

Building a Sustainable Future for BRTS Surat: A Green TOD Framework

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Abstract—The concept of self-sufficient, transit-oriented cities lies at the heart of green transit-oriented development (TOD). It combines a BRT system with nearby environmentally friendly structural development. It uses renewable energy sources including solar, wind, and biofuels and emphasizes the integrated growth of society, transportation, and the environment. Recycling and reusing materials, insulation, bioswales, and low-impact building materials all help green buildings have smaller environmental footprints. Energy independence, waste-free living, and sustainable mobility are all potential outcomes of TOD and green urbanism.

Keywords—Green TOD, Sustainable Transportation, BRT System.

I. INTRODUCTION

The TOD concept was introduced in 1993 by modern urbanism advocate Peter Calthorpe. This concept promotes the development of dense, mixed-use neighbourhoods around transport hubs. Planning and development for local communities had a significant role in the initial concept of TOD.

Green TOD is an extension of the TOD theory influenced by sustainable development theory and green urbanism with the aim of establishing a self-sufficient and sustainable transit-oriented city.

Green TOD was introduced by Cervero and Sullivan in 2011. Green TOD is a certified environmentally friendly TOD approach that offers an integrated form of sustainable urbanisation and mobility. To attain more ecological and environmental benefits, green TOD focuses on fusing TOD with green urbanism. In order to successfully implement the combination, Cervero and Sullivan's research suggests that the following elements should be taken into account: Higher densities, mixed land uses, fewer impermeable surfaces, fewer places for parking, and solar energy production at stations are the four key factors.

Green TOD, which combines TOD with green urbanism and ideas related to an ecological community, is a sustainable and livable city that is transit-oriented. According to the study, combining TOD with green urbanism might reduce energy consumption and carbon emissions by about 30%. Although it has benefited from relevant research and project ideas, there are some unanswered questions in the following areas. Urban design initiatives still fall short, and the majority of Green TOD solutions are theoretical at this point. It is essential to assess and classify the physical environment of Green TOD transit station locations in order to implement the advanced TOD concept.(Niu et al., 2021)

II. LITERATURE

1. Concept of TOD:

The idea of "Transit Oriented Development" (TOD) promotes the development of dense, mixed-use neighbourhoods close to transport hubs. The TOD concept was first put up in 1993 by modern urbanism advocate Peter Calthorpe. To help with public transport and to take advantage of any development opportunities that such a framework may offer, TODs are compact, mixed-use projects that are pedestrian-friendly. TOD has discovered the importance of carefully building a community around a transit system, providing a range of housing, employment, shopping, and entertainment alternatives, creating possibilities for the general public and the private sector, and enhancing the quality of life for both new and existing residents. A transit hub should be situated in the middle of the community, 400 metres (m) or a 10-minute walk from where people live.

In TODs, institutional, commercial, and residential construction are combined to provide non-motorized vehicle flexibility alternatives like cycling and walking. A transit station can be 0.5 miles or 1 miles away from a TOD zone depending on its radius. TOD combines land use and transportation planning to accomplish planned sustainable urban development that focuses on high-density mixed land use that is walkable and decent. The feasibility of TOD is increased financially and practically by establishing a framework that is pedestrian- and Non-Motorized Transport (NMT) friendly and benefits a wide number of residents. Utilising the travel framework would enhance the corridor's peak-hour traffic flow.(Khare et al., 2020)

2. Components of TOD:

- Urban design
- Land use planning
- Transport planning
- Urban regeneration
- Real estate development
- Land value capture
- Infrastructure implementation

3. The Idea of Green TODs:

Green TOD is a development of TOD theory informed by green urbanism and theories of sustainable development. A sustainable form of urbanism known as TOD consists of mixed-use, small-scale activity centred on BRT stations that are also connected by pedestrian facilities. It is one of the more effective methods for ending the destructive cycle of sprawl and automobile dependence and replacing it with a positive cycle in which greater transit use reduces traffic jams and compact station area development aids in reducing sprawl. TOD focuses on limiting VKT, or vehicle kilometres travelled, which is directly tied to energy use and exhaust emissions, in order to lessen a city's environmental impact. Living and working in TODs reduces VKT, but so does diverting car trips to off-site places in favour of on-site walking and cycling.

Green architecture and environmentally friendly community plans are two ways that green urbanism reduces emissions and waste from stationary sources. By using insulation, triple-glazed windows, bioswales, recycling, and low-impact building materials, TODs also lessen their carbon footprint. When coupled, the co-benefits of TOD and Green Urbanism can result in waste-free living, sustainable mobility, and energy independence. Higher densities, diverse land uses, less surface parking and impermeable surfaces, as well as solar energy generation at stations, are a few ways that TOD and Green Urbanism can collaborate to produce synergies. When combined, these synergies can lead to sustainable mobility, waste-free living, and energy independence. (Ververo & Sullivan, 2013)

4. Components of Green TOD:

- Promote environmental design
- Maximize the utilization efficiency of resources and energy
- Use green building construction techniques
- Develop a city that connects protected area, ecology and community

5. Parameters of Green TOD:

- Sustainable urbanism
- Green urbanism
- Sustainable urban regeneration
- Zero waste
- Zero emission
- Renewal energy
- Sustainable modes of transportation and compact polycentric cities
- Development of green buildings and districts
- Aesthetic view of the city

III. STUDY AREA PROFILE

1. About study area:

Surat is a city located in Gujarat, a state in western India. It was located close to the Tapti River's mouth and previously had a big harbour. In the 1500s, a castle known as Surat was built to defend the city against Portuguese invaders. The surrounding Dutch, Armenian, and English cemeteries have elaborated colonial tombs. There is currently the commercial and economic centre of South Gujarat. The city's textile and diamond industries are well-established, and it is a mecca for clothes and accessory shopping.

Geographical Area	474.185 km ² (183.084 sq mi)
Population	6,176,000
Rank	2nd in Gujarat
Density	13,000/km ² (34,000/sq mi)
Sex Ratio	1.27 ^[9] ♂/♀
Metro Rank	9 th
Pincode(s)	394 XXX, 395 XXX
Literacy rate	86.65% ^[10]
Website	www.suratmunicipal.gov.in https://surat.nic.in/

Surat Demographic Profile

(Source: Census 2011)

2. Infrastructure:

The Surat Municipal Corporation is in charge of upkeep for the city's amenities for the general population. Out of 21 Indian cities, it ranked seventh for having the finest administrative procedures in 2014. The local government's weekly budget updates are only provided by this one city in India. A planetarium, science centre, museum, art gallery, auditorium, and amphitheatre are all part of the complex. The Lalbhai Contractor cricket stadium, which has hosted numerous Ranji, Irani, and Duleep Trophy games, can accommodate more than 7000 spectators. The stadium is also a well-liked hangout for local cricket fans and aspiring players. 5,000 CCTV cameras will be positioned strategically throughout the city by the Surat police.

3. Transport:

Airport:

Surat International Airport is Gujarat's second busiest airport in terms of aircraft movements and passenger volume. The city's train station was recognised as the best large station in India based on cleanliness. A fast transit rail system is currently being built in the city of Surat.

Railway:

Surat Railway Station, along with Gothangam, Kosad, Utran, Udhna Junction, Bhestan, Niyol, and Sachin, is a significant railway station servicing Surat. It is governed administratively by the Indian Railways' Western Railway zone. Surat is an Indian Railways Western Railway Zone A1 category railway station.

the ST station code

Useful platforms: 4

Founded in 1852

6 tracks

Elevation: 194.29 feet (59.220 metres)

Zone(s): Mumbai WR, Western Railway Division

BRTS:

An integrated bus rapid transit and public bus transportation system serves Surat, Gujarat, India, under the name Sitilink or Surat BRTS. Since January 26, 2014, Surat Municipal Corporation has started running it.

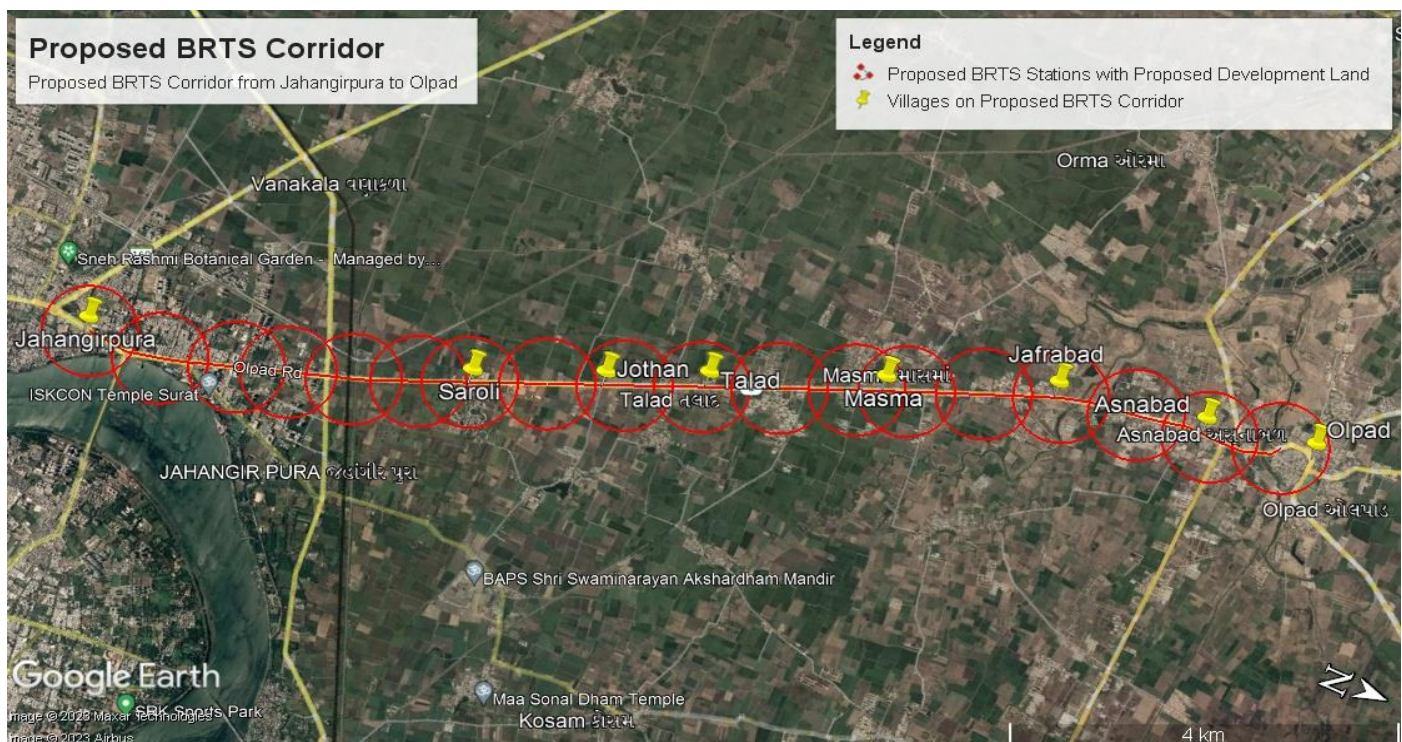
Operation started in November 2013

Surat Municipal Corporation is the operator(s).

125000 bikers per day

There are 15 lines (Phase I and II).

4. Location of Study area with Proposed Land use and Proposed BRTS Station Marked:



Location of Study Area with Proposed Development Land and Proposed BRTS Station Marked

Source: Google

This image shows the location of the study area with the BRTS station and projected development site noted. This crucial section of the BRTS ran from the Jahangirpura Community Hall, an existing BRTS station, to Olpad, a proposed BRTS station. The communities between the crucial stretch from Jahangirpura to Olpad, including Saroli, Jothan, Talad, Masma, Asnabad, and Jafrabad. Development land is placed on either side of the 18 proposed stations. According to BRTS rules, there are 500 to 800 metres between each station that has been located and proposed for BRTS. According to TOD rules, the proposed development land is 500 metres from each proposed BRTS station.

IV. SAMPLE SIZE FOR SURVEY

1. SLOVIN'S FORMULA

The sample size needed to attain a specific confidence interval while sampling a population is determined using Slovin's formula. When you don't have enough knowledge of a population's behaviour (or the distribution of a behaviour) to determine the ideal sample size, you can apply this formula.

- The formula for Slovin is: $n = N / (1 + Ne^2)$.

Where n is the number of samples, and the degree of confidence is 95%.

N is the population as a whole.

- For survey form of all wetland sites area total population size is $N = 25,557$

Confidence interval	Z value	Total sample size for survey
95%	1.645	393

After using the formula the total of sample size for survey is 393. (Bel & Isip, 1960)

V. CONCLUSION:

This study developed a variable system for the Green TOD built environment using ideas of green urbanism and the 5D built environment framework. The following five factors—neighbourhood spatial form factor, facility completeness factor, open space factor, high-density mixed land-use factor, and walking amenity factor—are drawn from the original 13 variables. A distinct factor score is assigned to each station area to indicate how well it did in relation to the five aspects. The technique provided by this study can be used to evaluate the built environment of the Green TOD development in the areas close to the existing MRT stations. It describes the physical characteristics of the sites of TOD station locations in various rail transit neighbourhoods and how well they function in terms of a number of Green TOD measures. It is possible to conduct additional comparative research in different cities. Determine the causal links between Green TOD characteristics and resident travel and the livability of sustainable communities by combining the Green TOD typology with information on resident use of public transportation, trip carbon emissions, and degree of life satisfaction.

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