Smart Cities Planning and Transit Oriented Development

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Abstract—*While there are numerous definitions to Smart Cities, by a holistic perception a smart city is one in which the quality of life of its inhabitant is enhanced through conscious intervention at the physical, human, digital and environmental levels for a sustainable development. The concept of smart city integrates various physical and non-physical components. This study focuses on one such important component of transportation linked to urban planning and urban design. The fast rate of urbanization in Indian cities is resulting in continuously expanding urban sprawl and unmanageable densification of the core city. Combined with highly strained and congested transport system, the concepts of mobility and human productivity are below desirable levels in most of the Indian cities in today's scenario.*

It is important to understand the link between land use and transportation to provide effective mobility solutions. The understanding of mixed-use cores, walkable communities and modal split integration is necessary for Indian cities where rapid urbanization is taking place around the old historic cores. This study explores the concept of Transit Oriented Development as an essential smart-sustainable city strategy and discusses the implications of the study through a proposal for the Southern city of Madurai.

1. INTRODUCTION

The idea of smart city has been gaining strong ground in India in recent times. However the word 'smart city' implies various ideas; and needs to be objectified for an efficient application/ implementation. The concept of smart city is built on three fundamental components- people, infrastructure and technology. The idea of smart should imply a mode of development that is sustainable and equitable, thereby enhancing the quality of life of all people and their habitat. For a true version of smart-the necessary infrastructure and technology have to be reoriented towards efficiency, affordability, resource optimization and conservation. An important component of infrastructure that acts as the lifeline of urban centers is transportation.

"Economic efficiency of cities and wellbeing of urban inhabitants are directly influenced by mobility or lack of it. City efficiency largely depends on effectiveness of its transport system" [8].

This study explores the idea of transit-oriented development as integral to the concept of an equitable, affordable and sustainable smart city.

2. ISSUES OF URBAN GROWTH IN CURRENT SCENARIO

As early as 1961 Jane Jacobs made a scathing attack on the modern theories of city planning that had bred the humanless cities of America. Jacobs criticism on the attitude of planners who believed to have solved the problems of cities by solving the problems of traffic still holds good 50 years later.

"The simple needs of automobiles are more easily understood and satisfied than the complex needs of cities..." [4].

The U.N General Assembly's concern at the degrading housing situation and the impact of urbanization on human settlements since the last century only seems to worsen with the increasing number of megacities. The rate of urbanization in the developing regions of Asia and Africa is increasing at an alarming rate.

In India particularly, the number of cities with a population of more than a million has increased from 5 in 1951 to 53 in 2011 [3]. The rate of change is even more alarming in the number of cities with a population above 0.1 million, from 42 cities in 1951 to 468 cities in 2011. Based on the 2011 census it is estimated that nearly 38% of the Indian population now lives in over 8000 cities and towns across the country and contribute to 50% of the country's GDP.

However this increase in the urban population is concentrated in certain cities alone placing a heavy toll on the physical and social infrastructure of these cities. One of the direct impacts has been the failure of the public transport system to keep pace with this increased urbanization leading to sudden influx of private vehicles that has in turn been the major cause of transport crisis in India such as delay, congestion, pollution and accidents.

Statistical data from the transport research wing, Ministry of road transport & highways indicate that while the number of

buses has increased 43 times since 1951 to 2009, the number of cars & two wheelers has increased 525 times since 1951 to 2009. According to Roychowdhury [7] as on March 2010 India had 1 bus for every 8500 passengers reflecting an enormous under capacity of public transport in India. This situation was expected to change with an allocation of 11% of the total investment of JNNURM towards the urban transport sector. The JNNURM programme attempted to improve public transport system in large cities through:

- Funding of public transport buses

- Development of comprehensive city mobility plans

- Supporting city transport infrastructure projects

However post project analysis [9] observed that JNNURM funded projects in urban transport lacked land-use transport integration and that more amount was spent on roads & flyovers and very less amount spent on NMT- non motorized transport.

The key issues due to urban development from the transport perspective can be summarized as-

1. Strain on transport infrastructure due to increasing urban population and expanding urban geographies- urban sprawl
2. Increased dependency on private vehicular transport leading to unsustainable transport infrastructure and environmental degradation.
3. Challenges for providing more equitable mobility solutions with greater access and reach.
4. Reduced importance for Non-motorized transport resulting in proliferation of vehicles in all streets and thereby a decline in the quality of urban life.
5. An unconscious shift to personalized transport is bearing a direct impact on the environment in the increasing levels of air pollution in cities due to vehicular emissions.
6. Increased requirements for parking has created severe space crisis issues in many historic towns.
7. The lowering of the average journey speed(km/hour), especially in cities of population within 10 lakh to 40 lakh where the average journey speed has reduced by 4-5km/hr between 2007 and 2011 [5]

3. NEED FOR TRANSIT ORIENTED DEVELOPMENT

The World Bank's concept of Eco^2-Ecological cities as economic cities advocates integration of different sectors to achieve sustainable economic growth. The integration of transit and land use development towards fulfilling the visions of smart city provides a new strategic focus for the city.

Based on the above discussion this author proposes a three-pronged tool for future growth of urban areas in Indian cities.
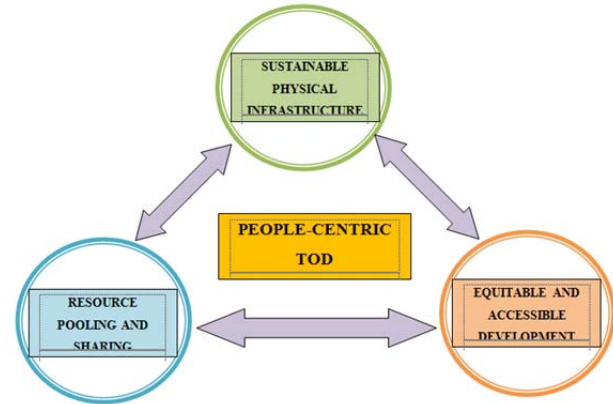

Fig. 1: People-centric TOD

TOD is a successful concept in new mobility and aims to achieve affordable, sustainable and equitable transportation solutions for networking between communities at the regional level as well as achieving greater access within the community.

"Mobility goes beyond vehicles. It is about development, urban design and planning". (Anand Mahindra, Vice-Chairman M&M) [9]

The need for TOD is because of this shift in transportation planning concepts that are now advocating "mobility of people" and not "mobility of vehicles".

Experts feel that the share of mass/public transport is not very significant due to various reasons such as adequacy, route availability, pricing and convenience; resulting in a higher choice for personalized transport leading to the current scenario [3,7]. However given an option of an efficient mass transportation system people have shown higher preference to TOD's as evident in Delhi Metro Rail Project (RITES Survey, 2008). 75% of the commuters inspite of owing a private vehicle have shifted to Metro Rail for reasons such as comfort, cost saving & time saving.

Mass transit is thus seen as a viable idea for developing nations facing faster rates of urbanization and greater increase of urban poor population.

4. CONCEPT OF TRANSIT ORIENTED DEVELOPMENT

Transit oriented development (TOD) is oriented towards developing settlements with greater mobility and sustainability. This pattern of development is formed by a primary transit network (train or bus) that connects to multiple housing communities or neighborhood. The advantage of this concept lies in its networking between faster mass transportation and non-motorized transportation supported walkable communities.

4.1 TOD should operate at three levels:

1. A Primary transit spine at the regional level:

This spine should connect the urban area to its surrounding regions of the district within the LPA – Local Planning Area. This spine should enable mobility from peripheral regions and rural centers to the urban center.

2. A Secondary transit spine at the urban level:

This spine should connect the various urban centers across the city within the corporation limits these urban centers are to be integrated with the surrounding land use and they must be strategically located as transit modal interchange hubs. These hubs must be located at intersection points of major arterial roads of the city thereby aiding in maximum modal split options.

3. A Tertiary transit spine at the neighborhood level:

These spines should be numerous and should be based on their carrying capacity and destination range.

The spines which lead to destinations within 5to 8 km range must have dedicated two wheeler lanes. These spines can vary in design some may have dedicated auto lanes while some can have dedicated mini bus lanes. Such decisions should be based on elaborate travel characteristics study.

The spines which lead to destinations within 2 to 5 km must have dedicated tracks for bicycles and non motorized vehicles.

However at this scale high priority is to be accorded for dedicated pedestrian walkways in both categories of spines. Securing pedestrian safety needs to be given serious thought as most of the Indian cities lack even minimum concern for pedestrians. This is inspite of exhibiting a high percentage for walk (28 to 37) in the modal spilt data for Indian cities [8].

"a transport paradigm that only looks at mobility and speed would invest in infrastructure that is motorised, thereby discouraging investments in infrastructure for NMT modes that are predominantly used by the poor. [9]. Special focus must be accorded to eliminate Heavy vehicles from these spines and must be permitted based on time regulations.

4.2 Innovative concepts for improved TOD:

1. A TOD network is successful only when implemented across all scales from the regional to community. Thus TOD's must be designed with a 'door to door' approach.

2. Innovative ticketing system based on pre-paid smart card concepts applicable for all routes reduce manual labor at various stages.

3. Affordability for the urban poor living in the peripheries is a problem that can be solved with innovative subsidized monthly tickets based on income slabs.

4. The urban rich using private motor vehicles must be made to shoulder social responsibility by paying higher infrastructure tax.

5. Transit interchange hubs must be integrated into the urban design of local urban area.

6. Based on the locational and social context each TIH may be designed with a predominant primary use such as a market hub, entertainment hub or mixed use hub. This shall ensure vibrancy and round the clock surveillance of the zone.

7. The percentage of urban poor in all Indian cities is very high and must be considered in the design of TOD's by giving high priority to pedestrians and cycles.

8. Residential zones within the access of transit networks must be developed as close knit high density communities to curtail sprawl.

4.3 Success of TOD:

TOD has been applied in many developed nations and proven effective. And many developing nations are also implementing various forms of transit networks as in Curitiba, Bogota and Jakarta [1]. In India rapid transit systems; such as light rail transit and bus rapid transit systems; have been implemented in Delhi, Ahmedabad, Chennai, Pune etc...

While developing new infrastructure for the transit network has been achieved, integrating this network into the existing historic landuse is a complicated task and must be based on elaborate travel characteristics studies.

The studies must identify:

1. Existing strategic urban corridors

2. Strategic intersections of corridors

3. Locations on corridors that can act as Transit Interchange Hubs (TIH's).

4. Catchment zones/ feeder zones of each TIH to enable community oriented urban design measures.

5. CASE STUDY OF MADURAI:

Madurai is a historic city of Tamilnadu dating back to more than 2500 years. Madurai has evolved as a temple city centered around the Meenakshi Sundareshwarar temple and exhibits a unique urban structure. The core city of Madurai is organized around four concentric ring streets connected to the central temple through the axial roads oriented along the main directions. This core city has since 1840 seen continuous expansion when the old fort was demolished to make way for the construction of the broad 'Velli streets'.

The district of Madurai today is spread over 3741 sq. km. and has a population of above 3 million as per the 2011 census. Madurai is a major economic center for the southern districts and caters to a large floating population on a daily basis. It is also one of the most important tourist and religious destinations in the country.
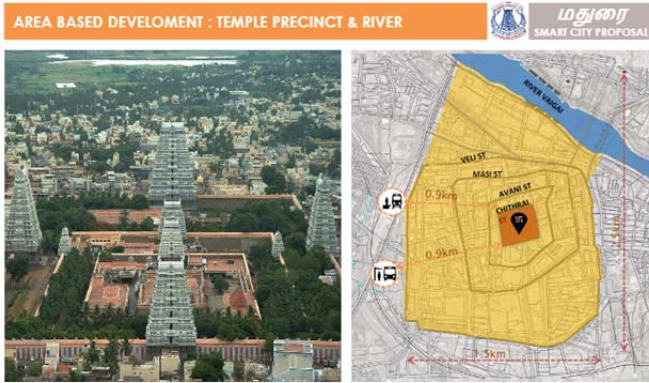
Fig. 2: Map and Aerial photo of the temple and city core.
(Source: Madurai smart city proposal, Madurai Corporation, 2015)

5.1 Characteristics of Urban growth:

Madurai has witnessed a 17.84% increase in population in 2011 from the previous decade. This increase in population is relatively high compared to the 7.41% increase in 2001. Of this population 39.22% is in Rural and the remaining 60.78% is in the urban areas. The total population of the Madurai metropolitan region is 1.4 million of which the corporation area constitutes a 1 million population.(Census 2011).

The city has been predominantly expanding along the National Highways on the North- South direction. The construction of the ring road has further catalyzed the growth of the city on the western direction.

The density of Madurai district for 2011 is 819 persons per sq. km. and exceeds 1000 in certain zones within the core city.

The government of India launched the JnNURM in 2005, Madurai was one among the 63 mission cities and comes under the category of heritage city.

5.2 Transport and Travel characteristics:

Madurai is accessed by the NH7, NH45B and NH49 apart from the other state highways that connect to the neighboring districts of Dindigul and Ramnad.

Madurai has seen a consistent increase in the total number of vehicles registered in the state. It is the third largest operator of state owned public transport next only to Chennai and Coimbatore. (www.tn.gov.in). Madurai has also registered the fourth largest number of non-commercial vehicles as on 2015. The city has been witnessing a steady increase in the number of vehicles and the resulting effects of congestion, pollution and delay. A total of 121 road accident related deaths were noted in 2010-11. The residents of the city have continuously voiced out against the growing insecurity and ill effects of the uncontrolled growth of traffic in the city in numerous daily papers.

Fig. 3 shows the main corridors of transportation along which the city has been expanding. The North-South corridor connects to Kanyakumari and Chennai via the two peripheral municipalities of Tirumangalam and Melur. The East-West corridor connects to the neighbouring districts of Dindigul and Ramnad.

Fig. 3: Transport Corridors of the Madurai LPA region

5.3 Proposal for TOD Madurai:

The city of Madurai is fragmented into two halves by the river Vaigai flowing east to west. A large percentage of the trips involve the crossing of people to either sides for various reasons. A large percentage of the population travel to neighbouring regions of the LPA on a day to day basis. Madurai being a trade center necessitates everyday travel of people from the rural areas to the city. Thus based on these aspects a conceptual 3 level transit network as seen in Fig. 4 is proposed:

- Level 1: MRTS Metro rail transit system on the two primary corridors –
  - approx 45 km NS Tirumangalam to Melur
  - approx 30 km EW Samayanallur to Tirubhuvanam
- Level 2: BRTS Bus rapid transit system on as the secondary corridors along the NH7 and NH45B
- Level 3: TIH Transit Interchange Hubs – on the primary city nodes at 5 intersections change over points : Thiruparankundram, Pazhanganatham, Bypass Kaalavasal, Goripalayam and Vandiyur Theppakulam
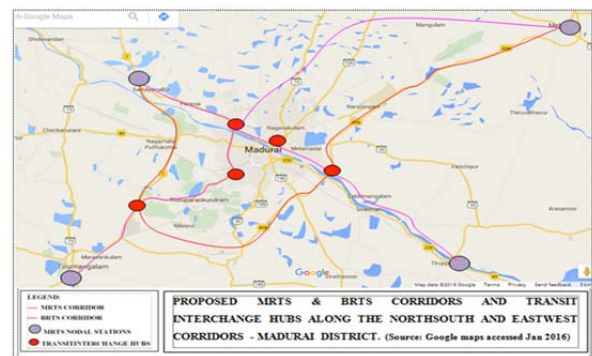

Fig. 4: Proposed transit network and interchange hubs for Madurai.

The network is still incomplete at level 3 and needs to be integrated with existing road networks in level 4 based on the 'door to door' concept. A secondary level of transit interchange hubs consisting of rental cycle pools and battery operated rickshaws can be integrated at this stage. The core city is classified as heritage and hence does not have the entry of heavy vehicles as well as private vehicles. It shall be serviced by slow bus loop connecting Pazhanganatham, the town bus stand, the railway station and the temple
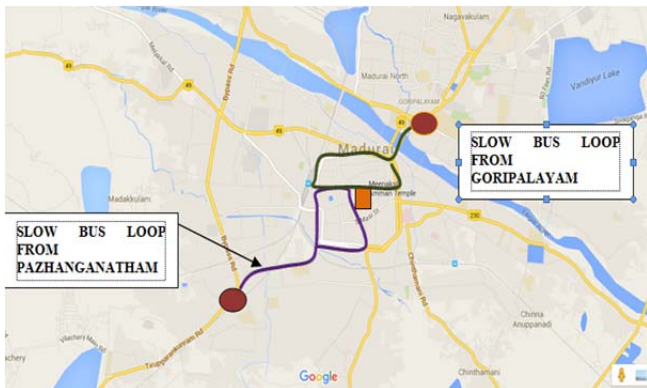

Fig. 5: Proposed slow bus loops connecting to the temple from the interchange hubs for Madurai.

Another important transit characteristic of Madurai is the large number of floating population especially during the festival seasons. Fig. 6 shows the crowded Goripalayam intersection during Chitrai festival. Hence the proposal of the bus loops directly connecting from the fast transit networks of level one ensures immediate modal change of the floating population thereby reducing conflict with regular commuters.

Fig. 6: Traffic congestion at Goripalayam junction during the annual chithirai festival. (Source: The Hindu, May 26, 2012)

6. CONCLUSION

This study has explored the theoretical concepts of Transit Oriented development and how it forms an integral part of a smart city initiative. Of fundamental importance is the concept of TOD at various levels integrating different modes of transit

networks. An important urban design parameter is to transform the transit interchange hubs as mixed use 24x7 accessible areas of the city to ensure continuous surveillance.

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