Non Motorised Vehicle Characteristics and Its Effect on Mixed Traffic

P. Baji Babu¹, M. Srinivasa Reddy²

¹PG Scholar, Dept of Civil, Nalanda Institute of Engineering and Technology, Sattenapalli, AP, India, E-mail: Baji.babu357@gmail.com.
²Assistant Professor, Dept of Civil, Nalanda Institute of Engineering and Technology, Sattenapalli, AP, India, E-mail: Srinivasareddy.marri0@gmail.com.

Abstract: In this paper a novel methodology developed for Non-Motorized vehicle routing in mixed traffic. In developing countries like India, South Africa, Srilanka etc. we find mixed traffic flow. We observe that in our country traffic flow consists of all the vehicles like cars, cycles, pedestrians, bullock cart, heavy vehicles etc. Many cities in India still uses Non-Motorized vehicles (NMT) for transportation of goods and also for traveling. In peak hours like school opening and closing hours, in business hours for goods carriers the NMT flow is very high. Every public transport mode of transport involves access trips by NMT at each end As far as the simulation results are concerned it was seen that speed value obtained experimentally and obtained from the model are almost same. It was studied that all the three parameters have a significant impact on the speed of a non-motorized vehicle in a mixed traffic. It was seen that speed decreases with increase in number of PCUs in the same strip, speed decreases with increase in number of PCUs in the adjacent strips and speed increase when distance from the road edge increases.

Keywords: Non-Motorized Transport (NMT), PCUs.

I. INTRODUCTION

Transportation planners in developing countries have given more importance to mobility than to accessibility. Mobility has been improved through construction of flyovers, subsidized fee for license and vehicle registration, widening of roads, provision of alternate rail-road-based transportation systems, etc. Such provisions along with improper planning of access to transportation systems have degraded the environment; increased the social cost, which involves health, accident and congestion costs; and increased the economic burdens such as loss of employment opportunities and higher cost of travel due to delays. The inherent shortcomings of non-motorized transportation modes such as being feasible for shorter distances only, and lower speeds make them suitable for providing access to any transportation system under congested conditions or to any land use in the vicinity of our homes. This project work is divided into two parts. First part is the experimental part and the latter is the analytical part. In experimental part a study of fundamental diagram of data obtained from various roads of Guntur city. It was seen that with increase in NMV % the flow versus density graph is adversely affected. Density decreases at a particular flow rate when NMV % increases. Along with this a study on pattern of lateral occupancy of NMVs and MVs was done with respect to various percentages of NMV and total density.

A. The Importance Of Nonmotorized Transport

Non-motorized transport (NMT) has an unambiguously benign environmental impact. In many cities it is the main mode of transport for the poor, and in some a significant source of income for them. It therefore has a very significant poverty impact. Where NMT is the main transport mode for the work journeys of the poor, it is also critical for the economic functioning of the city. Despite these obvious merits, NMT has tended to be ignored by policymakers in the formulation of infrastructure policy and positively discouraged as a service provider. The purpose of this chapter is to understand why that has happened, and in light of the evidence on its characteristics, role, costs, and benefits, to suggest a framework within which NMT’s potential may be better exploited. Some governments appear to have an ideological preference for motorized over NMT because they regard it as technologically more advanced. In India, traffic is heterogeneous i.e. it comprises of both motorized and non-motorized vehicles, again there are no clear demarcation of lanes and traffic regulations for segregation of vehicles. Non-motorized vehicles have a profound impact on the basic traffic parameters in India, particularly due to their lower speed compared to motorized vehicles.

The share of walk trips and bicycle trips are decreasing in urban areas, however the absolute number of bicycles and rickshaws are actually increasing even in the major cities such as Delhian and Mumbai. As non-motorized vehicles serve as the only means of transportation for a large underprivileged section of the Indian population, these are sure to increase with the expansion of Indian cities for the next few decades. Non-motorized vehicles are responsible for decreasing the capacity of lanes. In multilane roads non-motorized vehicles generally occupy the outermost or curbside lanes, however in intersections and bus stops non-motorized vehicles get mixed with the motorized vehicles. That’s why effects of non-motorized vehicles such as increment in accidents and decrement in capacity are more evident in intersections.
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B. Objective of The Work
The research is mainly concerned with the analysis of impact of non-motorized vehicles in traffic flow characteristics under Indian situations. The three main categories addressed in this research paper are listed below:

- Capacity analysis
- Lateral density distribution analysis
- Speed & distance headway relations

Capacity analysis is related evaluation of capacity and study of flow-density curves in various locations. Efforts are made to study the changes observed in capacity due to variation in share of non-motorized vehicles in overall density.

II. LITERATURE REVIEW
A number of studies are conducted all over the world on the impact of non-motorized vehicles in overall traffic flow. A huge percentage of those studies are concentrated in Asian countries where the traffic conditions are somewhat similar to India. Some of the studies are discussed as follows:

Tiwari et al (2007) analyzed the difference between homogeneous traffic flows with strict lane discipline in Western countries and heterogeneous traffic flows found in Indian cities. Basic traffic parameters & curves are studied by classifying the vehicles into: motorized four wheelers, motorized three wheelers, motorized two wheelers & non-motorized vehicles. They presented a methodology to verify the continuity equation as well as modifications in passenger car units to better understand the traffic flows under Indian conditions.

Rahman and Nakamura (2005) concentrated on overtaking movements with respect to total traffic volume for undivided urban streets along with the repercussions of variation in percentage of rickshaw. They additionally attempted to classify level of service of heterogeneous traffic into four categories from free flow condition to congested flow condition. Total number of overtaking per unit length & speed of passenger cars are considered as working parameters for level of service.

Oketch (2003) studied the variation in traffic parameters due to introduction of non-conventional vehicles such as bicycles & motorcycles on conventional traffic flow composed of private cars, buses & trucks. The investigation found that the heterogeneous streams had reduced lane saturation flows in comparison to homogeneous conventional streams, although the trends weren’t always consistent. It is also observed that heterogeneous flows have peculiar features that resulted in highly scattered plots of flow, speed & density.

Rahman et al (2003) analyzed effects of non-motorized vehicles on urban traffic characteristics in Bangladesh. They observed that non-motorized vehicles had a negative impact in the basic traffic parameters of speed, flow & density. A linear relationship was found between overtaking volume and total volume; however no clear pattern was observed on the impact of non-motorized vehicles on overtaking volume.

III. DATA COLLECTION
All the data were collected from Guntur city police surveillance department. All videos are of 30 minutes interval. A section on each road was selected which had sufficient number of non-motorized traffic. A 5 m long section was selected and using some marking tools the four corners of the area was marked and the video of the section was taken. All the data were recorded by using the video camera and later decoded in the computer by playing the video with the help of VLC media player. Videos were collected from 5 locations in Guntur.

- Market Center
- Near APSRTC Bus Station
- Sitaramnagar near Mirchi Yard
- Chuttugunta circle
- Auto Nagar

A. Extraction Methodology
- Videos are played in VLC Media Player, screen markers are used to demarcate the boundaries of the required section.
- A screen marker line is drawn perpendicular to the road from one end of the road to another. The number of vehicles passing the line per minute is evaluated to obtain the flow. Similarly, flow for non-motorized vehicles and motorized vehicles are evaluated separately.

The extracted data are:

- Flow
  - Non-motorized Vehicle Flow
  - Motorized Vehicle Flow
  - Total Flow
- Density
  - Non-motorized Vehicle Density
  - Motorized Vehicle Density
  - Total Density
- Speed
  - Non-motorized Vehicle Speed
  - Motorized Vehicle Speed
  - Total Speed
- Density for individual strips
  - Non-motorized Vehicle Density
  - Motorized Vehicle Density
  - Total Density

Fig.1. Road near Market Center.
A cellophane paper was pasted on the computer screen and the four corners were marked and joined with help of a white board marker. This was done because although the actual shape of the section is rectangular but when captured in a camera its shape gets deformed; somewhat trapezoidal depending on the position of camera.

IV. PROPOSED MODEL

A. Basic Structure of the Proposed Model

This gives an idea about the generalized structure of the proposed model. This model is to simulate the speed versus various parameters; an experimental observation was done to see how speed of a non-motorized vehicle varies according to various parameters like

- Number of PCUs in same strip.
- Number of PCUs in both adjacent strips.
- Distance of test vehicle from road edge

V. RESULTS

A. Capacity Analysis

The flow-density relations are analyzed and capacity for all locations are evaluated as well as compared with the percentage share of non-motorized vehicles in total density.
Fig. 7. Flow-Density Curve for Downstream flow in Market center.

Fig. 8. Flow-Density Curve for Upstream flow in Market center.

Fig. 9. Flow-Density Curve for Downstream flow in Seetharamnagar.

Fig. 10. Flow-Density Curve for Upstream flow in Seetharamnagar.

Fig. 11. Flow-Density Curve for APSRTC Bus Station.

Fig. 12. Flow-Density Curve for Auto Nagar.
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From the above trend line it is clearly observed that increment in share of non-motorized vehicles density linearly decreases the capacity.

B. Lateral Density Distribution

The capacity values obtained from the curves are adjusted for to represent capacity of a single lane for forward moving traffic.

**AdjustedCapacity = Capacity x 3.5/(Roadwidth) x (Traffic Type)**

**TABLE I: Variation of Adjusted Capacity and Percentage Contribution of NMV in Density**

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>ADJUSTED CAPACITY(PSU/s)</th>
<th>% Contribution of NMV in density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Center Up Stream</td>
<td>0.10</td>
<td>46.67</td>
</tr>
<tr>
<td>Market Center Down Stream</td>
<td>0.13</td>
<td>25.83</td>
</tr>
<tr>
<td>Seetharam Nager Up Stream</td>
<td>0.08</td>
<td>44.99</td>
</tr>
<tr>
<td>Seetharam Nager Down Stream</td>
<td>0.07</td>
<td>63.78</td>
</tr>
<tr>
<td>APSRTC Bus Station</td>
<td>0.19</td>
<td>29.64</td>
</tr>
<tr>
<td>Chuttagunta Circle</td>
<td>0.21</td>
<td>21.00</td>
</tr>
<tr>
<td>Auto Nagar</td>
<td>0.18</td>
<td>31.82</td>
</tr>
</tbody>
</table>

Fig.13. Flow-Density Curve for Chuttagunta Circle.

Fig.14. Adjusted Capacity-Percentage Contribution of NMV in Density.

Fig.15. Lateral Density Distribution of NMV for Downstream Flow in Market Center.

Fig.16. Lateral Density Distribution of NMV for Upstream Flow in Market Center.

Fig.17. Lateral Density Distribution of NMV for APSRTC Bus Station.
The center of area under lateral density distribution of non-motorized vehicles curves are obtained and its horizontal distance from the left side of the road are evaluated.

**TABLE II: Distance Of Center Of Density Of NMV From Left End Of Road**

<table>
<thead>
<tr>
<th>Location</th>
<th>Road Width (m)</th>
<th>Distance of center from left end of road (m)</th>
<th>Percentage distance of center from left end of road (m)</th>
<th>Percentage contribution of NMV in density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Center Up Stream</td>
<td>9</td>
<td>3.06</td>
<td>34.02</td>
<td>46.67</td>
</tr>
<tr>
<td>Market Center Down Stream</td>
<td>9</td>
<td>1.40</td>
<td>15.60</td>
<td>25.83</td>
</tr>
<tr>
<td>Seetharamnagar Up Stream</td>
<td>7</td>
<td>1.03</td>
<td>20.43</td>
<td>44.99</td>
</tr>
<tr>
<td>Seetharamnagar Down Stream</td>
<td>7</td>
<td>2.17</td>
<td>43.49</td>
<td>83.78</td>
</tr>
<tr>
<td>APSRTC Bus Station</td>
<td>15</td>
<td>3.56</td>
<td>23.76</td>
<td>29.88</td>
</tr>
</tbody>
</table>

Fig.18. Lateral Density Distribution of NMV for Downstream Flow in Seetharamnagar.

Fig.19. Lateral Density Distribution of NMV for Upstream Flow in Seetharamnagar.

Fig.20. Variation in percentage distance of center of density of NMV with percentage contribution of NMV in density.

From the above trend line it is observed that non-motorized vehicles tend to occupy the left side of the road, however increment in non-motorized vehicles force them towards the center.

C. Speed & Distance Headway Relations

Fig.21. Speed-Distance Headway Curve for Downstream flow in Market Center.

Fig.22. Speed-Distance Headway Curve for Upstream flow in Market Center.
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VI. CONCLUSION
Observations and analysis of the traffic data in this research implies a number of conclusions. The negative effects of non-motorized vehicles on capacity are clearly observed, a linear decrement of capacity is observed on increasing the share of non-motorized vehicle density. Significant relations are observed between the lateral distribution of non-motorized vehicles and percentage contribution of non-motorized vehicles on density. The center of the lateral distribution of non-motorized vehicles move linearly towards the center from the curb side with respect to increment of non-motorized traffic. Linear relations are observed between velocity and distance headway, however significant scattering of data points are observed. Velocity in roads allowing two-way traffic are related to the distance headway of motorized and non-motorized vehicles both in forward and backward traffic flow. Analysis reveals that distance headway of motorized traffic have more effect on velocity compared to distance headway of non-motorized vehicles. Another observation shows distance headway of forward traffic have far greater impact on velocity than distance headway of backward moving traffic.

VII. REFERENCES
