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Sustainable Public Transportation in Jaipur City

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ABSTRACT: Public transport is taken as a key point in urban mobility pattern and thus making cities more livable and sustainable. The growth in private vehicular ownership, significant commuting distances and lack of parking areas have created adverse impacts on the environment, the social and economic health of our cities. It is important to curtail these problems, and implementation of public transport can act as a catalyst to overcome this issue. This study is concerned with finding a relation between public transport system in Jaipur and sustainability aspects. Firstly, this paper offers an introduction to transportation issues in India and study area and trend of vehicular growth. Secondly, this article assesses past studies about sustainable transport systems, public transit system, and their benefits. Thirdly, the paper gives public transport scenario in the Jaipur (study area) and describing the problems faced in public transport system about sustainable aspects. Lastly, the paper concludes by offering a suggestion for improving public transport system to mitigate the challenges occurred to attain sustainable transport system.

Keywords: Public transport, Sustainable transport, Jaipur.

I. INTRODUCTION

India is the second largest country regarding the population having a population of 1.252 billion. As per the census 2011, there are fifty plus cities having population 1 million or more. This increase in population is due to the natural increase and migration of people from rural areas and smaller towns. This lead to increase in transport demand and number of motorized vehicles as shown in Table 1 and corresponding figure 1, which is reaching out to the existing capacity of roads.

Table 1: Forecast of Vehicles Population in India (in a million).

Population	2015	2025	2035
Two wheeler	87.5	174.3	236.6
Three wheeler	5.4	8.9	13.2
HCV	4.7	9.1	16.2
LCV	5.7	12.5	26.9
Car, SUV	18	41.6	80.1
Grand total			

Source: Ministry of Urban Development, Government of India, New Delhi 2010.

Cities started facing the problem of congestion, time delays, and pollution. Due to this, all Indian million plus cities are confronted with a severe urban transport problem. Imbalance in Modal choice, sub-optimal use of transportation infrastructure and inadequate transport facilities are the reasons behind these problems. The existing public transport system is also not capable of catering the demand, so passengers are switching to personalized transportation system.

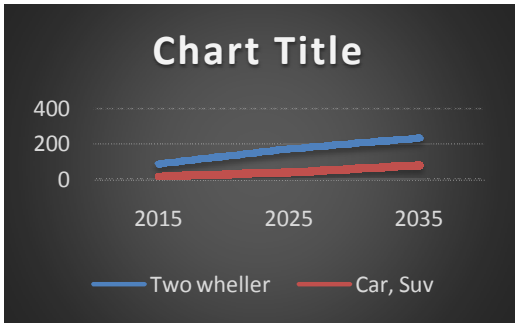

Fig. 1. Forecast of Vehicle population in India.

(Source: Ministry of Urban Transport 2010)

In India, as the city grows, the percentage of trips from public transport increases. Cities having 1 to 2.5 million population have 30 percent trips from public transport, whereas cities having 2.5 to 5 million population have 42 percent, and cities over 5 million residents 63 percent of travel. (Source: Census 2011), So there is an increase in demand of Public transport system.

II. STUDY AREA

Jaipur is the state capital of Rajasthan in India and was founded in 1727 (by Maharaj Jai Singh II). It is also known as the pink city.

The location of Jaipur city in a north-eastern part of Rajasthan state. The city is at an altitude of 431 m above mean sea level and at 26.92' N latitude & 75.82' E longitude. The geographical area of the city is 326 so. kilometers.The city is surrounded by Sikar and Alwar districts on the north by Tonk, Ajmer and Sawai Madhopur districts on the south by Nagpur, Sikar, Ajmer districts on West and Dausa district in the east.

Jaipur has a dry climate with a hot season. Cold season starts from December and lasts till February followed by hot season which continues up to the middle of June. The period from mid-June to mid-September is of the southwest monsoon, next remaining time till winter is post monsoon season. Maximum, minimum and mean temperature recorded are 37-degree C, 6-degree C, and 25.5-degree C respectively. The normal annual rainfall is 638. 4mm.

Jaipur city is having a population of 3.10million (Census 2011). Its annual-decadal growth rate is 4.6 percent and city is one of the fastest growing million plus city. The study area Jaipur City is presented in Fig. 2.

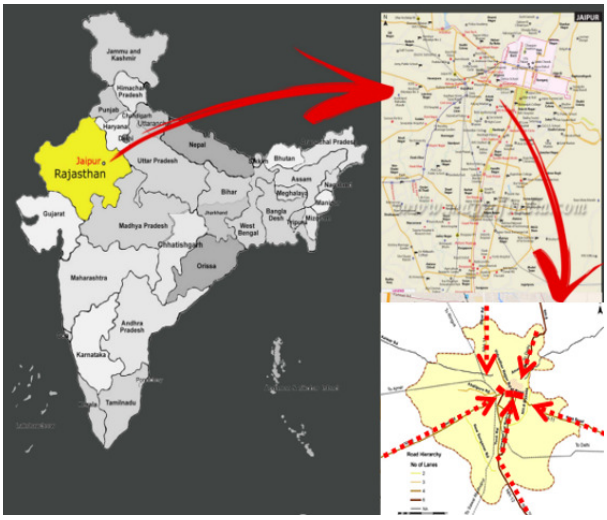

Fig. 2. Map of Jaipur.

Jaipur Transportation: Transport is one of the major infrastructure facilities necessary for economic development. The city of Jaipur is well connected to the rest of the country by road, rail, and air. Travel needs in the city are catered to by a variety of transport modes. They include Bus rapid Transit system (BRTS), Mass rapid Transit system (MRTS), buses operated by Rajasthan State Road Transport Corporation (RSRTC), mini buses run by private operators, Vikram (Tempos), auto-rickshaws and cycle rickshaws as Intermediate Public Transport and personalized modes such as cars, two-wheelers, and cycles. The existing road, rail network of the Jaipur city (study area)is presented in the Fig no. 3 and the important points like airport (Sanganer airport), railway station, Sindhi Camp (Bus Stand).

Fig. 3. Road Network of study area.
Source: CMP Jaipur

City transport is taken care by both personalized and free modes. Personalized mode of travel includes private cars, two-wheelers, cycles. Public transport modes include MRTS (Metro) from Mansarover to Chand Pol, BRTS from Sikar to Pani Pech, buses operated by Rajasthan State Road Transport Corporation (RSRTC) on 22 routes, minibusses run by private operators, auto-rickshaws, Vikram (Tempos) and cycle rickshaws in the form of Intermediate Public Transport. The existing transport share in Jaipur city comprises of Public transport 19 percent, taxi service 8 percent, auto service 6 percent, car 8 percent two-wheeler 27 percent and rest is Non-Motorized Transport. The details of the public transport system as shown in the Fig. 4.

As suggested by overviews of CMP report on Indian cities that the share of public transport is less as compared to other million plus cities. As the desirable modal split in Indian cities for a city like Jaipur should be 40 percent as suggested in City mobility plan of Jaipur.

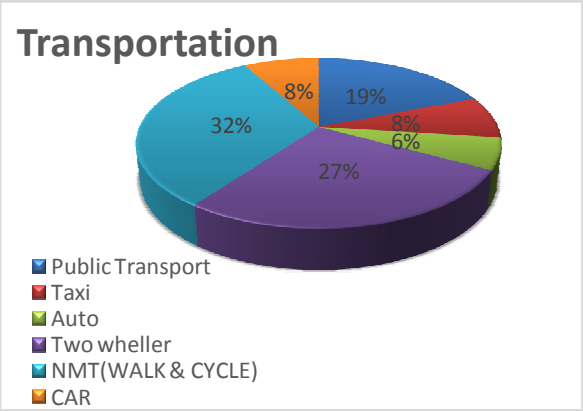

Fig. 4. Transport share.
Sourece: Detailed Project Report Jaipur for Metro 2014.

III. LITERATURE REVIEW

Sustainable Transportation: Environment, economy, and society are the three most important aspects of sustainable development. These three points are commonly referred to as a 'triple bottom line' (Pei *et al., 2010).* They are defined as follows by Low (2003):

- Environment: the natural or biological perspective considers the effects of human exercises and improvements on changing neighborhood and worldwide situations
- Economy: the financial improvement is the procedure of a group's development or advance towards monetary objectives, for example, expanded riches, work, efficiency or at last welfare
- Social: the social measurement of supportability regularly is depicted as managing issues of value and incorporation

Schiller *et al.* (2010) recommend that the application and meaning of sustainability go further side of industrial applicability. Creating sustainable transportation includes society everywhere – including parts of planning, financial matters, and resident contribution
suggest that the application and definition of sustainability go beyond technical progression.
The key reasons behind sustainable transportation concept to came in existence are:

- Concerns about transportation's effects and the counter profitability of routine expressway situated arranging that rose up out of the 1970s forward;
- Recognition that decreasing activity in urban communities (either through quieting or pedestrian) accomplished wellbeing and natural advantage; and
- Increased consciousness of maintainability ideas after the Brundtland report was published.

Bongardt *et al.,* (2011) recommends that transportation has an assortment of adverse effects, particular concentrate on natural, financial, and social issues ought to be included in a meaning of sustainable transport and its application. Despite increasing number of literature and studies on sustainable transport, there is no acknowledged original definition of sustainable transportation or how to quantify sustainable transportation.
The definition of sustainable transport can get by giving current direction for sustainability and transportation or sketching out particular estimations or consideration for a transport framework to be sustainable.
Black (2010) recommends that a sustainable transport framework is one that applies the Brundtland definition or just said: "traffic system that fulfills the present transportation and versatility needs without trading off the capacity of future eras to address those issues."
This definition secures sustainable transport line with more extensive research on sustainability.
Centre for Sustainable Transportation in 2005 develops different definitions and blueprints three key components of sustainable transportation:

- Allows the essential get to requirements of people and social orders to be met securely and in a way reliable with human and biological system wellbeing, and with value inside and between eras,
- Is moderate, works proficiently, offers decision of transportation mode, and backings a dynamic economy,
- Limits outflows and waste inside the planet's capacity to assimilate them, limits utilization of nonrenewable assets, limits use of renewable assets to the possible yield level, reuses its segments and restricts the use of land and the generation of noise.

Vreeker and Nijkamp (2005) also have a similar set of goals for transportation and distinguish that these might be hard to adjust:

- Economic productivity – reflected in the expanded intensity of areas through a change in network;
- Social value – reflected in more equivalent open doors for better access to transportation offices (for various financial gatherings, for less focal zones);
- Environmental manageability – pondered in more accentuation adapting to the adverse externalities of the traffic division, for example, contamination, commotion, scene rot, blockage, the absence of wellbeing.

Frameworks for Understanding Sustainable Transportation

A developing collection of research looks to apply meanings of sustainable transport into applicable systems.

These systems give comprehension to sustainability in two ways: supporting understanding of how undertakings or projects may make transport more sustainable and structures for perception the effects of traffic.

Banister et al., (2008) traces a feasible transportation worldview made out of four perspectives:

- Actions were taken to diminish the need to travel;
- Increase or Encourage to modal shift;
- Decrease or shorten the trip lengths;
- Increased proficiency.

This system might be connected to group arrangements or activities given how they bolster sustainable transportation.

Kennedy et al. (2005) proposed Sustainable transport be confined as an essential urban issue meeting with complex worldwide issues, for example, environmental change, and also nearby issues like human wellbeing. Like other structures, the creators outline feasible urban transportation as a harmony between economy, environment, and society. However, the distinction is in how this adjust is produced. Four columns recommended are:

- Governance: "the foundation of successful bodies for coordinated land-utilize transportation arranging,
- Funding: "the formation of reasonable, efficient, and stable financing instruments,"
- Infrastructure: "vital interest in significant foundation,"
- Neighborhoods: "the support of speculations through the nearby outline."

Jeon (2007) proposes from the review on sustainable transportation that all structures ought to consider:

- How viable the transport framework is,
- What are Impacts of the framework on financial improvement,
- How the context impacts on the social and personal satisfaction,
- What are Implications of the framework on natural respectability?

The system recommends this widespread triple primary concern with four measurements is an essential device for applying supportability examination to transport.

Challenges faced in Sustainable Transportation:

Transport converges with many sections of society and the earth and can make many advantages for human welfare. It can empower financial development and associate individuals to important administrations. Be that as it may, it can likewise cause various difficulties. The researchers propose that current patterns of auto-depended transportation are unsustainable because of substantial effects crosswise over environmental, economic, and social.

Moavenzadeh and Markow, (2007) says that private vehicle dependency for traveling leading towards congestion problem, where congestion is defined as the low rate of traffic volume flow and increasing no. of vehicles. As the no. of vehicles raise the level of pollution increased due to gasses emissions by these vehicles.

Dobranskyte-Niskota *et al.,* (2007) says that apart from energy generation and industrial processing, transport is the largest contributor to air pollution. The negative impacts associated are increasing pollution, decreasing economic productivity, and damage to human health.

Bannister (2005), says an from an economic point of view acceptable mobility is not available for different purposes of trips by various modes are counted as unsustainability.

Todd Litman and Burwell (2006) suggests transportation impacts over environmental, economic, and social aspects.

Environmental Impacts are:

- Contamination or Pollution in Air, Noise, and Water
- Change in climate
- Impacts on Hydrology
- Degradation of Ecology and Habitat and
- Depletion of non-renewable resources

Economic impacts are:

- Accessibility quality
- Traffic congestion
- Infrastructure costs
- Consumer costs
- Barriers to Mobility
- Accident Damages
- Depletion of non-renewable resources
- Aesthetics

Social implications are:

- Equity/Fairness
- Effects on mobility disadvantaged
- Affordability
- Human health impacts
- Community cohesion
- Community livability

Public Transport Benefits:

Public transport is an important driver for sustainability. Schiller et al.,(2010) says that public transport gives energy efficient, decrease pollution level and private vehicle dependency transport in urban areas. He also suggests that public for environmental benefits are falling in emissions and land resource utilization, social benefits are improved access, economic benefits are increased economic efficiency and contributions to the business.

The four fundamental public transport Sustainability intervention by
(1) Good Public transportation choices cause organizations and individuals to modify their area behavior,
(2) People who take public transport join stumbles into single trip – instead of particular auto trips decreasing the aggregate number of outings,
(3) Households that use public transport stop using cars,
(4) Public transport clients frequently utilize strolling or cycling to get to stations or stops.

IV. METHODOLOGY

Firstly, this research identifies the growth of private vehicle auto dependency from the reports of Ministry of Urban development and Ministry of Transport in all the cities in India. This increase seems to be a challenge for a sustainable transportation development in the towns. Secondly, studied literature to understand different features of sustainable transportation and benefits of public transport. Thirdly examination of public transport scenario in the Jaipur (study area) and labeling the difficulties confronted in public transport system about sustainable aspects**.** Moreover, debased on past studies done on traffic and transportation study for MRTS and BRTS, report of Comprehensive Mobility Plan of Jaipur. Finally contributing by giving a recommendation for improving public transport system to moderate the challenges occurred to achieve sustainable transport system.

Analysis of Public Transportation: Jaipur Public transportation is developed under the Jaipur Municipal Corporation and Jaipur Development Authority. It includes MRTS, BRTS, low floor buses. Metro runs from Mansarover to Chand pole for 11.2 Km, BRTS from Sikar to Pani-Pech for 6.6 km. Low floor buses run on 22 routes and operated by Rajasthan State Road Transport Corporation (RSRTC), minibuses run by private operators on 28 routes, auto-rickshaws, Vikram (Tempos) and cycle rickshaws in the form of Intermediate Public Transport. The operation, management, and regulation of public buses and BRTS in Jaipur under the purview of Jaipur City Transport Service Ltd (JCTSL), The operation, administration, and control of MRTS (metro) in Jaipur under the jurisdiction of Jaipur Metro Rail Corporation Ltd (JMCL).

Jaipur Public transport system is witnessing significant sustainability challenges due to the imbalance in modal share, inadequate and suboptimal use transport infrastructure, lack of public transportation on all routes, last and first-mile connectivity. By studies, the parameters adapted from the sustainable transportation are Environmental, Economic and Social.

Firstly, taking consideration of Environmental impacts, we find that Public transport of Jaipur city consists of only 19 percent other trips made by personalized vehicles which generate air and noise pollution. The existing public transport other than the Metro, buses run on diesel which is also poisoning air and environment by the emission of gasses and noise during operation. This contamination of and noise pollution changing the climatic conditions, which is degrading the ecology and the habitable place. By using resources which cannot be renewable for transport we are depleting it sources.

Secondly, taking consideration of Economic impacts we find that Public transport of Jaipur city is, that there is a lack of seamless transit system in all parts, substantial initial investments are needed for providing rapid and sustainable transport in all part of the city. There is no convenience in traveling by transit due to less frequency, lack of integration between different modes, so people move to a private vehicle, which is a costly solution. The increase in private vehicles on the road causes congestion and accidents. These congestion and accidents generate a barrier to movement and safety for the road users. This barrier causes ill effects for the public on economic sustainability.

Thirdly, taking consideration of Social impacts we find that Public transport of Jaipur city is, mobility or movement is obstructed, and high price or cost of transportation services decreases affordability. The right of using equity during travel in the town due to lack of NMT and Public transit infrastructure. The pollution from vehicles has impacted ill effects on the human health.

Inferences: By parameter's, Environmental, Economic and social sustainability challenges were identified in the study area are:

- Increasing automobile dependency,
- Lack of usage of cleaner education in motor vehicles,
- Lack of sustainable transport solution
- Shift towards private motorized transport
- Ill Health impacts due to pollution
- Equity or fairness in the design of roads.
- Share of public transport is less compared to other modes,
- lack of usage of cleaner energy in all public transport modes.
- Lack of integrated public transport infrastructure and its frequency.
- The high cost of initial investment for sustainable public transport.
- Lack of accessibility and convince in existing public transportation.

For the identified challenges following are some Strategies to improve public transport system to mitigate the problems occurred to attain sustainable transport system are

- Subsidized Public transportation,
- Technology advancement in the field of public transportation,
- Need of giving Disincentives r private mode users,
- Encourage the use of zero carbon modes,
- Design of roads made in a friendly way for Public transport and NMT,
- Last mile connectivity and ITS should be adopted,
- Public transport should run on cleaner education,
- Focusing on public transport particularly bus and metro transport,
- Introducing variety of public transportation services
- Improving the efficiency of bus transport operation,
- Enhancing public transport coordination,
- Restraining the use of polluting vehicles and fuels,
- Tightening vehicle emissions standards and inspection and maintenance programs.

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