Spring 2022 Collaborative Project: Vehicle Fleet Management

Group 3

Team Members:
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Matt Machado, and Corinne Scheddin

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Executive Summary

NEED: For our project, we have the goal of finding the most cost effective and environmentally efficient method to manage the TCNJ vehicle fleet on campus. We established that TCNJ should suggest slowly transitioning from ICE vehicles to zero vehicles in the fleet. To accomplish this, we have created a database that can showcase the different costs and environmental impacts on various proposed and future vehicles the campus intends to have in the fleet. Ultimately, we have provided a database with a user interface that allows the user to observe different characteristics of TCNJ's fleet in order to make informed decisions on how to reach TCNJ's goals. Our Stakeholders would include the TCNJ community and Paul Romano. Stakeholders would include any person or group affiliation that would use the cost/environmental information to make decisions about the TCNJ fleet..

APPROACH: In order to achieve our goal of finding the most cost effective and environmentally friendly method to manage the TCNJ vehicle fleet, we have created a database that allows the user the ability to observe various information regarding TCNJ's fleet vehicles at different stages. These stages include current, proposed, and future. The database can also be used to group the vehicle's by department. The user interface allows the user to compare different vehicles and their corresponding impact on TCNJ financially and the greater community. Our approach is unique as it gives options to show ALL vehicles no matter the stages (current, proposed, future). This will give accurate information and comparison of costs and carbon emissions for vehicles.

BENEFITS: The main benefit to the creation of this interface is that the user can group different vehicle's and establish different effects due to different variables. Our interface is valuable to TCNJ because there are no other websites that offer a user interface of TCNJ's fleet or has the

capability to create these comparisons. Alternatives do not offer the drop down menus available in our query which gives an advantage to our interface over the status quo.

COST: The approach we created is a completely new website and user interface. This would be the first website to showcase data for TCNJ fleet management. The cost to implement this interface would be a PC or VM that runs Linux. Additionally, since an interface like this does not currently exist, there could be a time-cost. This means that there can be a loss of time due to the need to learn how to use our interface.

Elaboration: Project Proposal and Specifications:

Problem Statement

For our project, we have been tasked with finding a more cost effective and environmentally friendly way for TCNJ's fleet to operate. In order to become more cost effective and better for the environment, we suggest slowly transitioning from ICE vehicles to zero vehicles. By doing so over time, no large budget will need to be immediately created. Instead, money shall be allocated per year for the entire transitioning period. This transition period may last 20+ years. ~~Our plan to achieve this involves retiring the older vehicles first and replacing them with zero emission vehicles.~~ Our plan to achieve this involves retiring the vehicles with most usage first, and replacing them with zero emission vehicles. This will allow for a slow, steady replacement of vehicles in order to avoid having the school have high expenses and be able to make the most use out of the current vehicle fleet before replacing them. This will allow newer vehicles to continue in operation, and keep replacement costs as low as possible. We will need to be able to keep track of costs such as fuel costs, and maintenance costs in the module to ensure that we are being cost effective as we create a more environmentally friendly fleet of vehicles.

Objective

Our overall objective is to create a solution that will address how TCNJ can be more efficient in reducing emissions and simultaneously create a plan that will be cost effective for the school. Our specific objective for the module is to provide a database that holds data regarding TCNJ's vehicle fleet such as fleet fuel source and emissions and fleet service life and depreciation. The database will include a user interface that allows the user to input a year and retrieve information regarding TCNJ's vehicle fleet such as cost and percentage of emission.

This data could then be compared with previous and future years based on TCNJ's proposed transition to zero vehicles.

Description of the desired end product/ the part you will develop for this class.

We hope that our final database will help us solve the problem of creating a more cost effective and eco-friendly fleet for TCNJ. Our database should highlight different characteristics per vehicle for the proposal/future years. It should also specify what vehicles will be the most cost efficient and environment safe options. The following elements will be major variables and output data needed to help solve the problem: fleet fuel source and emissions, fleet quantity and age, and fleet operational costs. By examining the variables and outputs, we will be able to properly determine which older vehicles need to be replaced first. The database will also provide costs such as fuel costs, and maintenance costs for the vehicles

Description of the importance/ need for the module/how it addresses the problem.

The module is necessary in addressing the problem because it provides information about how fuel source, emissions, age, quantity, and operational costs influences our solution. The module will also highlight the future plans for the vehicles and add a description to the proposed vehicles being put into place. Through our database, we will be able to illustrate how our plan for a slow integration of the new fleet will be the most beneficial to both TCNJ and the broader community. ~~The database will be able to show how using a FIFO method of inventory management will be a necessary process in order to replace older vehicles first, as older cars emit more emissions than more modernized vehicles. Additionally, it will highlight how straight-line depreciation will be most beneficial through a possible depreciation schedule.~~ We would like the database to highlight the vehicles usage levels in order to determine which vehicles should be phased out first, rather than the initial thought of doing a FIFO inventory phaseout. We are

switching to this method because different vehicles have different purposes, and some of the older vehicles aren't necessarily being used the most.

Plan for how you will research the problem domain and obtain the data needed

If we were to make a full transition to zero vehicles we would need to obtain current data of charging stations already available at the school. This would need to include how many charging stations are currently available and where they are installed. We would also have to research how installing more stations would impact the cost effectiveness of our plan (I.e. is there specific locations, cost constraints, other alternative power sources?) We would also need to research how different vehicles may emit different levels of emissions as this may impact our FIFO inventory restock and change which vehicles should be replaced first.

Other similar systems / approaches that exist, and how your module is different or will add to the existing system.

The module is different because it will be able to search for certain characteristics and for certain vehicles. The module will make it very easier to search the database to find the information that the user is looking for. The module will be much better than the database provided because the module will provide a user interface that will help the user find the information they are seeking easily and it will help them find the characteristics that they are looking for on certain vehicles.

Possible other applications of the system

Solution could also be used to determine the monetary cost and environmental costs of other machines/equipment in other industries. For example, monetary and environmental costs of certain kinds of manufacturing equipment.

Performance

Performance should be good since the data set for the database would not be large. We would try to make our database as efficient by using an ER model. Most importantly we would want to optimize our queries to not only allow our database to perform more efficiently but also improve its performance as a whole.

Security

Github is a private repository not open to the public therefore it should be pretty secure when creating our database. We could also create an administrator system which would only allow those with access to edit the database thus separating the web servers from the database. When the database is used by TCNJ, we would incorporate the use of administrative accounts and consumer accounts. Also, the use of password authorization would keep our database secured as well when it is used outside of Github.

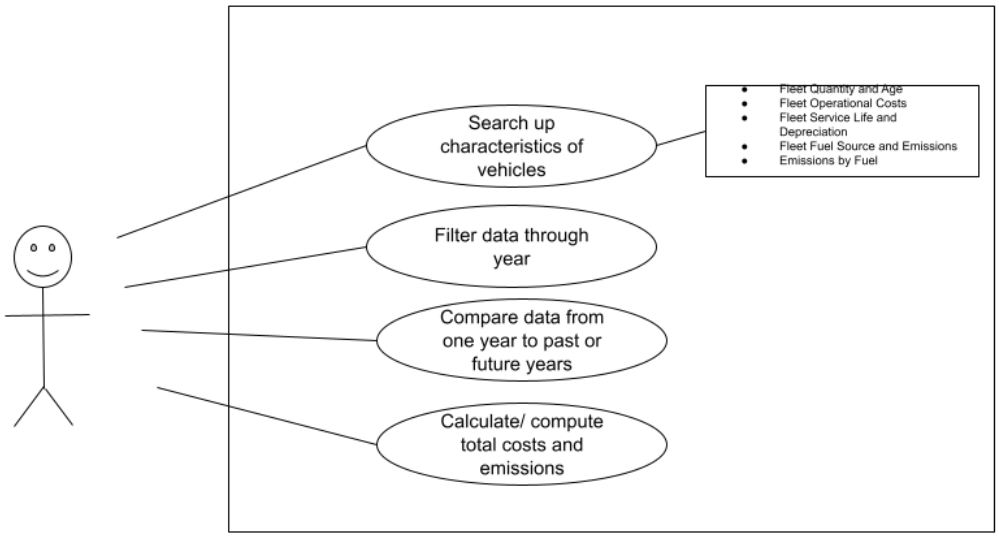
Backup and recovery

Github has backup capabilities that will allow us to be able to recover source code and update our source code. Additionally, we could develop a backup plan, perform effective backup management and perform periodic database restore testing. When our database is used by TCNJ, we would still implement the effective back management practices with periodic database restore testing.

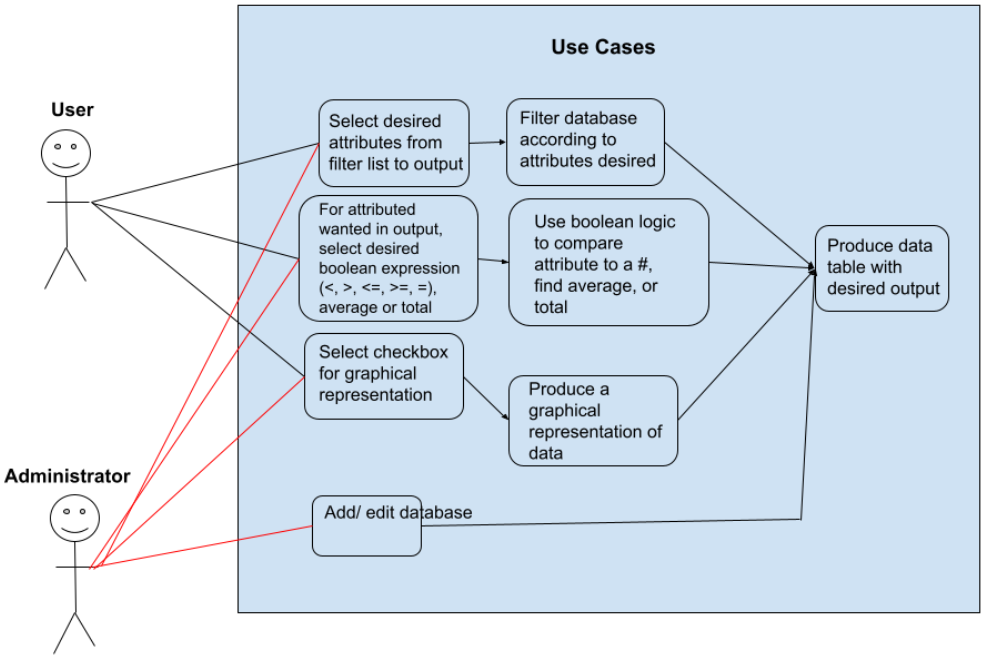
Technologies and database concepts the group will need to learn, and a plan for learning these

Our team would need to research various database models to find the most efficient way to hold our data, how to create a user and administrator interface that supports our database, and how to allow the user to filter the database in order to retrieve the desired information. In order to achieve this our team will also need to learn how to create efficient databases.

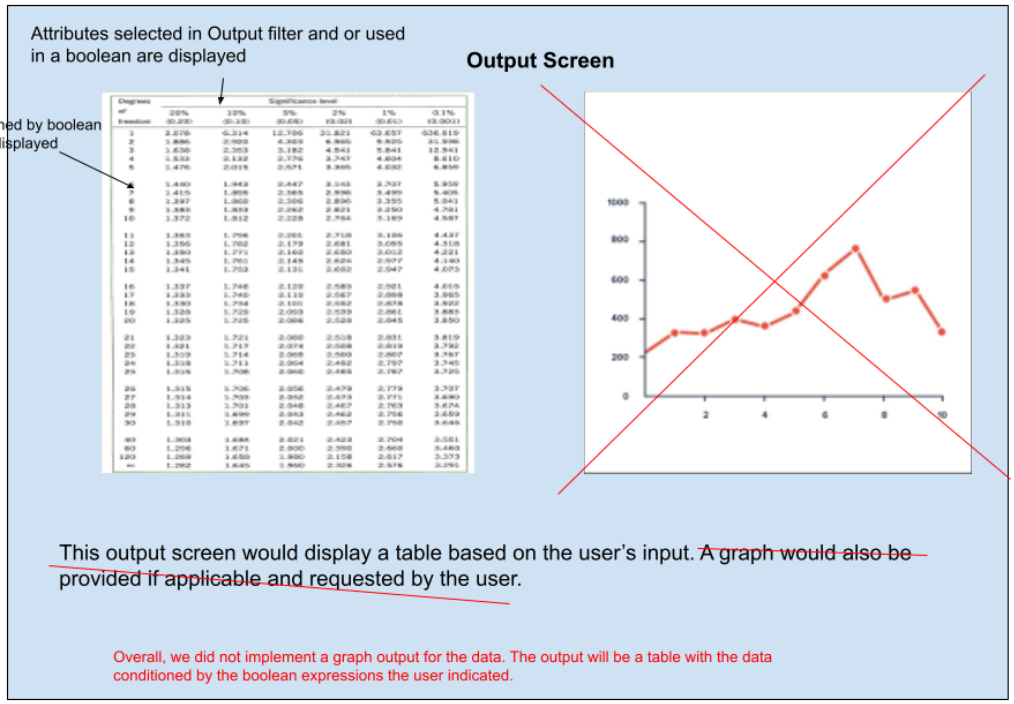
A diagrammatic representation of the system

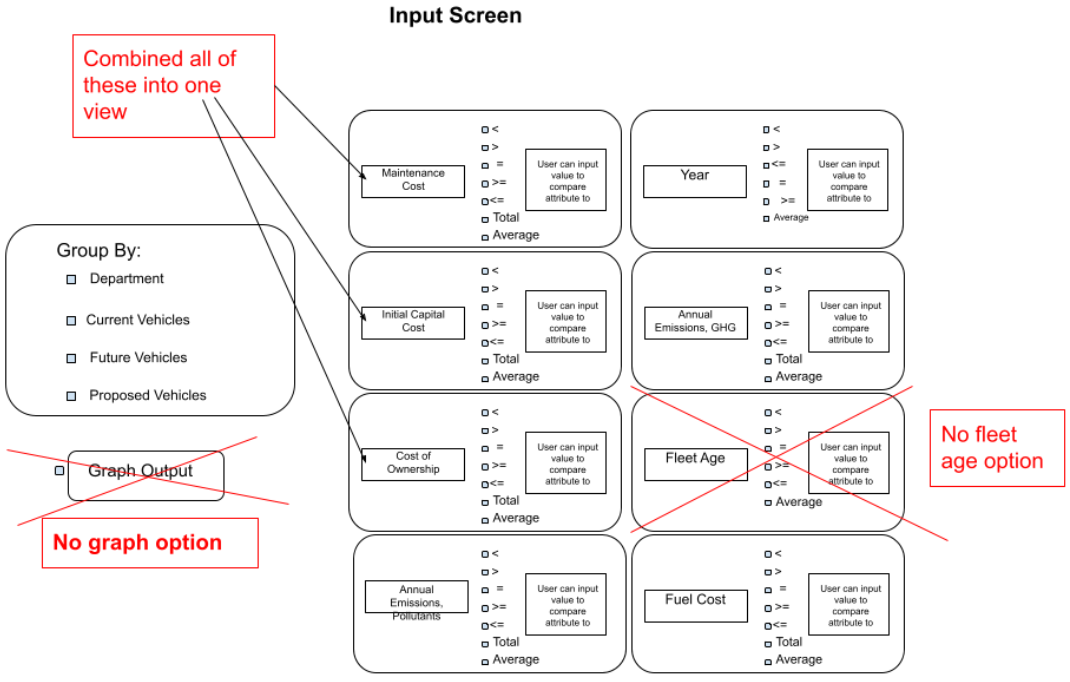


** Our revised diagrammatic representation is below*** We have added an Administrator view.



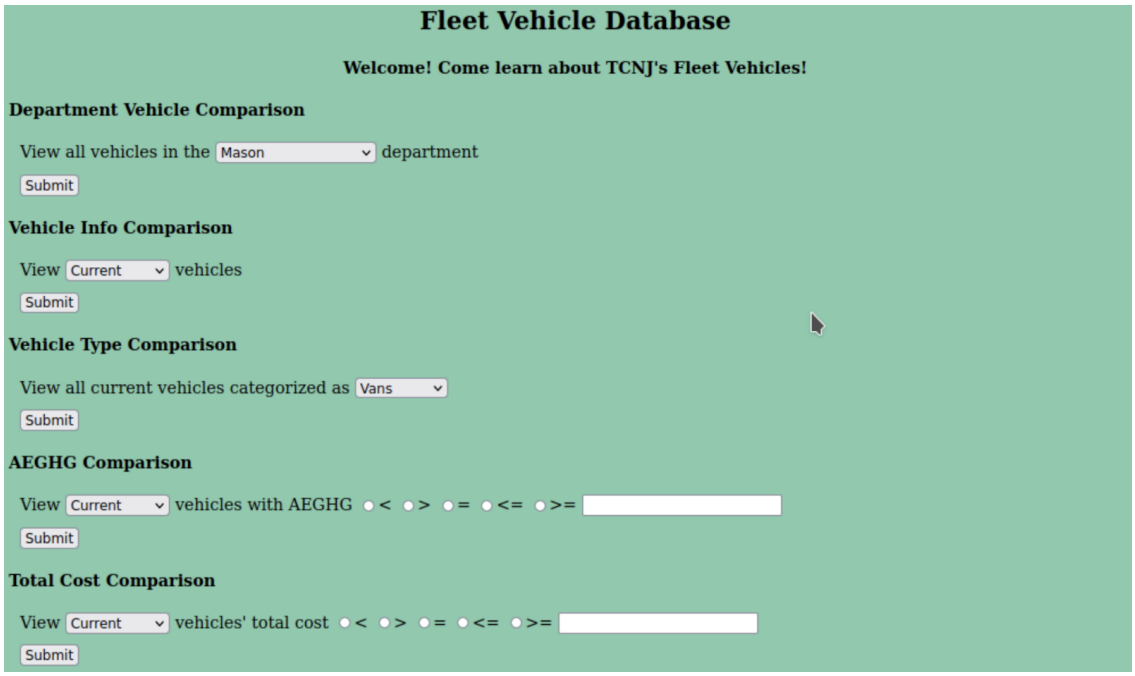
** We have also added an Input and Output Screen**





Overall, we changed the input screen to have 5 views that a user can query data from. The 5 views are Department Vehicle Comparison, Vehicle Info Comparison, Vehicle Type Comparison, AEGHG Comparison, Total Cost Comparison. All of these relations are present in one of the 5 views except Fleet Age.

** Our finalized database output on Github*



Vehicle_id	Category	Initial	Maintenance	Fuel	Total
189	F	51380.0	7200.0	0.05	58580.05
190	F	44900.0	7200.0	0.05	52100.05
191	F	44900.0	7200.0	0.05	52100.05
192	F	42000.0	7200.0	0.05	49200.05
193	F	16000.0	7200.0	0.05	23200.05
194	F	44900.0	7200.0	0.05	52100.05
195	F	44900.0	7200.0	0.05	52100.05
196	F	16000.0	7200.0	0.05	23200.05
197	F	16000.0	7200.0	0.05	23200.05
198	F	44900.0	7200.0	0.05	52100.05
199	F	16000.0	7200.0	0.05	23200.05
200	F	44900.0	7200.0	0.05	52100.05
201	F	16000.0	7200.0	0.05	23200.05
202	F	42000.0	7200.0	0.05	49200.05
203	F	42000.0	7200.0	0.05	49200.05
204	F	51380.0	12000.0	0.05	63380.05

Proposal Pitch Presentation (Slide Deck)

Fleet Management

Group 3: Paula Arroyave, James Blair, Faiza Hoque, Drake Lam, Nicole Lenge, Matt Machado, and Corinne Scheddin

Problem Statement

- Goal: Improve TCNJ fleet financially and environmentally
- Transition from ICE vehicles to zero emission vehicles
- FIFO method
- Straight line depreciation

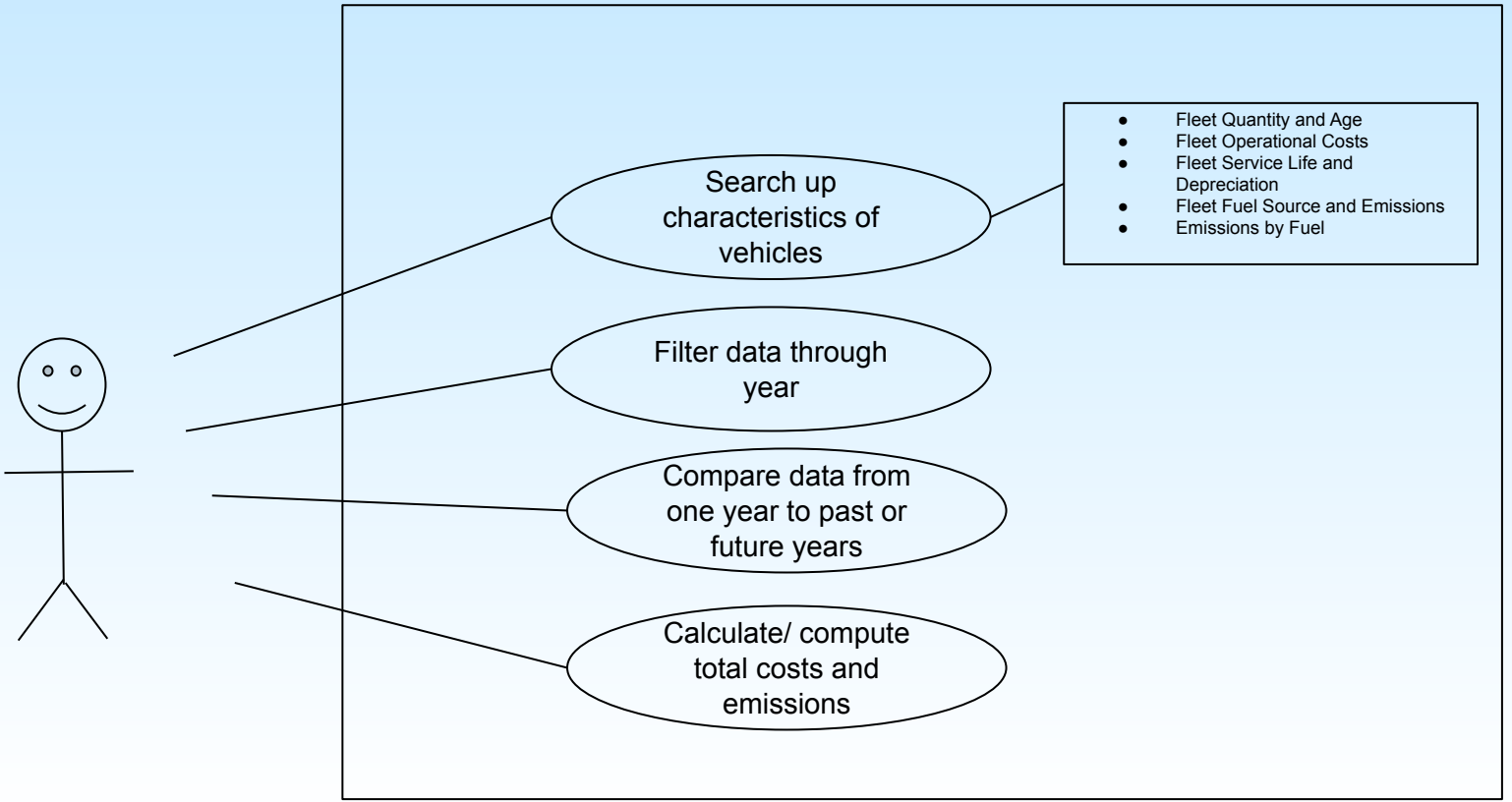
Objective

- **Overall:** create a solution that results in reduction of emissions while being cost effective
- **Specific:** provide a database with user interface that allow users to observe TCNJ's transition to zero vehicles through the years
  - Fleet Quantity and Age
  - Fleet Operational Costs
  - Fleet Fuel Source and Emissions

Desired End Product

- Our database should highlight different characteristics per vehicle for the proposal/future years.
- It should also specify what vehicles will be the most cost efficient and environment safe options.
- The following elements will be major variables and output data needed to help solve the problem: fleet fuel source and emissions fleet quantity and age, fleet operational costs.

Diagram


Search up characteristics of vehicles
Filter data through year
Compare data from one year to past or future years
Calculate/ compute total costs and emissions
Fleet Quantity and Age
Fleet Operational Costs
Fleet Service Life and Depreciation
Fleet Fuel Source and Emissions
Emissions by Fuel

Importance

- Module will keep track of fuel source, emissions, age, quantity and operational cost
- Highlight future plans
- Emphasize slow integration of new fleet
- FIFO method
- Possible depreciation model

Research Plan

- Obtain current data of charging stations already available at the school.
  - I.e. how many charging stations are currently available and where they are installed.
  - Impact the cost effectiveness of installation
- Variation of different vehicles and their impacts on emissions
  - I.e older vs. newer vehicles, vehicle type, etc.

Different from Similar Systems

- The module is different because it will be able to search for certain characteristics and for certain vehicles
- The module will make it very easier to search the database to find the information that the user is looking for
- The module will be much better than the database provided because the module will provide a user interface that will help the user find the information they are seeking easily and it will help them find the characteristics that they are looking for on certain vehicles

Other Applications of the System

- Our system determines monetary and environmental costs
- Can be applied to different kinds of machines/equipment in different industries given similar data and variables
  - Initial cost, depreciation, useful life, emission, make, model, etc.
- Ex: Manufacturing equipment

Fleet Vehicle Management

Group 3: Paula Arroyave, James Blair, Faiza Hoque, Drake Lam, Nicole Lenge, Matt Machado, Corinne Scheddin

Need

The customer needs an efficient, sustainable, and cost-effective strategy for the most economical composition of the TCNJ vehicle fleet. Along with developing an approach for the environmental conformation for the vehicle fleet.

Approach

The approach for addressing this is firstly transitioning ICE vehicles to zero vehicles. This will be done by using the FIFO method in retiring older vehicles and replacing those with zero vehicles first. Allowing for newer vehicles to continue operating smoothly.

Benefit

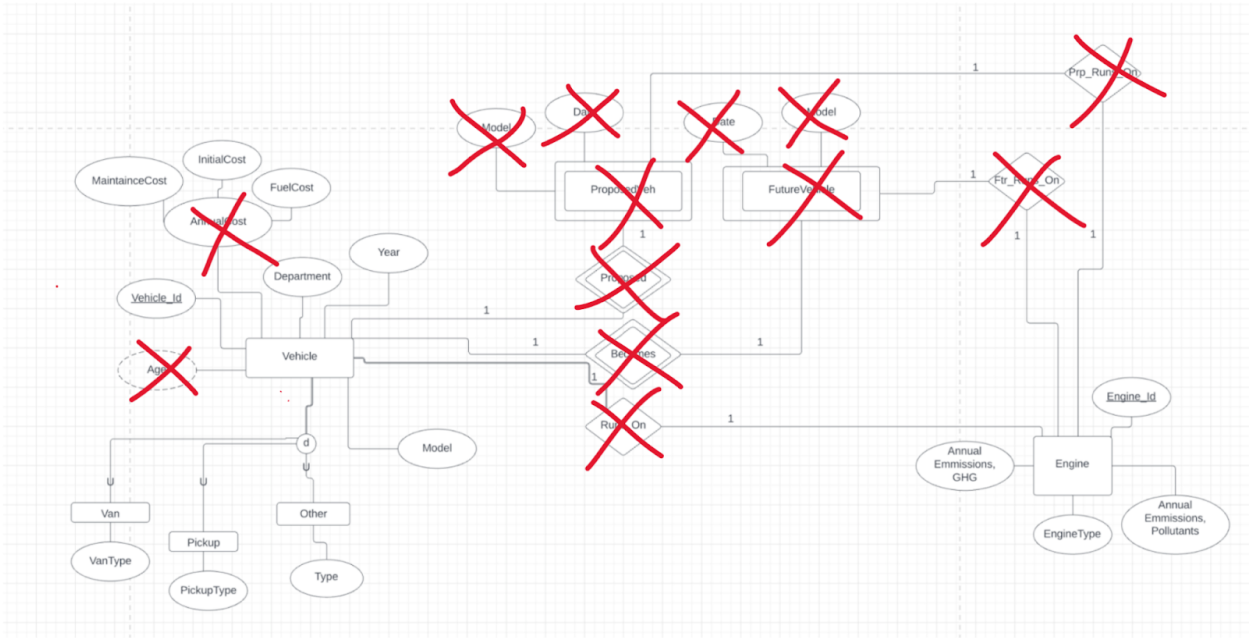
The specific benefits for the stakeholders would be the following: because of the proposed transition from ICE vehicles to zero vehicles this will cause money to be allocated annually for the entire transition period. No immediate budget is mandatory for this transition. The college's goal to reach carbon zero by 2040 will be feasible as well since this is a 20-year process.

Competition

The benefit of this approach is far superior to what others may propose because of the positive economic and environmental relationship. Different approaches can vary from rebuilding older models or decreasing the number of transportation vehicles being operated which would benefit the environment by less emissions but also put constraints on labor. Instead, the FIFO approach positively impacts the environment using minimal cost, and low constraints on labor.

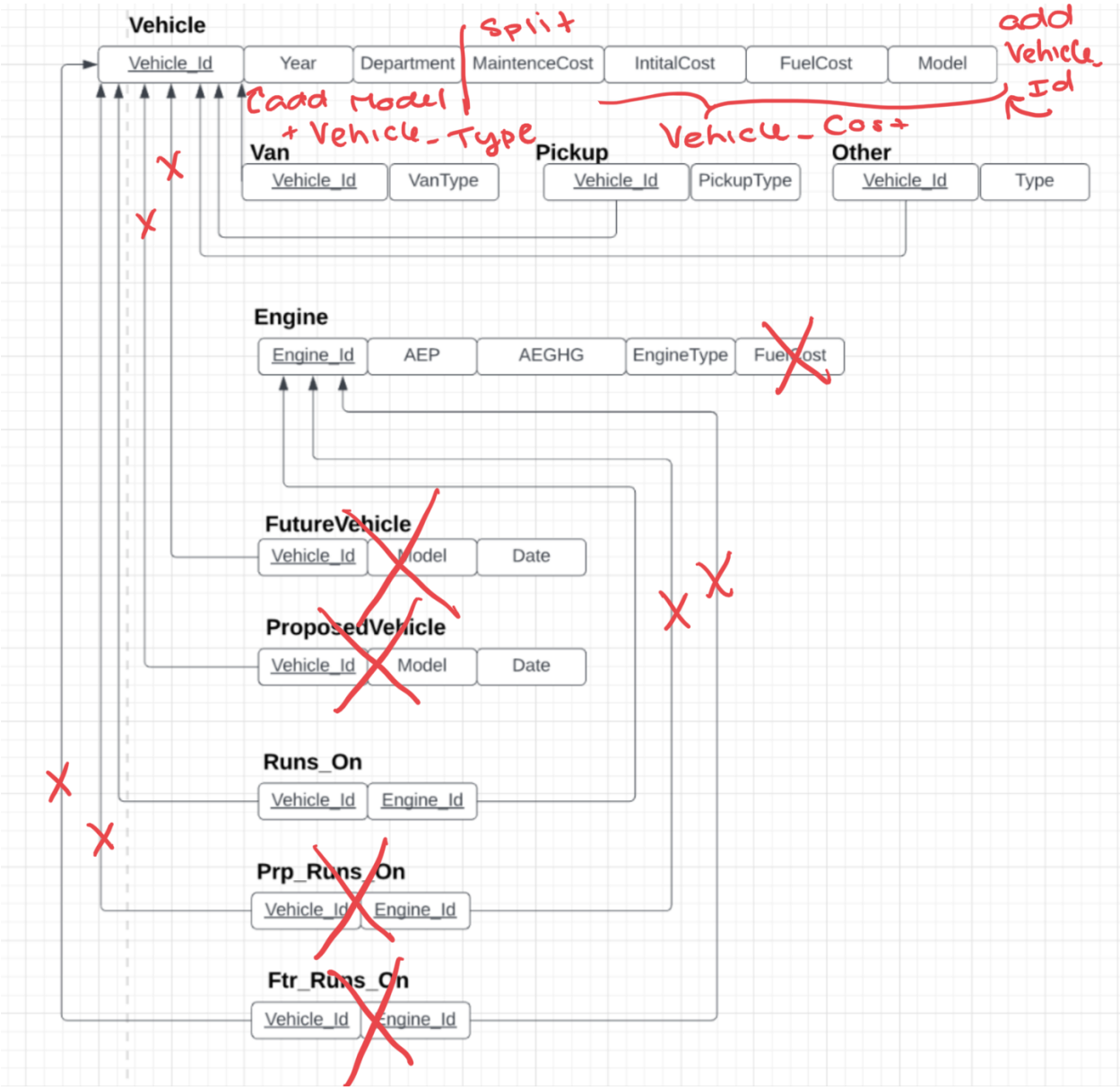
Elaboration: Design:

ER Diagram



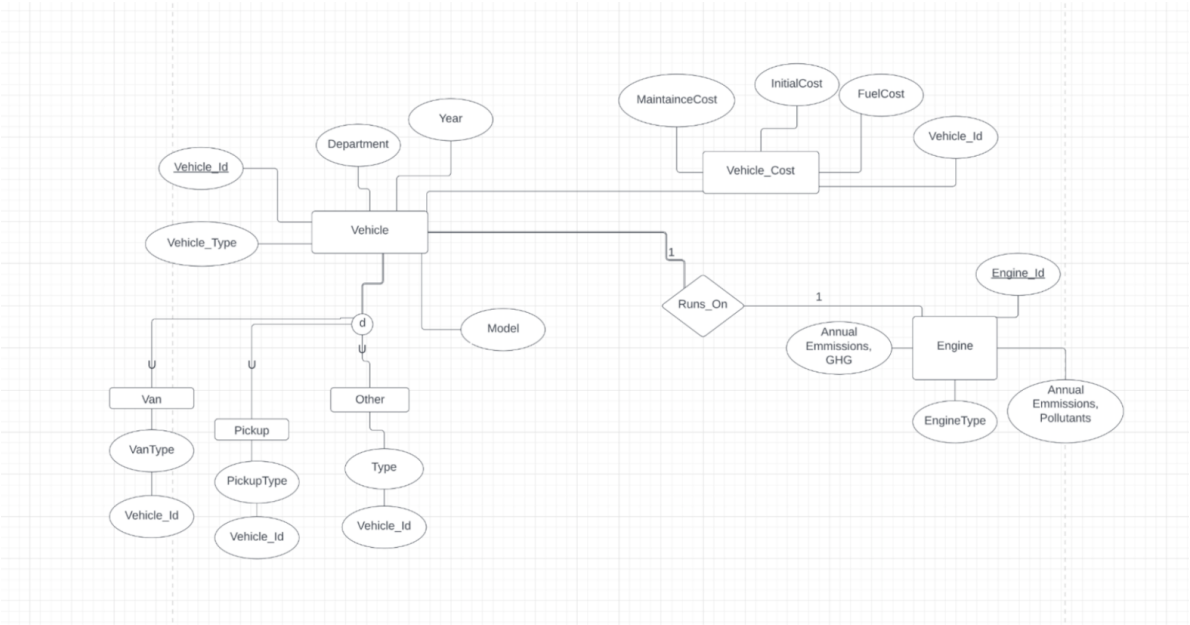
The ER Diagram was revised which resulted in the removal of five relations. The derived attribute Age was removed because having the Year information would suffice the user. Annual cost was removed from the ER Diagram because the different costs to maintain a vehicle were already being provided, those cost attributes were a part of a new attribute VehicleCost.

Relational Schema

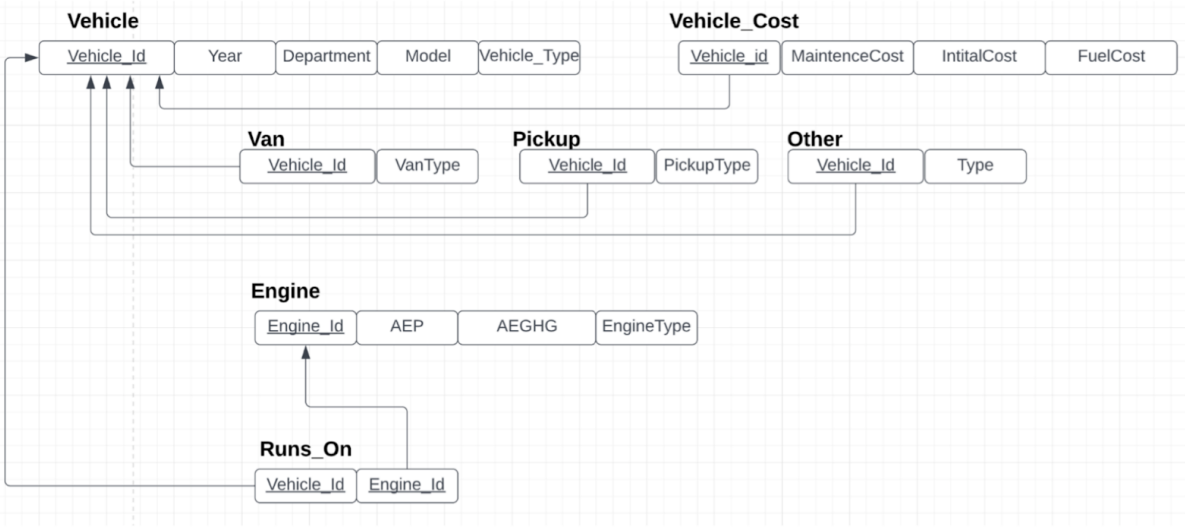


* Revised ER Diagram and Relational Schema *

ER Diagram



Relational Schema



Mid-Semester Presentation (Slide Deck)

Fleet Management

Group 3: Paula Arroyave, James Blair, Faiza Hoque, Drake Lam, Nicole Lenge, Matt Machado, and Corinne Scheddin

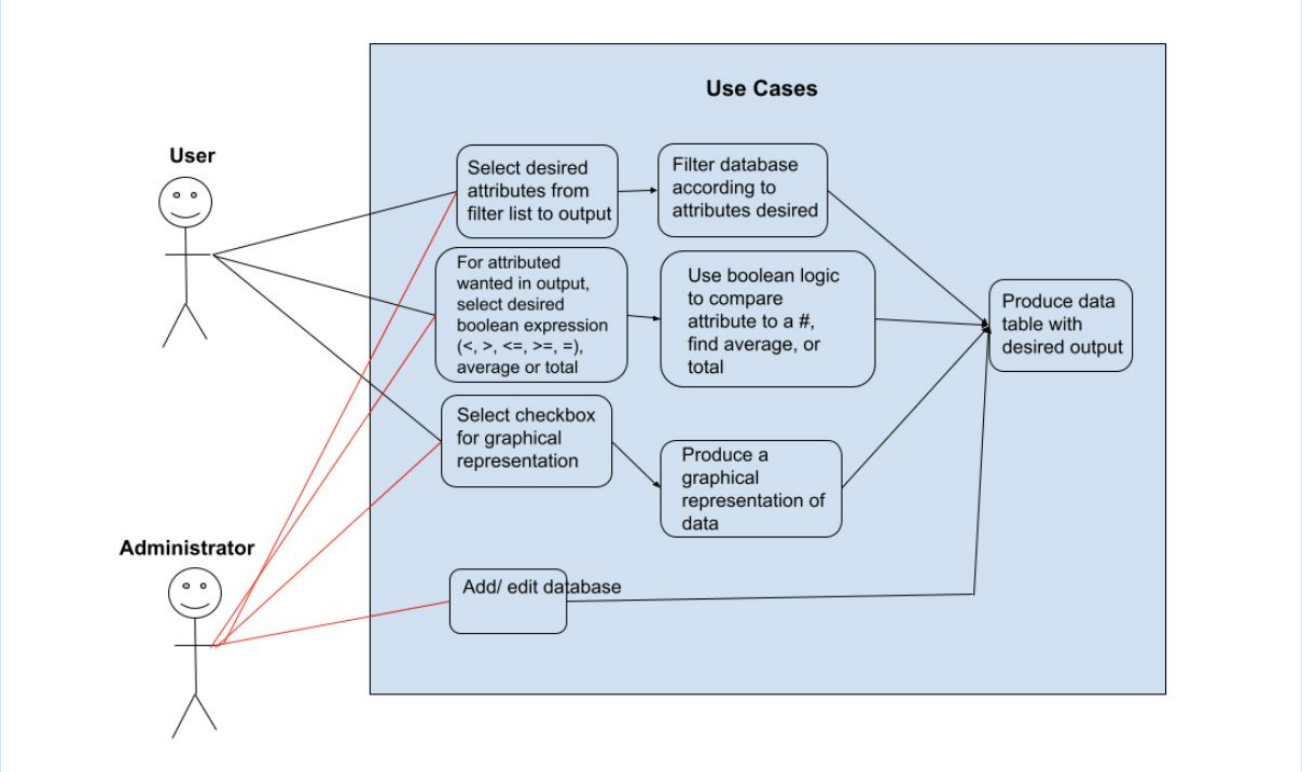
Goal of Our Database

- Improve TCNJ fleet financially and environmentally
- Identify current fleet metrics and outline potential future fleet combinations
- Answer various queries to aid understanding of TCNJ’s vehicle fleet

Questions our Database Should Answers

- What kind of fuel does each type of vehicle use and what are its emission?
- What are the financial costs of each type of vehicle?
- What are the specifications of each vehicle in terms of vehicle type, model, and usage?
- What is the age, department, and year of each vehicle currently in the fleet?
- What is the proposed and future course of action concerning each vehicle in the fleet?

User Cases


Use Cases
User
Select desired attributes from filter list to output
Filter database according to attributes desired
For attributed wanted in output, select desired boolean expression (<, >, <=, >=, =), average or total
Use boolean logic to compare attribute to a #, find average, or total
Produce data table with desired output
Select checkbox for graphical representation
Produce a graphical representation of data
Administrator
Add/ edit database

User Views

Input Screen

Output Filter

- Type of Vehicle Emission (Current)
  - Compare
    - User inputs type of vehicle emissions they want to compare
- Type of Vehicle Emission (Proposed)
  - Compare
    - User inputs type of vehicle emissions they want to compare
- Type of Vehicle (Current)
  - Compare
    - User inputs type of vehicles they want to compare
- Type of Vehicle (Proposed)
  - Compare
    - User inputs type of vehicles they want to compare
- Graph Output

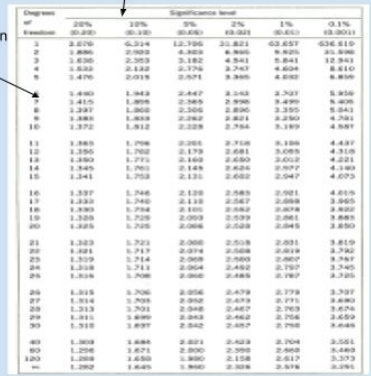
Boolean Expressions

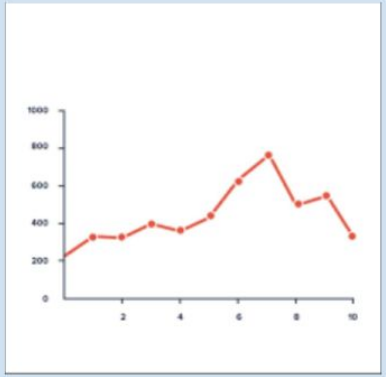
Maintenance Cost	< > = >= <= Total Average	User can input value to compare attribute to	
Year	< > = >= <= Total Average	User can input value to compare attribute to	
Initial Capital Cost	< > = >= <= Total Average	User can input value to compare attribute to	
Annual Emissions, GHG	< > = >= <= Total Average	User can input value to compare attribute to	
Annual Cost of Ownership	< > = >= <= Total Average	User can input value to compare attribute to	
Fleet Age	< > = >= <= Total Average	User can input value to compare attribute to	
Annual Emissions, Pollutants	< > = >= <= Total Average	User can input value to compare attribute to	
Fuel Cost	< > = >= <= Total Average	User can input value to compare attribute to	

Attributes selected in Output filter and or used in a boolean are displayed

onditioned by boolean sions displayed

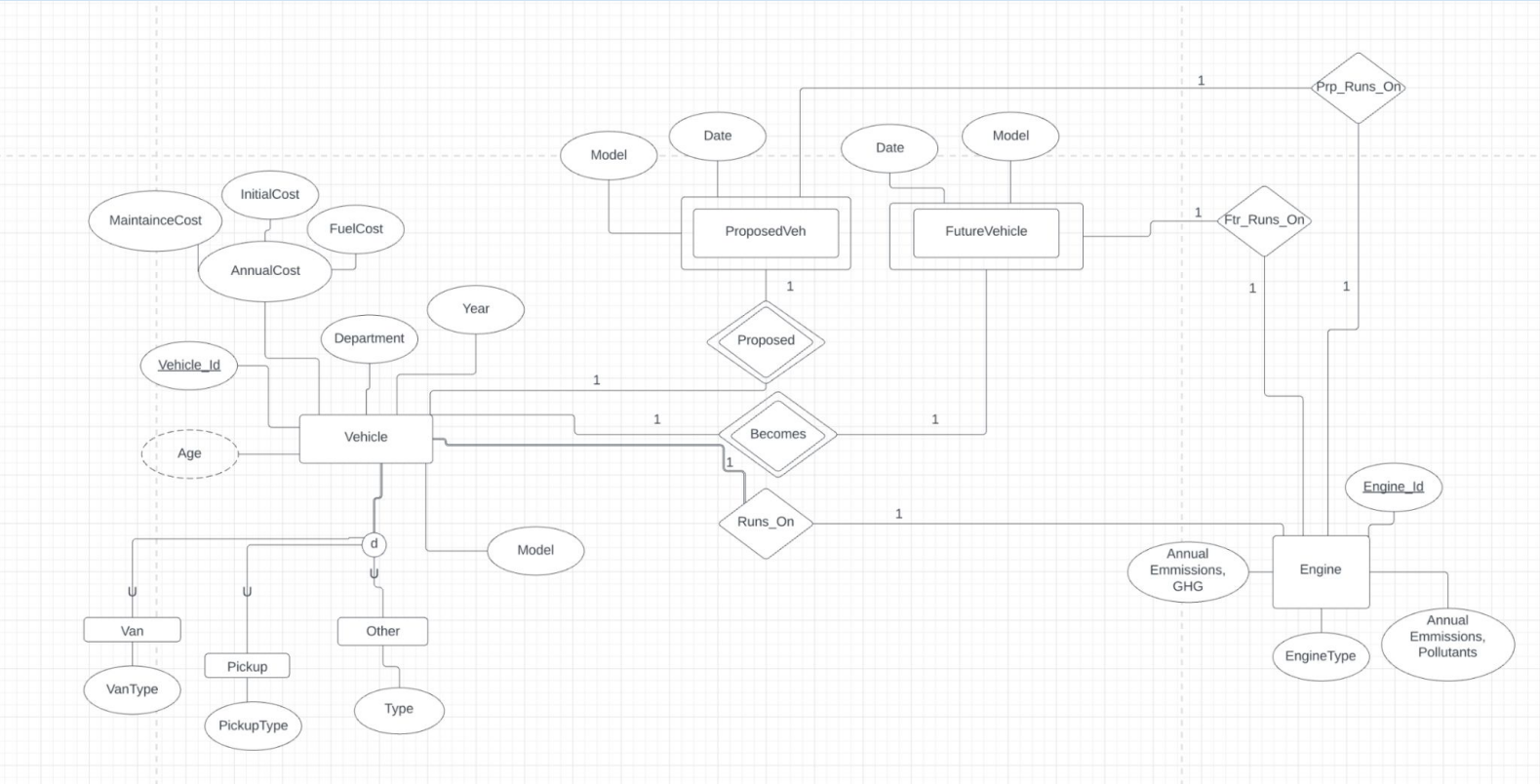
Output Screen



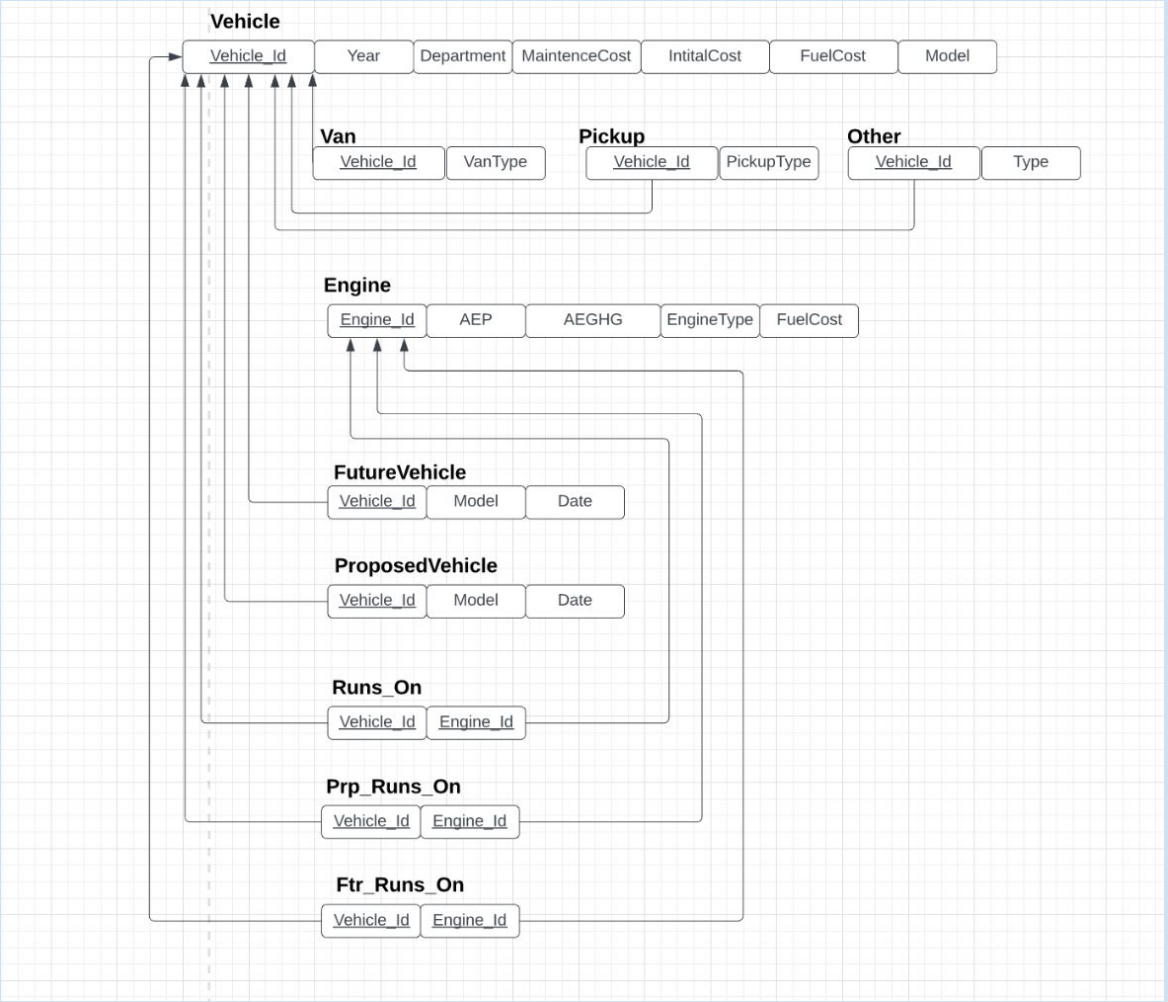


This output screen would display a table based on the user's input. A graph would also be provided if applicable and requested by the user.

ER Diagram


Prp_Runs_On
Model
Date
Date
Model
InitialCost
MaintainceCost
FuelCost
AnnualCost
ProposedVeh
FutureVehicle
Ftr_Runs_On
Year
Department
Proposed
Vehicle_Id
Vehicle
Becomes
Age
Runs_On
Engine_Id
d
Model
Annual Emmissions, GHG
Engine
Van
Other
Pickup
Annual Emmissions, Pollutants
VanType
EngineType
Type
PickupType
1

Relational Schema



Database Details

- Our database should be able to support about 200 entries since there about 100 vehicles in TCNJ's fleet and some may go.

- Our types of queries would be select and action queries:
  - Select queries: focus on retrieving information from the database to answer a question the user may have
  - Action queries: an administrative user would be able to insert, delete, and update the data in our database
- An average of 5 searches daily.

Construction: Tables, Queries, and User Interface

**** Stage Va is in the folder labeled "Construction: Tables, Queries, and User Interface" ****

AEGHG Comparison

View Current vehicles with AEGHG ○ < ◉ > ○ = ○ <= ○ >= 14000

Submit

Vehicle_id	Category	Model	AEG	AEGHG	Engine
1	C	Ford F350 Box truck	23.5	14100.0	ICE
2	C	Ford, Club wagon	23.5	17625.0	ICE
3	C	Ford, Club wagon	23.5	17625.0	ICE
4	C	Dodge, Ram wagon	23.5	17625.0	ICE
5	C	Ford, F250 truck	23.5	18800.0	ICE
6	C	Ford, P/U	23.5	18800.0	ICE
7	C	Chev, 12 pas van	23.5	17625.0	ICE
8	C	Ford club wagon	23.5	17625.0	ICE
10	C	Dodge mini van	23.5	17625.0	ICE
11	C	Ford van	23.5	17625.0	ICE
12	C	Dodge van	23.5	17625.0	ICE
13	C	Chev. Exp Van	23.5	17625.0	ICE
14	C	Ford E350	23.5	17625.0	ICE
15	C	Ford E350	23.5	17625.0	ICE
16	C	Ford F250	23.5	18800.0	ICE
17	C	Ford F250	23.5	18800.0	ICE

Total Cost Comparison

View Future vehicles' total cost ○ < ○ > ○ = ○ <= ○ >= 1000

Submit

Vehicle_id	Category	Initial	Maintenance	Fuel	Total
189	F	51380.0	7200.0	0.05	58580.05
190	F	44900.0	7200.0	0.05	52100.05
191	F	44900.0	7200.0	0.05	52100.05
192	F	42000.0	7200.0	0.05	49200.05
193	F	16000.0	7200.0	0.05	23200.05
194	F	44900.0	7200.0	0.05	52100.05
195	F	44900.0	7200.0	0.05	52100.05
196	F	16000.0	7200.0	0.05	23200.05
197	F	16000.0	7200.0	0.05	23200.05
198	F	44900.0	7200.0	0.05	52100.05
199	F	16000.0	7200.0	0.05	23200.05
200	F	44900.0	7200.0	0.05	52100.05
201	F	16000.0	7200.0	0.05	23200.05
202	F	42000.0	7200.0	0.05	49200.05
203	F	42000.0	7200.0	0.05	49200.05
204	F	51380.0	12000.0	0.05	63380.05

Transition: Maintenance
https://github.com/TCNJ-degoodj/cab-project-01-3

Final Project Demonstration (Slide Deck)

Fleet Management

Group 3: Paula Arroyave, James Blair, Faiza Hoque, Drake Lam, Nicole Lenge, Matt Machado, and Corinne Scheddin

Need and Approach

Goal: Improve TCNJ fleet financially and environmentally

Overall Objective: provide a database with a user interface that allows the user to observe different characteristics of TCNJ's fleet.

Approach: we provide the ability for the user to observe various information regarding TCNJ's fleet vehicles at different stages (Current, Proposed, and Future) while also being able to group the vehicle's by department. This is done through the user interface.

Benefits and Costs

Benefits: Relative to TCNJ our interface is valuable due to the fact, that as of now, there are no other websites that offer a user interface of TCNJ's fleet.

Cost: This approach is a completely new website and user interface. This would also be the first website to showcase data for TCNJ fleet management. The cost to implement would be a PC that runs Linux or a VM that runs Linux

Vehicle Type Comparison

View all current vehicles categorized as Vans

Vans
Pickups
Others

Submit

AEGHG Comparison

Vehicle_id	Category	Model	AEG	AEGHG	Engine
1	C	Ford F350 Box truck	23.5	14100.0	ICE
2	C	Ford, Club wagon	23.5	17625.0	ICE
3	C	Ford, Club wagon	23.5	17625.0	ICE
4	C	Dodge, Ram wagon	23.5	17625.0	ICE
5	C	Ford, F250 truck	23.5	18800.0	ICE
6	C	Ford, P/U	23.5	18800.0	ICE
7	C	Chev, 12 pas van	23.5	17625.0	ICE
8	C	Ford club wagon	23.5	17625.0	ICE
10	C	Dodge mini van	23.5	17625.0	ICE
11	C	Ford van	23.5	17625.0	ICE
12	C	Dodge van	23.5	17625.0	ICE
13	C	Chev. Exp Van	23.5	17625.0	ICE
14	C	Ford E350	23.5	17625.0	ICE
15	C	Ford E350	23.5	17625.0	ICE
16	C	Ford F250	23.5	18800.0	ICE
17	C	Ford F250	23.5	18800.0	ICE

Department Vehicle Comparison

View all vehicles in the Campus PD department

Submit

Vehicle_id	Model	Year	Department	Cateogry	AEP	AEGHG	Engine
79	Ford Explorer	2018	Campus PD	C	23.5	16588.0	ICE
80	Ford Explorer	2018	Campus PD	C	23.5	16588.0	ICE
81	Ford Explorer	2017	Campus PD	C	23.5	16588.0	ICE
82	Ford Taurus	2016	Campus PD	C	23.5	16588.0	ICE
83	Ford Taurus	2015	Campus PD	C	23.5	16588.0	ICE
84	Ford Taurus	2014	Campus PD	C	23.5	16588.0	ICE
85	Ford Taurus	2014	Campus PD	C	23.5	16588.0	ICE
170	NULL	2023	Campus PD	P	23.5	17625.0	ICE
171	NULL	2023	Campus PD	P	0.32	11750.0	Hybrid
172	NULL	2022	Campus PD	P	0.32	11750.0	Hybrid
173	NULL	2022	Campus PD	P	0.32	11750.0	Hybrid
174	NULL	2022	Campus PD	P	0.32	11750.0	Hybrid
175	NULL	2022	Campus PD	P	0.32	11750.0	Hybrid
176	NULL	2022	Campus PD	P	0.32	11750.0	Hybrid
261	NULL	2035	Campus PD	F	0.32	0.0	Zero
262	NULL	2035	Campus PD	F	0.32	0.0	Zero

Transition: Product Hand Over

https://github.com/arroyap1/cab-project-01-3