

Restructuring of Urban Transportation Infrastructure Governance to Improve Stakeholder Satisfaction and Urban Transportation Metabolism: A Citizen Centered Approach

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Abstract - Efficiency, Sustainability, Resilience and Attractiveness are fundamental considerations for city managers in managing urban infrastructures. Urbanization is projected to continue in the coming years and this extraordinary increase in metropolitan populations will inexorably increase the demand for urban mobility and transportation services in almost all cities around the world. Effective government and management systems maintaining productive, robust and sustainable environmental efficiency will placed economic sustainability at risk, jeopardising the quality of life of humanity in particular and urban communities. Only by incorporating advances in management and operations of urban service networks can sustainable growth in the 21st century be accomplished. Emerging strategic methods that combine community development systems with economic development and management is a daunting task that many communities are struggling with today but must be converted into viable and competitive growth engines in both developing and industrialised economies.

Keywords - Efficiency, Sustainability, Resilience, Urban transportation, Approach

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INTRODUCTION

Currently more than 4.35 billion inhabitants, or more than 54% of the world's population, reside in metropolitan areas. The urban and rural population forecasts are estimated in absolute terms until 2050. (The demographic development projection focused on the UN scenario for medium fertility). By 2050, global population is projected to increase to around 9.8 billion. It is estimated that more than twice as many people in the world will be living in urban (6.7 billion) than in rural settings (3.1 billion). It is estimated that population of India will be about 1.66 billion by 2050 out of which 876 million (approximately) 53 % will live in urban areas. (Source UN's median fertility scenario)

This significant increase in urban population will increase the demand for transportation, energy, mobility, water, and other urban services in cities. So effectually, cities have to psych up for the speedy growth and become more efficient in provision of urban

services. Further, urban areas and cities are the biggest polluters of the environment, accountable for more than 80% of Green House Gases emissions, 75% of waste generation and 70% of global energy consumption. Owing to worldwide recognition of the detrimental consequences of such emissions on the natural ecosystem, cities are under growing strain and are increasing their service standards. Transportation services in particular which consumes about 30 % of the total energy consumed and a major factor in increasing carbon footprint is under tremendous pressure to have reduced energy consumption and carbon emissions.

Increasing demand for sustainable, inclusive, reliable and efficient urban transport service puts our urban transportation infrastructures under a huge pressure. In such a challenging situation, management of urban transportation infrastructures

plays a key role to ensure the delivery of expected level of services in cities.

REVIEW OF LITERATURE

A planned and citizen friendly transportation system is the lifeline of a city and greatly boosts socio-economic development (www.morth.nic.in). In order to develop a world-class city, an integrated transit system is an absolute necessity (key mobility challenges in Indian cities by Prof Geetam Tiwary). Without proper integrated planning of mass transit in a multimodal transportation framework, it may not be possible to use the mass transit system to its full capacity. To implement an integrated transport system, it is essential to understand the barriers between the constituent modes to bring synergy into the operation as a component of the complete multimodal transport system. (Dr Vimal Gehlot PWD Govt of Rajasthan) Sustainable Urban Transport Project (SUTP), an initiative of the Ministry of Urban Development, launched in May 2010, is a sequel to adoption of National Urban Transport Policy (NUTP), 2006 (Study of traffic and transportation policies in urban areas in India –Ministry of urban development). SUTP aims at building capacity in Indian cities and pilot projects with the concept of “priority for moving people, not vehicles”. (Ministry of Urban Development Government of India). It is now an inescapable requirement to prepare a Comprehensive mobility Plan (CMP) which should have high class sustainable and efficient transport that will meet the needs of people and the economic developments including tourism proposed in the area. (JDA Vision document 2030 Wilber Smith Associates). CMP is a transport sector master plan-cum-investment program document to meet the mobility concerns arising from the population and business growth of the study area (Ministry of Urban Housing and Development Government of Rajasthan). Presently, there is no legislation at central, state or local level that comprehensively covers urban transport requirements of Indian cities. A few of these have evolved to address specific issues in urban transport resulting in fragmentation or overlap of jurisdictions. Overlapping legal framework and jurisdiction creates hurdles for efficient transportation. Multiplicity of governing bodies make transportation system complex (Urban transport crisis in India j. Pucher et al). Large human resources involved in urban transportation require proper management and training. Design standards for urban transportation network needs to evolve and mandated to make it more user friendly, viable and attractive alternate to private transport (Multi Modal Urban Transportation System Swayam NPTEL).

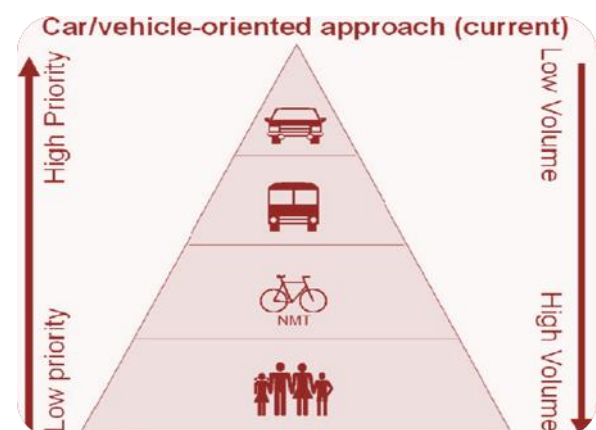
KEY CHALLENGES IN URBAN INFRASTRUCTURE MANAGEMENT

The main challenges that urban infrastructure systems face are numerous, some of the key challenges which have been identified to be inter related and coherent are:

- (1) Demographic
- (2) Socioeconomic
- (3) Technological
- (4) Environmental
- (5) Financial

1) The Demographic Challenge is related to the dynamics of the urban population. Currently the growth of urban populations in many areas of the world outpaces the ability of most urban infrastructure managers to expand their systems and provide service to the newcomers. Global urban population has passed from 746 million people in 1950 to 4.35 billion people in 2020 (United Nations 2020), and the trend is not expected to change. In addition, the increased number of citizens requiring access to the services, strains the system and exacerbates the negative effects of inefficiencies. These two consequences of the urban population growth greatly increase the risk of marginalization and expansion of urban slums, where even the most basic services are not delivered properly.

2) The Socioeconomic Challenge is related to the social and economic inequalities in cities. Ensuring adequate living conditions is a key goal of urban infrastructure systems, which has to be inclusive for all people living in urban areas. Several difficulties emerge when trying to achieve this goal and one of the difficulty is to provide adequate and equal mobility alternatives to ensure access to work and leisure opportunities. One of the important steps in this direction is the paradigm shift in Transport Planning Approach explained as under:



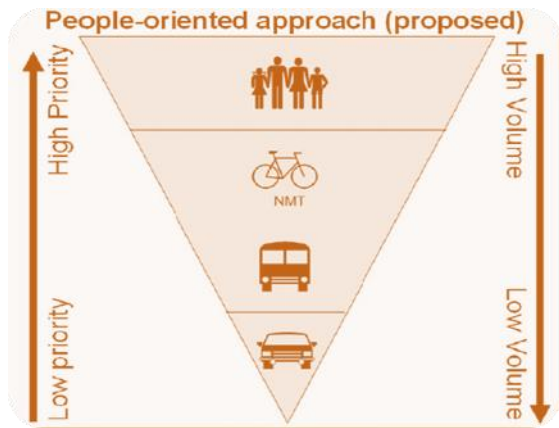


Figure 1: Government of India Ministry of Urban Development

An initiative in the form of a Sustainable Urban Transport Project (SUTP), initiated in May 2010, following the implementation of the National Urban Transport Policy (NUTP) was taken by the Government of India's Ministry of Urban Growth, 2006. The major aim of SUTP is to building capacity in Indian cities and initiate pilot projects with the concept of "priority for moving people, not vehicles".

3) The Technological Challenge is linked to the increasing complexity in planning and managing urban transportation infrastructure systems. There are, on one hand, the cities with legacy systems, where infrastructures were built in the early twentieth century. Some of these infrastructures are now at risk of collapse and of becoming obsolete which will have to be upgraded, if not totally renewed. On the other hand, new infrastructures are being built from scratch. In both cases, we are facing substantial technological challenges pertaining essentially to their efficiency. As per estimates, it is concluded that retrofitting a city can cost between three to eight times as much, or even more, than designing a city property from the outset. It is bad business to create bad cities, with infrastructure that is not proper. The second challenge is urban ageing. If equipment is not properly managed and ages and the asset management scheme simply does not work, communities start facing difficulties quite soon. And technologies and infrastructure are at the core of the interdependence of multiple infrastructures. A comprehensive view of the infrastructure is required, since one can not merely accept one utility without taking the other into account. Good urban planning, good city management and requires services to be thought through as in a holistic manner.

4) The Environmental Challenge mainly pertains to pollution and the effect of climate change on cities due to increased dependency on fossil fuel by transportation sector. Globally, cities have already become and are further evolving into global environmental forces. For example, urban settlements consume around 75 percent of global primary energy and emit a large chunk of the total world's annual greenhouse gas emissions. Curbing these emissions is an increasingly pressing task for city managers.

Overall, the challenge is to make urban transportation infrastructures more sustainable. The environmental characteristics refer to the interaction of urban infrastructures with their natural surroundings. The impact of urban infrastructure systems in the environment can be either negative (such as CO2 emissions, noise, pollutants, and changes of land use) or positive (such as integrated, green infrastructures and renewable energies). But in any case, urban infrastructures do affect the urban environment, generally negatively. Another environmental challenge is linked to infrastructure and the resilience of urban infrastructure to face environmental shocks. The climate change problem and the elimination in carbon pollution from cities must also be discussed. The international community is now seeking to overcome this dilemma by means of dialogue and agreement.

5) The Financial Challenge is related to the limited availability of financial resources to operate and to develop urban infrastructure systems. Establishing an institutional framework capable of ensuring a revenue stream to sustainably support the operation and maintenance of the urban infrastructure is a major challenge for cities. In most cases, urban infrastructure managers are required to provide more and better services with limited financial support. Creating funding is required, city assets have to be leveraged and we have to make sure that we exploit the increasing value of property as metropolitan communities expand. In certain situations it is a land that is not serviced, which does not meet essential needs and is rather difficult to allocate between utilities, water , transportation, housing and other resources. In theory, the operation and maintenance of the urban transport system must be created from a sustainable income stream. In certain instances, capital spending is actually handled well and proper infrastructure is given, however, the income to genuinely support this infrastructure is not appropriate. The infrastructure crashes, decays and facilities continue to fail without proper maintenance. This is demonstrated by the limited cooperation between local governments in many of our emerging cities , particularly our metropolitan areas.

ILLUSTRATIVE CASE: JAIPUR CITY

Jaipur City stands out as a noticeable global example of the challenges urban infrastructure system managers have to face. The city is the 10th most populated city in india and is home for over 4 million people today. The Rajput rule Jai Singh II, the ruler of Amer, named after the region, established the Jaipur in 1727. It was one of Vidyadhar Bhattacharia 's early designed cities in Modern India. The city acted as the capital of the state of Jaipur during the British Colonial era. Jaipur became the capital of the newly created State of Rajasthan (Wikipedia source) after its independence in 1947. Jaipur, a Pink City of India, was registered as a UNESCO World Heritage Committee on July 6,

2019. The UNESCO sites Amber Fort and Jantar Mantar are also located in the city.

Jaipur City is still battling its own problems, firstly to maintain its heritage status and then to ensure modern infrastructure development in consonance with the increasing demand of population residing in it. The Jaipur City case will help illustrate the demographic, socioeconomic, technical, environmental, and jurisdictional challenges modern urban infrastructure systems encounter around the globe.

The Demographic Challenge

Population growth in Jaipur City has followed a steep curve that has strained the city's capabilities to provide basic services. Acting as a magnet for rural populations in search of higher living standards, the city grew steadily throughout the past century, with a dramatic increase since the 1990s when the population exploded from 14.78 lacs to more than 40 Lakhs today, with a growth rate that has fallen below 2.54 percent per annum, the population is expected to reach 70 Lakhs by 2020 (source sites. uoit.ca World Population Review). Despite the drop of the population growth rate, the deep imprint of uncontrolled expansion remains starkly visible across the agglomeration, with poor housing and urban infrastructure marginalization erupting abundantly all over the city. The social structure is under transformation in Jaipur City. The demographic and economic changes in the agglomeration are driving the change. Drastic reductions in fertility caused by family planning policies and the increase in life expectancy have changed living styles, particularly among women. As a consequence, the population growth has decelerated (although not the city expansion); the population is aging rapidly and women are taking a more active economic role. Additionally, the traditional immigration of rural Jaipur into the Jaipur city has greatly increased. This has generated a shift from an uneducated, rural population massively coming into the city. All these trends are dynamically defining the new demographics of the city, whose infrastructures should be adapted to fit the new needs of a differently defined population. The effects of this demographic challenge heavily impact the urban transportation infrastructure systems in the city. These increments required the transportation system, to adjust for dealing with the growing needs of the city (that is, expanding the distribution network, building of new streets, and scaling up of current infrastructures). Without any adaptation of the infrastructure to such an important demographic growth, roads, for example, suffer from saturation caused by the ownership of more cars by the growing population, which has obvious environmental and economic impacts on the city as a system.

The Socioeconomic Challenge

In spite of the changing demographic trends, the urban area seems to stubbornly continue expanding as a unique feature of Jaipur. Jaipur, with 6,500 people per

square kilometre (or 17,000 people per square mile), is comparatively highly inhabited. The city's overall area is 467 square km (about 180 square miles). The city expands horizontally along the major national highways ie Ajmer road, Tonk Road, Sikar Road and Delhi Road. This need for expansion, which originated in the demographic challenge has created the problem of poor housing accumulation in the outskirts areas of Jaipur city. Bringing basic services such as drinking water, wastewater collection, electricity, and public transport to these irregularly formed areas is not an easy task. The extension of the infrastructure networks is hampered by the lack of long-term planning and proper conditions for its development. Currently, Jaipur's irregular settlements in unauthorised colonies constitute a huge urbanized area, giving shelter to a lot of population and covering a wide social spectrum, not limited to the poorest residents, as well as varied housing quality. Additionally, the concentration of lower-income residents in the outskirts of the city and inequalities in access to infrastructure puts additional pressure on the public transportation system, as well as on the traffic system itself, to ensure commuters reach their workplaces every morning. When added to the demographic challenge, unparalleled demands for the transport infrastructure emerge, clearly shown by the explosion in private cars traveling on the city streets.

To try to minimize further traffic congestion, the urban infrastructure managers need to ensure low environmental impact and sufficient complementary public transit. They need to think about how to incentivize the shift from personal car use to public transportation, by developing, for example, mechanisms to penalize the use of private cars and subsidizing public transit to make it really competitive to private car use for middle-class urban dwellers. For many lower-class urban dwellers in Jaipur, public transit costs represent a good amount of their daily income, which does not seem sustainable. Social pricing mechanisms, for those who cannot afford public transit, have to be developed to tackle the socioeconomic challenge. Associated with the change of land use after clear demarcation of industrial areas, industries moved out of town, this trend has helped create a fragmented city with disparate growth rates, unutilized industrial areas, and insular suburban service-oriented nodes. Urban infrastructure systems show low resilience to shocks and need much improvement.

The Technological Challenge

Technological change in networked infrastructures is uneven. Long asset lifetime and high capital costs tend to entrench the problem, making public authorities reluctant to confront it. Old transportation infrastructure with obsolete public transit vehicles, or the need to spread the reach of communication technologies networks concentrated in spared

economic hubs are just some of the technical challenges Jaipur City faces.

The Environmental Challenge

Jaipur, as any major city, has a large impact on the ecosystem in which it is located. The impact needs to be contained and managed by coordinating efforts through policies, infrastructure management, and users. Several policies were developed to implement public transportation systems to push citizens to choose collective public transportation rather than use personal cars, which had a positive impact on the city's green-house gases (GHG) emissions. The combined effects of multiple actions aligned into a unique direction toward reducing air pollution has proven effective in the long run, however there is still a long way to go. With the average level of PM 2.5 as 104 (PM 2.5 upto 50 is satisfactory and desirable), Jaipur is ranked 38th in the world as far as pollution is concerned. The transportation sector in Jaipur is primarily dependent on fossil fuels, with hardly any electric or hybrid vehicles on the road. The government is now taking initiatives to provide subsidy on electric and hybrid cars so that more and more people buy such cars and discard their old cars.

The Financial Challenge

All prior challenges have in common the need for financial resources to address the pressing issues combined. However, they have to ferociously compete against each other, as well as against other infrastructure services in the city, for scarce, limited funds. Rajasthan is a large state with limited natural resources and limited income. For operation of the services generally private investors are engaged and they are interested to see the return on investment. A private investor is particularly concerned about the policies and regulations which affect the services generation from industries and agriculture. It is very difficult for the state government to provide large amount of funds for urban transportation infrastructure. However in past few years, since the national road programmes have picked up momentum, Rajasthan is also keeping pace and providing enough funds for systematic improvements. Moreover with the success of PPP models, more emphasis is now being given to projects on PPP mode.

MAIN ELEMENTS OF URBAN TRANSPORTATION SYSTEM

The main elements or the components of urban transportation infrastructure system are firstly the Infrastructure itself and then the associated services:

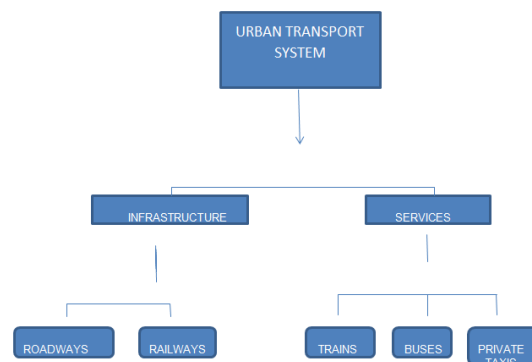


Figure 2: Elements of urban transportation system

PERFORMANCE DIMENSIONS OF THE URBAN TRANSPORTATION SYSTEM

The main performance dimensions of the urban transport infrastructure system are efficiency, attractiveness, sustainability and resilience.

Efficiency. Efficiency means the efficiency of the system in terms of time, cost, regularity, congestion, reliability, safety, comfort, convenience, energy and emissions.

Attractiveness. Attractiveness of public transport means the comparison with respect to private car, accessibility to public waiting and boarding areas, intermodal transfers, ease of travel, accessibility to commercial areas/ institutional areas/ recreational areas/ shopping areas etc. Another important criteria from public perspective is the affordability with respect to various other modes of travel. Affordability is very much related to the social criteria. It may be affordable for rich people, but not affordable for common or poor people. Intermodality or inter connectivity is another big concern for public transport attractiveness, making one common travel card for all available modes of urban transport can make it more attractive.

Sustainability. Sustainable transport applies to any 'green' means of transport with a low environmental impact. Sustainable transport therefore balances our existing and potential requirements. Examples of sustainable transportation include walking, cycling, transit, carpooling, car sharing, and green vehicles.

Resilience. Resilience is the capacity to plan, adjust, and tolerate and easily rebound from shocks. Resilience. The capacity to endure and rebound from disruptions deliberately causing attack forms, events or risks or accidents requires resilience. Through balancing and improving on the four key dimensions the resilience can be enhanced through carefully taking into account the system's characteristics as seen in the background,

Robustness: The urban transit infrastructure can absorb shocks by enhancing robustness and avoid disturbances.

Redundancy: Disruptions are compensated and the impacts of duplication on the transport infrastructure would be contained.

Resourcefulness: Related entities must be organised and willing to react and utilise the means required for intervention in the event of disruption.

Rapidity: After analysing various possible situations, the device will adapt rapidly and recover. Some of the explanations are simple to substitute components / modules / assets and default paths, etc.

MANAGING URBAN TRANSPORTATION INFRASTRUCTURE STAKEHOLDERS

It's very important to understand that in addition to managing infrastructure itself, in terms of maintenance, operations and planning, there are a series of stakeholders, like users, citizens, operators, investors and policy makers as well as political authorities that the urban infrastructure managers have to be attentive to. These stakeholders have objectives and it is imperative for the urban transport system managers to satisfy them. Merely being able to operate the system is not enough, the needs of stakeholders for whom the system is being operated, have to be satisfied. Users utilise the infrastructure and the infrastructure facilities that the system provides.



Figure 3: Urban Transportation Infrastructure Stakeholders

There are two types of users that is individual users and the businesses. The businesses could be factories, institutions, industries which are associated with manufacturing or export / import or consumer based items. These establishments depend heavily on the transportation system and its efficiency. They are

broad consumers, not inherently specifically related to infrastructure, but are primarily impacted by the expense and quality of infrastructure services. And there are individual users or households generally, who are directly affected by the transportation system on everyday basis. Affordability of transportation compared to their income is a prime concern of a household. How much and what proportion of their salary do they actually have to pay for travelling to their workplace, colleges, schools or offices etc. They are also affected by the quality, accessibility and efficiency of the services. These individuals or households are affected by the location of bus stands or metro stations, distance from their houses or workplace, accessibility of the services, frequency and timing of services, efficiency in terms of time and comfort etc.

Then there are the citizens who may be actually different from the regular users. However, as a public, many residents do not utilise this service because of the consistency, reliability and usefulness of the transport system, since if people utilise trams and the subway, the path is less congested, and they can travel along quicker in their vehicles. So, as citizens, they are worried about the efficiency of the urban infrastructure systems but not essentially as users. They are concerned about the efficiency and about the sustainability, pollution or about the resilience of the urban infrastructure systems. If the metro system breaks down and everybody has to take the car and that's going to last for three days, then everybody is affected and, ultimately, this is about the quality of life in the city. So the urban transport managers have to pay attention to the important aspect of users and citizens satisfaction.

On the physical infrastructure side, system operators as well as investors assume importance. Generally, it's the public authority like the State Government or the City Administration that invests in the development and operation of the transportation system, but since it's the public money even there, as a manager, it is utmost important to pay attention to the public authority who has invested money collected through taxes in the infrastructure, because many of these infrastructures and services are regulated by the government. The regulations and the regulated prices directly determine the profitability of the operation of transportation services.

A third element that is important here is the ease of operations ie how easy it is to operate in the defined framework of government guidelines and regulations. The ease to start a bus service, the ease with which one can obtain license, authorisation and most importantly the time taken in processing of paper work etc. And again this aspect has to be managed by the urban transport managers.

In terms of policy makers, there is a distinction

between several layers of policy makers. The most typical layer is the city government, which is lowest layer of the government and is directly in control of the services. The city administration is concerned about how much your operations cost, especially if the city has to give subsidies to the users or it supports the private operators in investments or on the maintenance of the infrastructure.

A city government is also directly responsible for the customer satisfaction and the citizen satisfaction as well as accountable for the expenditures involved the infrastructure development and operations. An operator of an urban infrastructure knows that the political authorities are extremely sensitive to the fact that the citizens may or may not be satisfied, because that will determine whether the private operator will get contract renewed or get additional investment or subsidy or in adverse case the penalty. Ultimately, the city government is apprehensive about the attractiveness of the urban infrastructure and the competitiveness of the city, and that's something that managers have to be vigilant for too.

In some areas, there are metropolitan government or an agglomeration government or an imposing city administration, in such cases there could be some jurisdictional problems, which can further complicate the services. But, if there's a metropolitan government, it has to manage other services as well like electricity, water, sanitation etc, in such cases the role of city administration or the local government becomes too important. Sometimes the operating contract is with the metropolitan government, not with the city government, but on ground the operator has to deal with the city administration on a daily basis.

Most of the times there are other layers of government which may be a regional / state government or may be directly the national government. These are important because the investments that are made are not directly made by the city, but they are actually made by the regional government or by the national government. These governments that invest or give subsidies or even make contracts with operators are concerned about the costs and time, but ultimately it is the local metropolitan government or the city administration which is concerned about the attractiveness of the metropolitan area and of the competitiveness of the metropolitan area.

So in such complicated government set up, the urban transportation managers have to manage the operations, the maintenance and the planning. Simultaneously the major stakeholders of these infrastructures the citizens, the users, the operators etc have to be managed or coordinated along with the different levels of policy makers.

MANAGING THE URBAN TRANSPORTATION SYSTEM

After having understood the main features of urban

transportation management by distinguishing between the key challenges, performance dimensions, the major stakeholders, management of the different transportation physical infrastructure, modes, services, it becomes important to understand who actually is the nodal agency or the fulcrum or the overall incharge of the urban transportation infrastructure system. The management of the urban transportation system, will decide how well-performing it is, how attractive it is, how efficient and sustainable it ultimately is.

So the management or in other terms the governance is the function by which attractiveness, efficiency, sustainability and resilience of the urban public transport is created. As already understood the performance dimensions have to be understood in context to the planning, operations and maintenance of the urban transport infrastructure system. As far the governance is concerned, it's very important for the government to gather important players to design, to build an agenda, and then to roll out such kind of projects. So this is basically the governance of the city, of the region, of the state to make policies to bring about the perceived changes.

ILLUSTRATIVE EXAMPLE : JAIPUR

Planning

In present day scenario, there appears to be an incoherent management between the various government organisations involved in planning the transport infrastructure. For example in Jaipur, the infrastructure development is undertaken by National or State government agencies like NHAI, Railways or PWD etc and the city administration who is the primary user doesn't have any role in this. Even in the state government there are different ministries involved in planning, coordination and management ie Ministry of Road Transport for construction of roads and licensing of vehicles, State PWD for construction of state and district roads, Ministry of Railways for trains, Ministry of Urban Housing and Development for urban transport and management agencies like JMRC, RSRTC, JMC, JSCL, JCTSL, JDA, RHB and Town Planning etc. Planning also involves planning of Interfaces, purchase / contracting of new vehicles. Planning of routes, planning of timetables etc has to be coordinated among each other in such a way as to make the urban transportation system efficient and attractive.

Operations

Operations of the vehicles, operations of the interfaces and operations of the infrastructures are being managed by RSRTC, JMRC and RTO. There are various technical and management aspects to that. For example JMRC is the owner and operator of metro trains, RSRTC is owner of bus fleet and also has a number of buses on contract/ lease. Private taxis and commercial vehicles operate on

permit basis for which RTO is the licencing authority. Operations of these services involve preparation of scheduling, preparation of routes, price policy, making the human resources available for services and making policy guidelines and regulations and other aspects like the customer relations, handling of complaints, customer information etc. The first management function is how well managed are the operations of urban and infrastructure system for each mode, each operator and each service. If all these functions are fragmented, then there is no overall coordination and a less efficient system performance.

Maintenance

The maintenance of infrastructures, vehicles, and interfaces is the next important performance parameter. And in case of urban infrastructure system, each element has to be maintained separately ie every road, railway track, vehicle, every interface, every station separately. The challenge for management of urban infrastructure, transport infrastructures, is the efficient coordination of all these.

So when the tramline has to be repaired on the street, the street can not be blocked during the day. This needs to be repaired and blocked at night in order not to hamper the other transport modes. The coordination of maintenance activities has be done in such a way that the customer is not affected in his daily activities and all alternate modes of transport are operated and rescheduled accordingly or traffic diversions/alternate routes are provided. This needs a close coordination between various organisations working towards management of urban transport systems.

IDENTIFICATION OF THE COMPLEXITY AND PROBLEM AREAS

It is imperative to understand the present day functioning of the system that is how is this being concretely done? Presently there are different transport modes and different transportation infrastructures and each of them has their own management logic.

As to street, the most significant aspect of urban development is considered to be sidewalks. Roads are not only scheduled, but often constantly operated, regulated and even often regulated by a local road operator. The road planning department and road infrastructure maintenance in each region, however, are different agencies.

There are also skill problems, which lay between two independent cities for transportation. Each of these towns has its own department of roads and transport. Road taxis are owned by private operators authorised by a regional government or a local taxi government. There are again many metropolitan areas, each with its own local taxi authority, licence, taxi company or corporation. Busses, minibuses, city buses and private bus companies are also available. Then there is licencing or supervision of numerous bus operators by

the local transport authorities and those local transport authorities and they may have to communicate with them while preparing schedules, fares or intermodal connexions with other types of transport. However, the urban transport authority is not the only taxi authority is an authority other than the department of regional public transport.

In addition, numerous forms of travel, such as metro and trams, operate. Metro and trams are corporations that maintain and effectively run their maintain routes, their own fleets. You administer yourself, run, sustain and prepare individually, not usually, seldom synchronised with any other authority. The metro operator that manages and maintains the tracks would not actually function under the LTC. The national train operator, passing the town and running stations in the town, manages the tracks and also the platforms, but this is a state operator rather than a particular regional operator. They all work independently and are not generally compatible, including the subway company, railway, the truck company, the auto company, the transit department, the taxi authority and the city road Authority. This also describes the difficulty of supplying such a decentralised network with an accessible and appealing public transit infrastructure.

Another way to understand the complexity of who the overall in charge or the controlling authority is to consider different modes of transport like cycles, cars, buses, trams, metros and trains, and there are different ways of coordinating, competition, tendering, and monopoly etc. For example Bicycles, which is a new trend in the cities, we may have a public bike provider by the city. The city provides public bikes, which can be free, or may be at a cost. There may be, in parallel to that, a private, or several bike-sharing companies operating inside the city. The bike-sharing company probably will have a license, and is tendered, whereas the public bike provider is there by virtue of a monopoly of the city. They may compete against each other. There have been issues with the operation and licensing of electric rickshaws and cycle rickshaw etc in the past. As for the cars, there are different types of cars operating and also services like Ola and Uber and new types of taxis and vehicles operating in the city with the concept of car-sharing etc. These private car-sharing companies are competing against each other, and are basically unregulated. Then there are private car-rental companies, which are competing against each other, and are not regulated either. And then we have private taxi companies, which are generally tendered and licensed by a local authority. All of them provide car services on different rates under different regulations. As for buses, there are private minibus companies, private bus companies, public bus companies. All of these are generally somehow coordinated by a city transport authority, but some are tendered, some are there by virtue of being publicly owned by the city and some are operating on permit or licenses. In case these meet

with an accident, there are different regulations for insurance. Government provides financial relief to the fatalities or injuries caused in public owned buses, but there is no financial assistance to those who lose their life or commit injuries while travelling in privately hired taxis, which too are operating based on licences approved by the government departments, so there is a difference in dealings.

The tram too is generally a public tram company, a monopolistic public tram company, which may or may not operate under local transport authority. The same goes for the metro company, which may be a public company, a city-owned company or a private metro operator. It has a license and is authorized by some government regulator, but not necessarily operating under the control of the transport authority of the city.

And then we have a public transport authority, a public transport company, which can basically own all the three, the bus, the tram, and the metro, but it can't manage all the public transport demand, so it has to issue licences to other privately owned companies to operate services, but under different set of regulations.

So, the question is, who is in charge? Who is in charge of the urban public transport system? What has been explained is that there is basically a fragmented and uncoordinated urban transport system. In comparison, it is in stark contrasts with urban electricity infrastructure. There is historically one urban electricity operator which provides and distributes the electricity including management of customers, tariffs, revenue collection etc. Though it is getting a little bit fragmented because of competition, but basically it's one operator of the urban electricity system. In the case of transport infrastructure there is nothing like it. Hence it remains a challenge to make urban transport more efficient and more attractive.

As per the above explained logics, the city or the urban centre should be made more accountable with respect to the main performance criteria of efficiency, sustainability, attractiveness and resilience. However it is the transport authority, a road department, a taxi licensing authority, a tram operator or the metro owner or different governing bodies. The city, in terms of transport, is not necessarily a coherently operating unit which can, by itself, create efficiency and attractiveness of urban public transport.

Table 1: Complex Matrix Of Present Day Management Of Urban Transport Infrastructure System

Urban Transport Management Elements Infrastructure	Managed/ Controlled by	Mode of Contract / Coordination / Permit	Executing / Governing Body	Licensing / Permit Authority	Ticket / Fare Management	Policy Maker/ Financing
Roads Infrastructure	National Highways	Public Management / PPP	NHAI / CPWD	MoRTH	State Road Transport Authorities	National Government
	State Highways	Public Management / PPP	CPWD/ PWD/ PMGSY	State Govt Transport Dept	State Road Transport Authorities	State Government
	Urban Arterial Roads	Public Management / Government Funding	PWD/ Local Development Authority	PWD / Local Development Authority	State Transport Department / Regulator	City Management / State Government
Railways infrastructure	Department of Railways	Public Management / Government Funds	Department of Railways	Department of Railways	Department of Railways	National Government

Metro Trains Infrastructure	Metro Rail Corporations	Public Management / PPP	State Urban Development Department	State Urban Development Department	Metro Rail Corporation	State Government
Transport Modes						
Buses	State Road Transportation Corporation	State owned / contracted	State Road Transport Department	Regional Transport Office	State Road Transport Department	State Government
Local Trains/ Metro Trains	Metro Rail Corporation	Public Management / Owned	Urban Development Department	Urban Development Ministry	Metro Rail Corporation	State Government
Taxis	Regional Transport office	Contracted / Competitive Bidding	Regional Transport Office	Ministry of Road Transport and Highways	Private Operators	State Government

The present structural inadequacies in urban transport management have necessitated a different and new outlook to have an accountable and transparent organisation to deal with the complexity. Currently, there is no regulation that covers the demand for urban transport expansively and conclusively. Instead there are multiple rules and legislations at the Central and State Government levels that affect urban transport either directly or indirectly. These intricacies get further intensified by the multiplicity of authorities/departments involved at different levels, mostly with conflicting agendas and ambiguous understanding of the assortment of issues relating to urban transport. Thus, responsibilities of the Centre and States remain fragmented, thereby, hindering the development of integrated and sustainable urban transport systems.

RATIONALE FOR RESTRUCTURING

All the above justifications and logics point towards the need for restructuring of the urban mass transport systems. It is imperative that there is an urgent need to have an effective unified urban mass transport operation system which is customer friendly and follows the basic management principles required for an efficient, attractive and resilient urban transport system.

In order to have a singular control point with complete accountability and concentrated responsibility for citizen centric coordination and

simplification of various transportation infrastructure, services and modes, it is recommended that the metro city should have one nodal integrated agency structured in such a way that it encompasses the governing authority, policy making powers, financial powers and control on scheduling, pricing, licencing, operations of all transportation services and modes. The agency can be suitably named as the Integrated City Metropolitan Transport Authority. Proposed structure of the ICMTA is as under:

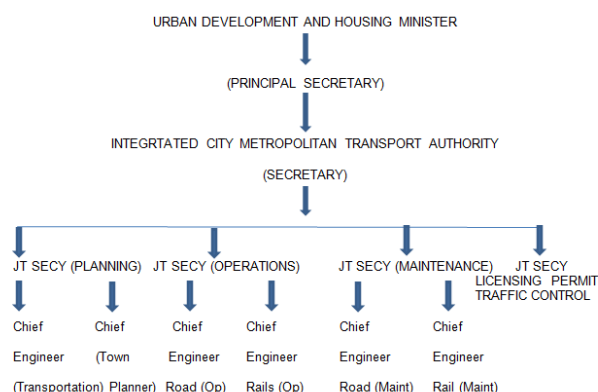


Figure 4: Rationale For Restructuring

The recommended roles of this authority are as under:

Integrated Planning

The planning division of the authority will be responsible to prepare long term transportation roll on plan or mobility plan by bringing in competent engineering consultants, town planners, infrastructure managers and city administrators. The team will also carry out various types of surveys and data collection for planning of new and modern modes of transportation assisted with intelligent transport services providers and industrialist's stakeholders. The plan should thereafter be made public before approval so that there is proper citizen scrutiny and vetting. The planning division will then coordinate with various engineering and construction departments and get the work executed preferably on PPP mode so that services can thereafter be provided by the same agency for a certain timeframe before finally been taken over by the Integrated Authority for operations on BOT platform.

Integrated Operations

Integrated operation management can be undertaken by bringing all transportation modes under this unified authority. This will facilitate coordination of all transportation modes, their interoperability, scheduling, pricing, route selection etc which will eliminate duplication and provide time efficiency, cost efficiency, comfort and convenience to commuters. This will also integrate and regulate the IPTs and their routes, timings, licensing etc to facilitate in providing feeder routes and accessibility of mass transit systems.

Integrated Maintenance

Such large network of transport infrastructure, services and modes will need to be maintained regularly for preventive maintenance as well as have to be ready for unforeseen breakdowns and repairs. The integrated maintenance division should then be responsible to prepare detailed maintenance schedules, carry out preventive maintenance and carry out urgent repairs whenever the situation so arises. This division will also maintain the intelligent transport systems and its related devices.

Integrated Mobility Plan

Management of urban transport should be the responsibility of the Metro City and the City as such is the main stakeholder. But since in India we have a system of state governments, urban transport becomes a subject matter of the state. The state government should put this Integrated Urban Transport Authority with its full compliments under a suitable ministry, preferably Urban and Housing Development Ministry. The Authority and Ministry should prepare this citizen centric long term comprehensive urban mobility plan which should contain the basic aspects discussed earlier that is efficiency, attractiveness, sustainability and resilience. Some of the important roles of the authority can be summarised as under:

Table 2: Management of urban transport

INTEGRATED ROUTE PLANNING AND CONNECTIVITY	The two-way mass transfer of passengers from road-based transit to rail-based transit and vis a versa is only possible if the connections between bus stops and railway stations are available through feeder IPTs or bus services.
INTEGRATED NETWORK AND JUNCTION DESIGN	Restructuring of network routes, nodes, junctions, links and corridors to reduce wasteful replication of transit services between different road mode routes and the mass rapid transit is essential for enhanced efficiency and accessibility.
INTEGRATION OF PHYSICAL INFRASTRUCTURE	The physical infrastructure needs to be weaved in such a way as to provide easy access and transfers to various modes. Sufficient space should be provided for interchange and mode swapping facilities around MRT stations for the smooth transfer of commuters from paratransit routes to the MRT. Adequate parking facilities and Park-n-Ride services should be provided at MRT stations to provide transit commuters with parking for their private vehicles.
INTEGRATION OF INTELLIGENT TRANSPORT SYSTEMS	Integration of intelligent transport systems which includes a wide range of communications, controls, vehicle sensing, acquisition of vast data on various aspects of traffic operations ie traffic volume, speed, headway, load carried etc for enhanced safety and improved operations.
INTEGRATED FARE SYSTEM	A common RFID card or ticket system is necessary for passengers to be able to go from their point of departure to their destination. A simple and single tariff system, if introduced, will reduce the travel time and increase the demand of using paratransit and the MRTS because of the comfort offered and time saved due to not having to buy separate tickets for travel at transit stops and MRT stations. It will enable hop on – hop off type of services and reduce waiting as well travel time.
INTEGRATED SUSTAINABLE SYSTEM	By having a coordinated control and management, there will be fuel efficiency. Simultaneously the transport services can be so planned as to reduce dependency on fossil fuels to have reduced carbon footprint ie electrical operated vehicles, hybrid vehicles etc.
INTEGRATION OF INFORMATION	A common transit and travel guide with complete information on the different services offered should be available for passengers at every major transfer location as well as on website and apps. The information should be advertised through various information agencies, radio, TV, internet, etc to make it more attractive.
INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTs)	The concept of smart transport is primarily based on the increasing role of ICTs. Since last few years, ICTs have played a major role in managing urban infrastructure systems. The main three functions that the ICT plays are efficiency gains, in empowered customer relationships and role of the customer and in terms of the new services that the ICTs allow.

CONCLUSION

There is a need to highlight the mobility needs of the urban transport customers for whom travelling is an everyday affair, which affects them as much as the basic human needs like drinking water or health, electricity or education. An urban commuter is looking for convenience, intermodality, time efficiency, energy efficiency and affordability. It is difficult to imagine how the mobility needs of the urban public transport user can actually be satisfied with such a fragmented system. In order to ensure a citizen centric approach, there is a need to carryout restructuring of the governance and management of urban transport systems by integrating the existing fragmented departments to a more organised management unit for which a recommended model is presented in this paper.

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