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The Effects of Vehicle Speeds on Accident Frequency within Settlements along Trunk Roads

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ABSTRACT: *Literature provides overwhelming evidence that a strong relationship exist between vehicle speed and accident risk, and an outcome severity in the event of an accident. Excessive speed is said to be a major causal factor of road accidents on trunk roads; contributing 60% of all vehicular accidents. However, speed rationalization measures implemented on a number of trunk roads in Ghana have realized very little success. This study therefore investigated the effects of vehicle speeds on accident frequency within settlements along trunk roads. Data was collected on accidents, vehicle speeds and other road and environment-related features for ninety-nine (99) settlements delineated from four (4) trunk roads. Correlation analysis was employed to establish useful relationships and provided insight into the contributions of relevant road and environmental-related variables to the occurrence of road traffic accidents. Using the Negative Binomial error structure within the Generalized Linear Model framework, core (flow-based) models were formulated based on accident data and exposure variables (vehicle mileage, daily pedestrian flow and travel speed). Incremental addition of relevant explanatory variables further expanded the core models into comprehensive models. Findings indicate the main risk factors are number of accesses, daily pedestrian flow and total vehicle kilometers driven, as vehicle speed did not appear to influence the occurrence of road traffic accidents within settlements along trunk roads. In settlement corridors, mitigating accident risks should not focus only on traffic calming but rather on measures that reduce pedestrian and vehicular conflict situations as well as improve conspicuity around junctions.*

Key words**:** *Accident frequency, Settlements, Conspicuity, Speed, Trunk road.*

I. INTRODUCTION

The National Road Safety Commission reports that non-urban environments in Ghana are the most accident-prone as they account for two-thirds of all road traffic fatalities (***Road Traffic Crashes in Ghana, 2010***). It is said that excessive speed is a major causal factor of road accidents on trunk roads; contributing 60% of all vehicular accidents (***Wikipedia***). However, a number of speed rationalization measures implemented on trunk roads in Ghana have realized very little success. This is attributed to the little knowledge about the exact relationship between vehicle speed and road traffic accidents. Speed is generally considered a major risk factor in road traffic accident occurrence though there may be other intervening factors (***Wegman and Aarts, 2006***). Literature has provided overwhelming evidence that a strong relationship exist between travel speed and accident risk, and an outcome severity in the event of an accident (***Nilsson, 2004***). Therefore, this study attempted to develop a relationship between travel speed and road traffic accidents within settlements along trunk roads in order to gain insight into the effects of speeds on the frequency of road traffic accidents. Thus, effective intervention strategies and measures are elicited to address the menace of road traffic accidents within settlements on trunk roads.

II. STUDY'S APPROACH AND METHODOLOGY

In the event of a traffic accident, it is assumed that kinetic energy of the two colliding entities will be converted at an instant to some form of heat, sound and material distortion. The masses of the colliding entities are therefore significant to the severity outcome as occupants of the lighter entity are normally worse off than occupants of the heavier entity. From the mathematical relationship, the contribution of the entities' speeds in the accident incidence and injury outcomes becomes a significant issue of concern.

Thus, in an EU-funded project known as MASTER, a vehicle speed and road traffic accident relationship (the EURO model) was derived for European rural single-carriageway roads. The emerged Power Model was based on the empirical evaluation of the different changes in speed limits against road traffic accidents. It was established that the percentage change in the number of injury accidents was proportional to the square of the relative speed change. This applied both to increases and decreases in mean speed (***Elvik R et***

al, 2004). However, data availability limitations for the Master study necessitated the Transport Research Laboratory (TRL) to carry out a more extensive investigation of the relationship on rural single carriageway roads in England. The selected sites were roads with the 60 miles/h speed limit and the sample was stratified to cover all road classes. Provision was also made for road, traffic and environmental-related data. These data were included in the model development so as to establish their various contributions in road traffic accident causation. The TRL approach and methodology was adopted for this study. Data were collected for vehicle speeds and road traffic accidents on settlements along trunk roads. Additionally, other road and environment-related data were collected for the study road sections. Employing scatter diagrams, the nature of relationships between the dependent variable (road accident counts) and each of the independent variables (road section length, traffic and pedestrian flows, speed, and other road and environment-related features) were examined. Following the correlation analyses, the Generalized Linear Model (GLM), a sub-model in the Stata Software Package Version 12, was employed since all the relationships were non-linear. In developing the models however road traffic accident counts and vehicle travel speeds were used as the main variable inputs with vehicle mileage and pedestrian flows as exposure variables. Additionally, appropriate road and other environment-related variables were considered in the model development. Relevant tests were then conducted to assess the goodness of the relationships based on logic and statistics. Study findings thus provided an insight into strategies required for effective speed rationalization measures on trunk roads in Ghana.

III. DATA COLLECTION

3.1 Introduction

Data was collected from two main sources, primary and secondary, for 99 settlement corridors located on 4 trunk roads classified as national and inter-regional roads. The data requirements for the study included:

- Accident data (for a defined 3 year period);
- Vehicular flow data;
- Pedestrian flow data;
- Vehicle speed data; and
- Road geometric characteristics.

The length of the study sections ranged between 0.2km and 8.2km with a mean length of 1.8km. National and inter-regional roads featured road widths of 7.5m and 7.3m with corresponding shoulder widths of 2.0m and 1.5m respectively. There is no variability in the presence of shoulder as all the road sections had paved shoulders.

3.2 Accident Data

Details of road traffic accidents were solicited from the national accident database centre at the Building and Road Research Institute (BRRI) in Kumasi. Following the manipulation of the TRL Micro-computer Accident Analysis Package (MAAP 5) software, synthesized accident data were obtained from 2005 to 2007 for the study roads. The number of accidents was disaggregated by 3 accident types, namely; general accidents, pedestrian-only accidents and non-pedestrian accidents. Table 3.1 illustrates the distribution of injury accident by type on the study road sections. Out of a total of 958 road traffic accidents recorded, 346 were pedestrian-only accidents. This represents 36% of the total injury accidents which is below the annual national average of 42% of all accidents. In terms of accident severity, the proportion of pedestrian death and serious disability on trunk roads is significant as it remains the single most dominant road user at risk.

Table 3.1 – Distribution of Injury Accidents by Type

Accident Type	**Injury Accidents**	
	Nr	**(%)**
Pedestrian Accidents	346	36
Non-Pedestrian Accidents	612	64
General Accidents	**958**	100

Source: National Accident Data, 2005 – 2007, BRRI

3.3 Vehicle Flow Data

Manual classified counts on selected census stations on the study roads were complemented by historical traffic data obtained from the Ghana Highway Authority (GHA). The observed daily traffic flows were converted to average daily traffic (ADT) by the application of appropriate variation factors. Table 3.2 shows the vehicular traffic flows recorded for the study roads.

Table 3.2 – Traffic Flows on Study Roads

Road Type	Daily Traffic Flow (vpd)		
	Average	**Minimum**	**Maximum**
National Road	7,147	3,482	15,012
Inter-Regional Road	4,069	1,920	7,887
Total	5,406	1,920	15,012

Source: Field Surveys, 2008

It is evident that the national roads experienced the highest vehicular traffic and accounted for 60% of the total cumulative traffic. With respect to the minimum and maximum flows, the huge variations are attributed to the influence of substantial "local" traffic recorded in some of the "big" settlements (towns) along the study road corridors.

3.4 Pedestrian Flow Data

Limited pedestrian volume counts were conducted at crosswalks and along locations of major activity centers. Pedestrian volumes were counted at 15-minute intervals for durations of 12 hours between the hours of 06:00 and 18:00. Additional four-hour counts were conducted between 18:00 and 22:00 at locations where pedestrian activities were more pronounced at night. Daily pedestrian flows were determined for the study roads. Table 3.3 presents the average, minimum and maximum daily pedestrian flows estimated for the study roads.

Table 3.3 – Daily Pedestrian Flows on Study Roads

Road Type	Daily Pedestrian Flow		
	Average	**Minimum**	**Maximum**
National Road	2,586	62	32,816
Inter-Regional Road	933	26	9,445

Source: Field Surveys, 2008

A prominent feature observed was the intensity of roadside activities within settlement corridors and this was reflected in the different levels and spread of human activities captured by the pedestrian flow counts.

3.5 Vehicle Speed Data

Using the "floating car method", the average speed of a vehicle passing a study road section was computed. Travel times over a road section were recorded directly for 3 runs per direction for 2 days. The section mean speeds were estimated by dividing the section distance by the travel time for the run. Section mean speeds computed for the road sections were then averaged to obtain the average section mean speeds. Table 3.4 presents the space mean speed estimated for the study roads.

Table 3.4 – Space Mean Speeds on Study Roads

Road Type	Space Mean Speed (km/h)		
	Average	**Minimum**	**Maximum**
National Road	66	25	127
Inter-Regional Road	81	27	132

Source: Field Surveys, 2008

It is evident that the national road corridors experienced slightly lower speeds than the inter-regional road corridors. While an average of 66km/h was recorded in settlements located on national roads, an average of 81km/h was realized for those on the inter-regional roads. This is not surprising because most of the settlements along national roads are densely populated than settlements along inter-regional roads. Drivers are therefore constrained by human activities and interactions, thus, reducing their vehicle operating speeds. The average speeds recorded in settlements are still high on the inter-regional and national roads.

3.6 Road Geometric Characteristics

Apart from traffic flow and vehicle speed, other road alignment features were also identified to be relevant to the incidence of road traffic accidents. For this study, data was collected for three geometric characteristics, namely; horizontal curvature, number of accesses and terrain type. The features were described as continuous or categorical and presented as physically measured or based on the features' options.

IV. CORRELATION ANALYSIS

From the correlation analysis, the relationships between accident count and vehicle speed as well as other possible risk factors; namely; traffic flow, pedestrian flow, road section length, road type, number of horizontal curve, horizontal curve density, and number of access, access density and terrain type were established.

As in exploratory studies, the correlation coefficient (r), which indicates the strength of relationships between variables are assessed based on some thresholds (***Okoko, 2001***). For this study, the following thresholds were adopted:

- Weak correlation, $0 < r < 0.3$;
- Fairly strong correlation, $0.3 < r < 0.6$;
- Strong correlation, $0.6 < r < 0.8$; and
- Very strong correlation, $0.8 < r < 1.0$

Details of the analyses between accident counts (all accidents, pedestrian-only and non-pedestrian accidents) and traffic flow and road geometry features along the study roads are presented. Tables 4.1, 4.2 and 4.3 provide summaries of correlations coefficients estimated for the analyses between accident counts and the independent variables considered to influence accidents.

Table 4.1 - Correlation Coefficient of Variables influencing All Accidents

Variable	Correlation Coefficient (r)	Remarks
Travel Speed	-0.204	Weak relationship
Horizontal Curves	0.302	Weak relationship
Average Daily Traffic	0.457	Fairly strong relationship
Road Section Length	0.605	Strong relationship
Number of Accesses	0.751	Strong relationship
Daily Pedestrian Flow	0.783	Strong relationship

Source: Field Surveys, 2008

Table 4.2 - Correlation Coefficients of Variables influencing Pedestrian Accidents

Variable	Correlation Coefficient (r)	Remarks
Travel Speed	-0.292	Weak relationship
Horizontal Curves	0.297	Weak relationship
Road Section Length	0.477	Fairly strong relationship
Average Daily Traffic	0.488	Fairly strong relationship
Number of Accesses	0.718	Strong relationship
Daily Pedestrian Flow	0.806	Very strong relationship

Source: Field Surveys, 2008

Table 4.3 - Correlation Coefficients of Variables influencing Non-Pedestrian Accidents

Variable	Correlation Coefficient (r)	Remarks
Travel Speed	-0.143	Weak relationship
Horizontal Curves	0.284	Weak relationship
Average Daily Traffic	0.431	Fairly strong relationship
Road Section Length	0.637	Strong relationship
Daily Pedestrian Flow	0.714	Strong relationship
Number of Accesses	0.717	Strong relationship

Source: Field Surveys, 2008

4.1 Correlation of Accidents with Significant Study Variables

For the three accident data sets, namely, all accidents, pedestrian-only accidents and non-pedestrian accidents, the risk variables showed positive correlations with accident counts except travel speed. The exposure variables (average daily traffic, daily pedestrian flow and road section length) showed significant relationships, from fairly strong to strong relationships with the three accident data sets. Road geometric characteristics represented by number of horizontal curves and road accesses contributed to the occurrence of road traffic accidents. The nature of relationships is mixed though with horizontal curvature showing weak relationships whilst number of accesses indicated strong relationships. Travel speed has weak relationships with the three accident data sets but it is still critical in determining the safety of users of road space.

The environs of the study corridors showed continuous exposure of people to road accident due to intense roadside activities. Another conspicuity problem is the presence of obstructive billboards, trees and shrubs at major road intersections and accesses. Generally, the road space lacked adequate facilities for pedestrians and the interactions among various users of the roads are of immense safety concern.

4.2 Correlations of Travel Speed with Other Risk Variables

The study focus is on establishing a relationship between travel speeds and road traffic accidents. Knowing however the significant contributions of other road and environmental-related factors to road accidents, the strength of relationships between travel speed and other potential risk variables was estimated. This was to assess the masking influence by some other risk variables on travel speed in the development of "model" relationships with accident counts. In all of the accident types under consideration, travel speed showed a fair relationship with average daily traffic (-0.4) but a weak relationship with daily pedestrian flow (-0.2). Another exposure variable, vehicle mileage, representing the combination of road section length and average daily traffic showed no relationship with travel speed. Table 4.4 presents the correlation coefficients of relationships between travel speed and other risk variables for the three accident data sets.

Table 4.4 - Correlations Coefficients of Other Risk Variables with Travel Speed

Correlates	**Coefficient (r)**		
	All Accidents	**Pedestrian**	**Non-Pedestrian**
Daily Pedestrian Flow	-0.253	-0.257	-0.253
Average Daily Traffic	-0.439	-0.457	-0.439
Road Section Length	0.070	0.091	0.070
Number of Accesses	-0.143	-0.149	-0.143
Horizontal Curves	-0.086	-0.040	-0.086
Terrain Type	0.025	0.040	0.025

Source: Field Surveys, 2008

4.3 Summary of Correlation Analysis

This section established useful relationships and provided insights into the contributions of some road and environment-related factors to road traffic accidents. Road traffic accidents increase with the risk variables of average daily traffic, daily pedestrian flow, road section length, horizontal curvature and number of accesses except travel speed. Generally, the nature of the relationships is mixed, as daily pedestrian flow and number of accesses consistently showed strong to very strong relationships with road accidents compared to the fair relationships between road accidents with road section length, average daily traffic and horizontal curvature.

On relationships between travel speed and the other study variables, it was established that travel speed has a fair relationship with average daily traffic (0.4) and a weak relationship with daily pedestrian flow (0.2). Another exposure variable, vehicle mileage showed no relationship with travel speed. Thus, provide indication to possible relevant and significant variables to be considered in developing the models. The requirement of retaining the exposure variables in the model development therefore made it necessary to consider only daily pedestrian flow and vehicle mileage as well as the other road and environmental-related variables as relevant and significant in the development of the model equations.

V. MODEL DEVELOPMENT

5.1 Introduction

Modeling was conducted within the framework of the Generalized Linear Models (GLM) using the Stata Software Package Version 12. A two-stage process was employed and included development of the core (flow-based) model and further expansion into the comprehensive (full variable) model. The core model included exposure variables only which were daily pedestrian flow and vehicle mileage as well as travel speeds. It was expanded into a comprehensive model by the addition of other explanatory variables, namely; horizontal curvature, number of accesses and terrain type. Based on previous work gleaned from literature, the core and comprehensive models are mathematically expressed as below:

For the core model,

$$E(Y) = a_0 P^{a_1} T^{a_2} V^{a_3} \text{..................................(5.1)}$$

For the comprehensive model,

$$E(Y) = a_0 P^{a_1} T^{a_2} V^{a_3} \exp \sum_{j=1}^{n} b_j X_j \text{.......................................(5.2)}$$

where,

E (Y) = predicted accident frequency,

P = daily pedestrian flow (per day),
T = vehicle mileage (veh-km),
V = travel speed (km/hr),
X_j = any variable additional to P, T and V,
exp = exponential function, e = 2.7183, and
a_0, a_1, a_2, a_3, b_j = model parameters.

In conformity with the GLM framework, equations 5.1 and 5.2 were transformed into the prediction mode using a log-link function as follows:
For the core model,

$$\ln[E(Y)] = \ln(a_0) + a_1 \ln(P) + a_2 \ln(T) + a_3 \ln(V) \ldots\ldots(5.3)$$

For the comprehensive model,

$$\ln[E(Y)] = \ln(a_0) + a_1 \ln(P) + a_2 \ln(T) + a_3 \ln(V) + \sum_{j=1}^{n} b_j X_j \ldots\ldots(5.4)$$

5.2 Modeling Procedure

The accident data sets were over-dispersed thus the Negative Binomial error structure was adopted as the most appropriate distribution and within the GLM framework to estimate the model coefficients (***Miaou and Lum, 1993***). By specifying the dependent variable, the explanatory variables, the error structure and the link function, the models were fitted. Model parameters (coefficients) were estimated using the maximum likelihood approach. The procedure adopted in the model development was the forward procedure in which the variables were added to the model in a stepwise manner.

In accordance with previous studies on accident prediction models, the decision on which variables should be retained in the model was based on two criteria. The first criterion was whether the t-ratio of the estimated parameter was significant at the 95% confidence level (p-value less than 5%) and the second criterion was whether the addition of the variable to the model causes a significant drop in the scaled deviance at 95% confidence level. Two statistical measures were used in assessing the validity of the model developed. These were the Pearson Chi square statistic and the Deviance statistic. The coefficient of determination (R^2) was also employed to determine the amount of variability in the response variable explained by the variation in the selected set of explanatory variables. The R-squared estimation was carried out by the method recommended by *Miaou (1996).*

5.3 Model Results

The results of the developed prediction models for the accident data sets, namely, all accidents, pedestrian-only and non-pedestrian accidents captured the differences in accident patterns and risk factors. From the best fit models, the differences in the model variables for all, pedestrian-only and non-pedestrian accidents were presented to enable comparisons to be made.

5.3.1 Core Models

The parameter estimations for the log-linear equation of the core (flow-based) model using the Negative Binomial distribution are as presented in Table 5.1.

Table 5.1 - Parameter Estimation of Core Model for All Accidents

No. of Observations	=	99	Deviance (1/df)	=	1.196
Residual df	=	96	Pearson (1/df)	=	1.014
Log likelihood	=	-271.82	AIC	=	5.55
			BIC	=	-326.34

Notation	**Parameter**	**Coefficient**	**Standard Error**	**z**
T	Mileage	0.5655	0.1018	5.55
P	Daily Pedestrian Flow	0.3511	0.0557	6.30
a_o	Constant	-5.3129	0.7721	-6.88

The resulting core model developed for all accidents is as follows:

$$E(Y) = 4.9 \times 10^{-3} \times T^{0.6} P^{0.4} \ldots\ldots(5.5)$$

where,
E (Y) = expected accidents along road section for 3 years,
T = vehicle mileage (veh-km), and
P = daily pedestrian flow (per day).

The goodness-of -fit statistic for the model shows that the model fits reasonably well with the data. Table 5.1 presents the Pearson Chi-square divided by its degrees of freedom and the deviance statistic divided by its degrees of freedom, and the two statistics were estimated to be 1.01 and 1.19 respectively. The values are within the permissible range of 0.8 and 1.2 (***Dissanayake and Ratnayake, 2006***) indicating that the Negative Binomial error structure assumption is therefore acceptable. The important variables were vehicle mileage and daily pedestrian flow. They were statistically significant ($p<0.05$) with positive estimated model parameters in the core model. Vehicle mileage and daily pedestrian flow are measures of exposure and had direct proportional relationships with road accident occurrence. Travel speed was not significant in the core modeling process of the three accident datasets, namely; all accidents, pedestrian-only and non-pedestrian accidents. Table 5.2 presents the coefficients in the core models for the different accident types.

Table 5.2 - Coefficients in the Core Models for Different Accident Types

Parameter	All Accidents	Pedestrian Accidents	Non-Pedestrian Accidents
T	0.5655	0.3640	0.6320
P	0.3511	0.5000	0.2683
a_o	-5.3129	-5.5507	-5.8118

Using the R-squared value, the variables in the core model, namely; vehicle mileage and daily pedestrian flow could explain 53% of the total variation in the all accidents data. The core model is regarded as relatively coarse and rough estimator of accident frequency (***Salifu, 2004***). However, the estimated coefficient of determination of 0.53 is good enough measure to substantially explain the variation in the accident data by the exposure variables. ***Dissanayeke and Ratnayeke (2006)*** said that the coefficient of determination is significant if found to be greater than 0.45. For the pedestrian-only and non-pedestrian accidents, the exposure variables could explain 51% and 48% respectively of the total variations in the accident datasets.

5.3.2 Comprehensive Models

In expanding the core models, relevant explanatory variables including speed were introduced. The parameter estimations for the log-linear equation of the comprehensive models using the Negative Binomial distribution are as presented in Tables 5.3, 5.4 and 5.5.

Table 5.3 - Parameter Estimation of Comprehensive Model for All Accidents

No. of Observations	=	99	Deviance (1/df)	=	1.19
Residual df	=	96	Pearson (1/df)	=	1.01
Log likelihood	=	-284.29	AIC	=	5.80
			BIC	=	-327.04

Notation	Parameter	Coefficient	Standard Error	z
T	Mileage	0.7900	0.1183	6.68
A	Number of Accesses	0.0268	0.0101	2.67
a_o	Constant	-5.3008	1.0187	-5.20

The resulting comprehensive model developed for all accidents is as follows:

$$E(Y) = 4.9 \times 10^{-3} \times T^{0.8} \times EXP^{(0.03A)} ......(5.6)$$

where,

E (Y) = expected accidents along road section for 3 years,
T = vehicle mileage (veh-km), and
A = number of accesses, and
EXP = Exponential function, e = 2.718282.

Table 5.4 - Parameter Estimation of Comprehensive Model for Pedestrian Accidents

No. of Observations	=	99	Deviance (1/df)	=	1.07
Residual df	=	96	Pearson (1/df)	=	0.83
Log likelihood	=	-186.6	AIC	=	3.83
			BIC	=	-338.16

Notation	Parameter	Coefficient	Standard Error	z
T	Mileage	0.3644	0.1351	2.70
P	Daily Pedestrian Flow	0.5033	0.0737	6.82
a_o	Constant	-5.5507	1.0230	-5.43

The resulting comprehensive model developed for pedestrian accidents is as follows:

$$E(Y) = 3.9 \times 10^{-3} \times T^{0.4} P^{0.5} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5.7)$$

where,

E (Y) = expected accidents along road section for 3 years,
T = vehicle mileage (veh-km), and
P = daily pedestrian flow (per day).

Table 5.5 - Parameter Estimation of Comprehensive Model for Non-Pedestrian Accidents

No. of Observations	=	99	Deviance (1/df)	=	1.19
Residual df	=	96	Pearson (1/df)	=	1.09
Log likelihood	=	-245.22	AIC	=	5.01
			BIC	=	-326.62

Notation	Parameter	Coefficient	Standard Error	z
T	Mileage	0.7543	0.1172	6.44
A	Number of Accesses	0.0258	0.0099	2.60
a_o	Constant	-5.4120	1.0133	-5.34

The resulting comprehensive model developed for non-pedestrian accidents is as follows:

$$E(Y) = 4.5 \times 10^{-3} \times T^{0.8} \times EXP^{(0.03A)} \ldots\ldots(5.7)$$

where,
E (Y) = expected accidents along road section for 3 years,
T = vehicle mileage (veh-km), and
A = number of accesses, and
EXP = Exponential function, e = 2.718282.

The goodness-of -fit statistic for the models show reasonably fits with the accident datasets. The Pearson Chi-square and deviance statistic divided by its degrees of freedom were within the permissible range of 0.8 and 1.2, indicating the Negative Binomial error structure to be an acceptable assumption. The computed coefficient of determination, R-squared values for all accidents, pedestrian accidents and non-pedestrian accidents are 0.64, 0.51 and 0.60 respectively.

This implies the comprehensive models could explain 64%, 51% and 60% of the systematic variation in the accident data. Suggesting that, there are still some important variables that could not be captured. For example, factors relating to weather, environment and human behaviour were not possible to be considered in the models and they could have contributed to accident occurrence. Following the model results, these significant risk variables were identified and their contributions to accident occurrence have been explained:

Vehicle Mileage

Vehicle mileage is an important exposure variable because of its influence in all the accident types. It shows a direct proportionality with accident frequency. In all and non-pedestrian accidents, especially, a 10% increase in vehicle mileage is expected to increase road traffic accidents by 8%. For pedestrian accidents, the influence of vehicle mileage was halved as a 10% increase in vehicle mileage will result in a 4% increase in pedestrian accidents.

Daily Pedestrian Flow

As exposure variable, the contribution of daily pedestrian flow was pronounced in pedestrian-only accidents. It shows a direct proportionality with accident frequency and a 10% increase in daily pedestrian flow will result in a 5% increase in pedestrian accidents.

Number of Accesses

The number of accesses was the only explanatory variable that featured in the all and non-pedestrian accidents. The predicted effect of this variable is such that, an additional access (junction) to a road section will be expected to increase the accident frequency by about 3%. It is not surprising because of the conspicuity problems motorists faced at junctions as the presence of overbearing billboards obstruct their lines of vision.

Travel Speed

Travel speed did not feature in any of the accident types either as an exposure variable or explanatory variable. Following the correlation analysis however it was established that travel speed was weakly related to average daily traffic and daily pedestrian flow. It is evident that vehicle speed did not contribute significantly to road traffic accident within settlements along trunk roads.

VI. CONCLUSION

The objective of this study was to investigate the effects of vehicle speed on accident frequency within settlements along trunk roads and from the analysis of gathered data, the following specific findings were made:

- The major risk factors that influence road traffic accidents within settlements along trunk roads are vehicle mileage, daily pedestrian flow and number of accesses. In the case of all accidents, the variables explained 64% of the systematic variation in the accident data confirming some earlier findings of ***Caliendo et al, (2006)*** and ***Stamatiadis et al (2008)*** on risk factors that influence road traffic accidents on highways (trunk roads);
- Mean speeds of vehicles appear not to influence the occurrence of road traffic accidents within settlements along trunk roads. In modeling the three accident types, it came out to be insignificant either as an exposure variable or explanatory variable. However, it only showed a weak relationship with average daily traffic and daily pedestrian flow in the correlation analysis and could not have been considered "masked" by other influential variable(s);
- In mitigating accident risks, therefore, intervention measures should not necessarily focus mainly on speed rationalization measures such as traffic calming but a more effective solution will be to segregate facilities for pedestrians and vehicles to eliminate conflict situations. The need to improve conspicuity at junctions became clear as overbearing billboards obstructed lines of vision of motorists; and
- A wider scope of studying the effectiveness of the application of traffic calming measures within rural settlements along trunk roads will provide the needed insight into the relevance of its continuous use. For instance, a "Before and After" study will help assess the impacts of such measures on the safety of road users.

The unique character of rural settlements and its emerging socio-economic circumstances pose enormous traffic safety challenges to practitioners. It is important that appropriate diagnosis of the road traffic accidents issues are conducted before proffering intervention strategies and measures. This should be done within the context of the rural setting dynamics that features a highway and the peculiarities of its environment.

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