Group 15
5/1/23
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CSC 315 / BUS/MGMT 385

Phase II: Proposal

Internal combustion engines have been the standard for vehicle production ever since the creation of automobiles in the late 1800s with the Mercedes Patent Motor Car and Ford Model T. These engines use a mixture of gas and air to create a chemical reaction that emits colossal amounts of carbon dioxide and other harmful emissions, representing 6.4 metric tons of carbon dioxide per vehicle annually. The burning of gas and diesel from internal combustion disrupts the natural procedure of the environment artificially heating the atmosphere, being a cause of climate change. From an ethical perspective, although cars provide essential transportation for billions of people everyday, there have been detrimental environmental impacts from vehicles that humans are obligated to prevent and sustain for the continuance of life. Climate change is responsible for: intense droughts, storms, heat waves, melting glaciers, air pollution etc. As technology has rapidly advanced other eco-friendly substitutes to combustion engines have been offered.

Heading into the twenty-first century hybrid vehicles rose to popularity following the financial success of Toyota's Prius. In 2021 hybrid vehicles represented 329 billion and a six percent market share. These cars feature a traditional combustion engine while simultaneously being powered through one or more electric motors. As a result hybrids provide superior gas mileage and reduced emissions compared to the traditional counterpart, over benefitting sustainability.

Although fully electric vehicles have been prevalent since the 1920s in the niche demographic of the elite, eventually they became more affordable and popular in the 2010s. Unlike Hybrids, EVs are completely electric emitting significantly less emissions than both combustion and hybrid vehicles and don't use gas. On average EV's produce just 200 grams of carbon dioxide per mile compared to 260 grams for Hybrids and 350 grams for internal combustion vehicles respectively.

Environmentalists praise electric vehicles for their apparent drastically reduced emissions rates. The United Kingdom announced they would be banning the sale of fully internal combustion vehicles by 2030 as a result of the reduced C02 rates from EVs. However, sales of hybrids will be permitted. If the shift from internal combustion to EV's has been so drastic, how efficient truly are electric and hybrid vehicles from a sustainability perspective? Examining data of the overall greenhouse gas and C02 levels from the three engine categories will develop an understanding of the difference in emissions each of these engines produce. Furthermore, the relationship between number of EVs (hybrid or electric) per capita and C02 levels per capita could be explored. If states and or municipalities with more EVs produce less C02 levels by vehicle adjusted for population a correlation between EVs and reduced emissions could potentially be concluded.

Secondly, the impact of gasoline, the necessary fuel for combustion engines, in relation to greenhouse gas levels overall can be examined. Collecting GHG data from gasoline production factories via heatmaps could further reason why combustion engines are influencing climate change.

Electric vehicles have gained lots of popularity in recent years, as they are promoted as being much better for the environment than gas-fueled cars and supposedly fix many issues that stem from conventional cars. The main problems with non-electric vehicles is the harmful impact they have on the environment. According to data from Sustainable Jersey, the municipalities in New Jersey with the highest percent of EV's tend to have lower total CO2 emissions. According to the charts, Pine Valley borough, Tavistock borough, and Walpack township, the leading municipalities in percentage of EV's, are the bottom three municipalities in CO2 emissions. Following a conclusive study done by a team at MIT, they were able to confirm that gasoline cars produce nearly one hundred grams more of carbon dioxide per mile driven than electric or hybrid cars. Moreover, according to the Alternative Fuel Data Center, the annual CO2 emissions for gasoline cars was nearly six times more than electric cars.

Due to perhaps the recency or cost of electric vehicles, there are still far too many gas powered cars on the road, which is why these issues keep persisting. The regularity of gas cars does not appear to be coming down anytime soon either, according to the U.S. Energy Information agency. The agency expects 78 percent of cars on the road to be gas-powered, and only five percent to be hybrid. There are also people who claim that EV's are almost, if not just, as bad as gas cars. One reason is because the batteries, according to a study done in 2023, could possibly lead to an increase in greenhouse gas emissions by reducing the available batteries for non-electric vehicles.

Use - Cases for the database:

Use - Case 1: Finding EV Chargers Near Me

Step 1: System prompts user to select county from drop down menu

Step 2: User selects and confirms county they want

Step 3: System finds all EV chargers linked to that county

Step 4: System finds graphic for EV chargers in county

Step 5: System presents user with addresses of EV chargers in the county

Step 6: User has option to copy address to clipboard

Use - Case 2: Cars compared to EV's

Step 1: System prompts user to select county from drop down menu

Step 2: User selects and confirms county they want

Step 3: System finds county in database

Step 4: System finds amount of vehicles and EV's in county

Step 5: System presents user with information listed

Use - Case 3: Environmental impact of non-EV's

Step 1: System prompts user to select country from drop down menu

Step 2: User selects and confirms county they want

Step 3: System finds county in database

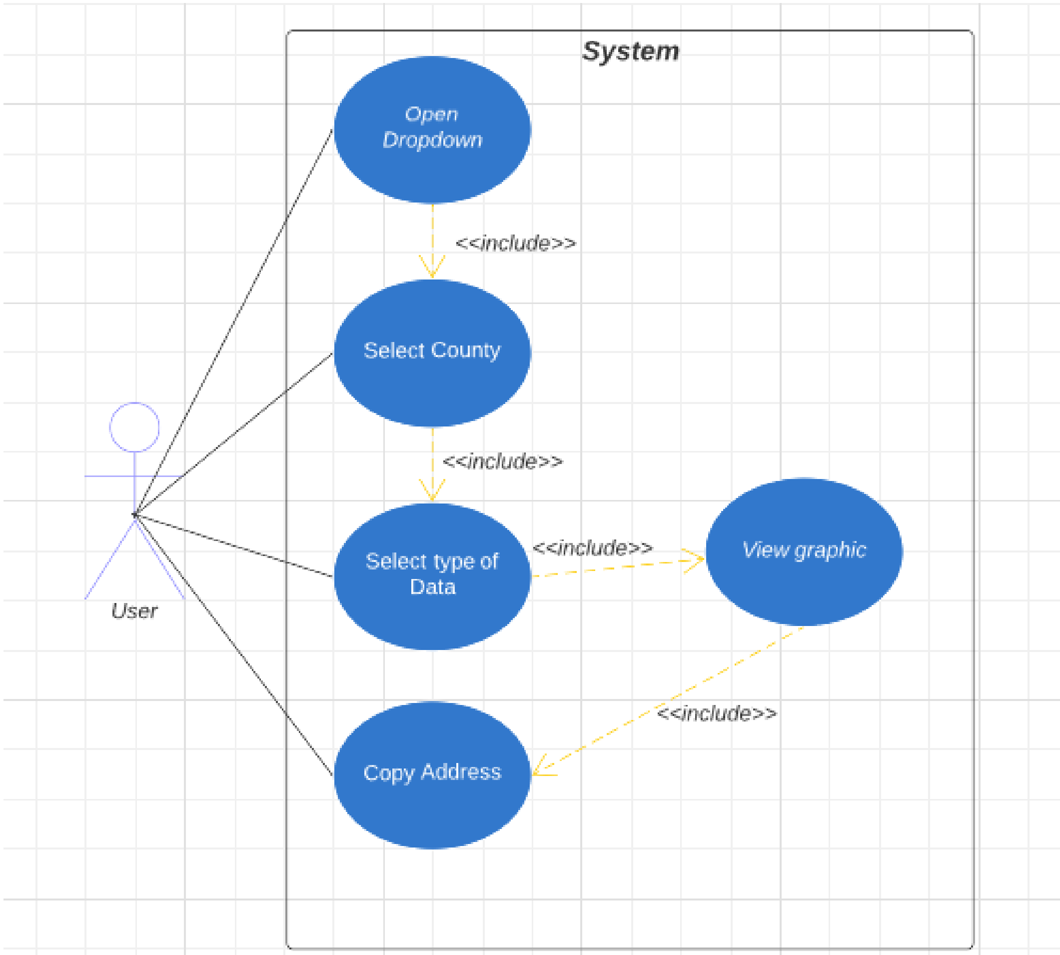
Step 4: System finds the greenhouse emissions of vehicles in selected country

Step 5: System presents user with information listed

Phase III: Narrative

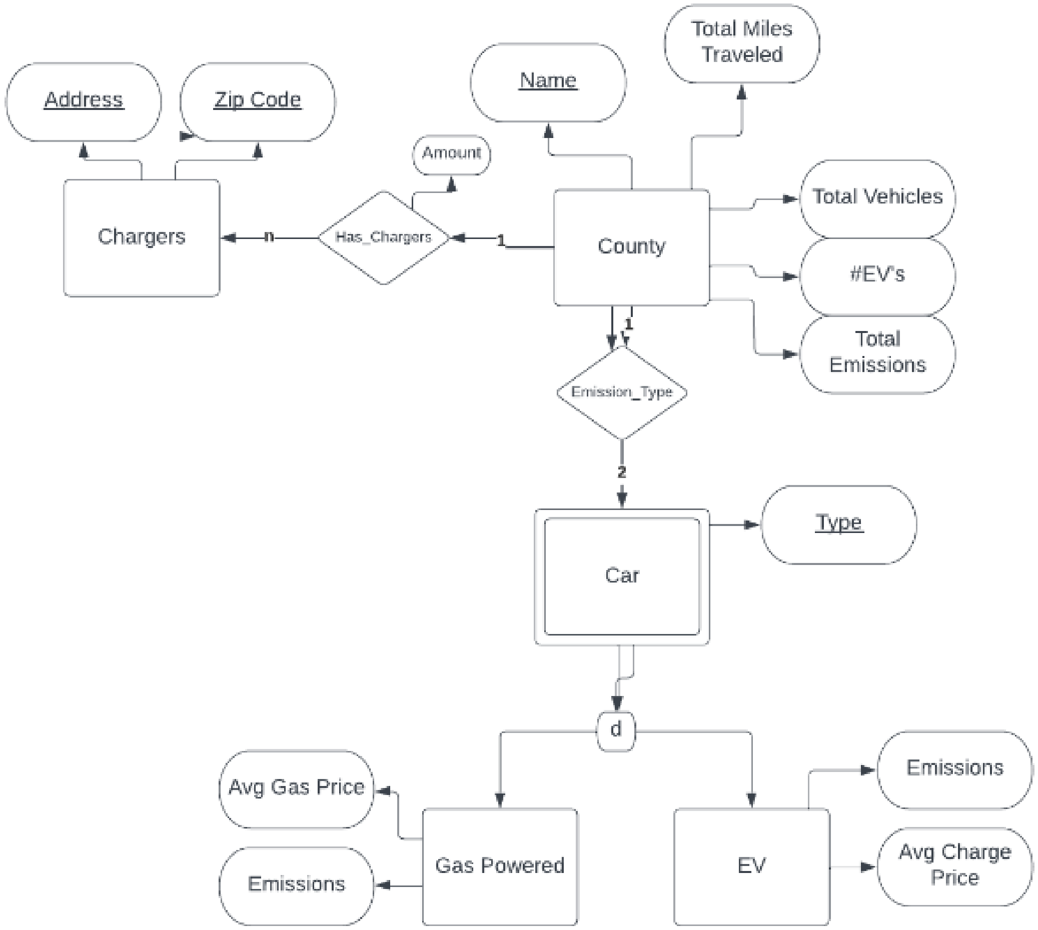
A relational database is a type of database that stores and organizes data into tables using a predefined structure based on the relationships between the data in the database. Some of the main components of a relational database are tables, rows, columns, and keys. A table is made up of rows and columns, and is a collection of all the data that comes from the rows and columns. Rows go horizontally across the table and represent individual instances of the data, while columns go vertically and represent specific types of data. Relational databases use a language named Structured Query Language, or SQL, to interact with the data within the database. Using SQL statements, users are given the ability to create, add, modify, or delete data by specifying the action and elements they would like to affect. The command is then executed by the RDBMS, or relational database management system, which is responsible for storage of the data and enforcing constraints on the data. Relational databases are extremely valuable because they provide data accuracy and integrity, simple use for users, and security(Lutkevich, 2021). The data can be easily categorized and stored, and if a new category were to be added, it can be done without affecting other applications. Moreover, users can easily extract data that they need using SQL, a simple language. Lastly, constraints and security is enforced, meaning that data will be accurate and only certain users can have access to certain data if specified. Overall, relational databases are extremely useful and valuable.

The UML Use Case Diagram depicts how a user would navigate our system and be able to extract the data that they desire. The user opens a drop down menu which presents them with a list of counties in New Jersey. Next, the user can select a county, and would then choose what kind of data to look at. The options given are a graphic of locations of EV chargers in said county, amount of vehicles and EV’s in said county, or greenhouse emissions of vehicles in said county. The user also has the capability of copying the address of the EV charger location. The goals of this system are to allow users to easily access data pertaining to vehicle energy, fuel consumption, and ownership statistics for any county in New Jersey. The scope of our system is not limited to any particular range, as it can be used by anyone who wants to view data regarding electric vehicles or gas-powered vehicles. The reason behind our database model being this way is to be able to show the harmful effects of conventional gas-powered vehicles compared to the lesser effects of electric vehicles.

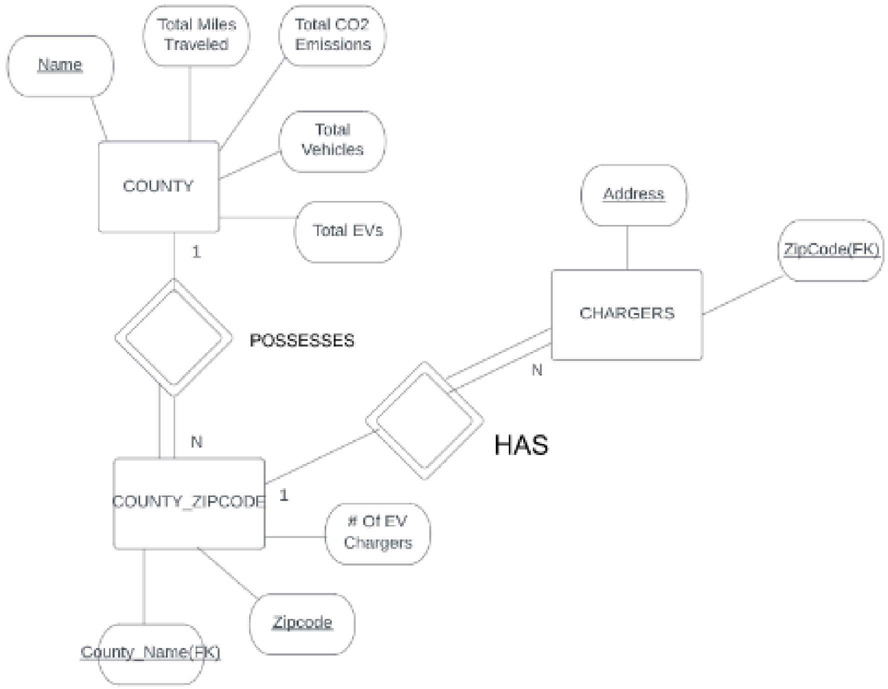


The user opens a dropdown which presents them with the liist of counties within New Jersey. The user then selects which county they wish to view. Then they choose what data they wish to see (the options being a graphic of locations of EV chargers in selected county, amount of vehicles and EVs in selected county, or greenhouse emissions of vehicles in selected county.) Can copy the address of EV charger location.

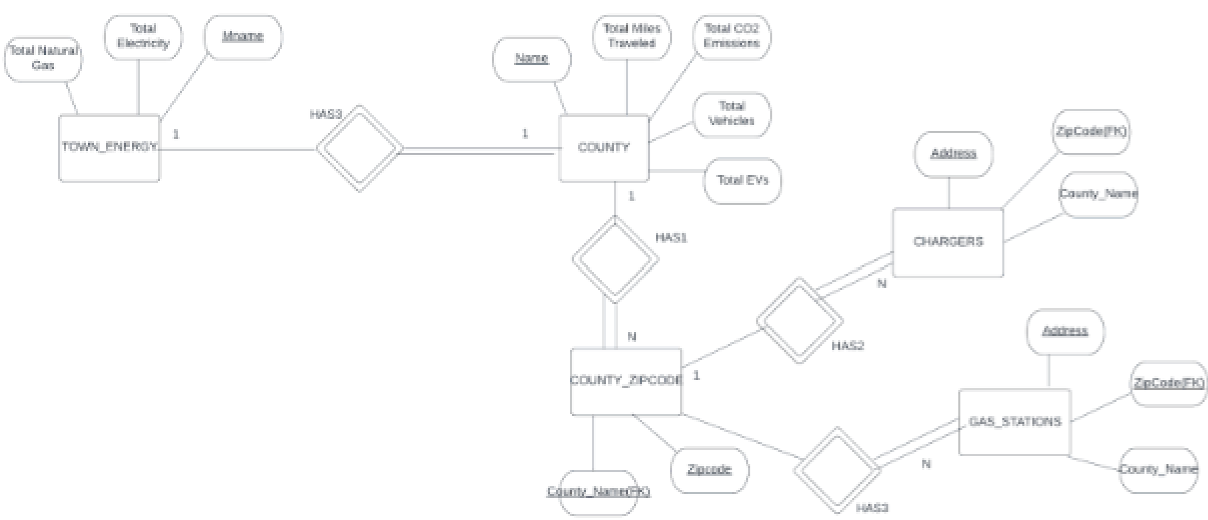
ER Diagram 0



ER Diagram 1 (as of 4/8/23)



ER Diagram 2 (as of 4/18/23)



ER Diagram 0 : The ER diagram shows how all of our entities relate to one another. You can get from entity to entity by showing how they all work and get different information from different attributes by doing so. There are 5 entities, Chargers, County, Car, Gas Powered, and EV. These entities represent what the user is most likely going to use as grounds to get the information they want. If they want information about the county, then they can access a county and get the information from there, same goes with chargers, and cars. Cars is an interesting entity because it is a weak entity, there is only a partial key for it, which is the type. This is because Cars is dependent on county for information on what is happening. Cars needs to know what county they are in before it can give the information of emissions of types of vehicles. All of the attributes are information that the user is going to want to access. They can also get different information by going between relations, for example, 1 county has 2 different car types, gas powered and EV's. You can access that by going through that relation.

4/8/23 : Changed ER Diagram to only have 3 attributes : COUNTY, COUNTY_ZIPCODE, and CHARGERS. The county entity contains attributes that provide information about the name, total miles traveled, total CO2 emissions, total vehicles, and total EVs for each county. COUNTY is part of the POSSESSES relationship, the other entity being COUNTY_ZIPCODE, which provides the county name, zip codes per county, and number of EV chargers per zip code. COUNTY_ZIPCODE is participating in a relationship with CHARGERS, which shows the address of each charger and the zipcode that it belongs to.

4/18/23 : Added GAS_STATION and EV_CHARGER entities, both with a foreign key referencing ZIPCODE from COUNTY_ZIPCODE. Also added energy and natural gas usage per municipality as an entity, TOWN_ENERGY, that references the municipality name of COUNTY.

Phase IV

Electric vehicles produce much less greenhouse gas emissions than their gasoline internal combustion counterparts. Carbon dioxide, methane, and nitrous oxide emitted from vehicles trap the earth's outgoing energy, retaining heat, heating the Earth's surface, and influencing climate change. Since electric vehicles have zero tailpipe emissions unlike gasoline-powered internal combustion vehicles, there's a noteworthy decrease in emissions produced from these automobiles since gasoline isn't being burned. By analyzing average emissions per mile from electric vehicles and gasoline internal combustion vehicles for each county it was evident that the counties with higher EV frequencies had fewer greenhouse gas emissions. This is evident by the relatively minimal 200 milligrams of C02 electric vehicles emit on average compared to roughly 350 milligrams of C02 per mile the internal combustion gasoline vehicle emits.

To improve sustainability, consumers must be influenced to purchase electric vehicles. To do so EV express lanes for tolls should be implemented. By partnering with the EZ pass toll system electric vehicle owners can receive a designated express toll lane with cheaper pricing and quicker downtimes. To inherit these benefits electric vehicle owners must subscribe to the EZ pass service. The EV express toll would create an increased motivation towards consumers to purchase electric vehicles resulting from the discounted fees and faster downtimes from EV toll privileges. This will potentially increase EV sales. However, on the downside, the infrastructure of the tolling system would need to be completely modified since a new designated EV toll lane must be implemented. Unfortunately, this new toll lane could potentially cause significantly increased waiting times for internal combustion vehicles and also confuse the millions of drivers on the road daily upon implementation.

Next, carpool lane privileges can be instilled amongst all electric vehicle drivers regardless of the number of passengers within the vehicle. On average HOV lanes save around 30 percent of travel time when compared to driving in the more congested standard lanes. This notable decrease in traffic allows HOV-eligible drivers to reach their destinations much more efficiently. If all EVs were allowed entry into HOVs this would influence segments such as businessmen looking to gain a timely advantage on their frequent commutes by purchasing an EV. An increasing amount of eligible vehicles would improve the HOV lane's lackluster amount of usage. The HOV lane usage has declined from 19.7 percent in 1980 to a minimal 8.9 percent in 2019 as fewer and fewer people are carpooling, known as empty lane syndrome. By injecting EVs into HOV lanes this rate would increase, restoring the usage rate. However, on the negative side, many of these electric vehicles produce massive amounts of power such as the 800 horsepower Rivian R1S and the over 1,000 horsepower Tesla Model Y Plaid. The instantaneous acceleration of these vehicles and other EVs combined with a vacant HOV lane influences the probability of speeding and collisions, creating a more unsafe driving environment overall.

Along with our implementations to drive the incentive of buying an electric vehicle, there already exist many other incentives to make the purchase. One of them is a big tax credit. You can earn up to $7500 just from purchasing an electric vehicle. This goes for both leasing or purchasing an electric vehicle. There is also the clean vehicle rebate project which applies to households with small to moderate incomes. This allows them to get increased rebate amounts if they have purchased an electric vehicle.

Using the data stored by our database, there are many ways to compare counties that can be used to prove why electric vehicles can improve sustainability and reduce carbon dioxide emissions. For example, comparing the percentage of electric vehicles across counties of similar total miles traveled generally shows that the counties with the higher percentage of electric vehicles have less carbon dioxide emissions. Camden and Burlington, both with approximately 3.8 million total miles traveled amongst all vehicles, have differing percentages of electric vehicles, with Burlington having three percent more. Although only having a three percent difference, Burlington has around four hundred thousand less total emissions than Camden. Another can be found when looking at Somerset County and Mercer County, with 3.5 million and 3.3 million miles traveled, respectively. Somerset County, with a staggering electric vehicle percentage of 66 percent, has two hundred thousand less total carbon dioxide emissions. This is just one of many ways our data can be used to help increase the regularity of electric vehicles, thus decreasing CO2 emissions and improving sustainability.

Work Cited

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