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Role of Sustainable Urban Transportation System in Environmental Sustainability: A Review

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ABSTRACT: As Indian cities swiftly grow in terms of population and physical size due to contemporary and widespread process known as urbanization. In the coming years, as urbanization increases, cities will face a critical problem of massive increase in population which leads towards unsustainability. City's efficiency, prosperity, economic development and sustainability essentially depend upon the efficacy of its transportation systems. The pressure increases on urban transportation system by increased demand of travel and dominance of private vehicles due to unrepressed urbanization in India, which further results in term of environmental unsustainability. This paper provides an over view on the impact of urbanization on efficiency and performance of urban transportation system in Indian context. Also, it elucidates the impact of poor urban transportation on sustainability of environment. This review paper describes the issues, challenges, current policies and strategies related to urban transportation system in India. Also, the end of this review concludes the role of sustainable urban transportation system in environmental sustainability.

I. INTRODUCTION

As cities are growing in terms of population and physical size due to contemporary and widespread process known as urbanization (United nations,1998). This physical and population growth of cities are responsible for increase in the dominance of the component of private vehicles in urban transportation system (Goodwind, 1996; Noland, 2001). The increment of private vehicles is at a much faster rate than the increment of the urban population. Todays, many cities are facing the problem of increase in the dominance of the component of private vehicles (Tiwari, 2003). The dominance of component of private vehicles in urban transport also influences the sustainability of city (Low and Glasson, 2003). City's efficiency, prosperity, economic development and sustainability essentially depend upon the efficacy of its transport systems. The pressure increases on urban transportation system by increased demand of travel and dominance of private vehicles due to unrepressed urbanization and population growth (Ewing, 1997; Kokaz, 2001). This review elucidates the effect of urbanization on urban transportation system. The review begins with a short appraisal of the urban transportation in Indian context. Then, it provides an overview on the impact of urbanization on efficiency, performance and trend of urban transportation system in Indian context.

The pressure is continuous increase on urban transportation systems, which leads to degradation in performance, efficiency and make it deprived. Today's cities are struggling due to the poor performance of public transport, resulting in environment unsustainability due to continuous emission of greenhouse and harmful gases (Peden *et al.,* 2004; Clarson *et al.,* 1995; Wolf, 1996; Pooley *et al.,* 2005). Most of the cities of India are being suffered by extremely high level of urban air pollution particularly in the form of CO, SO_2, NO_2, PM (Particulate Matter) and RSPM (Respirable Suspended Particulate Matter) due to deprived urban transportation system (Singh, 2012). Urban transportation contributes a major share to environmental pollution (around 70%). Among these pollutants CO is the major pollutant coming from the transport sector, contributing 90% of total emission (IIHS, 2011). Hydrocarbons, NO_x and particulate matter are next to CO. It is indeed interesting to observe that the contribution of transport sector to the particulate pollution is as less as 3-5%, most of the SPM (Suspended Particulate Matter). Also, it illuminates the effect of unsustainable transportation on the environment sustainability. This review paper describes the issues, challenges, current policies and strategies related to urban transportation system in India. Also, the end of this review paper conclude with the role of sustainable urban transportation system in environmental sustainability.

II. URBAN TRANSPORTATION IN INDIA

In India, the transport sector is enormous and diverse, it accommodates to the transport desires of 1.1 billion people. It contributed about 5.2 per cent to the nation's GDP during 2012-13 (IIHS, 2011). To ensure the economic growth of urban areas, good physical connectivity, efficient and reliable urban transport systems are essential. This continuous economic growth of India, has witnessed an increase in demand for travel and transport service, which affects the urban mobility. This continuous increase in urban travel demand leads to difficulty in terms of convenience, cost and time. In fact, present levels of urban mobility are already generating a crisis situation characterized by high levels of congestion, environmental pollution, traffic fatalities and inequity eventually leading to a situation of undesired accessibility crisis (Pucher *et al.,*2005).

Now a day, only few of the metropolitan cities are solved by well-organized urban transport services. Most of Indian cities are facing the problem of good urban transport service and related infrastructure to it. The current practices of urban transport are not reliable, safe, and economical for city use. There are virtually no transport modes in India, specifically de signed for urban conditions. Qualitatively, the availability of urban transport services is overcrowded**,** unreliable, and involve long waiting periods. Overcrowding in the urban transportation is more pronounced in large cities, where modes are supposed to carry double of their capacity during peak hours (Padam, 2004). At a result, there is a massive shift to personalized transport, especially two wheelers and also a proliferation of various types of intermediate public transport modes. If we talked about urban transport in Indian cities, then buses uses are still the best answer to provide mobility. It is regrettable that bus systems are neglected and allowed to decline due to uneconomic fares, poor performance benchmarking and outdated technologies.

III. URBANIZATION IMPACT ON URBAN TRANSPORTATION IN INDIA

Urbanization in India is not different, but similar to a world-wide phenomenon. Indian urbanization has continued as it has elsewhere in the world as a part and characterized by uninterrupted concentration of population and activities in cities. Rapid urbanization leads to continuous increase in population at a fast rate of growth. In India, total population has increased from 238 million in 1901 to 1210 million in 2011. Whereas the urban population has increased from 26 million in 1901 to 377 million in 2011. In last decade 2001-11, the urban population increased from 286 million to 377 million, accounted as 31 percent of total population. It is assumed that the urban population will increase to 600 million and account as 40 percent of total population by 2031. This continuous increase in urbanization and population also results in term of increase the physical size of city. In 1951, there were only five Indian cities with a population greater than one million, 42 cities with a population greater than 0.1 million and 2843 urban agglomeration town. In 2011, there were 53 cities with population greater than 1 million, 468 cities with population above 0.1 million and 7935 urban agglomeration town.

This continuous increase in urbanization and population leads to negative effect on urban transportation system by means of rapid increase demand of travel, and fast motorized which further leads to dominance of private vehicles component of urban transportation system (S.K. Singh 2012). The increase in travel demand is much higher in metro cities. According to Tata Energy Research Institute (TERI), New Delhi, estimated travel demand increase from 335 Billion Passenger-Kilometers (BPKm) in 1991 to 1905 BPKm by 2001 and is still increasing. RITES have estimated 462 million passengers trips per day (mptd) by 2016, for the class I cities alone. The annual growth of travel demand is increasing at the rate of 2.2% in Kolkata, 4.6% in Mumbai, 9.5% in Delhi, and 6.9% in Chennai (MAUE, 1996). This rapid increase in travel demand resulting in fast vehicular growth in urban cities.

The number of vehicles per 1,000 people in Indian metropolitan cities have grown ominously since 2001, The total registered vehicles in the country grew at a CAGR (Compounded Annual Growth Rate) of 9.8 per cent between 1991 and 2009. Personalized private vehicles like cars and two-wheelers grew at CAGR of 9.6 per cent and 10.3 per cent per annum (Road Transport Year Book 2010). The growth in registered vehicles are more in urban area or metropolitan city. Only, five metro cities account for 54 per cent of the total vehicles in the metropolitan cities as of 2011 (Sharma *et al.,* 2011). According to the statistics provided by the MORTH (Ministry of Road Transport and Highways), there is a dominant form of private transport on Indian roads constituting about 98 per cent of the141.8 million registered vehicles in 2011.

Rapid motorization and urbanization affect the shape, pattern and configuration of development of city and make it decentralize, low density, and results in sprawling of cities (Barton, 1992). This sprawl and continuous expansion in city limits results in increasing the average trip length, which further leads to decline in travel by non-motorized transport, cycling and walking (Roychowdhury, 2013).

The average trip length in Delhi has increased from 5.4 km in 1969 to about 13.5 km in 2001(Padam, 2004).The average trip length on Delhi Transport Corporation (DTC) buses has increased from 6.4 km in 1972 to nearly 18.0 km at present. Currently, it is estimated that the average trip length of four mega cities varies from 12.7 to 13.5 km (Roychowdhury, 2013). Cities with population up to 5 million has the higher share of trip made by non-motorized transport and walking than mega cities. But this sprawling phenomenon has a higher threat of losing walking and Cycling and NMT share to private motorized transport in the coming decades for medium and small sized cities. This dominance of private vehicles, dwindling share of non-motorized transportation, walking, changing in travel behavior, pattern and purpose results in terms of inappropriate modal split practices. The existing modal split in Indian cities are not in desirable modal split standards.

Hence, in India, it is clear that urbanization affects urban transportation system adversely and leads to rapid motorization, dominance of private vehicles, dwindling share of non-motorized transportation, walking, changing travel behavior, pattern and purpose and incongruous modal split.

IV. URBAN TRANSPORTATION IMPACT ON ENVIRONMENT

The rapid urbanization results in increasing dominance of private vehicles component and increasing travel demand, which leads urban transportation system towards unsustainability (Tiwari, 2003). The inefficient urban transportation system has a large range of negative consequences on urban system of cities (Whitelegg, 1993; Banister and button, 1993). Most of cities are facing prevalent challenges of environment sustainability. Environmental sustainability implies that certain environmental qualities can be preserved or attained. But, primarily the unremitting increase in carbon emission results in degradation of quality of environment, which further leads to unsustainability. Today, modern trend of transport sector is the major contributor to environment unsustainability. Atmospheric pollutants such as nitrogen oxides (NO_2), hydrocarbons, carbon monoxide (CO), sulfur oxides (SO_2), and Suspended Particulate Matters (SPM) are commonly associated with motor vehicles in transport sector. The both local and global environment affects due to increasing use of private vehicles. This trends results in more emission of CO_2, greenhouse gases emission and mutilation of environmental qualities and leads toward unsustainability and global warming phenomena.

The most of Indian cities are facing serious environmental problem due to growing air pollution caused by inefficient urban transportation. According to available air quality data, of 180 Indian cities, there is an extensive concentration of pollution (Kamyotra *et al.,* 2012). The ambient air pollution in terms of suspended particulate matter in many metropolitan cities in India exceeds the limit set by World Health Organization (Singh, 2008). In Delhi, Kolkata and Mumbai, the average annual emission of SPM is 543, 394 and 226 micrograms per cubic meter respectively, while the WHO standard is 75. If no action is taken, the air quality of large cities in India is likely to deteriorate by a factor of 3 in the next 10 to 15 years (CSE,1996). In India, it is identified around 70 cities, representing over 80 per cent of the cities that were being monitored, that were not complying with the NOx and PM standards (CPCB, 2008).

V. CHALLENGES

The major challenges in urban transportation in Indian cities are listed as following: (IIHS 2011)

- Gaps in Laws and Regulations
- Fragmented Institutional Frameworks
- Distorted land markets affecting transport infrastructure development
- Comprehensive design standards for transport infrastructure lacking
- Human Resource challenges
- Absence of reliable transport data
- Inefficiencies in bus based PT services

VI. POLICIES AND STRATEGIES

Various plans, strategies and programs are initiated by the central government to address urban transport challenges in Indian cities through the planning commission and ministry of urban development, listed as following:

- Jawaharlal Nehru national urban renewal mission (JNNURM) of 2005
- Central financial assistance (CFA) for betterment of urban transport planning& management
- Comprehensive mobility plan (CMP)
- Unified mass transit authority (UMTA)
- Dedicated urban transport fund at state and city level
- Transit oriented development policy, parking policy and advertisement policy
- City specific special purpose vehicle for managing public transport
- Traffic information and management control centre

- National road safety and traffic management board (NRSTMB) and inspection & certification (I&C) centres were set up across the country to address safety issues in urban transportation.
- National urban transport policy and sustainable urban transport policy were introduced to promote a safe, reliable, effective, efficient, coordinated, integrated and environmentally friendly public transport system and managed in an accountable manner to ensure that people experience improving levels of mobility and accessibility with the following objectives:
  - ✓ Integrating land use and transport planning
  - ✓ Equitable allocation of road space
  - ✓ Prioritizing public transport
  - ✓ Quality and pricing of Public Transport
  - ✓ Technologies for Public Transport
  - ✓ Integrated Public Transport Systems
  - ✓ Priority to Non-Motorized Transport
  - ✓ Integration of multi-modal system

VII. SUSTAINABLE TRANSPORTATION AND ENVIRONMENTAL SUSTAINABILITY

Addressing issues of sustainability allows societies to meet their present needs without compromising the environment for future generations. There are two important aspects of environmental unsustainability: the first is CO_2 emissions that cause climate change and the second is other emissions that contribute to air pollution due to private vehicles. Hence, sustainable urban transportation system is essential, has the potential to address the negative consequences of private vehicle in urban areas. It also a key component to ensure environmental sustainability and fulfill the travel needs of city (Miller *et al*., 2016). A sustainable transport system is one that provides transport and mobility with renewable fuels while minimizing emissions detrimental to the local and global environment, and preventing needless fatalities, injuries, and congestion (Black, 2010). Sustainable transportation is an aspect of global sustainability, which involves meeting present needs without reducing the ability of future generations to meet their needs. Sustainable transportation system consists of various kind of modes such as public transport (mass and intermediate public transport), para transit, non-motorized transport with provision of walking and cycling. It is more about the efficient, smart and equitable provision of public transportation, walking and cycling, resulting in reduction travel demand and pollutant emission (R. Hussain, 2013; R. Rastogi, 2011; R. Gadepalli, 2016). The public transport modes have less harmful consequences, while provision of walking and cycling has no harmful consequences to environment (Mees, 2000a, 2010b). The Sustainable transportation planning also provides prosperous integration between various modes of transportation in terms of physically, service, information, fare with land use planning which results in improve mobility by using all modes and reducing average trip length (Simphson, 1994; Richards, 2001).

Most of cities are looking for environment sustainability by reduction in carbon footprint through the concept of eco, green and low carbon cities (Kenworthy, 2006). Sustainable transportation system helps to reduce the carbon emission. Hence, it is an important element and plays role in development of eco, green, and low carbon cities. Zurich, Geneva, Vancouver, Vienna, Atlanta, San Francisco and Honolulu, Bad Ischl are best example of eco, green cities, documented the importance of sustainable transportation planning (UNEP, 2011).

VIII. CONCLUSION

Transport demand and dominance in private vehicles in most of the Indian cities has increased substantially due to increase in population caused by rapid urbanization. This increase in travel demand and rapid motorization affects the development configuration of Indian cities and make city sprawling, results in dwindling share of NMT and walking which further leads to undesirable model split. This improper modal split leads to unsustainable and inefficient transportation of urban cities. This trend of urban transportation results in environment unsustainability (air pollution and global warming) through emission of pollutants and toxic gases. Hence, sustainable urban transportation system is essential to ensure the environmental sustainability. It has the potential to address the negative consequences of private vehicle in urban areas. Various cities, has recognized the importance of sustainable transportation for environment sustainability by reducing carbon footprint. Now, the time has come to plan the sustainable transportation system in Indian cities to ensure the sustainability of environment.

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