

## Sustainable transport scenarios for New Delhi

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### Abstract

This paper explores the possibilities of the development and application of future scenarios for Government policy and business innovation by multi-stakeholder networks. The basic aim is to plan and stimulate sustainable innovation breakthroughs for transport in the context of New Delhi, India.

The future of New Delhi is in question; as the capital city is immersed in pollution and congestion by private as well as public transport vehicles and an everyday increase of private vehicle population. Increasing levels of air pollution, a traffic management crisis, urban population growth and limited infrastructure making the situation worse. To tackle the problems many short-term measures were in place, such as applying vehicular emission norms, switching to cleaner fuels and phasing out old vehicles. The long term planning needs initiation of stakeholder networks with the interest of all actors. Multi-stakeholder networks have to come beyond their current frameworks in order to plan long-term sustainable solutions. The challenge is to integrate policies, technologies and businesses to develop sustainable infrastructure for Delhi that can fulfil the needs for transport at the moment and flexible enough to accommodate for the future.

The objective of the research is to develop alternative scenarios and analyse how different technologies and policies may work for the future. It is a conscious effort to put the desk research and interviews with stakeholders in the form of plausible alternatives of sustainable future for passenger transport in Delhi.

**Keywords:** Sustainability, transportation, stakeholder networks, future vision and New Delhi.

### 1 Introduction

The relentless process of urbanization in developing countries creates densely populated localities. This influx of people creates more need for basic necessities like water, power, housing and transport. In the context of Delhi, people mobility is one of the growing concerns and the transportation system lags behind to respond to the basic mobility requirements. The present situation lacks the infrastructure and planning to fulfil the growing needs of present and of future. Due to policy shortcomings, lack of commitment and inability to invest in infrastructure the needs have been neglected.

Rising incomes combined with a demand for greater personal mobility and inadequate public transport are likely to result in pronounced increase in automobiles ownership and use. In Delhi the number is estimated to increase from 3.9 million in 2000 to 6 million in 2011 (Planning Dept, 2000). Growing motorization coupled with limited road space, inadequate separation of the working space from the living space and the space for movement, an ageing and ill maintained vehicle stock, a sizeable stock of two stroke engines, absence of efficient public transport and lower quality of fuels have led to traffic congestion resulting longer travel time, greater fuel consumption, growing air pollution, discomfort and degradation of urban environment. In these conditions the development of an efficient transportation system is a primary need to accommodate the mobility needs in the near future.

The methodology applied within this research is to develop alternative scenarios flexible enough to analyse the future options and see how technologies and policies may work in synergy. The scenarios will provide decision makers with a window on potential market

needs, a tool for systematic and innovative consideration of growing needs, and a method for evaluating the long-term viability of current trajectories or technology developments. The scenarios, which are different from each other and from the current operating environment, are developed on the basis of interviews with stakeholders and of assumptions how to make the transport system more sustainable<sup>1</sup>.

The goal of the research is to understand the mechanisms and approaches that characterize innovation and technological change (in particular socio-economic conditions) in order to define managerial practices (innovation management) and skills required to accomplish the task and to gather empirical evidence of cases and practices of innovation. The next step is identification of the sustainable mechanisms and approaches, which could lead to action plan by stakeholder participation. This research is an attempt to understand the system dynamics in terms of stakeholders' views and possible future directions.

## 2 Delhi: is it a sustainable city?

A sustainable city<sup>2</sup> is defined as one that is able to provide the basic needs of the population along with the necessary infrastructure of civic amenities, health and medical care, housing, education, transportation, employment, good governance, etc. There is a constant struggle with issues of air pollution, congestion of human population & traffic and availability of open green spaces. Strong, healthy, liveable cities depend on a healthy environment, a robust economy and ample employment opportunities for its population. It should take care of the population's needs and all sections of society without discrimination.

As it pertains to conditions in Delhi, due emphasis would be in controlling population and providing housing to the impoverished sections of society who live in sub-human conditions in slums, spin out livelihoods below the minimum wages and creating environmental degradation. Growing population also leads to exploitation, crime and lawlessness due to shrinking job opportunities. For example, the population of Delhi increases by 400,000 people every year due to migration, putting a question mark on the sustainability of this capital. This alarming increase in population puts an unacceptable strain on housing, employment, healthcare, water, electricity and mobility. Large "green" areas are converted to housing colonies leading to environmental degradation.

The focus in this context is to look into the mobility & accessibility of people to fulfil their travel needs. Delhi had 9.11 km of road length per 1000 number of vehicles and 2.15 km per road length for population of 1000 in 1997, which shows more vehicular density than any developing country standard. The limit for road space appears to be 20% of the urban area and Delhi already has 21% of land area covered by road space (DDA, 1990). Any increase in road capacity tends to be quickly swamped by an increase in travel demand (Zegras, 1996). Short mobility distances in the urban area and absence of systems like sub-urban rail system combined giving a unique challenge to the planners & decision makers.

## 3 Delhi's Transport situation

In the paradigm of growing mobility demand, concerns for safe travel and increasing levels of pollution & congestion Delhi is in midst of various experiments and in lure of quick fixes. Delhi reached a situation where things need to move quickly for present and at the same time meticulously for the looming future. During the year 1989, the motorized transport (buses, cars, scooters, motorcycles and others) was responsible for 70% of the total air pollution (CPCB, 2000). This gives the measure of severity of the transport situation prevailing in Delhi.

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<sup>1</sup> Sustainability has the following three criteria for certain demography: justice within and between generations; integration of social, economic and environmental requirements; and participation of all social groups in the process of strategy formulation and implementation. From these criteria "sustainability" is deriving its economic, social and environmental foundations and ethical notions of justice

<sup>2</sup> Defined by Development Alternatives, New Delhi.

In Delhi, a large proportion of the travel demand was catered by ageing buses (see Table 1); at the same time the use of private transport increased nine-fold in last three decades (Tiwari, 2002), where public transport has overloaded from time to time and hardly kept the pace in serving the mobility needs for all categories of travellers. The reasons behind this were not enough number, reach and frequency of the public transport.

Mode	1957	1969	1981	1994
Cycle	36%	28%	17%	7%
Bus	22%	40%	60%	62%
Car	10%	16%	6%	7%
Motor cycle	1%	8%	11%	18%
Others	31%	8%	7%	7%

Table 1: Modal split of daily trips in Delhi, 1994  
(ORG survey)

Modal share of bicycles were reducing but the numbers were increasing at a constant pace (planning dept, 2000). Many arterial roads of Delhi, during peak hours, bicycles make up for more than 30% of the traffic (CPCB, 1993), which emphasizes the fact, that majority of the bicycle riders are commuters. There is a serious concern of safety and health of cyclists, pedestrians and motorcyclists because of worse air quality and lack of infrastructure. Cyclists suffer the most because of heavier breathing whilst exercising close to the source of exhaust pollution. Normally bicycles and rickshaws use the left most line (free left turn) of the road, and this leaves buses to have less chances to stop in the designated bus stops which are actually obstruction to the slow moving traffic if they try to do so. To avoid this they stop in the middle of the road and disturbing the traffic in all lanes. This stresses the fact that non-motorized transport needs to get the priority for infrastructure in terms of policy and implementation, which was never there.

Large differences in income levels and social disparities have lead to the development of 'cities within cities' (Tiwari, 2002). Each part of the city has its own land use pattern and use of technologies and some of them become slums because of lack of basic amenities. Another emerging issue is the property development by various agencies without reference to land use and environmental impacts. The same road space has been used by the cars and buses, locally developed vehicles like three-wheeled scooter taxis, scooters and motor cycles, bicycles, rickshaws and animal & human-drawn carts. The curbside parking of personal vehicles and waiting auto rickshaws for customers at bus stops making the three lane roads to congested two lanes for movement. Unfortunately, the rail assets are not presently fully being utilized, as its share of commuter traffic is only a mere 2% in Delhi. The newly commissioned mass transport facility, the DMRC<sup>3</sup> (Delhi Metro Rail co) network in a phased manner, is estimated to serve large chunk of the mobility.

The road based public transit system is playing a crucial role in providing roughly 62% of the total 4 million passenger trips. These buses in coordination with auto rickshaws and cycle rickshaws are providing the cheapest and the most flexible system. Delhi's public transport runs on a complex system, where the bus services run by public private participation, it suffers from lengthy zigzag and overlapping destination routes, improper distribution of buses, disorganized private sector operation with little or no control, inadequate number of buses, poor spatial coverage and lack of priority to public transport. There has been inadequate attention to the public-based transport, which occupies less road space and is cheaper, more energy efficient and less polluting than private, individually owned transport (TERI, 1996). In the view of these considerations, the eighth five-year plan of the country has strongly recommended the strengthening of the public transport system and promoting energy efficient modes as the two major transport strategies (GOI, 1992). The transport situation highlights the need for technologies that will reduce the consumption of resources without

<sup>3</sup> The Government of India and the Government of National Capital Territory of Delhi set up Delhi Metro Rail Corporation Ltd., to construct a rail based system, comprising of a network of underground, elevated and surface corridors aggregating to nearly 200km and to construct 52 Km of Metro Rail tracks in Delhi by 2005, which can remove 1.95 commuter trips from roads.

necessarily reducing the services it provide and improve, which means that higher level of efficiency in the entire system cycle.

## 4 Emerging patterns and characteristics

### 4.1 Vehicle Ownership

Delhi had 3.21 million vehicles in March 1999 for a projected population of about 13.4 million. The number of vehicles per 1000 population increased by 24% from 192 in 1991 to 239 in 1999 (Planning Dept, 2000). Each household had an average 1.19 vehicles in 1999. About two-third of the motor vehicles are two-wheelers though a decreasing trend in that share has been observed, on the other hand due to arrival of low priced small cars there is an indication to shift from two-wheelers to cars. The number of slow moving vehicles is always increasing, the Municipal Corporation of Delhi has fixed the maximum number of rickshaws as 99,000, but it is estimated that more than 300,000 rickshaws are plying on Delhi roads, many of which without any authorisation from MCD.

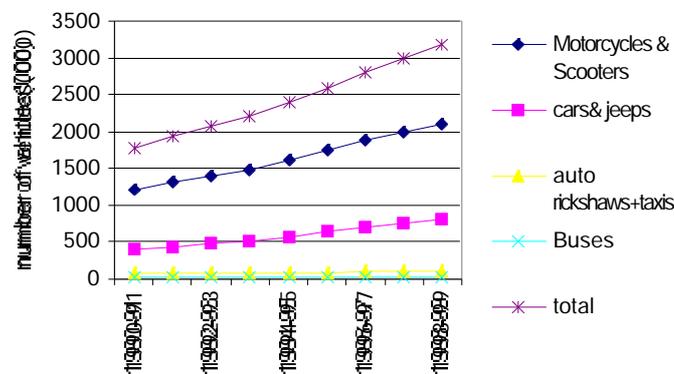
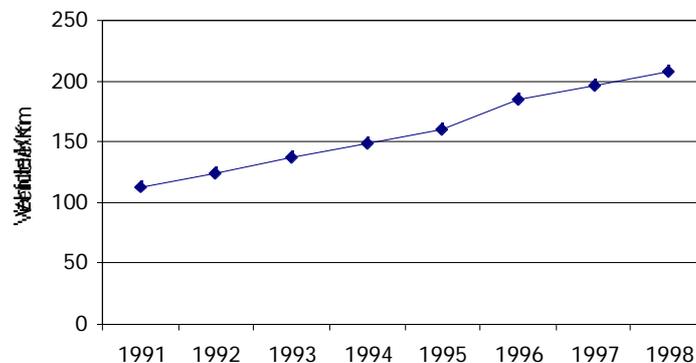


Fig 1: Number of motorized vehicles in Delhi

### 4.2 Vehicular Density

Vehicular population has gone up by more than 9 times from 1971 to 1991 where as the road length increased by 2.6 times only, resulting in high vehicle density because of vehicular speed has reduced and is also responsible for longer travel times, more accidents and extra fuel consumption. The increasing trend in vehicular density may aggravate the existing alarming situation in the near future. The higher vehicular density leads to idling of vehicles at high rate, which causes the loss of time as well as money. It has also been estimated that over 321,000 litres of petrol and 101,000 litres of diesel are burnt daily in the capital due to the idling of vehicles at 466 signalised intersections and this is equivalent to a loss of about US\$ 0.18 million per day at 1996 price<sup>4</sup>.



<sup>4</sup> More info at [www.rediff.com/news](http://www.rediff.com/news), June 23, 1998

Fig 2: the increasing Road Vehicular density  
(Number of vehicles per km of road)

### 4.3 Travel demand

The travel demand will rise from 4 million trips per day (in 1994) to 20 million trips per day (DES, 2000) by 2011, in which the road based transport need to fulfil 12 million trips (403% increase). The newly commissioned Delhi Metro Rail co estimated to take a load of 1.81 million trips by 2005. Still there would be unfulfilled demand for the road transit systems. One of the main reasons for this situation as the City was planned in circular fashion and residential satellite towns as suburbs, because of this land use planning there were always greater number of trips (of 10km as average) simultaneously greater challenges to planners. The projected travel demand can be seen in the table 2.

Mode	1994	2005	2011	2025
Bus	2.48	9.42	12.48	15.02
Rail	0.02	1.66	1.94	2.52
Metro Rail	0	1.81	2.34	2.86
Other modes*	1.50	2.83	3.68	4.47
Total	4.00	15.72	20.44	24.86

Table 2: Projected travel demand (million trips per day)(DES, 2000)  
(With modified phase I of Metro Rail)

(\*Other modes: Cycle Rickshaw, Auto Rickshaw and Taxi)

### 4.4 Governance (Role of Govt. as a stakeholder)

The local Government with the support of the central Government has formulated a number of legislations, policies and regulation programmes for tackling the traffic problems and to protect the environment. The Delhi development authority<sup>5</sup> has been playing the role to plan the master plans (DDA, 1990) for Delhi and give strategic directions to the Governing body. The ministerial agencies involved in transport sector are 'Ministry of Environment and Forest', 'Ministry of Urban affairs and employment' and 'Ministry of Surface Transport'. Apart from emission standards for Industries, the various measures taken by Government to mitigate emissions and traffic problems are as follows:

1. **Emission norms** (Euro I & Euro II) along with fuel quality specifications for national capital region laid down in 1996 (CPCB).
2. The BIS (Bureau of Indian standards) recommended **fuel quality specifications** for gasoline and diesel for the period 2000-2005 and beyond 2005. In a recent directive by the judiciary, the Minister of Petroleum and natural gas is ordered to supply diesel with 0.05% m/m sulphur to the entire National Capital Region from July 2001 (CPCB, 2000).
3. For gasoline, **lead was phased out** with effect from Feb 2000.
4. The benzene content is to be reduced to 1% for National capital region from April 2001.
5. Measures also include **bans on 15 year old commercial vehicles**, a ban on the registration of new auto-rickshaws with front engines, replacement of all pre-1990 autos & taxis with new vehicles using clean fuels like compressed natural gas (CNG).
6. **All the buses to switch over to CNG** (compressed natural gas) instead of diesel by August 2004. By July 2001, 18%<sup>6</sup> of the public transport including auto rickshaws & taxis were running on CNG (CPCB & MOEF 2001). The Delhi Govt forgoes sales tax on CNG to encourage use of clean fuel and gave a promise to continue to provide a tax incentive and make other efforts to encourage use of a clean fuel (TOI, 2002).

<sup>5</sup> Autonomous body under state Government.

<sup>6</sup> 46,000 CNG vehicles are plying by February 2002 (TOI, 2002)

7. At present construction of **flyovers/underpasses** at 20 different locations in Delhi are in progress and 25 more flyovers are in the stages of planning.
8. The **peripheral expressway** is under conceptualisation (DDA, 1990) to make a suitable bypass to avoid the intermixing of local and regional traffic, which acts as a major deterrence factor for the smooth flow of the traffic.
9. The **mass rapid transit system (MRTS)** is an ambitious project that aims at providing efficient rail based transport system.

Some of the issues like non-motorized vehicles, parking problems and commuter convenience were never the issues of implementation nor observed in policies. In recent years, the judiciary played a predominant role in environmental protection. A number of judgements relating to stringent vehicle emission norms, fuel quality, introduction of cleaner fuels, phasing-out of older vehicles have provided a great deal of momentum to the efforts for improving the air quality.

It is being argued by different transportation planning studies that, most of the efforts in terms of mere infrastructure improvement may provide a little relief mainly to the personalised motorized vehicles with low occupancy, but in long term they may not make much impact on the overall traffic situation and on the environment pollution level. Fundamentally, the factors causing problems are, multi-agency planning and implementation, inter-agency interests and conflicts, lack of commitment, lack of land use-transport integration and non-existent public transport culture. In order to fulfil all these factors to provide a safe, secure, economical, equitable, comfortable and efficient movement of passengers there is a need for a long-term strategic plan with the multi stakeholder networks.

## 5 Future directions

The field research started with the identification of stakeholders involved in Delhi's transportation system. Stakeholders are from Government (1), NGO (2), Commuter (3), Business (4), Research Organisation (5), Semi Government (6) and Autonomous Institute (7). The majority of the selected stakeholders were responsible for the state of the art strategic planning and policy creation. Interviews were planned to dwell their understanding of the situation and possible desired directions for the system. The stress was given in order to go in the right direction to solve the present problems and plan preventive measures for future. The objective is to make Urban Transport System (UTS), which is socially equitable, economically efficient and ecologically sustainable. The role of the stakeholders here is to ensure the above three components. The basic understanding of the stakeholders is to have a set-up of the policy, institutional frameworks and investment & action programme. The figure (3) shows our conceptual basis for a sustainable urban transport system.

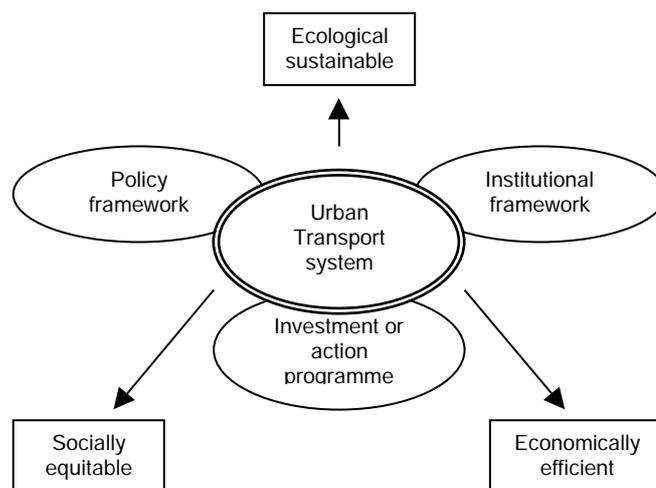


Fig 3: Conceptual basis for Urban Transport System (UTS)

Following are excerpts of the stakeholder interviews.

- Integrated land-use transport planning. (1)<sup>7</sup>
- Low cost system management measures. (1, 6)
- Dodge bicycles and cycle rickshaws from main arterial route. (1)
- Need of understanding 'mobility' by different stakeholders. (2)
- Government need to work with different NGO's for big picture solutions. (2)
- Promotion of non-motorized vehicles. (2)
- Create local non-motorized transport network services to connect to the Public transport and Metro Rail. (2)
- Improve the public transport. (3, 6)
- Technology advancements in motor vehicles by introducing technologically better quality transit systems. (3)
- Avoid Inter-agency interests and conflicts. (4)
- Focus more on better mobility system than on air quality (aim at curing the disease instead of merely attacking the symptoms). (5)
- Understanding the synergy between safety, security and sustainability. (5)
- Accord priority to buses or keep some roads open only for buses at peak hours. (5)
- Availability of public transport information to all potential users. (5)
- Collect and maintain reliable up to date statistics for traffic management and planning for future. (5)
- Measures to discourage the personal motor vehicles. (5)
- Promote equitable use of road space. (6)
- Segregation of traffic according to motorized, non-motorized and goods. (6)
- Adequate road infrastructure. (3, 6)
- Movement on foot, by bicycle and transit need to be cultivated by providing safe infrastructure. (7)
- Set performance objectives for services (availability of service for every commuter within 10 minutes on a busy corridor at peak hours) (7)

The interviews with stakeholders reflect the seriousness of the situation exists in New Delhi. To summarize the opinion, there is a need to all-round improvement of both demand and supply side interventions. Apart from the policy issues the opinion was weighed on to provide an institutional framework and business/implementation programme. It was also stressed to come up with integrity in solutions and follow system's approach. The cooperation of stakeholders is anticipated in near future to analyse the different future directions and make an action plan.

## 6 Rationalizing the Experts Interviews

Expert opinions provide the possible directions for the mobility system in order to expand and improve in the near future on the long-term basis. The concept of the UST (Fig 3) shows the system features to deal with profound social and economic inequalities. The UST shows the requirement of the policy, institutional frameworks and investment & action programme as the pillars to achieve sustainability. From the three mutually reinforcing factors (i) Socially equitable (ii) Economically efficient and (iii) Ecologically sustainable (Fig 3) the four dimensions of the transport system were defined. These dimensions are Spatial, Institutional, Economic and Societal.

The Spatial dimension contains the measure of structure and density levels, which define the land-use patterns and mobility patterns. The Institutional dimension contains regulation and priority of infrastructure as two factors. The Economic dimension measures the level of subsidy and the flexibility in policies. The fourth dimension, Societal one, gives the measure of cohesion in society and security. The transport system can be illustrated by connecting the points on respective 'measure'.

The transport 'web' model (Fig 4), which is adapted from the spiral model (Nijkamp et al, 1998), developed to extend the UST concept. The model tracks institutional, societal,

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<sup>7</sup> Represent the type of stakeholder mentioned earlier.

economic and spatial dimensions in terms of how all of these factors feed into a transport system.

The dotted line shows the present system and the thick line shows the scenario (see Fig 4) desired by the stakeholders. It shows the improvement is required in all departments of the system. One of the main concerns represented are priority for public transport and making transportation more subsidized.

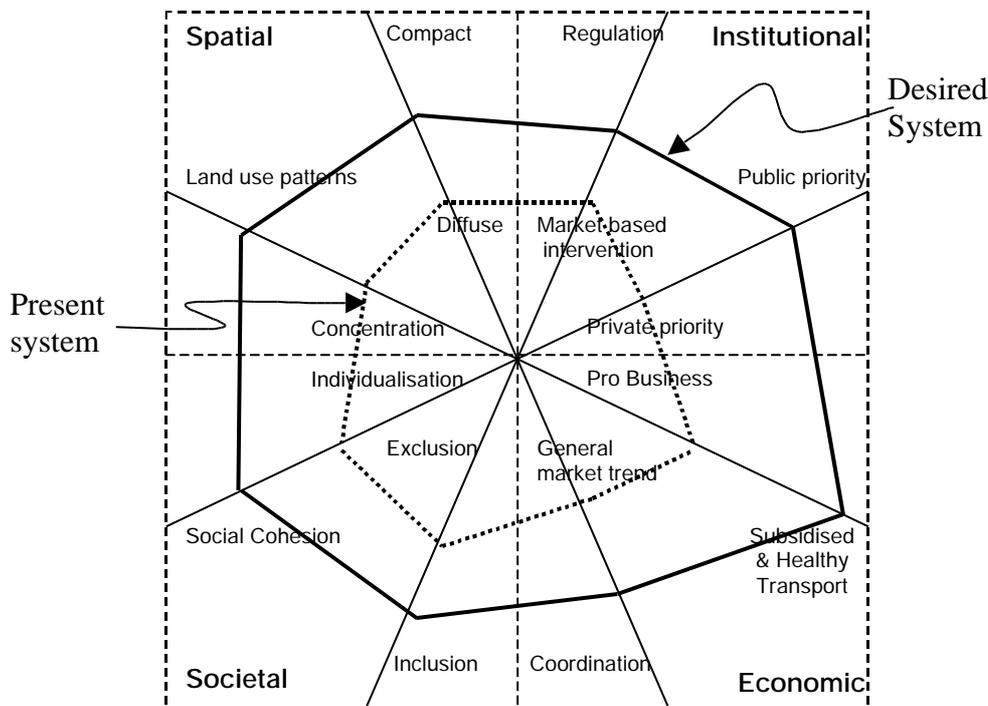


Fig 4: Transport 'web' model

## 7 Scenario summaries

Scenario's outlines have been created by the research team on the basis of the web model and based on features opined by stakeholders. The features are outlined by: better management, efficiency and human power as the main priorities.

### *Scenario 0 (Business-as-usual)*

The status quo continues. Future for New Delhi projects recent trends of incremental improvements in some areas, while some problems get worse. Although some aspects of New Delhi's quality of life improved, this was not a terribly promising future. This scenario is based on the actual outcomes if present trends were to continue.

### *Scenario 1 (Integrated Scenario)*

The scenario is aimed at creating sustainable urban transport policy to create integrated transport network. This mainly focuses on better management of the system. The assumptions of this scenario are: (a) technologically better quality transit systems (b) Promotion of non-motorized vehicle networks (c) Priority bus lanes (d) Measures to discourage the personal motor vehicles (e) Low cost system management measures (f) Integrated land-use transport planning.

### *Scenario 2 (Efficiency scenario)*

This scenario aimed at reducing the pollution created by the improved technologies and alternative fuels. This mainly focuses on increasing the efficiency of the system. The

assumptions of this scenario are: (a) Focus more on better transport than on air quality (b) Strengthen the public transport system (c) Accord priority to buses or keep some roads open only for buses at peak hours (d) Collect and maintain reliable up to date statistics for traffic management and planning in future.

### ***Scenario 3 (Human power scenario)***

This scenario aimed at giving a big push to non-motorized transport. The assumptions of this scenario are: (a) Identification of Cycle rickshaw as one of the important modes of transport (b) adequate infrastructure for bicycle users (c) Bicycle tracks to connect home and work places (d) Light rail to connect longer distances (e) Improvement of Para transit services as local networks.

These are basically outlined to see how things might work out in future and to look at validity of different strategies to support Government policy and Business innovation by multi-stakeholder networks. The aim is also to use these scenarios as input for stakeholder participation, as a first step to a wider policy & business programme.

## **8 Follow up**

Within this research, the aim is to develop a model that characterizes innovations and technological change in different socio economic conditions in order to define managerial practices. The follow up is summarized as

1. Analysis of the scenarios and **long-term action plan** with stakeholder participation.
2. Supporting the decision makers' understanding of possible futures and enhance decision-making process.
3. Realisation by **decision makers** of the challenges and tasks that must be accomplished if scenarios are truly to inform and influence the process.
4. How **business and research** bodies manage the technologies/innovations in the future and Identification of corridors/zones for the appropriate technologies.
5. The challenge for **policy makers and NGOs** to retain and improve the heritage of non-motorized modes of transport.

## **9 Conclusion**

The interviews with stakeholders have stressed the need to take along interests of all actors in order to create any public policy. One of the next steps to follow is analysis of scenarios by stakeholder participation. More participation is anticipated from the policy makers in the future to make the action plan more realistic. This is a starting point to provide insights and prompt right directions in the minds of stakeholders.

The future of transport in Delhi should have a regulatory approach to transport policy, with strong elements of public provision of transport and subsidisation, coupled with a strong enforcement to prioritise public transport over private transport and adequate infrastructure facilities for cyclists and pedestrians. Delhi need to act fast in choosing the right strategies, delaying such action would be costly, everyday the cost of recovering from inaction is even higher.

Environmental degradation is a problem that could not be wished away. If present trends continue, it can only worsen in the future and transport sector will contribute most of it. Mere insistence on the right to have clean air, increasingly stringent regulations with little prospect of implementation and manifestation of dire consequences of future generations will not make the situation better. There is a need to work with informed judgment, action backed with adequate reflection, healthy mistrust of simplistic solutions and quick fixes.

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