PERCEPTION OF THE IMPACT OF HEAVY VEHICLE MOVEMENT ON WALKABILITY IN KRISHNANAGAR MUNICIPALITY, INDIA

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Abstract

Relatively narrow roads of small cities get adversely affected by heavy vehicular loads, reducing pedestrian movement. This study aims to use spatial analyses and statistical tools to provide an assessment of the impact of heavy vehicular movement on walkability in Krishnanagar municipality in India from the pedestrians' perspectives. AHP-SWOT methods and walkability index were calculated over 10 road links. The results were verified using field observations and questionnaire surveys. It was observed that due to the absence of separate lanes and minimum scope for road expansion, walking on the roads is significantly impacted, reducing the walkability index on all the major road crossings to less than 0.3. The level of traffic and the externalities by the heavy vehicles' operation has an effect on different population group of pedestrians. Pedestrians have highly rated the distress due to traffic congestion caused by heavy vehicle operation and reduction of walking space due to encroachment by vehicles as major demotivating factors for walking. The study proposes that, with an opportunity of sufficient road width to support medium/light vehicular flow, re-planning of traffic flow with the help of policy makers, planners and engineers will help towards developing a smart city with multiple sustainable benefits.

Keywords: constricted road infrastructure, sustainable transportation, heavy vehicles, walkability

INTRODUCTION

For an inclusive sustainable urban transport development, there is a need to improvise traffic flow at a reduced cost for small cities of developing countries (Ministry of Urban Development, 2008). The existing constricted road infrastructure in the small old cities of India have limited scope for simultaneous heavy vehicle operation and pedestrian movement (Ministry of Urban Development, 2012). Many such cities are intersected by highways and major roads, which often provide short- cut routes to nearby villages, suburbs and towns. Hence, they are often used by these vehicles to facilitate movement of goods and people to surrounding settlements. As a result, the roads get damaged along with other problems such as traffic congestion, air and sound pollution within cities. Residents of these small cities, thus are unable to use these roads for walking (Jacobsen et al., 2009), which is one of the most sustainable form of transport. As small cities in India have mostly been neglected in the planning process, it demands urgent research to resolve these issues.

Literatures point out that heavy vehicles have a negative impact on road performance, particularly on the low-volume roads (Ahmed et al., 2013; Sebaaly et al., 2003). Its presence in the traffic stream causes perturbation to other vehicles (Al-Kaisy & Jung, 2004; Mannan & Enberg, 1998) and based on its types, speed reduction of the traffic too occurs (Moridpour et al., 2015; Roh et al., 2017). The negative impacts of heavy vehicle operation can also affect the walkability, as because walkability of the pedestrians depends on their safety, comfort and convenience while walking (Rashid et al., 2017) along with road characteristics (Brigante et al., 2019) and road user's behaviour (Mukherjee & Mitra, 2019).

OBJECTIVE

The current research aims to describe the impacts of heavy vehicle transport on walkability in a more systematic way within Krishnanagar Municipality.

STUDY AREA

Krishnanagar Municipality has a very high population density with a population of slightly more than 1.5 million. The city is well connected to other surrounding cities, towns, suburbs and villages by roadways. The city, therefore, has large number of inter and intra-city buses and trucks fleeting on the city roads and the rising number of pedestrians with the growing population are facing concerns over walkability.

DATA AND METHODS

For this study, primary data regarding decision on feasibility of the existing route and perception on walkability of the residents of the Municipality has been collected through a field-based questionnaire-survey of 20 persons on each of the 10 selected road links, selected by a systematic sampling technique of every 5th pedestrian. The road links have been selected on the routes over which the heavy vehicles operate, on the basis of the location of significant traffic posts and in its absence, the major traffic-entry nodes within the municipality have been selected. Data on motivations of walking of the respondents have been collected in the light of different effects and externalities due to heavy vehicle operation. Respondents have been classified on their gender and age. While the preference to walk on roads over which heavy vehicle operate has been categorized on the basis family income, the age of the respondents has been chosen as 18years and above. The data has been collected at different time intervals throughout the day, which mainly includes the working hours, i.e., 8:00am to 11am, 12pm to 3pm and 4pm to 7pm. Working Days have been considered for the purpose of data collection from the respondents. The questions in the questionnaire were set to determine the perception of the respondents through 5-point Likert Scale.

1. To determine the feasibility of the existing route bearing operation of heavy vehicles within the Krishnanagar Municipality, the questions were on the different attributes about the importance of the existing route in terms of connectivity and the flow of mixed traffic, the adequateness of the existing road infrastructure for supporting light and medium vehicle

traffic, heavy traffic and pedestrians, the effect of externalities associated with heavy vehicle operation on walking motivations on these routes and the need for re-routing heavy vehicles.

2. To determine the walkability of the existing route, the questions were as per the 9 different attributes set by the Ministry of Urban Development, India, for measuring Walkability Index.

The decision on feasibility has been done by the AHP-SWOT method (Oreski, 2012). The SWOT factors have been derived from questionnaire survey done on the residents of Krishnanagar Municipality.

Walkability index was also calculated by a method developed by Ministry of Urban Development (MOUD), Government of India (Fabian et al., 2010) using the following formula:

Walkability index = [(W1 X Availability of footpath) + (W2 X Pedestrian facility ratings)]

Where, W1 and W2 are weights (assumed 50% for both)

Availability of footpath = Footpath length/Length of major roads in the city

Pedestrian facility ratings = score estimated on opinion on available pedestrian facilities

MOUD method considers 9 attributes and pedestrians had to rate them on 5-point usability scale, where, 1= not at all usable and 5= highly usable The study considered both goods and passenger motors as heavy vehicles with unladen weight exceeding 12000 kg as per the Indian Motor's Vehicle Act, 1988 (The Motor Vehicles Act, 1988). However, data on sound pollution could not be collected due to lack of instrument, but rather the perceptions from the pedestrians have been gathered for understanding its effect on walking motivation.

The land cover data from Town Planning Map of Krishnanagar Municipality and LANDSAT-7 and 8 imageries have served as the secondary data. They were used to map the changes in built up areas around major routes.

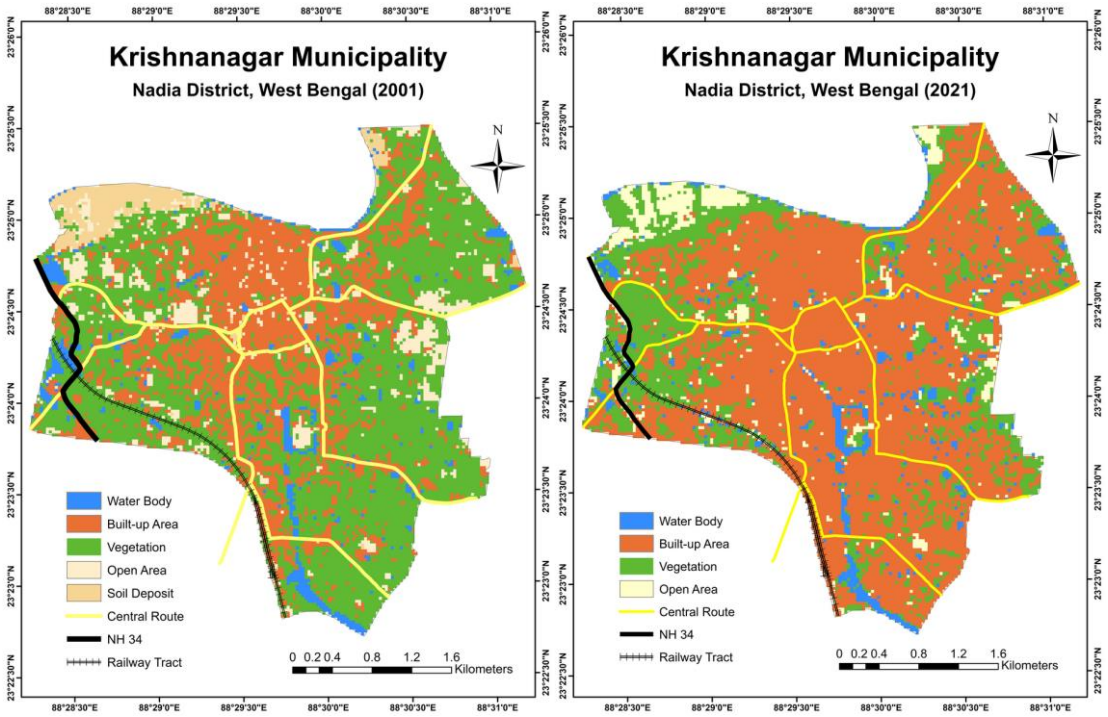

Fig. 1. Changes in Landcover within Krishnanagar Municipality from 2001 to 2021

RESULTS AND DISCUSSION

It was observed that over 20 years there has been no growth in road infrastructure, but the built-up area along the roads had a tremendous rise.

The changes in landcover served by the existing road network over 20 years show that while there has been no growth in road infrastructure, built-up area along the roads had a significant rise of 61.53%, causing traffic pressure over the existing infrastructure (Litman & Steele, 2017).

On this existing road infrastructure, almost 12% of the pedestrians share the road with an average of 7-8% heavy vehicle traffic at different times of the day. In the 12% of the pedestrian population, the number of females walking on the major roads are less in comparison to the males with a ratio of 31:69. The pedestrians vary almost equally among the different age groups, as on an average, the walking population in the age group of 18-30 years composes 31.2% of the total pedestrians, while, 36.3% of walkers are within 30 to 60 years of age and old age walkers composes 32.5% of the pedestrians.

Results from feasibility of the existing routes within the municipality for the plying of heavy vehicles has been determined by the different factors of strengths, weaknesses, opportunities and threats. Through the Analytic Hierarchic Process, each of the SWOT factors have undergone pairwise comparison. The proportion of inconsistency for the SWOT groups are under 10% as per Saty's Random Consistency Index which proves the matrix to be consistent for further analysis.

The AHP-SWOT analysis finds out that the strength of the present road network is to be the significant route of the city's road transport system. However, there is limited and inadequate road width for operation of heavy vehicles along with light vehicles, which is its weakness. While there is a high threat of traffic congestion through heavy vehicle operation within existing road infrastructure, but the opportunity lies in the fact that the road width is sufficient enough to support medium/light vehicular flow.

In order to determine the walkability prospect being affected by the heavy vehicle operation through the existing central route (LI, 2019), perceptions of the pedestrians who are the residents of the municipality has been conducted (Carbone et al., 2018) on the selected road links.

The value of the Walkability Index lies within the range of 0-1, thus, walkability of the studied roads is very poor, i.e., mostly 0.2 (Figure 1) (Minhas & Poddar, 2017). The road links from Beledanga to Gaudiya Math More and Court More to Municipality More have Walkability Index have 0.2 because of the presence of footpath serving the market area (Ministry of Housing & Urban Affairs, 2020). The other sections of the road network are devoid of any footpath facility or crossings, so, the pedestrians are forced to walk upon the roads over which the heavy vehicles too are plying.

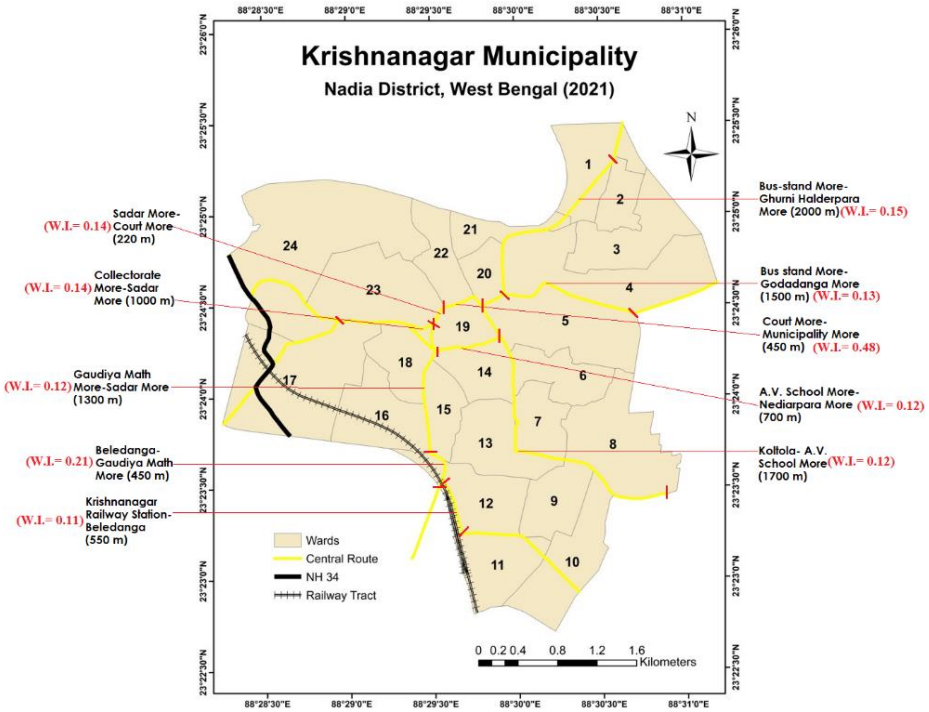

Fig. 2. Walkability Index over Selected Road Links

These roads with low walkability index, are still used by pedestrians for different purposes. The trip purpose varies among male and female walkers, where the females prefer to walk mainly for shopping purpose, while the males have preferred to walk with mixed purposes. Trip purpose varies among the different age group too, as the pedestrians in the age-group of 18-30 years as well as 30-60 years mostly walk for work, shopping, family and social purposes, while, the aged population walk for social and shopping purpose.

But the effect of heavy vehicle operation on the roads with low walkability index, has an effect on the walking motivations of the population. On the basis of the rating scale from 1 to 5, (1 signifying highly disagree to 5 signifying highly agree) the pedestrians have highly rated the distress due to traffic congestion caused by heavy vehicles operation and encroachment by vehicles as the major demotivating factors for walking. Air pollution has been rated as the average (rating lies above 4) for all the road links. Pedestrians perceive noise pollution to be a factor for their reduced walking only at the road links which face influx of heavy vehicles while entering the city. The effect of heavy vehicles plying on the limited road space over traffic congestion, air and noise pollution, and safety concerns affect the males' and females' motivation equally in negative terms, but is majorly seen for the pedestrians above 30 years of age. But mostly the working age-group, and mainly the males feel the need to shift towards personal motorized vehicles due to the operation of heavy vehicles reducing their motivation to walk.

While relating the level of traffic plying over the limited road infrastructure with the preference to walk for the different income groups, it comes up that the pedestrians belonging to the high-income group with monthly income to be Rs.20,000 and more are the least in number, where they consider the level of traffic to be high enough to reduce their walking preference. The pedestrians having low monthly income and those having monthly income between Rs.10,000 to Rs.20,000 are almost equal in average for the 10-road links, but their

preference to walk varies from remaining indifferent to the traffic level to being inclined towards reduced preference to walk when they perceive the level of traffic to be high.

So as to make the roads more walkable, the agreement of pedestrians for developing alternate routes for heavy vehicles have been computed (Fancello et al., 2020), where, 60% of the respondents have highly agreed upon it as for them the heavy vehicles are not of any utility. But the 8% of the respondents disagreeing, reason out the use of heavy vehicles to reach the surrounding villages and cities and sometimes for economic purposes.

CONCLUSIONS

The study adds to the literature related to impact of heavy vehicles in transportation field, whereby it draws out the conclusion that in a city with rapidly rising built-up area, there is a need for reducing the vehicular pressure by re-routing the heavy vehicles, as well as make the city more friendly for pedestrians. The level of traffic and the externalities by the heavy vehicles' operation has an effect on different population group of pedestrians. This study tries to draw attention towards forming strategies out of the SWOT factors to increase walkability of the cities, to gauge the preference of walkable population for creation of alternate routes and flyovers to support the proper channelization of heavy vehicles, proper laning to bear with the growing traffic and develop walkability by improving footpaths and crossings (Pune Municipal Corporation, 2016) within the Krishnanagar municipality. The idea so developed through this study can induce remodeling the transport infrastructure of small cities with restrictions in expanding the present road infrastructure, with the help of policy makers, planners and engineers towards developing a smart city with multiple benefits.

REFERENCES

Ahmed, U., Drakopoulos, A., & Ng, M. (2013). Impact of Heavy Vehicles on Freeway Operating Characteristics Under Congested Conditions. *Transportation Research Record: Journal of the Transportation Research*, *2396*, 28–37. https://doi.org/10.3141/2396-04

Al-Kaisy, A., & Jung, Y. (2004). Examining the effect of heavy vehicles on traffic flow during congestion. *Road & Transport Research Journal*, *13*(4), 3–14.

Brigante, G., Carleo, M., & Scorza, F. (2019). Land Suitability Analysis for New Urban Development Strategies Oriented to 'Active Mobility' and Walkability: Potenza Case. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *11624 LNCS*, 318–330. https://doi.org/10.1007/978-3-030-24311-1_23

Carbone, R., Saganeiti, L., Scorza, F., & Murgante, B. (2018). Increasing the walkability level through a participation process. *International Conference on Computational Science and Its Applications*, 113–124.

Fabian, H., Gota, S., Mejia, A., Leather, J., & Center, A. C. (2010). Walkability and pedestrian facilities in Asian cities: state and issues. *Asian Development Bank, Manila, Philippines*.

Fancello, G., Congiu, T., & Tsoukiŕs, A. (2020). Mapping walkability. A subjective value theory approach. *Socio-Economic Planning Sciences*, *72*, 100923.

Jacobsen, P. L., Racioppi, F., & Rutter, H. (2009). Who owns the roads? How motorised traffic discourages walking and bicycling. *Injury Prevention*, *15*(6), 369–373.

Li, S. (2019). The relationship between walkability and street vitality. An experimental explanation based on Milan.

Litman, T., & Steele, R. (2017). *Land use impacts on transport*. Victoria Transport Policy Institute Canada.

Mannan, M. S., & Enberg, Ĺ. (1998). *Impact of heavy vehicles on Finnish freeway traffic flow*.

Minhas, P., & Poddar, A. (2017). Walkability index by global walkability index method. *International Research Journal of Engineering and Technology*, *4*(7), 2957–2963.

Ministry of Housing & Urban Affairs, G. O. I. (2020). MoHUA recommends Holistic Planning for Pedestrian Friendly Market Spaces in Consultation with Stake Holders Million Plus Cities to select at least three market places for Pedestrianisation & Non-Million Plus Cities to select at least one market area Pedestrianisation in Market Places.

Ministry of Urban Development, G. O. I. (2008). The Urban Transport Environment in India . In *Traffic & Transportation Policies and Strategies in Urban Areas in India*. https://mohua.gov.in/upload/uploadfiles/files/traffic_transportation(1).pdf

Ministry of Urban Development, G. O. I. (2012). *Design of Urban Roads-Code of Practice : Ministry of Housing and Urban Affairs, Goverment of India*. https://www.mohua.gov.in/cms/Design-of-Urban.php

Moridpour, S., Mazloumi, E., & Mesbah, M. (2015). Impact of heavy vehicles on surrounding traffic characteristics. *Journal of Advanced Transportation*, *49*(4), 535–552.

Mukherjee, D., & Mitra, S. (2019). Impact of Road Infrastructure Land Use and Traffic Operational Characteristics on Pedestrian Fatality Risk: A Case Study of Kolkata, India. *Transportation in Developing Economies 2019 5:2*, *5*(2), 1–9. https://doi.org/10.1007/S40890-019-0077-5

Oreski, D. (2012). Strategy development by using SWOT-AHP. *Tem Journal*, *1*(4), 283–291.

Pune Municipal Corporation, G. O. I. (2016). *Urban Street Design Guidelines (USDG)* . https://www.pmc.gov.in/en/urban-street-design-guidelines-usdg

Rashid, M., Akram, W., & Tarry, S. R. (2017). The Study of Walkability Index: A Case Study at Jalandhar City in India. *International Journal of Engineering Research & Technology (IJERT)*, *6*(4), 796–799.

Roh, C.-G., Park, B.-J., & Kim, J. (2017). Impact of heavy vehicles on highway traffic flows: case study in the seoul metropolitan area. *Journal of Transportation Engineering, Part A: Systems*, *143*(9), 5017008.

Sebaaly, P. E., Siddharthan, R., & Huft, D. (2003). Impact of heavy vehicles on low volume roads. *Transportation Research Record*, *1819*(1), 228–235. *The Motor Vehicles Act*. (1988). https://www.indiacode.nic.in/bitstream/123456789/9460/1/a1988-59.pdf