iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5310

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

Bicycle Friendly Infrastructure's Potential Impact on Bicycling in Delhi-NCR

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Abstract: ***Bicycling is considered as one of the most efficient mode of sustainable transportation for shorter commutes. On the contrary, in India, modal share of bicycling is declining year by year. Although it is expected to be attractive option for short commute trips in India due to its extremely low cost of operation, studies have shown that it is not an attractive mode among commuter belonging to high and middle income group. Bicycle users in India are predominantly captive users such as lower income group people and students. In order to promote bicycling, development improvement of bicycle friendly infrastructure is highly essential. For a developing country like India, which depends heavily on imported fossil fuels for transportation, promoting bicycling for shorter commutes will have long term influence on its economy as well. This study aims to find the potential impacts of some of the bicycle friendly infrastructures and policies on urban Indian bicycling from the user perspective. A questionnaire survey was conducted in Delhi-NCR to collect data for this study. Using the collected data, an ordinal logistic regression model was developed to to rank some bicycle friendly infrastructures and policies based on public opinion. Bicycle Sharing Service and Dedicated bicycle lane was found to be the most preferred bicycle friendly infrastructures based on the public opinion and whereas facility to carry bicycle on public transportation was found to be the least preferred one. The findings from this study could be used by various policy makers and stakeholders to improve bicycling in their region.***
Keywords: Bicycle, Regression Model, Bicycle friendly infrastructure.

I. INTRODUCTION

India is the world's second most populated country with a population of 1.21 billion comprised of 2.4 percent of the world's surface area This is more than the population of USA. Urban population will be close to 600 million by 2031. Number of metro cities with population of 1 million and above have increased from 35 in 2001 to 53 in 2011 and is expected to increase to 87 by 2031. About 43 percent of the urban population of India lives in these cities (Census 2011).

Population Growth in urban areas is creating huge pressure on urban infrastructures thereby affecting the urban transportation sector. Most of the cities have been unable to meet the growing demand for an efficient transportation system. Present imbalance in modal split, inadequacy in transport infrastructure and its improper use can be considered as source of the main reason behind this situation. Unfortunately over past few decades public transport systems, bus services have not been able to satisfy the fast increases in demand. Intermediate public transport (such as autos, other three-wheelers and taxis) and personalised modes results in deteriorating public transport system, leading to traffic congestion. Increase in personal vehicle ownership due to economic boom in India The congestion in urban roads is increasing which is reversely affecting public transport system operations. Considerable decrease in modal share of non-motorized transport over the years has made the situation worse, adding environmental degradation with congestion problems. Studies show that cities around the world with high level of public transport, walking, cycling have less CO_2 emission rate.

II. LITERATURE REVIEW

A. Concept of Sustainable Transportation

This term refers to the modes of transport, and systems of transport planning, which are consistent with wider concerns of sustainability. There are many definitions of the sustainable transportation. The Council of Transport Ministers of the European Union adopted a more expansive definition of sustainable transport in April of 2001. This approach, an adaptation of an earlier proposal by the Centre for Sustainable Transport (CST) in Toronto, sees sustainable transport as a system that serves the purpose of basic access and development needs to be met safely and in a manner consistent with human and ecosystem health, and promises equity within and between successive generations. In the same this is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development, limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable

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resources at or below the rates of development of renewable substitutes while minimizing the impact on land and the generation of noise (Goldman and Gorham 2006).

B. Bicycle as a Sustainable Transportation

Bicycles are the most efficient mode of transportation(ICLEI 2001). They do not cause air pollution and place minimal burdens on natural resources, thereby become environmentally sustainable. Bicycles lower the public health care costs as bicyclists improve their health while biking. This is good for the bicyclist and for the community as well. Bicycles are typically appropriate in reducing the number of short trips up to five miles or so which constitute more than half of all driving(ICLEI 2001). However bicycles can also serve longer trips, if they are successfully combined with other urban transportation modes such as bus, rail, and ferry and in some cases on their own.

C. Determinants of Bicycling

It is quite clear that cycling presents a number of interesting advantages over other modes for society and an individual over other mode of transport. Besides having monitory and heath advantages, cycling can sometimes prove to be faster than other transport modes in urban areas and also allows cyclists to avoid traffic jams (Olde Kalter, 2007). Environmental sustainability (no direct emissions of pollutants, CO_2 or noise), cheap infrastructure requirements and improvements in public health remain to be some of the easily noticeable advantages for society (Olde Kalter, 2007). Cycling has a number of disadvantages also. It includesa greater physical effort, the difficulty of carrying loads while cycling, being at the mercy of the weather, and, outside urban areas, travelling more slowly than motorized transport. Factors such as physical effort and speed also limit the distance that a cyclist can travel. Policy-makers of different countries are showing increasing interest in encouraging cycling considering the social gain. Still little attention has been paid to cycling when compared with other modes of transport. But to develop sound policies that encourage cycling, understanding of determinants of bicycling is essential. Conventional knowledge on mode choice (models) is not sufficient for developing bicycle policies as characteristics of bicycle use are very different from the characteristics of car and public transport use (Heinen et al., 2010). For example bicycle use is influenced by factors such as the weather and the physical effort needed (Wardman et al., 1997). Although determinants of bicycling influences different forms of cycling differently, focus should be given on bicycling for daily commuting rather than for leisure or sport purpose as the former s more frequent and hence has much more impact on society.

D. Present State of Bicycling in The World

The European Union has officially recognized the importance of cycling as a practical mode of urban transport, generating environmental, economic, and health benefits(European Conference of the Ministers of Transport 2004). In most of the parts of USA, conception about bicycling is that it require special equipment, training, physical fitness, and the courage and willingness to ride it alongside motorized vehicles on streets without separate bike lanes or paths.

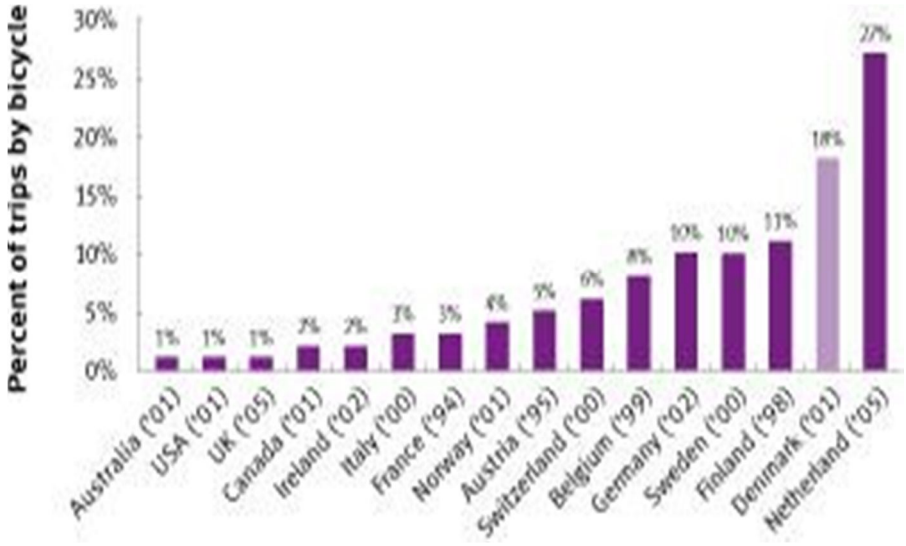


Fig no. 1

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E. Present State and Scope of Bicycling in Urban India

India is highly lacking in the context of presence of bicycle friendly infrastructures and policies. But modal share of bicycle in India though declining is typically 13 to 21 percent in medium and large cities and 6 to 8 percent in major cities (Tiwari & Jain, 2008) which in not that bad compared to global scenario and it must be noted that absolute numbers these are in millions. Bicycle ownership is 33 to 65percent (Census of India 2001 n.d.) in various cities and 44.8percent in overall India (Census of India 2011). According to NSSO data, 37.1 percent, 39.0 percent, 41.7 percent and 41.1 percent of household possessed bicycle in 1993-94, 1999-2000, 2004-05, 2009-10 in urban India respectively. Bicycle ownership among lower income groups has been higher than those in higher income groups(Ministry of Statistics and Programme Implementation - Government of India 2012). Though pedestrians are the major victims of road accidents, bicyclists contribute almost 5 to 10percent (20 to 30 percent of those are severe injuries) (Tiwari and Jain 2008). For 2001-05 in Delhi 10 percent of the accident victims were bicyclists (Mohan 2009). During a survey conducted in a major Indian city 18 percent of student bicyclists said they met at least one Accident (33.33percent carried injury) and 66 percent said they do not feel safe to ride bicycle again(Tiwari and Jain 2008). Bicycles are also not allowed in some major roads in many Indian cities (e.g. Kolkata). One more important aspect is that although there are bicyclists of various age groups in India but workplace and type of work determines bicycle ridership and it decreases rapidly with increasing income and literacy levels. There is ample opportunity to promote bicycling in India. Average trip distances in India are 5 to 10 kms. Persons having trip length up to 5 kms (which is 70 to 90 percent) can be the target group for promoting bicycling (Tiwari & Jain, 2008). Origins and destinations for bicyclists are almost same as those for motorists.

F. Analysing Impacts of an Infrastructure or Policy

Loo (2009) studied the opinion of people towards extension of a new railway line. Since it was done before the extension of the rail line, It was a stated preference survey in which people predicted their choice based upon certain attributes. They explained as to how the data of stated behavioural preference should be important for official patronage. They identified some 700 locations from road maps and after conducting feasibility studies, 586 of them were labelled as suitable but due to limited resources, finally a list of 50 locations was finalized.

Liern and Sheu (2009) studied the impact of an air crash on transportation mode choice of students. They initially planned to develop a travel choice model for the students of university who travel either by ferry or airplane to get to the mainland of Taiwan. They used a method of questionnaire survey and defined 20 variables based upon their survey and interaction with students. Later using factor analysis, they merged these 20 variables into 6 explanatory variables to be used in multinomial Logit model.

III. METHODOLOGY OF SURVEY

In this research work, questionnaire surveys were conducted to gather socio-economic information of commuters along with relevant information of their trips and their perspective about various bicycle friendly infrastructures, safety issues related to bicycling in their city. A questionnaire is a research or survey instrument consisting of a series of questions asked to respondents, and designed to extract specific information. It serves four basic purposes: to (1) collect the appropriate data, (2) make data comparable and amenable to analysis, (3) minimize bias in formulating and asking question, and (4) to make questions engaging. It was invented by Sir Francis Galton. Information is collected from a small number of people to be representative of a larger number of people. In this chapter, methodology behind the survey is discussed.

A. Survey Technique

In order to analyse the impact and effectiveness of any infrastructure or policy, it is important to gather information on conditions before and after the implementation. In this case, since any bicycle friendly policy or infrastructure is yet to be implemented (except in a small part of area in a very few India cities), only people‘s perspective about the possible policies or infrastructures can be collected.

To conduct the questionnaire survey, the best suitable method among the following needs to be chosen:

1) Visitor monitoring techniques e.g. mechanical counters
2) Observation
3) Interviews
4) Off-site survey (Web based, telephone, postal, interviewer-administered, self completion
5) On-site survey (Intercept interview, self-completion)

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B. Selection of Variables

Socio economic factors: Socio economic factors also play a key role in decision making of people.
For the purpose of this study, following factor could be collected:

1) Sex
2) Age
3) Occupation
4) Monthly Household Income

Safety and feasibility of bicycling captures the risk of a bicycle rider being killed or seriously injured during bicycling in the city. This also addresses how efficiently one can ride bicycle in his/her city so that he/she can reach his/her destination safely in time. In India, due to improper crash data collection methodology, the data available is of very poor quality. So in order to check the present conditions of Delhi-NCR with respect to bicycling, daily commuters can be asked about the safety and feasibility of bicycling in their city in the present day scenario as per their individual experience.

C. Questionnaire Design

Question order and design of the questionnaire is extremely important after individual questions have been formulated. While deciding the question order some common sense and a few general principle must be kept in mind like starting with easy, straightforward questions and putting difficult, sensitive questions towards the end. Keeping in mind the above mentioned policy, questions related to sex, age, occupation, access-egress trips, bicycle ownership can be asked in starting as they are easy, straightforward questions. The most important questions about bicycle friendly infrastructures which require people‘s judgement and opinion can be asked after these questions.

IV. DATA COLLECTION

After finalizing the techniques of survey and designing of the questionnaire for the survey, this chapter explains the detailed procedure of data collection for this survey. Actual conduct of survey was preceded by pilot survey and reconnaissance field visits.

A. Pilot Survey

Pilot survey is a preliminary piece of survey conducted before an actual survey to test the questionnaire and effectiveness of the research methodology, data collection method in practical conditions. This also helps to test the sampling procedures along with a more rigorous check on questionnaire design. In short, pilot survey is a brief preliminary survey or trial run of the survey, so respondents should be selected as intended for the main survey and distribution or interview procedures for the main survey should be followed. Response rate of 45 per cent was recorded without and with incentive respectively.

B. Reconnaissance Survey

After the successful completion of pilot survey, two reconnaissance survey field visits were done to identify the potential survey locations, finalize the timings of survey and to decide the dates of survey. Since the survey targets the people who are travelling, disturbing them during their commute may sometimes result in random choices just to fill out the form quickly, hence the survey location is a thing of importance. Following conditions were set while selecting the locations, dates, timings of the actual survey:

1) People from all categories listed in the questionnaire must be targeted equally.
2) People should be able to provide some time to fill out the form genuinely and not for the sake of filling resulting in random choices.
3) People should be able to understand and relate the terms and questions to their daily life.

C. Actual Survey Conduct

After successful pilot survey and reconnaissance trips, actual survey was conducted from 16/3/17 to 21/3/17 in areas where bicycle friendly facility are available e.g. Lodhi Road, Mandir Marg, Tilak Marg and Zakir Hussain Marg. Also the Off-site survey is also started from the same starting date but 1 month is taken for responses of the respondents .
Total of 200 People were Approached 100 during On-site and 100 by Off-site survey in which we get total 95 responses for further analysis. Data present in the forms was then converted into digital form using MS-excel. Various codes and symbols were used to systematically enter the data.

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V. DESCRIPTIVE STATISTICS

After the data collected from various areas were entered into spreadsheets, several observations were made from the data. Descriptive statistics helps to summarize the sample. Graphical explanatory data analysis techniques are often used to visualize the large amount of data collected. This helps to have a preliminary understanding of the data.

A Gender

While conducting the survey, it was observed than not many females were present at the survey locations compared to their male counterpart and the response rate among females was also very low. Out of 95 respondents, only 11 were females (13%) and rest 84 were males (87%).

B Age

Although efforts were made to get response from all age groups listed in our questionnaire, elderly people were not available for survey as we primarily targeted daily commuters of different occupations. Majority of survey respondents were in 18-30 and 30-50 age groups. Out of 95 respondents 48.4 % were in 15-25, 42.9 % were in 25-45 and the rest were in, <15 and >45 respectively. Fig no.2 shows the share of different age groups in survey population.

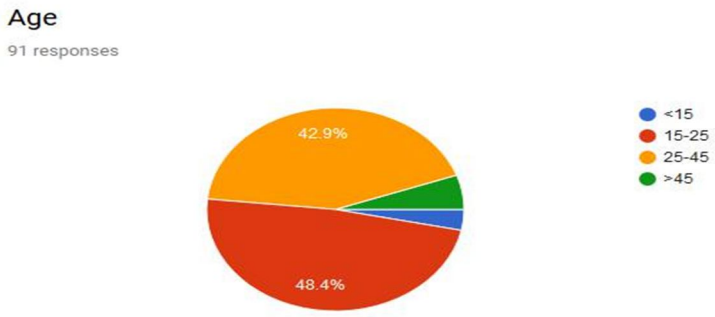


Fig no. 2

C *Income Level (Monthly)*

Majority of the respondents around 35.4 % were in <5000 income come group. Around 29. 3% were in 5000-25000 group. Table 5.2 shows the share of different income groups (monthly) in survey population.

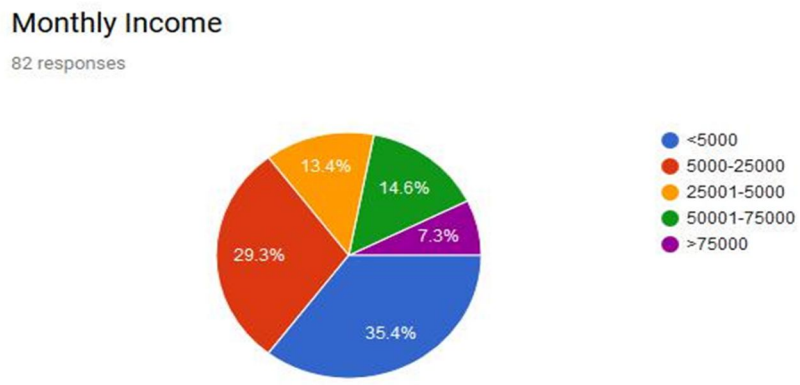


Fig no.3

D. Occupation

People from various common occupations listed in the questionnaire were targeted equally. Field worker consisted of medical representatives, sales man, post man etc. who have to travel a lot as a part of their job. They have a very busy schedule throughout the day. Response from people having occupations like security guard, liftman, housewife, doctor, driver, priest, rickshaw puller, unemployed and self employed people (doing some work for others), vendor etc. which was difficult to classify as per categories specified in the questionnaire were also recorded. Therefore, they were termed as others. Figure 4 shows the share of different occupations in survey population.

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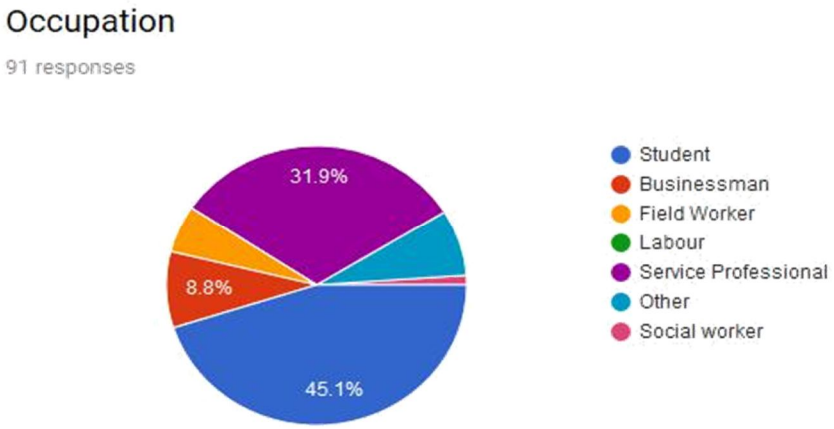


Fig no. 4

E. Transportation Mode Used

As stated in previous section, all commuters were targeted but more specifically efforts were made to get sufficient number of responses from Non - bicycle users. Out of 95 respondents, 14 were bicycle users. It must be noted that efforts were also made to make the survey population to be equally shared by all occupations and age groups listed in the questionnaire. Other major transportation modes used by survey population were motorized two wheeler (M2W), combination of walk and taxi/auto/tempo, combination of walk and bus, walk, combination of walk and other modes car etc. Figure 5 shows the share of different transportation modes used by survey population.

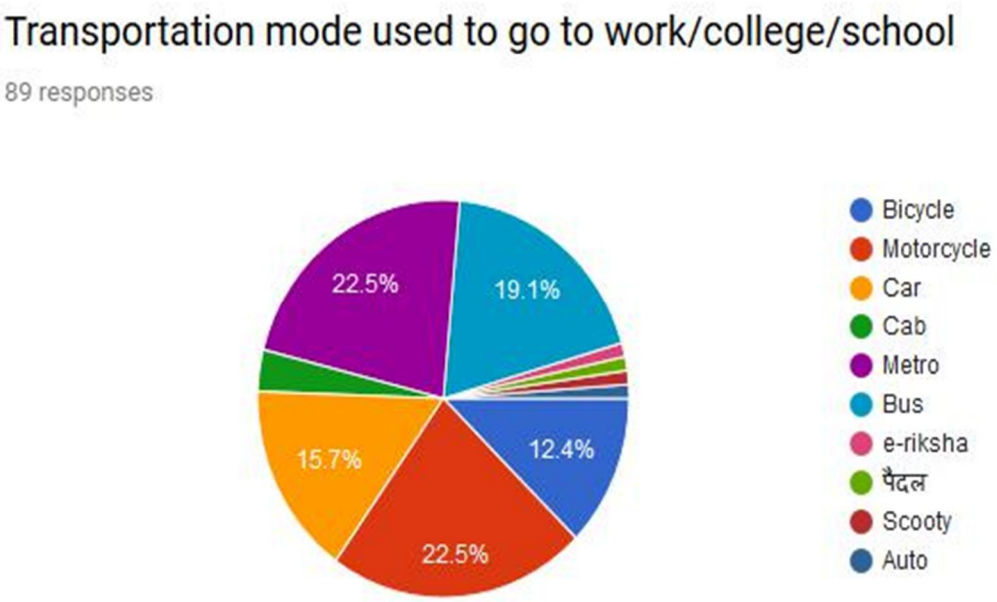


Fig no. 5

F. Ingress Mode Used

Majority of the survey population were using Rickshaw for ingress mode as the distance between the home and the mode which takes them towards the destination is not that close to be walked but some what more or we can also say that people think that walking takes more time that's why they take rickshaw. Figure 6 shows details about the ingess modes used by survey population.

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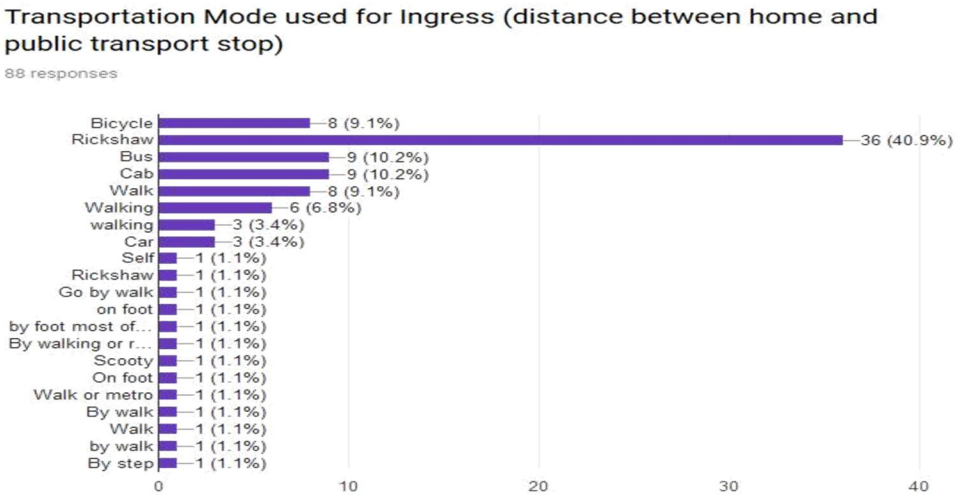


Fig no.6

VI. CONCLUSIONS AND SCOPE FOR FUTURE WORK

A. Conclusion

India with its large population and millions of bicycle users has a huge potential for becoming one of the top countries in terms of level of bicycling in the global context. Even without presence of any bicycle friendly infrastructures and policies as such, India has a considerable share of bicycle trips even more than some of the developed countries.

However, it is declining at a faster rate year after year due to the affordability of motorized vehicles and is becoming restricted only to captive riders such as lower income group people and students. This study also shows that age and perception about effect of bicycle on social status is not a factor for them as they do not have any choice to use other transportation modes. As safety concern regarding bicycling is very high in India, there is high chance that these people have will shift to other modes as soon as they could afford such change. This study also shows that income has statistically significant impact on bicycle ridership. High income group people are less probable to use bicycle than low income group people. Similarly, probability of choosing bicycling as a mode of transport decreases with increasing travel distance. However, limitation of the ridership model of this study lies in the fact that age, income and travel distance were not considered as continuous variable. Female participation in bicycling is also found to be far less than that of males. This type of situation is not at all sustainable. If steps are not taken immediately, situation could get worse and experience around the world shows the reverse transition is not that easy to attain. Attention must be given to maintain lower income group, kids and student ridership. Therefore, policy makers in India need take some urgent initiatives to promote bicycle in urban India across the country. Since policy makers are often bound by time and money constraints, this study may work as a guide for them to choose among their alternatives and prioritize them. Based on the results of this study, it can be concluded that dedicated bicycle lanes must be the given more importance than another infrastructure or policy to promote bicycling. In case when it is not possible to make all the roads favourable for bicycling, safety and congestion freeness should be compromised over travel time to some extent. Bicycle sharing service and policies like incentive for employers for using bicycle can act as a supportive measures to the before mentioned infrastructures.

Intersection modification must be done judiciously as public opinion in this regard is very much sceptical. Facility to carry bicycle on public transportation is hard to implement in a country like in India where amount of crowd in public transportation is very high.

B. Scope of Further Work

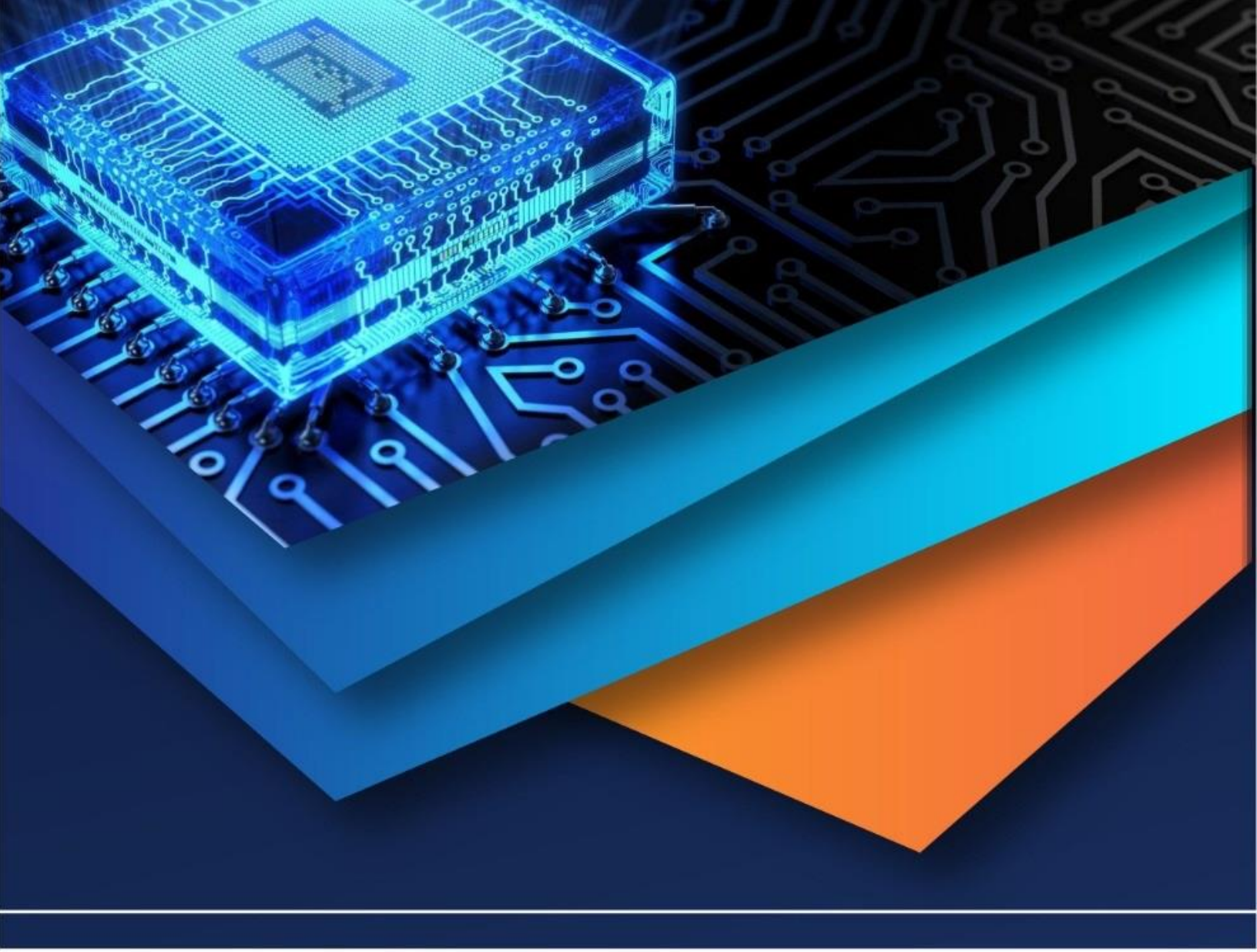
India is a vast and diverse country. Every Indian city has its own unique character. Therefore, separate study for each Indian city with larger database and city wise comparison may give interesting results. Moreover except some area in a few Indian cities, most of the Indian cities are yet to have any bicycle friendly policy or infrastructures. Hence this study was done by collecting only people's perspective about the possible policies or infrastructures. More studies could be done after implementation of such policies or infrastructures using actual ridership and other relevant data before and after the implementation. Such studies will give more realistic results. Bicycle ridership model can be improved by allowing interactions between explanatory variables used in this study or by introducing some more relevant explanatory variables.

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