CHALLENGES IN IMPROVING URBAN MOBILITY IN INDIA

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Abstract. *The urban mobility scenario in most Indian cities has deteriorated considerably in the last decade wreaking a havoc on millions of daily commuters. Lack of an integrated multimodal public transport has added to the woes of public, forced into using their cars and two wheelers for travel. This has led to an unprecedented rise in vehicular traffic and serious road congestion. This article explores the feasibility of various alternatives implemented and adopted in Delhi and its results shared for a feedback of various stakeholders. A large number of engineering associations like IRC, IRF, CEAI, IAStructE and WISE have been proactively helping the authorities in taking up technically appropriate solutions and engineering in order to improve mobility.*

Key words: *urban mobility, Indian Engineering Associations, integrated transport, metro feasibility*

1. India's Smart Cities and sustainable transport solutions

India's road networks, congestion, quality of its public and private transport, lack of infrastructure for 'non-vehicular traffic' and air pollution are influencing economy. The situation will worsen with the rapid pace of urbanization process unchecked According to a recent study by consulting firm McKinsey, India's cities will be home to 590 million people by 2030 accounting for 70% of all new employment. It will be a challenge to develop sustainable solutions for maintaining a clean, healthy and efficient environment for people to live and work.

The Indian government launched an initiative to develop 100 smart cities across the country. This project officially started in June 2015 and has been leading cities to the use of digital technology solutions to improve utilities, buildings, infrastructure, health and education to 'raise the standard of living of citizens in economical and eco-friendly ways. The first phase of the project is expected to be completed by 2022.

This project will include modernization of major cities and developing satellite towns. This step should be completed by 2022. 30% of India's total population leave in cities which accounts for 60% of the country's GDP (expected to be 75% by 2030). India's infrastructure needs huge investment to be able to withstand the pressures of a growing urban population.
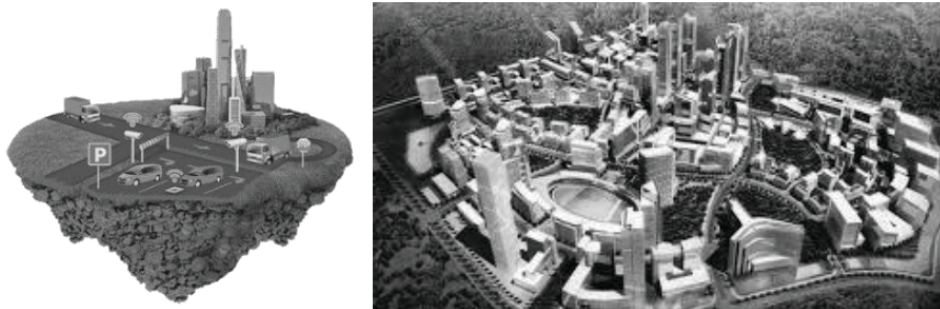
Figure 1. Smart Indian city vision
Source: http://indiatransportportal.com

To build successful and sustainable smart cities, an efficient transport system is crucial. **A study by the India's National Institute of Urban Affairs (2015) identified six key areas of investment in transportation:**
- urban transport management,
- technology in transport,
- inclusive transport,
- green low-carbon transport,
- community engagement, and
- land-use transport integration.

As part of this transformational project, many conferences and workshops focused on transport issues workshops have been organized. City leaders, entrepreneurs, transport and development experts, activists have been participating in those conference to determine how 'smart transport' can play a key role in reducing congestion, pollution and improving road safety in rapidly growing cities.

One of the most common and irritating problems we are facing in the capital of our country is getting caught in traffic jams. The daily commuting on the roads of Delhi is becoming longer and more queueing every day, depicting the failure of public transportation infrastructure to keep pace with the growing developing activities in Delhi. In fact, one of the fastest growing and developing cities of the world, Delhi, is also renowned for its bad sides. According to the report by IBM's global Commuter Pain study in 2013, New Delhi is among the top 10 cities in the world with the worst traffic jams. Really, the worsening traffic congestion on roads of Delhi presents a depressing profile of the capital city.

2. Traffic congestion in Delhi

Some of the major causes of traffic congestion in Delhi are:
- Substantial increase in number of vehicles on Delhi roads in recent years. In fact, the study has shown that almost every day more cars are on all important corridors in Delhi.

- The road length in Delhi has increased at the rate of 4.53% per year, which of course, is not in accordance with the increase of population. It is reported that the road density in Delhi is around 155 km per 100,000 population and about 80 vehicles per km.
- At intersections, the cycle time ranges from 120 to 180 seconds, which leads to long queues, especially during the peak hours.
- Delhi roads are characterised by mixed traffic, which include personal vehicles, buses, trucks, three-wheelers, two-wheelers, including animal--driven cars and pedestrians. This creates problems for traffic management and leads to delays in traffic.
- Increase in the growth of the population in Delhi, which includes the growing number of workforce, is another important factor.
- There has been inadequate public transport system in Delhi. In spite of metro and bus services, the transport system is not able to afford for the growing population, which results with the fact that more and more people use their private vehicles which leads to bigger congestion on the roads.
- Last, but not the least, ongoing construction of the metro lines in various locations, damaged roads, roads' constructions all contribute with growing traffic congestion in the city.

Outcomes of this are as follows:

- No doubt, traffic congestion is resulting with delays and reduction in speed.
- It has resulted with a non-productive activity for most people while getting stuck in traffic jams, late arrivals to work or back home.
- It has resulted in high rate of road traffic fatalities, making travelling and driving very unsafe in Delhi.
- Traffic congestion has also led to an increase in the number of accidents on the roads. In fact, Delhi has the highest accident rate in India and third-highest in the world.
- Here, ironically everyone is in a hurry but nobody reaches on time.
- Traffic rules, red lights, lane driving are not followed which are both the causes and effects of traffic congestion in Delhi.
- Inability to forecast travel time accurately.
- Fuel wastage.
- Increasing air and noise pollution.
- Wear and tear on vehicles.
- Increased road rage.
- Blocked traffic also interferes with the passage of emergency vehicles etc.

3. Role of the government in controlling traffic in Delhi

In order to improve the public transport quality, following measures have been taken:
- Completion of Delhi Metro second phase have been implemented to be a convenient public transport system in Delhi and the adjoining NCR cities of Gurgaon, Noida and Ghaziabad.
- More than 3,500 low floor air-conditioned and non-air-conditioned buses, including corporate sector buses, have been introduced by the Delhi Transport Corporation (DTC).
- Withdrawal of blue-line buses.
- Construction of new roads, flyovers, foot bridges, and widening of existing roads.
- A Delhi Transport Infrastructure Development Corporation has been set up to manage Inter- State Bus Terminals in Delhi.
- Ring Road bypass and elevated corridors in some areas of Delhi like Barrapula drain have been provided with signal-free flow of traffic.

4. Intelligent Transport System (ITS) and Delhi Integrated Multi-Modal Transit System Ltd. (DIMTS)

The main goal of the DIMTS is to provide safe, reliable, accessible, sustainable and user-friendly public transport for passengers and steady development of mechanism to deliver intelligent public transport service for inhabitants. Most of problems related to traffic on the roads in Delhi can be solved with proper implementation of Intelligent Transport System (ITS) as adopted by the DIMTS. ITS in Delhi and in the whole India can bring a sustainable and balanced transportation solution. It means the use of computer and communications technologies in solving transport problems. ITS can help in timely processing of data or intelligence and in providing feedback to traffic managers and road-users. Implementation of ITS is expected to reduce traffic congestion, increase traffic efficiency, upgrade safety to drivers, improve energy efficiency and increase economic productivity. Some examples of ITS include:
- Advanced Traffic Management Systems,
- Advanced Vehicle Control Systems,
- Advanced Traveller Information Systems,
- Electronic Toll Collection Systems,
- Advanced Public Transportation Systems,
- Wireless Traffic Signal Controller,
- Red Light-Stop Line Violation & Detection System,
- CCTV Junction Surveillance,
- Variable Message Sign,
- Video Incident Detection etc.

Those solutions have already been adopted in many countries for effective traffic management. In Delhi, it has started only recently. Proper implementation of ITS will definitely improve the Delhi scenario.

Figure 2. Smart Green Indian city model
Source: http://indiatransportportal.com

5. Engineering Associations advice on what other measures can be taken

Some immediate steps that need to be taken by the government to allow traffic to move somewhat safely in Delhi are as follows:
- Designing a well-maintained and well-developed public transport system.
- Designing separate roads or lanes to control speed and vehicles of different sizes, weights and velocities.
- Promoting traffic safety and traffic rules through education, advertising and strict enforcement.
- Improvements in vehicle design.
- Strict enforcement of travel demand management and policies to be adopted to reduce the use of private vehicles.
- Ensuring safety and convenience to commuters of public transport and pedestrians.
- Introduction of cost-effective, environment-friendly and efficient new modes of public transport for congested lanes, streets and feeder system for major public transport.
- Last but not the least, encouraging walking and bicycling.

The effectiveness of such measures depends to a great extent on us, the public, the road users, the police and, of course, proper enforcement of the laws.

6. Comments from some experts of our WISE members

- Width at intersections need to be doubled and more free exit ways are required. Most of the roads have parked vehicles thereby reducing the available width for moving vehicles. Development works like metro etc. need to provide roads for movement of traffic to reduce jams on roads. It is noted that people take U-turn on road itself. There is a need to provide suitable roundabouts for this purpose. Pollution is more at jams and congested roads rather than moving vehicles.
- Has your government sought assistance from other countries to learn about transportation systems in large cities? I am familiar with this and have used Chicago's systems for years. They could learn from smaller US cities that have recently added systems providing fast transport for passengers. Traffic signaling controls and promotion/education how to them has been of great value in the US. Academics/specialists in urban planning are of big assistance when developing transportation systems.
- I would like to share my thoughts on Delhi's traffic congestion. If we divide working hours and start offices at 7.30, 9.00 and 10.30 segment wise and also the weekends accordingly I believe we reach smooth traffic to a large extent. People who use their private cars will be able to reach destination in a shorter time, hence the pollution emission from their vehicles will also be reduced accordingly.
- Delhi government should say to all private/government sectors to move their offices from Delhi to the location (city) where their plants are situated and stop traffic of between Delhi and of other states. That would avoid many travels: vehicles on the roads and passengers in the public transport.
- Some cities are investing in setting up 'integrated transport networks' by merging various neighbouring transport authorities into '**Unified Metropolitan Transport Authorities (UMTA)**. Others are setting up **Comprehensive Mobility Plans (CMP)** to develop a strategy with clearly defined goals for transport and mobility. Others have already started building projects such as metro systems, green buildings and data centres for Integrated Transport Systems (ITS).
- Automobile manufacturers are being encouraged to invest in research and development to manufacture safe, energy-efficient, technologically advanced cars, trucks and buses. Local and state governments are investing in technology and engineering to develop smart traffic solutions such as intelligent parking systems, digital traffic management systems, solar powered lighting and various 'green' initiatives. These are all aimed at relieving the

chaos of congestion, reducing pollution and reining in India's traffic deaths rate.

7. Smart solutions - electric and hybrid vehicle, metro and more

Indian government is spending billions on spurring electric and hybrid vehicle production; electric vehicle charging stations; high-speed, mono and metro rail projects. There are plans for *'pedestrian skywalks, walkways, cycle tracks'* in various cities.

Even more eco-friendly are plans to employ 1000 river barges for transporting cargo and passengers across India's National Waterways. Intelligent traffic lights, bio-fuels, solar power are all similarly part of various projects aimed at making India safer, greener and cleaner.

City and state governments are setting up *Dedicated Urban Transport Funds* to finance public transport projects. These will be used to fund the construction of fee--based public parking spaces; *Integrated Transport Systems and Bus Road Transit Systems (BRTS)* in smaller cities where train systems might be unfeasible.

Figure 3. Smart Indian City Car vision
Source: http://indiatransportportal.com

Metro Rail Projects have been initiated in eight major cities (Bangalore, Chennai, Cochin, Delhi, Hyderabad, Jaipur, Kolkata, Mumbai) while BRTS are being deployed in 14 cities covering 465 km. A full BRTS has been launched in Ahmedabad. 15,260 modern buses with ITS features such as 'LED sign boards, audio visual passenger information, multiplexing, on board diagnostics, cameras, integrated controller GPS, GPRS, and smart card ticketing machines' were gradually deployed across 61 'mission' cities and more are planned for 118 other cities with populations of over 200,000. Pedestrianisation and NMV schemes are also being implemented but one can see slow progress.

The Smart City Plans replace the Jawaharlal Nehru National Urban Renewal Mission which was launched in 2005 and was largely considered unsuccessful. All stakeholders are much more confident of the success this time because of the high level of engagement of the government, local communities, foreign sponsors and global aid agencies. In June 2015, 98 cities were chosen to take part in the Smart City Mission based on a beauty pageant among local urban bodies. In December 2015, 20 of those mission cities were selected based on the results of a second competition, the 'City Challenge'. They were assessed on the basis of Smart City Plans submitted by their local and state governments and are to be financed by the federal government.

Delhi Metro gets the UN certification. The Delhi Metro Rail Corporation has been certified by the United Nations as the first metro rail and rail-based system in the world to get "carbon credits for reducing greenhouse gas emissions" and helping in reducing pollution levels in the city by 6.3 lakh tonne[1] every year. With this certification, the Delhi Metro has earned carbon credits worth about Rs.47 crore[2] annually for the next seven years and with the increase in number of passengers, this figure will only increase.

8. Delhi Metro decreased road congestion

The subway system of Delhi opened up in 2002 has a coverage of around 189.63 kilometres including 142 stations servicing Delhi, Gurgaon, Noida and Ghaziabad. Since 2002, the metro rail of Delhi has carried an impressive 1.25 billion commuters and has quite clearly become the preferred means of transportation much to the relief of the city's road congestion. This has not only helped to contain traffic snarls but has kept the pollution under acceptable level. This environmentally friendly transport system perfectly suits the 'Go Green' initiatives across the world as it reduces to a large extent greenhouse gas emissions. In fact, the Delhi Metro Rail Corporation has the distinction of achieving carbon credits which was the first of its kind in the world. Certified by the UN as a part of its Clean Development Mechanism (CDM) of the Kyoto Protocol, this feat will help the subway system in mitigating the impact of greenhouse gas emissions. This certification has also earned the Delhi metro train annual carbon credits of a net value of 47 Crore. The significant impact of the metro in Delhi has been praised on an international level and according to the UN report, owing to the presence of the metro rail in Delhi pollution level has gone down by 6.3 lakh tones annually which will definitely reduce the adverse effects of global warming. A study conducted by the Associated Chambers of Commerce and Industry of India (Assocham) has concluded with a statement that around five lakh vehicles have been withdrawn from the city's streets since the opening of the metro rail, saving around 8,00 Crore of fuel in the year between 2010 and 2011.

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1   100 000 tonne
2   10 mln

Metro railway became the nerve centre of Delhi and is an important component of the city's traffic management system. In the capital of India that is plagued with a high density of population and high vehicular traffic, the importance of a mass rapid transit system is beyond question. The metro rail has not only offered commuters a more secure and comfortable travel experience that comes with world class facilities, but it has also reduced the time of travelling and rush hour commuting. Its wide network coverage and connections with other means of transport, such as the Delhi metro feeder buses, have had a very positive impact on daily commute of the people of Delhi. Most importantly, the Delhi metro has significantly helped to reduce the number of vehicles on the city's roads.

Figure 5. Delhi metro view
Source: http://indiatransportportal.com

With more and more people opting for the subway system as opposed to the conventional means of transportation, the challenge now for the *Delhi metro rail* is to meet the rising demands. This requires development of more infrastructural facilities as well as improving the already existing ones by addressing the occasional technical glitches that can cause great delays. Strong government initiatives to meet these growing demands will definitely help Delhi's metro to further evolve and grow.

Metro unclogs Delhi roads. Delhi roads breathes easy, thanks the metro which helps remove more than 91,000 vehicles from the roads of the capital daily. During the last two decades, Delhi had an exponential growth in the vehicular population having more vehicles than the combined number in the other three metro cities of India - Mumbai, Chennai and Kolkata.

Literature

1. http://indiatransportportal.com
2. DMRC website

WYZWANIA POPRAWY MOBILNOŚCI MIEJSKIEJ W INDIACH

Streszczenie: *Warunki mobilności w wiekszości miastach indyjskich pogorszyły się znacznie w ciągu ostatniej dekady, utrudniając życie milionom ludzi dojeżdżającym codzienne do pracy. Brak zintegrowanego multimodalnego transportu publicznego wyrażana jest społeczności miast, zmuszonej do korzystania z samochodów i jednośladów w codziennej podróży. Doprowadziło to do bezprecedensowego wzrosut ruchu kołowego i niebywałego natężenia ruchu drogowego. Niniejsza praca poświęcona jest omówieniu studium wykonalności różnych alternatyw rozwiązań wypróbowanych i przyjętych w Delhi, których wyniki udostępniono dla opinii różnych zainteresowanych stron, w tym organizacjom NGO i stowarzyszeniom. Wiele stowarzyszeńi inżynierskich, takich jak IRC, IRF, CEAI, IAStructE, zostało aktywnie zaangażowane w doradztwo i pomoc władzom w podejmowaniu odpowiednich rozwiązań technicznych i inżynierskich w kierunku poprawy mobilności.*

Słowa kluczowe: *mobilność miejska, stowarzyszenia inżynierskie India, zintegrowany transport, metro*