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NEEDS FOR NATIONAL BICYCLE SCHEMES IN ASIA

(Background Paper for Plenary Session 6 of the Provisional Programme)

Final Draft

This background paper has been prepared by Roelof Wittink, Anvita Arora and Tom Godefrooij, for the Seventh Regional EST Forum in Asia. The views expressed herein are those of the authors only and do not necessarily reflect the views of the United Nations.

Needs for National Bicycle Schemes in Asia

Draft background paper for the EST conference in Bali

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To be discussed and completed

1. Introduction Cycling in South East Asia

1.1. Terms of reference for this project

Non-motorized transport (NMT) or rather Active Transport especially bicycle have played an important role for clean, safe and effective mode of urban transport worldwide, particularly in developing countries. Thus, the implementation of safe, dedicated cycling infrastructure not only provide effective mode of transportation but also enhance the economical growth, social inclusion, healthy society and environmental protection. Since NMT will continue to be the part of overall transportation system in developing countries, cycling should be taken into account to enhance the efficient and effective way of the public transport system.

The United Nations Centre for Regional Development UNCRD is promoting Environmentally Sustainable Transport (EST) in Asia by initiating a range of activities, including formulation of national strategies with short and long-term actions and establishment of a Regional EST Forum. The Bangkok Declaration of 2020 and the outcome of the integrated conference of the Urban Mobility India and Sixth Regional EST-Forum in Asia in New Delhi 2011, asks for a fine mashed and well integrated pedestrian facilities and cycle network in member's countries. It adds: "Workability and cycling can significantly be improved to provide local access and connections between modes. (...) Priority is to be given to the construction of footpaths and cycle tracks as part of design and connection of roads. (...) There is a need to protect NMT infrastructure against encroachment through strict enforcement and community participation measures. (...) All cities need to encourage walking and cycling and to design cities that reduce mobility and increase accessibility. This approach needs to look at a basket of solutions. There is a need to restrain car and motorized two wheeler transport, and instead serve sustainable modes in the most optimal way".

More than 1.2 million people are killed only by the road accident worldwide, out of which about 10 % in India. Most of those victims are bicyclists and pedestrians due to lack of adequate, dedicated bicycle lane and walkways. Transport related air and noise pollutions, huge congestion, obesity and environment degradation are the other common transport problems in India which have increased premature deaths, environmental hazard and degrade the overall quality of life. In addition, excess CO2 and green house gas emission due to motorization would enhance the rate of global warming and climate changes are other burning issues in India. Similarly, millions of urban citizens in India do not have access to location where they can find better workplaces and generate more income, make use of public services, and improve their living standards. These negative consequences of transport sectors in India, if calculated in terms of money, go up to 10% of the total GDP, which clearly indicate that India faces serious problems as the consequence of the current traffic and transport system, therefore urgent change is essential for the sustainable development of the country.

The integrated conference of the Urban Mobility India and Sixth Regional EST-Forum in Asia in New Delhi held in December 2011 stated; "Mobility and accessibility are in the centre of

the sustainable transport which not only enhance economical growth but also improve social equity, health, resilience of cities, urban-rural linkages and productivity of the rural areas". Therefore, the introduction of the NMT particularly dedicated to bicycle infrastructure and good walkway facilities provide efficient mobility which increases connectivity and accessibility in India".

Cities and countries that promote cycling, show a particular interest in public bike schemes. Public bikes seem to work as a showcase that a new or another cycling culture is growing. A city that wants to have a profile as a cycling culture, delivers quickly first results with a public bike scheme. The rapid expansion of public schemes is a manifestation of the rising agenda for cycling. Cities follow the successes with these schemes elsewhere. The UNCRD and the Ministry for Urban Development in India an interest to know better the function public bike schemes might have for sustainable mobility.

Hence, the UNCRD and MoUD asked the Dutch Cycling Embassy and I-Trans Delhi, to propose how comprehensive public bicycle scheme can be operated in the different cities of India in the best way to serve "safe, clean, cheap, fast, reliable and efficient mobility which will increase accessibility and connectivity, and enhance economic activities in Indian cities helping make cities more self sustainable, resilient, and more socio-economical co-benefit, particularly for urban poor".

Since cycling is currently regarded as a poor man's means of transport in Indian society, it would be necessary to improve its brand image, and make bicycling is a fashion and part of city life. However, there are number of factors to be considered to determine the effectiveness of bicycling transport in contributing the health of the city economy as well as the impact on the quality of life in the Indian cities. In addressing the very wide ranging questions, the consultant should refer to the experience different part of the world including the Netherlands, and will apply good practices which fit within the Indian context to make bicycle an important transport mode again. And the consultant will come with recommendations paying particular attention to how to launch more effective and sustainable public bike scheme in India providing alternative of private motorized mode and developing bicycling as a culture.

It is against this background that the UNCRD asked the Dutch Cycling Embassy to deliver a report on public bike schemes in the context of India and to establish a partnership with I-Trans Delhi for this. The consultant will come with recommendations paying particular attention to how to launch more effective and sustainable public bike scheme in India providing alternative of private motorized mode and developing bicycling as a culture. The consultant should refer to the experience different parts of the world including the Netherlands, and will apply good practices which fit within the Indian context to make bicycle an important transport mode.

2. Benefits of cycling, current cycling in India and planning for cycling

Before we enter into the function, public bike schemes might have, and into operational aspects, we present an overview of the benefits of cycling, current cycling in India and the planning for cycling provisions, to sketch the policy context for public bike schemes.

2.1. Benefits of cycling for Indian cities

As a single mode, cycling can improve accessibility. Currently worldwide, rough estimations indicate that more than 10% of people in the world do not have proper access to destinations that are important for their livelihood. This percentage will be higher in India. Compared to walking, cycling can enlarge an individual's radius of action within a given travel time budget with a factor 3 to 4 thus covering an area which is 9 to 16 times larger. Compared to public transport, cycling (as a single mode) is individual, is much more flexible, and has a high 'penetration ability'. Cycling can be used by all social classes, and thus contributes to accessibility in a very equitable manner. Accommodating cycling through the provision of more cycling friendly road conditions doesn't harm or exclude anyone. Public spending on cycling facilities is (in principle) beneficiary for all parts of the population.

Cycling can contribute to a better performance of public transport. Since cycling as a feeder mode can be 3 to 4 times faster than walking, the catchment area of public transport stops thus can become 9 to 16 times larger. If used intelligently one can build an integrated 'cycling and public system. Such an integrated transport system would optimise both the public transport route network and the (more local) cycling route networks. The latter should be optimally connected to the important public transport stations (or 'stops'), and these stations should offer the proper services (bicycle parking facilities).

Cycling can counter congestion. Attractive cycling conditions will help to moderate (or at least delay) people's aspirations to own and use a private car and current car owners may be tempted to substitute a part of their trips by cycling trips. But to utilise this potential co-benefit of bicycle use, the competitive position of cycling (in combination with public transport) should be improved substantially.

Cycling can improve road safety. Arguably, cyclists are vulnerable road users. But enhancing the cycling conditions, including taking measures to mitigate the number and speed of motor vehicles and to reduce risk at intersections, combined with a substantial increase of bicycle use will improve cyclists' road safety. 'Cycling promotion' and 'improving road safety' can result in a self-reinforcing interaction of these two policies; the so-called 'safety by numbers' effect.

Cycling makes cities more attractive. The introduction of motorized transport has created urban structures that accommodate vehicular traffic rather than people. Children are amongst the groups that have suffered most of this at the cost of their scope to develop themselves as independent citizens. The promotion of cycling can help in a paradigm shift from vehicle oriented to people oriented transport planning. It can reintroduce the human scale in road design. And as a coherent network of cycling routes is one of the conditions for successful cycling promotion, it can help to overcome the severance effect of urban

highways by a change in priorities. As a consequence of increased cycling the dominance of motorized traffic in the ‘townscape’ will be moderated.

Cycling contributes to improving air quality and mitigating climate change if it substitutes short (often urban) motorized trips. Those trips contribute substantially to air quality problems (like SO_2, NO_x, PM) and the climate problem (CO_2). This substitution of private car trips by cycling is very relevant for developed countries. For India the relevance of cycling is also that promotion of cycling can help to prevent a shift to private motorized modes. Transport related CO_2 emissions are expected to increase 57% worldwide in the period 2005 – 2030, and it is estimated that transport (passenger and freight) in developing countries will contribute about 80 percent of this increase. The gains of cycling promotion should be measured against the expected trends in transport in a business as usual scenario.

Noise reduction. Motorized transport is also the cause of the noisy environment in large parts of our cities produced by a combination of engine noise and the interaction between tyre and road surface. (Not to mention the excessive use of horns by car drivers in Indian cities!) Both are correlated with driving speed. Given the restrictions of whatever mitigating measures it remains worthwhile to try and prevent this problem by promoting the use of non motorized modes of transport like cycling, and measures to discourage and restrict car use in sensitive urban areas.

Improved physical health. One of the (many) downsides of motorized transport is its enhancement of a sedentary lifestyle, with detrimental effects for individual and public health. But for many individuals it appears a too large appeal on their discipline to build in exercise as a specific activity in their activity pattern. The required (minimum) level of daily exercise (20 to 30 minutes moderate exercise) equals an average cycling commuter trip. Cycling commuters appear to have (on average) a substantial better physical health than commuters using other modes. According to a Lancet study “Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport” by James Woodcock, Prof. Mohan and Dr. Tiwari, 2009, shifting to more active travel modes by 2030 would decrease the burden of heart diseases by 25%, diabetes by 17%, road fatalities by 69% and depression by 7% in the city of Delhi.

Emission reduction: The strategy adopted to reduce emissions from the transport sector is best described as the avoid-shift-improve paradigm. Avoid travel by land-use and demand management, shift travel to sustainable modes like public transport and non-motorized modes, and improve vehicle and fuel technologies.

The Wilbur Smith report, 2008 states that between 60 to 90 percent of CO_2 emissions in India’s urban areas come from cars and MTWs, which is corroborated by the IPCC 2007 report, according to which the emissions per passenger-km of buses are lower than those for cars and MTWs. It must also be kept in mind that non-motorized transport (walking, cycling, cycle-rickshaws etc.) has no direct GHG emissions at all, while these modes currently support about 39 percent of trips in urban India. Though Indian cities have a good share of non-motorized transport, the challenge is to retain and improve their modal shares in the face of current trends. Many cities in Europe (e.g. Amsterdam and Copenhagen) with high car ownership took specific steps to prioritize bicycling as a mode, which has resulted in bicycling now contributing to over 30 percent of trips.

According to the report on Low Carbon Strategies, 2011 by Dr Kirit Parekh, if by 2020 we make an aggressive effort to increase public transport share by 8% and non-motorized transport share by 4% the resultant savings in CO_2 emissions are 29 MT, and in oil imports are 18,000 Cr for a 9% GDP growth (This is without change in technology or fuel). So apart from reducing GHG emissions, cycling would have a significant impact on the energy security of our country.

The mayor of London, Boris Johnson, presented in March 2013 a cycling plan for this city with a budget of 913 million British Pound and stated: “Cycling will create better places for everyone. It means less traffic, more trees, more places to sit and eat a sandwich. It means new life, new vitality and lower crime on underused streets. It means more seats on the tube, less competition for a parking place and fewer cars in front of yours at the lights”.

2.2. Current cycling in India and national policy

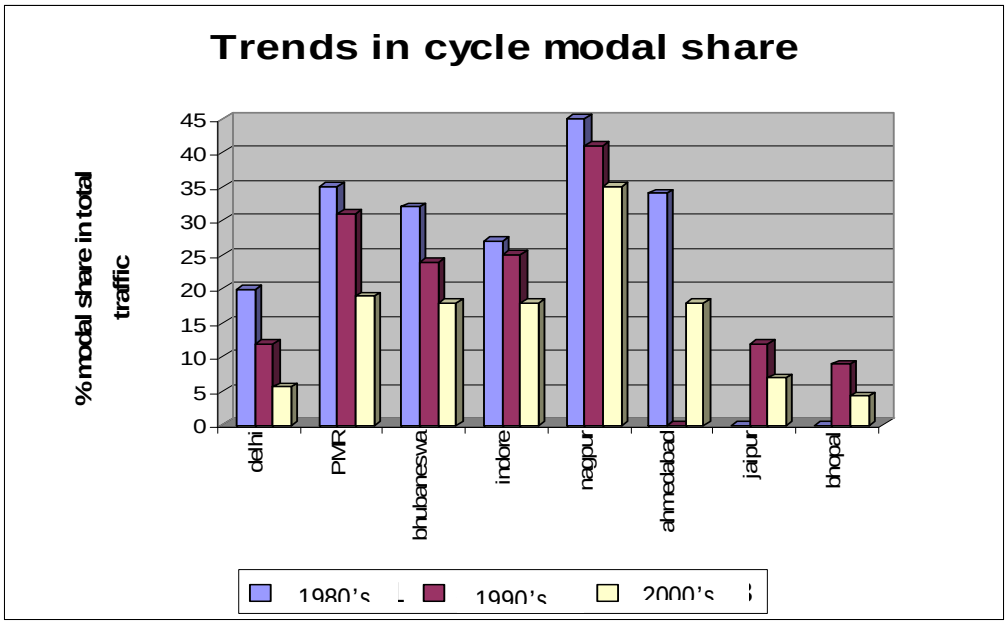
Indian cities are sprawling with unrestricted growth, the sprawl is leading to severe environmental degradation. While the share of public transport and non-motorized transport (walking and cycling) is declining there are low investments these sectors with the major share going to increasing road capacity for cars. It would be worthwhile to put effort in at least maintaining the existing levels of cycling and walking or even better: to actively promote their usage and to moderate the increase of the use of motorised modes. After all active transport (walking, cycling, cycle-rickshaws etc.) has no direct GHG emissions at all, while these modes currently support about 39 percent of trips in urban India.

Indian cities have still substantial trips on bicycles. Its use varies from 7-15% in large cities to 13-21% in medium and small cities. Its high ownership, low cost and easy use makes it in principle an attractive mode of transport for students and low income workers. But these shares were much higher 20 years ago and appear to come down very fast if we fail to stop the decline.

Communities in these cities have a latent demand for bicycles and walking trips, which can be realized with suitable facilities and resources. More bicycle trips will be attracted with a coherent, direct and safe bicycle infrastructure. However, the absence of safe infrastructure and high cycle fatalities deter these potential groups from shifting to bicycle use in large Indian cities.

A large amount of utility cycling is present in Indian cities because the bicycle is the most affordable form of transport available to low income households. However, Indian cities do not have bicycle infrastructure and bicyclists are forced to use the same carriageway as other motorized vehicle. Bicycle ownership is very high in all the cities. Most of the medium and large cities have 35% - 65% households owning one or more cycles as per Census 2001. Whereas in the smaller cities, it varies between 33% 48% (the exceptions being Mysore with only 27% households owning bicycles). There are 54.43% households in Ahmedabad and 63.4% households in Chandigarh owning one or more bicycle (Census 2001). In Delhi there are an estimated 0.96 million households (37.6%) owning bicycles in 2001. Indian policy makers and experts building roads have not been very supportive for creating bicycle infrastructure. The existing urban road guidelines which can be used effectively for creating bicycle infrastructure are not detailed enough in cities.

Indian cities have experienced a continuous decline in the shares of cycling and mostly the captive riders are using bicycles to meet the daily commuting needs. These developments suggest that the current road environment is not very attractive for cycling and that people give up cycling as soon as they can afford to use other modes. Availability of dedicated cycling infrastructure is likely to result in a less steep decline in bicycle use. This would imply that better cycling conditions could turn captive cycling into choice cycling.



Though declining, the bicycle ownership and the mode share of cycling is still high in Indian cities; with modal shares as high as 30% in mid-sized cities like Patna and Nagpur. Due to environmental and socio-economic reasons we cannot afford to let the shift from cycling to motorized 2 and 4 wheelers go unchecked in our cities and pro-active measures need to be taken at The National level to retain and in fact increase shares of cycling in Indian cities.

Bicycle Ownership and Per Capita Trip Rates (PCTR)

Bicycle ownership is very high in all the cities. Most of the medium and large cities have 35% - 65% households owning one or more cycles as per Census 2001; whereas in the smaller cities, it varies between 33% to 48% (the exceptions being Mysore with only 27% households owning bicycle). There are 54.43% households in Ahmedabad and 63.4% households in Chandigarh owning one or more bicycles (Census 2001). In Delhi there are an estimated 0.96 million households (37.6%) owning bicycles in 2001; about 1.2m to 1.4m trips per day (7-10%) are bicycle trips.

While experts suggests that bicycle use may decline over the years, there will still be a large number of non-motorized trips at the rate of 8% modal share by 2021 (MPD-2021). There is a significant reduction in non-motorized mode shares over the years - in Delhi, bicycle trips fell from 36 to 7% of trips by all vehicular modes between the years 1957 and 1994.

Trip Length Frequency Distribution

The average trip length for all vehicles excluding walk in small cities varies from 2.5 to 4.8 km. About 70 - 90% of the trips are less than 5 km and are short trips. Such short trips are ideal for non-motorized modes like bicycles. The average trip length for bicycles in small cities varies from 1.9 to 3.1 km. The average trip length for all vehicles excluding walk in medium and large cities varies from 4.2- 6.9 km; with the exception of Jaipur (8.6km). It is observed from the trip length frequency distribution that 56% to 72% trips are short trips (below 5km, cyclable distance). The average trip length for bicycle in medium and large cities varies from 3.1 to 4.5km. In Delhi the average trip length of all vehicles excluding walk is 10.66 km and for bicycle is 5.1km. About 35% of the total vehicular trips are short trips.

Bicycle as A Feeder Mode

Public transit systems play an important role in the urban transport network. Public and para-transit systems carry about 14% -25% of the total trips in medium cities. This share increases to 40% in Delhi. The various factors (e.g. access, egress, cost, age, income etc.) affecting the trip profile of a person determine public transit use. The access and egress links in a public transport chain greatly determine its ridership and success. Mostly these trips are made by non-motorized modes like walk, cycle or pedal rickshaws.

The results of bus users survey (TRIPP, 2005a) in Delhi shows that of the 3600 bus commuters surveyed, 20% owned cycles, but only 1% used it for access trips. 48% walk more than 500 m but less than 1 km and 9% walk more 1 km distance (because most of them are from the lower income group whose household income ranges from 1000 Rs. to 10,000 Rs.). If a bicycle friendly infrastructure is created, these 57% commuters can use bicycles for their access trips reducing travel time by approximately 33%. Also 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. It is also observed in the survey that 7% of bus commuters travel for short distances (access + main + egress < 5km). These people are likely to shift to the bicycle. (Advani,Tiwari, 2006).

Multimodal bicycle / transit trips expand the catchment area of public transit stations without the large expense and space requirements of automobile parking. Over longer distances, using the bicycle as a feeder mode for public transit can result in shorter trip times. If the public transit system transports bicycles, then a passenger's bicycle may also be used at the egress end of the trip (Allen, 1999). If the bicycle has to be promoted as an access mode to public transit, all facilities like secure parking at bus stops and safe cycling paths have to be considered.

Integration of the bicycle with the public transit network can enhance the travel potential for both modes of travel by offering a number of advantages. Bicycle to-transit services (trails, on-road bike lanes, and bike parking) enlarge the transit's catchment area by making it accessible to travelers who are beyond walking distances from transit stations.

2.3. Cycling On The National Policy Agenda

The National Urban Transport Policy (NUTP, 2006) envisions a focus on movement of people and goods rather than vehicles as the paradigm of transport planning leading to equitable allocation of road space with priority to public transport and non-motorized

transport. Since JnNURM investments in urban transport in cities have prerequisite condition to comply with the NUTP agenda, inclusion of facilities for walking and cycling is being highlighted.

The National Mission on Sustainable Habitats (NMSH, 2009) focuses on the greater use of non-motorized transport as an important strategy for reducing GHG emissions from Urban Transport and advocates the following action points:

1. investing in a segregated right of way for bicycles and pedestrians;
2. converting crowded areas like marketplaces into no-vehicle zones;
3. improving bicycle technology;
4. providing safer parking facilities for bicycles in workplaces;
5. launching a public cycle program on PPP;
6. organising cycle rickshaws through PPP; and finally,
7. promoting cycling and walking as healthy activities.

According to the report on Low Carbon Strategies for Inclusive Growth, 2011 by Dr Kirit Parekh for the Planning Commission, if by 2020 we make an aggressive effort to increase public transport share by 8% and non-motorized transport share by 4% the resultant savings in CO_2 emissions are 29 MT, and in oil imports are 18,000 Cr for a 9% GDP growth (This is without change in technology or fuel). So apart from reducing GHG emissions, cycling would have a significant impact on the energy security of our country.

2.4. Starting points for planning for cycling provisions

To design for cycling one needs a basic understanding of the characteristics of bicycle, cyclist and cycling. These characteristics can be summarized in 7 points:

- the bicycle is powered by muscles: a bicycle friendly road design keeps energy-loss to a minimum.
- the bicycle requires balancing from its rider: the cyclist will sway forward to stay upricht and needs some width to do so. Turbulence caused by cars, involuntary low speed means the use of more space.
- the bicycle has no crumple zone: cyclists are vulnerable and everything had to be applied to give them a spatial crumple zone to make anticipation possible.
- the (average) bicycle has hardly any suspension: cyclists prefer a smooth road surface.
- the cyclist rides in the open air: designers should take note of possibilities for keeping away wind and rain and sometimes the sun.
- cycling is mostly a social activity: cyclist want to ride side by side; riding side by side is a must for parents to escort their children safely.
- people are the key-factor: cycling is a multitasking activity; designers should respect this, avoiding complex situations overcharging the mental capacity of human being

These quality preferences can be translated into 5 main requirements for bicycle infrastructure. In short:

- perception and being able to ride side by side create requirements in the area of attractiveness and comfort;

- the minimisation of resistance creates requirements in the area of comfort and directness;
- the optimisation of mental capacity and the section of free space create requirements in the area of comfort and safety;
- the vulnerability of cyclists creates requirements in the area of safety;
- the need for a complete, comprehensible bicycle infrastructure creates requirements in the area of cohesion.

Generally speaking, if the minimum level of one or more of the 5 requirements cannot be met, the infrastructure must be modified.

2.5. The five main requirements explained

First main requirement: Coherence

As the word suggests, coherence means that the bicycle infrastructure forms a coherent whole. Furthermore the network has to provide connections between the all origins and destinations for cyclists, especially the most important ones. So coherence is about giving people the opportunity of going somewhere by bicycle, with integration with other means of transport, Metro, Bus, as well as making the whole journey by bike.

Elements that play a role in this regard include ease of way finding, consistency of quality and the freedom to choose different routes. And at the begin and end of the journey a possibility to park the bike safely.

Second main requirement: Directness

Directness means that the cyclist is always offered a route as direct as possible, thus keeping detour to an minimum. If the travelling time by bicycle is longer than by car, this is the major reason for people to use cars. On the other hand many motorists are willing to use the bicycle for short trips if it is quicker and more convenient. For people without a car, the bicycle gives, compared with walking, the possibility to lengthen the journey within the same time, thus enlarging their radius of action and bringing more destinations within cycling distance. Using the bike is less expensive and mostly there are not the problems and losing time in case of looking for a parking place.

All factors that influence the travelling time have been included, delays by traffic lights and by crossing busy main roads, detours, sharp curves and so on. Important is to shorten travel time and distance anyway.

Sometimes there are possibilities to create short cuts between roads; sometimes to admit two way bicycle traffic in one way roads; or to create two way cycle path at both sides of main roads to avoid crossing: all interventions that enhance the directness of the cycling network.

Third Main requirement: Safety

This requirement entails the bicycle infrastructure guaranteeing the safety of cyclists and other road users in traffic. Cyclists are vulnerable because they are in

the same space as motorised traffic, with the consistency of major differences in mass and speed. The cyclist does not have the benefit of external technical provisions such as cave constructions or crumple zones.

Designers are unable to exert any influence on this inherent vulnerability, but they are able to influence the conditions in which cyclists travel. One of the key points of this aspect is that encounters with fast motorised traffic should be avoided as much as possible by means of a separation in time or space. The importance of this requirement is confirmed by the accident figures. In towns and cities with a large number of busy intersections there are relatively more serious accidents involving bicycles than in urban environments with fewer busy intersections.

Safety is relevant on many different levels and can be influenced in a variety of ways. The requirements formulated as part of a sustainable safe traffic can play a leading role in the designing process. Some points of major interest:

- construction of extensive residential areas with mixed traffic and low speeds, maximum 30 km/h
- a minimum part of the journey on relative dangerous roads;
- combine the shortest and safest routes;
- avoid situations in which cyclists have to search to find their way;
- limit the number of traffic solutions and give them an plain design;
- separate different types of vehicles in case of higher mass and speed differences;
- reduce speed of motorised traffic at potential conflict locations.

Finally, cyclists are more vulnerable in dark or rainy weather: visibility in those conditions is a major important thing. Designers can prevent this problem by creating situations where the different road users can see each other long before they met.

Boiling down in a complementary approach:
- If high volumes and high speeds of motorized vehicles: segregated facilities
- If segregated facilities are not desirable or not possible: traffic calming

In all cases:
- avoid complexity
- allow for eye contact and interaction between all road users

Fourth main requirement; Comfort

This main requirement comprises factors that concern nuisance and delay caused by bottlenecks and shortcomings in the bicycle infrastructure. These leads to additional physical effort on the part of the cyclist. We know that not only extreme exertion but also interrupted journeys make cycling less enjoyable. Also does nuisance caused by vibrations because of a bad road surface.

The main message is to make a smooth pavement, to minimize the chance of stopping, avoid unnecessary narrowings and small radiuses, and nuisance caused by other traffic and weather.

Fifth main requirement: Attractiveness

Attractiveness means that the bicycle infrastructure fits into the surroundings in such a way that cycling becomes easy and relaxed.

Attractiveness includes the criterion “social safety”. Social insecurity is indisputable linked to the layout and the context of the surrounding. People feel safer in busy places and more important, potential offenders are deterred by the present of people. But even the busiest cycle route in a city can feel deserted and isolated in the evening or at night. For the designer this all means: the greatest yield in terms of social safety can be achieved at the level of network formation by ensuring that there is supervision and social control.

2.6. National Public Bicycle Scheme – initiatives by MoUD

While the NUTP and the NMSH lay out the vision statement and the macro-level approaches towards cycling inclusive planning in the country, there is a need to detail out each component of the larger agenda into actionable policies and implementable plans. Towards this end the MoUD is proposing to take the initiative to promote cycling in the country by launching a National Public Bicycle Scheme.

The Public Bicycle Schemes are schemes in which numbers of bicycles are made available for shared use by individuals who do not own them. Publicly shared bicycles are a mobility service, mainly useful in urban environment for proximity travels.

To ensure the success of the Scheme the MoUD is planning to take the following initiatives:

Develop a National Policy for promotion of Non-Motorized Transport in Indian cities:

- The National Policy would look at the status of cycling in India, benefits and barriers to cycling in India, importance of cycling in Public transport systems, and strategies to include informal cycle based systems like cycle rickshaws, vendors and bike-rental shops in National Policy. It would delineate policy implications on institutional restructuring, planning and design of cities, planning and design of networks and streets, infrastructural facilities like parking and education and enforcement. It would define a calculation of economic, environmental, and social benefits for cycling inclusive planning and advocate strategies to create active citizenship around cycling. It would give roadmap for promotion of schemes in Indian cities in three years.

Develop a Toolkit for Public Bicycle Scheme projects

- This toolkit would define the structural elements of the scheme like station and parking location and design, operational Systems, maintenance strategies, and IT systems for information, communication, revenue collection. It will propose an institutional structure for planning and implementation. It will also define the roles and responsibilities of different stakeholders like municipalities and development authorities, public transport providers, bicycle manufacturers, private investors, city police, RWAs and Civil Society organizations. It will suggest branding and marketing strategies for the PBS. It will advocate strategies to create active citizenship and user responsiveness to Public bike schemes. It will layout monitoring and evaluation Protocols including Service level

Benchmarks, service level agreements needed and performance based incentives and disincentives.

Develop Product design and Specifications for the Public Bike Schemes in India

- This will include detailed design specifications for design of bicycles, design of locking systems, design of parking stations, integration of IT systems in design of different components, design of information and transaction stands, and structures for ongoing research and development on product specifications

Propose Financing Mechanisms for Public Bicycle Schemes

- This will include financing models and development of a strategy for support, development of model concession agreement, identification of potential financial sources, fiscal incentives required, and propose a financing road-map for 3 years

3. Public Bicycle Schemes

3.1. Public bike schemes a catalyst for an improved cycling climate?

Public bike schemes can be a catalyst for other interventions to facilitate cycling and for an evolution of cycling policies. The interest for public bike schemes goes together with a general interest in the promotion of cycling in India, in the South East Asia region and worldwide. The rapid expansion of public schemes is a manifestation of the rising agenda for cycling. Cities follow the successes with these schemes elsewhere. Public bikes seem to work as a showcase that a new or another cycling culture is growing. A city that wants to have a profile as a cycling culture, delivers quickly first results with a public bike scheme.

Paris, a front runner with the Velib, accompanied the public scheme with retrofitting of infrastructure, allocating more space for cycling at the costs of cars. The city developed a cycling policy and public bikes were part of this. In Rio de Janeiro the first public bike scheme was developed in 2008 when the civil society organisation Transporte Ativo successfully started to campaign for the introduction of a speed limit of 30 km per hour in certain areas to increase road safety for pedestrians and cyclists. In the Netherlands, the so-called 'public transport bike' has been introduced in 2002 since train passengers arriving by bike at a train station expressed the need to also use a bike to arrive at the final destination of their trip. Here the public bike serves a seamless door-to-door trip for users of (particularly) the train system.

So we see that public bike schemes evoke other interventions to facilitate cycling or that interventions for cycling stimulate the interest in a public bike scheme. Still there are much more opportunities to use public bike schemes as a driver for cycling policies and the success of a public bike scheme will only increase when an integrated bike policy regarding facilities and promotion, will be developed.

But public bicycle schemas are no cure-all solution for urban traffic problems. In order to prevent a 'jumping to solutions' without proper consideration of the problems to be solved or the aims to be met by the implementation of a public bicycle scheme it is necessary to contemplate a number of foregoing questions. Questions like:

- What is a public bicycle scheme?
- What could be the function of such a scheme in the urban transport system? How to position public bikes strategically in policies to promote cycling and sustainable urban transport? What conditions make the use of public bikes efficient? A systems perspective
- What do these schemes add to the mobility options of the (potential) users? Who might be the target groups?
- What (additional) benefits can public bicycle schemes yield (and to whom)?
- For what type of problems can these schemes be a (part of) the solution and under which conditions?
- What different technical and organizational models can be applied for a public bicycle scheme.
- How to integrate them with bicycle parking strategies and policies?
- Which are possible appropriate financing mechanics in India?

- How to institutionalize the public bike schemes in Indian cities?

As each question will have various answers, it will become clear that depending on the context the potential role of public bicycle schemes in the urban transport system might differ as well as the way in which the scheme should be organized. That is why we start this chapter with some general observations on these questions.

3.2. What is a public bicycle scheme?

Public bicycle schemes are systems that make bicycles available for use by individuals that want to use a bicycle but don't have a private bicycle available. In fact public bicycle schemes enable people to cycle without the need to own a bicycle. The ownership of the bicycles is 'public' or 'shared'. That is why also the designation 'bike share system' is used. There are various attempts to define the difference between public bicycle or bike share schemes and the traditional 'rental bicycles'. In the table below some characteristics of rental versus public bicycles are summarized, as found in some publications. But in the real world several systems are a mixture of the characteristics being labelled as 'rental' and as 'public'. In fact we can conclude that there is no sharp distinction between the two, but there is a continuum from rental to public.

	Public Bikes	Rental Bikes
Customer base	Transport-oriented	Recreational-oriented
Revenue	Advertisement, basic subscriptions, subsidies and sponsorships	User fees
Aimed for	Short trips	Longer trips
Return	Drop-off other station allowed (one way trips)	Mostly same station (two way trips)
Membership	Annual memberships (mostly)	No memberships
	Access more fast &easy (niches, …)	
Maintenance responsibility	Public's/ none	Owner's
Space	Takes no private space	Takes private space
Type of use	Flexibility in use; one-way trips	Limitations in use
Financial responsibility	PBS	personal

Upon that there is an important semantic issue here that we should mention: the designation 'public bicycles' positions these bicycles as part of the public transport system. Usually the designation 'public transport' is used for transport systems that can carry (larger) groups of individuals, like buses, trams and trains. The matrix below shows a more sophisticated classification, making a distinction between 'public' and 'private' on the one hand, and between 'individual' and 'collective' on the other hand. In this classification we can label public bicycles as a public individual mode of transport.

	Public	Private
	Strength – More efficient use of a transport system (fewer unused hours); – Available if user does not have own vehicle *Weakness* – Attuned to average needs, not to individual needs – Only available in case of sufficient demand	*Strength* – Independent from collective (i.e. political) decision-making *Weakness* – Sum of individual choices does not necessarily result in the best total result for society
Collective *Strength* – Advantages of scale in case of large flows *Weakness* – No access to individual addresses	Train Bus Tram Metro Airplane …	Charter transport – Company bus – Touring car – Charter plane – … Carpool Shared car ownership
Individual *Strength* – Accommodates travel from door to door (access individual addresses) – Meets individual travel needs *Weakness* – Wasteful use of transport capacity	Taxi Rickshaw Boda-boda Public bicycle/bike sharing ….	Walking Bicycle Moped Motorcycle Car

Around the world both 'public bicycles' and 'bike-sharing' is being used to indicate systems that make bicycles available to the general public. In this publication we have chosen to use the designation 'public bicycles' so as to emphasise the complementary role of these systems as part of the public transport system.

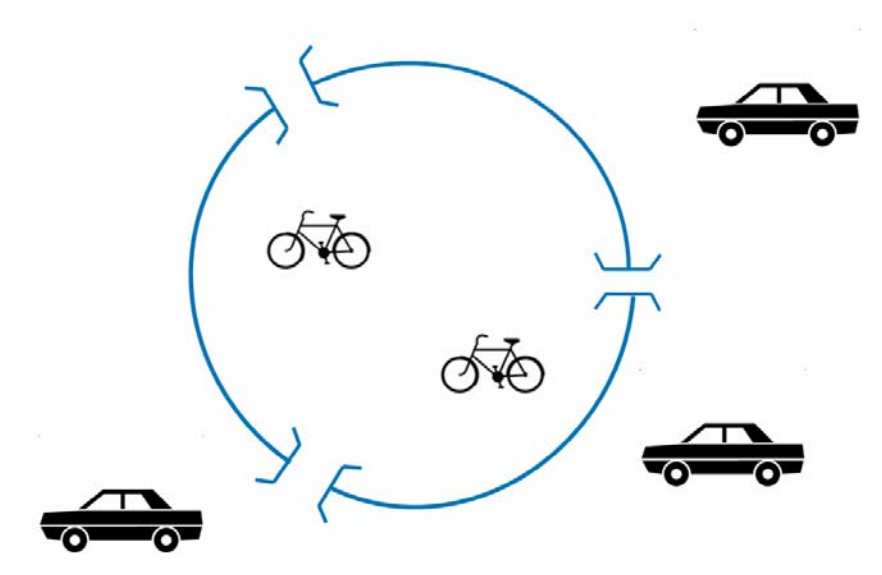
3.3. Functions of a public bicycle system in the urban transport system

Many debates on public bicycle systems are devoted to the operational aspects of such a system: what type of bicycles, what type of technology, what type of logistical organisation et cetera. These are all very necessary discussions, but even more so if precedingly there is an

agreement on the envisaged function of the public bicycle system, and what are the benefits that the city (or any other agency) is trying to achieve by implementing such a system.

We can distinguish 4 functions of public bicycle systems:

Offer mobility options in 'closed' car free areas.
E.g. a university campus, a nature reserve or a car free city centre. People entering the area leave there motor vehicle (if applicable) and can use public bicycles within the area limits. So the function of the system is to compensate for the ban of motor traffic in the area. Or, to put it more positive: to offer an attractive mode of transport in an area free from motor traffic.



Provide mobility to city inhabitants within the boundaries of a certain area.
Citizens of a city can use the system for short trips. Bicycle use can replace a walking trip, a public transport trip or a car trip, and also enlarge the radius of action for individuals in the city. This function is very relevant in cities where a large proportion of the inhabitants don't own a bicycle, as the system allows them to take advantage of the efficiency of cycling for urban trips. This is the envisaged function of most modern public bicycle systems.

Provide mobility to visitors (like tourists) of a city.

Visitors from outside usually don't have a bicycle at their disposal (even if they own one) when visiting another city. A public bicycle system will enlarge their freedom of movement in the city substantially.

Providing 'feeder' mobility for public transport users.

As public transport trips require access and egress trips to get to and from the public transport system to get for origin to destination, cycling appears to be a very efficient option for these access and egress trips, provided a bicycle is available for these feeder trips. Particularly for egress trips this is often a problem. (Bicycle owners can use their own bicycle for the access trip, but won't have a bicycle available for the egress trip.) A public bicycle system can help to improve the door-to-door connectivity of the public transport system.

Of course these functions don't exclude each other, but the chosen transport function may have an impact on the set up of a public bicycle scheme. E.g. if the main user group of the system will consist out of tourists then procedures to get one should be quick and easy. If the system is primarily meant to accommodate feeder trips then the availability at public transport terminals is key.

3.4. What do public bicycle schemes add to the mobility options in the city?

The existing situation in a city should determine whether a public bicycle system is a useful extension of the available transport options and for whom. In the Netherlands with its high levels of bicycle ownership and massive use of private bicycles a city system for its own

citizens is less useful, but making bicycles available for egress trips is very relevant. Similarly and for the same reason the public bicycle system in Copenhagen was primarily used by tourists. (The set up of the Copenhagen system was indeed very accessible and easy to use by anybody but it was also very vulnerable for theft.) The systems targeting the inhabitants of the city are very useful and attractive for cities that are in the starting phase of building an urban cycling culture by attracting people who didn't cycle before. In those cities a public bicycle system enables its inhabitants to find out how useful and practical cycling can be without the need to buy one first. As a consequence of the implementation of the Velib system in Paris the sales of private bicycle increased substantially.

The answer to the question what will be the added value of a public bicycle system in a specific city is, of course, dependent on the context. The analysis of the context should answer at least three basic questions:

Is the context suitable for a public bicycles system? There should be enough potential demand, i.e. enough people in the area that could use the system and enough density of relevant destinations in the area. That is: a substantial percentage of all trips in the area should be trips within a cycling distance;
Is the road environment acceptable for bicycle use? If road conditions are extremely hostile for cycling, then these conditions need to be improved to an acceptable level first.
Is there currently a problem with bicycle availability in the area, either in general or with regard to specific target groups that would justify additional supply of available bicycles?

These questions have to be answered for the specific context of Indian cities.

3.5. What other purposes can be served by the implementation of a public bicycles scheme?

Although the first purpose of a public bicycles scheme is to improve the mobility options within the city and thus to contribute to a better functioning of the city, it is worthwhile to contemplate on specific co-benefits of public bicycles in the urban transport system. These intended co-benefits might have an impact on the operational choices for the implementation of such a scheme.

Basically the benefits of public bicycle schemes can be divided in two categories:

1. the (general) advantages or benefits of (increased) bicycle use and
2. the specific benefits of a public bicycle system.

The first category is based on the assumption that public bicycle schemes are firstly aiming at an increased bicycle use. If the availability of public bicycles is resulting in this envisaged outcome, then all benefits of increased bicycle use can be attributed to the public bicycles as well. But as the implementation of Public Bicycles Schemes is only one (and very specific) method to promote the increase of bicycle use, this intervention should be decided upon in co-ordination with (and sometime weighing against) other interventions meant to promote cycling.

The list of benefits of increased bicycle use should be well known by now:

1. Improved access
2. Improved road safety

3. More attractive cities
4. (If used as feeder mode:) better performance of public transport
5. Improved air quality and reduction of CO_2-emissions
6. Reduction of noise
7. Reduction of congestion
8. Affordable (and equitable) mobility options for (almost) everyone
9. Improved public health
10. Positive (societal) cost/benefit ratio of investments

Of course these benefits will be more prominent if the promotion and accommodation of cycling is an integral part of the urban transport strategy. In fact such a strategy should be aiming at the optimal mix of transport modes, where people choose their mode of transport based on its appropriateness for the specific trip made according to trip purpose and trip distance. The more short urban trips (with a length between 1 and 5 km) would be made by bicycle the more this would save both society and individuals a lot of money and a lot of problems associated with mass car use. Statistics show that the majority of urban trips worldwide is in this category.

The public investments needed to accommodate this category of trips are very different for the various modes of transport. Both the use of public transport and private motor vehicles for these (short) trips require a much higher public and private investment than the use of bicycles for these trips. If the urban strategy deliberately seeks to promote optimal mode choice, encouraging the most suitable transport modes and discouraging the less suitable modes would be the best way to maximise the positive effects of the transport system in general and cycling more specifically.

Upon that, also urban development strategies should be aiming at the creation of the spatial conditions to minimise the need for long distance trips. This requires mixed land use and a certain urban density, so as to bring as much as possible relevant destinations (jobs, shops, education) within cycling distance.

For an effective promotion of cycling for suitable types of trips it is necessary that individuals perceive cycling as convenient, safe and efficient, at least in comparison with other travel options. And equally important they should perceive cycling as acceptable and well respected mode of transport not detracting anything from the status of its user.

It is obvious that the implementation alone of a public bicycles scheme will not be enough to get to the desired competitive position of cycling. But it is also obvious that in certain contexts public bicycles can contribute to the promotion of cycling if some basic conditions have been met. Amongst these conditions are at least a road environment that provides an acceptable level of safety for cyclists. Thereupon the cycling connections between origins and destinations in the considered area should be rather direct and without too much delay.

If these conditions are being met the availability of public bicycles can enable people to discover the usefulness of bicycles for their daily mobility needs. They can make bicycles more visible as a viable option. And when sufficiently being used public bicycles can enhance a better interaction between cyclists and other road users. An important tactical relevance of public bicycle schemes is that their success can enhance the process towards a more cycling-inclusive urban transport policy. The use of public bicycles can demonstrate the

efficiency of cycling, take away the association between cycling and low status, and more importantly: justify investments in further improvement of road conditions and other services related to cycling. Thus public bicycle schemes can be a catalyst for continued cycling-inclusive urban development beyond the direct mobility options they provide to their actual users.

Looking upon public bicycle schemes in this way the challenge is to implement these schemes in a way that is maximising their positive impact on a continued cycling-inclusive policy development.

Additionally we can look at the very specific benefits of public bicycles schemes beyond the general benefits of increased cycling. These benefits are:

1. Availability of bicycles for those who do not own a bicycle;
2. Availability of bicycles for situations where people can't have their own, e.g. for egress trips or visiting other cities;
3. Flexibility for the users: they can pick up and subsequently leave the bicycle whenever they need to;
4. Business opportunity for provider of the system
5. Job creation opportunity
6. City branding
7. Providing opportunities for individuals to fins out the usefulness of bicycles by just trying
8. Improvement of the public image of cycling thus reinforcing public support for cycling in general
9. ...

In the framework of overall bicycle promotion the implementation of public bicycle schemes could be a tactical intervention to enhance the political support for cycling in general and to justify larger budgets for creating more cycling-friendly urban environments. But an assessment of local dynamics is required to judge the appropriatenss of such a tactical approach.

4. Cycling and Public bicycles : Taking the Systems Perspective

From a commuter's point of view, safety (and the perception of safety) plays a key role in making cycling a credible choice as a transport mode in an urban mixed-traffic environment. As the level of safety (and the perception thereof) improves, an important condition is fulfilled for considering the choice to cycle for commuting. Furthermore, motorists will develop better awareness of cyclists when there are more of the latter on the roads, leading to improved cycling safety, resulting in a reinforcing loop R1 as shown in Figure 4.1. Such a dynamic feedback loop has been observed in numerous research studies (Pucher, Dill and Handy 2010, Pucher and Buehler 2008, Mcclintock 2002); policies and infrastructure promoting cycling safety are found to be effective in promoting cycling. Such policies include (i) provision of cycle lanes along busy corridors, preferably separated from motorised vehicles, (ii) cycle-friendly intersections and (iii) wide- spread traffic calming.

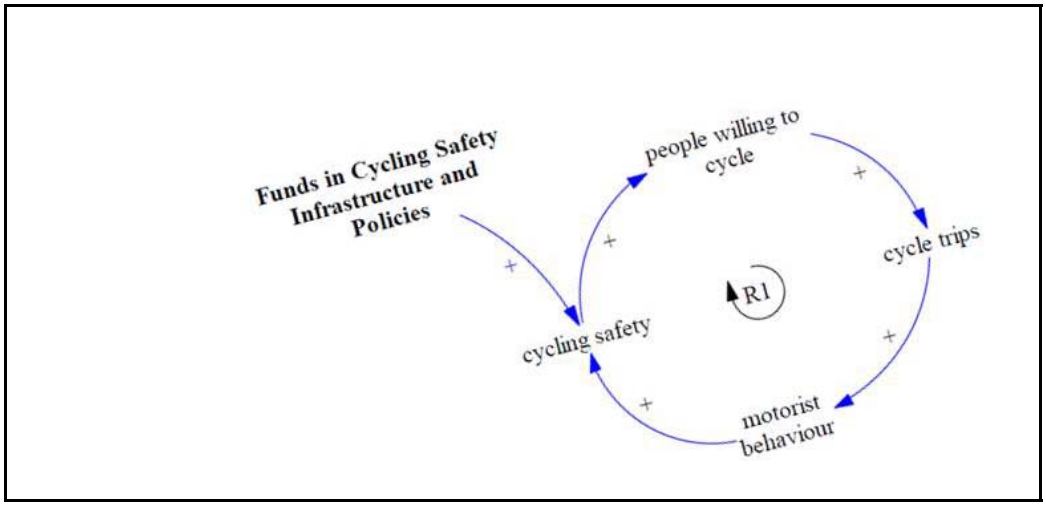


Figure 4.1 Cycling Safety Reinforcing Loop

Besides cycling safety, extensive cycle parking, especially at transit station, and mixed land-use can also increase cycling levels (Krizek and Levinson 2005) (Buehler 2010) (Mcclintock 2002) (Pucher and Buehler 2008) (Pucher, Dill and Handy 2010). Good bicycle parking at transit stations have been shown to encourage the usage of bike as a last mile transportation mode (Pucher and Buehler 2008, Katia and Kagaya 2011). Mixed land-use in urban planning policies put the workplace closer to the home, thereby decreases the average trip length and enhances the attractiveness of cycling as an option. The contribution of these measures to the reinforcing loop R1 is shown in *Figure 4.2*. The balancing loop B1 in *Figure 4.2* illustrates the dynamics when car are substituted by bicycles, and vice versa. Better public transport and car discouragement policies, such as a higher tax for car usage / ownership, would further encourage the switch from private car to bicycle usage.

On their own, public bicycles systems are unlikely to have a big impact on cycling levels overall. Firstly the impact of public bicycles on bicycle use is limited to the areas where the system is implemented. And most likely the bicycles are used for so called 'incidental trips', less regular trips during the whole day. The systems are not sufficient to accomodate the mass of commuters. The cost of owning and maintaining a bicycle is not the key issue preventing the choice of cycling in urban peak-hour commute. A majority of the commuters also follow the same origin-destination travel routine, thereby minimizing the need to rely on a large geographical coverage of bike- sharing network. And even when bicycle use doubles in a certain area because of the availability of public bicycles the overall share will remain low if existing shares were low.

Instead, cycling safety, comfort and trip length are the key determinants of cycling modal share, and public bicycles do not change much of these attributes. Data from big public bicycles projects, including *Velib*, *Bixi,* and *CaBi*, showed that while the number of cycling trips has increased in Paris, Montreal, and Washington DC respectively, the modal share remains low and accounts for less than 2% of all trips. On the other hand, cities in Netherlands, Denmark, Germany and Japan continue to have high levels of cycling modal share without any big bike- sharing system (Katia and Kagaya 2011, Buehler 2010, Warren 2010). Essentially, if cycling is already an attractive commuting option due to safety, comfort and trip length considerations, there are few factors prohibiting an individual from owning using his/her own bike.

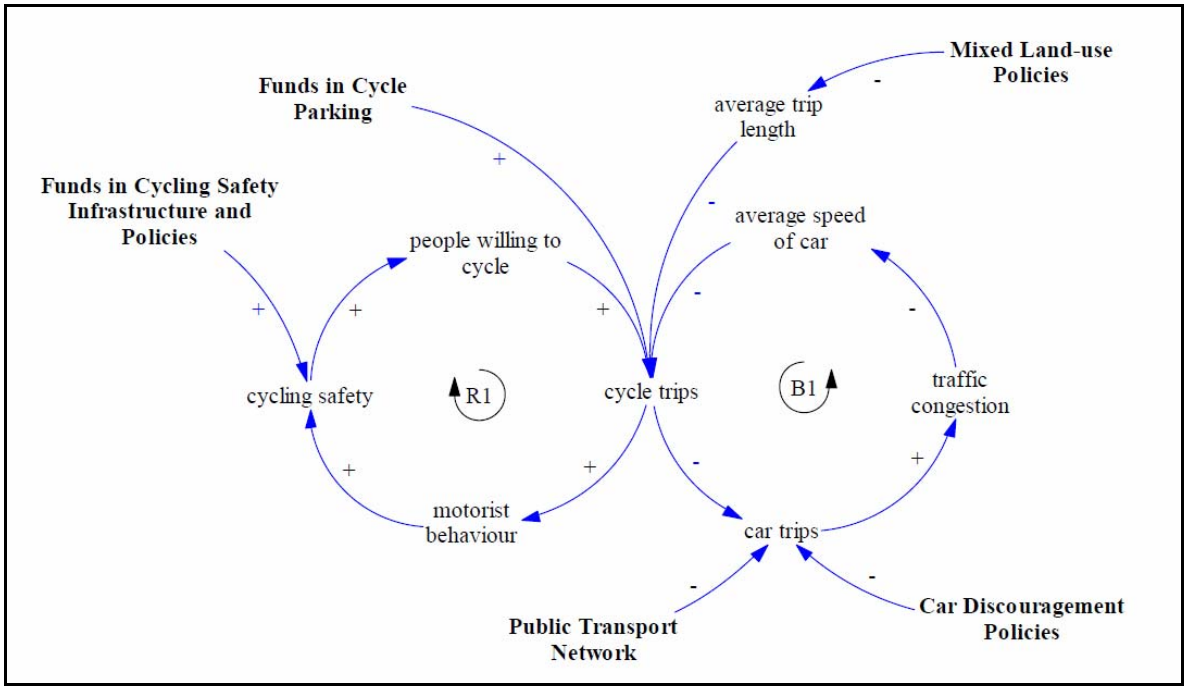


Figure 4.2 Causal Loop View of Cycling levels in Cities

It is also important to ensure that public bicycles systems are not implemented at the expense of private cyclists.The implementation of public bicycle systems shouldn't result in a shortage of bicycle parking spaces for private bicycles. If a significant portion of shared

bike rides come from private commuter bike-rides (Midgley 2011), there would be little improvement in the cycling modal share.

Nevertheless, public bicycles systems may increase the total number of cyclists on the road and a corresponding demand for better cycling infrastructure. This may in turn prompt governments to increase fund allocation for cycling (OBIS 2011). This dynamic is captured in the reinforcing loop R2 in *Figure 4.3*. Public bicycles may also improve public transport ridership as some (or even a substantial part) of the shared bike trips could be last-mile trips.

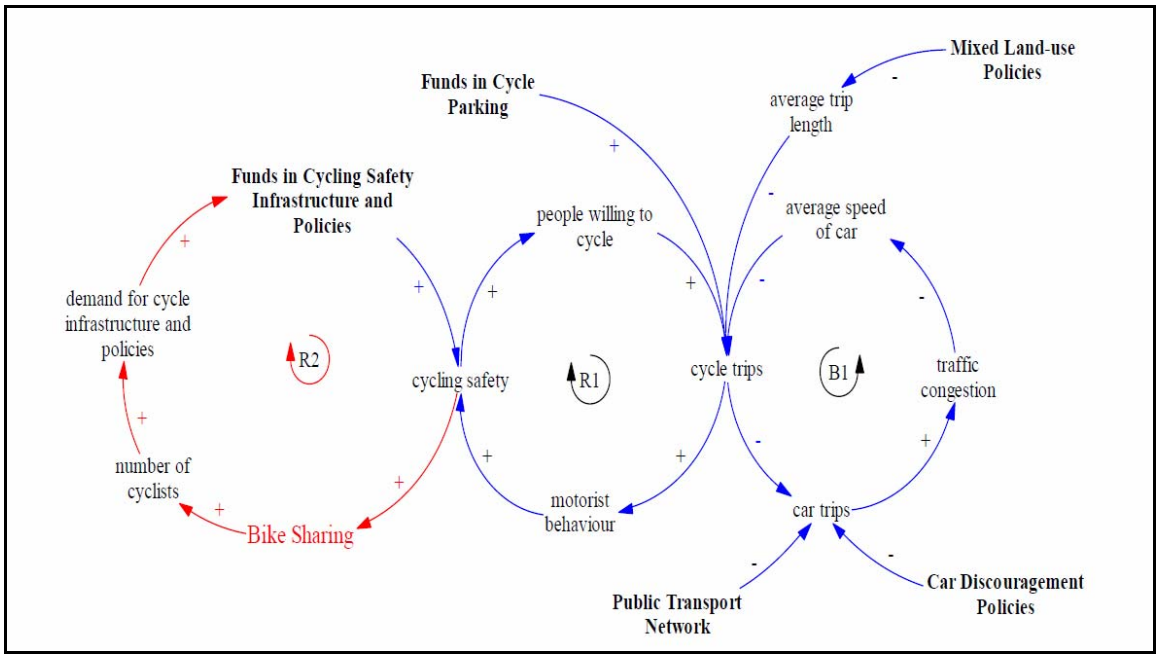


Figure 4.3 Expected short terms casual loops for Bike Sharing

As highlighted earlier, most big bike-share programs have not shown to be economically sustainable (Midgely, 2009; Midgley, 2011) if supported only with public funds. It should be prevented that in the long-run, continued support of these bike- sharing projects using public funds may reduce the resources available to improve and maintain the cycling safety and parking infrastructure. This dynamics is shown by time delayed relationships in the balancing loop B2 in *Figure*. Conversely, if private capital is invested in public bicycles projects, city governments can deploy the funds saved to focus on cycling safety and parking infrastructure. But this dynamic is very much depending on political framing of the issue. If the implementation of public bicycle schemes would contribute to the efficiency of the urban transport system, and are being used to justify (even only modest) restrictions on car use in the concerning areas, the societal cost/benefit ratio would probably be positive. This certainly could justify continued public funding of those schemes.

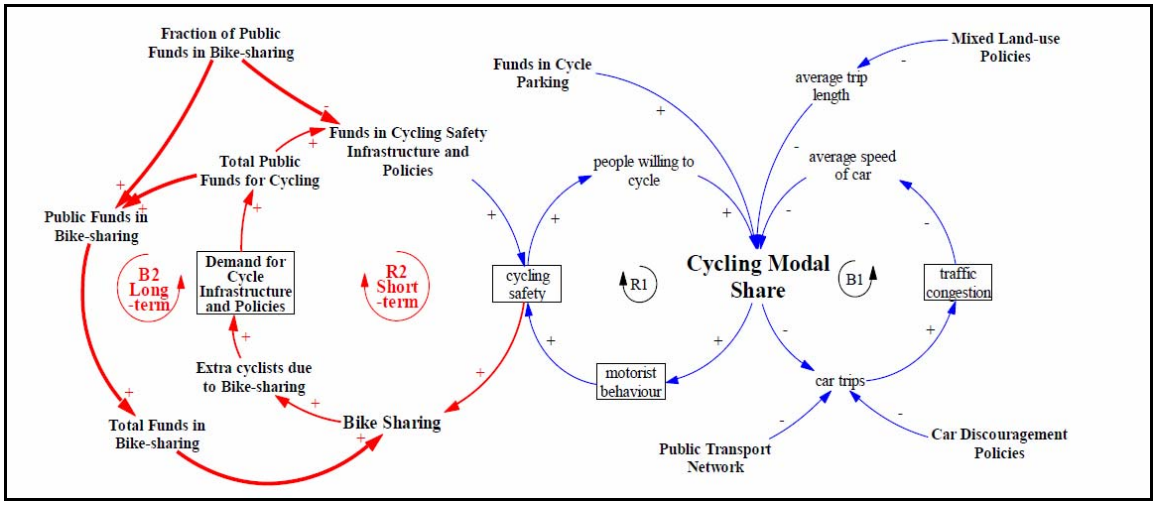


Figure 4.4 Causal Loops Depicting Long-term Implications of Public bicycles Projects

4.1. Conclusion

Cycling is a clean, fast and non-congesting option for short-distance trips in cities, and can play an important role in alleviating urban mobility problems in different urban contexts. In cities with good transits, cycling can help to increase ridership of mass-transits by providing efficient last-mile connections. It can also satisfy most short distance end-to-end trips.

Policies available to promote cycling include provision of safe, preferably separate, cycling infrastructure along the busy commuter corridors, extensive bike parking at important locations such as transit stations, and wide-spread traffic calming on city roads. Active discouragement of car usage through speed, priority and parking controls can also play an important supplemental role. Moreover, land-use policies promoting compact, mixed-use developments can help shorten the trip lengths and make cycling more attractive. Implementing these policies in a well- coordinated manner over the long-term can help bring about higher cycling levels, introduce a cycling culture and make cycling a choice mode in addressing the urban mobility problem.

While bike-sharing or public bicycle systems may enlarge the reach of public transport and increase the number of cyclists and cycling trips, they are not sufficient in promoting cycling. Conversely, high cycle modal share can only be achieved and sustained with a safe, extensive and continually improving cycling infrastructure. Thus investments in public bicycle schemes do not take away the necessity of investing directly in cycling infrastructure to create an environment where cycling is an attractive commuting option. When that happens, individuals can buy and use their own bicycles. Although thus public bicycle systems are non-essential, they could be used as a tactical intervention. Such schemes may help to try and discover the usefulness of bicycles for individuals who otherwise would never consider to cycle, and improve the public image of cycling. In turn this can help to create a more positive political attitude for re-allocation of transport budgets in favour of more cycling-inclusiveness of urban transport policies.

Much of cycling infrastructure is a public good which does not attract private investment. If governments can promote private investment in public bicycles projects through offering appropriate incentives, while ensuring that cycling infrastructural developments will come first, this would be the most attractive option for the introduction of public bicycle schemes.

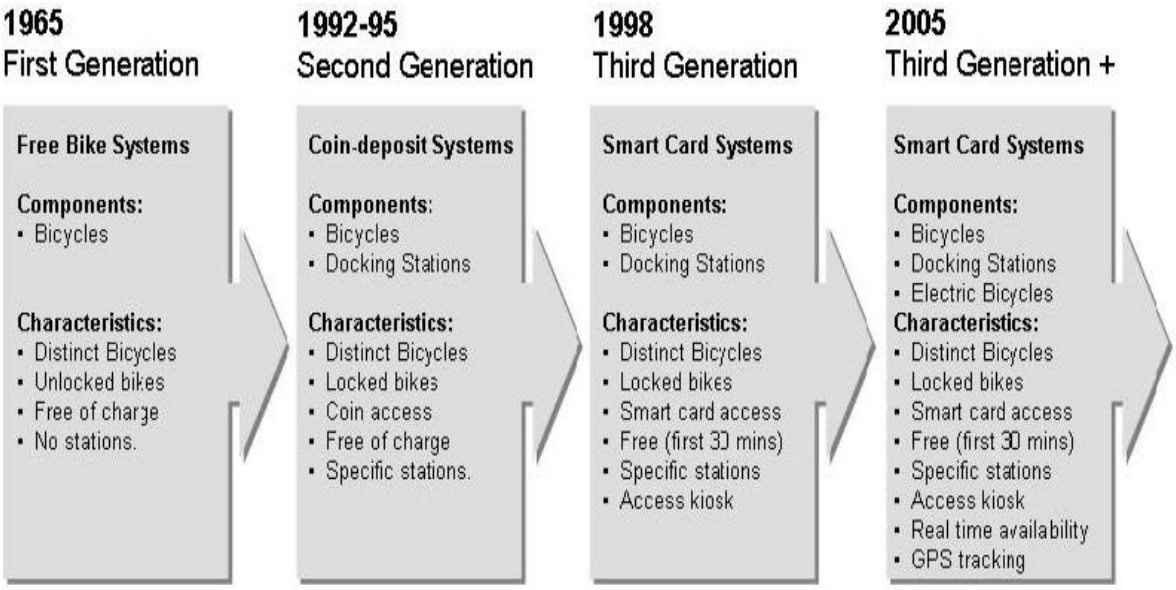
5. Historic overview of the development of the concept of public bicycles

(Basically a development from low tech to high tech)

First generation: white bicycles in Amsterdam (1968, the Netherlands), yellow bicycles (les velos jaunes) in La Rochelle (1974, France). The first generation of public bicycles was based on the simple idea that clearly recognisable bicycles would be available for anyone. The set up was very simple: bicycle painted white (or yellow) could be used by everyone. The system was based on confidence that people would respect the idea and use the bicycles accordingly. The organisation was very amateur-like with no arrangements for maintenance or precautions against theft. These first generation systems appeared not to be sustainable: bicycles were stolen or broke down. The idea was nice, but it would only work in an ideal world and it didn't meet the reality check.

The second generation of public bicycles came about in the 1990's. In the concept thought was given to the obvious weaknesses of the first generation. Second generation public bicycles were given a very specific design that would make them only usable for shorter distances, would make them recognizable as 'public bicycles' and upon that a small (coin-based) deposit system should encourage users to return these bicycles. Examples of these systems are the public bicycles in Copenhagen and Trondheim. Despite their special design it appeared that the problem of disappearing public bicycles wasn't solved: many of these bikes were stolen and popped up in cities far from where they belonged.

The experiences with the first and second generation of public bicycles showed that the trust in the good will of the users will not be enough to prevent a deterioration of the system. Clearly a system needed to be developed that enables the operator to identify the user in case the bicycle wouldn't be returned. The emergence of ict-tecnologies provided the tools to do this in a manageable way. Digital identification and paying methods enable the operators of such systems to identify the user that doesn't return the bicycle to the system without to much bureaucratic paperwork.



5.1. Operational systems

Paid or for free?

One can choose for a system in which users have to pay for every ride, or in which they can use the public bicycle for free. This choice isn't a black or white choice (and someone is paying anyway). In many systems the users register first (with an administrative fee) and subsequently they can use the public bicycle system for free. But usually there are limits to the duration of a free ride. In such cases exceeding the permitted timeslot requires an additional payment. The longer the ride, the more expensive it gets.

But one can also choose to ask payment for each and every ride. Again there are possibilities to discourage long rides by using a 'progressive' tariff system.

The choice between paid use and use for free is based on the overall funding arrangements of the public bicycle scheme. A memberships fee and subsequent free rides are very attractive for regular users, but more cumbersome for incidental users like visitors. But free systems obviously will be used more often and thus yield more societal benefits associated with increased bicycle use. In most public bicycle schemes the user fees are not covering their costs anyway, thus requiring additional funding.

5.2. Technology: card, phone or manned?

Technology: in the bicycle or in the station

Making use of ICT-technology requires some thinking about how to do this. Several systems have been developed. Smart card systems and mobile phones may be used to unlock the public bicycle. But it is also possible to have manned stations using scanning equipment for very efficient handing out public bicycles.

The technology can be applied either in the bicycles or in the docking stations or a combination. In any case the identity of the user and the identity of the bicycle should be established by the system so as to check whether the bicycle is returned properly. Additionally a smart system can keep record of the spatial distribution of the bicycles over the area. Sometimes redistribution is necessary to have bicycles available where the demand is.

In European countries technology is often used to save on human labour. In emerging economies however there might be an advantage to use a public bicycles scheme for job creation. A combination of more simple technology and manned stations might be more appropriate in case that cheap labour is available.

Overview

Operating system	*Characteristics*	*Domain of application*
Unregulated (first generation type)	> White bicycles, campus bikes > No registration > No fixed stations	Work best in closed area (campus, park) with controlled access
Coin deposit systems (second generation systems)	> Low tech > No registration > Fixed stations	Campus type Touristic environments
Manual system	> Registration and identification (every time of use) > Limited opening times (e.g. 10-21) and use (3-4 hrs.) > Typical: 50-300 bikes, > Typical 2-10 manned stations	Closed areas Urban environments Accomodating egress trips Public Transport
Smartcard systems	> Register once; then automatic unlock with card > Use 24/7. > Size: 100-20,000 bicycles	Mostly used by city inhabitants
Mobile phone operated systems (Call a bike)	> Lock and unlock with mobile phone > Possible: return to any intersection in area > Very flexible (no stations) > Technology may be barrier for use	Urban environments
Manual + Smartcard	> Manned and unmanned stations > Quick procedures	Additional service at existing bicycle parkings Accomodating egress trips public transport

With regard to the bicycles to be used there are a few requirements:

> Robust, solid vehicle that are as simples as possible to minimise the need of maintenance;
> Deviant design so as to emphasise that it is not a private vehicle;
> Features that discourage theft.

Indian Bicycle Industry and PBS readiness

The Indian Bicycle Market

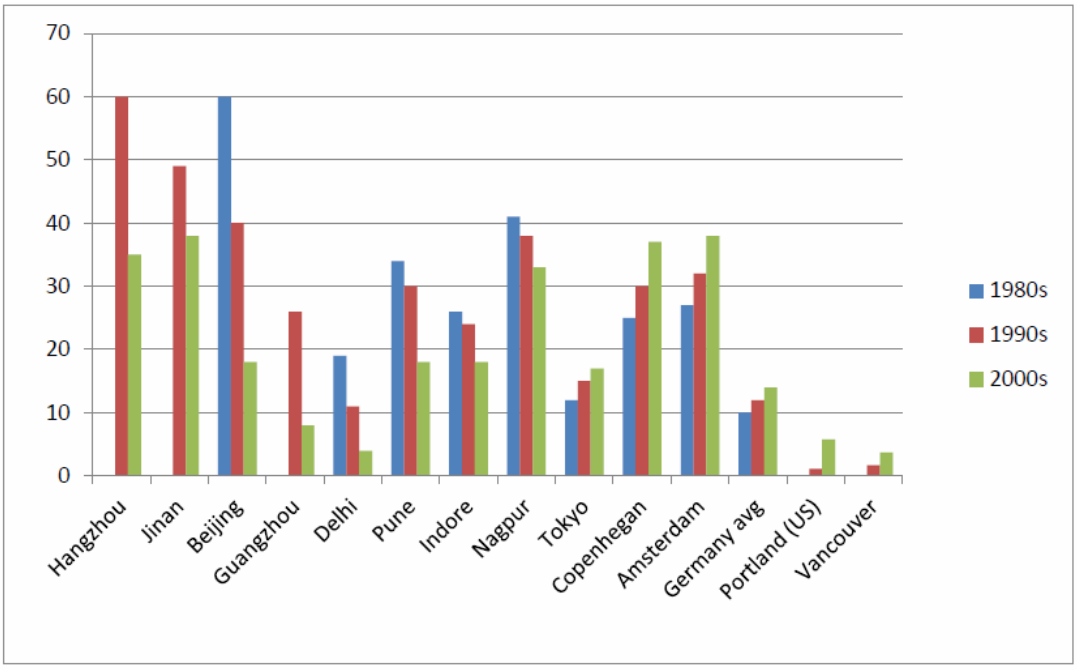
India produces approximately 10% of the world annual bicycle production, which is estimated at 125 Million units. It is the second largest manufacturer of bicycles in the world after People's Republic of China, with 12 million units annually. In value terms, that is US $1.2 billion. The annual domestic demand of bicycles in India is approximately 10 million units, out of which around 2.5 million units is government demand for the various welfare schemes. Hero Cycles is the largest bicycle manufacturer in the world. Major exports are to the Middle East, Africa and US.

While most manufacturers have a Research and Design Division, they have not ventured yet into designing specific bicycles suited to the Public Bike system. The few pilot projects initiated in some cities have not reached the critical mass needed for large scale manufacturing which would have the economies of scale needed to bring the per unit cost down. Also a variety of products need research on, for example

1. Different tyes of bicycles suited to manual, hybrid or fully automated syutems
2. Different types of locking mechanisms
3. Parking systems
4. Fare collection systems, smart cards and back-end software
5. Trailers to move bikes to different locations
6. Other support systems like advertisement spaces and kiosks

For this the bicycle manufacturers need to collaborate with other product manufactrers and user groups. The All India Cycle Manufacturers' Association (AICMA) is the nodal organization to take lead for initiating this research.

5.3. Cycle Modal Share across Selected World Cities over Past 2-3 Decades



Sources : (Tiwari and Jain 2008, Pucher and Buehler 2008, J. Pucher 2007, Pucher, Buehler and Seinen 2011, Pan 2011, Katia and Kagaya 2011, Pucher and Dijkstra 2000). *Note that: (i) values may not be comparable across cities due to differences in data collection methodologies and definitions, (ii) the 1980s data are not available for some cities.*

6. Institutional Framework

In the present context, where the importance of urban infrastructure and its relevance is recognized to improve the living conditions of urbanites who contribute maximum to the national development, the role of urban transport is more relevant. MoUD's recent thrust in urban transport projects through various schemes like JNURM explains this. Hence the proposed heavy investments in urban transport infrastructure needs proper guidance, planning, sustainability, adequate provisions for their maintenance and safeguard. Apart from the required fund, adequate expertise and proper institutional mechanism to implement the urban transport infrastructure is the basic requirement.

Bicycle sharing is a public transport system and requires a management structure similar to a good bus operating system. While, the ideal choice of implementing agency will differ from city to city, as each city has a unique institutional landscape, in general, it is recommended that cycle sharing systems be implemented by a special purpose vehicle (SPV) for public transport if one exists in the city. If there is no existing SPV, then the system can be managed by the municipal corporation. However, operating bicycle sharing through an SPV can confer several benefits with regard to revenue management and flexibility in hiring.

Roles of the Implementing agency

- Evaluating of the local environment,
- Planning the system,
- Contracting private operators, and
- Overseeing the phased roll-out of the system.

Role of the Private Sector

Most bicycle sharing systems contract out operations and maintenance activities to a private sector firm. Implementing bicycle sharing as a public-private partnership is advantageous because it creates opportunities for the private sector to contribute the latest in technological and operational know-how. It also creates a competitive environment with incentives for the operator to reduce costs. Private sector participation is beneficial only if the public sector is capable of providing sufficient leadership and oversight, ensuring that the private operator meets agreed-upon service level benchmarks

The initial provision of infrastructure can be packaged with the operations contract, or it can be carried out as a separate contract. Combining infrastructure and operations provides an incentive for contractor to supply high quality infrastructure so as to minimize maintenance costs over the life of the contract. On the other hand, issuing a separate contract for infrastructure may reduce implementation time, as was the case in Barcelona (OBIS 2011).

Integration with public transport providers

As a bicycle sharing system is one part of the city's larger transport system, integration with existing public transport modes is essential. Currently operating public transport authorities can contribute to the success of cycle sharing systems by accommodating cycle sharing

stations at major public transport terminals and stations. Doing so brings significant cost reductions, improves social acceptance of the bicycle sharing system, and achieves operational efficiencies. It also facilitates the implementation of integrated electronic payment systems for public transport and bicycle sharing. (In fact public bicycle systems can substitute the uneconomic short trips by public transport.)

If the implementing agency is a public transport provider, the public bicycle task force can work directly with counterparts in other divisions. The agency can save money through the coordinated use of station and terminal space and the sharing of data networks and other infrastructure (OBIS 2011). A good case study is the Guangzhou bicycle sharing system, which is overseen by the city's public transport operator. If the city chooses to create a new entity to manage bicycle sharing, this agency will need to pursue partnerships with the major public transport providers in the city.

Annexure 1

With sales of 12 million units a year, India is the second-largest player, after People's Republic of China (50 million units), in the approximately 100-million-unit global bicycle market. The Indian bicycle market comprises two segments: "standards" and "specials". Standards are the workhorses of the rural economy. These cheap and rugged bicycles have remained unchanged for decades. The specials or "fancy" segment comprises new generation bicycles, which are more expensive. Differentiation is the name of the game here.

Specials Out-pacing Standards: Standards, which accounted for over 90% of the market in the early1990s today account for only 66% of cycle sales in the country. This is mainly because:

- A new class of bicycles called juveniles, which are categorized in the specials segment, have over-taken the standards. The juvenile is, in effect, a standard bicycle with a more urban look, which is targeted at the rural and semi-urban youth. Its popularity can be gauged from the fact that while standard bicycles registered a compound annual growth rate (CAGR) of 2.7% between 1996-97 and 2001-02, juveniles raced ahead at 12.6% in the same period.
- Manufacturers have also increasingly attempted to wean away consumers to the specials segment through greater marketing push and by attractively pricing specials. This has, to an extent, hurt standard sales in semi- urban areas.
- Higher disposable income levels of the middle and lower middle class in urban and semi-urban areas have led to higher specials sales.
- To some extent, standards sales have also been affected by the irregular monsoons in recent years since rural incomes are dependent on the monsoons and standards are predominantly sold in the semi-urban and rural areas. In the last six years, standards achieved double digit growth (12%) in just one year, 1999-2000, due to unusually large purchases by the state governments of Gujarat and Andhra Pradesh for free distribution.

The Indian bicycle industry at a glance:

	Size of Market (Mn. Units)	% of Total	CAGR 1996-97 to 2001-02	CAGR 1999-2000 to 2001-02
Standards	*8.0*	*66.4%*	*2.7%*	*-2.4%*

Specials:				
SLRs	*0.5*	*4.4%*	*2.0%*	*-2.3%*
MTBs	*1.6*	*13.3%*	*22.4%*	*26.9%*
Juveniles	*1.1*	*9.5%*	*12.6%*	*2.2%*
Kids	*0.8*	*6.4%*	*15.5%*	*9.9%*
Total Specials	*4.0*	*33.6%*	*14.0%*	*12.5%*
Grand Total	12.0	100.0%	5.8%	1.9%

CAGR: Compound Annual Growth Rate, SLR: Sports Light Roadster MTB: Mountain Terrain Bikes

In the last six years, specials have posted a higher CAGR of 14% chiefly on the back of product innovations and pricing. Since specials offer higher topline growth and profits, domestic players have pushed the sales of these bicycles at the expense of standards.

In a bid to differentiate their products, bicycle manufacturers have also used the experience gained from exporting "specials" to developed countries to introduce innovative features and improve quality. This has resulted in a slew of new products hitting the market. In the last few years, players have also imported cheaper parts from People's Republic of China, which has enabled them to lower their prices without compromising on quality.

Sales largely restricted to the domestic market: Approximately 90% of the bicycles produced in the country are sold in the domestic market since Indian players are not very cost competitive. Also, they carry an average quality perception. In 2001-02, bicycle exports from India were pegged at close to 1 million units valued at around Rs. 1.5 billion. In contrast, People's Republic of China, the world's largest producer and exporter of bicycles, sold around 15 million units outside its home market. People's Republic of China has emerged as a global giant due to its strong operating efficiencies as it has access to cheap labour and components, especially plastic.

Dominated by three players: The domestic bicycle industry is oligopolistic in nature, dominated as it is by three organized players: Hero Cycles Limited (Hero), Tube Investments of India Limited (TI) and Atlas Cycles (Haryana) Limited (Atlas). These players account for over 90% of the country's total bicycle sales. Fringe players include Avon Cycles and Hamilton.

	Capacity Mn. units	Plant Locations	Brands		Volumes CAGR 1997 to 2002	CRISIL Rating
			Standards	Specials		
Hero	5.50	Ludhiana, Punjab Sahibabad, Uttar Pradesh	Hero Jet, Hero Royal	Ranger, Impact, Hawk, Citybike, Bond, Scarlet, Super Cop, Rex, Candy, Bandit, Cadet	6.1%	AA+/P1+
TI	4.49	Chennai, Tamil Nadu Nasik, Maharashtra	Hercules, Phillips, BSA Deluxe	BSA SLR, BSA Mach, Ladybird, Top Gear, AXN, Topshox, Photon, Rockshox, Champ, Mongoose, Combat, Captain, Boomer	12.9%	AA/FAA+/P1+

Atlas	3.34	Sahibabad, Uttar Pradesh Sonepat, Haryana Malanpur, Madhya Pradesh	Atlas Goldline	ABD, AGRD, APGR, ABMX, Stunner, MTB -T, AM 2521, AM 2531, ATB – TG, ATB – TL, Thunder	1.3%	BBB on Rating Watch with developing implications

Note: The list of brands in the above table is not exhaustive Source: Annual Reports and company websites

Efficient cost structure critical for competitive advantage: Given the price sensitive nature of bicycles, a low-cost structure is critical for competitiveness in the bicycle industry. This is particularly critical in the case of standards, which offer little by way of differentiation. Hence, a company's profitability is often determined by its operational efficiencies. Raw materials, comprising steel parts, tubes and components, account for approximately 60-70% of sales of bicycle companies, followed by selling expenses and employee costs. Companies have little control over the cost of iron and steel, which are used in raw materials. Hence, manufacturing processes, procurement policies as well as proximity to ancillaries and consuming markets play a critical part in determining a manufacturer's cost structure.

Hero has always had lean operations compared to TI and Atlas because of its proximity to cycle ancillaries in Ludhiana. Further, its implementation of a diluted just-in-time procurement system and its highly productive, non- unionized labour mean that Hero has low inventory and employee costs. Thus, despite having significantly lower realizations due to its higher proportion of lower value-added specials, Hero's profitability margins exceed those of TI.

TI has been actively trying to minimize its locational and cost disadvantage: the cheapest ancillaries and the largest markets are in the north and consequently, the south-based company incurs huge inward as well as outward freight costs. Hence, the company first began outsourcing standards from Avon, a Ludhiana-based manufacturer, to lower costs. Subsequently, it set up an assembly line in Nasik, Maharashtra, for the western market. Since manufacturing bicycles is not very capital-intensive, with a comparatively small investment, TI has now established a strong base in the west, the largest specials market in the country. In an attempt to further lower costs, TI is now planning to set up another assembly unit at Noida in Uttar Pradesh and a distribution unit at Durgapur in West Bengal.

6.1. The global bicycle market: People's Republic of China, a dominant player; India, a far second

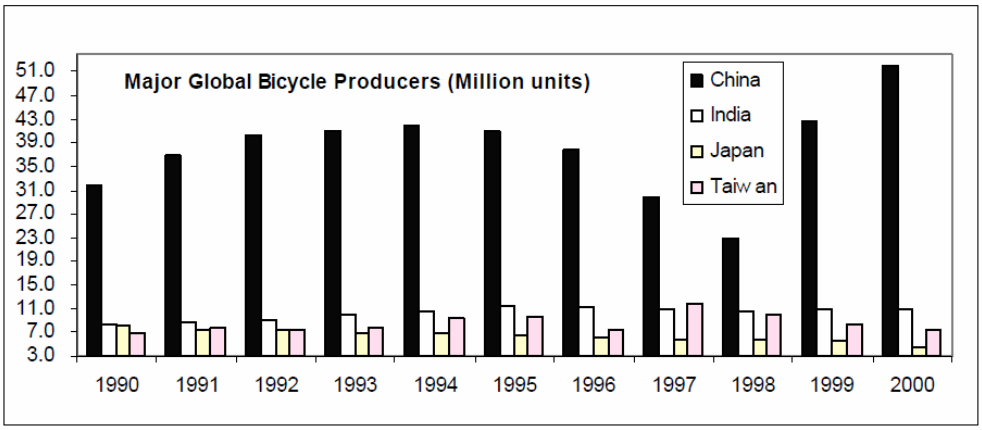
The bicycle is an important means of transportation in most developing and under-developed countries like People's Republic of China, India and Vietnam. In the developed world, especially in the European and North American countries, however, bicycles encompass multiple functions from basic transportation to sports. Consequently, the bicycle's utility varies depending on the region, nationality and level of economic development.

Global economic prosperity and seasonal factors heavily influence the bicycle industry. Economic downturns affect bicycle demand as well. Moreover, traditionally, spring and autumn are peak seasons for bicycle sales worldwide. Therefore, manufacturers adjust their output accordingly in order to avoid excess inventory.

People's Republic of China, with a population of around 1.2 billion, consumes 25-30

million bicycles a year and in addition, exports around 15 million units. USA and Japan, with an estimated population of 250 million and 125 million respectively, consume around 20 million and 7 million bicycles a year respectively. In contrast, India, with a population of 1 billion only consumes around 12 million bicycles a year, which indicates its low penetration levels.

Global bicycle production, which is today estimated at approximately 100 million units per annum, has grown at a CAGR of 0.94% between 1990 and 2000. People's Republic of China, which is known as the kingdom of bicycles, is the world's largest producer of bicycles and accounted for 52% of the world's bicycle production in 2000, followed by India (11%), Taiwan Province of China Province of China (7%) and Japan (5%).



Sources: Bicycle Retailer & Industry News Directory, Cycle Press, Japan Bicycle Promotion Institute and Bicycle Retailer & Industry News.

People's Republic of China's bicycle industry comprises 1081 plants (including component makers) with a total capacity of around 70 million units. As a result of the prosperity in the home market in the late 1980s, production grew rapidly in the 1990s and a multitude of small assembly plants were set up. For the most part of the 1990s, however, production in People's Republic of China was volatile due to the changing domestic demand. People's Republic of China witnessed a spurt in production towards the end of the last decade as over 100 Taiwan Province of Chinaese manufacturers shifted base to different Chinese cities because of the availability of cheap labour.

Taiwan Province of China Province of China has around 400 bicycle units and component manufacturers. The Taiwan Province of Chinaese bicycle industry is also facing severe international competition, especially since USA is one of its main markets and since leading US bicycle companies are seeking to outsource from original equipment manufacturers (OEM) in People's Republic of China. As a result, the US companies are bringing state-of-the-art techniques and market information into People's Republic of China.

USA, which was once among the top five global producers, has gradually lost market share as Chinese and Taiwan Province of Chinaese products have flooded the US market. Of the approximately 19 million bicycles sold in the US market in 2001 (compared to 21 million in 2000), imports accounted for over 90% of the pie. USA, in fact, is the largest importer of bicycles and imports from People's Republic of China and Taiwan Province of China accounted for 75% and 15% of its total imports in 2001. The unit price of Chinese bicycles was lower at around US$ 41, however, compared to US$ 94 per unit for Taiwan Province of Chinaese bicycles since the former are mainly traditional light bikes.

The global trade in bicycles is estimated at around 30 million units, with Europe, North America and Japan accounting for around 70% of it. These markets are characterized by their large and steady demand and high retail prices. People's Republic of China exports around 25-30% of its bicycle production to Europe and USA. Chinese bicycle makers have secured a foothold in the high-end export markets due to their superior products, which use high-tech raw materials like titanium alloy, chrome-molybdenum alloy and carbon fibre. Europe is the largest destination for Taiwan Province of Chinaese bicycles followed by USA.

Overall, bicycle exports from People's Republic of China amounted to around US$ 1 billion in 2001 compared to around US$ 0.8 billion of exports by Taiwan Province of China and US$ 0.03 billion by India. India's exports are mainly to the African and South Asian nations. Also, a major portion of India's bicycle exports comprises standards due to the similar consumer demographics. Hero plans to increase India's presence in the high-end segment through its recent tie-up with Japan's National Bicycle Industries whereby it will produce high-end bicycles.

6.2. The Road Ahead for Indian Players

Excise levy to impact offtake of standards: The bicycle industry, especially the standards segment, is facing additional challenges following the imposition of 4% non-modvatable excise duty in the 2002-03 budget. Although manufacturers have passed on part of the excise duty levy to consumers, their ability to effect price hikes in the standards segment in future would be crucial for maintaining margins, particularly in light of the recent increase in the prices of some key inputs like steel. Further, competition in the standards segment is expected to intensify as the levy would widen the price differential between the organized players and the unorganized sector (estimated at between 0.3-0.5 million units and where prices are 5-6% lower then the organized sector). Adding to the pressure on standard volumes in the current year is lower rural incomes due to the weak monsoon in the northern region.

Standards to remain largest segment: Although the share of standards in overall bicycle sales has steadily fallen in recent years and future trends are not expected to be favourable, standards would still constitute the largest segment of the domestic industry in the medium term. Standards would continue to be important for any bicycle manufacturer as they not only allow for economies of scale but being a bread-and-butter product, also open the doors for a company's specials into dealer outlets.

Higher share of specials and cost reduction critical for future profitability growth: In CRISIL's opinion, in the medium to long term, increasing the share of specials through product differentiation while pruning the cost structure would be critical for a bicycle company to improve its profitability. With standard volumes expected to remain sluggish, players are expected to increasingly focus on the high-growth, high-margin specials segment. Given the aggression shown by most bicycle players in the marketplace, the existing high credit and ad-spend levels in the specials segment are unlikely to disappear in the medium term. Brand equity, product differentiation and new model launches would continue to be the key success factors in the specials segment.

No significant impact of WTO-based tariff rationalization: In adherence to the guidelines of the World Trade Organization, bicycle imports into India were permitted under the open general licence in 1999-2000. This required the abolishment of all quantitative restrictions. Initially, the move saw a small number of Chinese specials making their way into the

Indian market. But on the whole, barring the children's segment of specials, where a greater proportion of plastic is used compared to other segments (plastic is cheaper in People's Republic of China compared to India), the Chinese have failed to impact the volumes of domestic players.

Chinese bicycles are unlikely to penetrate the other specials segments (where freight is a relatively lower component unlike in the case of standards) in future as there are large entry barriers in the form of brand and distribution strengths as well as local economies of scale.

Even Chinese standards, priced at around US$ 25 per unit, are not a threat because after adding freight costs and a 30% customs duty, the landed cost comes close to Rs. 1,900 today. Transportation costs are high since a 40-foot container only accommodates around 350 bicycles. Freight charges from People's Republic of China to India average around US$ 2,500 for a 40-foot container translating to around Rs. 350 per bicycle. Moreover, the actual selling price would have to take into account credit costs and profit margins. In contrast, Indian standard bicycles are available at between Rs. 1,200 and Rs. 1,400.

Thus, going forward, even if tariff rates are lowered to 15-20% as per the WTO norms or even if they are brought down to zero, Chinese bikes are unlikely to beat domestic ones in the standards segment since their high freight costs would not give the Chinese any significant price advantage.