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# Effect of Weather on Vehicles Speed (Case Study at KM23 FT050)

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**Abstract**

Statistical methods are utilized in this research to understand vehicle speed on KM 23 FT050 Jalan Kluang, based on rainy and sunny weather conditions. The data was collected on the speed of 100 vehicles that were present on the roads on the rainy and sunny days which included cars, motorcycles and trucks. Descriptive statistics such as mean, median, and standard deviation were calculated to analyze the speed variations among different vehicle types. Hypothesis testing confirmed that vehicles travel faster on sunny days, with a significant difference in speed between the two weather conditions. Furthermore, ANOVA tests showed that while speeds were roughly the same for all vehicle types in sunny weather, but they varied significantly for different vehicle types in rainy conditions. The research draws particular attention on the possible effects of weather on driving speeds and implications in managing traffic on this route in a way that improves road safety.

## 1. Introduction

Transportation is a major factor in modern infrastructure that enables the traveling of people and goods across various geographic areas. With the expansion of road networks, international relevance has been given to safety and efficiency in transportation systems. Among many factors that influence traffic flow and safety, weather conditions turn out to be one variable which more than any other factor influences vehicle speeds (Yasanthi et al., 2021) and driving behavior (Tsapakis et al., 2013).

Some of the conditions affecting the behaviors of motorists (Yousif et al., 2020) and performance of vehicles include rain, fog, snow, and wind. It has been proved through research in several parts of the world that bad weather brings down the speed of movement (Becker et al., 2022), extends the distance of stopping, reduces visibility, and increases the rate of accidents (Gaffney & Hovenden, 2023), (Maze et al., 2006), (Qiu & Nixon, 2008) and (Islam et al., 2023). Weather-induced changes in the speed of vehicles can be a particular problem in areas that show regular changes in weather; tropical areas, for example, having sudden heavy rain (Sakhare et al., 2023). Compared with all the traffic accidents, accidents that happen in bad weather conditions take a high proportion, and the degree of damage is relatively serious compared with other accidents happening in fine weather conditions (Lim et al., 2023) and support by (Malin et al., 2019).

The effect of weather conditions on the flow of traffic is widely recognized globally. Limited direct studies have been done to date on the effects of the individual weather conditions on the behavior of different classes of

vehicles in the tropics. In general, studies have identified unfavorable weather, primarily rain, as an influencing factor in reducing vehicle speeds (Das et al., 2019); however, the studies appear to end at the general trends without digging into the differential responses of different kinds of vehicles (Tsapakis et al., 2013). Larger vehicles, such as trucks and buses, may react quite differently to weather conditions because of the difference in weight, braking system, and handling compared to lighter vehicles like cars and motorcycles.

Malaysia, where the tropical climate has seen warming and erratic rainfall, especially in the past 20 years, which has drawn a lot of attention to the study of climate trends and their implications (Tang, 2019) where, drivers often encounter fluctuating weather conditions that may affect their travel decisions, particularly in the state of Johor. It is of great importance to understand how different vehicles carry out their functions along highways and urban roads, where frequent heavy rains are common. Without understanding the effects that weather may have on vehicle speeds, existing traffic management systems could fail to account for these differential effects, therefore giving rise to inefficient management of traffic flow and prevention of accidents under bad conditions. This creates the need for studies that will investigate the exact impact of each prevailing weather condition on the speeds of different vehicle types. This paper, therefore, derives its basis from this background.

This study aims to investigate the effects of weather conditions on vehicle speeds, focusing on different vehicle types. The specific objectives of the research are to determine the effect of various weather conditions such as sunny and rainy on the average speed of different vehicle types (e.g., cars, motorcycles, lorries) and to identify which weather conditions have the most significant impact on the speed of different vehicle types.

This is important for both traffic management authorities and policymakers in Malaysia, especially in Johor, where road accidents due to weather conditions are frequent. These will assist in the design of targeted interventions to enhance road safety when the weather is not favorable. This might also be useful for vehicle manufacturers to improve features related to safety in specific environmental conditions, such as better braking systems for wet-weather driving.

This study focuses on KM23 FT050 Johor Federal Route, Malaysia, (Fig. 1) in front of SJK (C) Kong Nan where tropical weather patterns specially rainfall is frequent. It covers different vehicle categories, including cars, motorcycles and lorries.

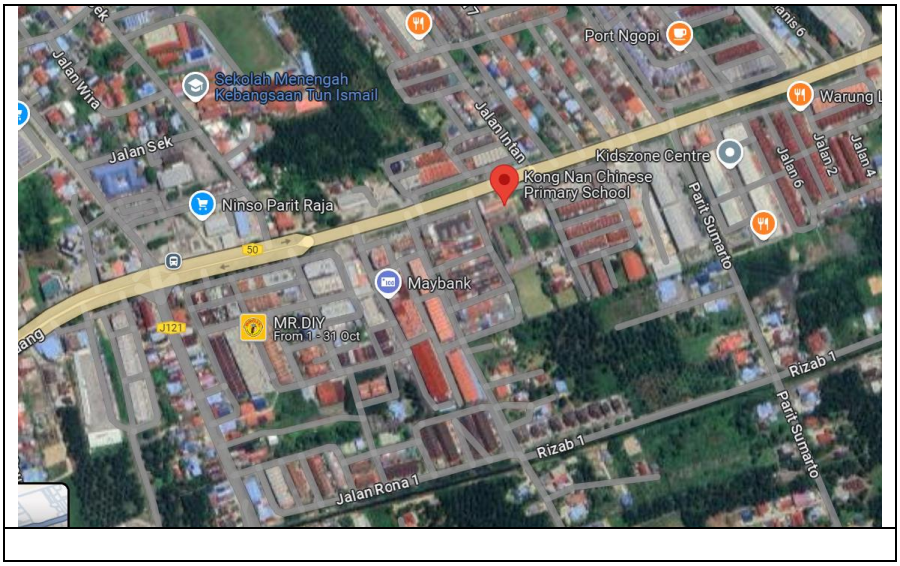


**Fig. 1** *Study location at KM 23 FT050*

## 2. Methodology

Traffic data includes vehicle speed and types of vehicles were collected on 28 Mei 2024 and 4 June 2024 at 6.00 pm, using the radar gun (see Fig. 2). The weather data was based on observation methods on sunny and rainy days. This method is effective because it is simple and cost-effective. Light drizzle to heavy rain was classified as rainy, and clear skies with few clouds were classified as sunny (Dahmane et al., 2021). Systematic random sampling was used in selecting the days representative of the data collection under different weather conditions.

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(a) (b)

**Fig. 2** *Radar gun (a) Radar gun accessories; (b) Radar gun*

The analysis covers both descriptive and inferential statistical methods for a comprehensive understanding of the relationship between weather conditions and vehicle speeds. Descriptive statistics provide an initial view of the data and allow one to see trends and general patterns. Using an inferential statistic allows for identification of significant differences in vehicle speeds across weather conditions and vehicle type (cars, motorcycles, and lorries)

## 3. Result and Discussion

This chapter presents the findings on how weather conditions affect the speed of various types of vehicles. Descriptive and inferential statistical methods were used to identify significant relationships and trends. This analysis includes comparisons of speed variations among different vehicle categories, such as cars, motorcycles, and lorries, highlighting any significant trends and statistical relationships. The discussion section interprets these results considering existing research, exploring the broader implications for traffic safety and efficiency.

### 3.1 Descriptive Statistic

This study has used a quantitative research design in measuring and analyzing the effect of weather conditions on vehicle speeds. A quantitative approach could be important, considering that numerical data about the speeds of vehicles needed to be collected and correlated with weather variables.

Table 1 shows descriptive statistics for the speeds of three vehicle types of cars, motor, and lorry on a sunny day. The table summarizes the mean, median, and standard deviation for each vehicle type.

**Table 1** *Descriptive result for sunny day*

| | Car (km/h) | Motorcycles (km/h) | Lorry (km/h) |
|---|---|---|---|
| Mean | 51.01 | 50.84 | 48.64 |
| Median | 48.9 | 49.5 | 48.05 |
| Standard Deviation | 15.20 | 16.28 | 15.53 |

The mean speeds for cars and motorcycles are very close to one another, around 51 and 50.8 km/h, respectively. Lorries have a slightly lower mean speed at 48.64 km/h. It shows that on average, cars and motorcycles travel at the same speed, while lorries move slightly slower.

Similar trends can be seen in the median speed, with motorcycles having the highest median speed at 49.5 km/h, just ahead of cars at 48.9 km/h and lorries at 48.05 km/h. For all vehicle categories, the median is somewhat slower than the mean speed.

Based on the standard deviation, motorcycles also have the highest speed variability 16.28 km/h, followed by lorries 15.53 km/h and cars 15.20. In contrast to cars and lorries, this shows that motorcycles speeds are more distributed, meaning that some motorcycles are moving substantially faster or slower than the mean speed.

**Table 2** *Descriptive result for rainy day*

| | Car (km/h) | Motorcycles (km/h) | Lorry (km/h) |
|---|---|---|---|
| Mean | 35.91 | 28.51 | 25.94 |
| Median | 30.55 | 24.6 | 22.4 |
| Standard Deviation | 14.78 | 13.47 | 8.22 |

Table 2 shows car have the highest mean speed at 35.91 km/h, followed by motorcycles at 28.51 km/h and trucks at 25.94 km/h. This indicates that, as Table 2 illustrates, all vehicles face a significant decrease in speed on rainy days relative to sunny days, with lorries slowing down the most on average.

Similar trends may be seen in the median speeds, where cars have the highest median speed, motorcycles are next, and lorries have the lowest median speed. The distribution may be left-skewed, as suggested by the fact that every median value is lower than every mean value, it seems some vehicles are moving substantially slower than the majority.

The range of speeds is displayed by the standard deviation. Cars have the most variable speed at 14.78, followed by motorcycles at 13.47 and lorries at 8.22. This suggests that while cars and motorcycles can cover longer distances on rainy days, lorries have a steadier speed due to their heavier weight and increased stability, which may avoid significant variations.

## 3.2 Inferential Statistic

Inferential statistics are techniques that generalize whether the weather has a statistically significant impact on vehicle speeds.

### 3.2.1 Hypothesis Testing

The average speed of vehicles will be significantly higher on sunny days compared to rainy days across all vehicle types. The impact of weather on vehicle speed can be investigated using hypothesis testing. Results show that, with a p-value (0.000) of less than 0.05, the weather does have a significant impact on vehicle speed. Because of variations in sight, road surface conditions, and driving habits, sunny and rainy days have different effects on vehicle speed. Due to great vision and dry roads, vehicles tend to drive faster on sunny days; on the other hand, rainy days typically force cars to slow down (Sakhare et al., 2023), (Ni et al., 2022) and (Yasanthi et al., 2021).

### 3.2.2 ANOVA

A one-way ANOVA is a statistical technique used to determine whether there are statistically significant differences in average speeds among cars, motorcycles and lorries. **Table 3** and **Table 4** show that P-value on sunny day is 0.895 and rainy day is 0.063, are more than 0.05 significance level. This indicates that fail to reject the null hypothesis where there is no significant difference among speed cars, motorcycles and lorries means.

**Table 3** *ANOVA result for sunny day*

| Source of Variation | SS | df | MS | F | P-value | F-crit |
|---|---|---|---|---|---|---|
| Between Groups | 53.85673 | 2 | 26.92837 | 0.110671 | 0.895466 | 3.195056 |
| Within Groups | 11436 | 47 | 243.3192 | | | |
| Total | 11489.86 | 49 | 8.22 | | | |

This can be explained during sunny days, there is no reason for drivers to drive slowly, therefore the speed of most vehicles is limited by how dense the traffic. Since the road is not too wide (3.20 m), even motorcycles cannot overtake every vehicle and thus are limited by the vehicles in front of them. This creates a scenario where almost all speeds are equal or close to each other.

**Table 4** *ANOVA result for rainy day*

| Source of Variation | SS | df | MS | F | P-value | F-crit |
|---|---|---|---|---|---|---|
| Between Groups | 976.6096 | 2 | 488.3048 | 2.928378 | 0.063305 | 3.195056 |
| Within Groups | 7837.215 | 47 | 166.7493 | | | |
| Total | 8813.825 | 49 | | | | |

During rainy days, there is no reason for drivers to drive faster (Yasanthi et al., 2021), (Becker et al., 2022) and (Gaffney & Hovenden, 2023), therefore the speed of most vehicles is low. There is no significant difference in speed between all the vehicles type at significance level 0.05, but there is a marginal effect at significance level 0.1 on these differences. So, further study needs to be done in this area.

It can also be seen that the average speed for all three vehicle types is almost similar. This suggests that whether sunny or rainy day, the types of vehicles do not affect the average speed.

Variance is a statistical measure that indicates how widely distributed or dispersed a set of data points are. In other words, how far a dataset's values depart from its mean. High variance means that data points are widely dispersed from the mean and from one another, whereas low variance means that data points are tightly packed around the mean.

**Table 5** *Summary ANOVA result for sunny day*

| Groups | Count | Sum | Average | Variance |
|---|---|---|---|---|
| Car | 22 | 1122.2 | 51.00909 | 231.1666 |
| Motorcycles | 14 | 711.7 | 50.83571 | 265.1532 |
| Truck | 14 | 680.9 | 48.63571 | 241.1163 |

On sunny days, motorcycles exhibit the highest speed variance compared to cars and trucks. This is due to the diverse riding styles of motorcyclists, the agility of motorcycles, their lack of stability systems, and environmental factors (Gaffney & Hovenden, 2023) that affect their performance. In contrast, cars and trucks tend to maintain more consistent speeds due to their larger size, advanced safety features, and stricter regulations, especially for trucks.

**Table 6** *Summary ANOVA result for rainy day*

| Groups | Count | Sum | Average | Variance |
|---|---|---|---|---|
| Car | 22 | 790.1 | 35.91364 | 218.9755 |
| Motorcycles | 14 | 399.2 | 28.51429 | 181.4736 |
| Truck | 14 | 363.1 | 25.93571 | 67.6594 |

During rainy days, the car category has the highest speed variance in the rain compared to motorcycles and trucks. This means that cars tend to have more inconsistent speeds in wet conditions, while motorcycles maintain slower and steadier speeds for safety (Becker et al., 2022) and trucks are bound by strict regulations and greater stability.

## 4. Conclusion

The vehicle speeds on sunny days are much higher and less predictable compared to rainy days (Sakhare et al., 2023). This could be because driving conditions are improved; hence, drivers are more confident in their driving on sunny days (Yasanthi et al., 2021). Such high variance in speeds on sunny and rainy days creates serious challenges for road safety, smooth traffic flow, and efficiency in driving. This depends on a set of road conditions, vehicle factors, driver behaviors, and car traffic density. All these issues require much-appraised multidirectional efforts regarding driver education, vehicle maintenance, infrastructure improvement, and integration of advanced technologies. Future studies should examine how average vehicle speeds are affected by different rainfall intensities (light, moderate, and heavy).

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## Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

*The authors confirm contribution to the paper as follows:* ***study conception and design:*** *Noorliyana Omar;* ***data collection:*** *Kelvin Pang Jia Hao, Low Jia Zheng, Dillion Dampa, Pang Jun Wen, Jason Ling Ji Chung;* ***analysis and interpretation of results:*** *Noorliyana Omar, Basil David Daniel;* ***draft manuscript preparation:*** *Noorliyana Omar, Basil David Daniel, Isham Ismail, Felix Ling Ngee Leh, Asmah Ibrahim, Nurul Adila Jablan, Siti Fadzilah Kasno, Norita Samsudin. All authors reviewed the results and approved the final version of the manuscript.*

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