A Review Study on Transit Oriented Development (TOD) Index by using Different Criteria

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Abstract

India's Population is increases day by day and for that different land use practices and transportation facilities provided by government but rather than only focus on improving transport service or improving land use practice individually if we combine both transport and land use in such a way that public tends to use public transportation and walking, cycling as a primary mode of transport than this planning concept is known as "Transit Oriented Development". TOD planning is done by everyone but measuring of existing TOD in quantitative form didn't done by everyone which is most important aspect for successful implementation of TOD. TOD Index is a Quantitative form of measurement of existing level of TOD. More importantly, measurement of TOD is essential for TOD planning. For Finding TOD Index here literature review is done and various criteria and indicators were found out which give efficient TOD Index of the area.

Keyword- TOD, TOD Index, Criteria, Indicators, Land Use Density, Land use Diversity, Economic Development, Walkable and Cycle Able Distance

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I. INTRODUCTION

India is one of the fastest growing country in the world which is developing at faster rate. With continuous development it's population is also increases day by day. India is on 2nd rank having highest population after China. India's current population is 135.6 carore which is around 17.9% of total world's population, while population density of India is 455 per km2.With increasing population urbanization trend is also increasing with high pace. In India from 1951 to 2011 urban population is increases and rural population is decreases. As per census report in India urban population is increases at higher rate compared to overall population rate. People migrate from rural to urban area for the more job opportunity, better infrastructure facilities, better education and healthcare services etc. But due to rapid urbanization many problems happens like increasing unemployment, more Resource utilization, pressure on infrastructures, Inequitable income distribution between different groups, item's production decreases while cost increases and many more. Major problems among this which considered are pressure on infrastructure and resource utilization. Pressure on infrastructure includes various problems in infrastructure like Transportation, communication, Housing, Education, healthcare etc. while in later case resource utilization includes problems of land area, water resource, forest.

Here, in this paper two problem related to transportation and land use are considered. With combination of this two area better solution can be find out. If transportation as well as land use planning combine in such a manner that people use public transit , cycling and walking as their daily transportation also solved many problems related to traffic congestion ,accidents, pollution, urban sprawl and many more. This concept of integration of land and transportation services to increase the use of public transit and reduce dependency on private vehicles is known as "Transit Oriented Development" (TOD).

A. Aim
To review the work done by different researchers to find TOD index.

B. Objectives of Paper
The main objective of this paper is to find out the major criteria and indicators which are important to finding out current TOD Index of the area.

II. WHAT IS TOD?

Transit Oriented Development which is commonly known as TOD. The aim of TOD is to develop planned sustainable urban growth centers, Walkable, Cycle able & livable communes by integrating land use where citizens have access to open green & Public space with better transit connectivity. TOD development can be done at different levels which are station area level (surrounding transit station), transit corridor level (surrounding whole transit corridor) & regional level. It should be of 500-800 m radius around the station area with 5-10 minutes walking distance in which resident can live, work, play, shop & learn in the same

area without the use of personal vehicles. TOD enhance the use of public transport and reduce the use of private vehicles which result in less traffic in area, less pollution problems, Good health and better environment, safety, sustainable growth of the city, etc. With proper planning of TOD we can get high density with mixed land use planning with better accessibility.

A. *Benefits of TOD*
– Increase the use of public transit, walking &cycling
– Better land use planning
– Secure life services
– Reduce carbon foot print
– Increase economy of local area
– Better access to recreational area
– Having job, residence and green space in same area
– Access to more job opportunities
– Better access and connectivity to neighbourhood area

B. *Aspiration of TOD*
– Prioritizing Public Transit Use and Reduce use of private vehicles
– Diverse mix of land use
– Reducing Trip length and number of trips
– Capitalizing upon the land value potential

By Indian government there are mainly 12 guiding and 9 supportive principles are set as below:

C. *Guiding Principles* [4]
– Integration of Multi Modal
– Connectivity from the First mile to the Last mile
– Interconnected Street Network
– Complete Street
– Non-Motorize Transport (NMT) Network
– Traffic Calming Measures
– Mix Land Use
– Optimized Densities
– Street Oriented Buildings
– Managed Parking
– Informal Sector Integration
– Housing Diversity

D. *Supportive Principles* [4]
– Engage Private Sector
– Barrier Free Environment
– High Quality Transit System
– Land Value Capture
– Preserve and Create Open space
– Green Building Infrastructure
– Right size Infrastructure
– Integration of latest technology
– Safety and Security of passengers

III. CRITICAL LITERATURE REVIEW

Yamini Singh, Zuidgeest, Flacke, van Maarseveen[5](2012) gives design framework for quantitatively measured TOD by various stakeholders different definitions & different methodology is given for measuring TOD. In this paper describe the TOD Planning over multiple scales like station area level, transit corridor level (Along BRTS, MRTS, and LRTS) and for the whole urban-regional level. Till now, most of researcher's work on finding level of TOD based on qualitative measured like high, medium, low TOD area but no any work done to find out TOD level on the quantitative form so that anyone can compared the TOD level for different stations, corridor and region. For successful planning of TOD existing TOD Index (level) in form of quantitative must be known. This research work give a complete design frame work for developing TOD level on the spatial platform of GIS where result of TOD level can access by multiple stakeholders & proposed planning & interventions can be improved.

Sat Pal[2](2018) used main Criteria for TOD index measurements with different indicators. The criteria are Population Density, Land Use Diversity, and Walkability Analysis. In population density he used land use map & Building foot print, In land use diversity he use Simpson Index with 800 m radius and different mix land uses like residential, Commercial, Industrial, Public

& Semi Public, Parks. While in walkability Analysis he used pedestrian catchment area having walkable distance of 400-800 m with pedshed analysis. From the study, conclude that stations having high value of TOD-Index should be first applicable for TOD concept properly. Based on success criteria & indicators improvement can be done at the station level.

Herika Taki, Mohamed Maatouk, Emad Mohammed Qurnfulah[1](2018) Chosen criteria are density, diversity and economic development (Development) which is commonly known as 3-D concept of TOD. This criteria have different indicators. For the analysis of this criteria & indicators Analytic Hierarchy Process (AHP) is used, where first ranking of criteria is done by 12 experts and then same ranking of indicators for individual criteria are done. This statistical analysis done for the distribution of data and co-relation between different variable found out. Also co-ordination between different variables and different corridor also found out. From this literature can be conclude that every station have different criteria and having different indicators this is reason behind stations having high index tend be in urban area and having low index value tend be in suburb area. If good planning of transportation is done and if efficient travel services will provide than TOD can be successful which can reduce the problems related to traffic congestion, pollution, safety.

Subekti Sulistyaningrum, Jachrizal Sumabrata[3](2018) done research using 8 criteria and 17 indicators having both spatial & non-spatial data. Where spatial analysis is done using Arc GIS and non-spatial analysis is done by buffer area using observation method.From the analysis and calculation of result found out that Depok Baru station have the high level of TOD which means that station has busiest activities as a transit node in comparison to other nodes. With the busiest activity this node also have mixed land use function and good economic growth which is idle for TOD development. Other advantage is that it is important place for resident to reach from residential area, as it is located in the Centre of the city.

Yamini J. Singh, Pengwei He, Johannes Flacke, Martin van Maarseveen[6](2014) choose 4 criteria : Density, Diversity, Walkable & cyclable distance, Economic development.in this criteria 8 different indicators are used, and weightage is given to this criteria as well as indicators as shown here.
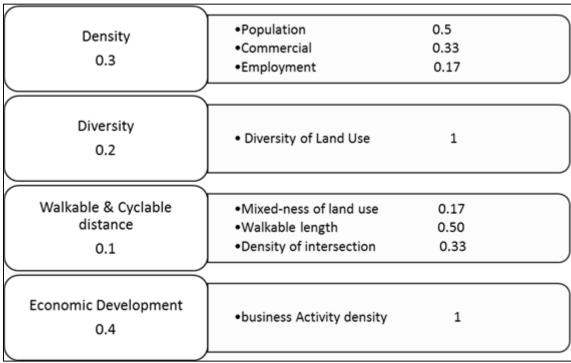

Fig. 1: Weightage of Criteria and Indicators

Using the TOD index, Author have been able to measure the level of TOD present at various locations in the City region. It has also helped in identifying hot-spots of high TOD index values that are expected to be transit oriented. Supplementing this has helped to shortlist those hot spots that need better transit connectivity. It is recommended that a high quality transit service like train or BRT may be extended to these areas. BRTS should be one of the best solution because train based can be costly. TOD measurement can be complicated because more number of stakeholders are involved and spatial & non-spatial both the data need to be measured together.

Singh, Fard, Zuidgeest, Brussel, Maarseveen[7](2014) Calculate TOD Index using Multiple Spatial Criteria (MCA). After calculation by this manner 2 urban area named as Arnhem & Ninjingem have high index of TOD values, which means rest of the regions have low value of TOD. After finding high index values hot-spot were identified & mapped and then further analysis done for development of hot spot having high TOD but station is far from the area like more than 800 m with less accessibility.

IV. MAJOR FINDINGS

Before planning or regenerating any area it is necessary to find out the current situation of the city. Every city have TOD but to which extent TOD is present is necessary to find out. TOD index is a measurement of finding out the extent of TOD in the study area. TOD Index give quantitative form of TOD in the area which help us to plan TOD. In micro level planning 3 different index should be find out at station area, corridor level, regional level. In station level TOD index for different stations are find out and among them which station have low values of Index should be develop based on lacking criteria. Same things are apply for corridor level and regional level planning.

There are major 4 criteria which is necessary to study for finding accurate TOD Index. This criteria are:
- Land Use Density
- Land Use Diversity
- Walkable and cycle able distance
- Economic development of the area

For this different criteria different indicators are there which help us to find TOD index.
- Land Use Density indicators are:
1) Residential density
2) Commercial density
3) Employment density
- Land Use Diversity indicators are:
1) Mixness of land use
- Walkable and cycle able distance indicators are:
1) Mix level of land uses
2) Quality & suitability of street for walking as well as cycling
3) Intersection density
- Economic development indicators are:
1) Zone of private investment
2) Number of service or retail establishments
3) Tax earnings of municipality
4) Unemployment level

From this criteria and indicators index can be find out which value is between 0-1. If value is high that mean area have good level of TOD and less improvements is needed and vice versa.

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