Analysis of Bicycle Usage in India: An Environmental Perspective

Akash Krishna Srivastava\textsuperscript{a,1}, Shashank Mishra\textsuperscript{b,ii}, Debalina Chakravarty\textsuperscript{c,iii}

\textsuperscript{a}. Student, Department of Computer Science, National Institute of Technology, Jamshedpur, Jharkhand, India.
\textsuperscript{b}. Student, Department of Computer Science, National Institute of Technology, Jamshedpur, Jharkhand, India.
\textsuperscript{c}. Faculty, Department of Humanities, Social Sciences and Management, National Institute of Technology, Jamshedpur, Jharkhand, India.

Corresponding Author: Akash Krishna Srivastava

Abstract:

Bicycles are the easiest and cheapest form of mode of transport which can be used to reduce pollution and other environmental negative externalities. For the low income group, especially in developing countries like India, bicycling also offers an affordable transport option where it is difficult to afford any form of motorized transport. In the era of stringent climatic and GHG emission target, it is highly recommended from various level of researchers, academicians and policy makers to promote bicycle use. Existing literatures mainly deals with the perception and behavior towards bicycle use; but ignore the baseline or existing usage pattern of bicycle. In this backdrop, the objective of the study is to explore the existing usage pattern and GHG savings potentials of bicycle in India. The results shows, bicycle is mostly used by lower income class who are commuting small distance with lack of proper transit system. Bicycle ownership is an important indicator of the well-being of the backward households and community of India. In the urban and semi urban area, households are using motorized two wheeler for their short and medium distance trips. Using bicycle instead of motorized two wheeler for these trips (at least short trips) can save significant amount of GHG and local pollutants. The GHGs savings potential is estimated to be 1696726 kg/km by substituting all motorized two-wheeler with bicycle. This include 85% SPM, 8% HC, 5% NOX, 3% CO, 0.4 % CO\textsubscript{2}, 0.3% PAH and less than 0.3 VOCs. 46% of this GHG savings can be done from Rural Area and 54% from urban Area. So, it can be understand that primarily government should focus on promoting bicycle use to rural area. Although it has significant positive health effects due to decreased air pollution emissions, decreased greenhouse gas emissions, and increased levels of physical activity, shifts in individual adverse health effects such as higher exposure to air pollution, heat stress and risk of a traffic accident may prevail. However, it require few supporting infrastructure like road network improvement, awareness about the health and environmental benefit of bicycle use etc.

Key Words: Bicycle, urban area, GHG, Sustainability, Pollution

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1. Introduction

People in fast growing medium and low income cities face the problem of sustainable urban mobility which causes serious health, economic, social and environmental problems. One of the Sustainable Development Goals (SDGs) adopted by the United Nations is to “Make cities and human settlements inclusive, safe, resilient and sustainable” (Goal 11)(United Nations, 2016) by introducing non-motorised mode of transportation. The growing urban population further demands transport infrastructures, but cities are lack of proper roads, public transport and non-motorized transport (NMT) infrastructures(Becker and Dresdan, 2011). Often the provisions of transport infrastructures are not demand driven or evidence-based, but pilot-projects based on political decisions(International Growth Centre, 2016) in developing countries. A consequence of this is severe congestion and pollution faced by Indian cities despite lower vehicular ownership as compared to developed and other developing economies. This also leads to health problems and economic losses. As the size of the city increases(population), the amount of transport facilities used by the people increases. Moreover,
India is undergoing increasing population growth, urbanization and rapid economic growth. One of the concerns is increasing energy use due to urban passenger transport. The demand for motorized vehicles in urban areas has increased due to higher incomes, mobility, expanding cities, and the proliferation of employment centers. This has led to disproportionately high concentration of vehicles in urban centers. A study by Central Pollution Control Board (CPCB) reveals that the air pollution shares of transport have gone up from 20 percent to 70 percent in the last four decades (Parida and Parida, 2010). The frequent traffic jams, increase in idling time of vehicles at intersections aggravate the pollution levels further. Road transport is responsible for over 80% of fossil fuel energy consumption and responsible for around 64% of the total air pollution load (Parida and Parida, 2010). The contribution of motor vehicles on total pollution in the capital of India has increased from 23% in 1970-71 to 63% in 2000-01 (Parida and Parida, 2010). Cars and two wheelers contribute to 11.5% and 77.7% of the total transport related air pollution (Parida and Parida, 2010) whereas non-motorised two wheelers contribute nothing.

The Indian bicycle industry is the fourth largest bicycle industry following China, Taiwan and Japan. It has experienced a number of changes in structure, organization and growth over the last four decades, and especially after the mid-1970s. Although India is the second largest producer of bicycles in the world (Worldometers, 2013), the usage of bicycles in India is decreasing every year. Bicycle riders in urban India are mostly lower income group people and students (Basu, 2013). They are predominantly captive riders. Safety issues regarding bicycles is a high level concern among the Indians. In order to promote the usage of bicycles in India, development of bicycle friendly infrastructures and implementation of policies promoting bicycling is essential.

The tenth five year plan (2003-07) for India emphasizes the issue of road safety and energy savings/planning, because transport is the second largest consumer of energy (NUTP, 2005). The National Urban Transport Policy (NUTP) in 2014 ensures the support of central government in formulation and implementation of “Area Plans” to increase bicycle use. According to NUTP, the target of equity between the rich and the poor can be achieved by reserving corridors and lanes exclusively for public transport and non-motorized modes of travel. The Central Government decided to give priority to the construction of cycle tracks and pedestrian paths, under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), to enhance safety and thereby enhance use of non-motorized modes (NUTP, 2005). The Master Plan of Delhi (MPD) – 2021 has proposed road hierarchical system which includes separate cycle tracks. The MPD-2021 policy pertaining to bicycle/cycle rickshaws claims it to be an important mode of travel for short and medium distances but identifies it as unsafe in the presence of fast moving and mixed traffic. In the smart city mission (2015) context, GoIIs taking several initiative to promote bicycle use in the cities. For examples Ludhiana, Moradabad, Vadodara Bhurbaneswar, Bilaspur, Ranchi and Tiruchirapalli, have already put forward the idea of promoting bicycle use. Mysuru and Bhurbaneswar has introduced public bicycle sharing service in 2016. The Ministry of Urban Development (MoUD) shows that a large number of cities have proposed to create more bicycle lanes. Ludhiana “the clean and green bicycle capital” which aims to create bicycle highways along canals, dedicated cycle tracks along footpaths and public bike sharing stations.

In this backdrop, this paper is a humble attempt to study the existing usage of bicycle in Indian economy by experimentally investigating the usage pattern of bicycle and to find out the GHG emission reduction potential of bicycle use compared to other modes of transport in India as well as for all individual states in India. Various policies have been proposed to increase the use of bicycles along with meeting the economic needs of people. The section two explore the existing literature exploring why bicycle use could be a sustainable solution compared to the motorized two-wheeler use. Next section deals with methodology and data. The third section explain the findings. It discusses the existing bicycle production, demand or usage pattern in household sector of urban and rural India and estimated the GHG savings potentials of bicycle use. The last section summarized the study and then deals with the conclusion and policy suggestions.
2. Bicycle use – a sustainable solution or not?

In 21st century the most sustainable form of transport (Lumsdon, 2011; Cavill and Davis, 2007; Lumsdon and Tolley, 2001) are bicycles having advantages like less noise pollution, less congestion, less accidents and less maintenance costs (Rastogi, 2009; Litman, 2003; Rietvelt, 2001; Liu, 2003; Replogle, 1992) compared with motorized modes. For the low income group, especially in developing countries like India, bicycling also offers an affordable transport option where it is difficult to afford any form of motorized transport (Buis, 2009; Joewono, 2005; Guitnik, 1994; Pucher, 2005; Servaas, 2000; Srinivasan, 2005). As a matter of fact it can form an important means for accessing destinations particularly for short distance trips that are too long for walking or are not served by transit. Although it was significant positive health effects due to decreased air pollution emissions, decreased greenhouse gas emissions, and increased levels of physical activity, shifts in individual adverse health effects such as higher exposure to air pollution, heat stress and risk of a traffic accident may prevail. It is estimated that the estimated health benefits of cycling were substantially larger than the risks relative to car driving for individuals shifting their mode of transport (Hartok et al., 2010).

Despite these pros, bicycling is not a popular choice among commuters in Indian subcontinent. Bicycle use varies strongly between countries, and even between localities within the same country. It appears that most of the inter-municipality variation in bicycle use is related to physical aspects such as altitude differences and city size, and features of the population (share of youngsters). The primary hindrance to bicycling include factors like long trips, harsh weather conditions and difficulty of use in recreational trips. Along with this infrastructure unavailability, extreme traffic conditions, and a lack of health and environment consciousness among people. These barriers are, in one way or the other, clearly shows the internal and social considerations of commuters such as their current attitude, social perspectives, and prognostic environment considerations. The effects of these impediments may change from individual to individual depending on their perception of bicycling and their level of experience with cycling (Gatersleben, 2007; Gatersleben and Appleton, 2007). For example, non-cyclists may value these impediments quite differently from cyclists (Heinen, 2010). Moreover, the perception of an individual’s history with bicycling may also pose an obstruction. Dill and Voros (2007) associate an individual’s childhood bicycle usage with his habit that decides the current bicycle usage. Eliciting this childhood’s insight can extract the necessary steps that can maintain a respondent’s bicycle usage even after his transformation from childhood to adulthood (Heinen, 2010). Most of the existing studies on bicycle use are limited to the effect of socio-demographic factors and physical infrastructure factors (Verma, 2015; Rastogi, 2009).

In addition the relative position of bicycles with respect to cars (speed, parking costs) also appears to matter. There is significant growth in motorized vehicles as compared to non-motorised mode as the factors affecting bicycle mode choice, are not carefully addressed through suitable policies in the urbanization strategy of India (Tiwari, 2008). Studies failed to understand the varying requirements of a transition from non-cyclist to cyclist, for commute short to medium trips. It is, actually, not very difficult to upgrade the existing roads to provide a safer and more convenient environment for non-motorized modes. This also results in improved efficiency of public transport vehicles and enhanced capacity of the corridor when measured in number of passengers transported per hour per lane. Therefore, a popular outcome can be substitution of bicycles with motorized two-wheelers with increase in purchasing power. A sustainable transport system must provide mobility and accessibility to the households and environment friendly mode of transport. The best example of such a scenario would be Copenhagen, Denmark where cycling is one of the major modes of transportation. It is expected that by converting 10% of cities total freight into bi cycle, these cities can reduce 20-80% of emission by 2020.

In this backdrop, when the countries target is to reduce its GHG emission by 20% by 2020, Indian government is encouraging the more and more use of bicycle, it is very essential to know the existing usage pattern of bicycle in India and the GHG savings potential of bicycle in India.

3. Material and Methods

The objective of the study is to explore the existing usage pattern and the GHG savings potential of bicycle in different states of India. In this study, the bicycle usage pattern in India is reconnoitered by using the basic
statistical tools by using ‘R’. An experimental investigation of the influence of bicycle is compared to other modes of transport in India. The study first find out the growth in production and usage of bicycle in Urban and Rural areas of India by using the data on production of bicycle in the bicycle producing industries. Statewise analysis of bicycle usage and its trend over the decades are also explained by using Census data, Government of India and Household Consumption Expenditure data, National Statistical Survey Organisation (NSSO), Ministry of Statistics and Programme Implementation (MOSPI), Government of India. The study has explored the possible improvements in backward castes through more access to bicycle as Census India defined that the bicycle ownership shows the important asset possession of the Indian households. Finally, the study estimate Green House Gases (GHG) reduction potential of bicycle compared to motorised two-wheelers. This study tries to explore some sustainable solutions and policy recommendations related to bicycle use.

Our sources for household bicycle ownership data include the secondary data collected from Census, Government of India(2001), CSO (Central Statistical Organization) and NSSO (National Sample Survey Organization), MOSPI (Ministry of Statistic and Program Implementation), Government of India.

4. Calculations
The study tries to explore the baseline economic and environmental scenario of bicycle use in the Indian economy.

![Industrial Production of Bicycles in India from 1975-76 to 2011-12](image-url)

Figure 1: Industrial Production of Bicycle in India from 1975-76 to 2011-12
Source: Estimated from secondary data
4.1. Bicycle Production

India produces approximately 10% of the world annual bicycle production, which is estimated at 125 Million units in 2014/13/15. The annual domestic demand of bicycles in India is approximately 10 million units out of which around 2.5 million units is a government demand for the various welfare schemes. Exports out of India are largely to Africa and the less developed economies and negligible to western markets. Major players in the domestic bicycle industry are Hero Cycles, TI, Avon& Atlas with 40%, 22% & 17% & 10% of share of volume respectively. Most cycles manufactured & sold in India are in the low price range of Rs. 2,500 to 3000 (Industry Statistics of India) (Estimated from Secondary Data).

Table 1: CAGR of Industrial Production of Bicycle in India

<table>
<thead>
<tr>
<th>Time Period</th>
<th>From 1975-76 to 2011-12</th>
<th>From 1993-94 to 2011-12</th>
<th>From 2001-02 to 2011-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAGR (in %)</td>
<td>5.22</td>
<td>3.58</td>
<td>2.03</td>
</tr>
</tbody>
</table>

Source: Estimated from secondary data

Industrial Production of bicycle grew at a trending rate during 1993-94 due to industrialization and globalization. There was a fall in the production of bicycle because of less demand when the motorized vehicle came into the picture. After mid-nineties the production of bi-cycle starts increase because government of India initiated several social policies by providing bi-cycles to the marginal households.

4.2. Bicycle Use

In India, approximately 45% of all households uses the bicycle for their primary transportation. In urban area the use of bicycle is lower than the rural area of India with approximately 42% and 46.12% households are using bicycle in urban and rural area respectively. As compared to the motorized two-wheeler, Indian households are using more bicycles. This implies that there already persist a good cultural and societal practice for bicycle use. The statistics in the following sections also prove the same thing. The proportion of non-motorised two-wheeler or bicycle and motorized two-wheeler are almost same in urban India. In rural India households using bicycle are almost twice of households using motorized two wheelers.

Figure 2: Percentage of households using the bicycle in India

Source: Census India, Government of India, 2011

Percentage of households possessing bicycle in urban areas in different localities varied according to the MPCE (minimum per capita expenditure in Rs.) class. The lower income households have higher use and ownership of bicycle than the higher income group in urban India (figure 3). In rural areas, the percentage of household using bicycle followed almost a regular pattern when plotted against MPCE(in Rs.). The plausible
explanation for this is that poor public communication, poor infrastructure etc. Moreover, most of the individual from rural area has to commute urban or semi urban area for their daily earnings (Sinha et al., 1994). The graph of percentage of households in rural, urban and combination of rural and urban against the states and union territories gave non uniform results. As per the results the number of bicycles users were more in rural areas than in urban areas with few exceptions like Lakshadweep and Manipur. Highest and lowest percentage of households using bicycles were in Lakshadweep and Sikkim respectively.

Figure 3: Percentage of households possessing bicycle in rural areas MPCE class wise.

Figure 4: State-wise non-motorized and motorized two wheeler use in India
Census India has identified Bicycle as an important asset of a representative households in India. Bicycle ownership of a households can indicate the economic performance or productivity of the households. Not only for rural area or low income class, but bicycle ownership can also indicate the well-being of the backward community of India like reserve category households. The plot of percentage of households of backward classes of India in rural, urban and combination of rural and urban against the states and union territories gave non-uniform results. As per the results the number of bicycles users were more in rural areas than in urban areas with few exceptions like Rajasthan and Madhya Pradesh. For scheduled tribes highest and lowest percentage of households using bicycles were in Lakshadweep and Sikkim respectively similar to the aggregate ownership pattern of India. For scheduled castes highest and lowest percentage of households using bicycles were in Punjab and Mizoram respectively.

Figure 5: State-wise non-motorized and motorized two wheeler use in backward class of India

Source: Estimated from Census, India, Government of India, 2011
4.3. GHG savings potentials

The study attempt to explore the local pollutants and GHG savings potential by using bicycle in India. From above two section it can be summarised that two-wheelers are mainly used for personal or domestic short-trips in India. Individual engaged in small portable business also use their own two-wheelers in their commercial purpose. Therefore, total two wheelers are non-motorised (bicycle) and 32% motorized (moped, motor-cycle etc) in India. 48% of total two-wheelers are non-motorised (bicycle) used by rural households and 20% are used by urban households. Motorized and non-motorized two-wheelers serve almost same service. However, the former is faster than latter due to its motorized engine but also create emission and prone to accidental fatalities. Bicycle, on the other hand, an affordable and eco-friendly option with less accidental incidences and good amount of health benefits; although both are difficult to drive in extreme weather condition. Bicycle does not need any kind of registration of vehicles, insurance, pollution certificates etc which make bicycle use more convenient and hassle free at least for short to medium distance road trips. So, the study hypothesized that if the existing motorized two-wheeler (32% of the total two-wheelers) can be replaced by the non-motorised bicycle, then significant amount of local pollutants and GHG emission can be saved without compromising the transportation service, at-least for short to medium distance trips. Figure 6: Share of Motorised and Non-motorised Two-wheelers in India

In this study, the GHGs savings potential is estimated to be 1696726 kg/km (1696.726 Mt/km) by substituting all motorized two-wheeler with bicycle in India. This could save less than 1% of total vehicular emission in India(267832.03/km GG total vehicular emission in India estimated by CPCB). 1This include 85% SPM, 8% HC, 5% NOX, 3% CO, 0.4 % CO2, 0.3% PAH and less than 0.3 VOCs. 46% of this GHG savings can be done from rural Area and 54% from urban Area. State wise savings potentials are shown in the following figure (table shown in appendix). Evidently, Indian states having lower number of bicycle user, has lower local pollutant and GHG emission savings potential and the states with higher number of bicycle user, has higher potential. Figure 7: State wise emission savings potentials

Source: Estimated from secondary data

1267832.03GG/km total vehicular emission in India estimated by CPCB.
5. Summary and Conclusion

Bicycles are the easiest and cheapest form of mode of transport which can be used to reduce locale pollution and GHG emissions. The existing socio-economic patterns of India supports the mass use of non-motorized modes or bicycles, which is an integral part of the transport system in all over India. Bicycles are the major modes of transport for the majority of the rural, poor backward class households as well. The study has explored the existing usage of bicycle in Indian economy compared to other modes of transport in India. It points out the production trend of bicycle and various pros and cons of using bicycle usage. Production curve of bicycles should have a more steep curve by promoting bicycle as an attractive product, promoting bicycle campaigns, improving its brand image of bicycle etc. The study shows the distribution of non-motorized vehicles in different parts of India among different classes (Scheduled Castes and Tribes) of people along with comparison with motorized vehicles. Rural households possess more bicycles than urban households.

Households who can afford motorised two wheeler, strongly prefer motorised two wheeler since, commuters can even travel long distances with less physical efforts. Commuters can save time for short to medium distance trips with motorised two wheeler with motorized engine with higher speed. However bicycle has some other advantages over motorised two wheelers- it is affordable, eco-friendly, less accident prone and associated with health benefits at least for short to medium distance trips. The study hypothesized that if atleast each household owning motorised two wheeler, replace their motorised two wheeler with bicycle then India could save significant amount of GHG emission with zero social cost. GHG emission reduction potential of bicycle has been estimated for India as well as for all the states in this study.

There are two pathway to reduce local pollutants and GHG emissions from mode of transportation- either we have to find out a cheap sustainable alternative fuel and go on explore the rest of the universe or we will go back to where we were millions of years ago with usage of bicycle. The second option is cost effective but need few supporting infrastructure like road network improvement, awareness about the health and environmental benefit of bicycle use etc. To increase the usage of bicycle need to increase awareness and moreover need to change the lifestyle. Changing lifestyle to increase the bicycle use may include bicycle sharing in campus, using bicycles for short distances, etc (Roy and Pal, 2009). Massive bicycle use should be encouraged for not only rural, middle to low income class people but also among high income advanced progressive citizens. Literature discuss a lot about the infrastructure development for bicycle use (like different road pavement for bicycles), but, massive bicycle use in urban area are difficult due to existing land use pattern, poor road infrastructure and lack of bureaucratic interest. So, primarily government should promote bicycle use to rural area, and semi-urban area where households commute short to medium distant trips. Gradually it should also be increased inurban area atleast for side-ways/ local road etc.

References


