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Implementation Plan based on TOD Typology by Spatial Analysis using GIS for Dense Cities

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Abstract: Transit-Oriented Development (TOD) is one of the most appropriate solutions to make city sustainable as proved in many foreign countries. This study aims to develop an implementation plan through TOD Typology based on existing site condition. Hyderabad Metropolitan Area (HMA) is considered as study area. Surveys such as landuse survey and stated preference survey are planned to understand the ground realities. A sample size of 1.13% is collected as part of stated preference and it revealed that 71% of people showed willingness towards TOD. Finally, study suggested TOD Typology as Residential TOD, Commercial TOD, Public&semi-public TOD and Mixed TOD.

Keywords: Transit-Oriented Development, TOD, TOD Typology, Spatial Analysis

1. Introduction

Rapid growth in urbanisation is taking place all over the world, especially in developing countries like India. Metropolitan cities and class I cities are facing more problems related to traffic and transportation, environmental and social related issues. This puts people's lives in dangerous situation. To make the city liveable and also to keep the future generations on safer side, transportation engineers and planners have a comprehensive solution through implication of Transit Oriented Development (TOD). This paper discusses in detail how TOD would address the above said problems and suggest to implement best optimal TOD. From the literature review, it is understood that TOD is not a new concept. It is well known and implemented in developed countries like Northern America and Australia in early 1960's. While the concept is not defined and using the similar designs, until Peter Calthorpe published 'The New American Metropolis' in 1993. However, these concepts are based on green field development which may not suite the developing countries where cities are not planned and highly dense. It is the same case with Indian Cities as they are densely populated and are not planned. To implement concept like TOD, there should be definite unique formulae for each country or community. Hence there is a need to understand various influencing factors like demographical features, traffic conjunction level, transportation network, landuse, environmental, social, economic, political and institutional issues etc. Strategic plan presented in the following session with respect to Indian Conditions are listed down for successor TOD.

2. Literature Review

Literature is reviewed to have knowledge on TOD importance and its typology carried out around the world. Md. Kamruzzaman (2014) developed different TOD typologies in different contexts, they are based on subjective evaluation criteria derived from the context in which they are built and typically lack a validation measure. LI Xiangnan (2011) gave five types of TOD based on the cluster analysis of different types of land use

on some typical cases of TOD communities. Chen Yang (2008), firstly discussed the relationship between land use pattern and transit modes, and then an adaptive transit combined with transit-oriented development. J.J. Lin (2006), studied about maximizing subway system ridership; maximizing living-environment quality; and optimizing the social equity of land development. Hyungun Sung (2011) illustrated the distributional patterns and characteristics of planning factors such as transit supply service, land use, street network and urban design at each rail station area. To identify effects of TOD planning factors upon the transit ridership. Li Zhiqiang (2008) revealed foreign TOD models and suitability to Chinese cities where it cannot be simply copied and ultimately developed TOD designs and procedures appropriate for China. Xiangnan (2011) conducted a study to categorise the different types of categories under which TOD can be classified based on cluster analysis. This helped to analyse the appropriate TOD clusters that had more commercial activity or residential zones. The TOD cluster with highest mix index value was concluded to be the most typical type of TOD community.

Understanding the importance of TOD typology, in the present study a macro level or system level typology with respect to landuse which are feasible to Indian conditions is proposed.

3. TOD Strategic plan

The TOD Strategic Plan is a necessary action to plan before taking up the project. This would help the authorities and local people to be mindful of future changes about their place. It also works as a guide for planning and implementation activities. The Strategies are drawn based on existing difficulties as follows:

- Defining TOD
- TOD Typology and its benefits
- Parking policies with in TOD
- Change in Traffic circulation plans
- Strengthening of Non-Motorised Transport (NMT) Facilities

3.1 Definition of TOD

TOD is defined as creating liveable environment with in walkable distance from the transit station which emphasis the use of transit as main mode of transport and walking for all other trip purposes. TOD is essential as lives (survival) in urbanisation became miserable because of traffic and transport related issues.

3.2 TOD Typology

TOD Typology can be a segregated design plans among the Transit Stations. Each station is to designed according to its existing characteristics related to infrastructure and other facilities. Typology provides the information about its development. Characteristics covered like land use mix, density of building, transportation facilities are also used at maintenance stage after implementation.

3.3 Parking policies with in TOD

Provision of parking is really a challenging job within TOD. Provision of parking within premises of station area is the general practice. In such cases, people would use motorised transport to reach transit station, where the concept of TOD (encouraging the walk mode) would disappear. So the placement of parking has to be decided in a manner where the walking environment is not affected.

3.4 Change in traffic circulation plans

To do this exercise, firstly TOD area is defined. Then the market potential, landuse activities and road network available within TOD area to plan and fulfil the TODness is explored. Traffic circulation plans should be hassle free to the Non-motorised transport.

3.5 Strengthening of NMT Facilities

As of now Indian cities have poor facilities related to the NMT. Minimum walking facilities are to be designed to reach station from everywhere in TOD. Also, there should be at least two or more major roads with NMT facilities (bicycle paths/Foot paths) in different directions.

4. Study Area

The area considered for present study is Hyderabad Metropolitan Area (HMA). It is occupied by 6th and 3rd positions of population and area respectively among the metropolitan cities in India. HMA population is about 10 million as of now and is estimated to be 19 million by the year 2041. HMA area is 7,200 SqKm. Registered vehicles in HMA are 2.5 lakhs (year 2011) with a growth rate of 11% per year. Road length is 5,500 km. Average journey speeds in a core area in peak hours is less than 20 kmph. All major arterial roads are facing traffic congestion with a volume capacity ratios varying from 0.9 to1.3. To address the major issue related to traffic and transportation, authorities launched Mass Rapid Transit System (MRTS). It is Hyderabad Metro Rail

(HMR) which is currently under construction and has 3 corridors with a length of 72 km. Hence it is a great opportunity to study and explore the suitable TOD to make city sustainable even for future generations. The corridor selected is from Nagole to Secunderabad (Corridor III), which is in the first phase and ready to operate MRTS. Influence zone considered is 500 metre (as it is acceptable walking distance) on either side of the corridor.

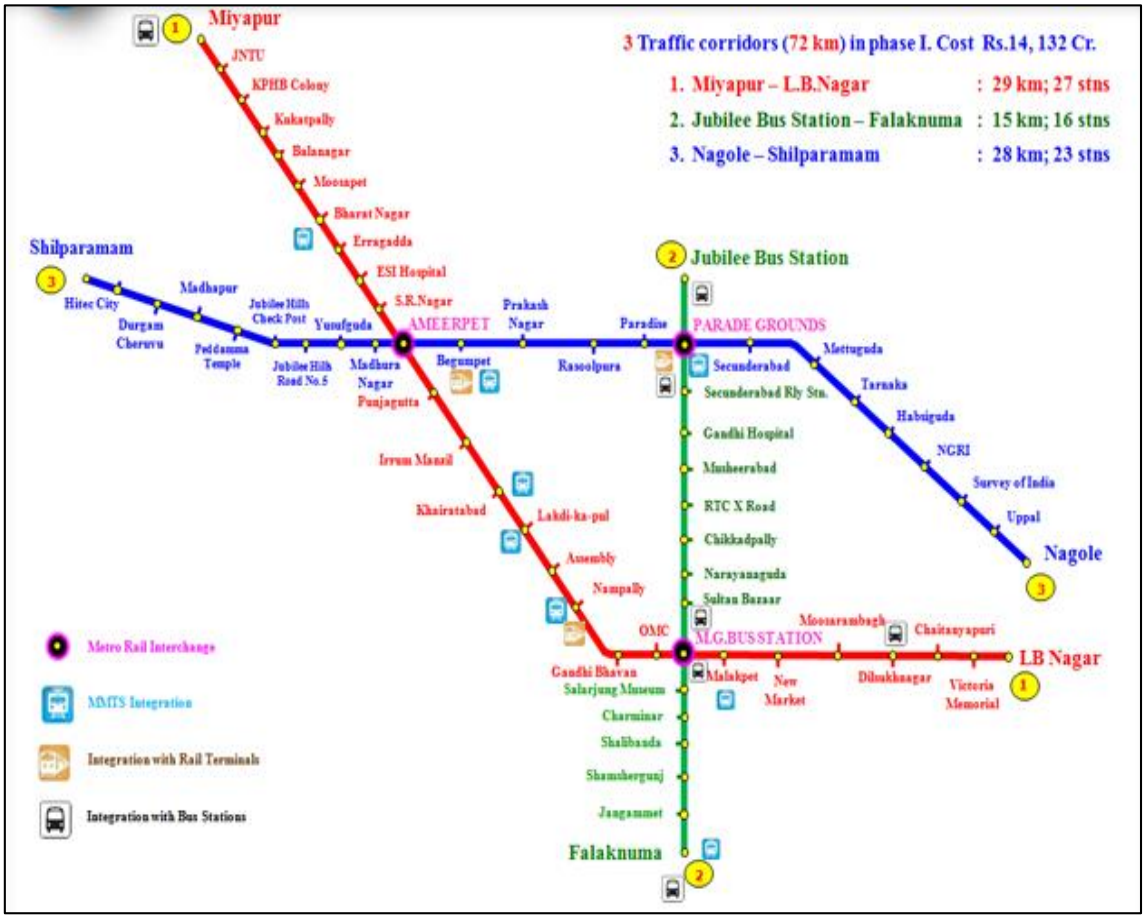


Figure 1 Hyderabad metro rail route map

Soure: http://www.hmr.gov.in/route-map.html

5. Analysis and Results

Analysis is being carried out in two stages to bring out the most possible and implementable strategies through proposing TOD Typology. Stage-I is Spatial Analysis and Stage II is Stated Preference Survey. From stage one, spatial analysis is carried out for seven Transit Stations on MRTS corridor from Nagole station to Mettuguda station. Landuse survey is conducted for each station influence area (with radius of 500 meter) to understand the existing landuse characteristics. Based on the existing landuse activities, plans are proposed for future betterment. Also the other parameter considered is vacant land availability to distinguish among the TOD. For this Google earth is used to identify the empty land pockets. Based on the vacant land availability, design aspect of TOD is carried out.

Stage II – A stated preference survey is conducted to capture user's perception about the proposed TOD environment and also prescribed questions to reveal their present travel pattern. Survey is carried out on either side of corridor within one kilometre distance. Estimated population is about 1.06 lakhs. Survey is conducted for a sample size of 1200, which is about 1.13% of total population within the study area. In this survey salient features covered are income level, monthly travel expenses, number of years residing in the house, Shopping preference, mode usage for shopping purpose and finally how would they support TOD?

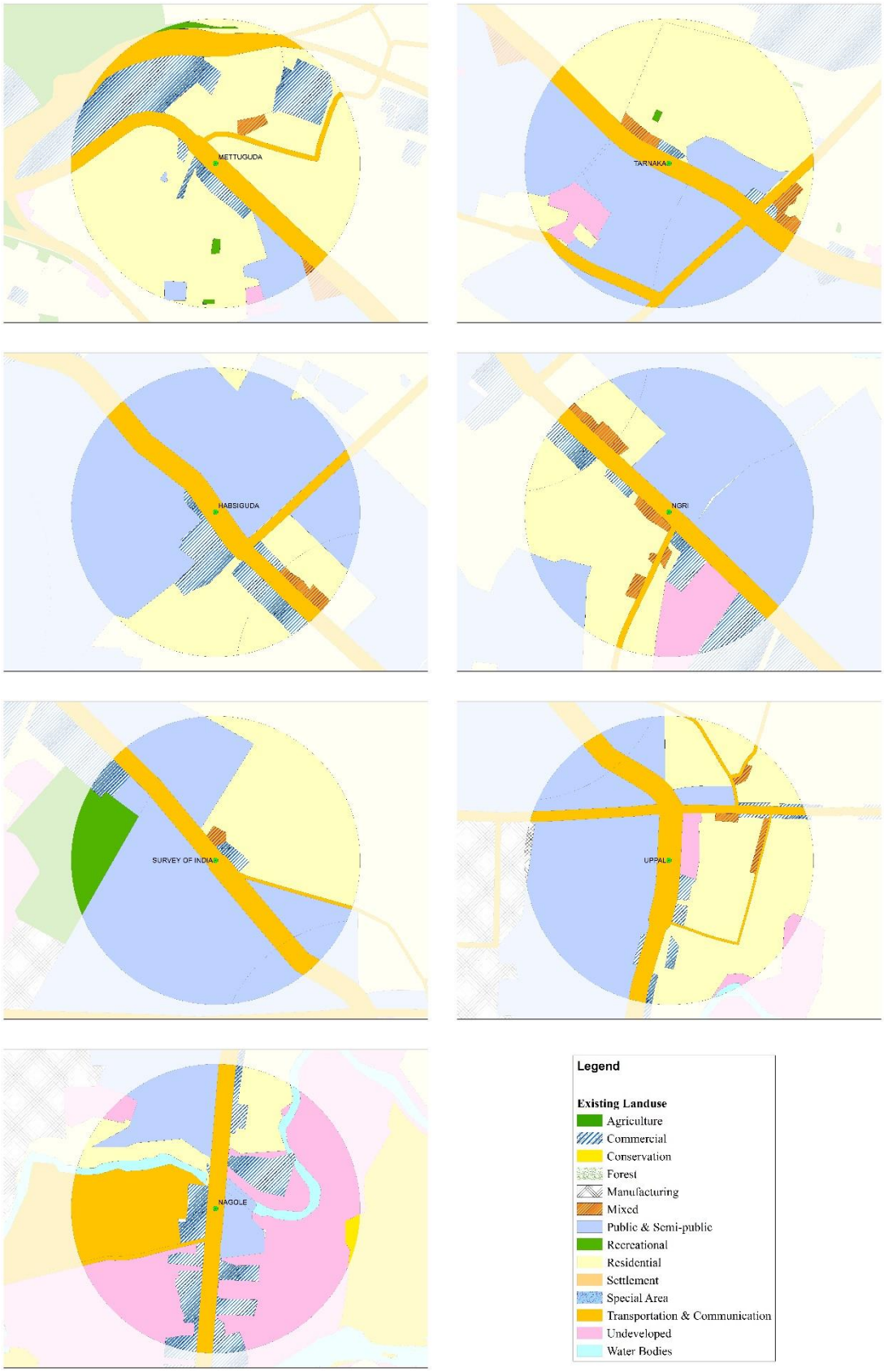


Figure 2 Existing Landuse characteristics around the stations

Table 1, represents that 59% of people residing within the study area have monthly income of about Rs.10,000-25,000 and 29% of people have within a range of Rs. 25,000-40,000. Study revealed an average cost of travel per month is about Rs.1950. Author is interested to know about people's history of living in that area and noticed that about 65% are residing from last 8 years (table 2). People shopping within the study area is about 38% only. Most of the commuters, about 30% use motor cycle and 16% use car for shopping purpose to reach out station as presented in figure 3. Usage of public Transportation as of now for the shopping purpose is too low about less than 20%.

Table 1 Income level of peoples

Income level (in INR)	Percentage of Population
< 10,000	6%
10001-25,000	59%
25,001-40,000	29%
40,001-50,000	4%
> 50,001	2%

Table 2 Number of year residing

No. of Year Residing	Percentage of Population
< 4	42%
4 - 8	23%
9 - 12	24%
13 - 16	9%
>16	2%

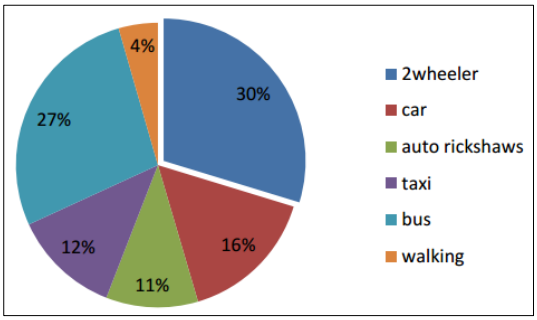
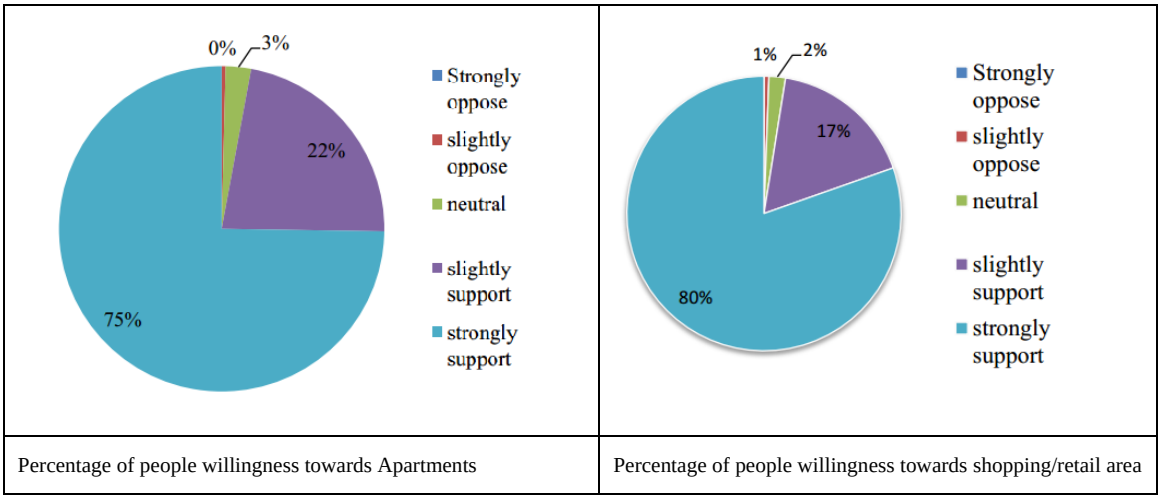


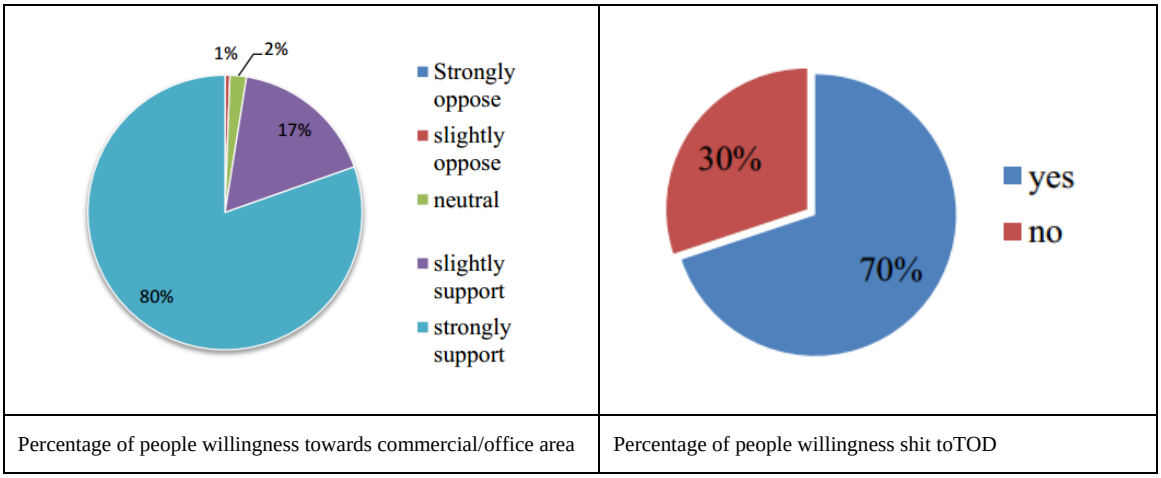
Figure 3 Mode share for shopping trips other than within TOD

Finally, there are 70% of positive response captured and showed their willing ness towards TOD community. Questions formulated to know their responds on, like will they support high raised building for residence?, how would they support for retail/shopping and commercial/office? And lastly willingness to shift to that area? Results are illustrated in the figure 4.



Percentage of people willingness towards Apartments

Percentage of people willingness towards shopping/retail area



Percentage of people willingness towards commercial/office area | Percentage of people willingness shit toTOD

Figure 4 Proposed TOD Typology

From the table 4, it is understood that is of 62% of land is covered by residential at station mettuguda is of followed by Uppal and Tarnaka. At Nagole the predominant landuse observed is undeveloped and commercial. Based on the above observations proposed TOD typology with respect to landuse is drawn and presented in figure 5. Public and semi-public (including research and institutes) landuse is high across the stretch and maximum of 54% Survey of India. Mixed landuse is consistently low for the study area. To boost the mixed usage of land, there is a need of at least two TOD has to represent "Mixed" type.

Table 4 Existing Landuse details

Transit Station	Residential	Commercial	Mixed	Public & Semi-public	Transportation & Communication	Undeveloped	Others	Grand Total
Mettuguda	62%	16%	1%	4%	16%	0%	1%	**100%**
Tarnaka	38%	1%	2%	42%	14%	3%	0%	**100%**
Habsiguda	19%	12%	7%	52%	11%	0%	0%	**100%**
NGRI	31%	6%	3%	44%	9%	7%	0%	**100%**
Survey Of India	28%	2%	0%	54%	9%	0%	7%	**100%**
Uppal	39%	2%	1%	39%	15%	3%	1%	**100%**
Nagole	10%	12%	0%	13%	23%	38%	5%	**100%**
Grand Total	**33%**	**7%**	**1%**	**37%**	**14%**	**7%**	**2%**	**100%**

6. Recommendations

Study aimed to reduce the trips made by commuters for shopping purpose. As of now shopping trips are predominant after work trips. hence to reduce the shopping trips and decongest the CBD (Secunderabad) which is just beside study area, plans were drawn. Strategic plan for TOD typology is proposed in such a way to minimise the trips other than work purpose.

It is observed that as a whole the land available for transportation within TOD is about 14% which is quite good. The major arterials present in the study area are shown in figure 2. Other than NGRI and Survey of India station all others can be facilitated with good NMT tracks along arterials.

Special parking regulations are to be proposed at stations which have commercial and mixed TODs. Habsiguda, Uppal and Nagole should have control regulations on parking like parking payment technology, parking data base, real time parking information. Ultimately parking policy should be minimise the parking requirement with in TOD area.

At nagole, there is about 38% is undeveloped area and is proposed as commercial TOD. Proportions of 70% to commercial and 30 % to residential and civic purpose can be planned. Also few TODs like NGRI, uppal and tarnaka have vacant land, which can be utilised to make sustainable in terms of social and environmental friendly.

To make study area as sustainable, TOD Typology is proposed that mixed TOD in two number, Commertial/Retail TOD in two number, Residential TOD in two number and Public & semi-public one as shown in figure 5.

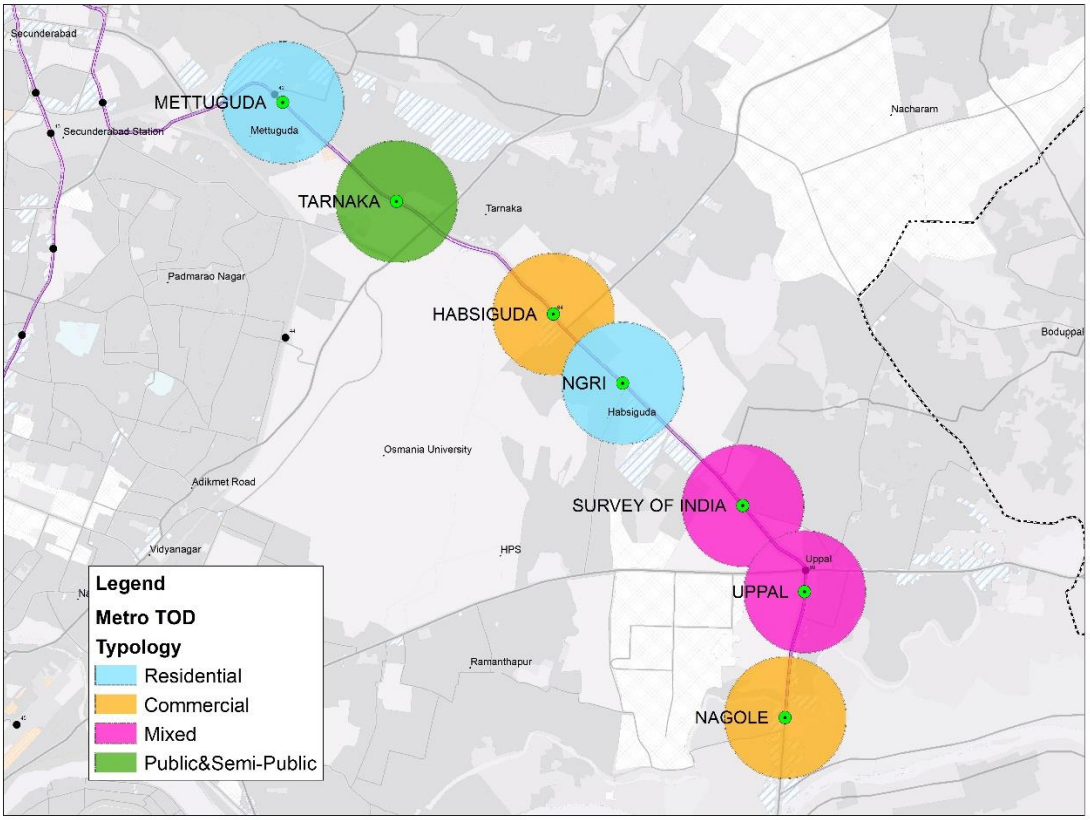


Figure 5 Proposed TOD Typology

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