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# Factors Influencing Non- Motorized Mode Choice: A Review

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**Abstract**— *Q* automobile travel by reducing traffic congestion and air/noise pollution. Their modal share is decreasing in developing countries day-by-day which is evident from the data collected by different organizations. At present, in most of the cities modal share of these modes is about 50 % and the same is expected to be around 30% in the year 2031. In this paper an attempt has been made to identify, classify the factors and also to show the differences between developing and developed countries in light of these factors which are likely to have a significant influence on non- motorized mode share. In addition, a review of works done by various researchers using these factors are also given.

**Keywords**— non-motorized modes, bicycle, walking, built environment, socio-demographic factors

## I. INTRODUCTION

Non- motorized trips constitute majority number of trips made by the population living in the cities of developing countries. Walking and cycling has been the dominant modes of non- motorized transport (NMT) in all countries over centuries before industrialisation took place. In the Asian cities which are generally known as “developing Asian cities”, after the Second World War in the 1960s the population started increasing rapidly and on the other hand with the rapid urbanization of cities, motorized vehicles came into picture. Coming to the present scenario of India the growth of motor vehicles increased significantly between 1951 and 2009 from 0.31 million to 115 million (Ministry of Road Transport and Highways, 2011). Statistics (CPCB, 2010) reveal that road transport sector alone contributes around 73% of total CO<sub>2</sub> emissions and the main reason for this is motorized vehicles which consume fuel, petrol and diesel etc. and other fact which is alarming is India ranks top in the road accidents which are increasing day by day with vehicular population growth. So it is clear that the transportation system which exists in India at present is not fulfilling the objectives of a sustainable transportation system in terms of mobility, safety, environmental criteria etc. and now it is important to look at an alternative that makes the present transportation system sustainable and among such alternatives NMT stands first due to the benefits they offer like flexibility, affordability by even low income groups, generates community benefits by increasing social interaction among people, helps to environment by reducing noise and air pollution and they utilize little road space which in turn causes a reduction in congestion. But from the figure -1 it is clear that unfortunately non- motorized vehicles (walking and cycling) modal shares in India started declining rapidly. As the city sizes are increasing, so the trip lengths and there by leading to rapid urbanization all over the world. Developed nations are moving towards a concept called “New Urbanism” in which all the activities are planned, in such a way that people can have easy access to public transportation and use NMT modes to reach their destinations. And it is desirable for developing nations too.

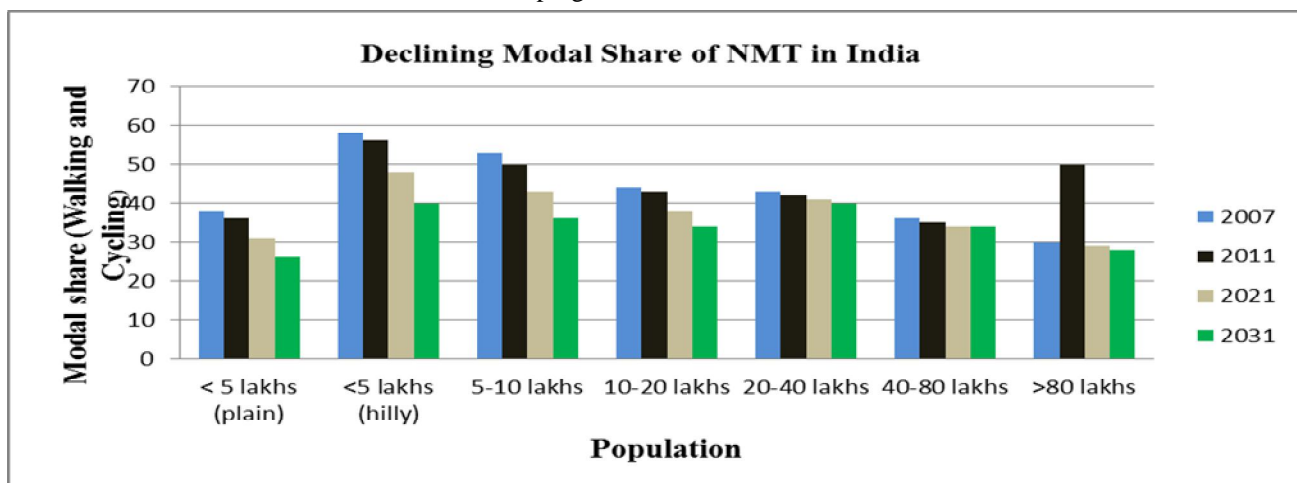


Fig. 1 Estimated Modal Share (% of trips) of Walking and Cycling in Indian Cities

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The differences between developing and developed countries regarding NMT are also included in addition as it is known that the share of NMT is increasing in developed countries which are revealed from the following figure 2.

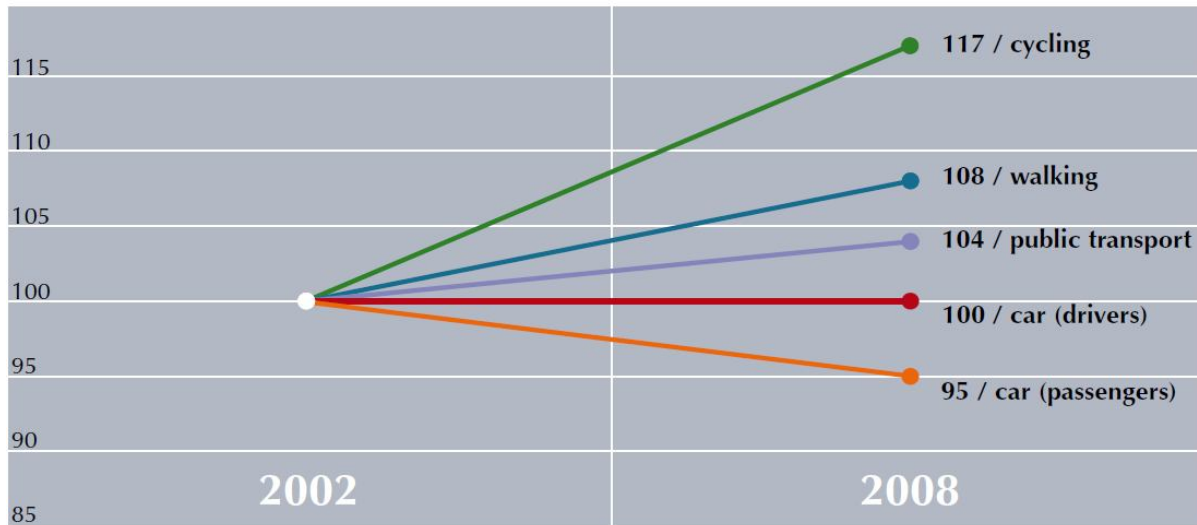


Fig.2 Increase in Modal Shares of Walking and Cycling in Germany from 2002 to 2008

One of the challenges at present India is facing is to boost up the NMT and the research issue is to identify the factors which are having impact on non- motorized modes. So the main objective of this paper is to identify the factors which are likely to have an influence on non- motorized mode choice particularly in the developing countries. Knowing these factors helps us in devising policies which are targeted to increase the NMT share. These factors are broadly classified into six types and are discussed in the next sections.

### A. Socio- Demographic Factors

These are the factors involving a combination of socio and demographic factors. In other words, these are the characteristics of a population such as age, education level, gender, income level, family type, vehicle ownership etc. These factors influence the commuter’s decision of mode choice, such as children and youth gives more importance to non- motorized modes whereas aged people may not prefer NMT due to the physical activity involved. Low income people who are not able to afford even public transit prefer the NMT modes. In case of people who are having high income with availability of car the probability of choosing these modes decreases and this trend is very common in developing countries. Figure-3 shows the variation of cycling share with income in Dhaka city and also reveals that Females prefer cycling less compared to males.

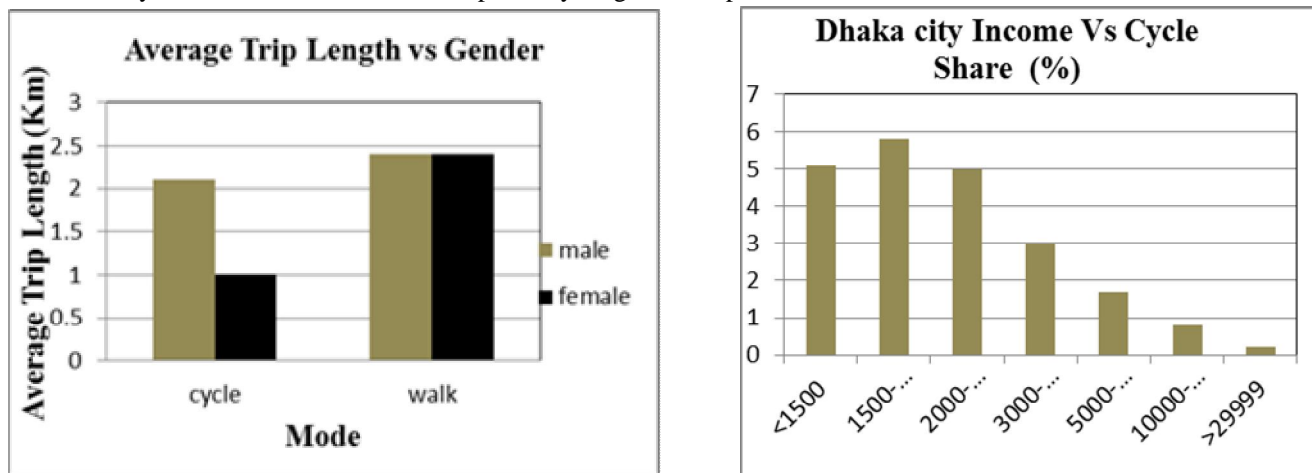


Fig. 3 Showing Demographic Characteristics Variation on NMT Share

These factors might encourage or discourage the NMT use and this is the basic information that is to be obtained for the

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development of mode choice models. Researchers used these variables in a variety of ways. The average income (GDP per capita) is increasing at a fast rate in case of developed countries but this is not the case in developing countries. Age differences and gender differences are also significant between the developed and developing countries i.e. numbers of working women are more in developed countries compared to the developing countries. Middle aged people also prefer cycling in developed countries. It is surprising to know that the growth of NMT is significantly increasing in the rich countries where the car ownership rates are high and in developing countries there is a significant decrease in NMT modal share.

### B. Attitudinal and Perception Factors

Attitudes and perceptions of individuals towards motorized and non- motorized modes are important to know as they have major effect on modal shares. Awareness of physical activity involved in using these modes, safety aspects, enjoyment in riding cycle etc., play a major role in individual's mode choice decisions. The increased awareness of people in using NMT modes and the benefits they obtain from these modes individually and communally makes the difference between developing and developed countries. The aspect of health improvement resulting from physical exercise is actually most valid in high income countries.

### C. Environmental Factors

Some of the factors which are related to environment such as topography, weather might influence people's decision in choosing commuting mode in such a way that if it is a hilly area it may not be convenient for using cycle for example Gangtok in India where cycling share is zero percent (MOUD, 2008) and bad weather (rainy, stormy etc.) is not suitable for making walking trips etc. In developing countries no one pays particular attention towards these factors and generally they are negligible in the analysis.

### D. Trip Related Factors

Trip distance, purpose of the trip (work, shopping, recreation etc.), time of the day, day of the week (week day or week end) when the trip is undertaken etc. are the major factors that are likely to have influence on individuals mode choice decision. Trip purposes play an important role in mode choice decision of individuals. In Asia and Africa bicycle is used mainly as primary transport mode (India and China) but in Americas (USA, Peru, Brazil) it is mainly used as recreational mode and for mixed uses in some other countries (Netherlands and Denmark). In developing countries it is often heard that the captive- ridership is the main reason for walking or cycling and it is true that cyclists and pedestrian hardly voluntarily choose these modes.

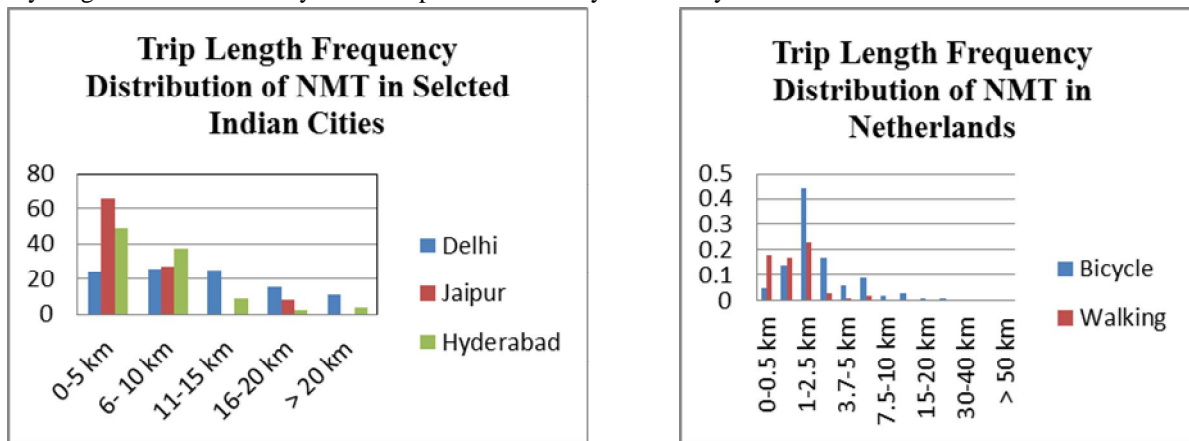


Fig. 4 Showing the variation of NMT share along with trip Length in Indian Cities and Netherlands

In developed countries the NMT modes also play an important role as feeder modes to public transport and this multimodality behaviour of these modes helps to give a strong competition to motorized modes.

### E. Infrastructural Factors

Factors such as presence of sidewalks, presence of bicycle parking facilities, bikeways etc. will come under this category of factors and these factors might encourage or discourage the commuters to use NMT. Some of the researchers tried to explore the relationship between the non- motorized facility factors and the non- motorized mode use. Most of the modernised

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cities in developed countries (Netherlands, Germany and Japan) are pioneers in facility improvements for pedestrians and cyclists and the figure- 5 shows that the space used for infrastructure which is needed for urban transport is high in industrialised countries and this conveys us that it is difficult in developing countries like India to provide separate Infrastructural facilities for NMT as the space allocated for the urban transport itself is less in these nations.

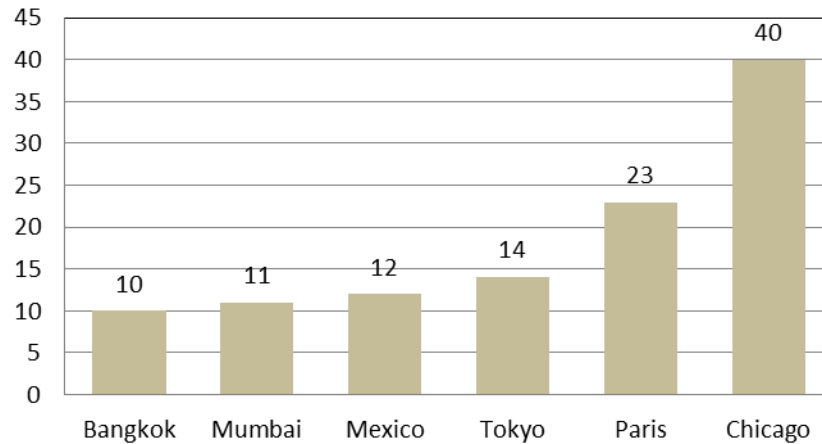


Fig. 5 Percentage Space Used for Urban transport in Selected Cities

The figure -6 shows that with the incorporation of non- motorized facility factor the utility values of cycling increases in Brazilian University campus.

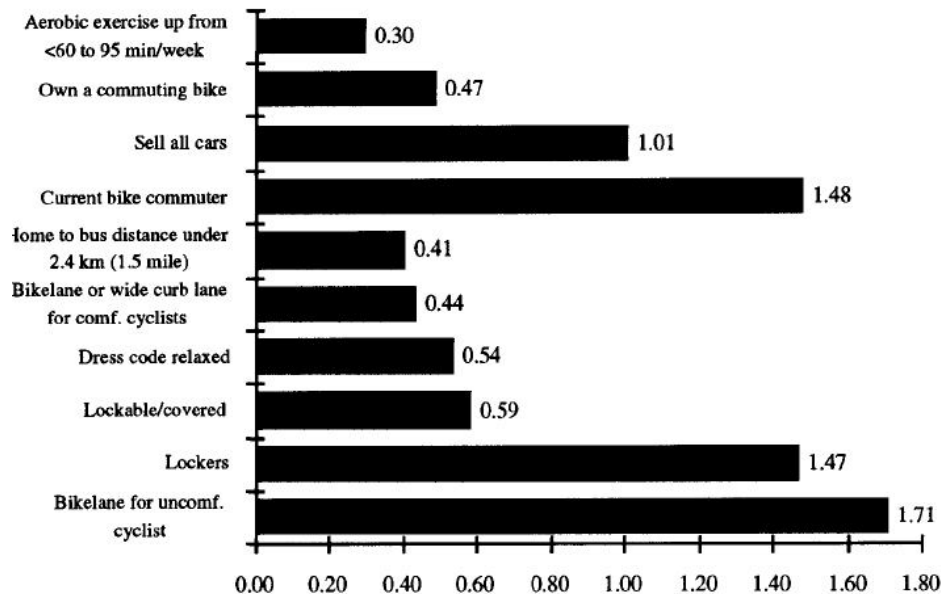


Fig. 6 Comparison of bike and ride utility gains by several means in the lower level access mode model

Infrastructure problems have a strong impact on NMT in developing countries. In most of the developing countries the sidewalks which are provided for pedestrians are used by the street vendors making the people not to use these modes. But there is an urgent need to provide separate infrastructural facilities for NMT in developing countries where mixed traffic conditions prevail and the safety issues of NMT users are of major concern.

### F. Built Environment Factors

Built environment include the urban form variables that are found to have a significant effect on physical activity using non-motorized mode. Some of the built environment characteristics are land use mix, accessibility, density, road way design etc. Many

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researchers have tried to explore the relation between the urban form variables and the non- motorized mode use. Urban form plays a significant role in either encouraging or discouraging use of NMT. More than all other modes, the utility of walking and cycling are largely dependent on the neighbourhood characteristics and the built environment. In Mixed land uses, the placement of activities (shopping, recreation, education etc.) provide easy access to public transport, increased density provides the commuters with more viable options. As city size increases the trip length also increases and in developing countries most of the city sizes are increasing as a result of rapid urbanization and motorization .This led the NMT users to consider the NMT as inefficient modes. The figure- 7 shows the variation of NMT share with the degree of Urbanisation in Netherlands.

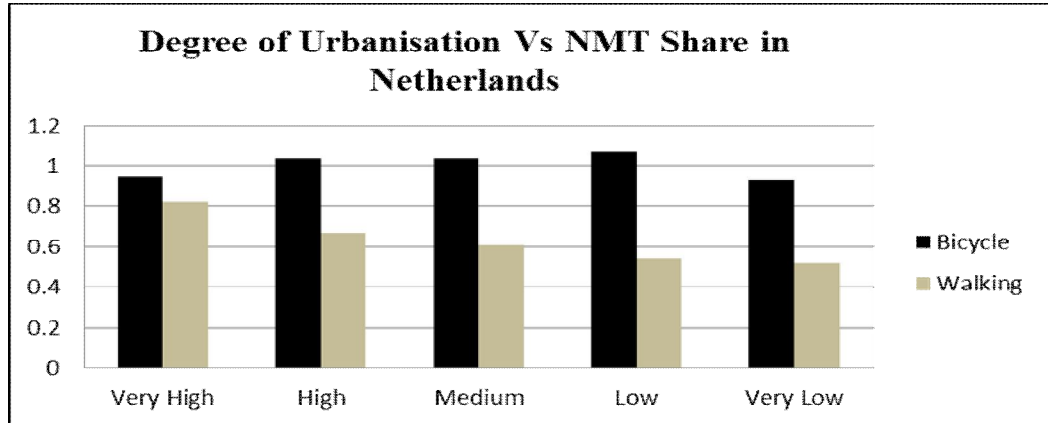


Fig. 7 Showing the Impact of Urbanisation on NMT Share in Netherlands

### II. REVIEW OF PAST WORKS

TABLE I

REVIEW of WORKS DONE by VARIOUS RESEARCHERS

Researcher (S)	Year	Factors Used	Model Developed	Key findings
Handy	1996	SDF & BEF	Individual Choices about Pedestrian Trips	Distance to Destination is Most Significant
Taylor & Mahmassani	1996	IF	Nested Logit Choice Model	Presence of Bicycle Lockers is Significant in Promoting Cycling
Moudon et al.	1997	SDF,EF & BEF	Matching of Sites	Site Design plays a significant role in predicting pedestrian volume
Nelson & Allen	1997	IF & EF	Cross-Section & Regression analyses	Positive Association between miles of Bicycle Pathways and % of commuters using bicycle
Kuppam et al.	1999	SDF , A&PF	Multinomial Logit Models	Omission of attitudinal variables may lead to serious problems
Sanches & Arruda	2002	SDF, IF & TF	Binary Choice Logit Model	As the Trip Length Increases the Probability of Choosing Walking decreases
Stinson & Bhat	2004	SDF, IF, EF & TF	Ordered response Model	Unpleasant Weather, Inadequate Daylight are main deterrents for cycling
Rodriguez &Joo	2005	SDF, IF,EF & TF	Multinomial Logit model	Local Topography is directly related to propensity of walking & cycling
Plaut	2005	SDF & TF	Logit Analysis	higher salary, car owner ship are associated with reduced likelihood of using non – motorized transport

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An & Chen	2007	SDF, IF & BEF	Regression & Correlation	strong correlation between environmental, non- motorized facility factors and non- motorized mode share
Kerr et al.	2007	SDF & BEF	Logistic Regression Analyses	Association between urban form variables and walking is more significant in households with more cars and high income.
Tiwari & Jain	2008	IF	Comparison of Cities	Provision of cycling infrastructure will encourage the people to have a shift from motorized to non- motorized mode i.e. cycling.
Kuhnimhoff et al.	2010	A&PF	Weighing	Cycling is more subjected to individual attitudes, preferences and enjoyment of physical activity.
Yang et al.	2010	A&PF, TF	Odd ratio statistics & Binomial Logit (BL) Models	Convenience is the most significant among bicycle-related perceived benefits and trip distance is negatively correlated with cycling
Heinen	2011	A&PF	Bivariate Logit Models & Regression Analysis	Bicycle commuting distance lengthens the attitude of commuters towards cycling becomes positive.

\*Socio-demographic factors (SDF), \*Infrastructural factors (IF), \*Built environment factors (BEF), \*Trip related factors (TF), \*Attitudinal and Perception factors (A & PF) and \*Environmental Factors (EF)

### III.CONCLUSIONS

As NMT share is declining rapidly in developing countries like India, it is very much necessary to pay attention to implement certain measures in order to establish a sustainable healthy transportation system which is inclusive of NMT modes. In developing countries as the trip lengths are increasing day-by-day, it is necessary to make use of the multimodality behaviour of non- motorized modes in order to reduce severe traffic congestion thereby improving the journey speeds. The development of NMT mode choice models are mainly hindered by the improper data collection i.e. missing of data regarding slow modes etc. So keeping in view the impact of above discussed factors on NMT share, while data collection it is necessary to focus on individual attitudes and perceptions towards various modes, non- motorized facilities and neighbourhood characteristics prevailing in the survey area, trip related information in addition to the household socio- demographic information. As the life style, geographical characteristics etc. are much varied between developed and developing countries it is not entirely possible to follow the regulation measures which are implied by the developed countries to boost up NMT but some measures which are applicable for developing countries may be chosen wisely.

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