Research in Transportation Economics 38 (2013) 22–34

Contents lists available at SciVerse ScienceDirect

Research in Transportation Economics

journal homepage: www.elsevier.com/locate/retrec

Economic impact of non-motorized transportation in Indian cities

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ARTICLE INFO

Article history:
Available online 5 July 2012

Keywords:
Non-motorized transport
Economic impacts
Role of non-motorized transport
Problems hindering non-motorized transport development

ABSTRACT

Lack of a clear understanding regarding the economic impacts of non-motorized modes is a major reason why they are excluded from the transportation development agenda of cities in India. Keeping this aspect in mind the present study has been divided in to two parts. The first part tries to understand the non-motorized traffic evolution in India. It focuses on the declination of non-motorized modes, necessity to revamp it, the favorable conditions to promote them in India and the relative problems associated with it. It is found here that there is a necessity for defining the role of non-motorized modes in India for the viable implementation of infrastructure and policies related with it.

The second part consists of two case studies of Bangalore city where the economic benefits are worked out. The first case study provides a framework for monetizing the economic benefits of non-motorized modes. Here the economic benefits of congestion and air pollution reduction, accident and vehicle cost reduction are considered and total savings are worked out. A savings of Indian Rupees (Rs.) 250,000 was found for an assumed 1% shift of travelers to non-motorized mode in a single day. The second one enlists the expected economic benefits associated with pedestrianization of a major arterial called M.G road in Bangalore and estimates a savings of 1611.4 Rs./day due to air pollution and accident reduction. The economic benefits thus found could be used to convince the policy makers and also to form a framework within which decisions can be made regarding non-motorized modes.

1. Declination of non-motorized mode culture and necessity to revamp it

Walking and bicycling had culturally been an integral mode of trip making in India. According to Riplogle (1991), non-motorized modes in India accounted for 10 to 30 percent of all person trips and 30 to 50 percent of traffic on primary urban roads. The reasons for this dependence were attributed to the less developed economy and inexpensive lifestyle which the people had at that time. But later there was a massive economic boom in India which led to the development of urban conglomerates where majority of the economic activities were concentrated. The purchasing power of people increased and so the gap between have and have not's. The rich became richer and poor became poorer. Even in transportation field this disparity was quite visible with vehicles like cycle rickshaws and bicycles which were visible identities in Indian cities during earlier 2000's paving way to motorized modes (Fig. 1). With the policies also being motor vehicle oriented there was a rapid decline in the use of non-motorized modes. Table 1 shows the rapid increase in vehicular population over the years till 2006 as per Ministry of Shipping, Road Transport & Highways Government of India (2009).

Majority of this vehicular growth was oriented in the urban centers and were preceded by lot of problems. Buis (2009) took the case of Netherlands and stated the main problems due to motor vehicular growth as increased pollution and congestion, economic losses in cities and high fatality rates due to accidents. A similar scenario can be found in India also. The expected decrease in the projected speed on major city corridors in India given in Table 2 in case of a do nothing scenario gives an indication of the congestion problem.

The estimated carbon emission increase of 61% between 1990 and 2001 for India (Ng, 2007) points to the pollution problem. Even though the pollution could be expected to show a downward trend by setting up vehicle emission standards, an enormous increase in number of motor vehicles will make this attempt futile. Road fatalities have also been showing upward trend as shown in Table 3. Ng (2007) found accidents to be highly relative to the distances

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http://dx.doi.org/10.1016/j.retrec.2012.05.005

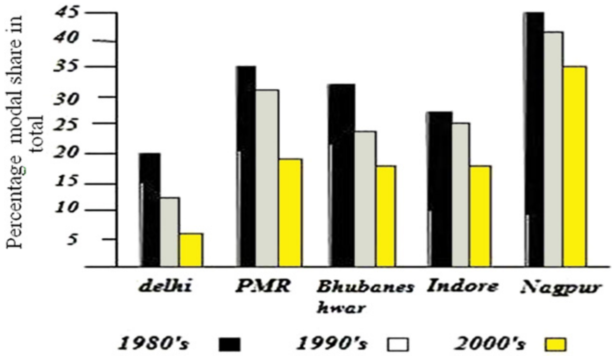

Fig. 1. Cycle share reduction over years in Indian cities. Source: Tiwari and Jain (2008).

actually traveled by motor vehicles. Supporting this argument, Litman (2010) mentioned that in countries like Germany and the Netherlands where walking and cycling travel rates are high the per capita traffic death rates are much lower than in automobile dependent countries. Similarly in India also we can argue that the increase in trip rate of motorized vehicle (Table 4) and also the increase in trip length (Table 5) mainly for cities with a population above 4 million are a major contributor to the accidents in these cities. Here the 2007 survey was done by Wilbur Smith Associates (WSA) and 1994 survey was done by Rail India Technical and Economic Services (RITES).

All these facts points to the necessity of reducing the dependence on motorized vehicles and promoting an alternate mode in the urban centers. An alternative mode which can reduce the unwanted impacts of motorization but at the same time is user friendly. The answer for this question of alternative mode could be found in the work of Riplogle (1991) who proposed that Asian cities need to adopt a non-motorized mode inclusive development to confront diminishing environmental and economic benefits in these cities due to their rapid and uncontrolled motorization. Riplogle also added that non-motorized vehicles are potentially important in solving these problems even though they cannot be considered as a complete solution.

2. Factors favorable for non-motorized development in India

The above mentioned discussion gives an idea of the declination of non-motorized vehicles due to motorization and points to the necessity of developing a non-motorized culture in urban environment in India. Now we will explore some factors which are favorable for such a development. The two major factors which can be attributed in favor of non-motorized development are the high percentage of low income and middle income groups, and the high percentage of short trips existing in Indian cities. The World Bank Official Website had classified India a lower middle income economy which points to the presence of high percentage of middle income groups. Tiwari (2003) estimated that in Delhi the percentage of low income group which earns a salary less than Indian Rupees (Rs.) 2000 forms 60% of total population of 13 million and that majority of trips performed by them use walking or cycling as the main mode (Table 6). Tiwari (1999) explained that even a subsidized transportation system remains in-accessible for a large portion of this low income group who works in informal sectors and that cycling and walking was their only logical mode option. The study also suggested the necessity of including these captive riders for a sustainable transportation development. According to the Comprehensive Traffic and Transportation Plan for Bangalore (2007) (CTTP report, 2007) for Bangalore city the percentage of population earning less than Rs. 5000 a month is around 3%, but the number of trips made by non-motorized mode contribute to 10.55% in total trips made. Two of the reasons for this high NMT trips may be due to the acceptance of walking and cycling even in the population of other income groups mainly the middle income groups and also due to the comparatively better foot paths provided in the city of Bangalore. This fact suggest that even urban poor and middle class people need to be included in the transportation development and that non-motorized mode has a role in achieving it.

Another factor favorable for non-motorized traffic development is the number of short distant trips made in urban cities. As indicated by Rastogi (2009) in his work, European cases show that bicycle is far more superior below 5 km. This has been verified even for the case of Bangalore in the CTTP report (2007) which found the average trip length of cycle as 3.88 km and of walking as 1.01 km. Even studies done by Arasan, Rengaraju, and Rao (1994) in Indian scenario for Tiruchirapalli indicates a pedestrian acceptability of 1700 m for walking and 5200 m for cycling. Rastogi and Rao (2003) found the same as 910 m and 2724 m in Mumbai. Tiwari and Jain (2008) in her work mentioned the average trip length for bicycle in Delhi as 5.1 km and 35% of the total vehicular trips as short trips. For Bangalore, the CTTP report (2007) mentioned the average trip length for entire class of vehicles as 10.57 km and 27% of the trips as below 5 km. Table 5 shows the trip length variation with population in urban cities of India.

From the table it may be inferred that the average trip distance is below 5 km for cities with population less than 40 lakhs and that there is an immense potential for promoting non-motorized modes especially the bicycle in Indian cities.

3. Problems hindering non-motorized traffic development in India and factors effecting non-motorized ridership

Even though there is a huge scope for non-motorized modes in India there are certain basic factors which prevent people from using it. The first and foremost one is the lack of infrastructural provisions. There is a lack of proper foot paths and cycle tracks which often compels the commuter to use the road along with the

Table 1
Vehicular population in India.

Year end march	2 Wheelers	Car jeeps etc.	Buses	Others	Total (million)
	(as % age of total vehicle population)				
1951	12.02	71.04	15.16	1.78	0.22692
1961	17.67	62.38	11.51	8.43	0.49302
1971	37.87	44.85	6.13	11.15	1.51776
1981	54.18	23.97	3.34	18.51	4.83483
1991	70.86	14.73	1.60	12.70	20.02369
2001	74.10	13.53	1.27	11.10	52.02054
2002	74.32	13.58	1.16	10.95	55.974
2003	74.79	13.50	1.16	10.55	63.52548
2004	75.32	13.71	1.16	9.92	68.93856
2005	75.81	13.35	1.16	9.57	77.5065
2006	71.04	12.02	1.78	15.16	85.21911

Note: Others include Tractors, Trailers, 3 Wheelers & etc. (P): Provisional. Source: Ministry of Shipping, Road Transport & Highways Government of India, 2009.

Table 2
Anticipated average journey speed (kmph) on major corridors by city Category.

Sl. No	City	Population	2007	2011	2021	2031
1	Category	<5 lakhs	26	22	15	8
2	Category-1	5–10 lakhs	22	18	13	9
3	Category-2	10–20 lakhs	18	13	10	7
4	Category-3	20–40 lakhs	22	18	12	9
5	Category-4	40–80 lakhs	19	15	10	7
6	Category-5	>80 lakhs	17	12	9	6

Source: Ministry of Urban Development, 2008.

Table 3
Number of persons killed and injured by motor vehicles in selected metropolitan cities.

Cities	Persons killed								Persons injured							
	2000	2001	2002	2003	2004	2005	2006	2007 (P)	2000	2001	2002	2003	2004	2005	2006	2007 (P)
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ahmedabad	223	167	178	170	176	181	246	255	2905	2596	2384	2295	2342	2406	2642	2650
Bengaluru	659	697	820	883	897	835	919	961	6347	6933	7577	7980	6958	6102	6150	6591
Bhopal	–	–	95	201	171	208	127	254	–	–	2069	2378	2637	2571	2206	3163
Chennai	692	708	500	567	605	493	1136	1146	4496	4370	3434	4208	4800	4679	6722	7238
Coimbatore	–	191	187	165	174	172	245	285	–	1182	942	902	1073	1082	1219	1437
Delhi	1989	1842	1696	1801	1907	1862	2169	2141	8771	8449	7929	7829	8072	8447	8279	7711
Hyderabad	425	405	411	451	419	344	427	391	2357	–	3115	3373	3741	3537	3874	3447
Indore	173	142	187	388	357	207	205	219	2109	2246	2537	3355	3469	2861	2700	2836
Jaipur	312	236	312	318	343	414	453	495	1909	1727	1688	1826	1915	2152	2133	2096
Kanpur	483	430	468	483	463	515	474	578	851	–	953	630	662	627	741	1004
Kochi	148	141	148	146	174	183	163	172	2586	–	2735	2949	3193	2788	2432	2869
Kolkata	452	440	457	442	420	484	476	462	3316	2490	1912	–	1878	1647	1752	1861
Lucknow	–	–	487	342	383	438	484	496	–	–	800	592	516	583	567	633
Ludhiana	160	212	182	198	207	259	242	260	160	–	337	281	413	327	307	329
Madurai	383	114	104	89	105	116	126	105	1934	814	746	754	791	801	722	671
Mumbai	449	543	475	394	534	654	669	651	7122	6894	6547	6220	5562	7476	7471	6510
Nagpur	255	216	210	217	227	246	287	259	1359	2054	1352	1381	1474	1701	1808	1580
Patna	–	–	–	–	–	NA	125	318	–	–	–	–	–	NA	207	564
Pune	306	282	309	324	364	344	372	414	2242	2054	1915	1728	56	25	41	59
Surat	146	–	148	152	171	230	262	259	970	–	920	937	1102	1074	965	1193
Vadodara	147	161	126	136	133	132	147	138	1574	1361	1373	1401	1449	1372	1198	1245
Varanasi	177	–	203	153	–	154	145	217	119	–	157	101	–	95	110	145
Visakhapatnam	194	–	174	205	187	205	275	259	919	–	957	1092	1039	1067	1710	1881
Total	**7773**	**6927**	**7877**	**8225**	**8417**	**8676**	**10,174**	**10,735**	**52,046**	**43,170**	**52,379**	**52,212**	**53,142**	**53,420**	**55,956**	**57,713**

(P): Provisional. Source: Ministry of Shipping, Road Transport & Highways Government of India, 2009.

motorized vehicles. Figs. 2 and 3 gives the walking index and slow moving vehicle index in Indian cities, Ministry of Urban Development, 2008 (2008).

In Fig. 2, the higher the index, the better are the pedestrian facilities. It is observed from the figure that all larger cities have secured higher index, whereas the value is below average for many medium and smaller towns reflecting the scope for improvement in such cities. In Fig. 3, the higher is the index, the better are the facilities for slow moving vehicles (cycles and non-motorized rickshaws). One can see that as the city size grows, the index value reduces clearly indicating lack of facilities in larger cities for the bicycles. Laxman, Rastogi, & Chandra (2010) had mentioned that pedestrians are forced to walk along the carriage way along with the vehicular traffic even when foot paths are provided because of the encroachment by hawkers, vendors and shoppers which increase the chance of conflict between pedestrians and motor vehicles.

Table 4
Per capita trip rate (PCTR) for vehicles.

Sl. No	City	PCTR (all vehicles)			PCTR (motorized vehicles)		
		WSA 2007	RITES study 1994	Past Reports 2006	WSA 2007	RITES study 1994	Past Reports 2006
1	Panaji	0.76	–	–	0.48	–	0.69
2	Chandigarh	1.02	0.93	–	0.61	–	0.91
3	Guwahati	0.98	–	1.01	0.57	0.73	–
4	Agra	1.06	–	–	0.55	–	0.9
5	Trivandrum	1.03	1.3	–	0.56	–	0.91
6	Madurai	1.14	–		0.54	0.5	0.8
7	Kochi	1.21	–	0.91	0.96	–	1.03
8	Jaipur	1.26	0.81	–	0.77	–	1.02
9	Kanpur	1.20	–	1.15	0.63	0.22	–
10	Surat	1.28	1.49	2.71	0.74	–	–
11	Pune	1.30	1.34	1.11	0.87	1.11	1.88
12	Ahmedabad	1.41	–	1.26	0.90	0.81	0.53
13	Hyderabad	1.45	–	–	1.01	–	0.91
14	Delhi	1.55	1.19	–	1.10	–	1.16
15	Kolkata	1.56	–	1.16	1.05	1.17	–
16	Mumbai	1.67	–	–	1.12	–	0.54

Source: Ministry of Urban Development, 2008.

From Table 7 which shows the non-motorized accident rate we can see that metro cities like Bangalore, Mumbai, Delhi, Kolkata along with smaller cities like Nagpur and Surat are having a high pedestrian casualty rate. This may be attributed to their higher pedestrian population as compared to other cities. Similarly the less number of cycling accidents in metro cities may be connected with their less usage in these cities.

NIMHANS fact sheet (2008) for Bangalore put blame on the lack of infrastructural facilities for pedestrians as the main reason for a high pedestrian accident rate in Bangalore. This put forth the question of less safety of non-motorized modes due to poor infrastructure provision. Heinen, Maat, & Wee (2010) in his study suggested that the importance which commuters give for safety of cycling may be higher in cities where bicycle infrastructure is lacking. Rietveld (2001) emphasized that infrastructure planning with segregated facilities for motorized and non-motorized traffic greatly improve safety. So it is worth assuming that in India due to the poor infrastructure provided a lot of potential non-motorized commuters are forced to resort to other modes which are generally perceived safe. Hence the advantage of providing infrastructure is twofold 1) to reduce the fatality rate 2) to improve the safety perception of commuter to promote their shift to non-motorized modes.

The second problem which reduce the usage of non-motorized modes especially the bicycle is the general socio-cultural stigma that these modes are for poor people, Buis (2009). Supporting this

Table 5
Average trip length for cities base on population range.

City Category	Population Range in lakhs	Trip length (in Kms)	
		WSA, 2007	RITES, 1994
1	<5.0	2.1–3.0	3.70–4.38
2	5.0–10.0	2.6–4.5	4.38–4.86
3	10.0–20.0	4.1–5.5	4.86–5.51
4	20.0–40.0	5.0–6.0	5.51–6.40
5	40.0–80.0	6.1–8.6	6.40–7.62
6	Above 80.0	9.6–11.9	7.62–8.32

Source: Ministry of Urban Development, 2008.

Table 6
Estimated trips of transport modes in Delhi.

Mode	Share (%)		
	Low-income population	High-income population	Total population
Cycle	39	3	24
Bus	31	36	33
Car	0	28	12
Scooter/motorcycles	3	29	14
Three-wheeled scooter taxis	1	2	1
Taxi	0	0	0
Rail	1	0	1
Other vehicles	3	30	01
Walking	22	2	14
Total	**100**	**100**	**100**

Source: Tiwari, 2003.

notion at least indirectly, the study done by Rastogi (2010) found that shift to walking and bicycling from high income groups are negligible compared with the low income group. But this notion is completely wrong as historically the bicycle started as the transportation means of upper class citizens, and presently bicycle manufacturers do develop fashionable models that are attractive for higher income consumers also, Rietveld (2001). In countries like Netherlands it can be observed that cycle is integrated as part of culture and not as poor man's vehicle. There is need for changing the mindset of people in India and this could only be done through awareness programs emphasizing on importance of walking and bicycling as sustainable and environment friendly modes.

Factors which could play a critical role in the ridership of non-motorized traffic are weather conditions, physical conditions (gradient) and purpose, Rietveld (2001), gender ratio and age group, Servaas (2000) and occupation. Rastogi (2010) in his study determined the highest potential to shift to non-motorized mode from age group of 23–45 which is the economically active segment of the population and also that potential to shift decrease as occupational status increases. Arasan et al. (1994) identified the critical trip length based on factors such as sex, age, occupation and purpose.

4. Possible role of non-motorized traffic in India and strategies to promote their usage

Two possible roles which could be adopted for non-motorized traffic in India are; as a feeder mode or as a main mode. Rietveld (2000) while studying the role of non-motorized from the multimodal chain perspective analyzed data from Netherlands and found that the number of trips made by non-motorized modes will increase if considered as an access and egress mode to public transit or other private vehicles like car. But there are some major factors which one need to consider while using non-motorized mode especially bicycle as an access mode to public transit, which includes speed of public transit, characteristic of travel (work, education, shopping etc.), and egress availability, Martens (2004). Martens also found in his study that car availability hardly influence vehicle choice in a bike-ride framework. From the results of bus users survey of 3600 commuters in Delhi, Tiwari and Jain (2008) determined that out of the 20% owning cycles only 1% used it for access trips and that 91% of bicycle owners and 45% of the total bus commuters who do not own bicycles are potential users of bicycle for access trips, if a bicycle-friendly infrastructure is provided. Tiwari and Jain (2008) also found for Delhi that among the non walking access trips to metro 9% of the metro users pay more, 67% spend more time and 27% have higher distance to metro as compared to main line haul (MLH) and suggested using bicycle as a feeder mode for solution.

The second role of walking and cycling as a main mode may be justified in Indian cities by the low trip distance found (Table 5) and the percentage of poor people in urban areas with no other travel option, Tiwari (1999). While mentioning the role of non-motorized modes in India its quite necessary to point out the fact that Indian cities are very much diverse with respect to the earlier mentioned factors and also with respect to their sizes (population wise and area wise). So there is a complete need for defining the role of non-motorized traffic with respect to this diversity because a planning in general terms will lead to a failure in providing an effective and efficient infrastructure.

Litman (2010) suggests various strategies for promoting non-motorized travel as shown in Table 8. Similar works were done by Buis (2000) and Rastogi (2009) also.

Non-motorized modes are neglected presently in the planning process. One of the reasons for this neglect is the lack of acceptability of non-motorized mode among policy makers as a main mode. The main factor which makes the policy makers disdain its role is the lack of understanding of the economic benefits they offer. In policy makers opinion motorized mode provide revenue to the government by way of taxes but non-motorized modes do not. In order to change this attitude a complete understanding regarding

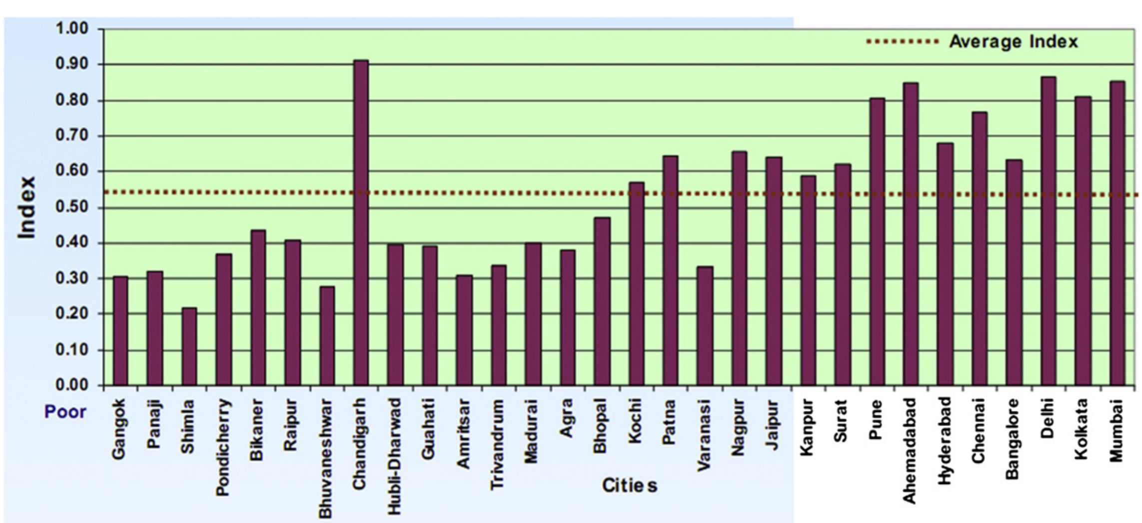

Fig. 2. Walkability index. Source Ministry of Urban Development, 2008.

Table 7
Percentage of bicycle and pedestrian accidents in various Indian cities.

Sl. No	Name of the city	Bicycle (%) accidents	Pedestrian (%) accidents
1	Agra	4	6
2	Bhopal	2	4
3	Kochi	11	14
4	Nagpur	14	25
5	Jaipur	2	7
6	Kanpur	10	7
7	Surat	4	43
8	Pune	3	13
9	Bangalore	5	44
10	Ahmedabad	10	0
11	Chennai	2	5
12	Hyderabad	5	19
13	Kolkata	5	64
14	Delhi	6	24
15	Mumbai	3	35

Source: Ministry of Urban Development, 2008.

the economic benefits of non-motorized traffic is necessary. Next part of our study deals with understanding the potential economic impacts of non-motorized traffic.

5. Past studies on economic impact assessment of non-motorized modes

The economic benefits of the non-motorized traffic have been a matter of discussion in both the policy and research circles across the globe for a long time. Even though initially policy makers were not contained with the idea of economic benefits of non-motorized traffic, the tide has turned around. This may be mainly attributed to the numerous studies done focusing on their economic aspects and cost benefit analysis. One such work worth mentioning here is that of Litman (2010) who comprehensively analyzed the economic benefits of non-motorized modes and proposed that some of the costs associated with motorized traffic could be expressed in $ per mile of total distance traveled which can then be used to calculate the potential savings due to the shift from motorized traffic to non-motorized traffic. He pointed out that an evaluation of non-motorized traffic benefits should be done based on a clear understanding of the following factors: improved non-motorized condition to existing users, increased non-motorized travel and reduced motorized travel. The various benefits used by him in his study were congestion reduction, roadway cost savings, vehicle cost savings, parking costs (per trip), air pollution reduction, noise pollution reduction, energy conservation, traffic safety benefits, health and fitness benefits, improved mobility for non-drivers, strategic land use objectives, economic development, user enjoyment, community livability, additional environmental benefits.

Elvik (1999) in his work pointed to the necessity of including; changes in the amount of walking and cycling, changes in travel time for pedestrians and cyclists, changes in road user insecurity (feeling of safety), and changes in road user health state; in cost benefit analysis for determining the economic impact of bicycling and walking. He also provided hypothetical examples with these impacts included. Similarly Rastogi (2009) identified the benefits of non-motorized modes on comparison with motorized modes as more traffic handling capacity, less space requirement, less cost of infrastructure and material requirement along with low energy consumption, environment emission and social cost; reduced congestion and operational cost, travel time cost, health cost, and accident cost.

Another pioneering work was done by Saelensminde (2004), who performed a cost benefit analysis of the three cities in Norway and found net cost benefit ratio to be greater than zero. He identified the cost of construction of new bicycle and pedestrian networks and based on certain assumptions he found out the average annual daily traffic (AADT) of non-motorized traffic and projected the future AADT. Then he calculated the reduced costs due to each benefits after which he did the benefit cost analysis. Earlier Buis (2000) had pointed out that the cost benefit analysis of the cycling facilities based on their economic benefits could put non-motorized traffic like bicycle in the political agenda. He not only listed out the various economic benefits of the bicycle use but also provided case studies of four cities. The various economic benefits for cycling listed out by him were reduction in the costs of traffic and transport facilities, accessibility and use of space, the urban economy and the quality of life, improved environment and health, traffic safety, increased employment, reduced travel costs and individual mobility. He identified the cost benefit ratio with respect to a road in Vikasmarg in Delhi as 1:20 and even concluded that cost benefit ratio was higher in those cities where so far nothing has been done with respect to bicycles.

Korve and Niemeier (2002) perfor`bicycle phase at an intersection. Considering only the benefit of reduced traffic accidents and a period of projection of 20 years they found a benefit cost ratio of 7.98. They even performed a sensitivity analysis taking conservative values and found that benefit cost ratio gives positive values except under certain extreme conditions. Similarly 'A Report to cycling England' (2007) also specified certain economic benefits and worked out the savings due to increase in cycling distance in the future years. All the works mentioned above tried to attach a monetized value to the benefits of non-motorized traffic which could be achieved on promoting it.

Krizek (2007), pp. 219–248 did a review of the various works done in estimating the economic benefits of cycle and suggested methods and strategies for doing such works. He pointed out the necessity of providing facilities for non-motorized vehicles so as to promote transfer from motorized vehicle to non-motorized vehicle and implied to identify the impact of such a project in present and future and then impute them an economic value. In his review he identified all the cost benefit studies done till date as showing benefits exceeding costs and also described the necessity for

Table 8
Strategies to improve non-motorized travel.

Improves transport options	Price Incentives	Land use management	Implementation programs
Transit improvements	Congestion pricing	Smart growth	Commute trip reduction programs
Walking improvements	Distance-based fees	New urbanism	School and campus transport management
Cycling improvements	Employee transportation benefits	Location-efficient development	Tourist transport management
Bicycle parking facilities	Parking cash out	Parking management	Transit marketing
Bike/transit integration	Parking pricing	Transit oriented development	Non-motorized encouragement
Guaranteed ride home	Pay-as-you-drive	Car free planning	
	Vehicle insurance	Traffic calming	
	Fuel tax increases		

Source: Litman (2010).

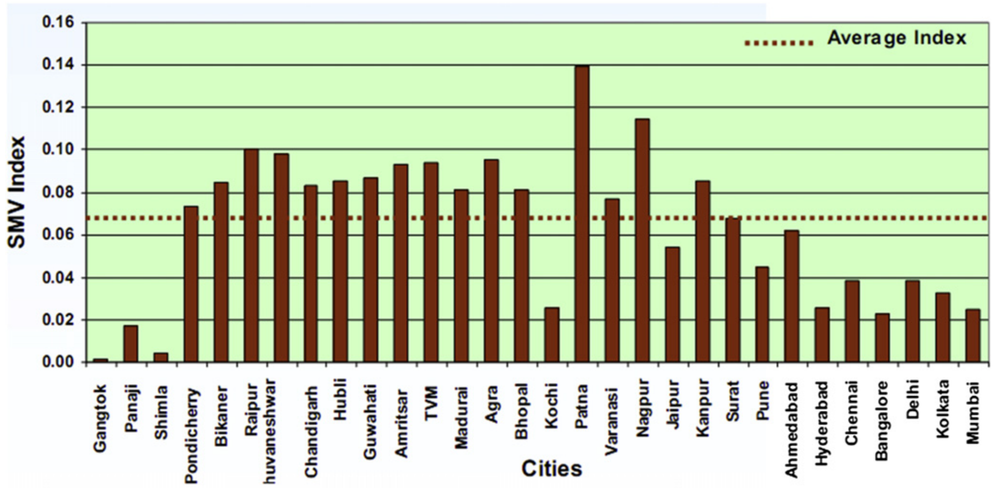

Fig. 3. Slow moving vehicle index. Source Ministry of Urban Development, 2008.

expressing the monetary benefits in a common unit and the difficulty in achieving the same.

Lindsey, Man, Payton, & Dickson (2004) in their work identified the positive effects of property values and recreational values along the urban green ways with multi user trial. This study indicated the economic significance of walking and cycling resulting in an increased property values and recreation values. Lindsey also pointed out that estimated outcome may vary for different green ways. Flusche (2009) emphasized the huge potential of bicycling in promoting tourism. He estimated bicycling industry to be contributing an amount $133 billion a year to the U.S. economy and supporting nearly 1.1 million jobs and generating $17.7 billion by federal, state, and local taxes. Also estimated was an amount of $46.9 billion generated by food, transportation, lodging, gifts and entertainment during bike trips and tours.

Litman (2011) in his work described various methods which can be used to monetize the impacts of non-motorized traffic like the user savings, social cost savings, control costs, contingent valuation surveys, revealed preference studies, hedonic pricing studies and compensation rates. These methods were actually techniques used for valuing non market goods which are generally not traded in the market.

In India the NUTP (National Urban Transport Policy) developed by Ministry of Urban Development, Govt. of India in 2006, emphasized on developing sustainable transportation technologies for India and envisaged the role of non-motorized traffic in achieving it. According to Rastogi (2009) “the present transport system which give importance to providing and improving mobility at the cost of accessibility have resulted in degradation of environment (air, water and noise pollution), increase in social cost imposed by transportation like health cost, accident cost, congestion cost, etc. and economic burdens like cost of time lost in transportation, employment opportunities lost, higher cost of transportation, etc”. But even with a clear understanding of the importance of non-motorized traffic, in India there is a clear dearth of studies done with respect to the economic benefits of non-motorized traffic. Economic aspects form a major platform within which decisions are formed with in the policy circles.

In the next section a methodology for evaluating the economic impacts of certain NMT benefits in India is formulated. Then a case study of Bangalore city is taken. As a first part the monetary values of benefits are found out per kilometer using the existing data and the total savings in Indian Rupees (Rs.) per day are worked out for the entire city of Bangalore for a potential 1% mode shift to NMT from the current total distance traveled by motor vehicles, considering improvements in the NMT facilities. In the second case study the economic benefits of pedestrianizing a major arterial called M.G road at Bangalore is determined and the savings per day are worked out for the air pollution reduction and accident reduction benefits.

6. Methodology to determine economic impacts of NMT for the case study

While formulating the methodology the economic benefits are divided in to qualitative and quantitative benefits. Quantitative benefits are those which can be quantified and an economic value could be found in monetary units. While qualitative benefits are those which can only be rated by the people on the basis of requirement but will indirectly provide some monetary advantage. The quantitative benefits which are considered in the case study are those caused due to the decrease in number of motorized vehicle such as reduction in – vehicle operating costs, air pollution cost, congestion cost and accidents cost. The qualitative benefits taken are health cost, community livability and user enjoyment. Here community livability indirectly increases the price of land in an area, user enjoyment reduces the money spend on recreational facilities like parks and persons willingness to rate non-motorized modes as a requirement for health will actually reduce the sum spent by them on health care. Fig. 4 depicts a procedure developed by authors for determination of quantitative and qualitative impacts of NMT.

6.1. Procedure developed for determining economic impacts of NMT

6.1.1. Quantitative benefits

1) Delineate the study area

Here one needs to identify the particular city or study area of which economic impacts are to be determined. Majority of the trips inside city should be internal trips as is the case with urban centers. This case is specified because our aim is to identify the short trips

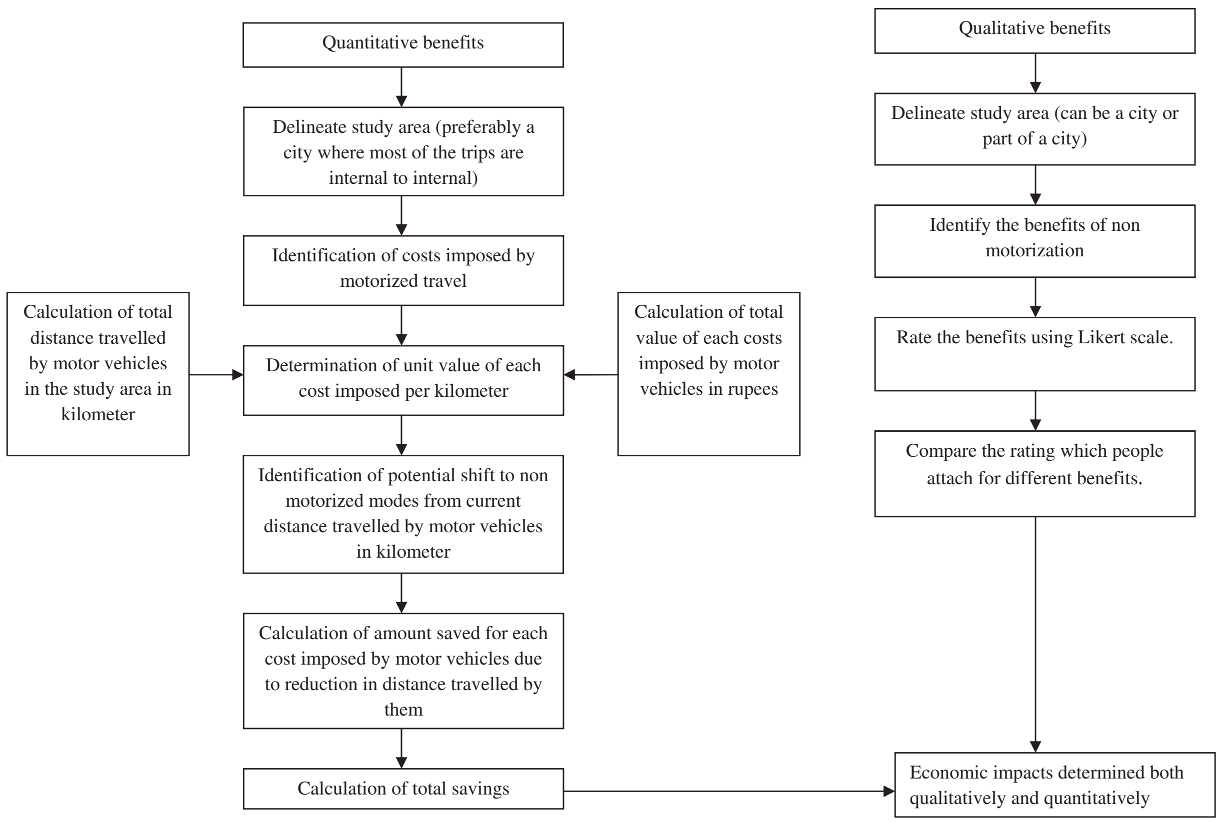

Fig. 4. Methodology developed for calculating economic benefits of NMT.

within city which have a potential to be converted to non-motorized modes.

2) Identification of costs imposed by motorized travel based on the data collected
3) Determination of unit value of each cost imposed per kilometer

The costs imposed by the motorized travel have to be determined per kilometer of total distance traveled by them. This can be done from the data pertaining to the total distance traveled by motor vehicles and the total value of each costs imposed by them. For example: total costs caused to health by pollution in city of Bangalore divided by the total distance traveled by motor vehicles will give costs caused per kilometer due to air pollution.

4) Determination of potential shift

Identify the expected potential shift to NMT from the existing distance traveled by the motor vehicles on improvement in their facilities and by non-motorized friendly policies. This shift is expected mainly from short distance trips of less than 5 km.

5) Calculation of amount saved for each costs imposed by motor vehicles due to reduction in distance traveled by them.
6) Calculate total savings – Add all costs saved to give the total benefits.

6.1.2. *Qualitative benefits*

1) Delineate the study area

It can be a city or a part of the city since it mainly consists of open questionnaires to know about people's opinion.

2) Identify the expected qualitative economic benefits of non motorization.
3) Rate the benefits using a Likert scale.

Likert scale is used to rate the response of the user in a five point scale (very much needed, much needed, needed, not much needed, not needed), Amistad (2010). This can be used to determine peoples attached view on identified qualitative benefits. The rates received by the various benefits will provide an idea about the order of preference of these benefits in the mind of people.

4) Compare the rating which people attach for different benefits.

On comparing the mean of ratings of each benefit one will be able to determine the variation of economic significance which people attach to these benefits.

7. Case study 1

The two case study presented in this paper will put lime light on the huge economic benefit potential of non-motorized improvements in the city of Bangalore. The first case study presents quantitative benefits occurring as a result of reduction in the distance traveled by motorized vehicles, owing to potential mode shift of 1% of total trips below 5 km to NMT, assuming improvements in the NMT facilities.

7.1. *Bangalore city present scenario*

As per the report of Ministry of Urban development (2008), the walkability index for Bangalore is 0.63. Even though it is greater than the national average, the CTTP report (2007) for Bangalore

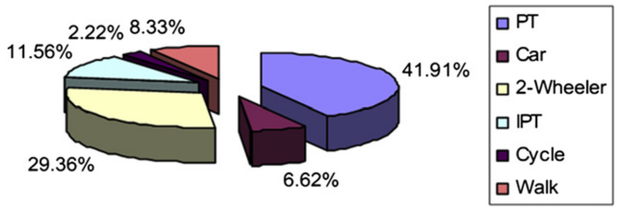

Fig. 5. Modal split in Bangalore. Source: CTTP report (2007).

Table 9
Shift potential in Mumbai toward walking and cycling.

Situation	Percent shift potential			
	Vile Parle (East)	Ghatkopar (East)	Up to 1250 m	Outside 1250 m
Objective responses	04.40	10.15	08.14	07.40
Environment benefits statement	12.50	11.50	6.03	10.93
Limitation of use of mode	07.50	09.00	10.71	08.01
Modified facility scenario	06.00	11.00	4.41	7.38
Subjective response: maximum	10.70	13.86	10.07	11.39
minimum	06.40	08.28	6.04	6.83

Reference: Rastogi (2010).

specifies the poor state of pedestrian facilities prevailing in the city. The foot paths in many parts of the commercial areas are occupied or encroached by hawkers and vendors which force the pedestrians to spill on to the road. Adding to the difficulty is the narrow widths and poor surface of foot paths and lack of pedestrian crossing facilities. Presently there are no cycling facilities provided in the entire city of Bangalore. Accordingly the slow moving vehicle index for Bangalore, as determined in the report of Ministry of Urban development (2008), is 0.02 which is very less and the percentage of accidents involving non-motorized traffic is found to be around 49%. But in spite of all these difficulties, non-motorized traffic still contributes a share of 10.55% of the total passenger trips. Fig. 5 shows the modal split in Bangalore for the year 2007.

Saelensminde (2004) in his work assumed that new cycle tracks and walking tracks would attract 15% of current journeys below 5 km made by car or public transit. Supporting this notion Krizek (2007), pp. 219–248 pointed out that separate bicycle facilities will improve public perception of safety which in turn will encourage cycling. From the above literature it is reasonable to conclude that there are a number of commuters in Bangalore who doesn't use non-motorized modes due to the lack of proper facilities. Similarly, Rastogi (2010) in his study calculated the shift potential for walking and bicycling for accessing transit in Mumbai on improving their facilities. The results of this study are given in Table 9.

Here under the subjective response criteria, where a person indicates his willingness after understanding the uses and limitations of non-motorized traffic, the minimum shift expected was 6.04%. It points at the huge potential of shift toward non-motorized traffic on improving the facilities and making people aware of its advantages. For the present case study, saving in the total distance traveled below 5 km due to 1% mode shift from motorized vehicles to non-motorized vehicles is quantified and converted to economic benefits. This is quite a conservative estimate of modal shift considering the studies of Rastogi (2010) and Saelensminde (2004) who obtained a shift of 6% and 15% respectively.

The next sub-sections discuss this process of quantification.

Table 11
Vehicle fuel cost.

Vehicle	Cost (Rs./veh-Km)
Car	3.31
2-wheeler	1.12

Source: CTTP report (2007).

7.2. Total distance traveled by motorized modes

According to the CTTP report (2007), the total number of passenger trips in Bangalore is 6,285,680. The report also specifies the number of trips made by each mode. By multiplying these trips with the average distance traveled by passenger in each mode, the total passenger distance traveled in each mode is found out and then based on the average occupancy of each mode from CTTP report the total vehicle distance traveled by motorized modes (Table 10) are worked out.

7.3. Monetization of benefits

The scarcity in the data availability played a crucial role while identifying the economic value of benefits. For majority of the calculations in the case study data are used from the CTTP report (2007). The air pollution reduction benefit uses data from 2002 and accident reduction benefit uses data from 2008. And so the costs produced by the motorized vehicle in Rs./Km calculated using the above data can be assumed highly conservative considering the huge urbanization gallop which Bangalore has done in the recent years. It is these costs which can be saved due to mode shift to NMT appear as the monetized value of the benefits of non-motorized traffic. The methodology for calculation of economic benefits is shown in Fig. 4.

7.3.1. Vehicle costs (fuel saving)

Vehicle cost consists of costs which a motorized vehicle incurs during their journey mainly as fuel cost, maintenance cost, insurance etc. Litman (2010) estimated vehicle cost savings of 25 Cents per mile under urban-peak conditions, 20 Cents per mile under urban off-peak conditions, and 15 Cents per mile under rural conditions. The average value of vehicle operation costs considering only the fuel cost identified by CTTP report (2007) for Bangalore, is given in Table 11.

For the buses, mileage of 4.3 km/L is taken as per Low Carbon Life Styles, Centre for Environment Education (2010) and considering a fuel cost of 40 Rs./L, the average fuel cost is arrived as

Table 10
Total distance traveled by motorized modes.

Mode	Mode share (%)[a]	Number of passenger-trips[a]	Average trip length (Km)[a]	Total distance (passenger-km)	Average occupancy (pers/veh)	Total distance (veh-km)
Bus	41.91	2,634,471	14.99	39,490,720.29	50	789,814.4058
Car	6.62	416,304	11.59	4,824,963.36	2.59[a]	1,862,920.216
2-wheeler	29.36	1,845,476	8.02	14,800,717.52	1.53[a]	9,673,671.582
3-wheeler	11.56	726,425	8.59	6,239,990.75	2.49[a]	2,506,020.382
Total						**14,832,426.59**

[a] Source: CTTP report (2007).

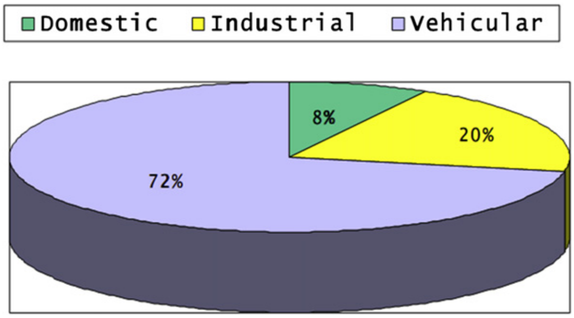

Fig. 6. Sector wise contribution in air pollution. Source: Sengupta (2001).

9.3 Rs./veh-Km. The average cost of all motorized modes taken together comes as 4.58 Rs./veh-Km.

7.3.2. Air pollution

Vehicles contribute a major chunk in the total pollution especially in urban areas and pose a major health threat to the communities living there. Understanding the economic implication of air pollution on health is an area of research actively pursued in various parts of the world. But in India still there is a dearth of such studies. The contribution of various sectors to the air pollution as given by Sengupta (2001) for the major cities in India is given in Fig. 6.

Kathuria (2002) identified contribution of vehicles to air pollution as 66% in Delhi, 52% in Bombay and about 32% in Calcutta. Regarding the economic implication of air pollution one of the prominent study was done by Delucchi (2000) who attached a value to the health cost caused by exposure to each pollutant in $/Kg for both high and low morbidity and mortality. He estimated this based on studies of the value of lost work days, of restricted activity, of tolerating certain symptoms of illness, and so on. Later this work was extended to Indian context by Sengupta and Mandal (2002). They transferred the health quality parameters determined by Delucchi in to Indian urban situation and determined the health cost in Rs./Kg.

(Table 12). This they did by considering various factors like difference in purchasing power of currencies of the two Economies, variation in the income level in PPP terms between the two countries, difference in population density and inflationary adjustment to convert the damage cost in 2000–01 Indian prices. The major pollutants contributing toward air pollution considered in this study were carbon monoxide (CO), oxides of nitrogen (NOX), particulate matter (PM) and hydrocarbon (HC). According to statistics of Ministry of Petroleum and Natural Gas the vehicular pollution occurring in the various cities in the year 2002 are as given in Table 13.

Due to lack of vehicle pollution data in Bangalore for the year 2007 the same data obtained in year 2002 (Table 13) is used and it is multiplied with the health cost due to pollutants as obtained by Sengupta and Mandal (Table 12) for determining the total health cost due to pollution. The total health cost is estimated as Rs. 257,827. This is a highly deflated value considering the present situation in Bangalore and points to the necessity of updating the data on both vehicle pollution load and health cost due to pollutants. On dividing this value with the total distance traveled by motorized vehicles we will get the air pollution cost per kilometer caused by the motorized traffic, which comes around 1.74 Paise/Km. Litman (2010) provided a value of 10 Cents per mile for urban-peak driving, 5 Cents for urban off-peak and 1 Cents for rural driving as air pollution cost. This value determined by Litman for urban-peak driving calculates around 0.09% of the Per Capita Personal Income estimated from the midyear population estimates of the Bureau of Census in USA for the year 2010. Similarly if we consider for India, a cost of 1.74 Paise/Km constitutes about 0.03% Per Capita Income for the year 2002. This difference in percentage may be attributed to the low level of pollution which existed in India in 2002. But if we consider the current scenario in India this share can be expected to increase due to the tremendously high industrialization in the recent past. Since non-motorized traffic does not cause any pollution the entire cost caused by the motorized traffic can be assumed to be saved, for the amount of distance saved due to mode shift to NMT.

7.3.3. Congestion costs

"Traffic congestion external costs consist of the incremental travel time, vehicle operating costs, stress and pollution emissions

Table 12
Health cost of pollutants (Rs./Kg).

Cities	CO	HC	NOX	PM
Agra	0.01	0.09	1.13	9.73
Ahmedabad	0.02	0.29	3.49	30.16
Allahabad	0.01	0.12	1.48	12.77
Amritsar	0.01	0.19	2.32	20.08
Asansol	0.00	0.05	0.63	5.43
Bangalore	0.015	0.19	2.33	20.12
Bhopal	0.00	0.06	0.69	5.95
Chennai	0.01	0.17	2.04	17.67
Coimbatore	0.01	0.08	0.98	8.51
Delhi	0.05	0.60	7.37	63.73
Dhanbad	0.00	0.03	0.36	3.09
Faridabad	0.01	0.12	1.51	13.05
Hyderabad	0.03	0.37	4.53	39.11
Indore	0.01	0.11	1.33	11.51
Jabalpur	0.00	0.05	0.67	5.80
Jaipur	0.01	0.14	1.68	14.52
Jamshedpur	0.00	0.04	0.53	4.60
Kanpur	0.007	0.09	1.08	9.35
Kochi	0.01	0.07	0.87	7.54
Kolkata	0.01	0.17	2.11	18.20
Lucknow	0.01	0.07	0.81	6.98
Ludhiana	0.02	0.23	2.80	24.23
Madurai	0.01	0.17	2.12	18.30
Meerut	0.00	0.06	0.79	6.83
Mumbai	0.03	0.40	4.87	42.05
Nagpur	0.02	0.21	2.57	22.17
Nasik	0.01	0.08	1.02	8.80
Patna	0.01	0.08	0.96	8.28
Pune	0.02	0.20	2.40	20.70
Rajkot	0.01	0.18	2.19	18.89
Surat	0.04	0.50	6.11	52.84
Vadodara	0.01	0.16	1.92	16.63
Varanasi	0.01	0.09	1.14	9.85
Vijayawada	0.01	0.16	1.99	17.21
Vishakhapatnam	0.01	0.09	1.12	9.67

Source: Sengupta and Mandal (2002).

Table 13
Vehicular pollution loads (tonnes/day) in eight Indian cities.

City	Carbon monoxide	Oxides of nitrogen	Hydrocarbons	Particulate matter
Agra	17.93	3.30	10.28	0.91
Bangalore	207.04	29.72	117.37	8.11
Chennai	177.00	27.3	95.64	7.29
Delhi	421.84	110.45	184.37	12.77
Hyderabad	163.95	36.89	90.09	8.00
Kanpur	28.73	7.25	11.70	1.91
Kolkata	137.50	54.09	47.63	10.80
Mumbai	189.55	46.37	89.93	10.58

Source: Central Pollution Control Board (2010).

Table 14
Travel time lost due to congestion in Bangalore.

Mode	Number of trips[a]	Number of congested trips	actual trip time (hrs)[b]	Ideal trip time (hrs)[b]	Cumulative actual trip time (h)	Cumulative ideal trip time (h)	Cumulative hours saved
Bus	2,634,471	1,844,130	1	0.37	1,844,130	682,328	1,161,802
Car	416,304	291,413	0.64	0.29	186,504	84,510	101,994
2-wheeler	1,845,476	1,291,833	0.40	0.20	516,733	258,367	258,366
3-wheeler	726,425	508,498	0.57	0.21	289,844	106,785	183,059
						Grand total	**1,705,221**

[a] Source: CTTP report (2007).
[b] Source: Gota and Mutalik (2007).

that each vehicle imposes on other road users, including impacts on motorists and non-motorized (called the barrier effect)", Litman (2010). He also identified a cost of 25 Cents per mile under urban peak conditions and 2 Cents per mile under urban off-peak conditions for congestion. Even studies done in India as mentioned in Mobility crisis Agenda for action, Centre for science and environment (2010) emphasize on the high fuel wastage and loss of time due to congestion. They pointed out that for each hour of idling, a vehicle lose about 0.5–1 L of fuel and also that due to congestion commuters in Delhi and National Capital Region (NCR) looses about 2–2.5 h every day to reach their destinations. In their work, Gota and Mutalik (2007) estimated a cost of Rs. 208 million per day as the congestion costs in Bangalore. They did it by identifying the approximate cost a traveler will spend per hour for his journey which comes around 91.35 Rs./h and the total number of hours lost due to congestion. Table 14 show the calculation of total number of hours lost due to congestion. Here the congested trips are taken 70% of total trips, Gota and Mutalik (2007). The total hours lost due to congestion comes out to be 1.7 million hours per day. Multiplying this with the average time cost of 91.35 Rs./h, the total congestion costs for Bangalore comes out to be Rs. 156 million. Dividing this by the total distance traveled by motorized vehicles the value comes around 10.50 Rs./Km.

7.3.4. Accident cost

It has been proved that providing facilities for non-motorized traffic will help in reducing their accident due to collision with motor vehicles. Korve and Niemeier (2002) in their study used the decrease in number of accidents for bicyclists due to an added bicycle phase as a benefit. As mentioned by Litman (2010) shift to non-motorized modes reduces the total per capita crash casualty rates in an area and also per capita collisions between motor vehicles and non-motorized travelers. These findings show a direct link between non-motorized mode accidents and the number of motorized vehicles. So for Bangalore also it has been assumed that a shift to non-motorized traffic will reduce the accidents. According to the NIMHANS fact sheet (2008) for Bangalore Injury Prevention Program, the city on an average is having 550 pedestrian deaths, 10,000 injuries and 40–50,000 minor injuries every year. And almost all of them were caused by the motorized vehicles. Partheeban et al. (2008) in their work estimated the cost incurring due to a fatal accident, a serious injury and minor injury for the city of Chennai. Their findings are given in Table 15.Here they assumed the consumption per month which gives an indication about the loss of productivity as 1700 Rs./month (1/3rd of the monthly income). They did not consider the cost due to human suffering, grief and pain which makes the estimate quite conservative. On assuming a same trend in Bangalore the total expenditure caused per day by the non-motorized vehicles accident can be tabulated as given in Table 16.

On dividing this value with the total distance traveled we get the accident cost as 0.1267 Rs./Km. Litman (2010) estimate this value as 5 Cents per urban peak mile, 4 Cents per urban off-peak mile, and 3 Cents per rural mile. One fact to be noted here is that according to the data provide by the Labour Bureau (Government of India) Bangalore is having a higher Consumer Price Index (CPI) for industrial workers compared to Chennai which point to the high expenditure incurred in medical care in Bangalore. Even so due to lack of data authors here are forced to use Chennai Data and this one can assume to be leading to a low accident cost per kilometer in Bangalore.

Table 15
Average value of factors of accident cost.

Description	Average value		
	Fatal accident	Serious accident	Minor accident
Expectation of life (years)	60	60	60
Average age of accident victim (years)	30	30	30
Income per month (Rs.)	5200	5200	5200
Period of loss	30 years	60 days	7 days
Period of hospitalization (days)	5	25	1
Daily hospital Expenses (Rs.)	400	350	100
First time payment in the hospital (Rs.)	1000	8000	800
Court related expenses (Rs.)	2450	2500	500
Administrative expenses of Police, Insurance etc., (Rs.)	3110	3000	400
Consumption per month (Rs.)	1700	1700	1700

Source: Partheeban, Arunbabu, and Hemamalini (2008).

7.4. Mode shift to NMT and cost savings

In this case study, a mode shift of 1% of trips with total distance traveled below 5 km is assumed from motorized vehicles to non-motorized vehicles, if the facilities for non-motorized traffic are improved in Bangalore. This is quite a conservative estimate considering the studies of Rastogi (2010) and Saelensminde (2004) who assumed a shift of 6% and 15% respectively, for the similar case. Table 17 gives the total distance traveled by motor vehicles under 5 km. Here 1% of the grand total comes around 16,357.81 km.

Table 18 gives the total cost savings due to 1% of mode shift to NMT. The savings comes as **Rs. 249,068 per day** for the assumed shift.

Table 16
Accident cost calculation.

Accident intensity	Accidents/ year[a]	Cost (Rs.)/ accident[b]	Total accident cost in a year (million Rs.)	Total accident cost in a day (Rs.)
Fatal	550	620,560	341	935,090
Serious	10,000	25,650	257	702,740
Minor	40,000	2197	87	240,731
			Grand total	**1,878,561**

[a] Source: NIMHANS fact sheet (2008).
[b] Calculated from Partheeban et al. (2008).

Table 17
Estimation of total distance traveled below 5 km.

Vehicle type	Number of trips (<2 km)[a]	Number of trips (2–5 km)[a]	Total distance traveled (passenger-Km)	Average occupancy	Total distance (veh-km)
Bus	197	117,434	411,216	50	8224.32
Car	46	27,809	97,378	2.59[a]	37,597.490
2-wheeler	142,633	482,306	1,830,704	1.53[a]	1,196,538.5
3-wheeler	0	279,891	979,619	2.49[a]	393,421.08
				Grand total	**1,635,781.4**

[a] Source: CTTP report (2007).

8. Case study 2

In this case study the economic benefits which could be attained by pedestrianizing a major arterial M.G road, which is also a major commercial hub of Bangalore, are discussed. Economic benefits are identified from the various literature and are both qualitative and quantitative. Quantitative benefits of air pollution and accident reduction are then monetized using the methodology mentioned earlier in this paper. Also a key factor which could play a huge role in the success of this pedestrianization scheme, the metro rail connectivity, is discussed.

8.1. Expected economic benefits of pedestrianization of M.G. road at Bangalore

M.G. Road is one of the major commercial hubs in Bangalore. Many establishments like banks, private and government offices, food courts, retail shops, shopping complex and places of religious importance are located along this road and also adjacent to it. It attracts persons from every part of the city and even tourists due to its popularity. The pedestrian volume and the vehicle volume, for 12 h, along the M.G. Road as determined in the CTTP report (2007) for Bangalore is 5366 and 9940, respectively. But a major portion of the above mentioned volumes occur during morning and evening peak hours. The pedestrian spill over to the main road due to huge crowding along the foot path is a common phenomenon along the road stretch. The main reason for this is the lack of width of foot paths catering to the huge pedestrian population. Adding to the woe is the huge volume of traffic. Frequent crossings of pedestrians occur as is the case with any commercial center and they find it very difficult to cross. This leads to frequent conflicts between pedestrians and vehicles. All these factors point to the necessity of pedestrianization of M.G. Road.

One of the major requirements which should be taken in to consideration while planning for pedestrianization is the accessibility to public transport or to private vehicles outside the area. In case of M.G. Road, the upcoming metro rail line will act as a major carrier of trips. Presently, this elevated line is under construction (to be shortly opened for operation) which is aligned parallel to M.G. Road and is placed on the median with a proposed stop in the middle section of M.G. Road from where it is easier to access various commercial locations by walk within a time span of less than 10 min Iranmanesh (2008) specified a 7 min walking distance between bus stops and shopping centers. In this case study we have tried to evaluate the expected benefits of pedestrianization of M.G. Road from the economic point of view, by considering and observing the similar economic benefits reported by various research studies for different case studies elsewhere.

8.1.1. Increase in retail income of the pedestrianized district

Li and Phyllis (1983) mentioned that a vehicle free environment will help retailer in providing a good exposure for their goods to customer. It will improve sale and thus increase profit. Even Iranmanesh (2008) supports this notion by mentioning that most of the pedestrian schemes established show an increase in the sales in that area. Kumar and Ross (2006) did a survey on Khao San Road in Bangkok and found that pedestrianization and traffic calming, in addition of making the street safer and more pleasant, also makes the retail sales go up. Table 19 gives a Percentage increase in pedestrian flow and retail sale in traffic free zones of selected districts due to pedestrianization. This clearly depicts a similar expected impact on M.G. Road, due to proposed pedestrianization.

8.1.2. Increase in rental price and occupancy

Increase in rental income is a byproduct of increase in sale. As the sale increases there will be an increase in demand which will in turn increase the rental income. This has been proved in the study done by Kumar and Ross (2006). In Germany also, it was found that the average rent increased by 50% in 11 cities as an impact of pedestrianization, Iranmanesh (2008).

8.1.3. Reduction in air pollution and noise pollution

All studies done with respect to pedestrianization such as by Li and Phyllis (1983), Kumar and Ross (2006), Iranmanesh (2008) have mentioned this as one of the major advantage. This will also result in economic benefit because pollution causes an economic burden on the community as determined in the earlier case study. Table 20 gives the Air pollution and noise level before and after implementation of traffic free zones of selected districts.

In the CTTP report (2007) the 12 h motor vehicle count at a particular point in M.G. Road was determined as 9940. Assuming this as the average vehicle count through M.G. Road in a day neglecting the meager traffic in the night time and that about 75% of this traffic covers the entire length of M.G. Road which is around 1.5 km, the number of vehicles covering the entire length of M.G. Road in a day can be estimated as 7455. On multiplying this count with the length of M.G. Road the total distance traversed by motor vehicles along the entire stretch of M.G. Road can be estimated and

Table 18
Total savings estimated.

Benefit	Cost (Rs./km)	Total cost (Rs.)
Vehicle costs (fuel saving)	4.58	74,919
Air pollution costs	0.0174	285
Congestion costs	10.50	1,71,792
Accident costs	0.1267	2072
	Total savings	**2,49,068**

Table 19
Percentage increase in pedestrian flow and retail sale in traffic free zones of selected districts.

Districts	Percentage increase	
	Pedestrian flow	Retail sale
Fresno	60	30
Kalamazoo	40	20
Miami	50	10
Norwich	43	10

Source: Li & Phyllis, 1983.

Table 20
Air pollution and noise level before and after implementation of traffic free zones of selected districts.

Districts	Air pollution level (ppm)		Noise (dba)	
	Before	After	Before	After
New York	22	8.0	78	58
Marselle	14.3	3.4	n.a	n.a
Goteburg	6.5	5.5	74	67
Cologne	8.0	1.0	70	45
Tokyo	14.2	2.9	n.a	n.a

Source: Li & Phyllis, 1983.

then on multiplying this distance this with the air pollution cost of 1.74 Paise/Km monetary savings due to pedestrianization of M.G. Road can be calculated. The total distance traversed along M.G. road along with the savings due to air pollution reduction comes as 11,182.5 km and 194.58 Rs./day respectively.

8.1.4. Safety improvement

As already mentioned in the previous case study accidents lead to a cost. According to Li and Phyllis (1983) if pedestrianization is included as part of a traffic management scheme it will help in reducing pedestrian vehicle conflicts and also enables a smooth vehicular flow. So it is logical to assume that pedestrianization of M.G. Road will also reduce accidents providing an economic benefit. Similarly as in the air pollution benefit, on multiplying the total distance of 11,182.5 km traversed by motor vehicles along the entire stretch of M.G. Road with an accident cost of 12.67 Paise/Km one can calculate the monetary savings due to reduction in accidents and it comes around 1416. 82 Rs./day.

8.1.5. User enjoyment and health improvement

Litman (2010) mentioned aspect of walking and cycling as a means of recreation for people. Pedestrianized areas could thus be used by people for recreation. It will improve the health of users thus providing a health benefit and as pointed out by Litman (2010) also prevent huge sums of money spend by communities on parks and other recreation facility, which is again an economic benefit.

9. Summary and conclusion

The present study identifies the necessity, problems, favorable conditions and economic benefits of non-motorized traffic with respect to sustainability, typically in Indian context. Two case studies are presented; the first case study provides a framework for monetization of these benefits with the help of present data available and calculates the total savings for the city of Bangalore for an expected percentage of modal shift to NMT. The second case study tries to identify the expected economic benefits of pedestrianizing a major arterial and commercial hub M.G. Road in Bangalore. Since this study highlights the economic benefits and a framework to calculate the same, of promoting non-motorized transport, it will provide policy makers a decision support while planning and implementing economic schemes. Following are the salient points derived from the study:

a) There is a necessity and huge potential for non-motorized mode inclusive development in India. So there is an urgent requirement for policy makers to include non-motorized transport in their agenda. Researchers also need to contribute to confront the issues in developing and planning non-motorized traffic considering India's diversity aspect. They need to clearly define the role of non-motorized modes and have to envisage ways in which these roles could be implemented.
b) An economic savings of Rs. 0.25 million per day, due to 1% mode shift from motorized transport to NMT for trips below the length of 5 km, points to the immense potential of non-motorized traffic in achieving the goals of sustainability and such a considerable savings for a small shift underlines the necessity of including it in the development agenda for the Bangalore city.
c) Out of the four benefits considered in first case study the benefits in congestion cost are substantial. This can be attributed to the enormous amount of time lost by vehicles while traveling on road. Another factor which triggers it is the high value of money spent per hour by the trip makers of Bangalore. It also indirectly points to the benefit which people will value the most and identify with, and on which the policy makers can thrust, if they are going for a non-motorized drive.
d) In the first case study a number of other benefits like reduced social cost, infrastructure cost, health costs, improved community livability etc. are not included. On including these benefits, savings can be expected to go high. The expected high value of these benefits can be supported by the benefit cost ratio of 20:1 which Buis (2000) estimated for developing cycle track along a road in Delhi.
e) The pedestrianization of M.G. Road can attract more people to the area thus providing an overall economic benefit. But it has to be compatible with the easy availability of public transit in that area, which is quite feasible with the upcoming metro rail line. The air pollution reduction and accident reduction due to pedestrianization of M.G. Road together produce a monetary savings of 1611.4 Rs./day.

10. Limitations of the study

Most of the studies done on NMT in India are concentrated on few cities/areas. India is a land of diversity and non-motorized traffic entities are clearly linked with the behavior, attitude and composition of the people in an area. The requirement in one area may not be same in other.

In the first case study done for Bangalore the accident costs are identified based on the collision of motorized vehicles with pedestrians as that was the only data available. But it is argued in some studies that an increase in non-motorized traffic will cause more accidents since they are the most vulnerable group. Even Litman (2010) have mentioned that in walking and cycling the per mile accident rate is more. But again as they justified, it is assumed here that proper safety facilities are provided for the non-motorized traffic. Also, the National Urban Transport Policy (NUTP) for India have set their vision to address safety concerns of cyclists and pedestrians by encouraging the construction of segregated rights of way for bicycles and pedestrians. Further, due to scarcity of data available the costs are found on an average basis for the entire day. It would be very interesting to see how these costs will vary for urban off peak and peak period as in the work of Litman (2010). More over an exact shift of the passengers could be found out using preference surveys to quantify the economic benefits.

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