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Vehicle Emissions Database Final Report

Phase I - Initial Video Proposal:

https://youtu.be/dO2Fo7_ZFm0

Phase II - Written Proposal:

Gathered data to incorporate into the database

Various different datasets have been gathered in order to properly demonstrate the amount of vehicle emissions that have been produced in the past decade. These datasets will help determine the distribution of emissions between different vehicle types, along with miles traveled with these vehicle types. Data gathered on vehicle miles traveled (VMT) can help determine and understand the amount of emissions produced by various vehicle types. The database will also incorporate overall greenhouse gas emissions in order to determine the amount of emissions produced in total vs. on-road vehicles as a way to demonstrate the amount emissions have been produced by daily driven vehicles.

With the rise in vehicle manufacturers creating emissions free alternative vehicles, datasets in electric vehicle (EV) ownership, along with a data set in a means of transportation can help determine the amount of different types of vehicle on the road,

and determine what percentage are EVs. Combined with previous gathered datasets, it can help determine how much of an impact EV ownership has in terms of the difference in the amount of emissions produced between 2015 and 2020.

Questions to be Explored:

Exploring the relationship between the usage of different transportation, distance traveled, and portion of greenhouse gas emissions taken by vehicles within the municipalities can give a better understanding of their social infrastructure. For example, we could look at how much a particular type of vehicle is used and get information on the efficiency of different road infrastructures, or how people prefer to travel in different municipalities. We will examine how vehicle usage and emissions have been affected by time by comparing data gathered from 2015 and 2020. Policy makers will be more able to gauge the impact different policies have within different municipalities, such as policies that aim to reduce carbon emissions. Our database will uncover different trends in EV ownerships and their impact on the environment as well, which will be beneficial to the goal of being sustainable.

Identifying Sustainability Problems and an Opportunity for Positive Change:

The data could help us identify sustainability problems by pointing out major greenhouse gas emissions sources and where they are most prominent. A great example is the dataset that shows the “2020 Community-Scale Energy-Related GHG Emissions by Sector and Energy Type”. This dataset showed us where a majority of the greenhouse gases are coming from and in first place with a whopping 43% were from on-road vehicles and in second place was residential natural gas which takes up 15%. This dataset showed that we have a major sustainability problem at hand with on-road

vehicles and because of that, we should be focusing on trying to reduce our GHG in those vehicles. An opportunity for positive change for on-road vehicles is switching to electric vehicles since they don't burn gasoline or emit greenhouse gases while driving. People can make the argument that you are burning fossil fuels to create electricity which powers the car but if the energy for electric vehicles is sustainably sourced then there will be a significant reduction in emissions.

An Overview of the Sustainability Issue We Will Be Exploring

The issue we will be exploring is the use of on-road vehicles and their impact on the environment through GHG emissions. Transportation is a part of our everyday lives and we need it for every aspect of our life. People need to go places, whether it be for work, groceries, school, etc which is why transportation vehicles are an absolute necessity. Transportation for the most part does hurt the environment since on-road vehicles emit greenhouse gasses which pollute the air and atmosphere around us. Since transportation is such a necessity we want to explore ways to improve transportation to make it more efficient.

Offering background on the problem

Over the past decades, the issue of pollution has continued to be a persistent problem, with little solutions to resolve it. In recent years, the topic of trying to move away from GHG emitters and turn towards electric alternatives has been brought up, with various electric alternatives being produced. Although this may not severely decrease the amount of GHG emissions, it helps create a path towards a more clean alternative. One of the contributing factors towards emitting greenhouse gasses (GHG), is transportation. The vast majority of the population owns at least one vehicle, and due to the country

being vehicle dependent, most will use some form of vehicle transportation in order to get to their destination. It has become one of the major points of trying to convert from natural gas to electric. If vehicle manufacturers move towards an electric vehicle (EV) alternative, along with more people owning EVs, as the years go by, there could be some significant reduced rate in GHG emissions. In order to determine its significance, data must be collected to determine how much of an impact this can help solve the issue of GHG emissions.

Why the Sustainability Problem persists:

When getting anywhere, whether it be to work, school, or the store, it is almost always easiest to travel by car. That way, you can travel on your own time wherever the roads go. However, this has become a major sustainability issue. With so many roads and so many cars, extreme amounts of greenhouse gasses are produced from all of this transit. More sustainable methods of transportation exist. You could take a train or bus, which transports more people with less energy cost. If your destination is close enough, you could ride a bike. And for those times where you need to drive, electric vehicles, at least in the context of on-road greenhouse gasses, have far lower, if any, emissions. Despite these options, the convenience of cars combined with the spread-out nature of many suburbs in the area can make it difficult for individuals to reduce their impact on the environment.

Affected Stakeholders:

This database is specifically made for Sustainability Jersey, so they could better organize and analyze their datasets on vehicle usage and emissions, as well as possibly uncover new relationships that could promote sustainability improvements

within New Jersey and its municipalities. Since the problem we are addressing is the environmental impact of vehicles, our database will affect many different people. This will change how vehicle distributors, owners, and buyers will see trends in transportation. In particular, this will benefit people investigating the environmental impact of electric and other sustainable vehicles. Policy makers and city planners will also see the impact of different policies and infrastructures on the environment as well as they will have an influence on vehicle usage and distribution.

Ethical Issues Presented by the Problem

There are some ethical issues presented by the use of electric vehicles and switching from a gas vehicle to an electric one. The main issue presented from the switch is the energy source and how both energy sources can be traced back to the same fossil fuel. A gasoline-powered vehicle gets its energy from gasoline which comes from petroleum and petroleum is a non-renewable energy source since it takes a very long time to replenish and won't come back after we use it. We drill for petroleum and then refine it and burn it in its gasoline form which emits greenhouse gasses. On the other hand an electric vehicle could indirectly be burning greenhouse gasses if it gets its electricity from a non-renewable source. If an electric vehicle is getting its electricity from a power plant that is burning coal then that power plant is emitting greenhouse gasses. The only way an electric vehicle would be extremely ethical is if the energy source that it is getting its electricity from is a clean renewable energy source. This would ensure that it is ethical and helps the environment since it is not emitting any greenhouse gasses along the way.

Use Case Examples:

Use case 1:

The system presents the options to view information by municipality or across the state.

The user chooses a municipality to view.

The system presents three graphs.

The first graph compares modes of transportations used to get to work for 2015 and 2020, as well as on-road vehicle emissions.

The second graph compares Vehicle Miles Traveled for 2015 and 2020, as well as on-road vehicle emissions.

The third graph compares Electric Vehicle Ownership to Vehicle Miles Traveled for 2015 and 2020, as well as on-road vehicle emissions. In addition, this may contain information on population as well as total greenhouse gas emissions.

Use case 2:

The system presents the options to view information by municipality or across the state.

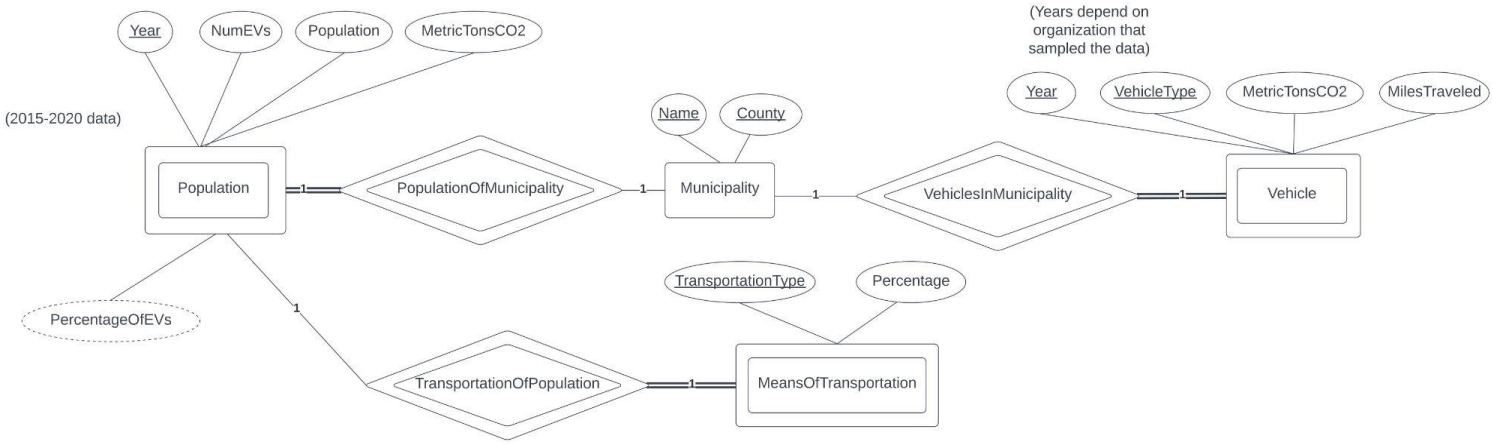
The user chooses to view data across the state.

The system shows greenhouse gas emissions on a map across the state, which can be viewed for 2015 or 2020.

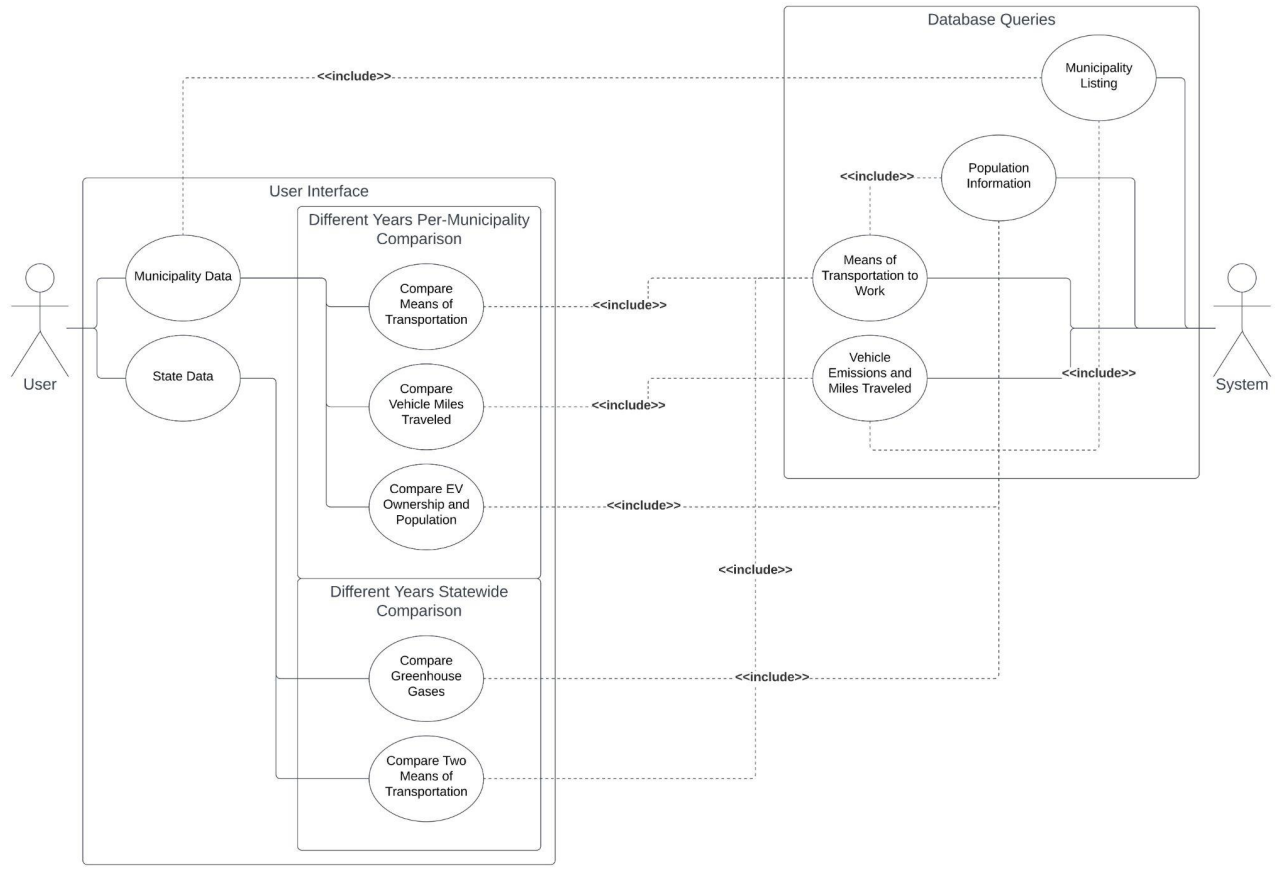
The user selects the next view.

The system shows a heatmap that can be used to compare any two types of vehicles based on their use to get to work, which can be viewed for 2015 or 2020.

Phase III - Entity Relationship Diagram:



Phase III - UML Use Case Diagram:



Phase III - Narrative Explanation:

Our project consists of using various different sources of data, in which we portrayed this data using different types of diagrams, including an ER diagram, a UML diagram, and an EER diagram.

The entity relation diagram (ER diagram) demonstrates how the data will be presented under tables, in which we call ‘relations’. The diamond demonstrates the type of relationship the entities have with each other. These types of diagrams help us create a proper format as to how we can display data to the user. It also helps describe how to access other pieces of data using underlined keys, which are used to pinpoint to a specific entity, or another entity using foreign keys, borrowed from other entities.

The ER diagram itself helps isolate data by year, as years could depend on organization in which sampled the data for the vehicle data. Populations gets its own separate entity due to the conflict of sampled data in years. The vehicle entity describes the emissions of GHG and miles traveled under vehicle types, not explicitly noting EVs, while the population entity describes GHG emissions, number of EVs, along with the difference means of transportation, including passenger vehicles. This helps solve the issue of inconsistent data due to not containing sampled data in 2015 or 2020. There is also another issue involving the municipality. Due to the data demonstrating a municipality with different counties, in order to create isolated data without duplicates and no conflicts, each municipality can be identified by both its name and county. We could have gone with a county based entity, but instead we went with a municipality as we believe it is a better way to demonstrate the emissions produced within each municipality to isolate where most emissions come from. If the user wishes to more

simply view data on the basis of county, queries can be used, which are commands to help isolate specific pieces of data in the relation, we can simply count up the data by municipality and present it by county.

The EER diagram enhances the ER diagram, which describes the relationships and specifies how each entity can access each other. This specification is presented through foreign keys, which are underlined. The foreign keys help create connections between entities, as these attributes are derived from each other in order to directly or indirectly access one relation to another. Within our EER diagram, we have four relations, three of which are connected to the municipality relation using the municipality name as the foreign key. Other than municipality, the other relations also have their own superkey to access its own individual data.

The UML diagram demonstrates how the user will access the data through an interface, either access it through the basis of municipality, or the overall state. The user will then be given an overview of data collected in 2015 and 2020. Under municipality data, the user can see comparisons based on vehicle miles traveled, a means of transportation, population, and percentage of EV ownership. Along with those pieces of data, it will also extend to the comparison of greenhouse gas emissions (GHG) in different years as a way to try and demonstrate how the increase in EV ownership could also help decrease the rate of GHG emissions. Under state data, it is just a more simplified version of the municipality data, only comparing between greenhouse gas emissions, and means of transportation in 2015 and 2020. Outside of those presented data, both will include the list of municipalities, vehicle emissions, and the means of transportation to work.

The proposed graphical user interface will be a dropdown that allows selecting by municipality, with an option to view statewide data instead. For the municipality data, users will be presented with three views that allow viewing all means of transportation to work in a municipality, the makeup of vehicle miles traveled in a municipality, and the EV ownership relative to the total personal vehicle ownership and population. The user is also presented with options to switch these views between two different years, to see trends.

For statewide data, the user can compare greenhouse gasses across the state, as well as compare two selected means of transportation to work. Ideally, this would be presented using a heatmap, but if that proves too difficult, a sorted bar graph would do. These views also allow selecting between years.

Phase IV - Video:

https://youtu.be/M_pTvb2QLC0

Phase IV - Final Proposal:

We want to make people more aware of the environmental impact of transportation. If the public takes advantage of more efficient forms of transportation, such as biking, walking, or taking mass public transit. In addition, we want to encourage methods of improving sustainability that are currently more in the public eye, in particular, electric vehicles, or EVs.

Our project highlights various methods of transportation and their impact on the environment. The graphs allow users to compare the impact of various methods of transportation, and see the changes over the years.

The implementation of a map could also present the user an understanding on how impactful natural gas vehicles are in terms of producing emission in comparison to other means of transportation as demonstrated by the map, further encouraging the user to support alternative methods of transportation.

We propose a greater effort to support increasing accessibility and convenience of methods of transportation that are less harmful to the environment. This could be achieved in various ways.

One method that could be implemented is adding more routes for buses where not many people are able to get around by bus. If the number of people who take the bus is

significant enough to offset the environmental costs of the bus route, then improved sustainability is achieved.

Another method could be to promote biking by providing bike racks at more convenient locations, such as neighborhoods and the commercial and industrial areas near them. This can indicate to people that they can bike to these locations, and can improve sustainability with a one-time action that requires little maintenance.

For instance, note how many people bike on campus, and how we have several bike racks installed at many locations, including residence halls. This enables more people to get around on campus by biking instead of walking, reducing travel times across campus.

Promoting a more walkable environment can help to reduce dependency on gas vehicles which contribute a majority of CO_2 emissions out of all on-road vehicle emissions in the state.

The promotion of more walkable environments and the use of bikes can ultimately incentivize the reduction of on-road vehicle dependency. It can also influence the change from building more roads, which would increase the use of vehicles, to producing more walkable environments such as plazas, sidewalks or bike lanes. Such incentives would not only reduce emissions, but could also promote a healthier lifestyle.

This could also decrease the cost of maintenance as the construction of roads is costly, where as when more people are obtaining vehicles, roads would have to be expanded, along with the cost of street light maintenance, and the cost to fix damaged roads, which may also create traffic jams as construction may block off a lane. The promotion of walkable environments can reduce such costs as sidewalks and plazas require very little maintenance.

Encouraging increased use of EVs can help to reduce emissions. It is also important that this coincides with decreased use of gas vehicles, otherwise the effect is not as significant. We highlight the importance of this by showing the number of vehicles per-person on our website. Ideally, this number would not increase by very much, otherwise the number of gas vehicles increases to the point that there is much more emissions.

Ultimately, our goal is to improve sustainability through encouraging and enabling more efficient use of transportation in a way that results in lowered emissions overall.