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INVESTIGATING THE IMPACT OF SPEED HUMP HEIGHTS ON VEHICLE SPEED REDUCTION

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ABSTRACT - This study investigates the impact of the height of speed humps on vehicular speed reduction, focusing on two common heights of 50mm and 75mm. Drones were used to capture the motion of vehicles prior and after passing the speed humps. Those surveys were performed in August 2023 in two straight road sections in Kurunagala, Sri Lanka. Tracking software was used to extract the speed trajectories from which speed of each vehicle at 5-meter intervals up to 70 meters before and after the speed hump were obtained. The study encompassed five vehicle categories. Analysis revealed a consistent reduction in vehicle speeds across all vehicle categories in response to height of speed humps. Two-sample t-test conducted for each vehicle category indicate statistically significant differences in speed reduction between the 50mm and 75mm hump heights, with p-values ranging from 0.023 to 0.037 well below the standard significance level of 0.05 for Three-wheelers, Cars, Small vehicles, and Heavy vehicles, respectively. However, Motorbikes exhibited a p-value of 0.286, indicating there is no statistically significant difference in speed reduction based on hump height. These findings provide a valuable foundation for evidence-based decision-making in urban road infrastructure development and maintenance, ultimately fostering safer and more comfortable transportation systems.

Keywords: Speed hump; Hump height; Arrival speed; Speed reduction

4. INTRODUCTION

The primary contributing factor to road accidents is often identified as the speed of vehicles. Implementing various traffic calming strategies, such as roundabouts, speed humps, speed bumps, transverse rumble strips, and cat-eye reflectors, have been proven effective in reducing the occurrence of such accidents. Among these strategies, speed humps are particularly notable for their ease of construction and low cost. According to Shwaly et al. (2018), speed humps serve dual objectives: regulating traffic flow and reducing accident rates.

While some studies have explored the geometric characteristics of speed humps (Kiran et al. 2020, Yaacob et al. 2013), there remains a notable gap in research regarding the relationship between speed hump height and the degree of speed reduction they facilitate using rigorous statistical methods. For instance, Gamlath et al. (2023) investigated the effectiveness of speed humps in Sri Lanka using speed reduction percentages but did not employ statistical analysis such as two-sample t-tests. This study aims to fill this gap by empirically investigating the impact of speed hump height on vehicular speed reduction, specifically in the context of Sri Lanka. By elucidating this relationship through rigorous statistical analysis, our research aims to provide valuable insights that can inform more effective road safety measures and contribute significantly to the reduction of road accidents in Sri Lanka.

5. METHOD

Two hump heights, 50mm and 75mm, were selected for this study. Data collection took place in August 2023 using drone surveys. Data collection was scheduled between 9:00 AM and 12:00 PM to capture typical off-peak traffic conditions at the sites. Surveys were conducted during daylight hours to ensure clear visibility for drone footage and consistency in lighting conditions. The data collection periods were chosen to coincide with moderate traffic flow, minimizing the impact of extreme traffic conditions on the study's outcomes. Figure 1 shows the 75mm height hump located at the 10th kilometer post on Muttetugala – Hiripitiya Road (B-300 Road, coordinates: 7.582951N, 80.366254E).

Figure 1. Drone view of 75mm height hump located at the 10th kilometer post on B-300 Road

To extract data, Tracker software was utilized. Vehicle speeds at 5-meter intervals both before and after 70-meter stretch from the hump was extracted. This allowed for an examination of speed reduction profile attributed to the speed hump. Five vehicle categories: motorbikes (MC), three-wheelers (TW), cars, small vehicles (SV), and heavy vehicles (HV) were analyzed ensuring broad applicability to Sri Lankan road conditions. Statistical analysis was performed using Minitab21 (Version 4.2.0) software. Two-sample t-test was conducted for each vehicle category to compare the effects of the 50mm and 75mm hump heights on speed reduction. Before conducting the two-sample t-tests, normality tests and Levene's tests were performed on the data sets to ascertain whether the assumptions of normality and homogeneity of variance were met. This rigorous analysis ensured the validity of the subsequent statistical comparisons.

6. RESULTS AND DISCUSSION

Two-sample t-tests were conducted for each vehicle category to determine whether there are statistically significant differences in speed reduction between the 50mm and 75mm hump heights. Speed reduction was defined as the difference between arrival speeds at 70 meters before the hump and at the top of the hump. While traditional practice often measures speeds before and after the hump, our method focuses on the speed at the top of the hump to provide a detailed analysis of the deceleration process. Before conducting the t-tests, normality tests and Levene's tests were performed on the datasets to assess the assumptions of normality and homogeneity of variance. The results of these tests and number of observations are tabulated in Table 1.

According to the statistical analysis, three-wheelers (TW), cars, small vehicles (SV), and heavy vehicles (HV) exhibited statistically significant differences in speed reduction based on the height of the humps ($p < 0.05$). Conversely, for motorcycles (MC), there was no statistically significant difference in speed reduction based on the height of the humps according to the t-test results ($p > 0.05$). These findings indicate that while motorcycle speeds reduce due to the presence of speed humps, the extent of this reduction does not significantly depend on the height of the hump.

Table 1. Number of Observations and the results of the normality tests, Levene's tests and t-test

Vehicle category	Number of Observations		P value (Normality Test)		P value (Levene's Test)	P value (Two sample t-test)
	50mm	75mm	50mm	75mm		
Car	33	33	0.088	0.122	0.637	0.023
Three-wheeler (TW)	35	35	0.249	0.086	0.553	0.005
Small Vehicles (SV)	32	32	0.342	0.090	0.235	0.038
Heavy Vehicles (HV)	30	30	0.759	0.507	0.222	0.037
Motorcycles (MC)	40	40	0.166	0.111	0.429	0.286

4. CONCLUSION

In this study, the impact of speed hump height on vehicle speed reduction was investigated through statistical analysis. The results revealed that three-wheelers (TW), cars, small vehicles (SV), and heavy vehicles (HV) exhibit statistically significant differences in speed reduction based on hump height ($p < 0.05$). However, for motorcycles (MC), there was no statistically significant difference in speed reduction between the two hump heights ($p > 0.05$). These findings suggest that the amount of speed reduction may vary depending on the vehicle type and characteristics, with some vehicles being more influenced by hump height than others.

Additionally, this research can be continued to identify the optimum geometrical characteristics of speed humps for different types of vehicles and to investigate unnecessary traffic jams caused by humps. Understanding the specific needs of various vehicle types can lead to the development of more tailored and effective traffic calming measures, ultimately contributing to safer and more efficient transportation systems.

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