02-7

Vehicle Fleet

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Executive Summary

Need

The stakeholder for this project is TCNJ who can use this project to assist in managing the vehicle fleet of the college. Maintaining an expansive vehicle fleet is costly in terms of economic and environmental cost. In terms of economic cost there are high initial costs of purchasing the vehicle as well as fuel costs and maintenance costs. These costs can add up to be a major cost for the college. In terms of environmental costs many of the vehicles release greenhouse gasses. These gasses are harmful to the environment and greenhouse gasses from transportation are one of the most major causes of climate change. Therefore it is imperative that the college have a vehicle fleet composition that provides the least cost in terms of both economic and environmental cost.

Approach

In order to obtain the composition that provides the least cost, we provide an application where one can clearly view relevant information. Our project allows users to view all relevant information pertaining to each vehicle in a clearly formatted table. In order to get the most relevant information that the user wants to see there are multiple options for filtering which information is displayed in the table. These options are filtering to only see vehicles of a specific make, a specific engine type, and being able to filter by year and amount of emissions. We also provide an about page which provides the user with additional context about the engine types used in the college's vehicle fleet. With all this information it is easy to get a clear picture of the most optimal composition of the college's vehicle fleet. It can clearly be seen which makes and engines are the most expensive and generate the most emissions through filtering by make or engine. It also can clearly be seen which year of vehicle is better for cost as well as which vehicles cause the most emissions through the filters for those options.

Benefits

Nowadays, climate change has become a huge concern for our world and this change can impact the world and the society in so many negative ways. Therefore, it is important for the campus and us as individuals to focus on the sustainability aspect that can prevent us from warming our planet. Looking at the benefits of our projects, the value of our product encompasses many concerns and provides the consumer a newly improved solution to the vehicle fleet in 2 ways. One of the benefits focuses on sustainability. Through our project, we show ways where TCNJ can be a sustainable vehicle fleet operation. Another benefit that we focus on is economic feasibility. Not only are we finding the eco-efficient way to run the vehicle fleet but we are also making sure to save money. These benefits are furthered by the ease of use and understanding of our application.

Cost

The stakeholder for this project is TCNJ and our project approach will be a separate new website. We have already developed the website and database. Therefore the user will not need to spend the time and cost doing so. Our build_db and insert_db files create and populate the database making it so the user does not have to spend the time and effort doing this as well.

Project Proposal and Specifications

Problem Statement

The general problem we are addressing is the optimal composition in The College of New Jersey's (TCNJ) vehicle fleet. The vehicle fleet consists of 9 different vehicle types that may or may not be the most economically or environmentally efficient fleet. The make year of the vehicles range from 1994-2020 and TCNJ uses petroleum, electric, and hydrogen to fuel their vehicles. We will be developing our own analysis, using fundamental accounting ideas, to develop a cost-benefit analysis for the make and model of cars across the different categories. Considering the age and fuel consumption of the current fleet, along with the issues and ideas on a more global scale, the vehicles seem to have the problem of not being the most environmentally efficient, which segways us into the financial problem of maintaining the "most environmental benign composition," which in turn lead to the final problem of determining the best overall composition. We will delve into the environmental impact of each fuel type to determine the most environmentally friendly fuel, while also determining whether the environmental benefits of the fuel support the economic cost of the fuel.

Objective

The objective of our model is to give us clear, simple answers on the financials and utility behind each scenario. To achieve this model, some of the questions we have to answer are: What are the operational costs to keep and maintain each vehicle? What is the average expected life span of these vehicles? Are there better options or alternatives that could save us money? What is the cost for fuel for each vehicle? Would it be cheaper to switch to a different fuel source? Since we are at the start of the project these are just some initial questions we have that need to be solved. As we dive deeper into the project and find more information we expect more questions to be arised along the way.

End Product and Development

The goal of our research is to identify the job each vehicle is used to perform and select the vehicle TCNJ should utilize based on our cost-benefit analysis. After completing our evaluations and taking additional factors into account, we will be able to identify which vehicles TCNJ should continue to use and which vehicles TCNJ should look into replacing. These would be vehicles that are not economically or environmentally stable by our cost-benefit analysis. Finally, we will offer a recommendation on vehicles that fit the mold of being economically and environmentally sustainable that TCNJ can consider to use as replacements. By doing this, the college will become as efficient as they can be in vehicle fleet management as they will have the lowest possible economic cost and the highest possible environmental sustainability, which is the ultimate goal.

All of this information, including the research and proof behind it, will be neatly compiled on multiple webpages. The raw data will also be available for viewing on an additional page. There will be an interactive form where users can choose a vehicle category and a specific make and model. From that, a cost-benefit analysis will be performed and an efficiency score will be calculated and displayed. All vehicles fitting the selected criteria will be queried and displayed to the user. This use case will be available for both economic efficiency and environmental impact.

Importance

This project has a great deal of importance on this campus. In a time when rhetoric surrounding climate change is demanding immediate change, it is critical that a college campus, such as TCNJ, analyzes operations that could potentially negatively contribute to the current climate situation. Sustainability should be a goal for any college campus, and this project will attempt to show ways in which TCNJ can remain a sustainable vehicle fleet operation in years to come. Another important aspect of this initiative is the economic feasibility. At any college campus, there is a finite amount of funding to support campus operations. While it is important to find the most eco-efficient way to run the vehicle fleet, the amount of money needed must also be considered. In addition, it is always important to find ways to save money in any project of this caliber. Thus, there are to be two solutions: one that addresses environmental concerns, and one that addresses economic concerns. From this, there is a possibility that one solution could be derived: one that best encompasses both objectives simultaneously.

In order to accomplish two viable solutions that advance the quality of TCNJ's vehicle fleet, we will need to use quite a bit of data. Some of this data is already provided through TCNJ's Collaborating Across Borders (CAB) vehicle fleet spreadsheet. There is a wide range of data provided in this spreadsheet. This includes general information about the vehicles in the fleet, such as year, make and model. In addition, other information about the vehicles unrelated to physical characteristics are included, such as cost of fuel, types of fuel used, maintenance costs associated with the vehicles, depreciation on the vehicles, and the expected useful life of each vehicle. There are a few different types of fuel used, as noted. These types of fuel include ICE petroleum, hybrid petroleum, electric, and hydrogen. Another metric on the CAB spreadsheet covers emissions based on fuel types. All of this data has been collected previously by TCNJ, and it is used to maintain the vehicle fleet status over the years.

Research

Despite all of this information being relevant and important to this project, there are still other areas where data collection is needed. These areas relate to data on the spreadsheet, such a fuel and vehicle utility. In regards to fuel, we will need to know the mechanics of refueling the vehicles, such as how often refueling is necessary. This metric will likely be different across the board, as there are nine different types of vehicles in the fleet. We will also need to know more about the vehicles themselves, what they are used for specifically, and how often they are used. Another area we will research is if there exist other fuel alternatives that satisfy our objectives. That is, a fuel that is the most cost-effective, and a fuel that is the most environmentally friendly. There likely will not be a fuel that accomplishes both objectives, and there is a possibility that there are no other fuel alternatives that satisfy each objective.

Other Systems

Our application differs from other systems in that we will be performing not just cost analysis or not just sustainability analysis but will be focusing on both. Many other similar systems we found focused on either analyzing cost or analyzing sustainability separately. Our application will be a one stop place where both could be analyzed allowing the user to get a clear sense of what is the most economical and sustainable approach to TCNJ's vehicle fleet.

Other Applications

Our solution is easily modifiable and reusable. Simple migration commands allow for new data and/or columns to easily be added allowing the database to still be used as more data related to TCNJ's vehicle fleet becomes available. The database being searchable and sortable as well as allowing large columns of data to be stored make the data easily accessible to be modified. The database and the application itself is general purpose and could be used for other similar domains, such as analyzing the vehicle fleets of other universities or transportation industries.

Performance

In terms of performance, the datasets provided to us are not intensive which results in the runtime not being an issue. However, all our database design decisions will be made under the assumption that more data will be available in the future. In addition, all queries will be written using an efficient algorithm, resulting in providing the user with the correct result set faster, which makes the application seem faster to the user. Furthermore, the application will also be thoroughly tested and all bugs will be addressed, leading to a pleasant user experience.

Security

A database usually holds confidential and sensitive information, therefore making it a prime target for cyberattacks. Therefore security is highly important in database management because the information stored in a database is very valuable. Our code will be contained in a private GitHub repository that can only be accessed by our group members. And the database itself will be accessible through PgAdmin, which can be viewed only after a user logs in. Additionally, in order to avoid harm from malicious data uploads, the queries will have a built in sanitization system and all the data available will be manually updated through the code itself rather than the application, therefore data can be updated only by people with access to the code. Furthermore, we will be implementing a log in system to ensure only authorized users have access to the data after our project is delivered to TCNJ Facilities.

Backup and Recovery

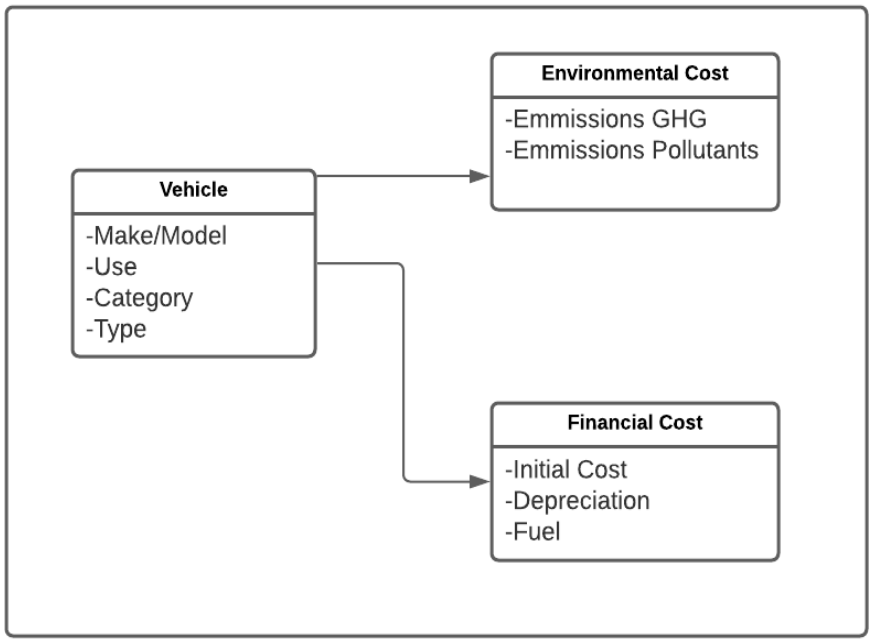
All of our project code will be stored on Github which stores all files on their servers. Therefore, regardless of whatever possible error happens on our local machines, the code will always be backed up on and easily restored from Github's servers. For the database itself, the pg_dump command can create a file of SQL commands. This file can be used to restore the database in the state it was in at the time the command was used. The data itself will also be stored separately in a CSV file so regardless of what happens to the database the data itself will always be safely stored and easily recoverable. The application will run off of a database that is accessible through a separate browser, ensuring an extra copy is always present.

What We Need to Learn

This project will require a lot of skills that the team does not yet possess. Our general understanding of databases is still very limited at this time, so we will need to increase our overall knowledge of databases and how they work. With that, we need to learn how to load in initial data, and how to quickly add more if a new data set was released. Also, knowing the SQL language and

how to write in it is highly important. Because of this, we will all independently be learning SQL through LinkedIn Learning.

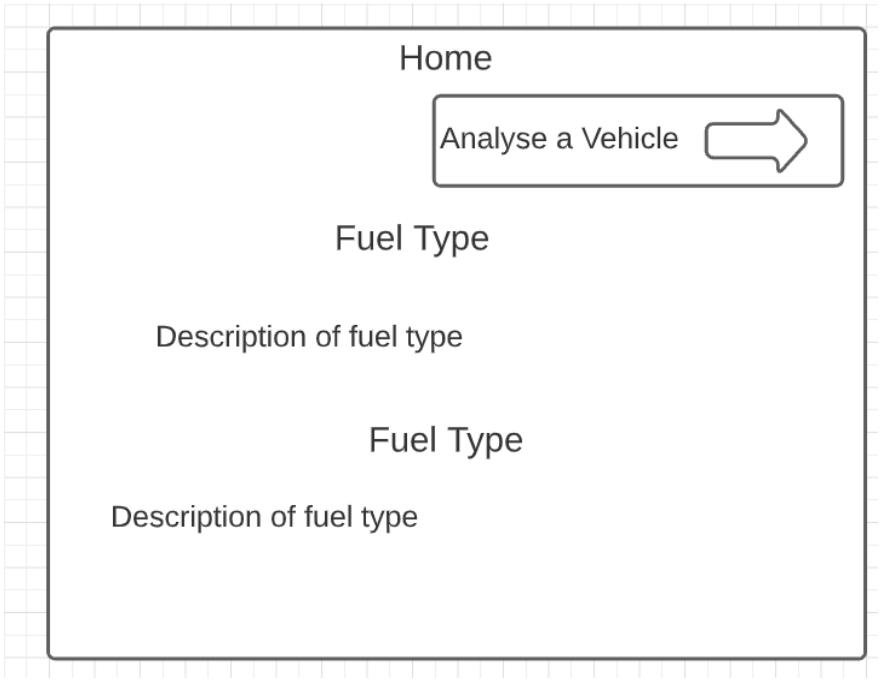
Diagram

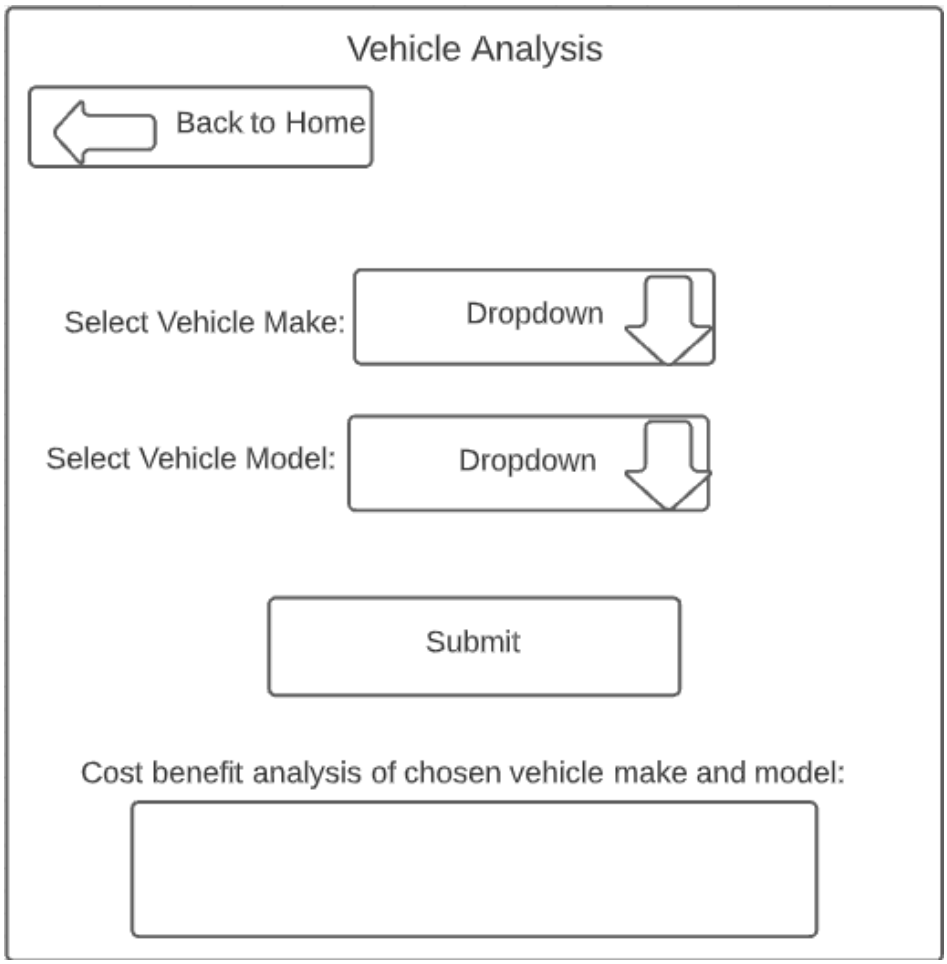


Use Cases

Users can read about fuel types and each one's environmental impact on the home page of the application. On another tab, users will be able to select a car type from the drop down menu and then select a car make and model. After pressing submit, the user will be shown the result of a cost-benefit analysis.

UI Mockups


Home
Analyse a Vehicle
Fuel Type
Description of fuel type
Fuel Type
Description of fuel type


Vehicle Analysis
Back to Home
Select Vehicle Make:
Dropdown
Select Vehicle Model:
Dropdown
Submit
Cost benefit analysis of chosen vehicle make and model:

Quad Chart

TCNJ Vehicle Fleet

Ben Lifshey, Colleen Rauch, Jason Tango, Joseph Schlageter,
Michelle Naval, Nicole Kondrk, Nallu Muthukumar

Need

- Consumers need a newly improved solution to the vehicle fleet that is cost-effective
- A more environmentally sustainable plan is needed to mitigate the carbon footprint of this campus

Approach

- Creating two solutions to address two different needs: economic sustainability and environmental sustainability
- Using current data and researching to find more data related to the improvement of the vehicle fleet
- Combining knowledge about databases and financial analysis to bring an elevated skill set to the problem

Benefit

- Stakeholders can benefit from a plan that has potential to be sustainable for a great length of time
- This plan encompasses many concerns, and it addresses concerns in the two main areas that are potential problem areas

Competition

- This plan has benefits that consider sustainability in the future
- Competition could stem from unwillingness to participate from other members of the TCNJ campus
- This plan's benefits outweigh those of the competition, as there are two distinct solutions that address prevalent concerns

02/06/2022

Proposal Pitch Presentation

TCNJ Vehicle Fleet

Ben Lifshey, Colleen Rauch, Jason Tango, Joseph Schlageter, Michelle Naval, Nicole Kondrk, Nallu Muthukumar

Problem Statement

- Our group will be addressing the optimal composition of The College of New Jersey's (TCNJ) vehicle fleet.
- Problem: Age and fuel consumption on the current fleet makes the vehicles not environmentally efficient.
  - This segways into the financial problem of maintaining the "most environmental benign composition," resulting in the final problem of determining the best overall composition.
- Solution: developing analysis using fundamental accounting ideas to figure out the best way for the management of these vehicles with finance or environment being the top priorities.

Objective

We will analyze and answer the following questions:

- What are the operational costs to keep and maintain each vehicle?
- What is the average expected life span of these vehicles?
- Are there better options or alternatives that could save us money?
- What is the cost for fuel for each vehicle?
- Would it be cheaper to switch to a different fuel source?
- Some initial questions we have brought up, as we dive further into our research we anticipate to come up with more questions that will need to be answered

End Product and Development

- Evaluate the performance of all 9 vehicles types from both a economically and environmentally sustainability standpoint
- Identify vehicles that are not economically and/or environmentally sustainable
- Advise TCNJ to replace vehicles with poor performance grades
- Suggest replacement options and plan to allow TCNJ to be as economically and environmentally sustainable as possible in terms of vehicle fleet management
- Neatly compile all findings and raw data on a user-friendly application with an organized database

Importance

- Determining plausible solutions to address concerns regarding the sustainability of the vehicle fleet
  - Environmental concerns
  - Economic concerns
    - Importance of considering all factors: all-encompassing solution

Research Plan

Data available:

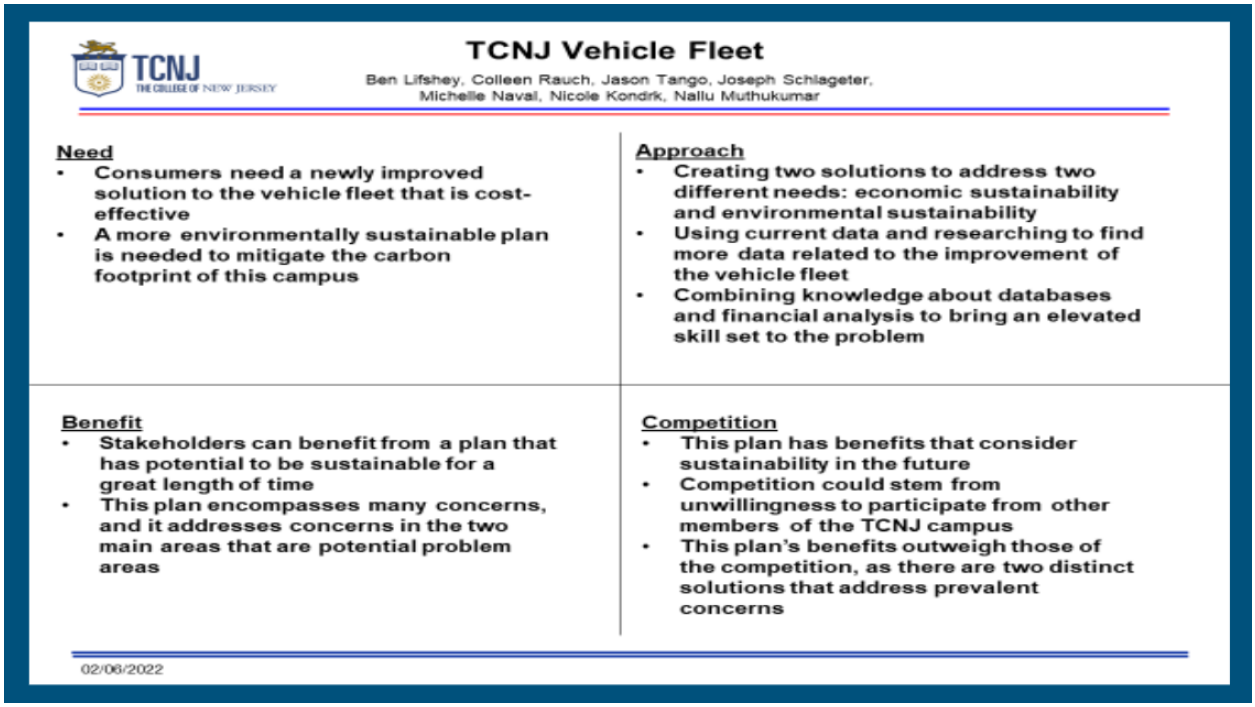
- From CAB fleet vehicle spreadsheet
  - Make, model, year
  - Cost of fuel
  - Types of fuel used (petroleum, electric, etc).
  - Cost of maintenance
  - Depreciation on vehicles
  - Anticipated service life

Research:

- Other data is necessary, including:
  - How long the fuel lasts in each vehicle
  - How often the vehicles are used
  - What they are used for
  - Alternatives that could be either more cost-effective or more eco-friendly
  - Other types of vehicles that can be added to the fleet

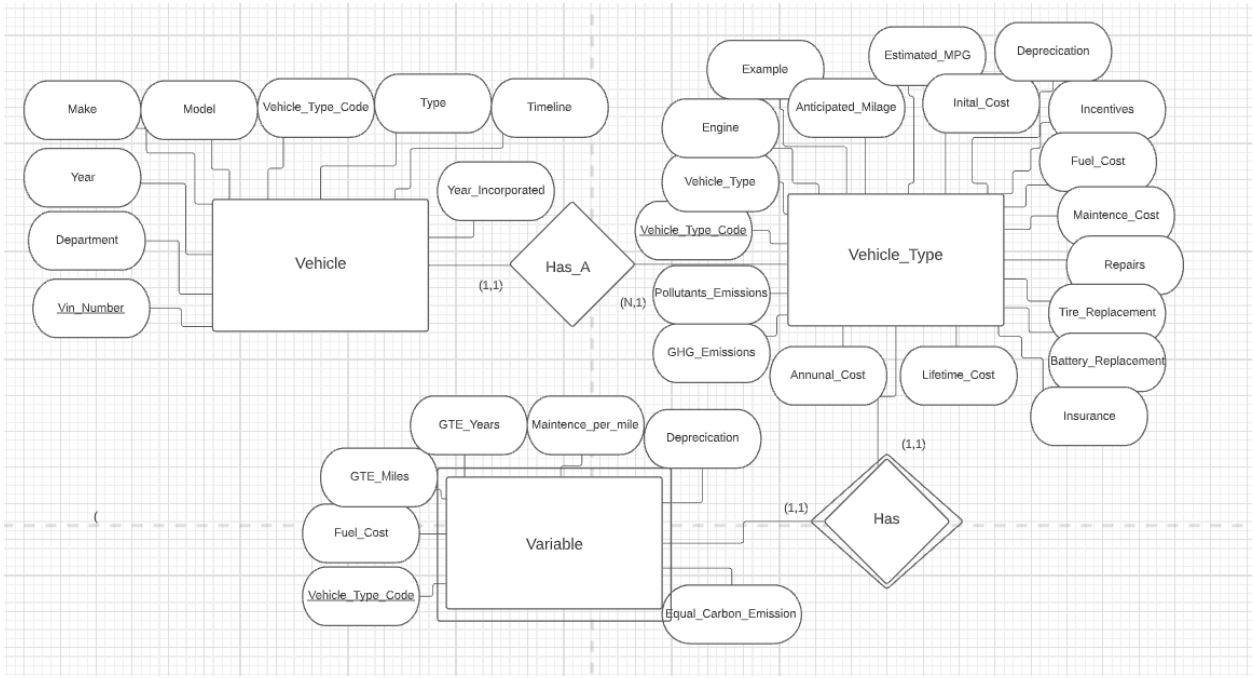
Similar Systems

- Similar systems perform analysis of cost or sustainability
  - Would have to use one system for cost and one for sustainability
- Our system performs analysis of both cost and sustainability
  - One system that can perform multiple analyses
- User will get a clearer sense of most optimal composition of TCNJ's vehicle fleet
  - Economic and environmental analysis



Design

ER model:



The actual, implemented ER diagram has these same attributes, but some of them have different names because of SQL reserved words.

Mapping to Relational Schema:

Vehicle

VIN_Number	Department	Year	Make	Model	Vehicle_Type_Code	Type	Time_Line	Year_Incorporated

Vehicle_Types

Vehicle_Type_Code	Vehicle_Type	Engine	Example	Anticipated_milage	Estimated_MPG	Initial_Cost	Depreciation	Incentives	Fuel_Cost

Maintenance_Cost	Repairs	Tire_Replacement	Battery_Replacement	Insurance	Lifetime_Cost	Annual_Cost	GHG_Emissions	Pollutants_Emisions

Variables

Vehicle_Type_Code	Fuel_Cost	GTE_Miles	GTE_Years	Maintenance_Per_Mile	Depreciation	Equal_Carbon_Emission

Estimates:

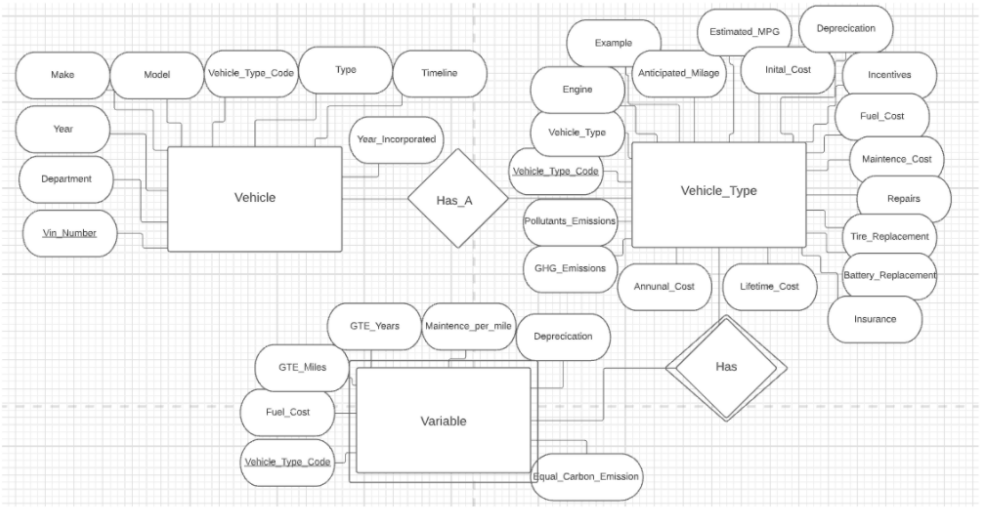
Total Number of vehicles: 97 * 3
Total number of vehicle type: 19
Total number of variables/assumptions: 4

Initial size: 291 + 19 + 4 = 392

Average user will complete 1-10 searches. There are only 19 possible search options.

<u>Mid-Semester Project Presentation</u>

ER Diagram



Relational Schema

Vehicle

VIN_Number	Department	Year	Make	Model	Vehicle_Type_Code	Type	Time_Line	Year_Incorporated

Vehicle_Types

Vehicle_Type_Code	Vehicle_Type	Engine	Example	Anticipated_milage	Estimated_MPG	Initial_Cost	Depreciation	Incentives	Fuel_Cost

Maintenance_Cost	Repairs	Tire_Replacement	Battery_Replacement	Insurance	Lifetime_Cost	Annual_Cost	GHG_Emissions	Pollutants_Emisions

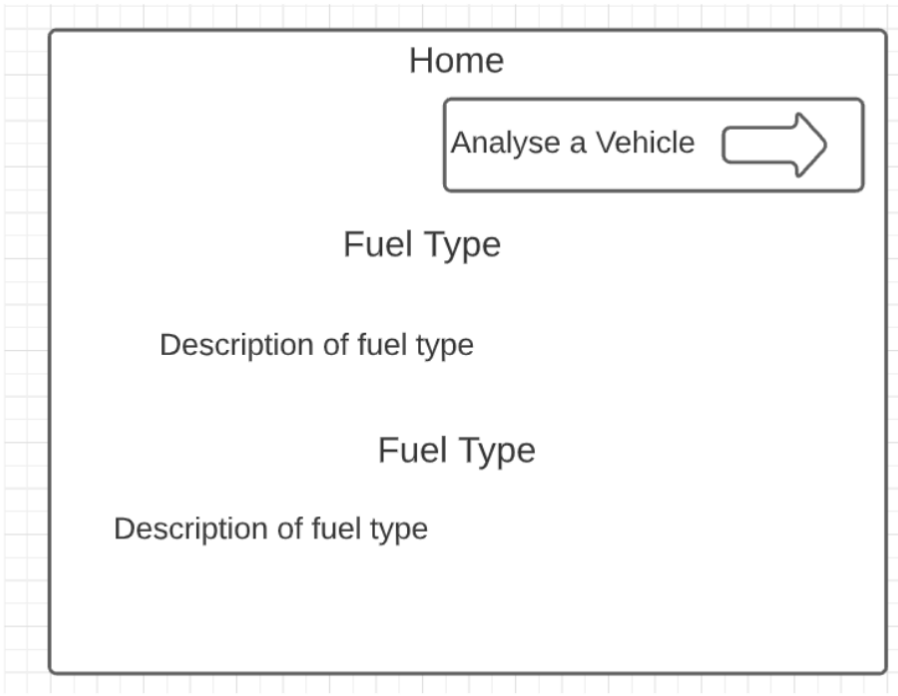
Variables

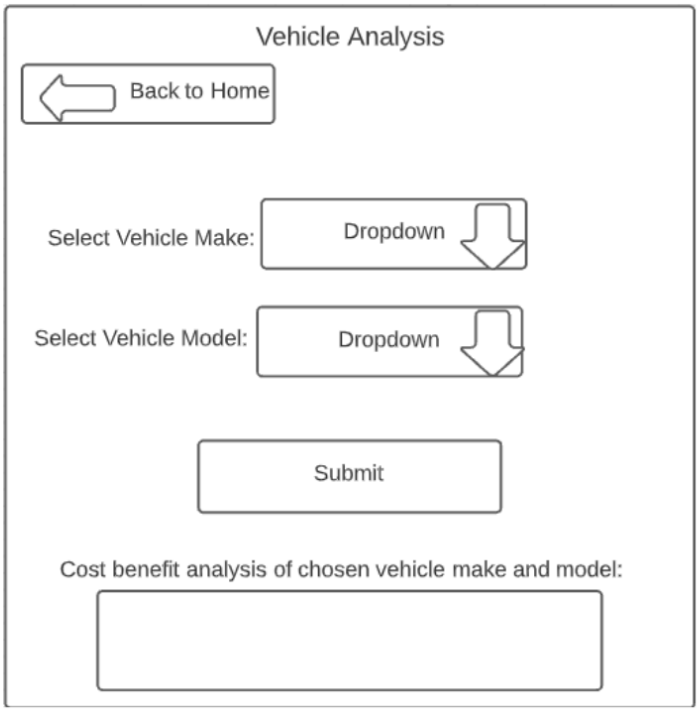
Vehicle_Type_Code	Fuel_Cost	GTE_Miles	GTE_Years	Maintenance_Per_Mile	Depreciation	Equal_Carbon_Emission

Supported Queries

- A user can select a car's make and model from the drop down menus
- After clicking on the "submit" button, the data corresponding to the selected vehicle type will be analyzed using an encoded cost-benefit algorithm
- The results will contain all the attributes stored about each vehicle, its corresponding type, and the related analysis

UI Mockups


Home
Analyse a Vehicle
Fuel Type
Description of fuel type
Fuel Type
Description of fuel type


Vehicle Analysis
Back to Home
Select Vehicle Make:
Dropdown
Select Vehicle Model:
Dropdown
Submit
Cost benefit analysis of chosen vehicle make and model:

Tables, Queries, and User Interface

Tables

```sql
CREATE TABLE Vehicle (
    Make varchar(50),
    Model varchar(50),
    Typev varchar(50),
    Department varchar(50) NOT NULL,
    VIN_Number int PRIMARY KEY,
    Yearv int NOT NULL,
    Vehicle_Type_Code int NOT NULL,
    Time_Line varchar(50) NOT NULL
);

CREATE TABLE Vehicle_Types (
    Vehicle_Type_Code varchar NOT NULL,
    Vehicle_Type varchar(50) NOT NULL,
    Engine varchar(50) NOT NULL,
    Anticipated_Mileage int NOT NULL,
    Estimated_MPG int,
    Initial_Cost int NOT NULL,
    Incentives int,
    Annual_Fuel_Cost int NOT NULL,
    Maintenance_Cost int NOT NULL,
    Repairs int NOT NULL,
    Tire_Replacement int NOT NULL,
    Battery_Replacement int NOT NULL,
    Insurance int NOT NULL,
    Lifetime_Cost int NOT NULL,
    Annual_Cost float NOT NULL,
    GHC_Emissions float,
    Vehicle_Type_Code int REFERENCES Vehicle,
    PRIMARY KEY (Vehicle_Type_Code)
);
```

```
CREATE TABLE Variables (
    Fuel_Cost int NOT NULL,
    GTE_Miles int NOT NULL,
    GTE_Years int NOT NULL,
    Maintenance_Per_Mile numeric(3,2) NOT NULL,
    Depreciation float NOT NULL,
    Equal_Carbon_Emission numeric(4,2),
    Vehicle_Type_Code int REFERENCES Vehicle_Types,
    PRIMARY KEY (Vehicle_Type_Code)
);

CREATE VIEW view1  AS
        SELECT *
    FROM Vehicle_Types NATURAL JOIN Vehicle;
```

Scripts

```
#get values from vehicle csv
vehicleFile = open("Vehicles.csv", 'r')
vehicleCSV = csv.reader(vehicleFile)

vehicleHeader = next(vehicleCSV)


#insert vehicles into database
for row in vehicleCSV:
    if(row[2].isdigit()): #if vehicle has year
        dbCursor.execute('INSERT INTO Vehicle(VIN_Number, Department, Yearv, Make, Model, Vehicle_Type_Code, Typev, Time_Line) VALUES (%s, %s, %s, %s, %s, %s, %s, %s)', (row[0
    else: #year assigned to zero if none given as yearv has to be an integer
        dbCursor.execute('INSERT INTO Vehicle(VIN_Number, Department, Yearv, Make, Model, Vehicle_Type_Code, Typev, Time_Line) VALUES (%s, %s, %s, %s, %s, %s, %s, %s)', (row[0
```

```
#get values from vehicle type csv
vehicleTypeFile = open("Vehicle_Types.csv", 'r')
vehicleTypeCSV = csv.reader(vehicleTypeFile)

vehicleTypeHeader = next(vehicleTypeCSV)

#insert vehicleTypes into database
for row in vehicleTypeCSV:
    if(row[6].isdigit() and row[4].isdigit()):  #if vehicleType has incentives and estimated mpg
        dbCursor.execute('INSERT INTO Vehicle_Types(Vehicle_Type_Code, Vehicle_Type, Engine, Anticipated_Mileage, Estimated_MPG, Initial_Cost, Incentives, Annual_Fuel_Cost,
    elif(row[6].isdigit()): #incentives given but estimated_mpg not given
        dbCursor.execute('INSERT INTO Vehicle_Types(Vehicle_Type_Code, Vehicle_Type, Engine, Anticipated_Mileage, Estimated_MPG, Initial_Cost, Incentives, Annual_Fuel_Cost,
    else: #incentives assigned to zero if none given as attribute has to be an integer
        dbCursor.execute('INSERT INTO Vehicle_Types(Vehicle_Type_Code, Vehicle_Type, Engine, Anticipated_Mileage, Estimated_MPG, Initial_Cost, Incentives, Annual_Fuel_Cost,
```

```
#get values from variables csv
variableFile = open("Variables.csv", 'r')
variableCSV = csv.reader(variableFile)

variableHeader = next(variableCSV)
#print(variableHeader)

#insert variables into database
for row in variableCSV:
  try: #carbon emissions and fuel cost are given
    float(row[6])
    dbCursor.execute('INSERT INTO Variables(Vehicle_Type_Code, Fuel_Cost, GTE_Miles, GTE_Years, Maintenance_Per_Mile, Depreciation,Equal_Carbon_Emission) VALUES (%s, %s, %s,
  except: #carbon emissions are not given
    dbCursor.execute('INSERT INTO Variables(Vehicle_Type_Code, Fuel_Cost, GTE_Miles, GTE_Years, Maintenance_Per_Mile, Depreciation,Equal_Carbon_Emission) VALUES (%s, %s, %s,
dbCursor.close()
dbConnection.close()
```

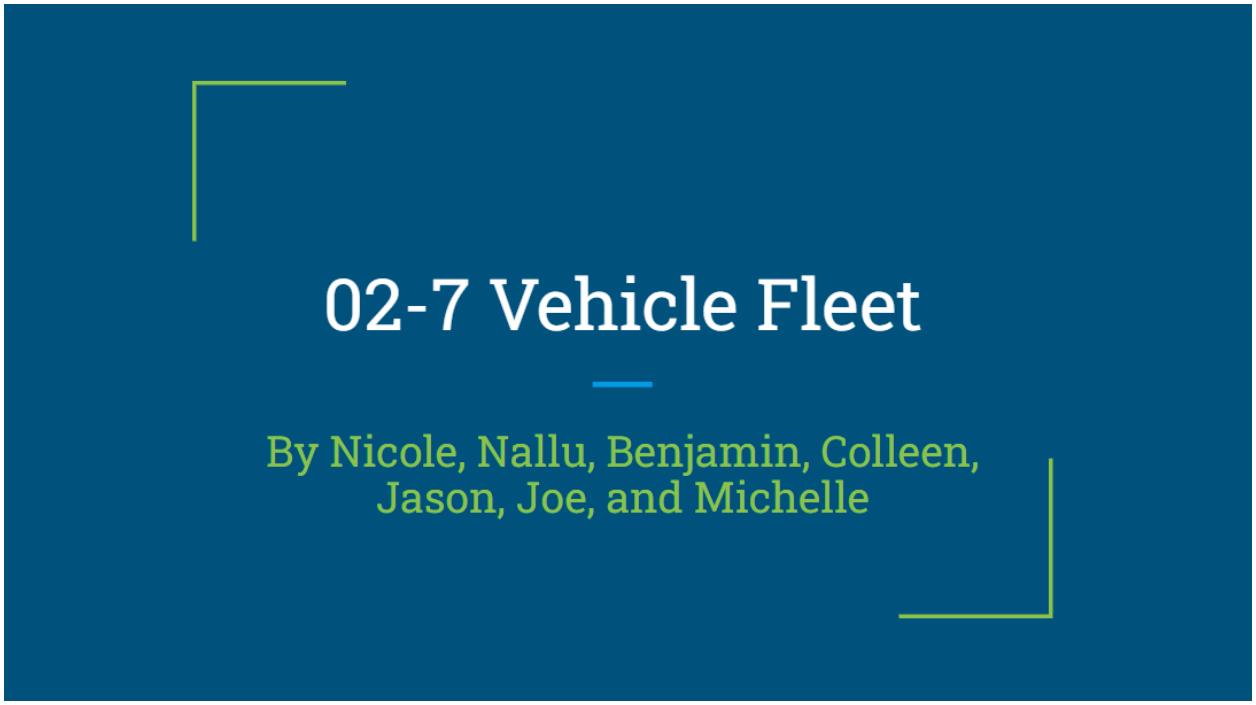
Queries

```sql
SELECT Initial_Cost, Annual_Cost, Lifetime_Cost, GHG_Emissions
FROM view1
WHERE make ILIKE 'ford%' AND model ILIKE 'explorer%';


SELECT *
FROM view1
WHERE make ILIKE 'ford%' AND model ILIKE 'explorer%';


/* sort by engine type */
SELECT Make, Model, Year, Initial_Cost, Lifetime_Cost, Annual_Cost, GHG_Emissions
FROM view1
WHERE Engine ILIKE 'PICE%';

/* table with all of them that sorts by age or efficiency */
SELECT Initial_Cost, Annual_Cost, Lifetime_Cost, GHG_Emissions, Timeline
FROM view1
ORDER BY ASC GHG_Emissions;
```

Maintenance

https://github.com/TCNJ-degoodj/cab-project-02-7

Final Project Demonstration

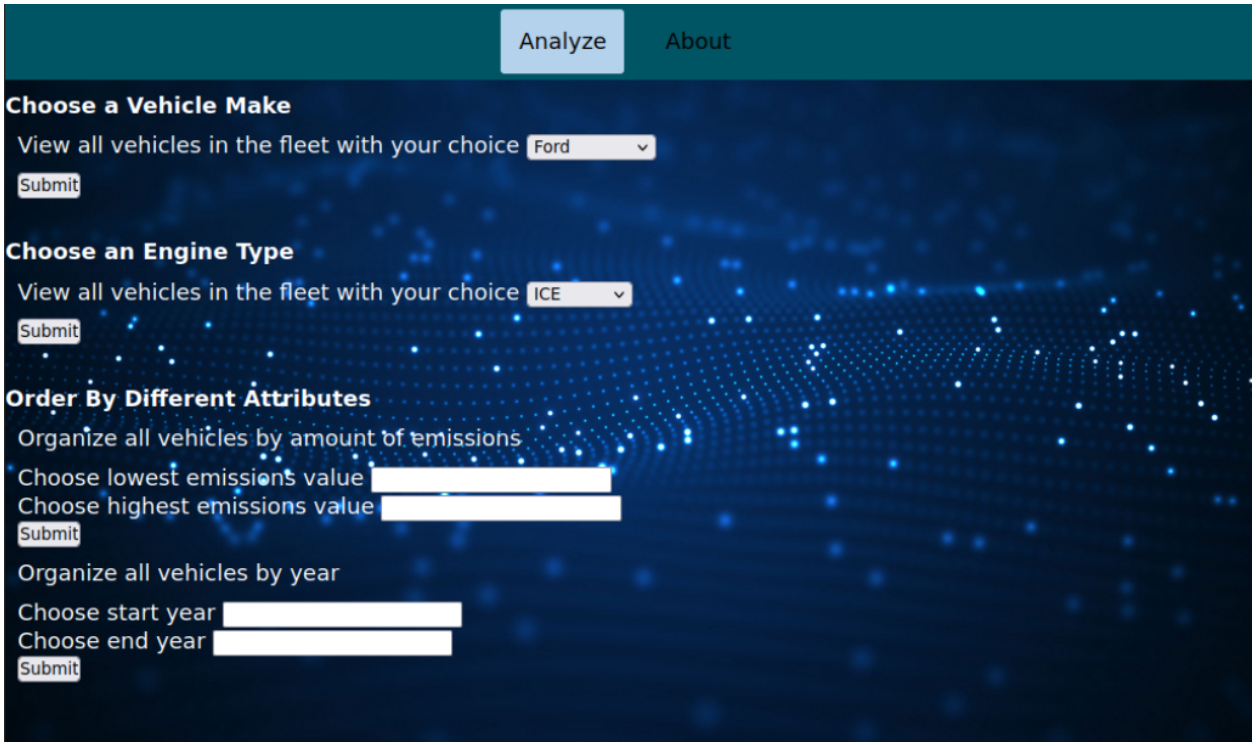


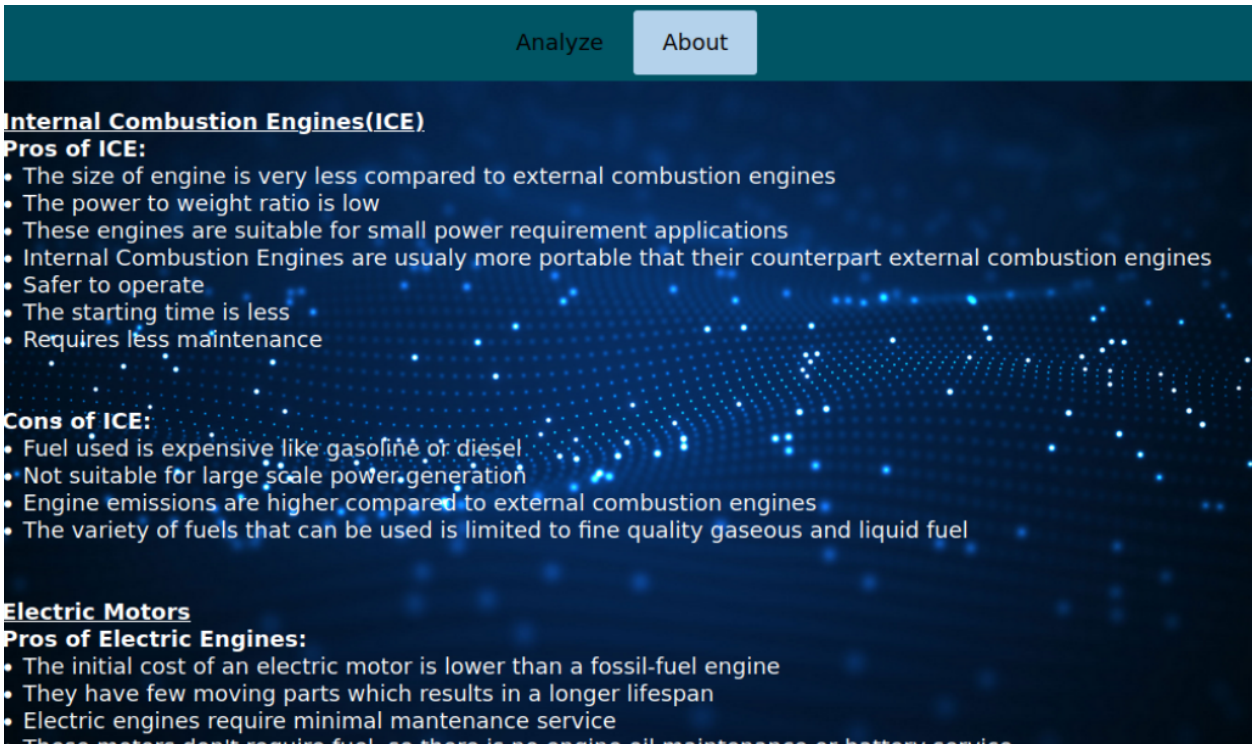
Need and Approach

- The stakeholder for this project is TCNJ who can use this project to assist in managing the vehicle fleet of the college
- Maintaining an expansive vehicle fleet is costly in terms of economic and environmental cost
- In order to obtain the composition that provides the least cost, we provide an application where one can clearly view relevant information
- Our project allows users to view all relevant information pertaining to each vehicle in a clearly formatted table

Costs and Benefits

- Separate new website
- build_db and insert_db files create and populate the database making it so the user does not have to spend the time and effort doing this
- Climate change has become a huge concern for our world and this change can impact the world and the society in so many negative ways
- It is important for the campus and us as individuals to focus on the sustainability aspect that can prevent us from warming our planet





Product Handover

https://github.com/TCNJ-degoodj/cab-project-02-7

https://github.com/TCNJ-degoodj/cab-project-02-7/releases/tag/v6.0.0