UNIVERSITI MALAYSIA PAHANG
AL-SULTAN ABDULLAH

PROJECT TITLE:

NAVIGATING ELECTRIC AND HYBRID VEHICLE EFFICIENCY

PREPARED BY:

GROUP: 8 (01G)

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GROUP PROJECT

DATA SCIENCE PROGRAMMING II (BSD2223)

SEMESTER II 2022/2023

ABSTRACT

The transition to electric and hybrid vehicles marks a significant shift in the automotive industry, driven by the need to reduce greenhouse gas emissions and dependency on fossil fuels. As governments enact policies to facilitate this transition and consumers increasingly prioritize sustainability in their purchasing decisions, there is a critical need to understand the efficiency, performance, and suitability of FEVs and Hybrid Vehicles (HEVs) across various characteristics and metrics. This assignment project will investigate essential areas of efficiency, providing insights into the technology, driving behaviours, and maintenance procedures that can improve their performance. Through interactive dashboards and data visualization tools, the project seeks to facilitate understanding and decision-making among policymakers, manufacturers, and consumers in the context of the global transition towards sustainable transportation solutions. Through the incorporation of advanced visualization methods, this project strives to enable stakeholders to effectively navigate the complexities of electric vehicles.

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INTRODUCTION

The transition to electric and hybrid vehicles marks a significant shift in the automotive industry, motivated by the need to reduce greenhouse gas emissions and dependency on fossil fuels. Traditional internal combustion engine (ICE) vehicles contribute significantly to environmental pollution, the use of electric and hybrid vehicles is regarded as a critical technique for addressing climate change. Electric vehicles (EVs) run solely on electric motors with energy stored in batteries, whereas hybrid vehicles (HEVs) combine an internal combustion engine with an electric propulsion system to improve fuel efficiency and reduce pollution. This change is not only changing transportation technology, but it is also forcing a rethinking of energy consumption patterns and infrastructure needs. This assignment project will investigate essential areas of electric and hybrid vehicle efficiency, providing insights into the technology, driving behaviours, and maintenance procedures that can improve their performance. Electric and hybrid vehicles are well-known for their efficiency, which means they use energy wisely to travel further and function more effectively. This efficiency is determined by a variety of factors, including the type of battery used, how energy is managed, and the design. Improvements in these areas have increased the popularity of electric and hybrid vehicles, which can now compete with traditional cars in terms of range, performance, and cost. Using renewable energy sources to charge these vehicles can also improve their environmental performance.

However, there are still certain barriers to widespread adoption of electric and hybrid vehicles. They can be costly to purchase, and there aren't enough charging stations everywhere now. People are also concerned about how long the batteries will last and how they will be disposed of. More research, as well as government and private sector funding, are required to solve these problems. This involves offering buyer incentives, expanding charging stations, and increasing battery recycling. As the worldwide push for decarbonization grows, electric and hybrid vehicles play an increasingly important role in obtaining a cleaner, more sustainable future. We hope that this investigation of efficiency optimization options will drive a move toward eco-friendly mobility systems that value both performance and environmental responsibility.

OBJECTIVES

- To identify the critical factors that impact the efficiency of electric and hybrid vehicles.
- To explore optimization strategies that can enhance the performance and efficiency of electric and hybrid vehicles.
- To raise awareness about the benefits of electric and hybrid vehicles in terms of efficiency, environmental impact, and long-term sustainability.

PROJECT DESCRIPTION

This project focuses on investigating and comparing the efficiency, performance, and suitability of electric and hybrid vehicles (EVs and HEVs) with conventional vehicles. We aim to understand the factors influencing the efficiency of EVs and HEVs, such as technological advancements, driving behaviors, and maintenance practices.

The significance of the project lies in its contribution to the transition towards sustainable transportation solutions. By providing insights into the benefits of EVs and HEVs, we empower policymakers, manufacturers, and consumers to make informed decisions. This, in turn, helps address environmental concerns, promote sustainable mobility, and improve overall decision-making processes in the automotive industry.

The project utilizes comprehensive data analysis and visualization techniques to present complex information in a user-friendly manner. Through interactive dashboards and data visualization tools, we aim to enhance awareness and understanding of the advantages offered by EVs and HEVs. Additionally, we seek to bridge the gap between technical concepts and practical applications, facilitating easier adoption of cleaner transportation alternatives.

DATA DESCRIPTION

This dataset is about fully electric vehicles (FEV) statistics with their attributes. The dataset includes cars that could be purchased in Poland as new at an authorized dealer, the dataset does not include discontinued cars that cannot be purchased as new from the authorized dealer. All 20 columns in the dataset indicate the car and its specifications. This dataset contains 47 rows with 20 columns.

No	Title	Explanation	Type
1	Brand	Brand for each car	Qualitative
2	Model	Model of each car	Qualitative
3	Price [RM]	Price of the car	Quantitative
4	Engine power [KM]	Engine power of the car in KM	Quantitative
5	Maximum torque [Nm]	Measurement of the maximum twisting force that the engine can generate	Quantitative
6	Type of brakes	Type of brakes that the car use	Qualitative
7	Drive type	Drive type of the car	Qualitative
8	Battery capacity [kWh]	Battery capacity of the electric car	Quantitative
9	Range [miles]	The distance it can travel with the current amount of battery	Quantitative
10	Wheelbase [cm]	Distance between the centres of the front and rear wheels on the same side of the vehicle	Quantitative
11	Length [cm]	The length of the cars	Quantitative
12	Width [cm]	The width of the cars	Quantitative
13	Height [cm]	The height of the cars	Quantitative
14	Maximum load capacity [kg]	Maximum weight that the vehicle is designed to carry safely	Quantitative
15	Tire size [in]	Size of the tire in inch	Quantitative
16	Maximum speed [kph]	Highest speed at which the vehicle is designed to operate safely	Quantitative

17	Boot capacity (VDA) [l]	The available storage space in the trunk or cargo area of the vehicle.	Quantitative
18	Acceleration	How quickly the vehicle can increase its speed from one speed to another. (from 0 – 100 km/h)	Quantitative
19	Maximum power charging	The highest charging rate at which the vehicle's battery can be charged	Quantitative
20	Energy consumption	The amount of electrical energy consumed by the vehicle per unit distance travelled	Quantitative

The second dataset is about hybrid cars statistics with their attributes. The dataset includes cars that could be purchased as a new car from a dealer, the dataset does not include discontinued cars that cannot be purchased as new from the authorized dealer. All 10 columns in the dataset indicate the car and its specifications. This dataset contains 30 rows with 10 columns.

No	Title	Explanation	Type
1	Model	Model of each car	Qualitative
2	Brand	Brand of each car	Qualitative
3	Fuel	Type of fuel used in the vehicle (hybrid)	Qualitative
4	Engine Type	Type of engine used in the vehicle	Qualitative
5	Engine Size	The capacity of the engine	Quantitative
6	Price	Price of the car	Quantitative
7	Airbag	The number of airbags present in the vehicle	Quantitative
8	Wheelbase	The distance between the centers of the front and rear wheels	Quantitative
9	Engine power	The maximum power output of the engine	Quantitative
10	Acceleration	How quickly the vehicle can increase its speed from one speed to another. (from 0 – 100 km/h)	Quantitative

DATA PREPARATION

In this part, we will prepare the obtained datasets to get a better insight for future analysis. We decided to use 2 dataset which are FEV_DATA and HYBRID_DATA. First, we do the renaming column to make sure the name represents well the data they hold and give the audience an early description about data in the column. Sometimes, we also rename the column to remove unwanted characters or symbols. In the first dataset, there are about 20 columns and for the second dataset, there are about 10 columns. We use Microsoft Excel to clean and prepare our data.

For the first dataset, we renamed the columns according to what we desired. We also change the unit to follow the data type that we want. After that, we check for the missing value, and we fill in the missing value or delete it. Missing value or NA could impact the interpretation of the data when analysis begins. Then, we filter the brand of the car according to what we need which are Tesla, Honda, Nissan, BMW, Kia, Audi, Hyundai, Mercedes and Porsche. We also delete some columns that is not related with our objectives.

For the second dataset, we renamed the columns according to what we desired. We also change the unit to follow the data type that we want. After that, we check for the missing value, and we fill in the missing value or delete it. Missing value or NA could impact the interpretation of the data when analysis begins. Then, we filter the brand of the car according to what we need which are Audi, Hyundai, Honda, Kia, Mercedes, BMW, Nissan and Porsche. We also delete some columns that is not related with our objectives.

DATA ANALYSIS, RESULTS AND DISCUSSION

VEHICLES PRICE ANALYSIS

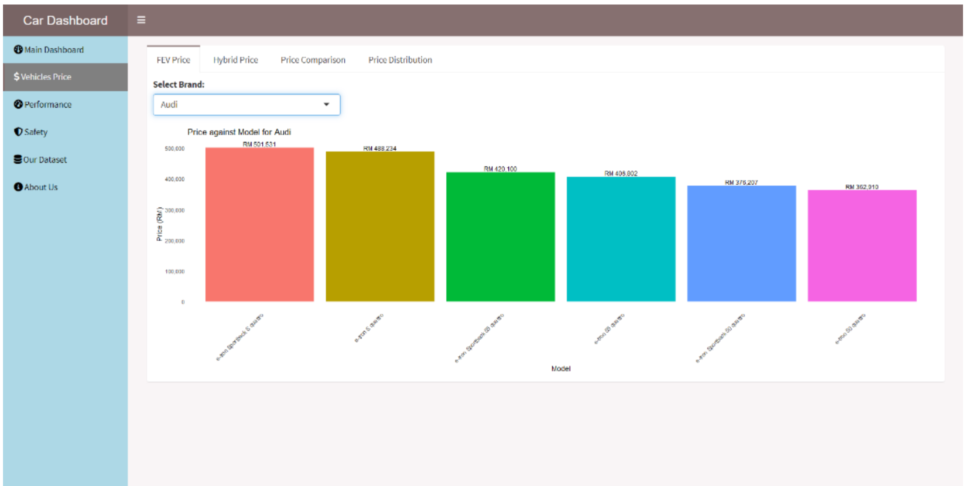

Figure 1: Price against Model for FEV Cars

Result:

The figure 1 shows the bar chart that indicates the Price against Model according to the model of the car for electric car. It is filtered by the Brand to see the trends of the price of the car by its brands. The user can select the brand of the car that they want to know about by clicking on the drop-down button. For Audi brand, the model with the highest price is E-Tron Sportback S Quattro with RM501,531 while the lowest is E-Tron 50 Quattro with RM 362,910. The colour of the bar chart represents the model of the car. This graph is part of a user interface that allows the selection of different car brands to compare their models' prices.

Discussion:

This visualisation helps user to understand the range of prices for Audi's E-Tron models which is from RM 300,000 to RM 510,000. From this, we can identify the most expensive model and the least expensive model. The price evaluation will be further analyse based on it safety and performance.

Conclusion:

The pricing range of Audi's E-Tron models, which starts at RM 362,910 for the E-Tron 50 Quattro and goes up to RM 501,531 for the E-Tron Sportback S Quattro, is clearly displayed by the bar chart visualisation. The interface makes it simple for consumers to compare prices between models by allowing them to filter by brand. This feature gives significant information about Audi's pricing strategy in the electric vehicle industry. This figure not only makes it easier to determine which models are the most and least expensive, but it also lays the groundwork for a more thorough examination of these costs in light of each model's performance and safety features. By using this kind of analysis, consumers may improve their overall buying experience by making better selections about the value proposition of each Audi e-tron model.

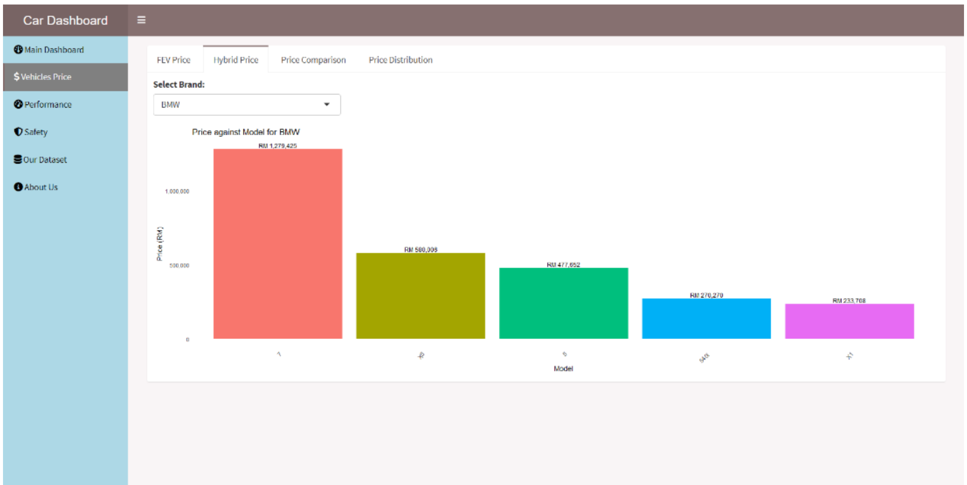

Figure 2: Price against Model for Hybrid Cars

Result:

The figure 2 shows the bar chart that indicates the Price against Model according to the model of the car for hybrid car. It is filtered by the Brand to see the trends of the price of the car by its brands. The user can select the brand of the car that they want to know about by clicking on the drop-down button. For BMW brand, the model with the highest price is BMW 7 Series with RM1,279,425 while the lowest is BMW X1 with RM 233,708. The colour of the bar chart represents the model of the car.

Discussion:

This visualisation helps user to understand the range of prices for BMW Hybrid models which is from RM 200,000 to RM 1,100,000. From this, we can identify the most expensive model and the least expensive model. The price evaluation will be further analyse based on its safety and performance.

Conclusion:

This visualization serves as an effective tool for understanding the pricing trends within BMW's hybrid vehicle line-up. By allowing users to filter and compare prices by model, it provides valuable insights into BMW's market positioning, the value proposition of different models, and consumer targeting strategies. This analysis sets the groundwork for a more detailed examination of the features, performance, and market reception of each model within the hybrid segment.

Figure 3: Average Price of FEV and Hybrid Cars by Brand

Result:

The figure 3 shows a side-by-side bar chart that indicates the Average Price of FEV and Hybrid Cars by Brand. The orange bar represents FEV cars while the turquoise bar represents Hybrid Cars. The highest average price for FEV cars is Porsche with RM 702,015 while for Hybrid cars is BMW with RM 568,212. The lowest average price for FEV cars is Smart with RM115,204 while for Hybrid cars is Kia with RM 124,595. But there are some brands who cannot be compared because the car brand only exists for Electric type of cars like Tesla, Volkswagen, Renault, Opel, Peugeot and Smart.

Discussion:

Based on the visualisation brands like Porsche and BMW have significantly higher average prices for their FEV and Hybrid models, indicating their focus on the premium segment. Brands like Kia and Smart offer the lowest average prices for Hybrid and FEV models respectively, catering to the budget-conscious segment. For many brands, FEVs are priced higher than Hybrid models. Examples include Porsche, Mercedes-Benz, Audi, Tesla, Hyundai, Honda, Volkswagen, Renault, Opel, Peugeot, and Smart. BMW is an exception where the average price of Hybrid models (RM 568,212) is higher than its FEV models (RM 499,976).

Conclusion:

This visualization provides a comprehensive overview of the average prices of FEV and Hybrid cars across different brands, highlighting significant trends and market positioning. By comparing prices, it offers valuable insights into how brands are catering to different market segments, the relative cost of FEVs versus Hybrids, and the strategic focus of each brand within the electric vehicle landscape. This analysis is crucial for consumers, manufacturers, and market analysts alike to understand the evolving dynamics of the automotive industry.

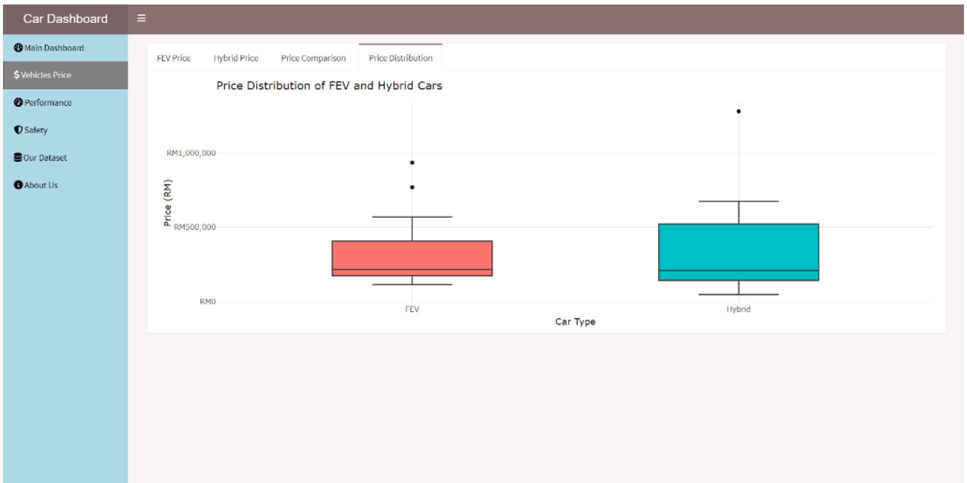

Figure 4: Price Distribution of FEV and Hybrid Cars

Result:

The figure 4 shows a boxplot which indicates the Price Distribution of FEV and Hybrid Cars. The price range for FEV cars is approximately from RM 100,000 to slightly over RM 900,000 while for Hybrid cars is around RM 50,000 to slightly over RM 1,000,000. The median price for FEV cars is RM 214,280 while for Hybrid cars is RM 208,119. The interquartile range (IQR) for FEV spans from roughly RM300,000 to RM600,000 while the Hybrid IQR spans from about RM250,000 to RM650,000. Both FEV and Hybrid cars have outliers beyond the whiskers, indicating some cars are priced significantly higher than the rest. These outliers are shown as individual points above the upper whisker. The distribution is symmetric but slightly skewed towards the higher end, indicating a small number of higher-priced FEVs. The distribution is more spread out and has a few higher-priced outliers.

Discussion:

While Hybrid cars show a slightly lower median price compared to FEVs, their price distribution is broader. This means that while the typical (median) Hybrid car might be a bit cheaper, there are Hybrid models that are priced significantly higher than most FEVs. Then, the presence of outliers in both categories suggests that there are premium models or brands within each category that are priced much higher than the average vehicle. Lastly, the broader price distribution of Hybrid cars could imply a wider variety of models and price points, making them accessible to a broader audience. The slightly higher skew in FEV prices might indicate a newer market with fewer budget options.

Result:

In summary, while Hybrid cars present a broader and more varied price distribution making them more versatile and accessible, FEVs seem to cater to a market with fewer but generally higher-priced options. This analysis underscores the diversity within the Hybrid market and the emerging nature of the FEV market.

PERFORMANCE ANALYSIS

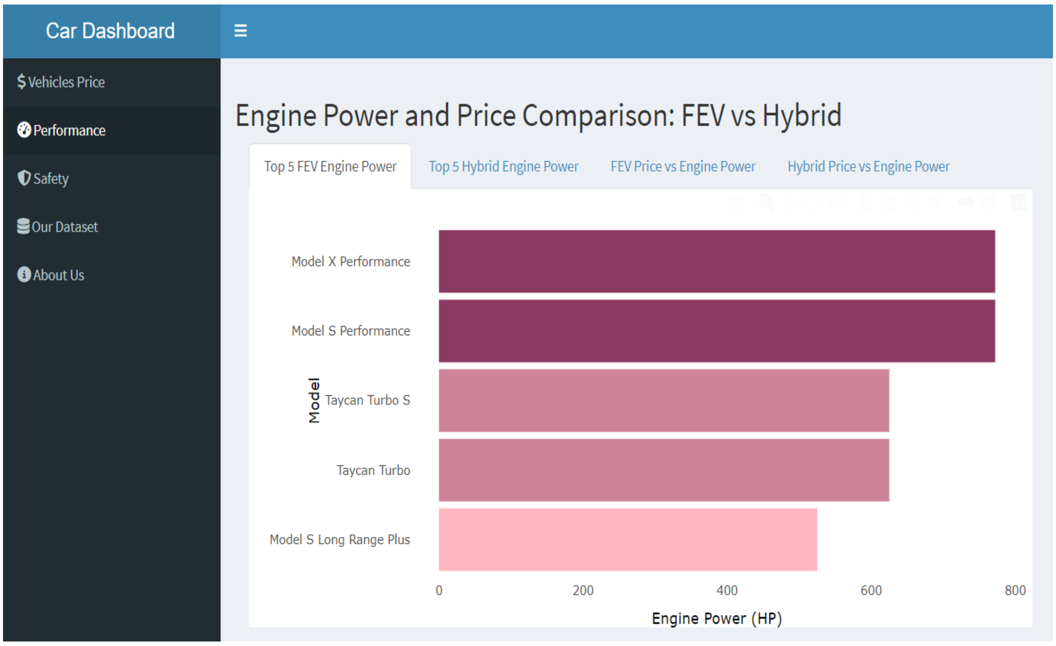

Figure 5: Top 5 FEV Engine Power

Based on Figure 5, the bar chart graph of the top 5 model from all brands in FEV by looking at Engine Power (HP) would look as follows:

- Model X Performance (Tesla) – 772 HP
- Model S Performance (Tesla) – 772 HP
- Taycan Turbo 5 (Porsche) – 625 HP
- Taycan Turbo (Porsche) – 625 HP
- Model S Long Range Plus (Tesla) – 525 HP

The analysis indicates that Tesla dominates the list of the top 5 FEV models with the highest engine power, with three of their models featured. Notably, the Model X Performance and Model S Performance, both from Tesla, lead the ranking with an impressive 772 HP each. This highlights Tesla's strong focus on producing high-performance electric vehicles.

Porsche also makes a significant appearance with two of its models, the Taycan Turbo 5 and Taycan Turbo, both achieving a substantial 625 HP. Porsche's inclusion in the top rankings showcases its capability to compete with Tesla in the high-performance electric vehicle market.

The significant horsepower figures for these models demonstrate the advanced engineering and technological efforts put into maximizing performance in fully electric vehicles. The higher horsepower not only contributes to better acceleration and speed but also enhances the overall driving experience.

Overall, Tesla leads in electric vehicle performance with the highest engine power, while Porsche also demonstrates substantial capabilities. The emphasis on powerful electric vehicles reflects advancements in technology and engineering, driving the market forward.

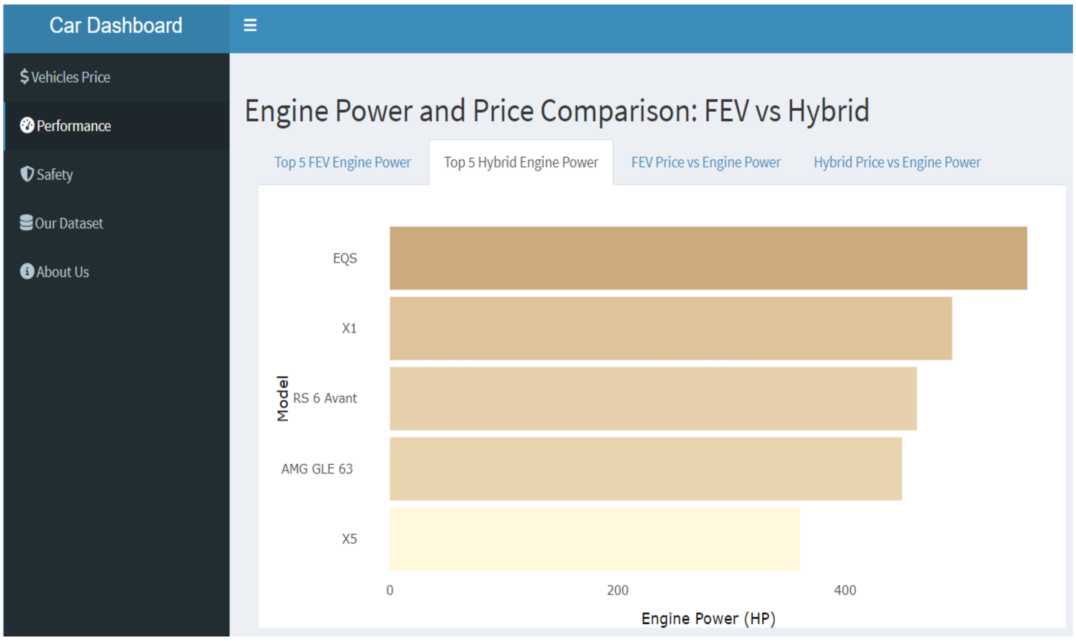

Figure 6: Top 5 Hybrid Vehicle Engine Power

Based on Figure 6, the bar chart graph of the top 5 model from all brands in Hybrid by looking at Engine Power (HP) would look as follows:

- EQS (Mercedes-Benz) – 560 HP
- X1 (BMW) – 494 HP
- RS 6 Avant (Audi) – 463 HP
- AMG GLE 63 (Mercedes-Benz) – 450 HP
- X5 (BMW) – 360 HP

The results show that Mercedes-Benz, BMW, and Audi dominate the top hybrid models in terms of engine power. Notably, Mercedes-Benz secures the first and fourth positions, demonstrating its commitment to blending luxury with high performance. The EQS, with 560 HP, leads the pack, underscoring Mercedes-Benz's prowess in engineering powerful hybrid vehicles.

BMW also makes a significant impact, with the X1 and X5 models appearing in the top five. This highlights BMW's consistent focus on performance across its hybrid range. The X1, with 494 HP, is particularly notable for its combination of power and efficiency, making it a strong contender in the hybrid market.

Audi's RS 6 Avant, positioned third with 463 HP, illustrates Audi's capability in producing high-performance hybrids. This model combines the brand's signature sporty characteristics with hybrid efficiency, appealing to performance enthusiasts who are also environmentally conscious.

Overall, the dominance of these brands in the top five underscores the significant advancements in hybrid technology. The capability to deliver high engine power in hybrid vehicles indicates that the automotive industry is successfully addressing consumer demands for performance and sustainability. This trend is likely to continue, with more high-powered hybrid models expected to enter the market.

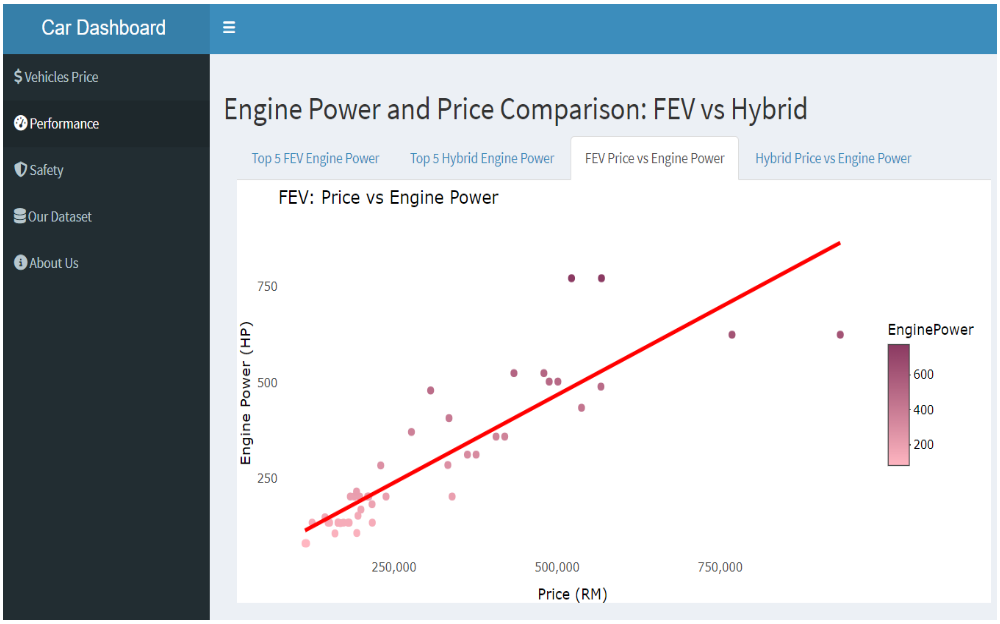

Figure 7: FEV Price vs Engine Power

Figure 7 shows that scatter plot of FEV Price vs Engine Power shows a positive correlation between the two variables. As the engine power increases, the price also tend to increase. The data used for this analysis includes 136 HP to 772 HP.

This positive correlation suggests that higher engine power is a significant factor in the valuation of FEVs. Manufacturers likely invest more in advanced technology and higher quality components to achieve greater engine power, resulting in increased production costs that are reflected in the higher prices of these vehicles.

The data range from 136 HP to 772 HP covers a broad spectrum of FEVs, encompassing both standard and high-performance models. Vehicles at the higher end of this spectrum, such as the Tesla Model X Performance and Model S Performance with 772 HP, command premium prices due to their exceptional performance characteristics. Conversely, models with lower engine power are priced more affordably, catering to a different segment of the market that prioritizes efficiency and cost-effectiveness over top-tier performance.

Overall, the scatter plot analysis confirms a positive correlation between engine power and price in Fully Electric Vehicles. This correlation indicates that as engine power increases, so does the price, reflecting the higher costs associated with producing high-performance FEVs.

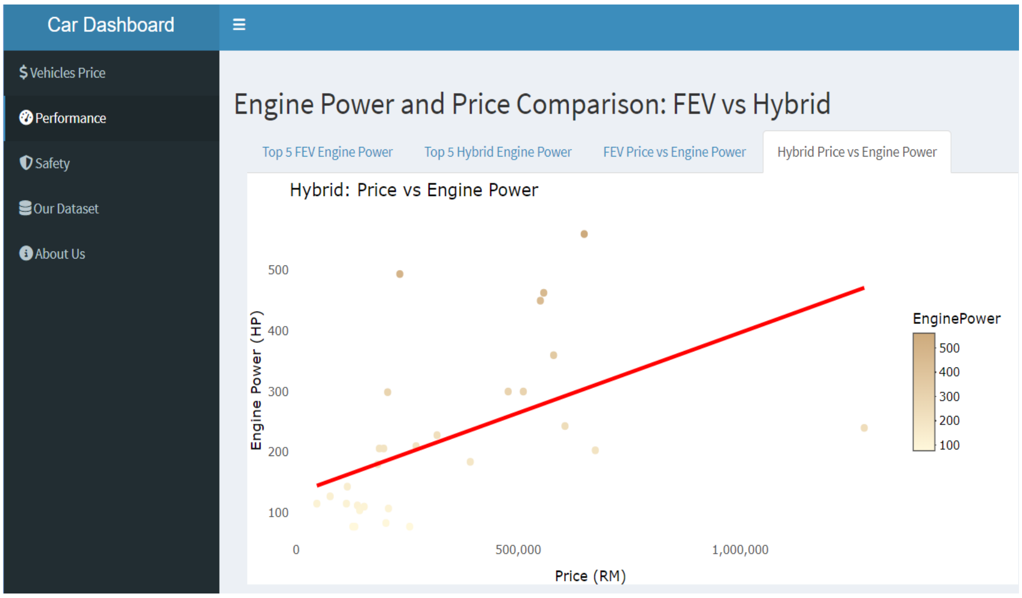

Figure 8: Hybrid Vehicle Price vs Engine Power

Figure 7 illustrates the relationship between engine power (HP) and price for hybrid vehicles, demonstrating a positive correlation between these two variables. This indicates that as the engine power of hybrid vehicles increases, their prices also tend to rise. The data range used in this analysis spans from 115 HP to 560 HP.

The positive correlation suggests that engine power is a critical factor influencing the pricing of hybrid vehicles. Higher engine power typically involves advanced engineering, more robust components, and sophisticated technology, all of which contribute to increased production costs. Consumers looking for enhanced performance, better acceleration, and superior driving dynamics are thus willing to pay a premium for higher-powered hybrids.

Within the examined range, vehicles at the higher end, such as the Mercedes-Benz EQS with 560 HP, are priced significantly higher due to their advanced performance capabilities and luxurious features. On the other hand, hybrids with lower engine power, around 115 HP, are more affordably priced, targeting a different market segment that values efficiency and cost-effectiveness over high performance.

The scatter plot analysis of hybrid vehicle prices versus engine power confirms a positive correlation, indicating that prices tend to increase as engine power rises. This trend reflects the higher production costs associated with advanced engine technologies and components used in more powerful hybrids.

SAFETY ANALYSIS

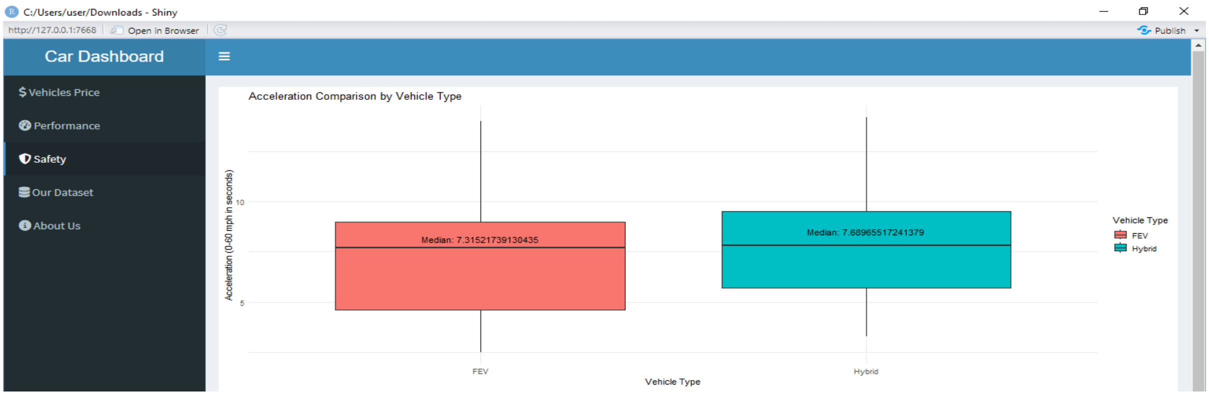

Figure 9 : Acceleration Comparison by Vehicles Type

Figure 9 show the comparison of acceleration times for Full Electric Vehicles (FEVs) and Hybrid Vehicles in the acceleration distribution boxplot. The acceleration times have been represented in a box plot with the Y-axis showing Interquartile Range (IQR) for 0 to 60 mph and X-axis showing types of vehicles i.e., FEV or Hybrid. The box itself represents this range with its lower and upper boundaries being the first (Q1) and third (Q3) quartiles respectively. Inside each boxplot, there is a horizontal line that depicts median acceleration time while whiskers extend up to 1.5 times IQR for minimum/maximum values; any data point outside these limits is an outlier.

The horizontal line inside the boxplot for FEVs represents an average acceleration time of about 7.32 seconds. The median acceleration time for Hybrid cars is approximately 7.69 seconds. This indicates that, typically, FEVs have a quicker acceleration than Hybrid cars. The interquartile range for FEV vehicles is smaller than that of Hybrid vehicles, suggesting that there is less variation in acceleration times among FEVs. Hybrid vehicles display a broader interquartile range, indicating more variability in their acceleration speeds. Both FEV and Hybrid vehicles have extreme values in terms of acceleration times, suggesting the existence of cars that greatly differ from the majority. A lower median acceleration time means that many vehicles in that category have faster acceleration times.

In summary, FEVs typically have a slight advantage in terms of quicker acceleration in contrast to Hybrid cars, as shown by their lower median acceleration time. The increased distribution and median speed of Hybrid vehicles indicate a greater variety in acceleration times, possibly because of the different models and technologies available in the Hybrid sector. The presence of models with considerably slower acceleration is emphasized by the skewness in the distribution of acceleration in Hybrid cars. This analysis provides valuable information on the acceleration capabilities of both FEVs and Hybrid cars, enabling consumers to make informed choices according to their preferences and performance needs.

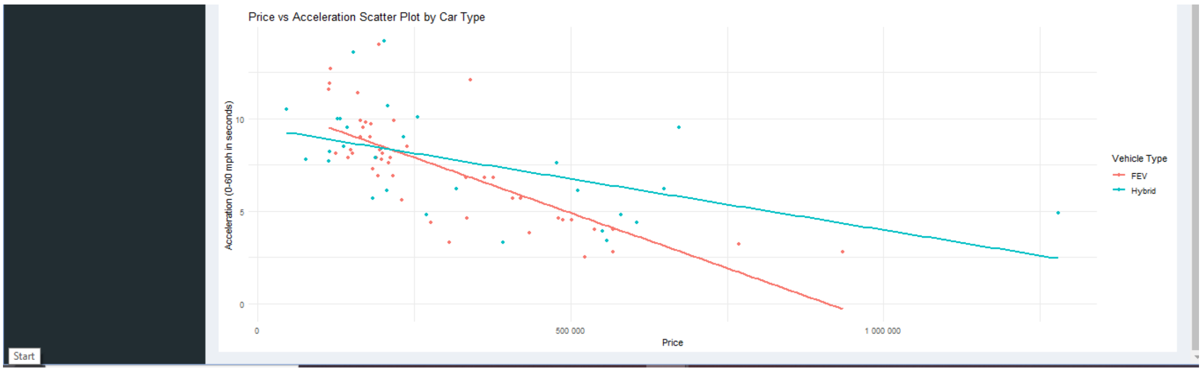

Figure 10 : Scatter Plot Price vs Acceleration By Vehicle Type

Based on figure 10, The scatter plot shows a negative relationship between the price of the vehicle and the time it takes to accelerate in both FEV and Hybrid cars. This indicates that vehicles with higher prices generally have quicker acceleration times which is lower y-axis values. The downward sloping trend lines for both types of vehicles visually confirm this connection. The slope of the FEV cars' trend line is more slope compared to that of Hybrid cars, suggesting a more slope between price and acceleration for FEVs. This indicates that with a higher price for FEVs, their acceleration time decreases more noticeably when compared to Hybrid vehicles.

The medians indicate that FEVs generally have acceleration times than Hybrid cars, suggesting that FEVs typically provide superior acceleration performance for their cost. The distribution plot also shows some asymmetry, especially for Hybrid cars. This asymmetry suggests that there are a small number of Hybrid models with significantly slower acceleration speeds, potentially outliers or models specifically focused on other performance aspects.

The trend lines show a visual depiction of how price and acceleration are related in both FEV and Hybrid cars. The more sloper of the FEV trend line implies a stronger connection between elevated prices and enhanced acceleration capabilities in FEVs. This may be due to progress in electric vehicle technology, with investments in advanced batteries and motors leading to improved acceleration. On the other hand, the gentler incline of the Hybrid trend line suggests that there is not as significant of an enhancement in acceleration as prices increase. This could be attributed to the diverse range of hybrid technologies and their emphasis on maintaining a balance between fuel efficiency and performance.

The scatter plot analysis shows an inverse relationship between the cost of vehicles and the time it takes for them to accelerate, for both FEV and Hybrid cars. FEVs demonstrate a more robust and reliable correlation, where increased prices usually lead to much quicker acceleration. Hybrid vehicles, although following this pattern, demonstrate greater diversity and some models with slower acceleration speeds. These differences are most evident in the trend lines, which offer consumers useful information when determining the price-performance level of their required vehicle. Purchasing more expensive FEVs provides more consistent performance advantages than the diverse performance of Hybrid cars.

CONCLUSION

This project provides important insights into the benefits and challenges of electric and hybrid vehicles (FEVs and HEVs). These vehicles help to reduce greenhouse gas emissions, save on fuel costs, and improve energy security. Their efficiency depends on advances in battery technology, regenerative braking, and the usage of renewable energy. Consumer awareness and government policies are also crucial for encouraging the use of these vehicles.

EVs and HEVs provide numerous advantages and hope for the future. They help to clean up the environment and combat climate change by lowering reliance on fossil fuels. These vehicles also support technological innovation and economic prosperity by accelerating the development of renewable energy and sustainable materials. Furthermore, widespread use of EVs and HEVs can result in healthier communities by lowering air pollution and its associated health hazards. Overall, EVs and HEVs offer a potential path to a more sustainable and resilient future.

However, there are still issues to resolve. The infrastructure for charging FEVs, especially fast chargers must improve. Batteries are produced and disposed of in an environmentally harmful manner, necessitating improvements in recycling and sustainable materials. Efficiency varies with driving conditions and user behaviour, indicating the need for more tailored car systems. While electric and hybrid vehicle show promise for sustainable mobility, more study and supportive regulations are needed to realize their benefits.

LIMITATION OF STUDY

The availability and accuracy of data is one of the study's primary limitations. The research relies on data from various sources, which may not always be accurate, complete, or up to date. Data quality issues can have an impact on the dependability of the study's conclusions. Additionally, gathering comprehensive data on hybrid vehicles specifically is particularly challenging. This scarcity of detailed hybrid data limits the depth of analysis and may result in less precise insights.

Another important constraint is technological variability. The efficiency of electric and hybrid vehicles varies greatly among models and manufacturers. This study may not capture the intricacies of these technological changes, resulting in broad generalizations that may not apply to other vehicles. Furthermore, the study's geographic focus may limit its usefulness. Infrastructure and regulatory conditions for EVs and HEVs range significantly across regions and countries. As a result, the findings may not be fully applicable in all geographic locations, limiting their generalizability.

Finally, economic issues such as fuel price fluctuations, subsidies, and raw material cost changes can all have an impact on EV and HEVs adoption and efficiency. The study's conclusions may have limited long-term application due to the fluctuating economic environment. Future research that addresses these limitations will contribute to a more thorough understanding of the efficiency and acceptance of electric and hybrid vehicles, allowing for the creation of more effective methods for promoting sustainable mobility.

APPENDIX

DATASET

https://www.kaggle.com/datasets/dhamur/cars-data?select=FEV+data.xlsx

https://www.kaggle.com/datasets/sarmitha16/car-price-prediction-dataset

R CODE FILE, DATASET, VIDEO, & SLIDE PRESENTATION

https://drive.google.com/drive/folders/1MGV5OIl9ah-94-LXQZUn7Jm7BiTHCVjS

COMPLETE GUI SCREENSHOT

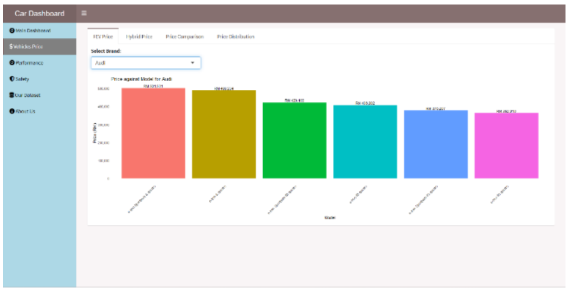

Chart 1: FEV Price Bar Chart

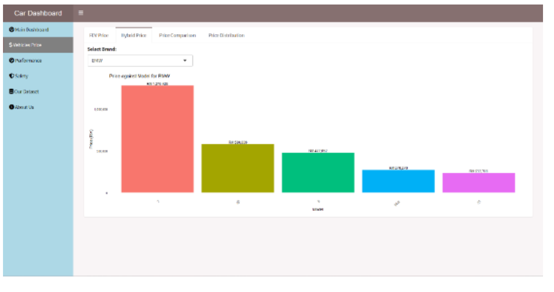

Chart 2: Hybrid Price Bar Chart

Chart 3: Side by Side Bar Chart of FEV and Hybrid Price

Chart 4: Boxplot of Price Distribution of FEV and Hybrid

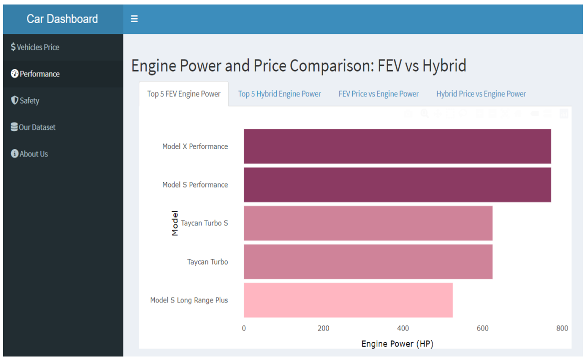

Chart 5: Bar Chart of Top 5 FEV Engine Power

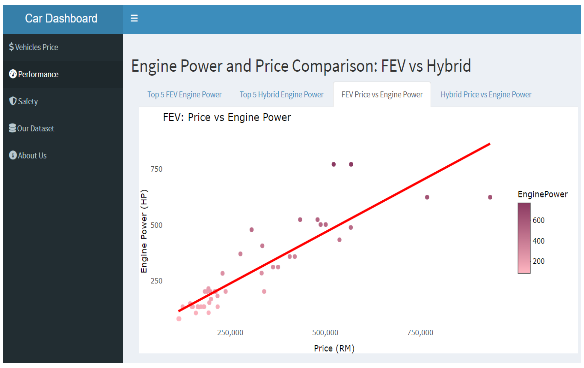

Chart 6: Scatter Plot of FEV Engine Power

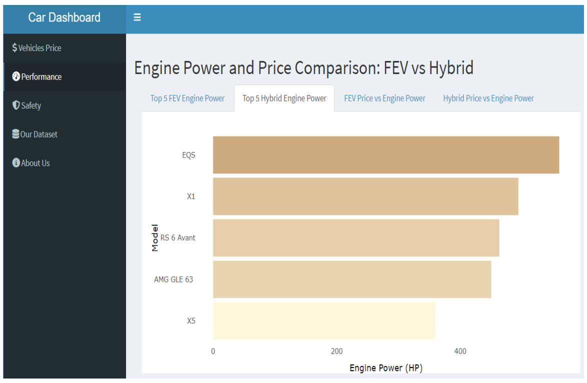

Chart 7: Bar Chart of Top 5 Hybrid Engine Power

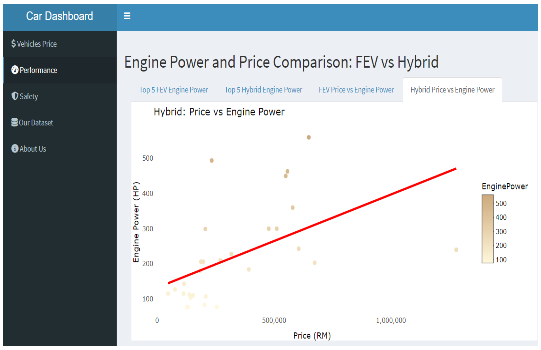

Chart 8: Scatter Plot of Hybrid Engine Power

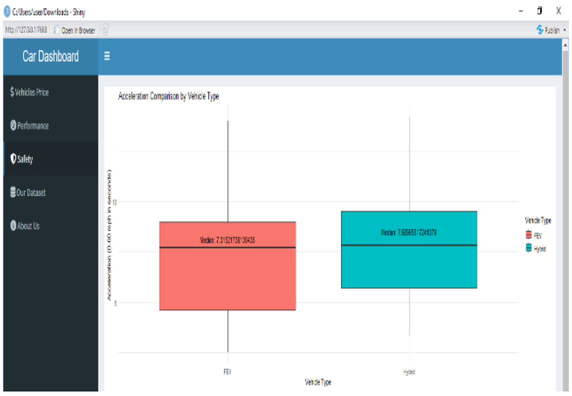

Chart 9: Boxplot of Acceleration Distribution of FEV and Hybrid

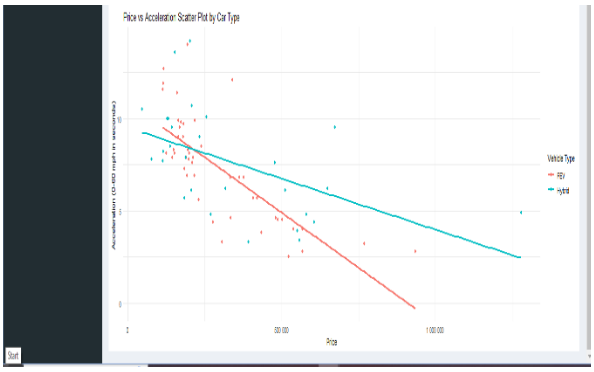

Chart 10: Scatter Plot Price vs Acceleration By Vehicle Type

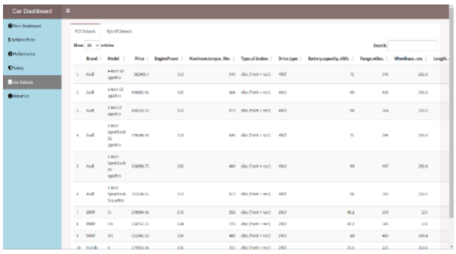

Figure 11: FEV Dataset

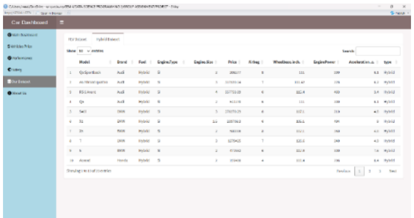

Figure 12: Hybrid Dataset

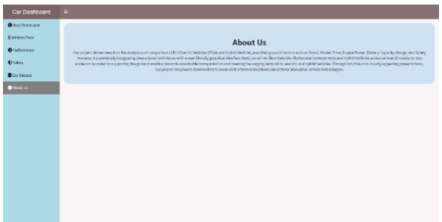

Figure 13: About Us Dashboard

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GROUP PROJECT PLAN & APPROVAL

<table>
<tr><td>SECTION NO.</td><td colspan="2">01G/ 02G/ 03G/ 04G</td></tr>
<tr><td>GROUP NAME</td><td colspan="2">GROUP 8</td></tr>
<tr><td rowspan="5">GROUP MEMBERS
(Leader’s name is the first in the list)</td><td>Id. No.</td><td>Name</td></tr>
<tr><td>SD22053</td><td>NUR NABILAH BINTI SUZELAN AMIR</td></tr>
<tr><td>SD22004</td><td>NUR AINUL NASUHA BINTI MOHD AZREEN</td></tr>
<tr><td>SD22047</td><td>NURUL FAQIHAH BINTI MAZLI AMRAN</td></tr>
<tr><td></td><td></td></tr>
<tr><td>PROJECT TITLE</td><td colspan="2">NAVIGATING ELECTRIC AND HYBRID VEHICLE EFFICIENCY</td></tr>
<tr><td>PROJECT DESCRIPTION</td><td colspan="2">This project explores the efficiency and performance of electric (FEVs) and hybrid vehicles (HEVs) to enhance understanding and decision-making for sustainable transportation. Interactive dashboards and data visualization tools will support stakeholders in navigating this transition.</td></tr>
<tr><td>DATA DESCRIPTION</td><td colspan="2">The data provides a comprehensive overview of various aspects of FEV and hybrid including price, engine power, acceleration. This information can be used to make informed decisions about which movies to watch and to analyze trends in the film industry.</td></tr>
<tr><td>APPROVED BY
(signature)</td><td colspan="2">Associate Professor Dr. Roslinazairimah Zakaria</td></tr>
<tr><td>DATE</td><td colspan="2">4 APRIL 2024</td></tr>
</table>

	DATA SCIENCE PROGRAMMING II (BSD2223)		MARKS: 120 (30%) /120
UNIVERSITI MALAYSIA PAHANG PUSAT SAINS MATEMATIK	**GROUP LEADER: NUR NABILAH BINTI SUZELAN AMIR**	**ID NO:SD22053**	
	GROUP PROJECT	**SECTION NO: 01G/02G/03G/04G DUE DATE: 19/6/2023**	

RUBRICS FOR CLO2/PLO2

CLO2: Analyse and summarise data using appropriate programming tools	PLO2: Cognitive Skills and Functional work skills with focus on Numeracy skills. **C4: Analysis**	/40	/10

Criteria	Achievement Level						Weightage	Score
	0	1	2	3	4	5		
	Incompetent	Inadequate	Emerging	Developing	Good	Excellent		
Ability to **obtain appropriate data** for the project	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	2	10
Ability to **summarise data numerically and graphically using R**.	Unable to do the task.	Limited ability to do the task.	Able to do the task with errors.	Able to do the task with no errors but wrong answer.	Able to do the task with no errors.	Able to do the task efficiently and correctly with no errors.	2	10
Ability to **analyse data using R and obtain data insights**.	Unable to do the task.	Limited ability to do the task.	Able to do the task with errors.	Able to do the task with no errors but wrong answer.	Able to do the task with no errors.	Able to do the task efficiently and correctly with no errors.	2	10
Ability to **provide conclusion** and recommendation from the project.	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	2	10

RUBRICS FOR CLO3/PLO3

CLO3: Develop programming codes to solve problems	PLO3: Functional work skills with focus on Practical, and Digital skills. **P4: Mechanism**	/40	/10

Criteria	Achievement Level						Weightage	Score
	0	1	2	3	4	5		
	Incompetent	Inadequate	Emerging	Developing	Good	Excellent		
Ability to **construct R codes to summarise data numerically and graphically**.	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	2	10
Ability to **construct R codes for data analysis**.	Unable to do the task.	Limited ability to do the task.	Able to do the task with errors.	Able to do the task with no errors but wrong answer.	Able to do the task with no errors.	Able to do the task efficiently and correctly with no errors.	2	10
Ability to **develop a dashboard (GUI) to present the data using Rshiny.**	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	4	20

RUBRICS FOR CLO4/PLO5

CLO4: Demonstrate verbal and written communication skills	PLO5:Functional work skillsfocus on with communication skills. **A3: Valuing**	/20	/5

	Criteria	Achievement Level						Weightage	Score
		0	1	2	3	4	5		
		Incompetent	Inadequate	Emerging	Developing	Good	Excellent		
Writte	Ability to write the report findings coherently.	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	1	5
	Ability to present the project report in the given format which include data description, data analysis, results and discussion.	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	1	5
Communicat	Ability to present the project proficiently by organizing and communicating the results in a clear, logical, and easy-tofollow manner.	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	1	5
	Ability to deliver the dashboard to summarise the project findings.	Unable to do the task.	Limited ability to do the task.	Reasonable ability to do the task.	Able to do the task with effort.	Good effort to do the task .	Able to do the task efficiently.	1	5

RUBRICS FOR CLO5/PLO8

CLO5: Relate entrepreneur skills in assigned task	PLO8:Entrepreneural skills **A4: Organising values**	/20	/5

Criteria	Achievement Level						Weightage	Score
	0	1	2	3	4	5		
	Incompetent	Inadequate	Emerging	Developing	Good	Excellent		
Ability to articulate the given/ chosen case study related to entrepreneurship.	Unable to articulate the given/ chosen case study.	Able to articulate the given/ chosen case study fairly weak.	Able to articulate the given/ chosen case study fairly well.	Able to articulate the given / chosen case study well.	Able to articulate the given / chosen case study reasonably well.	Able to articulate the given/ chosen case study excellently.	2	10
Ability to deliver entrepreneur ideas.	Unable to deliver any entrepreneur idea.	Delivery of idea is unclear, vague and not systematic.	Delivery of idea is les s cle ar, vague an	Delivery of idea is mod erately clear, vague and systematic.	Delivery of idea is clear and systematic.	Delivery of idea is very clear and systematic.	2	10

			d systematic.					