Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 7, S. 269-273, 10, 2023

Araştırma Makalesi

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 7, pp. 269-273, 10, 2023

Research Article

https://alls-academy.com/index.php/ijanser
ISSN: 2980-0811

Develop a model to analyse the roadside factors that affect the speed of vehicles on open-access highways

Aziz Ur Rehman*, Jamal Ahmed Khan[2]

[1] *MS Scholar, Department of Civil Engineering, University of Engineering and Technology, Taxila, Pakistan*
[2] *Lecturer, Department of Civil Engineering, Faculty of Engineering, University of Engineering and Technology, Taxila, Pakistan*

*(azizkhan5541@gmail.com)

(Received: 05 November 2023, Accepted: 13 November 2023)

(2nd International Conference on Contemporary Academic Research ICCAR 2023, November 4-5, 2023)

ATIF/REFERENCE: Rehman, A. U. & Khan, J. A. (2023). Develop a model to analyse the roadside factors that affect the speed of vehicles on open-access highways. *International Journal of Advanced Natural Sciences and Engineering Researches*, 7(10), 269-273.

Abstract **–** This study analysed the impact of roadside features and roadway characteristics on the travel speed of multilane highways. Video photography collected data on traffic count and roadside factors from ten sections. The study used the floating vehicle technique to gather data on speed, pedestrian road crossing, and side walking simultaneously. A regression analysis was performed to examine the correlation between speed and factors related to the roadside. The study found that pedestrian road crossing was the most crucial speed-influencing element on open-access multilane highways, followed by road built-up area and pedestrian side walking, through a multilinear regression analysis. The developed models were validated using predicted and observed speeds. Proper pedestrian crossings, standing facilities, and parking can mitigate the impact of these factors on travel speed. However, the study determined that limiting pedestrian crossing and side walking and preventing built-up areas across the road would increase the efficiency of open-access multilane highways.

Keywords – Speed, Roadside Factors, Regression Model

i. INTRODUCTION

Improving roadway geometry and traffic speed can significantly enhance safety and efficiency. Rural multilane highways play a crucial role in the rural network and should be prioritised for geometric improvements. Forecasting vehicle operating speeds accurately can aid in assessing roadway planning, designing, traffic operations, and safety. This study focuses only on the effect of highway shape and posted speed on operating speed, disregarding the impact of traffic flow [1].

Roadside resistance, roadway characteristics, and traffic composition impact travel speed of multilane highways in Pakistan. Local conditions differ from international standards, so they can't be directly applied. Speed criteria must be analysed separately.

This study analyzes several international research findings that shed light on the factors that can affect the speed of a trip. In [2], Researchers measured the impact of fictional activities on urban traffic; friction points gradually reduced capacity and speed. A similar study has been conducted to measure the impact of roadside friction on travel speed and level of service on Indian rural routes. They created speed-flow curves and proposed five LOS threshold values based on data from three study sections, using operating speed and freedom of manoeuvre as effectiveness measures [3]. Journey time reliability can be affected by side friction, but the extent of the impact depends on various factors, such as the type of road, traffic volume, and time. When measuring travel time variation, static side friction is considered more significant than dynamic side friction. [4]. Traffic accidents are caused by a combination of roadway and development factors, including differences in operating speed and speed limits [5]. Research shows that driving behaviour is significantly affected by higher speed limits on rural two-lane roads, and the purpose of the study is to gain a deeper understanding of how drivers choose their speeds after such increases in speed limits [6]. After researching two-lane roadways, it was found that the amount of slow-moving cars on the road hurt capacity [7]. The impact of varying friction levels on roadsides on speed and level of service (LOS) can be analysed using traffic and roadside element data, spot speed data, and roadway condition data [8].

The study investigated the effect of on-street parking and road visual complexity on travel speed [9]. A literature review on regression analysis was conducted to model roadside roughness elements, and road surface data was collected [10]. A similar study was reviewed [11].

The present study was conducted with the objective of (1) Assessing how various roadside resistance factors affect travel speed on multilane highways. (2) Quantifying the effect of road features on the travel speed of multi-lane highways. (3) Models are developed to study how factors like roadside resistance, traffic composition, and roadway characteristics affect travel speed on multilane highways.

ii. MATERIALS AND METHOD

To achieve the objectives and fill the existing research gaps, a two-phased research methodology with three main phases was adopted.

The first phase involved conducting a literature review of the current multilane highway crossing facilities, measurement, and speed-influencing parameters, both open-access and partially controlled-access. In the second phase, a field collection system was established, gathering data on vehicle speed, pedestrian road crossing, pedestrian side walking, and built-up areas. The statistical software SPSS was used to analyse the most critical speed/mobility influencing factors. A one-way analysis of variance (ANOVA) test was performed to determine any statistical differences across multiple factors. Detailed field data were collected from an open-access multilane highway, and the location map of the study section is depicted in Figure 1. A statistical model was established to relate highway vehicle speed and the influencing factors.

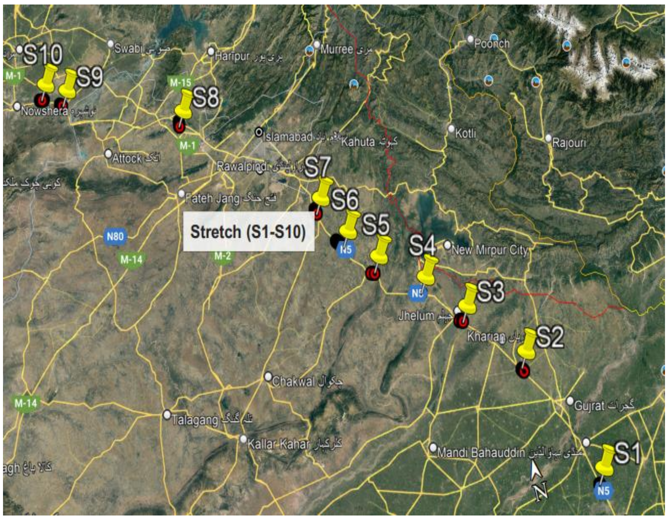


Figure 1: Location Map of Study Section from S1 to S2

Figure 2: Pedestrian Road Crossing on Open Access Highway

Simple Regression:

This study conducted a fundamental regression analysis to determine the significance of various factors obtained from research. The dependent variable was speed, while pedestrian crossing, side walking, and built-up area were independent variables. Figure 3a,b,c illustrates the relationship between these variables. Since the significant results, we further analysed and developed models using SPSS software.

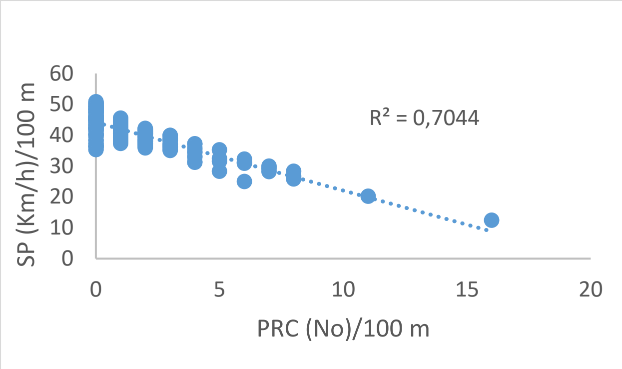
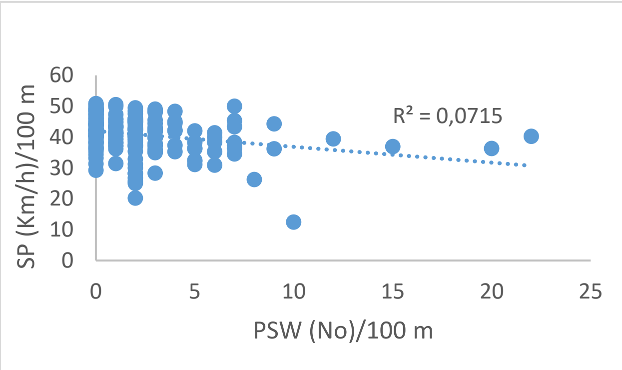


Figure 3a- Speed Vs Pedestrian Road Crossing



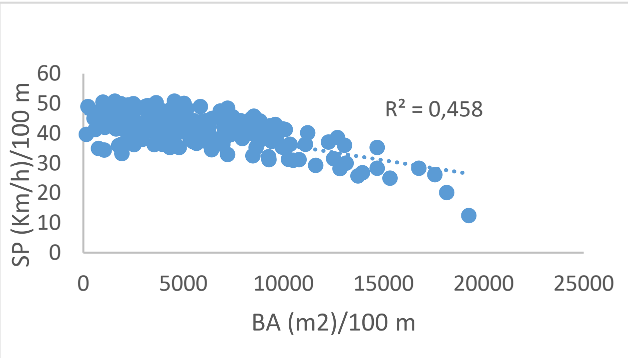


Figure 3a- Speed Vs Built up Area

iii. RESULTS AND DISCUSSION

Statistical Model Development:

The regression analysis used average travel speed as the response variable and identified roadside friction elements, cross-section characteristics, and on-road features as independent variables. We included roadside parking, pedestrian activity, and access density as part of roadside friction and represented roadside development using this variable. Cross-sectional features such as the number of lanes, median type, service road, pavement condition, and U-turn were also considered. To determine the relationship between the dependent and independent variables, we examined scatter plots initially. Most of the independent variables had a linear association with the dependent variables. We attempted nonlinear regression, but the multilinear regression model was considered the best fit compared to the significant variables and overall model statistics. We utilised SPSS, a statistical software tool for the social sciences, to model the data. The iterative process was repeated until all variables had a significance of 95% or above. We chose the model with minor independent variables and a higher coefficient of determination (R2) value. In conclusion, we successfully connected the dependent and independent variables using the multiple linear regression model.

Model Results:

After performing multiple linear regression analyses on the observed average speed, we obtained the best model for an open-access multilane highway:

$$SPEED = 45.273 - 1.94 * PRC - 0.263 * PSW \quad (1)$$

PRC: Pedestrian Road Crossing (Number of Pedestrians/100 m).

PSW: Pedestrian side walking (Number of Pedestrian/ 100 meters).

The statistical analysis resulted in an R2 of 0.730 (Adjusted R2 = 0.726) and an RMSE of 3.102, showing significant correlation between the dependent and independent variables. All independent variables were statistically significant at the 0.01 level. The negative correlation between speed and independent factors was confirmed through the regression coefficients' signs. Multicollinearity was examined using the variance inflation factor (VIF), and the results showed no significant issue among the predictor variables. Variables with a VIF score of more than 2.5 were considered to be of concern, but the values were less than 2.5, indicating no significant multicollinearity.

Model Validation:

To create the model, the data was randomly split into two datasets: one for calibration (80%) and the other for validation (20%). During validation, the predicted speed values were compared to the actual values observed on the field. The comparison showed that the predicted and actual values were the same (as seen in Figure 4), and the R-square value of 0.73 suggested that the model was effective.

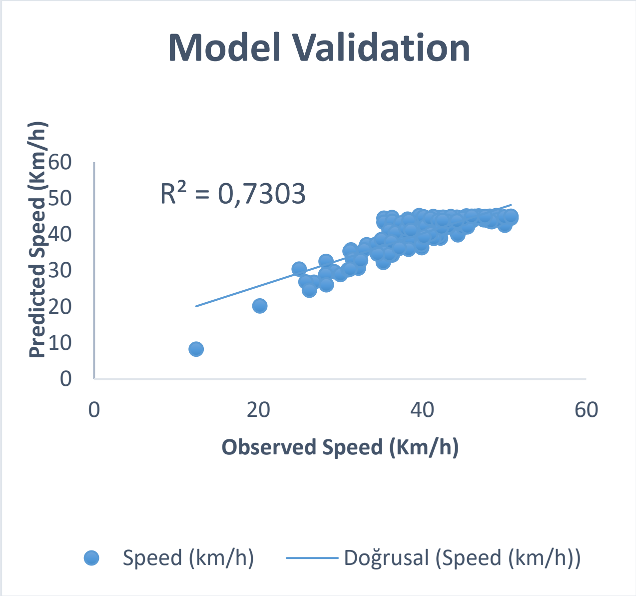


Figure 3-Relation between Observed and Predicted Speed

Table 1- Statistical Data of Variables

Variables/Description	Min	Max	Avg	SD
Speed (Km/h)/100 meter	12.46	50.82	40.91	5.92
Number of Pedestrian/ 100 meter	0	17	1.46	2.24
Number of Pedestrian/ 100 meter	0	23	2.05	3.08
Built up area (m^2)/100 meter	144	19256	5597	3792

Table 2- Summary of Multilinear Regression Result

Variable	Coefficients	Std. Error	T. Stat	Sig	Collinearity
PCR	-0.735	0.135	-13.310	0.000	2.186
PWS	-0.135	0.062	-3.531	0.000	1.033
BA	-0.110	0.000	-2.005	0.045	2.210

iv. CONCLUSION

An investigation was conducted to analyze the effectiveness of open-access multilane highways in developing countries using road data and the floating vehicle approach. The study evaluated the various factors that influence these types of highways. The subsequent paragraphs present the findings obtained from the survey, the literature review, and the regression analysis.

- Based on the results of the in-service road survey, it has been found that the presence of frequent pedestrian crossings, sidewalks, and roadside built-up areas has significantly hindered the efficiency of open-access multilane highways. This indicates that driving on multilane, open-access motorways is more complex and distinct than on partially controlled-access roads.
- The second conclusion is that PRC is the most influential variable on SP, followed by BA and PSW. Keeping all other factors constant, an increase in 1 PRC leads to a decrease in SP by almost 1.9 km/h. Similarly, an increase in one PSW while

keeping the rest of the factor's constant leads to a decrease in SP by 0.260 km/h.

Acknowledgment

I am extremely grateful to my research supervisor, Mr. Jamal Ahmed Khan, for his exceptional guidance, motivation, and support throughout my research journey.

References

1. Hashim, I.H.J.A.S.E.J., *Analysis of speed characteristics for rural two-lane roads: A field study from Minoufiya Governorate, Egypt.* 2011. **2**(1): p. 43-52.
2. Rao, A.M., S. Velmurugan, and K.J.T.r.p. Lakshmi, *Evaluation of influence of roadside frictions on the capacity of roads in Delhi, India.* 2017. **25**: p. 4771-4782.
3. Pal, S. and S.K.J.J.o.i.s. Roy, *Impact of side friction on performance of rural highways in India.* 2019. **25**(2): p. 04019006.
4. Harsha, M. and R.H.J.I.J.o.C.E. Mulangi, *Impact of Side Friction on Travel Time Reliability of Urban Public Transit.* 2021. **19**(10): p. 1221-1237.
5. Afandizadeh, S. and S.J.A.i.C.E. Hassanpour, *Evaluating the effect of roadway and development factors on the rural road safety risk index.* 2020. **2020**: p. 1-14.
6. Mahmud, M.S., et al., *Evaluating the impacts of speed limit increases on rural two-lane highways using quantile regression.* 2021. **2675**(11): p. 740-753.
7. Roy, N., et al., *Effect of mixed traffic on capacity of two-lane roads: case study on Indian highways.* 2017. **187**: p. 53-58.
8. Bitangaza, M., H.J.I.J.f.T. Bwire, and T. Engineering, *EFECTS OF ROADSIDE FRICTION ELEMENTS ON TRAVEL PERFORMANCE AND LEVEL OF SERVICE IN KIGALI.* 2020. **10**(2).
9. Edquist, J., et al., *The effects of on-street parking and road environment visual complexity on travel speed and reaction time.* 2012. **45**: p. 759-765.
10. Obiri-Yeboah, A.A., A.S. Amoah, and M.S.J.I.J.T.T.E. Gbeckor-Kove, *Analysis of congestion on some road link sections using roadside friction in congestion index in Kumasi.* 2020. **10**: p. 31-40.
11. Ker, H.-W., Y.-H. Lee, and C.-H.J.T.R.R. Lin, *Prediction models for transverse cracking of jointed concrete pavements: Development with long-term pavement performance database.* 2008. **2068**(1): p. 20-31.