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Statistical Analysis Engine Capacity, Weight, Torque on MPV Fuel Consumption Using Regression And Correlation Algorithms

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Abstract

The rapid increase in the production and usage of motorized vehicles, particularly Multi-Purpose Vehicles (MPVs), in Indonesia has led to growing concerns over environmental pollution and economic sustainability due to high fuel consumption. Addressing the urgent need to improve fuel efficiency in these vehicles is critical to reducing greenhouse gas emissions and conserving non-renewable energy resources. This study investigates the impact of engine capacity, vehicle weight, and engine torque on the fuel consumption of MPVs, providing insights into how these factors influence efficiency. A statistical analysis was conducted using MATLAB, employing Linear Regression and Pearson Correlation Analysis. Data were collected from various 1500 cc MPV models in the Indonesian market, focusing on technical specifications and fuel consumption rates from literature sources. The results reveal that vehicle weight has the most significant impact on fuel efficiency, with a strong negative correlation of -0.69, while engine capacity and torque show weaker effects with correlations of -0.28 and -0.11, respectively. These findings highlight the critical importance of reducing vehicle weight to improve fuel efficiency. This study offers valuable guidance for consumers in selecting fuel-efficient vehicles and for manufacturers in designing environmentally friendly MPVs, emphasizing innovation in lightweight vehicle design.

Keywords: Multi Purpose Vehicle (MPV); Fuel Consumption; Engine Capacity; Regression; Correlation;

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1. Introduction

With the advancement of the automotive industry, the impact of environmental pollution produced by vehicle exhaust emissions has had a significant effect on the environment and public health[1]. The rise in production and use of Multi-Purpose Vehicles (MPVs) has heightened concerns about fuel consumption and its environmental and economic impacts. In Indonesia, where MPVs are popular, their growing demand leads to higher fuel use, increased greenhouse gas emissions, and greater reliance on non-renewable energy. As sustainability becomes more crucial, enhancing fuel efficiency in these vehicles is essential for reducing their environmental footprint and lowering consumer costs.

It is important to understand the factors affecting fuel consumption for both the automotive industry and policymakers. While studies have investigated the effects of engine capacity and vehicle weight on fuel efficiency, more targeted research is needed on how these factors interact in MPVs, especially in emerging markets like Indonesia. Additionally, advancements in engine technologies and lightweight materials could improve fuel efficiency, but their specific impacts need further examination.

This study seeks to address this gap by analyzing how engine capacity, vehicle weight, and engine torque affect fuel consumption in MPVs. The findings will guide manufacturers in designing more efficient vehicles and help consumers make informed choices, supporting global efforts to reduce energy consumption and combat climate change.

Previous research has extensively explored the impact of engine capacity, vehicle weight, and engine torque on fuel consumption in various vehicle categories. Studies have consistently shown that vehicle weight plays a crucial role in determining fuel efficiency, with lighter vehicles generally consuming less fuel than their heavier counterparts. For example, Sullivan et al. (2018) [2] demonstrated that reducing vehicle mass can lead to substantial fuel savings, while Gołębiewski and Stoeck (2016) [3] emphasized the significance of engine torque in specific driving conditions, such as heavy towing or frequent acceleration. However, much of the existing research has focused on passenger cars or heavy-duty trucks, with limited attention to MPVs, which dominate markets like Indonesia and serve both commercial and personal use. Furthermore, advancements in engine management technologies and lightweight materials have not been fully integrated into studies of MPV fuel consumption, leaving a gap in understanding how these factors interact in modern vehicle designs.

This study aims to advance the field by focusing specifically on MPVs in the Indonesian context, utilizing up-to-date vehicle data and advanced statistical methods to quantify the effects of engine capacity, vehicle weight, and engine torque on fuel consumption. By doing so, this research provides a more targeted analysis of fuel efficiency in MPVs, offering insights that are directly relevant to both manufacturers and consumers. Additionally, the study contributes to the ongoing discourse on sustainable vehicle design by highlighting the importance of weight reduction and torque management in improving fuel economy

According to the analysis of the Indonesian automotive market, Multi-Purpose Vehicles (MPVs) sales continue to dominate compared to other types of cars [4]. Improving fuel efficiency in MPVs is crucial in reducing greenhouse gas emissions and conserving non-renewable energy resources. Research on fuel consumption factors has shown that engine capacity, vehicle weight, and engine torque are essential variables affecting fuel use efficiency [5][6].

Engine capacity is directly related to the engine's cylinder volume and the potential power that can be generated. Engines with larger capacities generally require more fuel, mainly when operating at high loads. However, modern technologies such as advanced thermal management and start-stop systems have helped reduce fuel consumption despite large engine capacities[7]. Engines with larger capacities require more fuel, producing higher carbon dioxide (CO_2) emissions[8]. While it is a common perception that larger engines inherently consume more fuel, this is not always correct. For example, a study comparing an old 7.5 HP diesel engine with a new 8 HP diesel engine found that the diesel engine with 8 HP was actually more fuel efficient with an average fuel consumption ratio improvement of about 18.49%[9]. This suggests that advancements in engine technology can lead to better fuel efficiency.

Vehicle weight also significantly influences fuel consumption. The weight of the cargo being transported affects fuel consumption, especially at low temperatures, which also has an impact on emissions[10]. This is confirmed that total vehicle mass and carrying capacity utilization rate are important factors affecting fuel consumption[11]. In other case, the vehicle's weight, along with the ambient temperature and road grade, significantly increases CO_2 emissions, especially in urban and uphill driving conditions[12]. Some efforts have been made such as aerodynamic and lightweight trailers can reduce fuel consumption by about 20.2% for heavy goods vehicles, the benefits of reducing vehicle weight[13]. And reducing vehicle mass can result in substantial fuel savings, whereas a 10% reduction can improve fuel efficiency by 2% to 7%[2]. Heavier vehicles require more energy to move, significantly when accelerating. In China, the implementation of lightweight design in commercial vehicles can reduce fuel consumption, especially in heavy trucks, which currently consume 20% more fuel than European models[14]. An increase in vehicle weight will exponentially increase fuel consumption, particularly in heavy vehicles such as trucks[5].

Engine torque, a measure of the rotational force of the engine, also plays a vital role in fuel consumption. The relationship between a vehicle's torque characteristics, including its ability to reach maximum speed and climb, directly affects fuel consumption, where higher dynamic parameters tend to increase fuel usage[3]. High-torque engines are more efficient when carrying heavy loads or driving on challenging terrain. However, this can also lead to increased fuel consumption without efficient fuel management technology[6]. Research on torque control methods has been developed to optimize torque values to minimize fuel consumption during vehicle operation[15]. Additionally, modifying the combustion chamber geometry of a single-cylinder otto engine can enhance the compression ratio, optimize torque and power, and reduce fuel consumption by up to 3.35%[16]. However, these studies still need a final and effective solution to achieve fuel efficiency[6].

Therefore, this study analyzes the effect of engine capacity, vehicle weight, and engine torque on fuel consumption using statistical analysis methods and MATLAB software. The data used are specifications of MPV cars produced in 2023-2024. This research aims to provide deeper insights into how these three variables affect the efficiency of fuel use in MPV cars circulating in Indonesia.

2. Methods

This study follows a quantitative research methodology to analyze the impact of engine capacity, vehicle weight, and engine torque on the fuel consumption of Multi-Purpose Vehicles (MPVs). The research process includes the following steps:

1. *Data Collection*

   Data were gathered from various sources, including technical specifications of 1500 cc MPV models available in the Indonesian market, with production years 2023-2024. The data include information on engine capacity, vehicle weight, engine torque, and fuel consumption rates. The fuel consumption data were primarily sourced from existing literature and manufacturer specifications.

2. *Software and Tools*

   MATLAB software was utilized for data analysis. Specifically, the Statistical Toolbox within MATLAB was employed to perform linear regression, Pearson correlation analysis, and other statistical tests to understand the relationships between the variables.

3. *Analysis Procedure*

   - Scatter plot analysis was conducted to visually examine the relationships between fuel consumption and each of the independent variables (engine capacity, vehicle weight, and engine torque).
   - Linear regression analysis was employed to examine the relationship between the independent variables (engine capacity, vehicle weight, and engine torque) and the dependent variable (fuel consumption). The goal was to quantify the extent to which each independent variable influences fuel consumption. The general form of the regression equation is:

     $$Y = \beta_0 + \beta_1 X + e \quad (1)$$

     Where Y represents the fuel consumption, X represents the independent variable (e.g., engine capacity, vehicle weight, or torque), $\beta 0$ is the intercept, $\beta 1$ is the slope of the regression line, and ϵ epsilonε is the error term. The slope $\beta 1$ indicates the rate of change in fuel consumption for a unit change in the independent variable[17][18]. A negative slope suggests that an increase in the independent variable leads to a decrease in fuel consumption, indicating better fuel efficiency
   - Pearson correlation analysis was used to measure the strength and direction of the linear relationship between fuel consumption and each of the independent variables. The Pearson correlation coefficient, denoted as r, ranges from -1 to 1. An r value of -1 indicates a perfect negative linear relationship, 0 indicates no linear relationship, and 1 indicates a perfect positive linear relationship. The correlation coefficient was calculated using the formula:

     $$r = \frac{\Sigma(X_i - \bar{X})(Yi - \bar{Y})}{\sqrt{\Sigma(X_i - \bar{X})^2 \Sigma(Yi - \bar{Y})^2}} \quad (2)$$

     Where Xi and Yi are the individual sample points, and $\bar{X}$ $\bar{Y}$ are the means of the variables X and Y. The sign of r indicates the direction of the relationship, while the magnitude indicates the strength[19][20].

4. *Validation*

The results were validated through statistical significance tests to ensure the robustness of the findings. The specific toolbox and algorithms used in the study are detailed as follows

- Toolbox and Algorithms : The Statistical Toolbox within MATLAB was employed to conduct the analysis. Key algorithms used include:
- Linear Regression : Used to model the relationship between fuel consumption and the independent variables (engine capacity, vehicle weight, engine torque).
- Pearson Correlation Analysis : Applied to measure the strength and direction of the linear relationships between the variables.
- Histogram and Box Plot Analysis : Used to explore the distribution and variance of the data.

3. Results and Discussion

The Results Research on Analyzing the Effect of Engine Capacity, Car Weight and Engine Torque on Fuel Consumption Using MATLAB involves several tests to see the relationship between these variables. The test results include the use of scatter graphs and histography. Through these graphs, the relationship between fuel consumption and engine capacity, car weight, and engine torque can be analyzed visually and statistically.

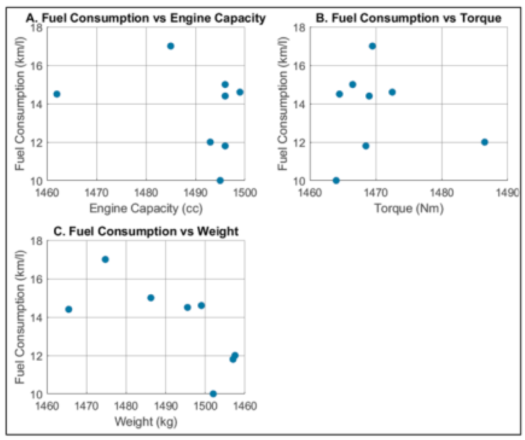

***Figure 1.** (a) Relationship between fuel consumption vs engine capacity, (b) fuel consumption vs torque, (c) fuel consumption vs weight.*

The relationship between fuel consumption and engine capacity, torque, and vehicle weight is illustrated in Fig. 1. Fig. 1a depicts the relationship between fuel consumption and engine capacity for MPV vehicles. From the graph, it can be observed that although some vehicles have similar engine capacities, their fuel efficiency can differ significantly. This difference can be attributed to the use of advanced technologies such as i-VTEC, which are designed to improve fuel efficiency. Other factors, such as lighter vehicle weight and better aerodynamic design, also contribute to reducing fuel consumption. Vehicles that adopt such technologies and designs exhibit higher fuel efficiency despite having the same engine capacity as other vehicles. This emphasizes the importance of technological and design innovations in improving fuel efficiency in MPV vehicles.

In contrast, Fig. 1b indicates no significant relationship between engine torque and fuel consumption. This finding contradicts the assumption that higher torque will always increase fuel consumption. Although high-torque engines are often associated with increased fuel consumption, technological adjustments such as torque converters can mitigate this effect. These technologies allow vehicles to manage torque more efficiently, so fuel consumption only sometimes increases. This demonstrates that high torque if adequately managed through the right technology, will only sometimes negatively impact fuel efficiency[21].

Interestingly, Fig. 1c illustrates the strong relationship between vehicle weight and fuel consumption. The graph shows that lighter vehicles tend to have higher fuel efficiency. This confirms that vehicle weight is a crucial factor affecting fuel use, as lighter vehicles require less energy to move, especially when accelerating. This finding supports the argument that reducing vehicle weight can be an effective strategy for improving fuel efficiency. Therefore, in an effort to make vehicles more fuel-efficient, manufacturers need to consider using lighter materials and more efficient designs.

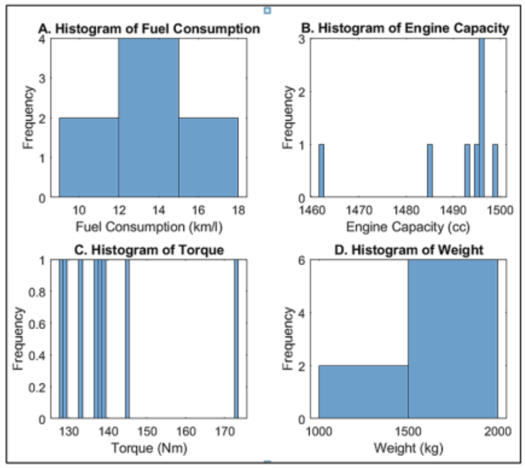

Figure 2. *(a) Histogram of Fuel Consumption, (b) Engine Capacity,(c) Torque, (d) Vehicle Weight.*

Fig. 2 illustrates the histogram distribution of MPV vehicle fuel consumption regarding engine capacity, torque, and vehicle weight. Interestingly, Fig. 2a shows that most MPV vehicles with an engine capacity of 1500 cc have a fuel consumption of around 14 km/l, which explains the popularity of this vehicle type in Indonesia due to its fuel efficiency. Fig. 2b highlights a significant spike in frequency at 1500 cc engine capacity, indicating that this capacity is becoming a desirable standard in the MPV industry due to its balance between performance and fuel efficiency.

Fig. 2c displays the frequency distribution of torque concentrated around 130 Nm to 150 Nm, indicating the consistency of the vehicle's stable traction performance in this range, although some peaks show variations in performance between models. Fig. 2d, with the car weight histogram, reveals two main groups of vehicle weight distribution around 1300 kg and 1800 kg, confirming that vehicle weight is a key factor in fuel consumption, with lighter vehicles showing better fuel efficiency.

Athorough analysis of these histograms shows that while engine capacity and torque play essential roles, vehicle weight significantly influences fuel efficiency. Reducing vehicle weight is a critical strategy in designing energy-efficient vehicles. To illustrate the relationship between fuel consumption and the three variables, we display the data in a box plot diagram format.

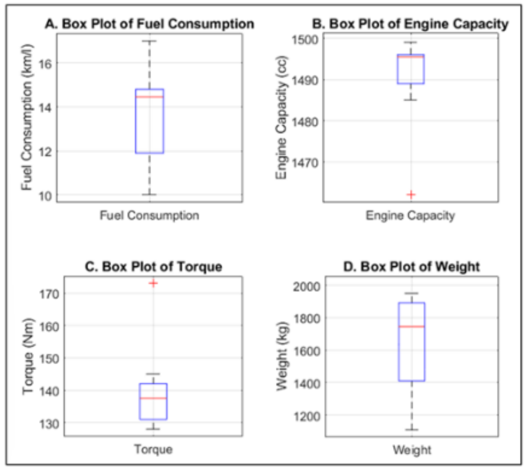

Figure 3. *(a) Box Plot of Fuel Consumption (b) Engine Capacity, (c) Torque, (d) Vehicle Weight.*

The box plots in Fig. 3 provide a comprehensive overview of the variation and spread of data on fuel consumption, engine capacity, torque, and weight of MPV vehicles. Interestingly, Fig. 3a shows significant variations in fuel consumption with a range of about 10 km/l to 16 km/l and a median close to 14 km/l, reflecting the consistent fuel efficiency of most MPV models. Fig. 3b reveals the distribution of engine capacity, with the majority ranging from 1488 cc to 1498 cc with one outlier at 1470 cc, indicating that despite minor variations, most vehicles have almost uniform engine capacity, reinforcing industry standards.

Fig. 3c shows the torque distribution, with the majority of the data ranging from 130 Nm to 145 Nm and one outlier at 170 Nm. This reflects the stability of the vehicles' traction performance, although some models have higher torque specifications. Fig. 3d, which displays the vehicle weight distribution, shows two main groups, around 1600 kg to 1900 kg, with a median of around 1800 kg, confirming that vehicle weight is an essential variable in fuel efficiency.

This box plot analysis highlights that while engine capacity and torque are significant, variations in fuel consumption are more influenced by vehicle weight, so reducing vehicle weight can significantly improve fuel efficiency.

Linear regression is a statistical method to find the relationship between the independent variables of engine capacity, car weight, and engine torque and the dependent variable, fuel consumption. The aim is to measure how strong the linear relationship is between these variables, providing an in-depth understanding of the factors affecting fuel consumption in this study.

Evaluation criteria for linier regression: R-Squared (R^2): The R^2 value indicates the proportion of the variance in the dependent variable that is predictable from the independent variable(s). A higher R2 value suggests a better fit of the model to the data. In this study, R^2 values were calculated for each regression model to assess how well engine capacity, vehicle weight, and engine torque explain the variance in fuel consumption. P-Value: The p-value associated with the slope of the regression line tests the null hypothesis that the slope is zero (no effect). A p-value less than 0.05 was used as the threshold for statistical significance, indicating that the relationship between the independent variable and fuel consumption is statistically significant [17][18]. Based on the linear regression:

- Engine Capacity: The negative regression coefficient for engine capacity (-0.0521) suggests that increasing engine capacity marginally decreases fuel efficiency. This implies that while larger engines generally require more fuel, technological advancements can mitigate this impact. Manufacturers should consider optimizing engine size and integrating technologies that enhance efficiency without sacrificing power.
- Vehicle Weight: The coefficient for vehicle weight (-0.0055) highlights its significant influence on fuel consumption. The strong negative relationship indicates that reducing vehicle weight is crucial for improving fuel efficiency. This finding

supports the automotive industry's ongoing efforts to develop lighter vehicles through the use of advanced materials and design innovations.

- Engine Torque: The small negative coefficient for engine torque (-0.0167) suggests a limited impact on fuel efficiency. Although torque is vital for vehicle performance, particularly in heavy load situations, its influence on fuel consumption is minimal compared to vehicle weight. Manufacturers should focus on optimizing torque in conjunction with other efficiency-improving measures.

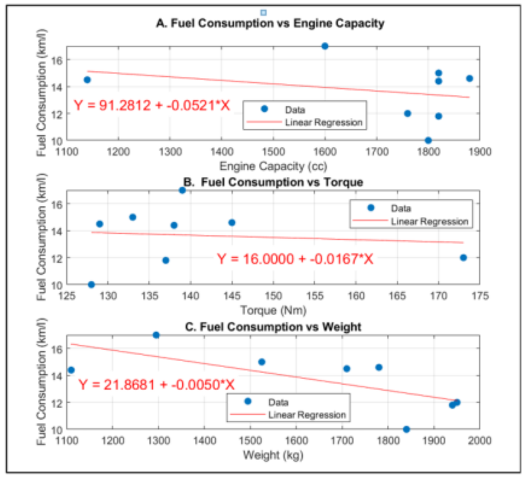

Figure 4. *(a) Linear regression between fuel consumption vs engine capacity, (b) fuel consumption and torque, (c) fuel consumption and vehicle weight.*

Table 1. *Linear Regression Results of Fuel Consumption against Engine Capacity, Torque and Weight*

Item	Linear Regression	Intersept (β_0)	Gradient (β_1)
Engine Capacity and Fuel Consumption	Y = 91.2812 - 0.0521X	91.2812	-0.0521
Fuel Consumption and Torque	Y = 16.0000 - 0.0167X	16.0000	-0.0167
Fuel Consumption and Weight	Y = 21.8681 - 0.0050X	21.8681	-0.0055

Fig. 4 shows that all three independent variables (engine capacity, torque, and vehicle weight) have a negative influence on fuel consumption, indicated by the decreasing regression line. Table 1 corroborates this finding with regression equations that illustrate the specific relationship between fuel consumption and each variable. The regression equation for engine capacity is Y = 91.2812 - 0.0521X, indicating that an increase in engine capacity by 1 cc will reduce fuel efficiency by 0.0521 km/l. For torque, the regression equation is Y = 16000 - 0.0167X, indicating that an increase in torque by 1 Nm will reduce fuel efficiency by 0.0167 km/l. Meanwhile, the regression equation for vehicle weight is Y = 21.8681 - 0.0055X, indicating that an increase in weight by 1 kg will reduce fuel efficiency by 0.0055 km/l. This analysis emphasizes that while all variables affect fuel consumption, vehicle weight has the most significant impact.

To further clarify that engine capacity, torque, and car weight negatively affect fuel consumption, we performed correlation calculations. The data was entered into MATLAB software and the results are shown in Table 2.

Table 2. *Correlation results of fuel consumption with engine capacity, torque and weight*

Correlation	Result

Fuel Consumption and Engine Capacity	-0.28
Fuel Consumption and Torque	-0.11
Fuel Consumption and Weight	-0.69

Table 2 shows the correlation results between fuel consumption and engine capacity, torque, and vehicle weight. Table 2 provides important insights into the strength and direction of the relationship between fuel consumption and the three independent variables: engine capacity, torque, and vehicle weight, through the correlation values. The correlation values range from -1 to 1, where negative values indicate an inverse relationship and positive values indicate a direct relationship.

Interestingly, the correlation results show that fuel consumption has a negative relationship with all three variables, but with different strengths. The correlation between fuel consumption and engine capacity is -0.28, indicating a moderate negative relationship. This means that an increase in engine capacity tends to be followed by a decrease in fuel efficiency, but the effect is not very large. The relationship between fuel consumption and torque is weaker, with a correlation of -0.11, indicating that torque has very little influence on fuel efficiency in the context of the MPV vehicles studied.

Most significant is the relationship between fuel consumption and vehicle weight, with a correlation value of -0.69. This shows a strong negative relationship, signifying that an increase in vehicle weight substantially decreases fuel efficiency. This finding confirms the importance of vehicle weight reduction in an effort to improve fuel efficiency.

One of the key findings in this study is the weak correlation between engine torque and fuel consumption (correlation coefficient of -0.11), suggesting that torque does not significantly influence fuel efficiency in the MPVs analyzed. This anomaly could be attributed to several factors, including the impact of modern engine management systems, such as torque converters and variable valve timing, which optimize torque output and reduce its direct effect on fuel consumption. Additionally, the specific usage patterns of the vehicles in the dataset, which may not fully capture scenarios where torque is more critical, and the relatively narrow sample of 1500 cc MPVs might limit the observed variability in torque's impact. Variability in measurement and data collection methods across different sources could also introduce inconsistencies. The weak relationship between engine torque and fuel consumption observed in this study contrasts with the findings of Gołębiewski and Stoeck (2016) [3], who identified a more pronounced effect of torque on fuel usage under specific driving conditions, such as heavy towing or frequent acceleration. This discrepancy could be attributed to the modern engine management technologies in the vehicles studied, which optimize torque and mitigate its impact on fuel consumption—a factor that might not have been as prevalent in earlier studies.

The results of this study, particularly the strong negative correlation between vehicle weight and fuel consumption, align with previous research that emphasizes the critical impact of weight on fuel efficiency. For instance, studies by Sullivan et al. (2018) [2] and Madhusudhanan et al. (2021)[13], have demonstrated that reducing vehicle mass can lead to substantial fuel savings, with similar findings observed in the present analysis where lighter MPVs exhibited better fuel efficiency. Additionally, the focus on a relatively narrow range of 1500 cc MPVs in this research could limit the observed variability, suggesting that broader studies encompassing a wider range of engine capacities and torque outputs might reveal more consistent patterns. To address these issues, future research should consider expanding the sample to include a broader range of vehicles, conducting in-depth case studies under various driving conditions, and performing longitudinal studies to track fuel consumption and torque over time. Furthermore, a focused analysis on the role of modern engine technologies in modulating the relationship between torque and fuel consumption could provide deeper insights. These efforts will help clarify the relationship between torque and fuel efficiency and contribute to more accurate assessments of vehicle performance, ultimately highlighting the need to consider technological advancements and sample diversity when interpreting the influence of torque on fuel efficiency.

Based on the findings of this study, it is recommended that vehicle manufacturers prioritize reducing vehicle weight by utilizing lightweight materials such as aluminum, carbon fiber, and advanced composites to improve fuel efficiency without compromising safety or performance. Additionally, manufacturers should continue developing advanced engine management technologies, like torque vectoring and hybrid powertrains, to optimize fuel efficiency, particularly in urban driving conditions. Policymakers are encouraged to introduce or strengthen incentives for adopting fuel-efficient technologies and lightweight materials, as well as implement stricter fuel efficiency standards that account for vehicle weight, thereby driving innovation and promoting environmental sustainability in the automotive industry.

4. Conclusions

This study examined the effects of engine capacity, vehicle weight, and engine torque on fuel consumption in MPV vehicles using MATLAB. The findings indicate that vehicle weight is the most significant factor, showing a strong negative correlation of -0.69 with fuel efficiency. Lighter vehicles consistently demonstrated better fuel performance. In contrast, engine capacity and torque had less influence, with moderate to weak correlations of -0.28 and -0.11, respectively. The linear regression analysis further reinforces the conclusion that reducing vehicle weight is a more effective strategy for improving fuel efficiency than modifying engine capacity or torque.

These results offer valuable insights for consumers seeking fuel-efficient vehicles and for manufacturers aiming to design more sustainable and eco-friendly MPVs. Prioritizing weight reduction through the use of lightweight materials and advanced engineering techniques emerges as a key strategy in enhancing fuel efficiency.

Future research could explore broader vehicle categories and include a wider range of engine sizes and driving conditions to further refine our understanding of these relationships. Additionally, longitudinal studies tracking vehicle performance over time, as well as an exploration of the role of emerging technologies such as electric and hybrid powertrains, would provide deeper insights into how these factors influence fuel consumption. These efforts will help build upon the foundation laid by this study and guide the development of even more fuel-efficient vehicles in the future.

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Appendix

Correlation

```
% Data input
data = {
    'ERTIGA GX', 14.5, 1462, 129, 1710;
    'APV Arena SGX', 12, 1493, 173, 1950;
    'XENIA 1.5 R Deluxe', 14.4, 1496, 138, 1110;
    'Luxio 1.5 X MC E4', 10, 1495, 128, 1840;
    'AVANZA 1.5G', 11.8, 1496, 137, 1940;
    'MOBILIO 1.5 S', 15, 1496, 133, 1525;
    'CONFERO 1.5 S', 17, 1485, 139, 1295;
    'XPANDER', 14.6, 1499, 145, 1780;};

% Create a table
varNames = {'Brand', 'Fuel_Consumption', 'Engine_Capacity', 'Torque', 'Weight'};
T = cell2table(data, 'VariableNames', varNames);

% Calculate correlations
corr_FuelCapacity_EngineCapacity = corr(T.Fuel_Consumption, T.Engine_Capacity);
corr_FuelCapacity_Torque = corr(T.Fuel_Consumption, T.Torque);
corr_FuelCapacity_Weight = corr(T.Fuel_Consumption, T.Weight);

% Display correlation results
fprintf('Correlation between Fuel Consumption and Engine Capacity: %.2f\n', corr_FuelCapacity_EngineCapacity);
fprintf('Correlation between Fuel Consumption and Torque: %.2f\n', corr_FuelCapacity_Torque);
fprintf('Correlation between Fuel Consumption and Weight: %.2f\n', corr_FuelCapacity_Weight);
```

Boxplot

```
% Data input
data = {
'ERTIGA GX', 14.5, 1462, 129, 1710;
'APV Arena SGX', 12, 1493, 173, 1950;
'XENIA 1.5 R Deluxe', 14.4, 1496, 138, 1110;
'Luxio 1.5 X MC E4', 10, 1495, 128, 1840;
'AVANZA 1.5G', 11.8, 1496, 137, 1940;
'MOBILIO 1.5 S', 15, 1496, 133, 1525;
'CONFERO 1.5 S', 17, 1485, 139, 1295;
```

```
'XPANDER', 14.6, 1499, 145, 1780;
};
% Create table
varNames = {'Brand', 'Fuel_Consumption', 'Engine_Capacity', 'Torque', 'Weight'};
T = cell2table(data, 'VariableNames', varNames);
% Display table
disp(T);
% Scatter Plot
figure;
subplot(2,2,1);
scatter([T.Engine_Capacity], [T.Fuel_Consumption], 'filled');
xlabel('Engine Capacity (cc)');
ylabel('Fuel Consumption (km/l)');
title('Fuel Consumption vs Engine Capacity');
subplot(2,2,2);
scatter([T.Torque], [T.Fuel_Consumption], 'filled');
xlabel('Torque (Nm)');
ylabel('Fuel Consumption (km/l)');
title('Fuel Consumption vs Torque');
subplot(2,2,3);
scatter([T.Weight], [T.Fuel_Consumption], 'filled');
xlabel('Weight (kg)');
ylabel('Fuel Consumption (km/l)');
title('Fuel Consumption vs Weight');
% Histogram
figure;
subplot(2,2,1);
histogram([T.Fuel_Consumption]);
xlabel('Fuel Consumption (km/l)');
ylabel('Frequency');
title('Histogram of Fuel Consumption');
subplot(2,2,2);
histogram([T.Engine_Capacity]);
xlabel('Engine Capacity (cc)');
ylabel('Frequency');
title('Histogram of Engine Capacity');
subplot(2,2,3);
histogram([T.Torque]);
xlabel('Torque (Nm)');
ylabel('Frequency');
title('Histogram of Torque');
subplot(2,2,4);
histogram([T.Weight]);
xlabel('Weight (kg)');
ylabel('Frequency');
title('Histogram of Weight');
% Box Plot
figure;
subplot(2,2,1);
boxplot([T.Fuel_Consumption], 'Labels', {'Fuel Consumption'});
ylabel('Fuel Consumption (km/l)');
title('Box Plot of Fuel Consumption');
subplot(2,2,2);
boxplot([T.Engine_Capacity], 'Labels', {'Engine Capacity'});
ylabel('Engine Capacity (cc)');
title('Box Plot of Engine Capacity');
subplot(2,2,3);
boxplot([T.Torque], 'Labels', {'Torque'});
ylabel('Torque (Nm)');
title('Box Plot of Torque');
subplot(2,2,4);
boxplot([T.Weight], 'Labels', {'Weight'});
ylabel('Weight (kg)');
title('Box Plot of Weight');
% Display plot
sgtitle('Vehicle Fuel Consumption Data Visualization');
```

Regression

```
% Data input
data = {
```

```
'ERTIGA GX', 14.5, 1462, 129, 1710;
'APV Arena SGX', 12, 1493, 173, 1950;
'XENIA 1.5 R Deluxe', 14.4, 1496, 138, 1110;
'Luxio 1.5 X MC E4', 10, 1495, 128, 1840;
'AVANZA 1.5G', 11.8, 1496, 137, 1940;
'MOBILIO 1.5 S', 15, 1496, 133, 1525;
'CONFERO 1.5 S', 17, 1485, 139, 1295;
'XPANDER', 14.6, 1499, 145, 1780;
};
% Create table
varNames = {'Brand', 'Fuel_Consumption', 'Engine_Capacity', 'Torque', 'Weight'};
T = cell2table(data, 'VariableNames', varNames);
% Linear regression for each independent variable against fuel consumption
mdl_EngineCapacity = fitlm(T.Engine_Capacity, T.Fuel_Consumption);
mdl_Torque = fitlm(T.Torque, T.Fuel_Consumption);
mdl_Weight = fitlm(T.Weight, T.Fuel_Consumption);
% Display linear regression results and regression formulas
disp('Linear Regression Results (Fuel Consumption vs Engine Capacity):');
disp(mdl_EngineCapacity);
fprintf('Regression Formula: Y = %.4f + %.4f*X\n', mdl_EngineCapacity.Coefficients.Estimate);
disp('Linear Regression Results (Fuel Consumption vs Torque):');
disp(mdl_Torque);
fprintf('Regression Formula: Y = %.4f + %.4f*X\n', mdl_Torque.Coefficients.Estimate);
disp('Linear Regression Results (Fuel Consumption vs Weight):');
disp(mdl_Weight);
fprintf('Regression Formula: Y = %.4f + %.4f*X\n', mdl_Weight.Coefficients.Estimate);
% Plot regression results
figure;
% Plot Engine Capacity
subplot(3,1,1);
scatter(T.Engine_Capacity, T.Fuel_Consumption, 'filled');
hold on;
plot(T.Engine_Capacity, mdl_EngineCapacity.Fitted, '-r');
title('Fuel Consumption vs Engine Capacity');
xlabel('Engine Capacity (cc)');
ylabel('Fuel Consumption (km/l)');
legend('Data', 'Linear Regression', 'Location', 'best');
% Add regression formula to the plot
text(min(T.Engine_Capacity), max(T.Fuel_Consumption), sprintf('Y = %.4f + %.4f*X', mdl_EngineCapacity.Coefficients.Esti-
        mate), 'FontSize', 12, 'Color', 'r', 'BackgroundColor', 'w');
hold off;
% Plot Torque
subplot(3,1,2);
scatter(T.Torque, T.Fuel_Consumption, 'filled');
hold on;
plot(T.Torque, mdl_Torque.Fitted, '-r');
title('Fuel Consumption vs Torque');
xlabel('Torque (Nm)');
ylabel('Fuel Consumption (km/l)');
legend('Data', 'Linear Regression', 'Location', 'best');
% Add regression formula to the plot
text(min(T.Torque), max(T.Fuel_Consumption), sprintf('Y = %.4f + %.4f*X', mdl_Torque.Coefficients.Estimate), 'FontSize', 12,
        'Color', 'r', 'BackgroundColor', 'w');
hold off;
% Plot Weight
subplot(3,1,3);
scatter(T.Weight, T.Fuel_Consumption, 'filled');
hold on;
plot(T.Weight, mdl_Weight.Fitted, '-r');
title('Fuel Consumption vs Weight');
xlabel('Weight (kg)');
ylabel('Fuel Consumption (km/l)');
legend('Data', 'Linear Regression', 'Location', 'best');
% Add regression formula to the plot
text(min(T.Weight), max(T.Fuel_Consumption), sprintf('Y = %.4f + %.4f*X', mdl_Weight.Coefficients.Estimate), 'FontSize', 12,
        'Color', 'r', 'BackgroundColor', 'w');
hold off;
```

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