Journal of Tourism & Sports Management (JTSM) (ISSN: 2642-021X) 2021
SciTech Central Inc., USA Vol. 4 (1)
650-655

REVIEW ON THE EFFECTS OF ROADSIDE FRICTION ON THE PERFORMANCE OF ROADS: A CASE STUDY OF AFRICA AND SOUTH-EAST ASIA

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Received 27 May 2021; Revised 05 June 2021; Accepted 07 June 2021

ABSTRACT

Tourism and sports are connected with roads to get facilitated. However, one of the roads' problems is roadside friction which can simply be defined as interaction of different activities on road carriage ways and by the roadsides. It includes pedestrians crossing roads, pedestrians passing by the roadsides, on street parking of cars or buses, movement of slow moving vehicles like bicyle or non-motorized moving vehicles and commercialisation of the roadsides. This problem is more pronounced in developing countries like Africa and South Eastern Asian countries. From India to Bangledash, Pakistan to Indonesia, the story is the same. In Africa, Nigeria has a fair share of this problem with other fellow African countries like Rwanda and Ghana visited in this review. The review findings revealed that vehicular speed is reduced, capacity and performance of road is reduced and pedestrians are disturbed whenever side frictional factors manifest. Some suggestions on the way forward were also presented.

Keywords: Roadside friction, India, IHCM, LOS, Capacity

INTRODUCTION

Tourism and sports developments require road networks to facilitate or enable them. However, these roads are not without problems. One of the many problems is the deterioration of capacity and performance caused by roadside friction. Road side friction can be defined as composite variables describing the degree of interaction between the traffic flow and activities along the side(s) and sometimes across or within the carriage way (Bang, Bergh, Carlson, Hanson & Ronggui, 1999). These activities include: road blockage (i.e. reduction of effective width often caused by commercial vehicles which may stop anywhere on the road to pick up and set down passengers, pedestrians crossing or moving along the travelled way, Non-Motorized Vehicles (NMV) like tricycles and motorcyles and Slow Moving Vehicles (SMV), Parking and un-parking activities, pedestrians and non-motorized vehicles moving along shoulders, blockage of roadside accessibility including vehicles entering and leaving roadside premises through openings such as gates and driveways, commercialization of roadsides by hawkers, food stalls and vendors, entering or exiting filling stations and movement of vehicles and pedestrians depending on land use type.

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According to (Chiguma, 2007), side frictions are all those actions related to the activities taking place by the sides of the road and sometimes within the road, which interfere with the traffic flow on the travelled way. They include but not limited to pedestrians, bicycles, and non-motorized vehicles, parked and stopping vehicles. These activities are normally very frequent in densely populated areas in developing countries like Nigeria and South-East Asian countries, while they are random and sparse in developed countries.

Additionally, side friction was also defined as a variable representing activities going on or along the travelled way. Various activities representing side friction are as follows: Reduction in traveled way which includes: Vehicles stopping to pick up and set down of passengers, pedestrians crossing or moving along roadside, non-motorized and slow moving vehicles, On street/road parking and improper coordination and lack of multimodal terminal (Kanani, Motwani & Dave, 2017).

However, side friction does not occur without activities and movement. The vehicular movement is known as traffic flow. Traffic Flow is the number of motorized vehicles passing a point on a road per unit of time, expressed in vehhr^{-}1 (Bang, 1995). Flow of traffic leads to maximization of road networks, a process called capacity. Capacity is seen as the maximum sustainable (stable) traffic flow over a road section under given conditions (Bang, 1995). These and many other factors combined to generate roadside friction.

REVIEW

In the light of the above, (Bang, 1995) selected two different roads; the urban road and interurban road to collect data on roadside friction. At urban roads, the side friction factors identified were pedestrian movements by the roadsides, pedestrians crossing the roads. Vehicle stopping was categorized into those that stopped on the road shoulders or on the road carriage ways. Parking and unparking of vehicle were also considered and vehicles entering or exiting the road facilities. At interurban road, the same side frictional factors were identified but in a different manner. The number of vehicles stopping and parking, the number of vehicles entering and leaving roadsides and the flow of slow moving vehicles like tricycles. Using the above listed factors, the study concluded that on interurban road, free flow speed was reduced by 0.76 kmhr^{-1} and capacity of road was reduced to 20%. In contrast, the urban roads speed was reduced by 0.59 kmhr^{-1}. Using this data collected, a HDM-Q model was developed to predict vehicle speed on road so that the time to cover for a journey can be known beforehand considering all the factors that interrupt free flow as discussed above.

In another comparative study, (Munawar, 2011) analysed predicted speed by Indonesian High Capacity Manual (IHCM) formula and actual observed speed in Indonesian city of Yogyakarta during peak hours. The study found that, when side friction was high, there was a significant difference between the speed predicted by IHCM formular/standard and vehicle speed and road capacity observed. In another words vehicle speed and road capacity is higher in IHCM standard than the road capacity and vehicle speed observed. Additionally, IHCM formular did not include sensitivity in speed reduction which increase impact of side friction and there was no clear statement in IHCM formular on whether parking and stopping vehicles should be included among the frictional factors either. The results revealed that regarding the capacity of roads and vehicular speed in IHCM, values obtained are expected from a large population of data collection

sites. Thus, the study concluded that there is a need for further studies to include all the factors exempted in IHCM formular to improve the IHCM model and to make a fair comparison with actual observed speed.

On his part, (Chetan & Joshi, 2014) studied on the six-lane divided urban road in Pune and Patna city of India. Speed-flow density relationships were developed for both the roads and parameter for mixed flow condition were derived and compared with Indian Road Congress (IRC) standard. The study took a dynamic car unit instead of passenger car unit. Due to roadside parking, effective lane width decreases from 10.5m to 7.0m resulting in reducing 57% capacity in Patna city. In addition, due to the presence of Non-Motorized Vehicles, 14% reduction in speed was observed in Patna city compared to Pune city.

Additionally, (Pal & Roy, 2019) used three differenct locations and collected data from a mixture of motorized vehicle, fast moving vehicles and pedestrians. The results from the three locations revealed a high presence of roadsided friction. A speed flow graph was developed using the data generated. It was recommended that five threshold values based on speed and free flow should be used for efficiency in subsequent or future studies.

(Conversely & Aronsson, 2006) studied speed characteristics of urban streets/roads. Macro and micro simulation of the influence of traffic flow with other road users were carried out. Vehicle speed profiles were collected from the field and several variables influencing traffic flows were identified from the various urban streets studied. The factors identified to be significant factors were traffic flow, pedestrians, bicycle movement, buses entering and exiting from the bus stop and on road/street parking. These traffic behavioral functions were modified and added into the microscopic simulation model. In the macro analysis, the results revealed that speed reduction caused by the variable was from 1 to 6 $kmhr^{-1}$ and in microanalysis; speed reduction was 1 to 4 $kmhr^{-1}$.

This was confirmed by (Pallavi & Arpan, 2018) where they observed and identified pedestrians, stopped vehicles, wrong movement of vehicles and entry and exit manoevres as the major causes of roadside friction in Telangana, India. The study also found that the vehicular speed decreases as side friction increases at all traffic volumes. Using Green shield's theory, capacity value obtained for combined data from the variables or factors that caused roadside friction revealed 9% reduction when there is presence of roadside friction factors as against their absence. The study suggested the use of a model to estimate average speed of vehicular stream with the effect of side friction and volume on the roads section.

Additionally, (Dushyant, 2012). focused mainly on the concept, theories, and methods related to side frictional impacts on performance and capacity of urban road links, and were performed in Ahmedabad city of India. The study identified all the likely roadside frictional factors. A model called FARIC was established for many road links by performing regression analysis involving flow and individual friction items as independent variables and speed of light vehicles as the criteria variables.

In another comparative study, (George, 2014) conducted an analysis of roadside friction on major arterial roads in three densely populated urban cities of India, the cities selected for the study were: Mumbai, Bengaluru, and Thiruvananthapuram. Side frictional factors were limited to only three. They were: pedestrian movements along the roadside, buses stopping at parking designate and on street road parking. Multiple linear regression analysis was selected to represent

their relationship among the three towns. Reduction in speed was studied for all individual factors and also for combined effects. The study concluded that side friction has a significant effect on speed and further studies should consider all factors that caused roadside friction not to limit them on only three for a better result.

(Raoa, et al., 2016) found that urbanisation is the major cause of roadside friction especially in developing countries like India. Also found was interference to the free flow of traffic on the roadside or along the carriage way. Factors that affect the efficiency and the capacity of road include: Speed of vehicles on the road, width of road, structure of the road, construction work on roads, land uses that attract motorists and pedestrians' activities such as commercial, hospital services, educational activities, shoulder and roadway width, access points, terrain of the road among others. However, on street parking, road entry and exit, pedestrians crossing among others are the major causes of the interference and roadside friction. The study also found that these common practices of roadside friction is not captured in HCM-Models and there is the need for including them. The study finally recommend imposition of restrictions or designation of the frictional points.

In African study, (Peprah, et al, 2014) investigated the Offinso road in Kumasi, Ghana to identify the factors that restrict pedestrians's safety and on street parking. Two sampling techniques; purposive and systematic were used in choosing the population for the study. The study found that; both private and commercial motorists impede the free flow of vehicles and safety of pedestrians. The study also revealed that, congestion and inconveniences are as a result of poor behaviour and cultural attitude of Ghanians. In order to reduce this bad practice, the study recommend sensitization, enlightment campaigns and enforcement of traffic regulations.

Supporting (Peprah, et al, 2014) findings, (Islam, et al, 2018) investigated cause of roadway width reduction in the city of Dhaka, Bengladash. The study found that roadway width reduction is as a result of commercialisation of roadside by traders and hawkers of roads and streets that often install their shops thereby reducing the road widths. The study also revealed that pedestrians experience many different problems due to side friction caused by the aforesaid elements. The study recommend using new techniques for movement free of roadside friction so that commercial, industrial and general economic growth can be achieved.

(Irawati, 2015) selected Mrageen city of Indonesia for a study. The study collected different data like total number of vehicles plying roads, roads geometry, and so on. The study used VISSIM software for delay analysis with and without side friction. The study concluded that with side friction, delay was 128.838 seconds time per vehicle(s) and without side friction, it was 96.310 second time per $vehs^{-1}$.

Similarly, (Shah & Raval, 2016) used VISSIM software for capacity which was more than what the IRC guidelines suggested. The study selected C.G. Road of Ahmedabad city of Gujarat state in India. Traffic volume and speed relationship at peak hours were determined. The capacity was also determined and compared with the IRC guidelines. The study concluded that the observed capacity was 16% higher than the specified in IRC guideline. Also found in the study was the traffic composition which also affect the capacity of the road.

(Pal & Roy, 2015) proposed interaction among fast moving vehicles, pedestrian, and non-motorized vehicles. The data collected from three roads was used to generate a speed flow curve for various side friction levels. The study suggested that Los of Service (LOS) should be considered on operational speed and freedom of vehicle to manoevre as measure of effectiveness. The study finally calculated road side friction index based on the collected data.

Deviating a little, (Dushyant, 2012). focused mainly on the concept, theories, and methods related to side frictional impacts on performance and capacity of urban road links, and were performed in Ahmedabad city of India. The study identified all the likely roadside frictional factors. A model called FARIC was established for many road links by performing regression analysis involving flow and individual friction items as independent variables and speed of light vehicles as the criteria variables.

In contrast, (Muhammed, 2019) analysed the impacts of roadside friction on flow of vehicular traffic in Kaduna State, Nigeria. The study used three major cities in the state; Kaduna metropolis, Zaria metropolis and Kafanchan town. Mobile topographer (an adroid phone application software) was used to identified areas affected significantly with side friction; generating their coordinates, compass bearings and altitudes. The study used a probe vehicle (car) and several runs were carried out for each time period to provide acceptable permitted errors in the estimate of average speed in the morning (7:30 a.m.), forenoon (11:00 a.m.), afternoon (3:00 pm) and evening (7:00 p.m.) for four days in each town. Each run resulted in performance box recording time, speed, and coordinate pair data. The study revealed that side frictional events occur more in the afternoon. The result also revealed that free flow of traffic is higher in Kafanchan town, then Zaria and Kaduna metropolis respectively with reduction of up to 28-30 $kmhr^{-}1$ in speed sometime. The study developed a model that can be used to predict vehicle speed at each of the four different times in each of the three cities.

Similarly, in another African study, (Moise & Hannibal, 2020) generated data from Kigali, Rwanda to analysed the effect of dynamic friction elements affecting performance of vehicles on roads. Speed and level of service were the parameters considered affected in the study. Data collected included vehicle speed, road condition and roadside elements. The data collection considered most busy roads in the city of Kigali, the capital of the country. Analysis of Variance (ANOVA) was the method applied to analyse the data with sensitivity analysis coming on top. The impact of roadside friction on speed and level of service was measured from the ANOVA analysis. Additionally, relationship of speed, density and flow were developed considering the dynamic nature of factors that cause roadside friction. The study recommend setting out guidelines for vehicular traffic movement and restrictions to reduce or eliminate the continues increase of roadside friction across the city of Kigali and beyond.

CONCLUSION

This reviews the effects of roadside friction on performance of roads in some African countries and South-East Asia. The major factors causing roadside friction as identified in the reviews include: on street parking, presence of slow moving vehicles on roads, presence of non-motorized vehicles on roads, commercialization of roadsides, pedestrians' movement among others. When side friction occurs, pedestrians suffer and road capcity and performance are greatly

affected. Different suggestions are made on how to reduce or eliminate the problem.

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