CHAPTER 5

INFLUENCE OF ROAD DIMENSIONS AND ON-STREET PARKING ON VEHICULAR SPEEDS ALONG RESIDENTIAL STREETS

5.1 INTRODUCTION

Speed is a simple measure that may be used to determine the efficiency of a road or road network that carries traffic. It is basically the total distance traveled by a vehicle divided by the time taken to traverse the distance. This movement is usually expressed in kilometers per hour (km/h).

The selection of driving speed depends on the road width that can be effectively used while driving. Studies have shown that speed tends to be lower for narrower roads. For every 0.3 m increment in road width, the 85th percentile speed reduction is approximately 4.7 km/h.

The length of road also affects the speed of the vehicle. Long, straight roads have been found to promote high-speed traffic. Thus, there is a need for conscientious design that limits the length of a road in order to restrict the amount of space that may ultimately be used by the driver to increase his speed.

Another factor that may have a significant impact on speed is on-street parking, which is quantified through parking density (vehicles per kilometer). High parking density, especially along narrow roads reduce the width of the actual path to the effective road width, which causes speed to reduce dramatically. In contrast, narrow roads that have low parking density has, in actual fact, the same road width as wide roads with high parking density.

To further investigate the influence of road width, road length and on-street parking on vehicular speeds along residential streets (local and collector streets), a comprehensive study was conducted in urban and suburban residential areas in Batu Pahat and Parit Raja. Spot speeds were recorded and reconnaissance surveys were conducted along local and collector streets in selected neighbourhoods. These data were then analysed using regression analysis to explore the relationship between speed, road dimensions and parking.
5.2 LITERATURE REVIEW

Speed varies according to the category of road, the road design and its surroundings. Speed is an important parameter to define the movement of traffic and ascertain the level of safety, particularly in areas with high pedestrian and cyclist activity, interacting with motorised vehicles. It is vital to control vehicular speed in such conditions for a safer and more effective transfer of road users.

Research has shown that drivers become more attentive and cautious when driving along narrow roads, thus lowering travel speeds. However, wider roads do not necessarily result in higher speeds as the additional space may be taken up by on-street parkers, hence creating a reduced effective width. The relationship between speed and road width is rather ambiguous, as there have also been studies that have failed to find any strong correlation between them.

There has been a mixed reaction to the notion that long roads attract high speeds. Drivers tend to operate at higher speeds on long, straight and unimpeded roads. As a result, newer residential streets have been designed to be more limiting in terms of speed choice, through the introduction of traffic calming measures. Authorities have also drawn up design guidelines to curtail speeding on local and collector streets by limiting the allowable length of roads and introducing speed breakers, particularly on local streets.

While there has been some evidence to show that short, narrow roads result in low speeds, there is however no clear relationship between vehicle speeds and the width of residential streets. The same can be said about the association between speed and the length of residential streets. This is partly due to the lack of research in this area, as researchers are more inclined to investigate roads that serve higher traffic volumes and speeds. Also, most speed-related research focuses on the driver rather than the road design and its environment.

High parking density, especially on narrow streets, noticeably reduces the width of the actual travel path, thus causing considerable speed reduction. Drivers become more alert due to the presence of parked vehicles along the road and anticipate pedestrian activity as the result of on-street parking. This effect however is more evident on local streets than on collector streets, because the latter is wider and has curb space that may be used for parking.
5.3 RESEARCH METHOD

Spot speed analysis was employed to achieve the objectives of this research by using a light detection and ranging (LIDAR) speed meter to directly measure speeds along local and collector streets in Batu Pahat and Parit Raja. The experimental setup is shown in Figure 5.1.

![Experimental setup of spot speed data collection using LIDAR technology](image)

**Figure 5.1**: Experimental setup of spot speed data collection using LIDAR technology [1]

Speed data were collected during weekday off-peak periods for the purpose of obtaining vehicular speeds independent of other traffic. Streets with effective widths large enough to allow opposing vehicles to pass each other without the need to slow down or stop were selected in order to eliminate the effect of parked vehicles. The effect of parked vehicles was considered negligible, since parking density was very low during off-peak periods.

Observations were made from inside a parked vehicle, thus concealing the observer from the sight of drivers in order to exclude the influence an observer might have on drivers’
speed. The vehicle was also positioned suitably so as not to impede traffic. All observations were conducted in clear and dry conditions to discount external factors that affect driving, such as lack of visibility and wet driving conditions.

The speed data was firstly screened to eliminate outliers, and then tabulated and processed to obtain the 85th percentile speed at unimpeded sections along the roads. Road widths and lengths were recorded, while parking density, defined as the number of vehicles parked per unit kilometer in length, was obtained from reconnaissance surveys.

Regression analysis was used to determine the best-fit model that significantly relates speed with the contributory variables (i.e. road width, road length and parking density). The best-fit models were expressed in mathematical functions and tested for statistical significance using F-test and t-test methods.

The regression model output summary generally discloses values for the coefficient of determination ($R^2$) and the standard error of the estimate (SEE). The $R^2$ corresponds to the goodness-of-fit of the model to the data, while the SEE represents the measure of accuracy of predictions made using the regression model.

The analysis of variance (ANOVA) table is used to indicate if the regression model is able to predict the dependent variable significantly well. The null hypothesis of the F-test is that the coefficient of the regression model is zero, while the alternative hypothesis is that the coefficient is non-zero. A significance value of the F-statistic (Sig. F) that is equal to or less than the statistical significance value ($\alpha = 0.05$ at a confidence level of 95%) is enough to reject the null hypothesis. Hence, the regression model can significantly predict the dependent variable.

The coefficients table shows details of the regression equation (coefficients and constant), whilst providing t-statistics and their significance values, which are used to make deductions on whether the coefficient is significantly different from zero. A significance value of the t-statistic (P-value) equal to or less than $\alpha = 0.05$ is enough to reject the hypothesis that the coefficient is zero, hence concurring that the contributory variable is significantly functional in the regression equation.

It should be noted that a high $R^2$ value is indicative of a strong linear relationship between the dependent and contributory variables. Where non-linear relationships are considered, the $R^2$ criterion is excluded because it does not provide an indication of a
goodness of fit to the data for nonlinear models. Hence, the following three criteria were set for selecting the best-fit regression model:

1. The Sig. F value should be equal to or less than 0.05,
2. The P-value should be equal to or less than 0.05, and
3. The SEE value should be relatively small (less than 5 km/h is desirable).

5.4 RESULTS AND CONTRIBUTIONS OF THE RESEARCH

Figure 5.2 illustrates the regression curve obtained to relate speed with actual road width. The results of the analysis show that the 85th percentile speed is significantly related to the actual road width, measured from curb to curb. The Sig. F value and P-value obtained were both 0.0037, while the SEE was 4.16 km/h. The association between these two variables can be best expressed in the form of a logarithmic model:

\[ V_{85} = 34.782 \ln(W) - 19.758 \]  

(5.1)

where \( V_{85} = \) 85th percentile speed (km/h)  
\( W = \) Actual road width (m)

The relationship between speed and effective road width, which is defined as the available width for travel measured from one end of a lateral obstruction to another end of a
lateral obstruction or curb, is presented in Figure 5.3. The statistical tests yielded positive results, with both Sig. F and P-values being 0.0011, while the SEE value was 3.94 km/h. Thus, it can be concluded that there is a significant relationship between 85th percentile speed on residential streets and effective road width. These variables can be best represented in the form of the following logarithmic model:

\[
V_{85} = 16.514 \ln(W_{eff}) + 10.847
\]  

(5.2)

where  
\(V_{85}\) = 85th percentile speed (km/h)  
\(W_{eff}\) = Effective road width (m)

Figure 5.3: Relationship between speed and effective road width

The influence of road length on speed was investigated and found to be statistically significant, with the Sig. F value and P-value both being 0.016, while the SEE value was
2.83 km/h. The logarithmic model that relates the 85th percentile speed with road length is shown in Figure 5.4 and can be written the form of:

\[
V_{85} = 9.766 \ln(L) - 6.177
\]  

(5.3)

where \( V_{85} \) = 85th percentile speed (km/h)

\( L \) = Road length (m)

Figure 5.4: Relationship between speed and road length

A linear model was found to be the best fit model to relate speed and parking density. However, the coefficient of determination (R²) was 0.437, which indicates a moderate association between the 85th percentile speed and parking density. The goodness of fit of the model is below average, as shown in Figure 5.5. Statistical tests revealed that the relationship is less significant, with the Sig. F value and P-value both being 0.074, while the SEE value was 4.85 km/h. Nevertheless, at a 90% confidence level, the model can be
considered statistically significant. The linear model of this relationship may be expressed as:

\[ V_{85} = 42.331 - 0.1103k_p \]  

(5.4)

where \( V_{85} \) = 85th percentile speed (km/h)  
\( k_p \) = Parking density (veh/km)

\[ 85th \text{ Percentile Speed versus Parking Density} \]

\[ V_{85} = 42.331 - 0.1103k_p \quad R^2 = 0.437 \]

**Figure 5.5:** Relationship between speed and parking density

The findings from this research can be used as a sensible guide for practitioners in urban planning and residential development. The predictive models generated from this research may be used to properly design local and collector streets in order to control vehicular speeds in residential areas, thus providing safe and livable communities.
5.5 CONCLUSIONS

This research has proven that vehicular speeds on residential streets are, to some extent, influenced by road dimensions and on-street parking. The following conclusions may be drawn from this research:

1. Reducing actual road widths by 1.0 m can result in speed reductions of up to 14.9%.
2. Reducing effective road widths by 1.0 m can result in speed reductions of up to 14.1%.
3. Reducing road lengths by 25 m can result in speed reductions of up to 5.3%.
4. Reducing parking density by removing 2 parking spaces every 100 m can result in speed reductions of up to 8.9%.
REFERENCES


