THE EFFECTS OF ROADSIDE FRICTION ON THE PERFORMANCE OF ROADS IN AFRICA AND SOUTH EAST ASIA – A REVIEW

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ABSTRACT

This paper is a review on the connection between socio-economic activities and road networks. An important aspect of this is roadside friction which is simply defined as interaction of different activities on road carriageways 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 bicycle or non-motorized moving vehicles and commercialisation of the roadsides through hawking. This problem is more pronounced in the developing countries of Africa and South East Asia. The review evaluates the empirical studies on the effects of roadside friction on flow of vehicular traffic and road Loss Of Service (LOS) in the South East Asian countries of India, Bangladesh, Pakistan and Indonesia. In Africa, Nigeria, Rwanda and Ghana were visited. The review 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 are also presented.

Key words: Roadside friction, India, IHCM, LOS, Capacity

1. INTRODUCTION

Transportation requires effective and efficient road networks to facilitate or enable different activities to take place in all sectors including health, education, religious, recreation and sports. One of the many problems of roads is the deterioration of capacity and performance caused by roadside friction.

Roadside friction describes the degree of interaction between the traffic flow and activities along the side(s) and sometimes across or within the carriage way (Bang, et al., 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 motorcycles 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.

According to Chiguma (2007), side frictions are all those actions related to the activities taking place by the sides of the road and sometimes on the road, which interfere with the traffic flow on the travelled way. They include but not limited to pedestrians, bicycles, 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, et al., 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. This study reviewed some of the latest findings on roadside friction.

2. THE REVIEW AREA

South East Asian countries of India, Bangladesh, Pakistan and Indonesia were studied in one hand and African countries of Nigeria, Rwanda and Ghana on the other; with the. aim of exposing and reporting the problems road users might encounter when faced with roadside frictions for researchers to expand the frontier of knowledge and policymakers to make good policies and decisions.

3. METHODOLOGY

Empirical studies on the effects of roadside friction on flow of vehicular traffic and road Loss Of Service (LOS) were reviewed intensively.

4. THE REVIEW

In the light of the above, Bang (1995) selected two different roads; the urban road and semi urban road to collect data on roadside friction and compare. At urban roads, the side friction factors identified were pedestrian movements by the roadsides and pedestrians crossing the roads. Vehicle stopping was categorized into those that stop on the road shoulders or on the road carriage ways. Parking and unparking of vehicle were also considered and vehicles entering or leaving the road facilities. At semi urban 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 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 Indonesian High Capacity Manual (IHCM) formular/standard and vehicle speed and road capacity observed. In other words, vehicle speed and road capacity in IHCM is higher than the road capacity and vehicle speed observed.

Chetan and 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 of road in Patna city. In addition, due to the presence of non-motorized vehicles on the road like push-carts, 14% reduction in speed was observed in Patna city compared to Pune city.

Additionally, Pal and Roy (2019) used three different 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 roadside friction. A speed flow graph was developed using the data collected. 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: pedestrians, bicycles movement, buses entering and leaving 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 $kmhr^{-}1$.

Aronsson (2006)'s finding was confirmed by Pallavi and Arpan (2018) where it was 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 Greenshield'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 for improve traffic flow performance.

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 suggested that

further studies should consider all factors that caused roadside friction not to limit them on only three for an improved/better result.

Rao 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 carriageway. 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 were the major causes of the interference and roadside friction. The study also found that these common practices of roadside friction are not captured in HCM-Models and there is the need for including them. The study finally recommends 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 Ghanaians. In order to reduce this bad practice, the study recommends sensitization, enlightment campaigns and enforcement of traffic regulations.

Supporting Peprah et al (2014)'s 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 recommends using new techniques for movement free of traffic so that commercial, industrial and general economic growth can be achieved.

Irawati's (2015) study of Mrageen city of Indonesia collected data including 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 and 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 and 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 maneuver 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 traffic flow and individual friction (macroscopic and microscopic) 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 android 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. Comparatively, the result 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 and 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 recommends setting out guidelines for vehicular traffic movement and restrictions to reduce or eliminate the continuous increase of roadside friction across the city of Kigali and beyond.

5. CONCLUSION

These reviews focused on the effects of roadside friction on performance of roads in some African and South-East Asian countries. There were similarities between the Asian and African situations/studies because LOS was common, involved and encountered in the two continents. 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 and vehicles entering or exiting roads. When side friction occurs, pedestrians suffer and road capacity and performance are greatly affected. Different suggestions are made on how to reduce or eliminate the problem.

These reviews will assist researchers in Geography, Urban Planning, Transport Planning and Civil Engineers on some of the latest findings on roadside frictions. Policymakers, decision makers and government at all levels are reminded of the likely situations on urban roads for better policies and decisions to help make roads more efficient and effective. The reviews will also help upcoming researchers in transportation to find gap on this, and similar issues.

References

Arosson, K. F.M. (2006). Speed Characteristics of Urban Streets Based on Driver Behaviour Studies and Simulation. Published PhD thesis, Royal Institute of Technology, Stockolm, Sweden.

Bang, K.L. (1995). Impact of side friction on speed-flow relationships for rural and urban Highways. *hdmiv/reports/sidefric.*

Bang, K.L., Bergh, T., Carlson, A., Hanson, A. & Ronggui, Z., (1999). Highway Capacity Study, Final report and capacity guidelines. National Highway Project of Peoples republic of China. Hebei and Henan Provincial Communication Departments.

Chetan, R.P. &Joshi, G.J. (2014). Mixed Traffic Speed-Flow Behaviour under influence of Road Side Friction and Non-Motorized Vehicles: A Comparative Study of Arterial Roads in India. *World Academy Science, Engineering and Technology International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering* 8(11).

Chiguma, M. L.M. C. (2007). Analysis of side friction impacts on urban road links. Case study, Dar-es-salaam. Published Doctoral Thesis in Traffic and Transport Planning, Infrastructure and Planning Royal Institute of Technology Stockholm, Sweden.

Dushyant, P. (2012). Side Friction and Side Frictional Factors in Ahmedabab Road Link Regression Analysis. *International Journal of Research*, 3(4).

George, S. (2014). Effect of Side Friction on Traffic Characteristics of Urban Arterial. https://www.civil.iib.ac.in

Irawati, I. (2015). Delay Evaluation of Impact of Side friction on Heterogeneous Traffic Towards Road Performance with VISSIM, microsimulation. *International Journal of Engineering Research Research and Technology* 4(2), 1163-1171.

Islam, M., Al Razib, S., Hasan, M., Ali, S. Monir, O & Hasan, M. (2018). Cause of Reduction of Effective Roadway Width Due to Side Friction in Dhaka City *American Journal of Traffic and Transportation Engineering,* 3 (1), 6-17.

Kanani, M., Motwani, R. G., & Dave. H. K (2017). Review of Influence of Road Side Friction in Urban Area. *International Journal of Advance Research, Ideas and Innovations in Technology* 3 (20).

Moise, B. & Hannibal, B. (2020). Effects of Roadside Friction Elements on Travel Performance and Level of Service in Kigali. *Transportation Research Board*, 10 (2), 236-251.

Muhammed, A.Y. (2019). *Effects of Roadside Friction on Flow of Vehicular Traffic in Kaduna State, Nigeria*. Unpublished Doctorate Thesis. Department of Geography and Environmental Management, Ahmadu Bello University, Zaria, Nigeria.

Munawar, A. (2011). Speed and Capacity for Urban Roads, Indonesian Eperience. *Procedia-Social and Behavioral Sciences*, 16, 382-387.

Pallavi, G., & Arpan, M. (2018). Analysis of Side Friction on Urban Arterials. *Transport and Telecommunication,* 19(1), 21-30.

Pal, S.& Roy, S. (2015). Impact of Roadside Friction on Travel Speed and LOS of Rural Highways in India, *Transportation in Developing Economics*, 2(9), 1-12.

Pal, S. & Roy, S. (2019). Effect of Side Friction on Travel Speed and Road User Cost in Rural Roads of India. *International Journal of Innovative Research in Science, Engineering and Technology*, 6(12).

Peprah, C., Oduro, C.Y., & Afi, K. (2014). *On-Street Parking and Pedestrian Safety in the Kumasi Metropolis: Issues of Culture and Attitude*. Department of Planning, Kwame Nkrumah University of Science & Technology, Kumasi, Ghana.

Raoa, A.S., Velmuruganb, S. & Lakshm, K.M.V.N. (2016). Evaluation of Influence of Roadside Frictions on the Capacity of Roads in Delhi, India. *Transportation Research Procedia*25 (2017), 4771–4782.

Shah, A. & Raval, N.G. (2016). Estimation of Capacity for Arterial Road of Urban Area. *International Journal of Advance Research, Ideas and Innovations in Technology, 2(12), 63-64.*