Group 1-5

Fleet Management: Emission/Cost Efficiency

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Elaboration: Project Proposal and Specifications

Problem statement

In the push for improving the current state of the environment, many businesses have made it a goal to reduce their impact on the environment as a whole. In the case of TCNJ, the goal is to become carbon neutral by 2040, and one of the steps in this process is to reduce the carbon impact of the vehicle fleet. However, there needs to be a plan of action when considering the costs of performing this transition and what the best course of action could be.

Objective of the module

The objective of our module is to build a tool that will help us determine the most cost effective solution in which the College can reach its goal of net 0 emissions by 2040. This process can be done by analyzing the costs of owning different types of vehicles and the amount of emissions they create at different points in time. Some potential questions our module could help answer are:

- Should the college move to transition its fleet immediately or later in our time frame?
- What is the most economical composition of the TCNJ's vehicle fleet both today and at annual milestones?
- What is the most environmentally benign composition of the TCNJ vehicle fleet both today and at annual milestones?
- Which is the best way that the College can minimize its real cash outflows in insurance costs, maintenance costs, etc.?
- How can we balance both the financial and environmental impact of transitioning to zero emission alternate vehicles?

Desired End Product

- We wish to create a model of the current TCNJ fleet where vehicles and vehicle factors can be changed and costs/carbon effects can be calculated and displayed over our time frame.
- Users can therefore test different replacement/transition strategies to find the best possible strategy for the transition both financially and environmentally.
- Metrics:
    - Maintenance Cost
    - Initial Capital Cost
    - Insurance Cost
    - Average MPG
    - Annual Emissions, GHG
    - Annual Emissions, Pollutants

Other similar systems/approaches that exist

- GREET Fleet Footprint measures GHG emissions associated with medium and heavy-duty vehicles, whereas our system can be applied to various types of vehicles making it more flexible. Additionally, our method also takes cost into consideration.
- The Energy Star program's system is linked to your electric bills and is applied strictly to buildings while determining solutions based on more successful buildings. Our system can do both cars and buildings (with slight modification) and offers ideas based on options that TCNJ has already determined viable
- AASHE's tool is designed for comparison between other schools and generating data for reporting purposes. Our system provides data for analytical purposes
- Systems used by other colleges
    - "Scope 3 emissions fluctuate year to year based on both employee behavior and slight changes in data collection methods to improve accuracy" (33)
    - "The GHG Protocol Product Life Cycle Accounting and Reporting Standard helps understand the emissions associated with a product and identify greenhouse gas reduction opportunities through its life cycle. Using this standard, Rutgers can measure the greenhouse gasses associated with the full life cycle of the products we procure, including raw materials, manufacturing, transportation, storage, use and disposal" (37)
    - Rutgers is specifically looking to eliminate greenhouse gas emissions in their program

Importance and Need for Module

We cannot jump to a solution for the carbon neutral problem without a system to test the possibilities towards reaching this goal. Before TCNJ even begins spending time and money on potential environmental efforts, our system will provide algorithmic information to help determine which option the school should take.

Plan for Researching

- Start with data from the excel files in Canvas
- Search other reports/studies about carbon emissions (TCNJ's virtual library)
- Find newspaper/magazine/journal articles about carbon neutral efforts and difficulties (Virtual/physical library)
- Look for statements from car manufacturers about their efforts to reduce carbon emissions from their vehicles

- Gain ideas from existing measurement systems that other schools made when tackling similar subjects

Other Potential Applications

- Can be used for on campus buildings, data would just need to be changed since it's a sustainability testing system
- The application doesn't have to just apply to TCNJ, other schools or even other companies could benefit from a sustainability testing system

Performance

- To ensure strong performance, efficient search algorithms need to be implemented
- Internal code will be optimized to reduce nested loops which slow down computation time when running through calculations for fleet of vehicles.
- Good database design can ensure optimal performance
- Design a user-friendly interface with easily identifiable displays of data and understandable inputting features
- Caching data to increase performance

Security

- The system can be protected through a two-step authentication with username and password login followed by security codes
- Only Facilities will be able to access this application and data

Backup and recovery

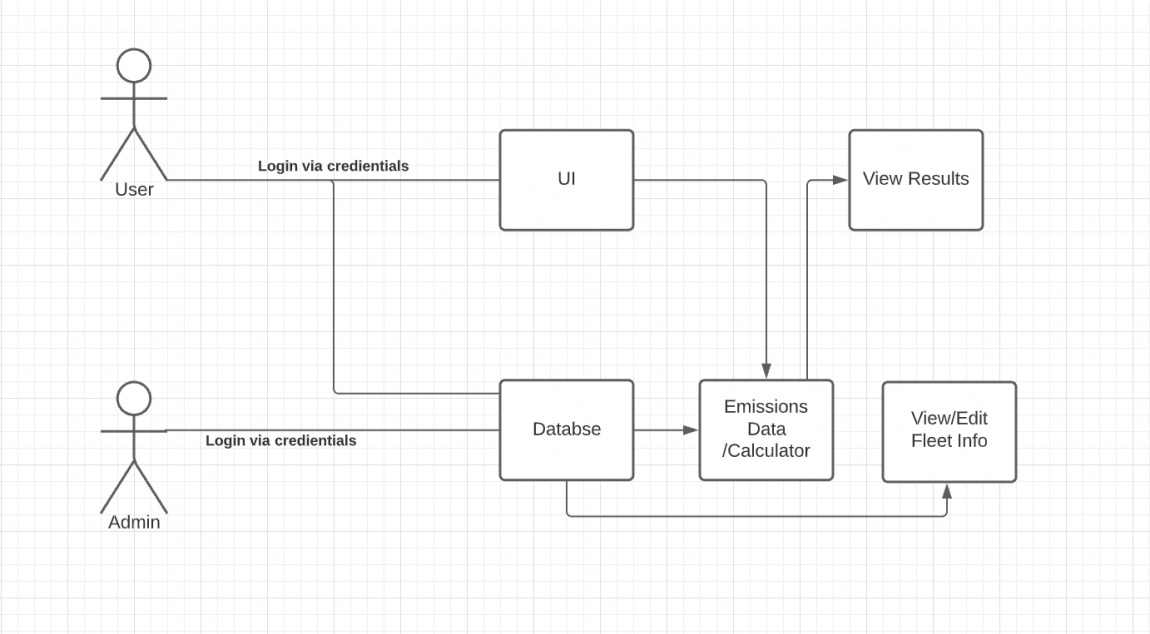
- All data will be uploaded to TCNJ servers for backup and ease of access
- Users will be required to submit credentials to access this information
- When this project leaves Github, facilities will have main access and will live on the TCNJ servers

Technologies/Database concepts we need to learn:

- Python + Flask
- Optimal Database Design with PostgreSQL
- Querying our database in an efficient manner
- Securing & Backing up our data

Diagrammatic representation

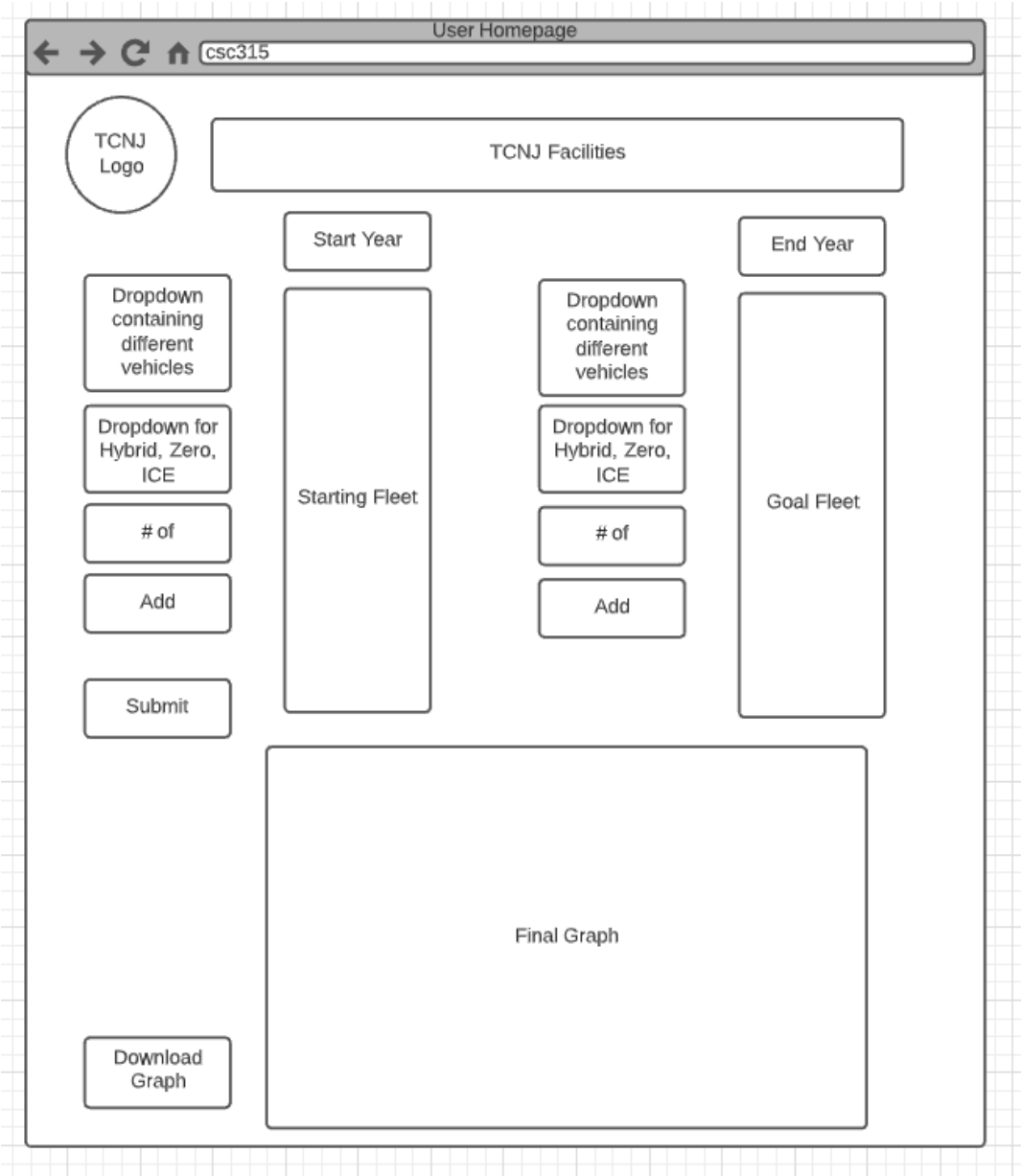
https://lucid.app/lucidchart/94cf8f07-9e04-4b84-8c95-eb41dba7f04b/edit?page=0_0&invitationId=inv_6dccc0ec-06b9-4f7e-bb22-64f91a8f5439#



Use Case Description:
User:
The user would be able to enter their current fleet by vehicle category (Passenger, Public Safety, Pick up Truck, etc.) and their vehicle type (ICE, Hybrid, Zero). The user would then enter their end year and the fleet they would like to have by that year. The user can then hit submit and our application would generate a graph and/or report showcasing the most optimal path the user could take while keeping emissions and costs in mind.

Admin:
Able to view and edit the database, as well as use the emissions calculator. Will also be able to see who has access to the UI and just monitor activity.

User Interface Mock-Up:
https://lucid.app/lucidchart/637b77ea-e95f-4350-ac98-278fefe5cd8a/edit?page=0_0&invitationId=inv_e1346c13-59a9-41a4-b6eb-bef2747b71a4#



1-page quad chart

Need *What are the customer and market Needs?* - To become carbon neutral by 2040 - Determine the most cost-effective method of meeting this need - Utilize a system for testing the possibilities towards reaching this goal	**Approach** *What is your unique approach for addressing this need?* - Gathering empirical data in order to provide accurate information - Our produced system will allow ease of method testing with quick result and predictions for the outcomes of switching vehicles in the vehicle fleet towards a 0 emissions solution
Benefit *What are the specific benefits for the Stakeholders?* - Ewing and the surrounding communities will benefit from the reduction of emissions from the College - The College of New Jersey will benefit from a more efficient fleet in the long run	**Competition** *How are the benefits superior to the competition and the alternatives?* - Our system is flexible and can be applied to various types of sources of energy usage (with some modification) - Our system is not based around comparison between other schools/buildings, but catered to what options the user is already picking between

Proposal Pitch Presentation

Problem Statement

- In the push for improving the current state of the environment, many businesses have made it a goal to reduce their impact on the environment as a whole.
- In the case of TCNJ, the goal is to become carbon neutral by 2040, and one of the steps in this process is to reduce the carbon impact of the vehicle fleet.
- However, there needs to be a plan of action when considering the costs of performing this transition and what the best course of action could be.

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Objective

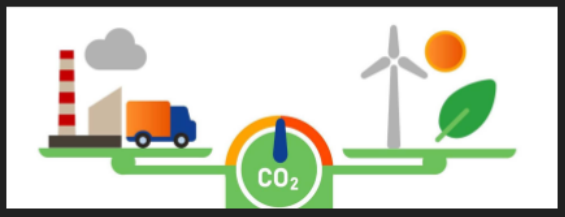
- What is the most cost effective solution in which the College can reach its goal of net 0 emissions by 2040?
- This process can be done by analyzing the costs of owning different types of vehicles and the amount of emissions they create at different points in time.
- Should the College move to transition its fleet to zero emission alternates immediately or later in our time frame?

Desired End Product

- We wish to create a model of the current TCNJ fleet where vehicles and vehicle factors can be changed and costs/carbon effects can be calculated and displayed.
- Users can therefore test different replacement/transition strategies to find the best possible strategy for the transition both financially and environmentally.

Importance and Need

- We cannot jump to a solution for the carbon neutral problem without a system for testing the possibilities towards reaching this goal.
- Our produced system will allow ease of method testing with quick results and predictions for the outcomes of switching vehicles in the vehicle fleet towards a 0 emissions solution.



Plan For Research

- We will first start with the data from the excel files in Canvas.
- We will then search other reports/studies about carbon emissions (Maybe from the TCNJ's virtual library).
- Next, we will find newspaper/magazine/journal articles about carbon neutral efforts and difficulties (Virtual/physical library).
- Look for statements from car manufacturers about their efforts to reduce carbon emissions from their vehicles.
- We would also try to gain ideas from other existing measurement systems to improve our module.

Other Systems

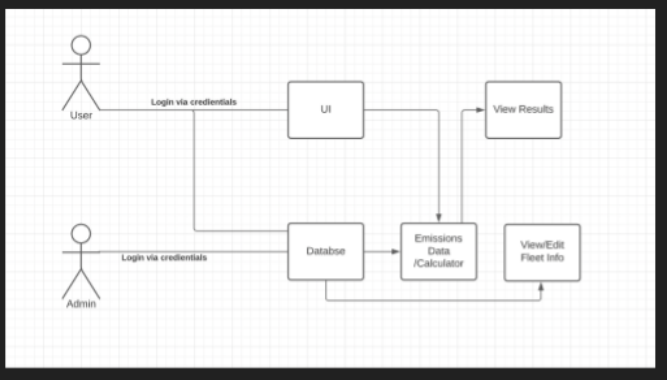
- GREET Fleet Footprint: measures the GHG emissions associated with medium and heavy-duty vehicles. Our system can be applied to various vehicles. Additionally, our method also takes cost into consideration.
- The Energy Star program's system is linked to your electric bills and is applied strictly to buildings while determining solutions based on more successful buildings. Our system can do both cars and buildings (with slight modification) and offers ideas based on options that TCNJ has already determined viable
- AASHE's tool is designed for comparison between other schools and generating data for reporting purposes. Our system provides data for analytical purposes

Other Applications

- We believe that our module can be used for campus buildings; the data would just need to be changed since it's a sustainability testing system.
- The application doesn't have to just apply to TCNJ, other schools or even car companies could benefit from a vehicle sustainability testing system.

Technology/Database Concepts + Diagram

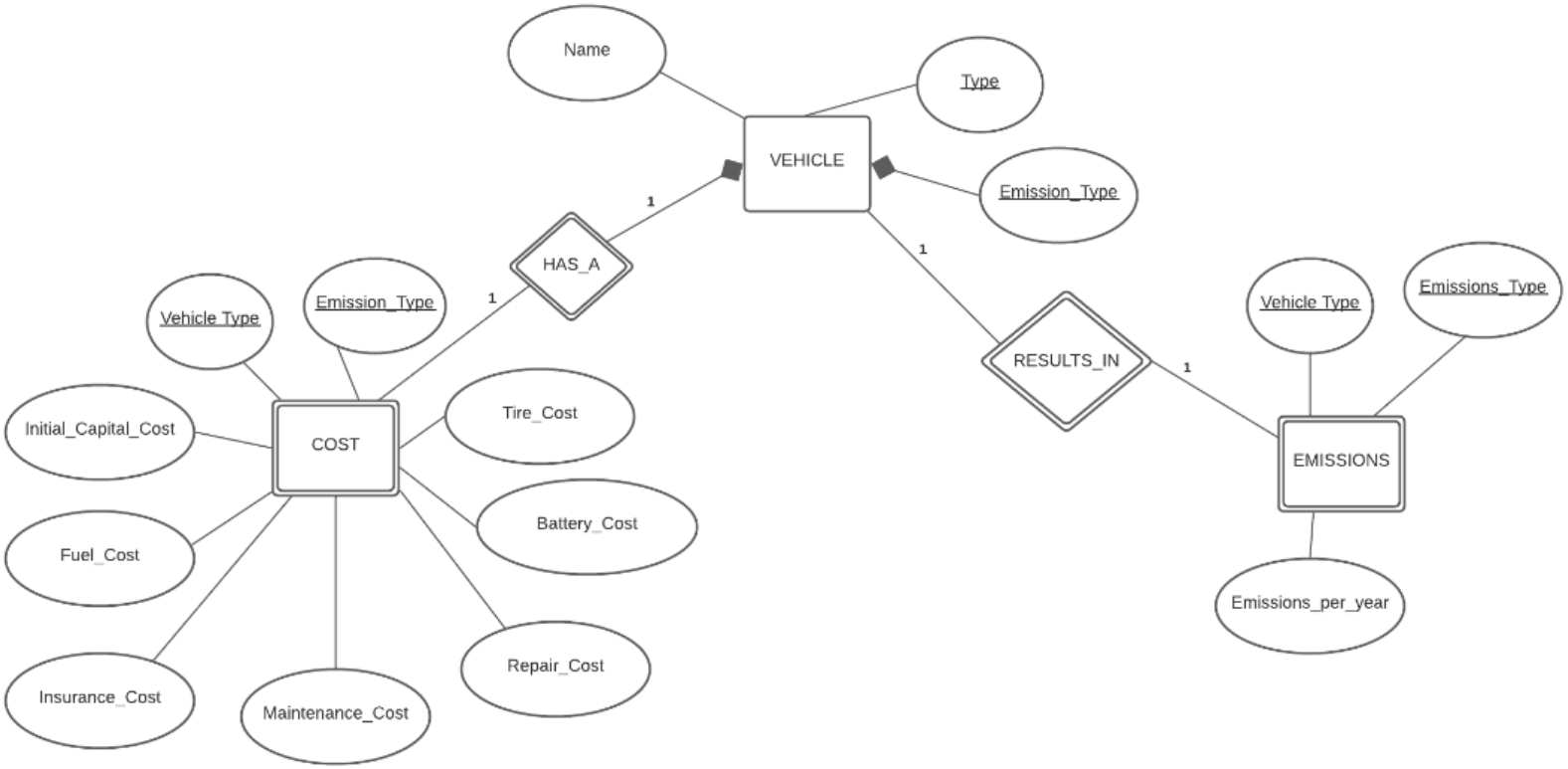
- We will need to understand how to use and view Excel files in order to keep track of our data.
- Some technologies & database concepts we will need to learn:
  - Optimal Database Design with PostgreSQL
  - Querying our database in an efficient manner
  - Securing & Backing up our data



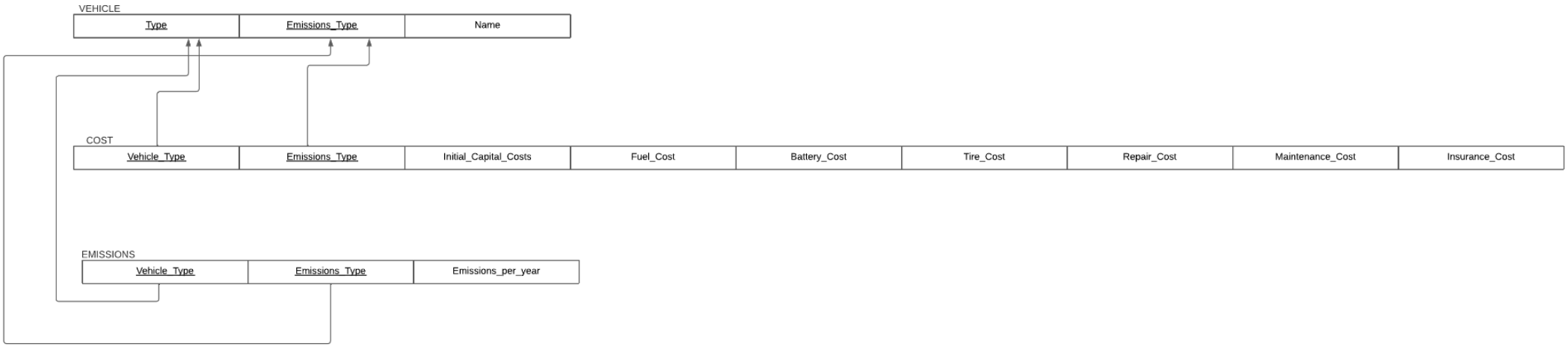
Elaboration: Design

[Link to the diagrams below]

ER Diagram



Relational Schema



- **Initial database size (approximate number of records)**
  - VEHICLE: 18 tuples, one for each combination of vehicle type and emissions type
  - COST: 18 tuples, one for each combination of vehicle type and emissions type
  - EMISSIONS: 18 tuples, one for each combination of vehicle type and emissions type

- **Types and average number of searches:**
  - In order to calculate the costs and emissions associated with each vehicle type & vehicle emissions type in the fleet, we will need to fetch its corresponding tuple in both the COSTS & EMISSIONS relations.
  - Since there are only 18 combinations of Vehicle type and Vehicle Emissions type, we will only need to perform at most 18 searches per year.
  - However, as fleet composition changes each year, we may need to perform these 18 searches repeatedly.

Mid-Semester Project Presentation

Group 1-5
Mid-Semester Project Presentation

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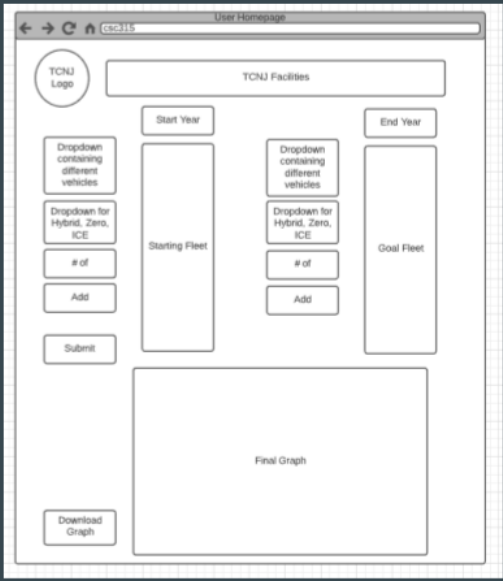
Our Project

- Using data provided to us through Microsoft Excel, we plan to create an application that can successfully predict how the TCNJ vehicle fleet will adapt to meet the College's emissions standards.
- Users will have an interactive interface to obtain a visual model in order to test different solutions.
- For today, we will give an idea of our plans for the database model, in terms of design as well as what we believe the best path will be to calculate the emissions over time when transitioning the TCNJ vehicle fleet to carbon neutral standards.

What it will look like



Supported User Queries:

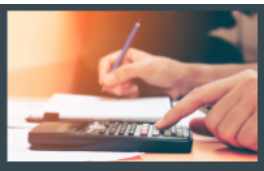
User:

1. The user would be able to enter their current fleet by vehicle category (Passenger, Public Safety, Pick up Truck, etc.) and their vehicle type (ICE, Hybrid, Zero).
2. The user would then enter their end year and the fleet they would like to have by that year.
3. The user can then hit submit and our application would generate a report showcasing the most optimal path the user could take while balancing emissions and costs.

Admin

1. The admin will be able to view and edit the database, as well as use the emissions calculator.

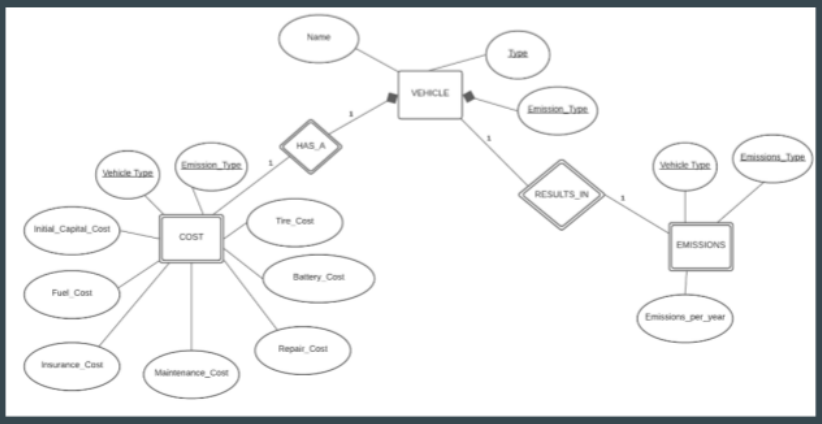
How will we calculate the best path?



- Two charts, both with a X-axis representing “Start year” to “End year”, Y-axis = “Cost” or “Emissions”
- The system will automatically calculate the cost/emission at Start Year and End Year using the Excel data provided
- To illustrate the transition from the Start Year’s vehicle fleet to the End Year’s vehicle fleet, the system will assume a straight-line adjustment for each year (Ex: replace one start-year specific vehicle with a vehicle of similar Initial Capital Cost)
- This, in turn, will calculate how to find the best path to transition in terms of which vehicles need to transition to carbon neutral options over time

ER Diagram

- Strong entity:
  - Vehicle
- Weak entities:
  - Cost
  - Emissions



Relational Schema

- Vehicle: contains 2 primary keys
  - Type & Emissions Type
- Cost: contains 2 foreign keys
  - Vehicle Type & Emission Type
- Emissions: contains 2 foreign keys
  - Vehicle Type & Emission Type

Thank You

Questions, comments?

What do you believe to be the best path in transitioning the vehicle fleet into a carbon neutral future?