

Group 02-04
Vehicle Fleet Management

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Project Proposal: Fleet Vehicle Management

Team 02-4

Jenna Stiesi, Peter Kobasa, Parvathi Krishnan, Jessica Giardiello, Sarah Rulkiewicz, Christina Farah, Joseph Carmichael

Problem statement

The TCNJ vehicle fleet is composed of many vehicles of different types, all of which have internal combustion engines. The current fleet is not as efficient as it could potentially be, both economically and environmentally. Other types of fuel and engines exist which, in the long term, can end up being beneficial to the college in terms of lowering the cost to maintain the vehicles as well as reducing CO2 emissions that impact the environment.

Objective of the application

The objective of our application is to help in decision making for an economically and environmentally stable vehicle fleet for TCNJ. By determining the most eco-friendly fuel sources, we can develop a purchasing strategy that maximizes benefits in relation to cost, providing for a cleaner campus and most effective budget.

This objective also encompasses our plan for the development of a secure and informative database which can hold financial data that can facilitate the analysis of what vehicles to purchase with their respective fuel source(s).

The various cost items intended for input to the database include factors attributable to each vehicle, such as annual cost per year, annual pollution per year, the budget, estimated annual repair costs, estimated insurance costs, etc.

For example, a user would enter the respective budget at the top of the page. From there, they would select the various categories which they wish to analyze, such as the annual cost of owning each vehicle. The user will submit the 'annual cost of ownership' (or another) variable, and the database will display each proposed vehicle in descending order of the cheapest to most expensive vehicle to own on an annual basis.

This same process can be used for any desired cost item, such as expected insurance per year, annual cost of fuel, annual pollutant levels, etc.

End product

We will develop a database system that allows for more cost-efficient and sustainable decisions relating to operation of the TCNJ vehicle fleet. A web-based user interface will also be implemented in connection with the database, to allow users to interact with, retrieve, and analyze the data using queries. Users can access this site and fill out fields and submit forms which will query the database, and the retrieved data from there can then be analyzed and displayed to best answer the users' questions about how best to compose the TCNJ vehicle fleet from an economical and environmental standpoint.

Mockups for the user interface where the user can fill and submit forms to view the data in a helpful manner can be seen below. Use cases can also be seen between input and output mockup screens. The first mockup/use case refers to the problem of determining economic impacts of upgrading the vehicle fleet, and the second refers to the problem of determining environmental impacts of upgrading the vehicle fleet:

Importance and need for the module

The module will facilitate the analysis of which vehicles will provide the most environmentally and financially efficient option for the college. Using cost analysis, we will try and maximize the college's environmental objectives while maintaining the respective budget. Investing in the proper machinery will provide for a cleaner campus environment.

The database and web interface will provide a secure and accessible tool to guide the college on which vehicles to purchase. Given that technology and energy is susceptible to change, our database will provide an initial foundation for storing this type of data as infrastructure for hydrogen and electric vehicles develop.

To elaborate, the main cost determinant of the model is to use the fuel source which maximizes net environmental benefits in regards to cost. The best option may not be the most beneficial to the environment, but will still improve TCNJ's current pollution outputs, and stay within the anticipated budget for TCNJ's fleet.

Within our cost analysis, we can implement a side-by-side comparison of each type of vehicle with respective fuel source (ICE, Hybrid, Electric, and Hydrogen). We can estimate these costs with the three separate time periods as described in the data file (present day, approximately 2030, and around 2040).

Cost inputs we can use for our calculations include fixed costs, such as: Insurance costs per year, depreciation per year*, and estimated service/repair costs. Three fixed capital costs over the lifetime of the vehicle include the initial MSRP cost of the vehicle, any financial rebates (deductions) for environmental benefits, and the anticipated one-time battery replacement of the electric, and potentially hydrogen and hybrid powered vehicles. Variable costs include the given amount of fuel costs based on the anticipated miles driven per year. Mileage driven also impacts the amount of carbon emitted per year, which varies per gallon of a given fuel source.

The cost object is the annual cost of owning each vehicle with respect to estimated useful life of the vehicle. All of the aforementioned variables contribute to the annual cost of vehicle ownership.

** For depreciation per year, we can utilize depreciation schedules to determine useful life of various vehicles if necessary*

Researching the problem and obtaining data

We will use data provided by Paul Romano on the current makeup of the TCNJ vehicle fleet. The provided data files include information pertaining to operational costs of current and proposed types of TCNJ vehicles, as well as information on what types of vehicles currently make up the fleet, what types are proposed for the near future, and what types are planned to be added in the far future.

To help deepen our understanding of the problem domain, we can conduct more research on different vehicle options that are both environmentally beneficial and economically viable. This research can also consist of researching the types of pollutants that each fuel source emits, and the impacts those emissions have. This information can help to inform decisions in cost analysis, because the user can see both economic costs and environmental costs. This data can also help us to determine how to analyze the data provided by Paul Romano, so we can show the user an output analysis that shows, for example, vehicles with both low costs and low emissions.

Other existing systems

At the moment, TCNJ does not have an application to assist in economic and environmental analysis of the vehicle fleet. Our module will provide this functionality so that the college can use the module to facilitate decisions in the future relating to the campus vehicles.

Other applications of the system

In the future, the database should be able to be modified and upgraded to support new attributes and types of data that may become relevant to the topic of different types of fuel and engines for vehicles. The database can also be expanded upon to also provide support for other similar areas, where financial data may be stored to help when considering cost and budget in other TCNJ projects, not only the vehicle fleet.

Performance

At the moment, performance of our application is not a concern. The data files provided that we will be working with are small in size and should not slow down the app when analyzing data. Efficient organizations of the tables in the database to ensure absence of NULL since they waste space. This will also increase performance.

Security

The database should have restricted access, so that it can only be modified by authorized personnel. Since the database is unique to TCNJ and is not on a network, security is not a serious concern. When the application is handed over to TCNJ, database admins will similarly need a login to allow them access to the database so that no one who is not authorized can modify the database.

Backup and recovery

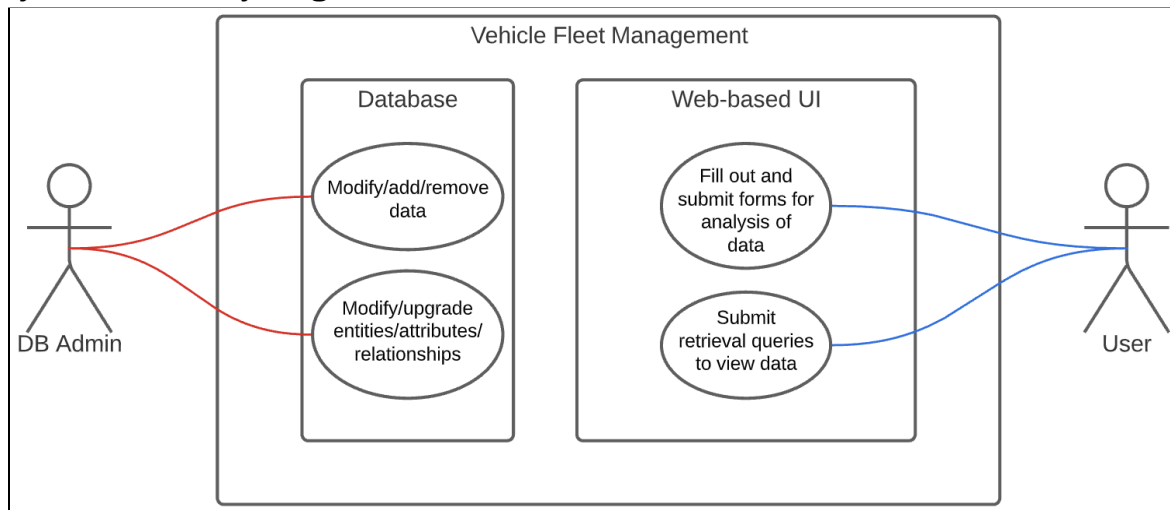
We will be using GitHub to store our application. GitHub is a well-known application for hosting code and managing software development used by many, so there is no concern of losing data that we host there. We will also use virtual machines on the TCNJ High Performance Computing Cluster. The manager of the cluster makes regular backups of all of the VMs, so in the event anything goes wrong we don't have to worry about losing our work.

When the application is handed over to TCNJ, the college can create backups in the same manner it has previously for other applications such as PAWS. It can be backed up physically by TCNJ, and a new private GitHub repository owned by the college could also be maintained.

Technologies and database concepts

Technologies and concepts that we will need to learn and use in the development of this application include git, Github, PostgreSQL, Python, SQL for simple queries to add, manipulate and retrieve data, and making ER diagrams.

System boundary diagram



This system boundary diagram shows the overall domain of our module, which is TCNJ vehicle fleet management. Within this module, we will have a database system as well as a web-based user interface for users to be able to access information about the data.

As seen in the use cases of each of these smaller components, database admins will be able to modify, add, or remove the data that is stored in the database. They can also modify and/or upgrade the database's entities, attributes, and relationships between those. Users can access only the web-based UI, and from there they can fill out forms and submit them to receive analysis of the data to answer their questions. If they wish to see a specific piece of information, they can use a form to submit a retrieval query to view the raw data.

Quad chart

Vehicle Fleet Management

Group 02-4

Need

- Develop a budget that maximizes benefit for environmental and economic reasons
- Application to assist in decisions relating to the vehicle fleet so that they are economical and sustainable

Approach

- Design a database system to store and organize data on vehicle fleet
- Develop application with user-friendly interface to allow access and analysis of data
- Manipulate and analyze data retrieved from the database to help in decision making for the college's budget

Benefit

- This app will help the stakeholders make better decisions from an economic and environmental standpoint
- Help TCNJ to become more eco-efficient
- TCNJ will save more money in the long term

Competition

- Focus on sustainability and environmental impact
- Can assist in more sustainable vehicle fleet operation both economically and environmentally



Vehicle Fleet Management System

Group 02-04:

Jenna Stiesi, Peter Kobasa, Parvathi Krishnan, Jessica Giardiello, Sarah Rulkiewicz,
Christina Farah, Joseph Carmichael

Problem statement

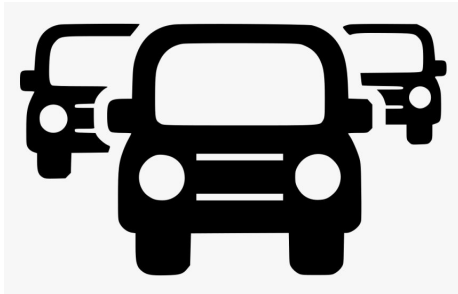
- The TCNJ vehicle fleet is composed of many vehicles of different types which all have internal combustion engines
- The current fleet is not as efficient as it could potentially be, both economically and environmentally
- Other types of fuel and engines exist which can lower the cost to maintain the vehicles and reduce CO2 emissions that impact the environment





Objective of the application

- Effective decision making for an environmentally and economically stable vehicle fleet
- Determine eco friendly fuel sources
 - Purchasing strategy:
 - Maximize benefits relating to cost
 - Provides a cleaner campus
- Development of a secure and informative database
 - can hold financial data that can facilitate the analysis of what vehicles to purchase with their respective fuel source(s)



End product



- In the end, we will have database system that allows for a more cost-efficient and sustainable operation of the TCNJ vehicle fleet
- An interactive web-based user interface will also be implemented in connection with the database, to allow users to interact with, retrieve, and analyze the data using queries
- Users can access this site and fill out necessary fields and submit.
 - Retrieved data from the database can then be analyzed to answer the users' questions about how best to compose the TCNJ vehicle fleet from an economical and environmental standpoint.



Importance of this application

- Determine which vehicles will provide the most environmentally and financially efficient option
- Maximize environmental objectives while maintaining the respective budget
- Provide a secure and accessible tool to guide which vehicles to purchase
- Provide a foundation for storing this data as infrastructure for hydrogen and electric vehicles
 - technology and energy are susceptible to change



Researching and obtaining data

- Use data provided by Paul Romano on the current makeup of the TCNJ vehicle fleet.
- The provided data files include information pertaining to
 - Information on what types of vehicles currently make up the fleet
 - What types are proposed for the near future?
 - What types are planned to be added in the far future?
- Conduct external research on different vehicle/fueling options





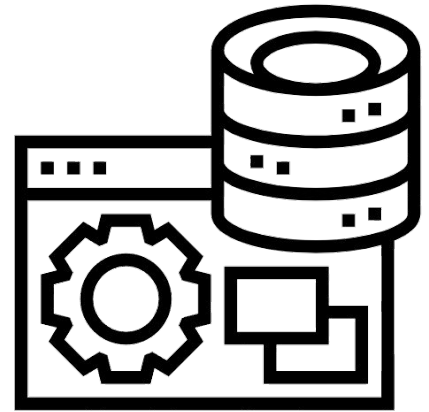
Existing systems

- At the moment, TCNJ does not have an application to assist in economic and environmental analysis of the vehicle fleet.
- Our module will provide this functionality so that the college can use the module to facilitate decisions in the future relating to the campus vehicles.



Other uses of this system

- System should be able to be modified and upgraded
- May need to support new attributes and types of data in the future
- Future will see new emerging alternative fuels and types of engines/vehicles
- Database can also be expanded upon to provide support for other projects
 - Can store financial data and run analyses to help in cost, budget, environmental impact decisions
 - Does not have to be limited to only the TCNJ vehicle fleet



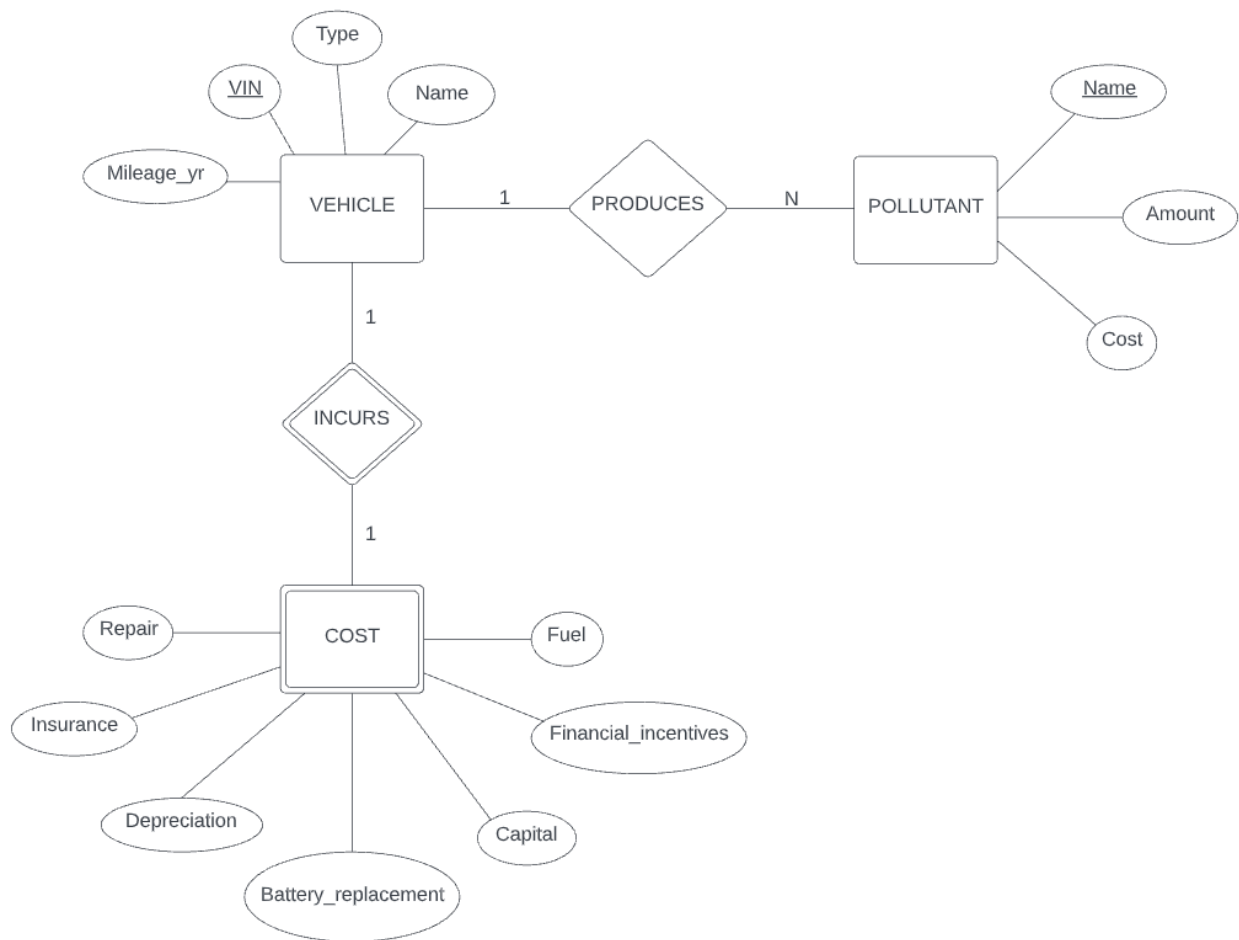
Stage III - Elaboration: Database Model

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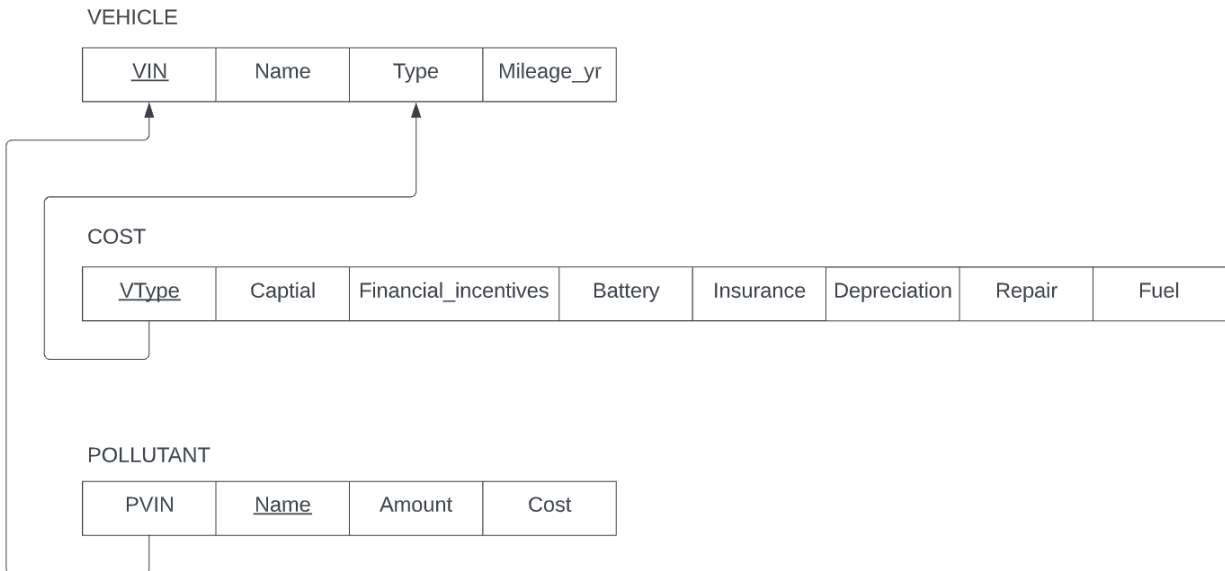
ER Diagram:

ER DIAGRAM



Relational schema:

RELATIONAL SCHEMA



Additional estimations:

- Based on the data provided by Paul Romano as well as some data we expect to find through our own research, we estimate the database to have around 15-20 records between the three tables
- The types of searches/queries to the database will likely be to see:
 - 1) types of vehicles and their economic costs based on an input dollar budget amount, and
 - 2) types of vehicles and their environmental costs based on an input emissions budget amount (in lbs)
- Searches will likely not be done frequently, as a user can make a query, keep the data for their own record, and only check back with the database if data is updated as time passes and new cost and emissions information is available

Mid-Semester Project Presentation

TCNJ Vehicle Fleet Management

**Jenna Stiesi, Parvathi Krishnan, Peter Kobasa, Christina Farah, Jessica Giardiello,
Sarah Rulkiewicz, Joey Carmichael**

Web interface: Economic impact

Economic impact analysis form

Sign In

User Name:
johndoe

Password:

SIGN IN

[Forgot Password?](#)

New User

SIGN UP

Economic Budget:
\$5000/year

Filter option
cost/year ▼

☒ ascending
☐ descending

Submit

Must be signed in to view data

Example options:

- annual cost/yr total
- cost of repairs, insurance

[illegible]

Web interface: Environmental impact

Environmental impact analysis form

Emissions Budget:
50 lb/year

Filter option
emissions/year ▼

- annual emissions per yr total
- ascending
- descending

Sign In

User Name:
johndoe

Password:

SIGN IN

[Forgot Password?](#)

New User

SIGN UP

Submit

Must be signed in to view data

[illegible]

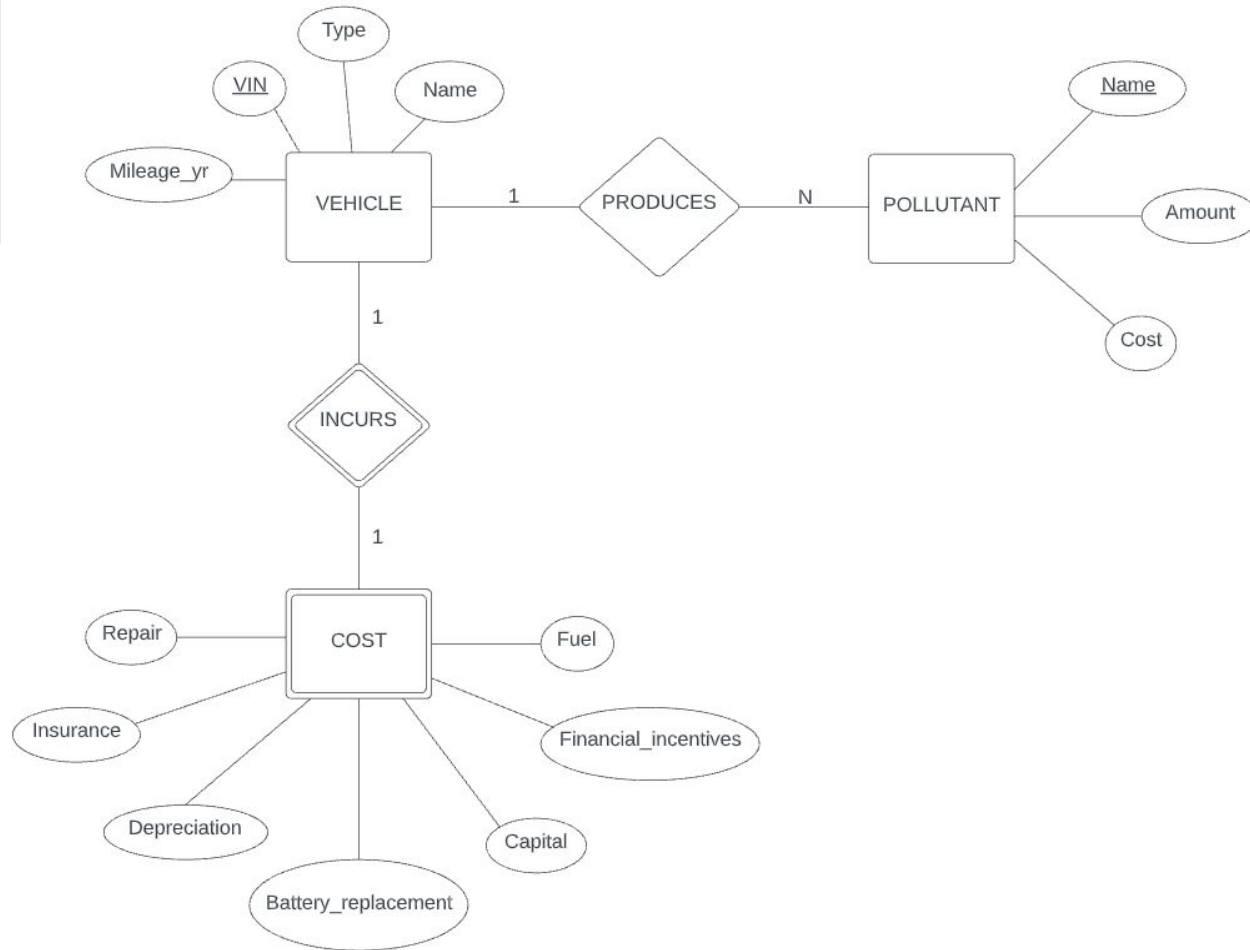
Financial Variables Considered



- **Direct, Fixed, and Indirect Costs**
 - Direct: Depreciation exp., monthly payments, significant maintenance (tires, brakes, batteries, etc.)
 - Indirect: Unexpected breakdowns, insurance, routine maintenance (oil changes)
 - Fixed: Insurance, depreciation exp., monthly payments, expected routine maintenance
 - Variable: Gasoline, unexpected (significant) maintenance
- **Cost Drivers**
 - Type of fuel determines how much is spent
 - Size/weight of each vehicle drives up fuel costs
 - Miles driven→ the more miles driven leads to more repair/maintenance costs
- **Cost Objectives**
 - Annual and total cost of vehicle ownership per year
 - Annual and lifetime pollutants emitted per year



ER DIAGRAM



RELATIONAL SCHEMA

VEHICLE

<u>VIN</u>	Name	Type	Mileage_yr
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COST

<u>VType</u>	Capital	Financial_incentives	Battery	Insurance	Depreciation	Repair	Fuel
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POLLUTANT

PVIN	<u>Name</u>	Amount	Cost
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