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Improvement of highway capacity due to cycle track in urban area

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ABSTRACT

This paper tries to make study of the Improvement of highway capacity due to cycle track in urban area. As urban areas develop in our country and the world, some issue related to urbanization such as traffic congestion became a serious issue. Cycle tracks are exclusive bicycle facilities that are physically separated cyclists from motor vehicle lanes. Cycle tracks are important part of infrastructure proven to increase ridership and improvement in highway capacity. Increasing bicycling can improve the overall quality in the urban areas. A separate cycle track can increase the speed of remaining vehicles so that it can save time, fuel consumption, wear and tear, reduce pollution etc. It can also increase the transportation choices, reduce parking and traffic congestion. In urban planning, cycle tracks are designed to encourage bicycling to an effort to relieve traffic congestion and reduce pollution, reducing bicycling fatalities and injuries by eliminating the need for cars and bicycles to journey for the same road space and to reduce overall confusion and tension for all users of the road. Cycle track may be one-way or two-way, and may be at road level, at sidewalk level, or at an intermediate level. I tried to find improvement of highway capacity if we construct cycle track in urban area. For this I did survey work on Chinhat to Dewa section of Itaunja-Mahona-Kumhrawa-Kursi-Dewa-Chinhat road, Lucknow. I did two way classified traffic survey of the road and also calculate average speed of commercial vehicles, personal vehicles and two wheeler vehicles except cycle. We studied of speed of commercial vehicles, personal vehicles and two wheeler vehicles based on algorithm that there will be no cyclist on mixed traffic. Lastly we studied and comparison of fuel consumption, wear and tear cost, air pollution cost, accident cost etc and as well as total cost saving due to separate cycle tracks.

Keywords— *Cycle Track, Traffic Congestion, Urbanization, Traffic Jams, Bicycling.*

1. INTRODUCTION

As the urban area develops in India, some issue related to urbanization such as traffic congestion becomes serious issue. This problem becomes serious mostly due to inappropriate design of the urban landscape pattern. According to a survey India's biggest cities may be losing up to $22 billion annually due to traffic congestion and its burden is bearing by its commuters. The cost of congestion was based on the basis of fuel consumptions and productivity loss, it includes the man hour and opportunity cost, pollution and accidents incurred on the yearly basis. On average, Indians bought almost 54,000 vehicles each day in 2018 as compared to 18,000 a day, a decade back. This number shows that Indian roads will continue to get more congested with each passing month as people will buy new cars, scooters, bikes as well as commercial vehicles like taxis and truck without necessarily junking older vehicles. Traffic congestion is partially attributes to India's large population and high population density. The cost of congestion was based on the basis of fuel consumptions and productivity loss, it includes the man hour and opportunity cost, pollution and accidents incurred on the yearly basis.

To make cycling safer and more attractive, much more needs to be done than only providing cycle tracks and cycle lanes. In case of Lucknow and other Indian cities, there are many aspects of the road planning and design that discourage cycling and make it less safe. Planning and design make cycling more attractive and safer. Construction of separate cycle tracks makes roads less congested so it can increase the speed of motor vehicles on the road. It can save fuel consumption, time of the commuters, there will be less emission of air pollution, accidents reduce due to less congestion. The main reason for traffic congestion in India is lack of urban planning. The slow vehicle such as cycle and rest of vehicles travels on the same road. Therefore speed of automobile vehicles decreases and becomes congestion. If we plan a separate cycle track then it must be good for traffic.

2. LITERATURE REVIEW

Jensen (2007)[9]: Compares bicycle tracks and lanes before and after study. The construction of bicycle tracks resulted in a 20 percent increase in bicycle traffic and a decrease of 10 percent in motor vehicle traffic on those roads where bicycle tracks have been constructed. The making of bicycle lanes resulted in a 5 percent increase in bicycle traffic and a decrease of 1 percent in motor vehicle traffic on those roads where bicycles lanes have been marked.

Dill and Gliebein (2008)[5]: In their research understand and measures bicycle behavior. In their study they found that the bicycle trips were 13.4 minutes longer than the estimated auto travel time. The medium difference was 9.5 minutes.
About half of the trips occurred during morning and evening peak travel times (6-9 AM and 4-7 PM) with about one third occurring between those time periods. Therefore, less than 20% of the trips occurred in the late evening and early morning.

Fraser and Lock (2010)[15]: The objective was to consider the effect of all interventions or physical factors on cycling in any population group, including cycle path or route. This review provides evidence for the positive association between certain built environment factors and cycling. Policies promoting cycle lane construction appears promising in helping to reduce physical inactivity and the transport component of greenhouse gas emission.

Lusk, Furth, Willett and team (2011)[3]: Had studied six cycle tracks in Montreal that are two way on the one side of the street. Each cycle track was compared with one or two reference streets without bicycle facilities that were consider alternative bicycling route. All six cycle tracks were two-way on one side of the street and separated from traffic by raised medians, parking lanes, or delineator posts. There were 8.5 injuries and 10.5 crashes per million bicycle-km.

Morency, Luis and team (2013)[14]: Researched on crash rates on cycle tracks in the United States. They studied state adopted bicycle guidelines to determine whether cycle tracks (physically separated) were recommended, whether they were built and their crash rate. For the 19 US cycle tracks they examined, the overall crash rate was 2.3% per 1 million bicycle kilometer.

Hull and O'Holleran (2013)[4]: Has used a detailed template to benchmark the level of service provided to cyclist in six European cities. The methodology has been tested using an experienced and a novice cyclist to capture their perceptions of the design of the cycle infrastructure in these cities. The research paper identified one of the barriers to encouraging more cycling is the potential/ inexperienced cyclists perception of the safety, comfort, and continuity of the cycling network in the city.

Kristinsdottir (2015): Had study attitudes towards cycling in general. According to his study "travel behavior surveys all over the world indicate that access to transportation is most important factor influencing mode choice. In this research when asked from people about the benefits of cycling, the most common answer were that is save money on both on soil/gasoline and on owning and managing a car.

Greibe and Thomas (2016)[8]: Study is based on empirical data collected through video recordings at 8 different locations in Denmark. Two synchronised cameras covering the observational area on the cycle track are used for the video recording. The main objective of this study is to examine how widths of one-way cycle tracks in urban areas influence the behavior, flow and capacity of bicycle traffic. Traffic safety has not been a part of the project but is of course a direct offshoot of the subject.

Ekblad, Svensson and Koglin (2016)[1]: Studied concerning how different factors associated with bicycle planning influence then propensity to choose the cycle for transportation. It has been shown in research that the organization of transport and urban planning can have a positive or negative impact on planning on cycle.

Prasanna Desai (2017): Provide information about the kind of cycle infrastructure that is needed at each road of the road network in the city of Pune. There are number of key success factors that need to be applied to increase the success of cycling infrastructure in Pune.

- **Continuity:** Detailed design need to be include dealing with trees, lamp posts, bus stops and pinch points.
- **Footpath width:** Not only cycle track need to be wide enough, footpaths need to be designed for the existing actual use and flow of pedestrians to avoid that cyclists walk on the cycle track. If footpaths are full of obstacles pedestrians will walk on the cycle track.
- **Maintenance: Many** cycle tracks in Pune have not been maintained. It is essential that the PMC reserve an annual budget for the maintenance of cycling infrastructure in the city. This budget should increase when the total length of cycling infrastructure increases.

3. DATA COLLECTION

I did all my survey work on Chihat to Deva section of Itaunja Mahona Kumhrawa Kursi deva Chinaht road (MDR 88C), which length is 47 km. It is a main district road with 2 numbers of lanes. The survey has been done for to give practical relation in the research work and this purpose the first thing I did is two way classified survey of the road for 24 hours. Calculate the average speed of commercial vehicles, personal vehicles as well as two wheelers vehicles except cycle in mixed traffic. Study of average speed of commercial vehicles, personal vehicles and two wheelers vehicles based on algorithm that there is no cyclist in mixed traffic.

3.1 Two-way classified traffic survey result

Table 1: Two way classified survey result

Types of Vehicles	No. of vehicles
Cars/ Jeeps/ Vans/ Three wheelers etc.	16,443
Buses	393
Trucks	741
Motor cycle/ Scooter	14,456
Animal Drawn vehicles	2
Cycles	5,863
Others (Tractors)	211

3.2 Average speed difference (Peak hour Vs Non Peak hour) for 10 KM

Table 2: Average speed difference (Peak hour Vs Non Peak hour) for 10 KM

Vehicles	Peak hour time (minutes)	Non- Peak hour time (Minutes)	Differences
Four Wheelers	13.21	12.1	1.20 m
Pickup	14.55	14.00	55 sec
Bus	16.5	15.4	50 Sec
Trucks	17.00	16.25	35 Sec
Two wheelers	12.41	12.28	13 Sec
Three Wheelers	19.37	17.28	2 m 9 Sec
Tractors	17.5	17.16	34 Sec

4. RESULTS

4.1 Average speed in peak hour (With cycle in mixed traffic) and non-peak hour (cycle is not in mixed traffic) for 1 hour

Table 3: Average speed difference

Vehicles	Average Speed in peak hr	Average Speed in non-peak hr	Differences
Four Wheelers	47km/hr	50km/hr	3km/hr
Bus	36.5km/hr	38.5km/hr	2km/hr
Trucks	35.5km/hr	37km/hr	1.5km/hr
Two wheelers	48km/hr	49km/hr	1km/hr
Tractors	34km/hr	35km/hr	1km/hr

After calculating the average speed of different types of vehicles, now calculated the fuel consumption for 1 hour for 1 vehicle in peak hour and non-peak hour.

4.2 Fuel Consumption Cost for 1 Hour (for 1 vehicle)

Table 4: Fuel consumption cost for 1 hr

Vehicles	Cost for peak hour (Rs)	Cost for non-peak hour (Rs)	Savings (Rs)
Four wheeler	261	243	18
Bus	496	435	61
Truck	598	503	95
Two wheeler	65	64	1
Tractor	385	297.5	87.5

4.3 Fuel Consumption Savings for 1 day

Table 5: Fuel consumption cost for 1 day

Vehicles	No. of vehicles in 24 hrs	Saving in 1 hr (Rs)	Total Savings (Rs)
Four wheelers	16443	18	18*16443= 295,974
Bus	393	61	61*393= 23,973
Truck	741	95	95*741= 70,395
Two wheelers	14,456	1	1*14,456= 14,456
Tractors	241	87.5	87.5*241= 21,087.5
		Total savings	**Rs. 425,885.5**

The total saving by fuel consumption for one day for all type of vehicles is Rs 425,885.5 by this calculation we can calculate total saving by fuel consumption for one year and that is 365*425,885= Rs 155,448,207.5. Assumed 1% of total fuel consumption due to that road and that is equal to Rs. 1,554,482.

4.4 Saving From Accident

Due to traffic congestion, according to police records there were total 53 accidents happened on this particular road in last year i.e. 2019. In this, some were minor accidents and some were major and there were 4 two wheelers, 5 four wheelers, 2 buses, 3 trucks and 3 tractors was damaged and total 2 people died in road accident on this particular road. For repairing cost, some garages were visited and data were collected for different vehicles and according to data, the average cost for repairing vehicles are, for two wheelers; Rs. 14,322, for four wheelers; Rs. 70,133, for buses Rs. 128,750, for trucks; Rs. 151,000 and for tractors; Rs. 58,750. One person loss is estimated as Rs. 1,000,000.

Table 6: Total repairing cost for vehicle

Vehicles	No. of vehicles damaged by accident in 2019	Average repairing cost for 1 vehicle (Rs)	Repairing cost for total damaged vehicles as per data (Rs)
Two wheelers	4	14,322	4*14,322= 57,288
Four wheelers	5	70,133	5*70,133= 350,665
Buses	2	128,750	2*128,750= 257,500
Trucks	3	151,000	3*151,000= 453,000
Tractors	3	56,600	3*56,600= 169,800
		Total saving	**Rs. 1,288,253**

There are 2 people died in 2019 in accident due to traffic congestion and one person loss is estimated Rs. 1,000,000 then total cost due to accident is Rs. 1,288,253+ 2,000,000= Rs. 3,288,253. It would be saved if there were no congestion on the road.

4.5 Costs due to air pollution

The study revealed that an estimated 4,127 people has been died annually in the city due dieses caused by air pollution. We can assume a total 2 people has been died due to air pollution at Itaunja-Mahona-Kumhrawa- Kursi-Deva-Chinahat road annually. It is estimated Rs. 10 lakh for one-person loss. Doctors at KGMU maintained that the number of patients with problems due to air pollution had jumped by 30%. Now the patient number is 325 per day. Assume that total number of patient annually suffering health issues due to that road is 182. Estimated Rs. 40,000 for treatment for one patient suffering health issues due to air pollution.

Table 7: Cost due to air pollution

Caused	No. of person (Yearly)	One person cost (Rs)	Total cost (Rs) (Yearly)
Died	2	1,000,000	2,000,000
Illness	182	40,000	7,280,000
		Total	**Rs. 9,280,000**

4.6 Tear and Wear Cost

The total tear and wear cost is calculated as Rs. 388,600 with there were no congestion on the road and Rs. 829,000 with there were congestion on the road. The value of tear and wear cost due to congestion is Rs. 829,000- Rs. 388,600= Rs. 440,600

4.7 Costs Due TO Time

Rs. 9,000 average monthly income estimated of a person working 8 hours daily. After analysis of data it come Rs. 1,620 for all four wheelers for 1 day. For buses it come Rs. 1,350, for trucks Rs. 1,110, for two wheelers Rs. 675 and for tractors Rs. 900. Total cost for one day is Rs. 5,655. For one year for all vehicles the cost due to time is Rs. 37,965,420.

4.8 Cycle Track Construction Cost

Let assume if we are estimating the cost of construction of one kilometer long and 2 meters wide cycle track. This track has 15 cm base of cm size stone boulders

Total cost estimated for 1 km construction of cycle track = 1,678,760
Estimated cost of construction of cycle track for 10 km= 10*1,678,760= 16,877,600

4.9 Total Cost Saving Due To Different Reasons

Table 8: Total savings

Factors	Savings (Rs)
Fuel consumption	1,554,482
Accidents	3,288,253
Wear and tear	440,400
Time	37,965,420
Total	**Rs. 43,248,555**

Estimated cost of cycle track for 10 km in one side= Rs. 16,877,600
Estimated cost of cycle track for 10 km for both sides= 2*16,877,600= Rs. 33,775,200
Net Profit Due To Cycle Track= 43,248,555- 33,775,200= Rs. 9,473,355

5. CONCLUSION

In the present world, the congestion of the traffic is increasing and therefore there are a lot of scopes for research in this field since with growing congestion it requires for improvements. This paper is not concerned with any designing aspect of cycle track, only estimated cycle track cost. India and the world are suffering with major traffic congestion mainly in urban areas. Traffic congestion had led to greater loss to country economy. With increasing people, the use of vehicles also increasing, be it via public transport or personal transport modes. The construction of cycle track in urban areas benefits in so many ways. It increases motor vehicles average speed, it saves time for automobiles commuters, it reduces pollution, reducing wear and tear etc.

It is the first step towards the Improvement of highway capacity due to cycle track in urban area. It is seen from the survey that if a cycle track construct on a highway, it can increase the average speed of four wheelers for 3 km per hour in Lucknow. According to survey it can increase the average speed of buses for 2 km per hour and trucks for 1.5 km per hour. It is seen from the survey that for covering of 10 km distance with cycle in mixed traffic and cycle is not in mixed traffic, four wheelers, buses, trucks, two wheelers and tractors takes 2 m 20 sec, 50 sec, 35 sec, 13 sec, 34 sec more average time with cycle in mixed traffic as compared to there is no cyclists in mixed.

India is going to face a lot of problems due to traffic congestion in future. The officials and government should try to avoid this problem to measure some steps and constructing cycle tracks in urban areas is one the solution. It is also good for health and it can any income group if they feel safe to ride bicycle and other hand it is beneficial for motor vehicles and traffic congestion.

Traffic congestion is frustrating in so many ways according to this study. According to this research the wear and tear cost also increases due to congestion of traffic, leading to more frequent replacement and repair as compared to those roads where traffic congestion in negligible. Therefore the cycle track option should be adopted at least on those roads where traffic congestion is regular. Total expenditure for the construction of 10 km of cycle track on both sides of the road is Rs. 33,775,200 and total benefit from various factors due to cycle track is Rs. 43,248,555 per year. Net profit due to cycle track is Rs. 9,473,355 per year.

6. FUTURE SCOPE

Based on this study and findings, it is believed that the better analysis can be done on those roads where there traffic capacity is more and can derive an arithmetic formula.

- The relation between the increasing in average speed of vehicles due to no cycle in mixed traffic could be done with more traffic capacity.
- The average speed difference between cyclists in mixed traffic and no cyclists in mixed traffic could be done for far distance for more accurate result.
- The exact pollution emission due to traffic congestion on a specific road could be calculated.
- A deeper study can be adopted for deriving an arithmetic formula.
- The result has been made from less number of data due global pandemic COVID19, hence for further research purposes, more data can be used.

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