example 10

List the proposed vehicle category for the make Chevy and model 12_Pass_Van

Submit

Example 11

List the future vehicle category for the make Chevy and model 12_Pass_Van

Submit

Example 12

List all the cars that are manufactured below the year 1994

Submit

Example 13

List all the cars that are manufactured above the year 1994

Submit

Example 14

List all the cars that are manufactured in the year 1994

Submit

Example 15

List the current engine type for the make Chevy and model 12_Pass_Van

Submit

Example 16

List the proposed engine type for the make Chevy and model 12_Pass_Van

Submit

Example 17

List the future engine type for the make Chevy and model 12_Pass_Van

Submit

Transition: Product Hand Over

Public Repository URL:

https://github.com/SumanaE/CAB-PROJECT-01-2