Study to Shift From Motorised to Non-Motorised Transport – A Case of Nashik City.

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Abstract- With the aim to reduce the adverse environmental impact caused due to the urban transportation system, an alternative solution is identified. Non-motorized transport is the most relevant alternative for low-carbon mobility. It not only helps in the city's sustainable development but also helps reduce traffic problems and improve one's health. In India and in foreign countries, the government is taking initiatives to promote Non Motorised Transport (NMT) and funding the project to come into operation. In most of the surveys, the solutions are given for improving NMT infrastructure, but from the literature, a gap is found that only improving the infrastructure is not important, instead at first it is important to recognize the actual need as to where we need to develop infrastructure, secondly recognizing the potential trips and then proposing infrastructure respectively. There is no study done on the potential trips that could be converted to NMT with reference to Nashik City. This research aims to study the mobility plan of the Gangapur road area of Nashik city and identify the potential trips of such area which can be shifted to non-motorised transport. The survey includes the study of daily trips taken by people for various activities, which caters to all age groups. The study also includes an understanding of the trip length, alignment of the roads, and important commercial and institutional zones in the area. A thought is also given for redesigning Public Bicycle Sharing System in the study area for the maximum usage of the system. A module is proposed after an analysis of the survey and the existing transportation plan. A plan representing the module and indicating the potential trips that can be converted to non-motorised transport is proposed.

Keywords – **NMT, Walk, Bicycle, Sustainable, PBS.**

1. Introduction

The transportation sector in India is given primary importance. Many schemes are made and major fundings are raised. GDP of any country is directly propotional to the increase in no of motorised transport **[13]** hence, it is rapidly growing and contributes up to 6.4% to the

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GDP of the country **[1]**. Motorised transport contributes upto 10% to 15% of total Co2 emission **[1] [8]**. NMT is a sustainable mode of transport with less emission of carbon, minimum energy consumption, and cost-effective. It mainly includes cycling, walking, and the cycle rickshaw. NMT is the safest mode of transport if proper infrastructure is provided for it. If a convenient and safe environment is created for Non-Motorised transport its modal share will increase which will even helps in increasing the modal share of public transport **[4]**. NMT is a pocket-friendly mode of transport, hence, the LIG people prefer NMT. Nowadays, due to increasing urbanization, urban sprawl is increasing and hence resulting in adverse environmental impact **[2]** thus, the use of NMT has become very important as it has less carbon footprint and less energy consumption. With the rise of pollution levels in our country NMT is mandatory in cities. It is said that time required by car >bike>NMT, therefore if proper infrastructure is provided NMT takes the least time to cover a trip **[10]**. There is an increase in the number of vehicles and hence no space to increase the road width, hence, it is found that there are many casualties happening due to motorised vehicles, there is a direct relationship between primary functional land use and casualties **[3] [9]**, use of NMT prevents casualties. Up to a distance of 3.5km, NMT is the best mode of transport **[11]**, but the willingness to use NMT decreases after 3km **[12]**. Awareness of the benefits of NMT should be created because a positive perception of an individual regarding NMT is directly proportional to travel behavior of an individual **[5]**. The national urban transport policy (NUTP) 2014, states that NMT should be given first preference in urban transportation planning **[6]**. Due to the enlightenment given to NMT through government policies and people's positive approach towards saving the environment, people are engaging in using NMT and hence many NMT projects are proposed in different cities.

Nashik being a developing city is developing in every aspect which also includes the transportation sector. The registration number of motorised vehicles (MV) has gone from 7,32,002 to 20,62,851 from 2016 to 2023 respectively **[14] [15]**. The rise in motorised vehicles results in rise of pollution level which is harmful to nature. The number of accidents are growing at the average annual rate of 6.9% **[14]**. Due to the rise in MV traffic congestion is also growing day-by-day. Hence, the city needs sustainable transport planning. NMT, being the best alternative for sustainable transport planning, can be helpful for the city.

2. Objectives of the Study

The objectives of the Research paper are given below –

- To study the policies/standards/guidelines/norms in the field of non-motorized transport in Indian and Foreign contexts.
- To study the streets, and travel patterns of the study area and find out the willingness ratio of people and potential trips that can shift towards Non-Motorised Transport.
- To propose a comprehensive plan where NMT acts as a first and last-mile connectivity linked to public transport.

3. Scope of the Study

The scope of the study includes reading various research papers and understanding the NMT scenario in various areas of the world. To study the National Urban Transportation Policy (NUTP) and NMT manual for existing opportunities for NMT and the planning norms for the same. Carrying out a survey through a Google form, for learning the willingness ratio of the people to shift towards NMT and the barriers which are stopping them to shift towards NMT.

4. Methodology

The methodology of the project is done in three parts. a) Various research works, case studies, and policies related to NMT are being studied. A basic scenario regarding NMT all over the world is studied. The NUTP of India which promotes the development of the NMT infrastructure is studied. With the understanding of the literature, further research is done. b) In the second part opinions of people are taken into consideration with the help of a questionnaire. First different road activities of the study area are identified. Further with the help of survey the travel patterns and the trip length carried by a single in a day are calculated. To support the research the willingness ratio to shift towards NMT is also recorded. The survey is done with all age groups. c) In the third part, the road network of the study ares is studied, and considering the first and third part of the methodology, pivot table analysis is done for analysing the data collected and a physical plan is prepared which will highlight the potential trips that can be shifted to NMT.

5. Study Area

The selected study area is located in the west direction of Nashik City. With an area of 0.91 sq. km and a population of 10,586 people [7], the area is moderately populated. The population here includes HIG, HMIG, and LIG people. The area consists of, (a) Mixed-used buildings - commercial on the ground floor where classes are held, grocery and other shopping is done, and residential on the above floors, (b) Three institutional buildings and two crowded vegetable marketplaces which attract people from around a 2km radius. (c) Jogging track which is extensively used by the public. The area is linked to Gangapur Road, which connects the old city, college road, the gangapur dam road and all the hotspot locations. Gangapur Road is one of the route of city link bus. Maximum use of the motorised vehicle is seen in this area, for all kinds of trips (short and long trips), observing that the people here are educated and sensitive towards nature hence, with the help of various parameters, its is observed that in this area there is a scope of converting the motorised transport trips to non-motorised transport.

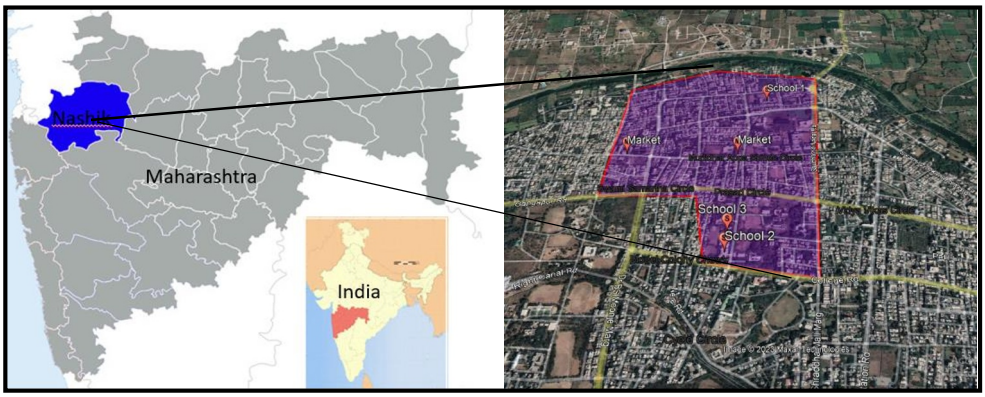

Fig. 1. Location Map of the Site. Source: nrhm.Maharashtra.gov.in, Google Earth.

6. Data Collection & Analysis

6.1 Population Calculation and Sample Size Population

Figure 2 highlights ward no 10 in pink delineated area with the population of 31,991 [7] and area of 2.72 sq. km. [7]. The population density of the area is 11,762. The yellow highlighted area represents the study area with an area of 0.91 Sq.km and hence according to the population density, the population of the study area is 10,586.

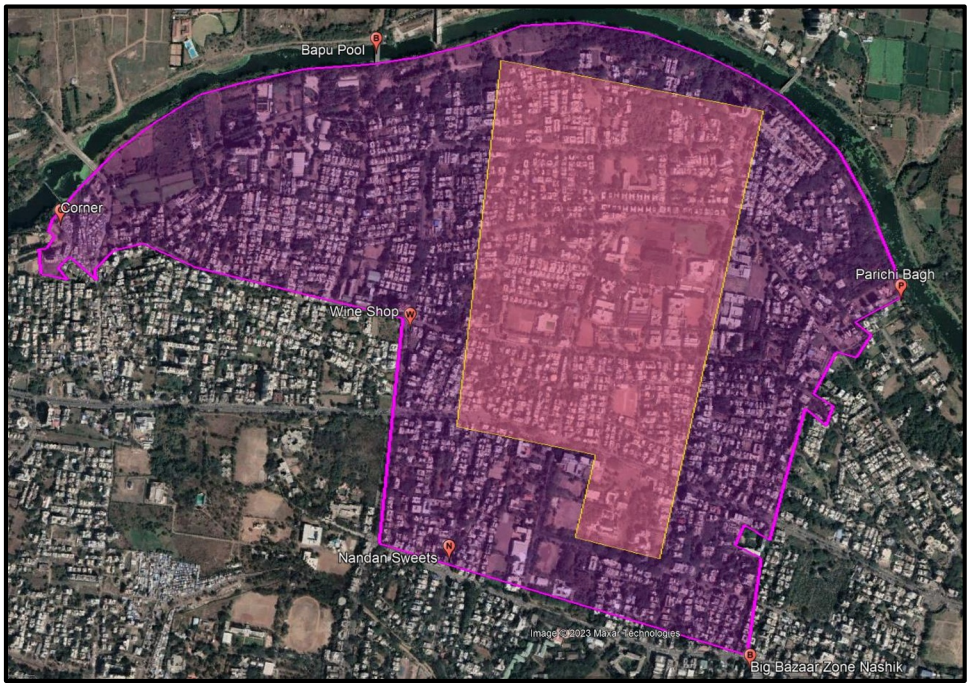

Fig. 2. Map showing ward no 10. Source: Google Earth.

Calculating the Sample Size Population of the study area =
Sample size formula: n = [z2 * p * (1 - p) / e2] / [1 + (z2 * p * (1 - p) / (e2 * N))]

Where: z = 1.96 for a confidence level (α) of 95%, p = estimated proportion, N = population size, e = margin of error.

z = 1.96, p = 0.5, N = 10586, e = 0.1
n = [1.962 * 0.5 * (1 - 0.5) / 0.12] / [1 + (1.962 * 0.5 * (1 - 0.5) / (0.12 * 10586))]
n ≈ 96

The sample size (with finite population correction) is equal to 96.

6.2 Data Collection

Primary data is collected from the residents of the study area. The method used for the collection of data is the questionnaire survey which includes various parameters like age, gender, occupation, trip lengths, willingness to shift towards Non Motorised transport, etc. Total 117 responses were collected for the same. Various conversations were held with the

residents of the area regarding the idea of Non Motorised transport. Following are some pie diagrams and graphs of the data collected.

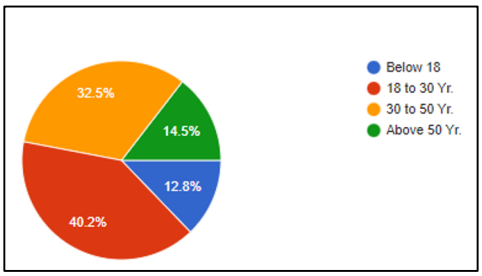

Fig. 3. % count of different age groups.

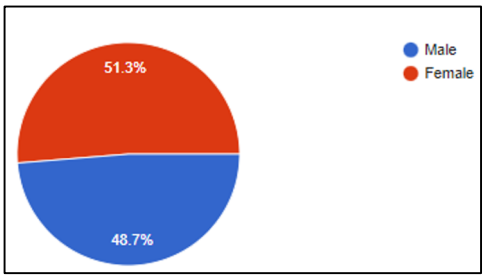

Fig. 4. % count of different Gender

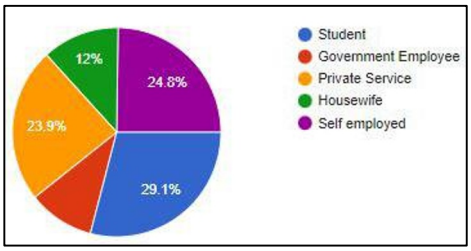

Fig. 5. % count of different Occupations.

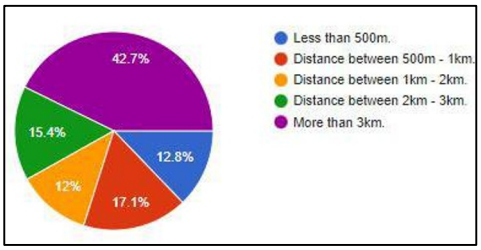

Fig. 6. % count of trip length.

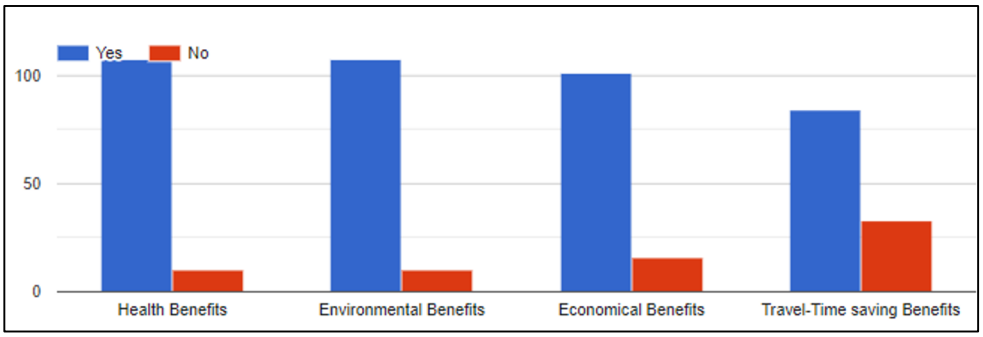

Fig. 7. Awareness ratio of various benefits of NMT.

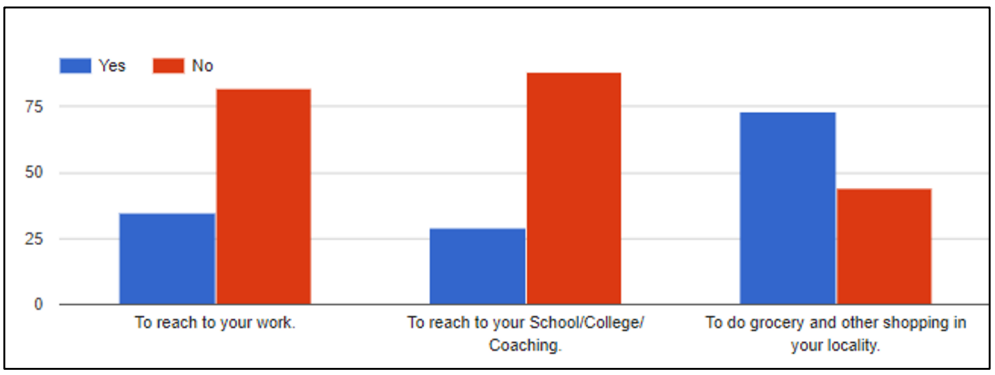

Fig. 8. Ratio of usage of NMT for various daily activities.

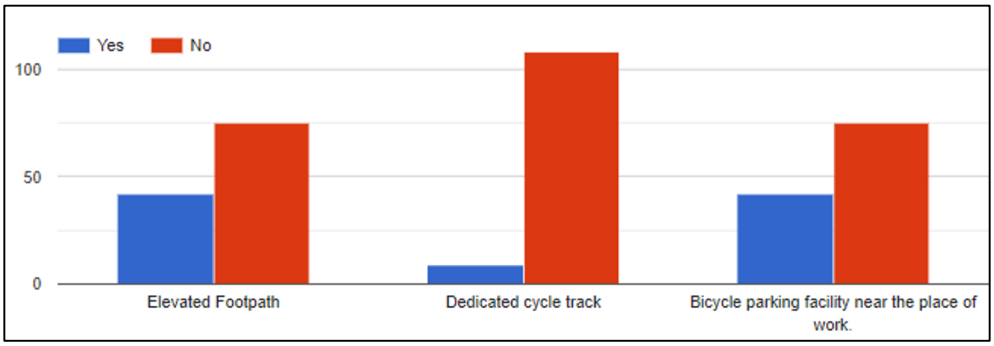

Fig. 9. Infrastructure Availability in the area.

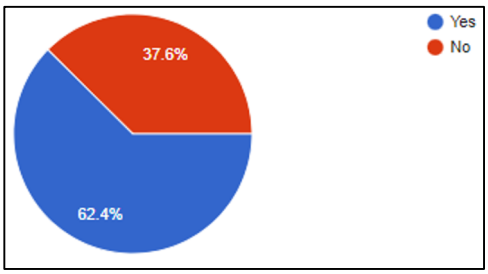

Fig. 10. Ratio of people using PT.

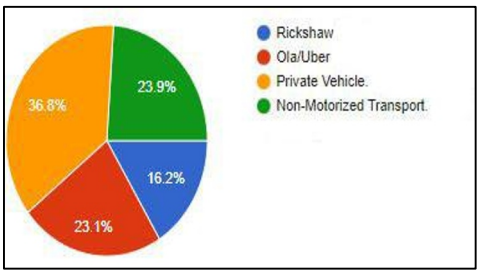

Fig. 11. % count of people reaching till PT.

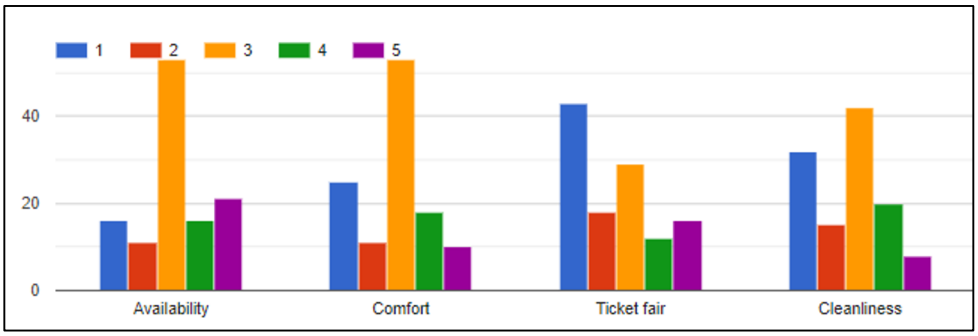

Fig. 12. Rate chart for Public Transport Services.

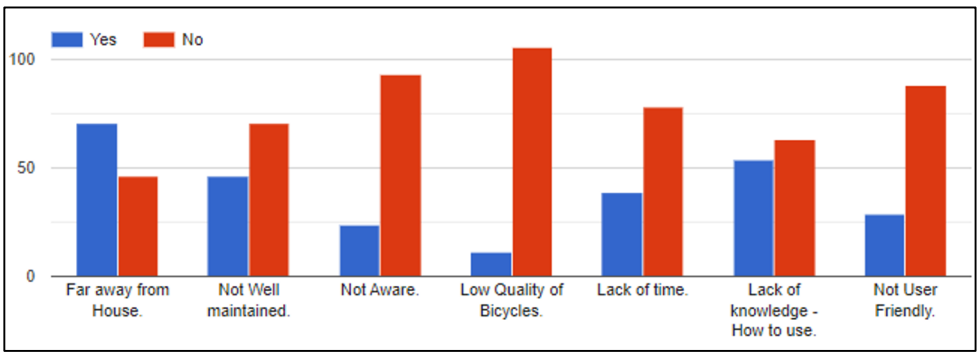

Fig. 13. Barriers stopping people from using Public Bicycle Sharing System.

6.3 Data Analysis

The data of different perspectives of people regatding NMT, its benefits, the percentage of people using NMT and existing NMT infrastructure is collected in Data Collection. Adding to it the percentage of peoplr using public transport and its linkage with NMT is also recorded in the Data collection.

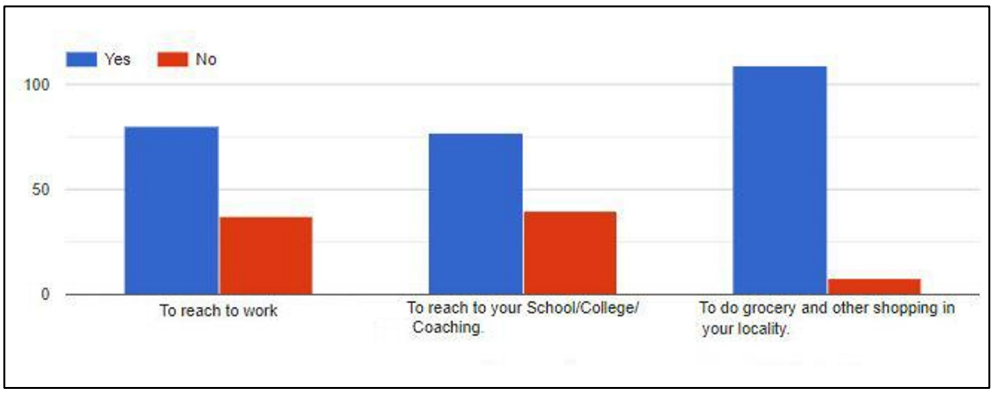

Fig. 14. Willingness Ration of People to Shift towards NMT after improving NMT infrastructure.

Fig 14 shows that 88.9% of the people are willing to shift towards NMT. A detail understanding about the different categorise of people willing to shift towards NMT is needed for a proposal to be designed. A cross analysis is done considering two most important parameters- age and travel distance, Cross analysis is done using pivot table analysis. Below are the tables and their explanation for pivot table analysis.

Age	Do you use Non-Motorized Transport?						Will you use Non-Motorized Transport if Proper infrastructure is provided?					
	To reach to your work		To reach to your School/College/Coaching.		To do grocery and other shopping in your locality.		To reach to your work		To reach to your School/College/Coaching.		To do grocery and other shopping in your locality.	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Below 18 Yr. **(12.82 %)**	3.42%	9.4%	5.98%	6.84%	7.69%	5.13%	7.69%	5.12%	12.82%	0	11.9%	0.85%
Between 18 to 30 Yr. **(40.17 %)**	11.11%	29.06%	9.40%	30.77%	24.79%	15.38%	27.35%	12.82%	27.35%	12.82%	37.61%	2.56%
Between 30 to 50 Yr. **(32.48%)**	11.11%	21.37%	7.69%	24.79%	19.66%	12.82%	23.93%	8.55%	23.93%	8.55%	30.77%	1.71%
Above 50 Yr. **(14.53%)**	4.27%	10.26%	1.71%	12.82%	10.26%	4.27%	10.26	4.27%	10.26%	4.27%	12.82%	1.71%

Table. 1. Before and After the improvement of infrastructure % of people using NMT, Age as a parameter.

Table No. 1 demarcates the percentage of usage of NMT before and after the improvement of infrastructure with respect to different age groups. 3.42%, 5.98% and 7.69% of children below the age of 18 use NMT for work, school and shopping respectively. 4.27%, 6.84% and 4.21% of children are willing to shift towards non motorised transport respectively if proper infrastructure is provided. Similarly, for age 18 to 30, 16.24%, 17.9% and 12.82% of people can shift from motorised to non motorised transport for work, school/college and

grocery/other shopping respectively if proper infrastructure is provided. Age group between 30 to 50 is also willing to shift towards NMT by 12.82%, 8.55% and 2.56% for work, school/college and grocery/other shopping respectively. Similarly, for age above 50, 5.99%, 8.55% and 2.59% of people can shift from motorised to non motorised transport for work, school/college and grocery/other shopping respectively if proper infrastructure is provided. According to the analysis people with age group more than 50 are willing more to change towards NMT than people less than age 50.

Distance	Do you use Non-Motorized Transport?						Will you use Non-Motorized Transport if Proper infrastructure is provided?					
	To reach to your work		To reach to your School/College/Coaching.		To do grocery and other shopping in your locality.		To reach to your work		To reach to your School/College/Coaching.		To do grocery and other shopping in your locality.	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Less than 500 m. **(14.5 %)**	5.98%	8.54%	6.83%	7.69%	9.45%	5.05%	11.96%	2.56%	12.82%	1.7 %	13.36%	1.14%
Distance between 500m to 1km. **(16.2 %)**	8.54%	7.69%	5.98%	10.25%	9.85%	6.35%	10.25%	5.98%	11.12%	5.12%	16.2%	0.9%
Distance between 1km to 2km. **(12%)**	5.12%	6.83%	5.12%	6.83%	8.0%	4%	10.25%	1.7 %	10.25%	1.7 %	10.59%	1.41%
Distance between 2km to 3km. **(41.9%)**	5.98%	9.4 %	5.98%	9.4 %	5.34%	36.56%	11.12	4.27%	11.12%	4.27%	36%	5.9%
More than 3km **(14.5%)**	0	14.5%	1.02	13.48%	5.25	9.25%	3.38%	11.12%	4.92%	9.58%	6.27	8.23

Table. 2. Before and After the improvement of infrastructure % of people using NMT, Trip length as the parameter.

Table No. 2, demarcates the percentage of usage of NMT before and after the improvement of infrastructure with respect to trip length. According to the table, the analysis shows a v high willingness ratio of the people covering a distance of up to 3 km. 3.38%, 3.9%, and 1.02% of people covering distances of more than 3km are willing to shift towards NMT. There is a high scope of people opting for NMT below 3km of trip length.

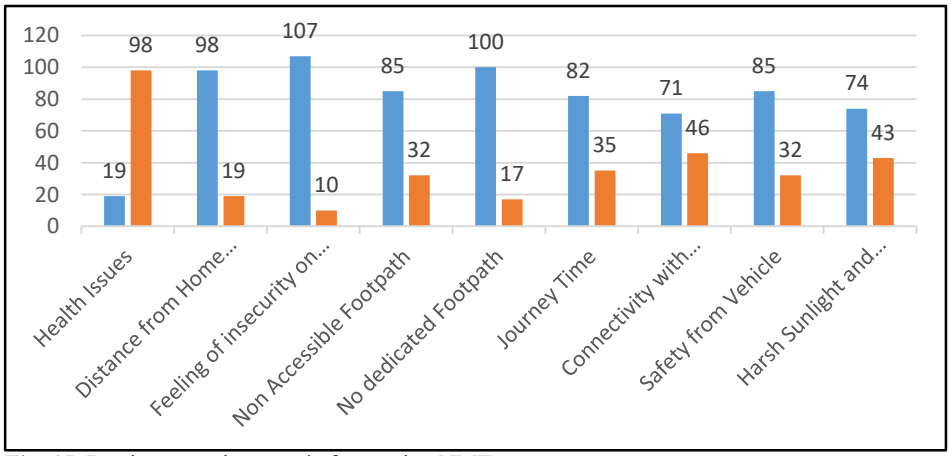

Fig. 15. Barriers stopping people from using NMT.

Figure 15 shows us the barriers stopping people from using NMT. The biggest barrier the people have marked is feeling of insecurity on footpaths, this barrier is 93% marked by female. The footpath situated along the primary road i.e. Gangapur road is usually covered by rickshaws and car parking because of which, the person walking on the footpath is not visible by people on the road which creates a feeling of insecurity and hence people end up walking on the road. The second biggest barrier marked is distance from home to public transport, the bus stand is located at maximum distance of 1.5 km in the study area, but due to lack of footpaths and less safety from vehicles people usually tend to drive till bus stop or take a rickshaw or cab to reach the bus stop. Harsh Sunlight and temperature is also a barrier, some paths of the study area are covered by trees but many are not, hence we come in direct contact with sunlight which makes it difficult for people to walk.

7. Proposal and Discussion.

7.1. Identification of Potential Trip.

Figure 17 shows the plan of the delineated study area. The red border demarcates the study area. The red highlighted portion demarcates the institutional zone and the pink highlighted area demarcates the market area, rest of the area is a residential area with commercial shops on the ground floor. The path demarcated from point A to B is 1.2 km, there is no public transport available in that area, whereas it is available along the blue demarcated pathway, so to reach from point A to B 16% of people hire a rickshaw, 36.8% of people use their private vehicle, 23.1 % people hire an ola and 23.9% of people walk. Hence, the trips covered from point A to B have the maximum potential to shift towards NMT. If a proper pathway is designed for walking the distance will also seem to be less. Similarly point C to point D has the potential trip that could be converted to NMT as it includes a big institutional campus and a big crowded marketplace.

Fig. 16. Proposal Plan 1 – Potential trips that could be converted to NMT.

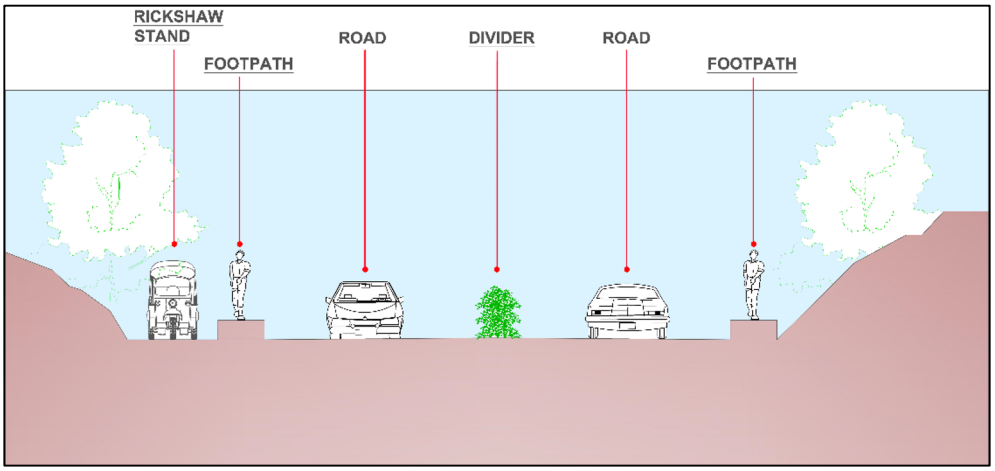

Fig. 17. Proposal Elevation – Proposed Footpath and Rickshaw Stand/Parking Location.

Supporting this, the blue delineated path consists of the footpath, but the footpath is always covered by rickshaws and car parking due to which a feeling of insecurity is generated while walking on the footpath and hence a maximum number of people don't use this footpath. In this case, while replanning we can plan the road section in this way, footpath on the left side of the road, followed by parking on the left side of the footpath, as shown in figure 17. This will ease the footpath access and even the car will be parked safely and it will be a dedicated lane for parking and rickshaw.

7.2. Redesigning Public Bicycle Sharing System.

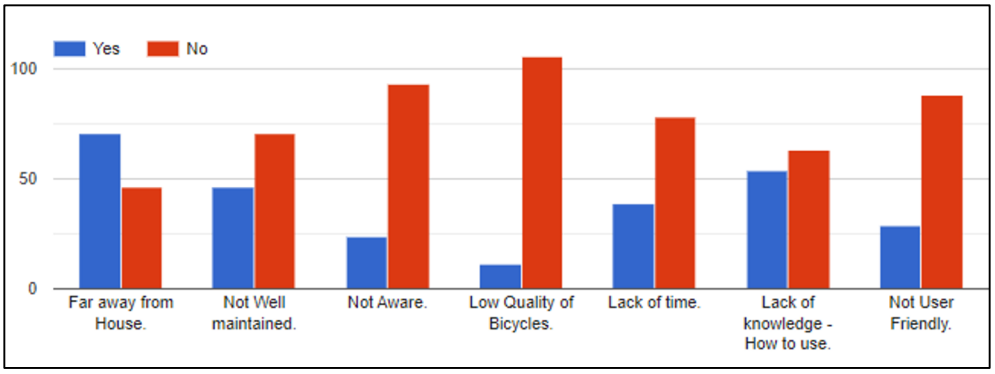

Fig. 18. Barriers stopping people from using PBS.

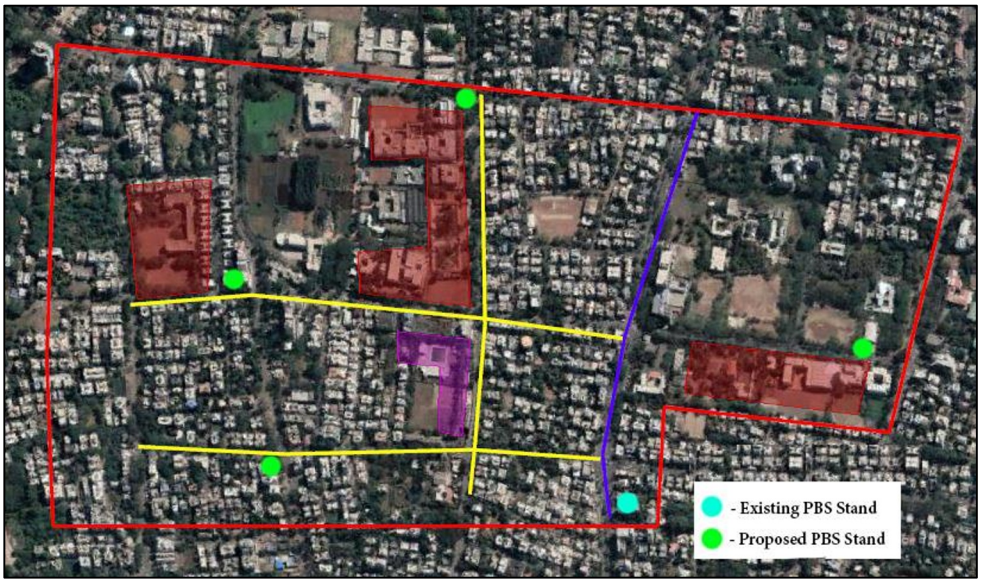

Fig. 19. Proposal Plan 2 – Proposed new PBS stand.

Figure no 18 shows us that due to lack of time, lack of awareness, lack of knowledge, and the PBS stand located far away from the house, maximum number of people did not use it. While having conversations with people it was found that people want such services near their houses so that they can easily access it or use it in emergency cases, even they don't find ownership over it. In the proposal given (figure no. 19) instead of keeping a bunch of cycles at one spot, they can be split into four different spots which are in the core residential area. Each spot will have minimum two cycles. This will help in the easy accessibility of the cycles. In addition to this people should be made aware of the system either by sharing pamphlets or direct advertising at hotspot points like vegetable market, jogging track etc.

8. Conclusion

The study concludes that, there is a huge potential to shift towards non-motorised transport. Certain categorized trips can be converted to NMT. Specific barriers like age, trip length, comfort can come across and stop people from using NMT, but on the other hand now a days people are educated and sensitive towards the environment, hence they opt for sustainable approach with low carbon footprint. Identification of the potential trips is very important before bringing any plan into action. Every area needs to be studied at micro level and a comprehensive planning should be proposed considering the site conditions and people's approach towards NMT. Public bicycle sharing system not being a very successful project, but if the drawbacks are studied properly with existing site conditions and people's perspective about it, PBS can be redesigned and can be bought into action again.

Acknowledgment

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