

Evaluation of Transit Oriented Development in the developing and developed nations

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Cities around the world are embracing the concept of Transit Oriented Development (TOD) and implementing TOD in the transition to move to sustainable development and mobility solutions. However, there has not been a framework that has been developed to evaluate these TOD projects. The framework aims to integrate the top down approach and bottom's up approach to take into account the Sustainable Development Goals (SDGs), the project level targets and objectives to assess the success of a TOD development. Such an approach would help in evaluating developments in terms of the individual project goals and also the overall success in terms of achieving SDGs.

Key Words : *Transit Oriented Development(TOD), evaluation, framework, indicators, Sustainable development Goals(SDGs)*

1. BACKGROUND

Currently, more than half of the world's population live in urban areas and it is predicted that 2030, 60% of the population would be urban dwellers¹. The consequence of this urban growth will be directly seen in the form of urban sprawl. In many of the regions in the world, the average ratio of land consumption rate to population growth rate is more than one¹, indicating that growth of urban areas is more than the rate of increase of population growth. Sustainable urban development is the need of the hour and various strategies across sectors needs to worked out individually and also in combination to bring maximum benefits and least environmental impact.

Transport activities accounts for almost 25% (2012) of the total energy consumption in the world and which is predicted to grow at 1.4% every year². Hence transport is a major game changer when it comes to making cities sustainable. The need to promote continued and improved mobility option to the population for better economic and social prospects and at the same time safeguarding the environment is the challenge most of the cities are facing. Sustainable urban transport solutions are being increasingly being linked to integrated land use transport approaches; Transit Oriented Development (TOD) is increasingly being hailed as a popular strategy by cities across the world.

There is a need to evaluate the TOD projects on the

best options for urban development in cities. Usually these projects are evaluated on locally decided objectives and targets/indicators and vary vastly between different projects. Therefore there is a need to identify indicator sbased on which all TOD projects can be evaluated on a general basis. Also the need to assess TOD against the Sustainable Development Goals to assess the contribution of TOD towards larger goals is also necessary. The principle of think globally apply locally come sto play here. The need to establish a uniform evaluation system is necessary to compare between various projects and this evaluation framework can also be used to assess various other kinds of projects or developments to evaluation and comparison.

2. OBJECTIVES

The objectives of the paper is to develop a framework for evaluating for TOD projects on a common base. The framework aims to integrate both targets/objectives of at the project level as well as the overall goals of SDGs, aiming at social, ecomic and environment well being to provide a overall assessment method. The framework is intended to be used to assess TOD developments in the developed and developing nations.

3. CONCEPT OF TRANSIT ORIENTED

DEVELOPEMENT (TOD)

The concept of Transit Oriented Development (TOD) planning was originally derived for North America where most large cities, except New York, have experienced low-density sprawl, resulting in worsening traffic congestion and degraded environmental quality³. It is concept which integrates land use and transport for the betterment of urban communities. Peter Calthrope defines TOD as “a mixed-use community within an average 2,000-foot (or 10-minute) walking distance of a transit stop and core commercial area. TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car” in his book *The Next American Metropolis*⁴. Cervero describes TOD as “concentrated mix of moderately dense and pedestrian friendly development around transit stations to promote transit riding, increased walk and cycle travel and other alternatives to the use of private cars”⁵. The improvement in the transit infrastructure and services is another facet of TOD which enhances the mobility in the city and in the TOD areas. The flexibility, speed and effectiveness of transit is expected to increase with the adoption of TOD by cities. Therefore, TOD aims to bring a reduction in trip lengths and reduction in travel times (main haul, ingress and egress); improving accessibility and mobility.

TOD is often linked to 3D’s: Density, Diversity and Design^{6,7}, the main factors through which TOD planning enables built environment to influence travel demand in a positive way. Densification aims to bring more residences and jobs in a designated area and within walking distances of transit stations and thereby improving accessibility. Diversity aims to bring a balanced mix of land-uses bringing facilities and variety of infrastructure closer to transit stations and improving the functionality of these areas. The design element looks into the form of the buildings, public spaces and the roads, giving more priority to non-motorized traffic and public spaces and efficient road systems.

The above-mentioned factors varies according to city character and customs and is essentially reflected in its mobility and land use culture. These three factors are used in varying effects at the system level, corridor level and station and site level to achieve specific objectives. The objectives vary from project to project depending on the community/region/city vision and various targets divided among station area and project level

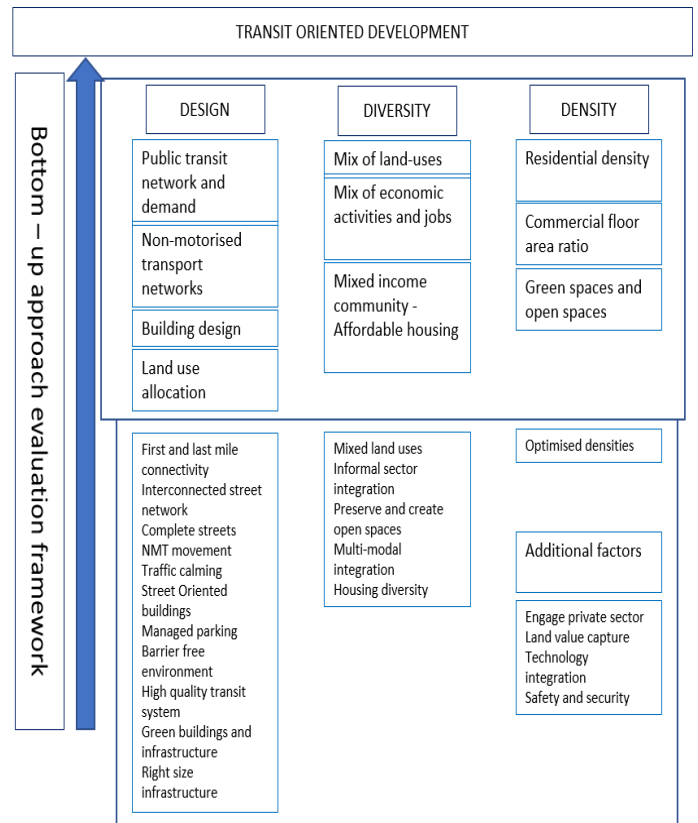


Fig.1 Bottom-up approach for TOD evaluation

4. METHODOLOGY FOR EVALUATING TOD

The methodology for evaluating TOD involves various available literature on TOD guidelines and project reports to identify the various objectives, targets and indicators that the projects have adopted to evaluate the the project at various timelines. Such a project project would help in preparing a list of established indicators that are already in use and successfully implemented at the project level. This would form othe basis of the bottom-up evaluation method. The second step involves reviewing the various Sustainable Development Goals (SDGs)⁸ targets and their corresponding indicators to form the basis of top-down evaluation method.

The bottom up approach is based on the TOD guideline and supporting principles based on the desired objectives of a TOD project in general. Figure 1 represents the adopted basic framework . This framework would be added with inputs and learnings regarding success evaluation and quantification of implemented projects from the project reviews to make the framework more robust and oriented to objectives of real TOD projects. The bottom level of Figure 1 represents the common objectives of TOD projects and are basically used as the guide-

lines/principles of any TOD project. The targets and objectives at the project level are used based upon achieving these principles. The second level of factors represents how the bottom indicators are linked to the broader objectives of TOD projects like transit design, building design, NMT networks, residential and job densities, mix of landuses, economic activities and jobs, mixed income housing, and achieving densities in terms of residential units and jobs. These elements are then linked to the overall factors of TOD, namely Design, Diversity and Density.

The top down approach on the other hand evaluated the SDGs, its targets and indicator system to deduced the targets which TOD could contribute in achieving. Figure 2 shows the basic framework of the top-down approach. In the top-down method given in Figure 2, the SDGs that can be achieved with the help of TOD are listed out. For example, TOD can help in achieving the goal of reducing poverty by helping achieve its target of ensuring that the poor have access to property ownership. Similarly the goal number 3 of good health can be achieved through ensuring that traffic accidents be reduced. The details of the SDG goals and the related targets that TOD can help in achieving are given in Table 1.

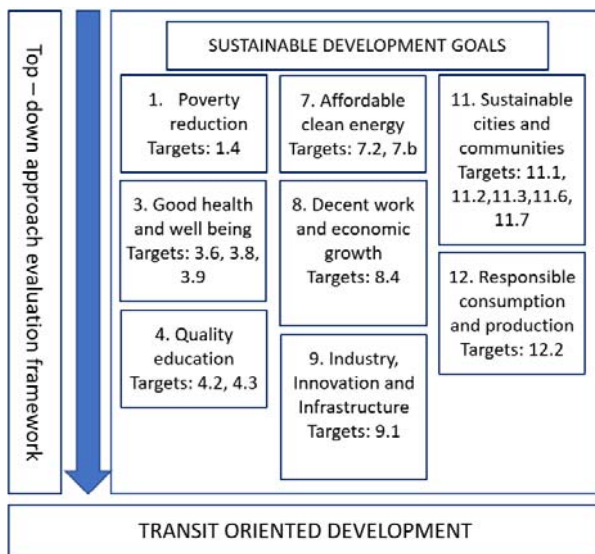


Fig.2 Top-down approach for TOD evaluation

Table 1 List of SDG and the targets related to TOD

No	SDG	Target
1	No poverty	1.4 - equal rights to economic resources, as well as access to basic services, ownership and control over land and other forms of property,
2	Zero Hunger	NA
3	Good health and well being	3.6 - halve the number of global deaths and injuries from

		road traffic accidents 3.9 - reduce the number of deaths and illnesses from hazardous chemicals and air pollution
4	Quality education	4.2 - access to quality early childhood development, care and pre-primary education
5	Gender Equality	NA
6	Clean water and sanitation	NA
7	Affordable and clean energy	7.2 - increase substantially the share of renewable energy in the global energy mix 7.b - expand infrastructure and upgrade technology for supplying modern and sustainable energy services
8	Decent work and economic growth	8.4 - improve global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation
9	Industry, Innovation and infrastructure	9.1- Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure
10	Reduced inequalities	NA
11	Sustainable cities and communities	11.1 - ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums 11.2 - provide access to safe, affordable, accessible and sustainable transport systems for all 11.3 - enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management 11.6 - reduce the adverse per capita environmental impact of cities 11.7 - provide universal access to safe, inclusive and accessible, green and public spaces
12	Responsible consumption and production	12.2 - achieve the sustainable management and efficient use of natural resources
13	Climate action	NA
14	Life below water	NA

15	Life on land	NA
16	Peace, justice and strong institutions	NA
17	Partnerships for the goals	NA

		land price
8	Safety and security	- No of accidents per year - No of crime cases in the community
9	Green and open spaces	- Percentage increase in green and open spaces since the project

5. EXPECTED EVALUATION OUTCOMES BY THE METHOD

Literature review needs to be carried out a number of successful and failed TOD projects to identify the factors that are considered for viewing the project as a success or failure. A comprehensive list of such factors would be then prepared. The research method aims to first short list the identified factors at the project level through regression analysis for the bottom up approach. The indicators for quantification of these selected factors would be then selected. It is expected that factors like mixed land uses, multi modal integration, housing diversity, optimised densities, private sector engagement, etc would feature as the important factors for evaluating a TOD project. The corresponding indicators for these factors are given in Table 2.

Table 2 List of possible factors and their corresponding indicators for bottom-up approach

No	Factor	Indicators
1	Public transit network, service and demand	- Increase in transit ridership - Increase in service-frequencies/ routes
2	Non-motorised transport networks	- Availability of walking/cycling paths - No of people walking or cycling on daily basis
3	Mix of land-uses	- Dissimilarity index - Vertical mix of land uses
4	Mixed income community	- Percentage of income levels - Percentage population of age groups - Property/ rent prices - Average income and average household income - Percentage of various dwelling types
5	Optimised densities	- Residential densities - Percentage increase in residential density
6	Private sector engagement	- Percentage of private sector investment in the project
7	Land value capture	- Percentage of increase in

For the top-down level, SDGs are taken for the evaluation and the targets and corresponding indicators have already been established by United Nations (UN). For the ease of evaluation and data collection, and more importantly to provide a common base for evaluation especially across nations, it is proposed that the research considers the same indicators as given by UN. The indicator list for the considered SDG targets are given in Table 3.

Table 3 List of SDGs and their corresponding indicators for top-down approach

No	SDG	Established indicator
1	1. No poverty	1.4.1 Proportion of population living in households with access to basic services 1.4.2 Proportion of total adult population with secure tenure rights to land
2	3. Good health and well being	3.6.1 Death rate due to road traffic injuries 3.9.1 Mortality rate attributed to household and ambient air pollution
3	4. Quality education	4.2.2 Participation rate in organized learning
4	7. Affordable and clean energy	7.2.1 Renewable energy share in the total final energy consumption 7.b.1 Investments in energy efficiency as a proportion of GDP
5	8. Decent work and economic growth	8.4.1 Material footprint, material footprint per capita, and material footprint per GDP 8.4.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP
6	9. Industry, Innovation and infrastructure	9.1.2 Passenger and freight volumes, by mode of transport
7	11. Sustainable cities and communities	11.1.1 Proportion of urban population living in slums, informal settlements or inadequate housing 11.2.1 Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities 11.3.1 Ratio of land consumption rate to population growth rate

		11.6.2 Annual mean levels of fine particulate matter (e.g. PM2.5 and PM10) in cities (population weighted) 11.7.1 Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities
8	12.Responsible consumption and production	12.2.1 Material footprint, material footprint per capita, and material footprint per GDP 12.2.2 Domestic material consumption, domestic material consumption per capita, and domestic material consumption per GDP

Note: The indicators 8.4.1 and 8.4.2 are for Goal 8 are same as the indicators 12.2.1 and 12.2.2 for Goal 12

The framework would include a part which would enable the TOD projects to be evaluated spatially on the basis of ease of accessibility for basic services that is required for quality of life. The basic services can include green spaces, work opportunities, educational opportunities, medical opportunities, etc. Density, Diversity and Design and also improvement in transport services (either as introduction of new transit lines/services or improvement in existing services in terms of spatial and temporal availability). These changes are expected to improve the accessibility and mobility of people by reducing the impedance to travel. Impedance is usually expressed in terms of travel distance, travel time and travel cost. Increased density brings origins and destination closer thereby reducing travel distances. Increased diversity implies that more facilities through varied land-uses in the same location, again decreases the impedance. The design element

increases the accessibility to transit and other NMT options. Therefore a spatial evaluation of TOD projects would also enable in understanding the reduction in impedance and increased access to basic services in the community or in the city as a whole.

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(Received July 31, 2017)