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TRAFFIC NOISE MODEL OF SUBURBAN RESIDENTIAL AREAS ALONG FT50 FEDERAL ROUTE

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ABSTRACT

Traffic noise can be a major nuisance, particularly in residential areas. Road traffic noise is the most significant source of environmental noise pollution. Exposure to noise pollution contributes to negative impact on the environment particularly to human. Therefore, in order to overcome this problem, the development of models that can predict the traffic noise is necessary. The aim of this study is to develop models of traffic noise at suburban residential areas along FT50 Federal Route. This study is carried out at Taman Kelisa, Taman Gading and Taman Gading 1. A total of 42 data in each residential area are used to analyze the noise level and the relationship with other traffic parameters. In this study, traffic noise models are clustered into three groups of variables. In summary, most predictors in this study affect the level of noise at study locations. Cluster 2 shows the most reliable model since the adjusted R-squared is the highest with 60.7 percent. The developed models can be hopefully utilized for traffic noise prediction in the future for suburban residential areas.

Keyword: Best Subsets Regression; Flow Rate; Multiple Linear Regression; Speed; Traffic Noise.

INTRODUCTION

The success achieved by most developed countries has indirectly created noise problems. This study focused on traffic noise. Noise is an unacceptable level of sound that creates annoyance, hampers mental, physical peace and may induce severe damage to the health. Road traffic noise can be a major nuisance, particularly in residential areas. Road traffic noise is the most significant source of environmental noise pollution in cities (Golmohammadi, 2009; Hamidi, 2008; Singal, 2006). According to Mansur Ibrahim (1997), a study conducted by the Malaysian Department of Environment shows traffic noise is the main source of noise pollution. Noise is almost one of the harmful agents for citizenship;

therefore many countries have introduced noise emission limits for vehicles and issued other legislations to reduce road traffic noise (Golmohammadi, 2009). The recognition of road traffic noise as one of the main sources of environmental pollution has led to design models that enable us to predict traffic noise level. Several models have been developed via a regression analysis of experimental data, from fundamental variables such as traffic flow, speed of vehicles and sound emission level (Golmohammadi, 2009). The aim of this study is to develop models of traffic noise at suburban residential areas along FT50 Federal Route (Batu Pahat to Ayer Hitam Road).

METHODOLOGY

Several residential areas have been selected for different data and the distance between roads and residential also differences. The selected residential areas in this study are Taman Kelisa, Taman Gading, and Taman Gading 1. Studies have been made on working days from 8.00 a.m. to 6.00 p.m. The main equipments used in this study are Sound Level Meter and Telescopic Mast, as shown in Figure 1.

(a) (b)

FIGURE 1 Main equipments: (a) Sound Level Meter and (b) Telescopic Mast

The noise data are taken simultaneously with traffic data in order to be useful in analysis. The factors that contribute to traffic noise that take into consideration are the volume of traffic, vehicle speed and vehicle composition (IDoT, 2007). Vehicles are categorized as Class 1 (C1) for passenger car, Class 2 (C2) for medium lorry, Class 3 (C3) for large truck and bus and Class 4 (C4) for motorcycle.

The techniques used in data analysis consist of best subsets regression (BSR) and multiple-linear regression (MLR) while the parameters that mainly take into consideration consist of Mallows' C_p, adjusted R-squared (R^2) and p-value. Best subsets regression identifies the best-fitting regression models that can be constructed with the predictor variables you specify. Best subsets regression examines all possible subsets of the predictors, beginning with all models containing one predictor, and then all models containing two predictors, and so on. Mallows' C_p is used to compare the full model to a model with a subset of predictors. A small C_p value indicates that the model is relatively precise (has small variance) in estimating the true regression coefficients and predicting future responses. Models with considerable lack-of-fit and bias have values of C_p larger than p (p is the number of predictors in the model, including the constant). Adjusted R^2 is useful for comparing models with different numbers of predictors or factors in MLR.

RESULT AND DISCUSSION

Cluster 1: Model of noise versus flow rate and speed

Table 1 shows the BSR of noise, flow rate and speed with noise as response or dependent variable.

TABLE 1 BSR analysis for noise versus flow rate and speed

No	Vars	R^2	R^2(adj)	C_p Mallows	Flow rate	Speed
1	1	43.6	43.3	8.2	X	-
2	1	0.0	0.0	169.5	-	X
3	2	45.5	45.0	3.0	X	X

Referring to Table 1, the best subset of predictors is the third subset with both independent variables in the subset since the adjusted R^2 is the highest and Mallows' Cp is the smallest. Therefore, flow rate and speed can be used to develop the traffic noise model, as shown in Table 2.

TABLE 2 MLR analysis for noise versus flow rate and speed

Predictor	Coefficient	SE Coefficient	T	P
Constant	60.610	2.6420	22.94	0.000
Flow rate	0.003	0.0002	12.98	0.000
Speed	-0.104	0.0388	-2.67	0.008

Based on Table 2, both predictors show the p-value of less than 0.05 which mean that both predictors are statistically significant at 95 percent confident. The adjusted R^2 value shows that 45 percent of traffic noise prediction can be carried out by using flow rate and speed. The regression model can be derived as follows:

$$\text{Noise} = 60.6 + 0.00321 \text{ Flow rate} - 0.104 \text{ Speed} \quad (1)$$

Cluster 2: Model of noise versus traffic composition and speed

Table 3 shows the BSR of noise, speed as well as volume of C1, C2, C3, and C4 with noise as response or dependent variable.

TABLE 3 BSR analysis of noise versus C1, C2, C3, C4 and speed

No	Vars	R^2	R^2 (adj)	C_p Mallows	C1	C2	C3	C4	Speed
1	1	46.6	46.3	75.7	-	-	-	X	-
2	1	33.6	33.3	142.6	X	-	-	-	-
3	2	54.2	53.8	37.9	X	-	-	X	-
4	2	50.1	49.6	59.1	-	-	-	X	X
5	3	59.8	59.2	10.9	X	X	-	X	-
6	3	56.4	55.7	28.8	X	-	-	X	X
7	4	61.5	60.7	4.4	X	X	X	X	-
8	4	60.0	59.2	12.1	X	X	-	X	X
9	5	61.6	60.6	6.0	X	X	X	X	X

Referring to Table 3, the best subset of predictors is the seventh subset with all predictors excluding speed in the subset since the adjusted R^2 is the highest and Mallows' C_p is smaller than p. Therefore, volumes of C1, C2, C3, and C4 can be used to develop the traffic noise model, as shown in Table 4.

TABLE 4 MLR analysis of noise versus C1, C2, C3 and C4

Predictor	Coefficient	SE Coefficient	T	P
Constant	54.878	0.5107	107.47	0.000
C1	0.003	0.0004	7.20	0.000
C2	-0.004	0.0007	-6.02	0.000
C3	0.004	0.0012	2.91	0.004
C4	0.019	0.0017	11.25	0.000

Based on Table 4, all predictors show the p-value of less than 0.05 which mean that all predictors are statistically significant at 95 percent confident. The adjusted R^2 value shows that 60.7 percent of traffic noise prediction can be carried out by using volumes of C1, C2, C3 and C4. The regression model can be derived as follows:

$$\text{Noise} = 54.9 + 0.00310\,C1 - 0.00406\,C2 + 0.00355\,C3 + 0.0188\,C4 \qquad (2)$$

Cluster 3: Model of noise versus light vehicle, heavy vehicle and speed

Table 5 shows the BSR of noise, speed as well as volumes of light vehicle (LV) and heavy vehicle (HV) with noise as response or dependent variable.

TABLE 5 BSR analysis of noise versus LV, HV and speed

No	Vars	R^2	R^2 (adj)	C_p Mallows	LV	HV	Speed
1	1	41.8	41.5	50.2	X	-	-
2	1	17.2	16.8	156.3	-	X	-

3	2	51.6	51.2	9.7	X	X	-
4	2	43.5	43.0	44.7	X	-	X
5	3	53.4	52.7	4.0	X	X	X

Referring to Table 5, the best subset of predictors is the fifth subset with all predictors in the subset since the adjusted R^2 is the highest and Mallows' C_p is equal to p. Therefore, volumes of LV and HV, and speed can be used to develop the traffic noise model, as shown in Table 6.

TABLE 6 MLR analysis of noise versus LV, HV and speed

Predictor	Coefficient	SE Coefficient	T	P
Constant	62.792	2.474	25.38	0.000
LV	0.0029842	0.0002387	12.50	0.000
HV	-0.010390	0.001589	-6.54	0.000
Speed	-0.09954	0.03592	-2.77	0.006

Based on Table 6, all predictors show the p-value of less than 0.05 which mean that all predictors are statistically significant at 95 percent confident. The adjusted R^2 value shows that 52.7 percent of traffic noise prediction can be carried out by using volumes of LV and HV, and speed. The regression model can be derived as follows:

$$\text{Noise} = 62.8 + 0.00298\,\text{LV} - 0.0104\,\text{HV} - 0.0995\,\text{Speed} \quad (3)$$

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