Densification of Planned Urban Area due to High Speed Rail Corridor

A case study of Antroli, Surat

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Abstract

This paper is an inquiry aimed at understanding the characteristics of the surrounding area of a HSR Terminal and formulate planning strategies for the future development.The objectives are framed to understand the characteristics of influence area and access the city level impact. When the transportation infrastructures are introduced to the urban environment, it leads to the transformation of that neighbourhood. *The UNESCAP Report (May 1986)* states that "The physical structure of a city, its size and sprawl its way of life and character are all dependent upon the nature and quality of urban transport system". This thesis explores the relationship between High Speed Rail Terminal and the densification of its surrounding land use development. The need of the study is to lead emphasis mainly due to the impact of Station Area Planning on the surrounding neighbour.There is also a need of study to analyze the importance of Intra-Urban transportation in Urban Development.

The Literature Review helps to understand different factors which are to be considered for the influence area like the activity pattern and need of integrated land management catchment area which generally ranges from 500 m to 1000 m, and the Land market has a tendency to place a higher premium on parcels that are in close proximity to the transit corridors, however, property price may not vary linearly with distance from Terminal area & higher end building does not come in the immediate vicinity (100m).It also is a function of last mile travel time, ease of access. After a deduction of 30% of the Original Plot area. the Final Plot area selected for the present study is 270 ha having 242 land parcel bounded by 60 m Surat Bardoli Road in the north, 60 m proposed DP Road in the east, 18 m Proposed DP Road in the south and the Niyol-Antroli Boundary in the west. Two different land management tools were applied for this research one is LPRR ie the concept of T.P Scheme and the other is Land Acquisition model. It is found that the Land acquisition model is much beneficial with a new concept of global FSI. Which might be incorporated in the DCR for future use before the HSR starts functioning.

Regional connectivity is proposed as per the policy guidelines of AMRUT to enhance the city level commercial centers and corridors in the station area, also to encourage Local Area Plan and inter city movement.At last conclusion was drawn based on the study conducted and area development planning proposals, policy framework is prepared to enhance implementation of proposed development in the Study Area.

Keywords

First and Last Mile Connectivity, Floor Space Index, Global FSI, Gross Domestic Product, High Speed Rail Corridor, Last mile Connectivity, Mass Rapid Transit System, Station Access and Mobility Plan. Transit Oriented Development.

Introduction

The next decade in India will see massive intervention in Urban areas with regards to infrastructure, unauthorized conversion of land, lack of planned settlement, traffic conflicts in vehicular and user activities that indicates towards poor level of services especially those areas related to terminal station of HSR.The introduction of a new infrastructure has an inevitable impact on the surrounding area. This is even more productive when it involves the transportation infrastructure on account of not only the changes due to the construction but also increases the accessibility. When the transportation infrastructures are introduced to the urban environment, it leads to the transformation of that neighbourhood.Due to exorbitant migration in urban areas in the last few decades, increasing vehicle ownerships, traffic congestion and rising extreme air pollution have resulted more and more cities in India to opt for various mass rapid transit systems such as metro rail, mono rail and BRT systems etc., but still there are disparities that fail to connect people directly to the network which hitch the growth and revenue collection of the mass transit systems. "Station areas are unique places where high-speed and intercity passenger rail can connect seamlessly with intermodal options like public transit. The infill development around the station can boost economic growth and community vitality" (JosephSzabo). This paper is an inquiry aimed at understanding the characteristics of the surrounding area of a HSR Terminal and formulate planning strategies for the future development.The objectives are framed to understand the characteristics of influence area and access the overall city level impact.

Need of the Study

The need of the study is to lead emphasis mainly due to the impact of Station Area Planning on the surrounding neighbour. National High-Speed Rail Corporation Limited (NHSRCL) which was incorporated on 12th February 2016 under the Companies Act 2013 has proposed a Rail Terminal for Mumbai-Ahmedabad Bullet Train at Antroli village of Surat District. This brings in positive features opportunity like Enhancing Mobility, Smart City, Smart Development, New Business and Revenue Generation. Negative features like Urban sprawl issues, Access to station, Congestion, limited space. Since there is no prior study/Research conducted to analyze the impact of the station Area at Antroli. The station Area might act as catalyst for guided Urban Development and can help inducing growth and Development in Antroli to keep pace with Surat, the Major changes in terms of Landuse, Urban Structure, Population and built-up density and built form have to be managed in a timely process for an Integrated develpoment of Antroli.There is a need of study to analyze the importance of Intra-Urban transportation in Urban Development. Also the first and Last mile connectivity to Public Transport. Due to introduction of High Speed Rail in the area, it would attract the population around the country and also will put Surat City on the world map which has High Speed Rail and thus will also attract the worlds eye and if left unchecked would lead to haphazard or uncontrolled development. Therefore it is essential to plan the

area to control the development which would help to provide better boost up the growth of the surrounding area and the Surat City. All these issues hence need a thoughtful consideration, strategic planning for the study concept.

Research Framework

A systematic approach was undertaken to complete this research work. Firstly, an extensive literature review of related studies was carried out. The case studies of different international & national HSR station area has been studied and analysed to find out the impact of HSR on the surrounding Station area. The information about the location of the Antroli HSR Terminal was obtained from the SUDA (Surat Urban Development Authority). Then the land value of the Antroli were noted down from the ASR Jantry Rates of SUDA and the DP Sheets were also obtained from SUDA, which were traced AUTOCAD. The table below shows the supporting Literature Review.

Table 1 Supporting Literature Review

Sr.No	Title	Author	Description
1	NMT as Green Mobility Solution for First/Last Mile Connectivity to Mass Transit Stations for Delhi	Chidambara, Assistant Professor, Department of Urban Planning, School of Planning andArchitecture,New Delhi, India	Role of non-motorized transport (NMT) as green mobility solutions in improving the last mile connectivity (LMC) to mass transit systems. The paper concludes with outlining a holistic policy approach that treats NMT planning as a non-negotiable component of transit planning to achieve higher ridership
2	Dedicated High Speed Rail Network in India	G.Raghuram& Prashanth D.Udayakumar Indian Institution of Management Ahmedabad.	The issue like route fixation, choice of grade line, location of station, need of standards, pricing, revenue & funding etc.
3	Does High speed Rail affect the behaviour of firms located in District around central station? The result of two survey conducted in Reims in 2008 & 2014	Christophe Beckerich,Sylvie Benoit-Bazin, Marie Delaplace	Shortens the time to travel. Improves accessibility at intra-regional level. Accessible to services industries as local & regional market
4	Impact of high speed rail on railroad network accessibility in China.	Shih -Lung Shaw, Zhiviang Fang, Shiwei Lu, Ran Tao	Travel accessability is changed. Corridor affect due to establishment of hubs in the HSR area
5	Detailed Project report for DMRC	Delhi Metro Rail Corporation Ltd. (2011).	Change in activity pattern Change in Property value

			Change in socio-economic condition.
6	Comparative analysis of High Speed Rail Station Development and Multi-Use Facilities: The Case of SanJose Diridon	Eric Eidlin	Strong Leadership. Planning in Phases. Coordination of different key players.

Study Area

The Study area for the research work is Antroli, which is the largest village of the Palsna Taluka of Surat District. The population of the village as per the census 2011 is 2,114 and the total area of it to be 495.54 ha. The nearest highway is the NH 48 and the State Highway is SH 605 also known as the Surat-Bardoli road. The nearest railway station is the Chalthan Railway Station, which is 8 Km from the Antroli, and the Surat Railway Station which is 10.8 Km. The Surat Airport is at a distance of 23.3 km from the Antroli.

The area of the study area of this paper is 270 ha of Antroli, delineated between the 60m DP road also known as the Surat-Bardoli Road, 60 m proposed DP road, 18 m proposed DP road and the Antroli-Niyol boundary.
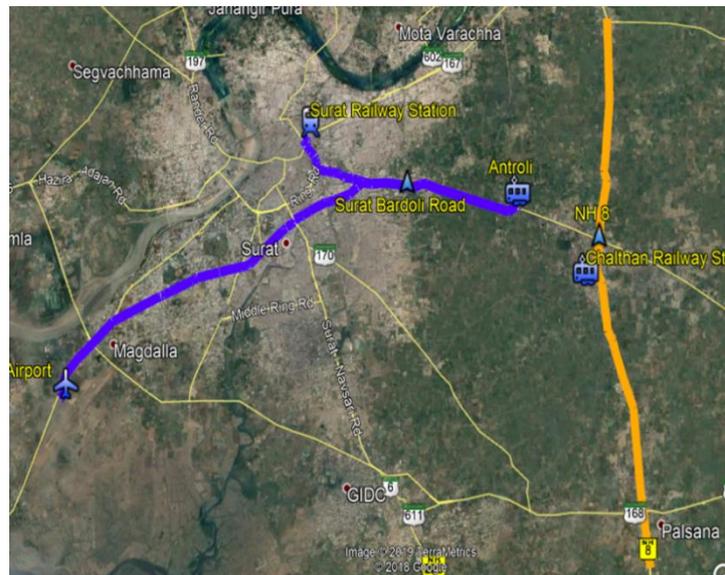

Figure 1 Locational map of the study area

Analysis

As per the JICA feasibility report vol. 6, there would be about 127 House owners who would be affected by the project. As per the physical displacement, there would be about 94 would be displaced. Among the Affected families it includes 4 shops, 5 factories and 3 store house. *(Source:Project Feasibility Report vol.6 NHSRCL).* From the GIS Survey the LULC class of the study area is identified. The graph below shows the LULC Class of Antroli.
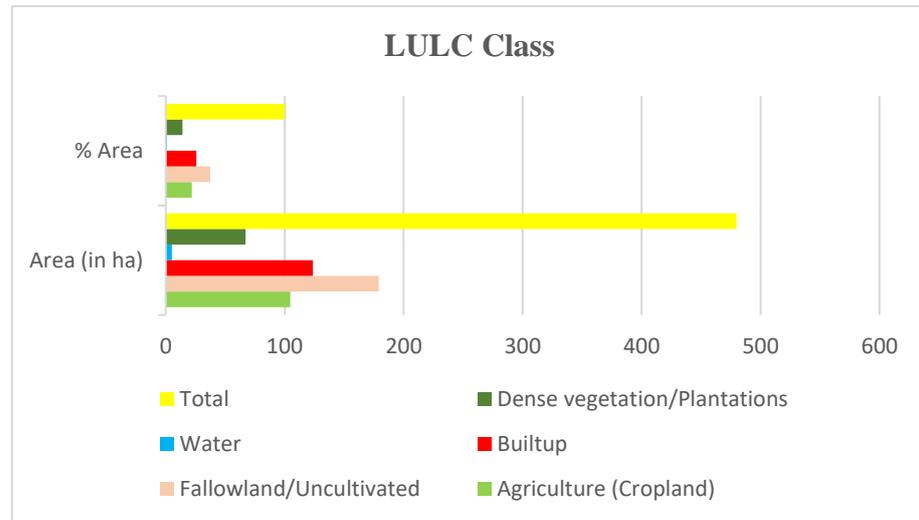
Figure 2 Graphical representation of LULC Class

The study area is basically divided in six major blocks namely A,B,C,D,E & F in N-W, N-E, W, E, S-W, S-E Zones respectively. As per abbuting roadwidth the FSI was kept as mentioned in CGDCR Area of plot within 250 m radius of roads having width ≥45m with (4 FSI), Area of plot between (250-500) m radius of roads having width ≥36 m but <45m (3.6 FSI), Area of plot between (500-1000) m radius of roads having width <36 m (2.7 FSI). The Table below shows the available FSI variation as per the DCR.

Table 2 Available FSI variation as per the DCR

Available FSI Variation			
Zone	Base FSI	Chargable at 40% of Jantry Rate	Maximum FSI
Residential/ Commercial	1.8	0.9	2.7
		1.8	3.6
		2.2	4

(Source: CGDCR 2017)

Both A, B block comes majorly within 200 m of the 60 m wide Suart Bardoli Road due to which the maximum f.S.i available is 4 (including base 1.8 and 2.2 payable) which would be mostly encourage to be developed as office space or commercial use. C,D Blocks comes majorly near the 56 m wide terminal road surrounding the HSR Terminal due to maximum FSI for those plots is also 4. E,F Blocks come between the 45 m Canal Road and the 18 m DP Road and is expected to be have a maximum FSI of 2.7 The figure below shows the FSI variation of the area as per the DCR.
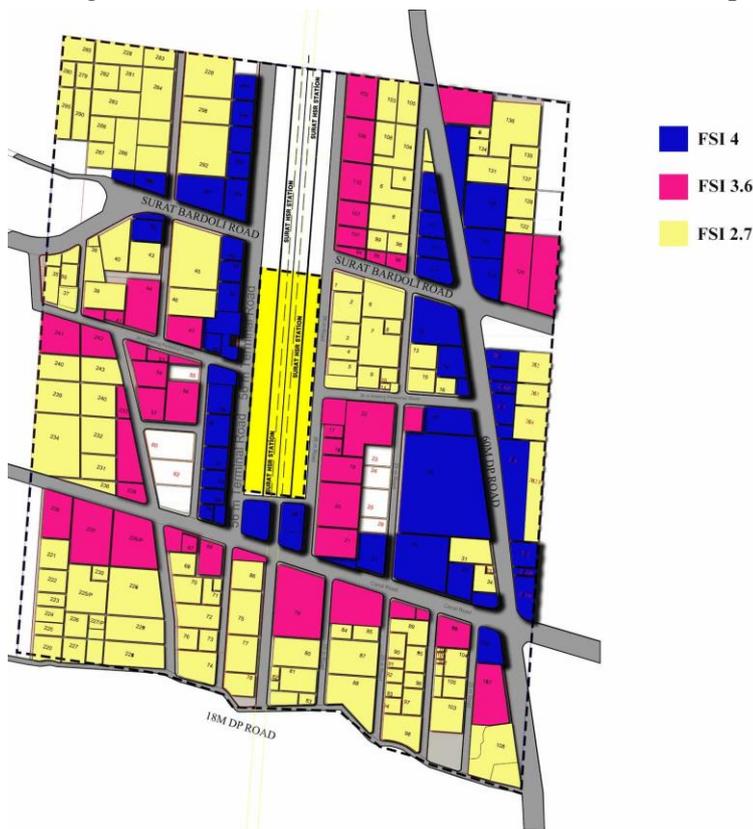

Figure 3 Representation of available FSI Variation of the Area

As per the DCR the distribution of FSI is done and the details of the plot area are listed below The Details of Different Blocks in Different Zones are Listed below.

Table 3 Details of the Plot in terms of Area and Percentage Distribution

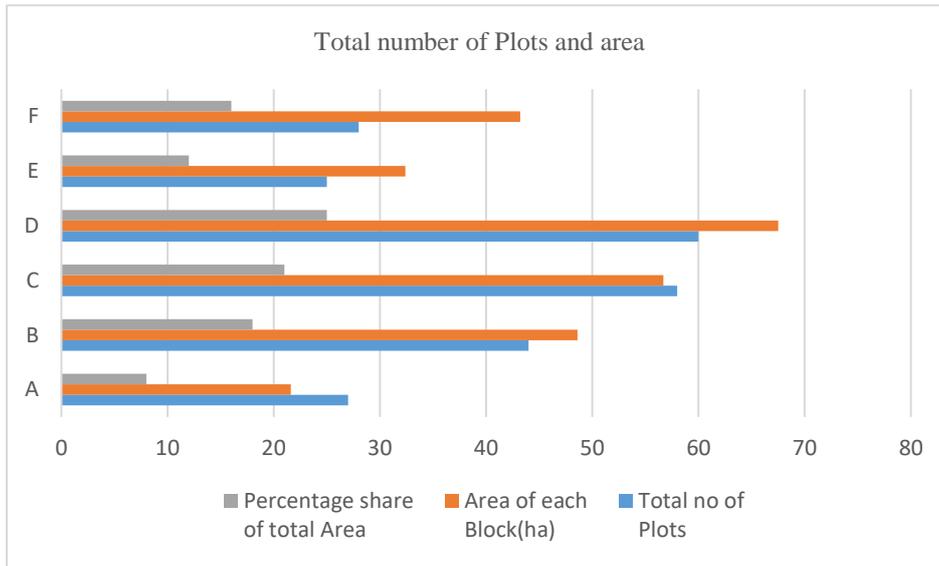| Total number of Plots						
Block	A	B	C	D	E	F
Total no of Plots	27	44	58	60	25	28
Area of each Block(ha)	21.6	48.6	56.7	67.5	32.4	43.2
Percentage share of total Area	8	18	21	25	12	16

(Source: Author)

Figure 4 Graphical Representation of the area & Percentage distribution of different zones

Proposals

T.P Scheme Mechanism (LPRR)

In this method, the land from the owners were collected and readjusted, the readjusted land is than given back to the owner with new final plot number.15% of the total land were dedicated to roads share of 40% of total land for Government and 60% back to owner.Plots were adjusted along the roads such that each plot gets the access. This process was repeated to whole land except the land which was acquired under the HSR Station as that land would be acquired as a whole. After the reduction a definite shape like square or rectangular was given to most of the land and if not possible, L shape is provided. Irregular shapes are not provided.

Assumptions

Table 4 Sharing of Land between Owner and Government

Sharing of land between Owner and Government		
Share	Percentage of share	Area in Ha
Government share	40%	108 Ha
Back to owner	60%	162 Ha
Road and other Infrastructure	15%	40.5 Ha
Land left for Government	25%	67.5 Ha
	Total Area	270 ha

(Source: Author)

ASR Jantry Rates of SUDA are Listed below

Table 5 Jantry Rates of Developed Land

Rate of developed Land per sqm (Rs)	Rate of Land + Construction in Rs per Sqm			
	Residential	Commercial	Industrial	Agricultural
4000	6500	8450	4000	3000

(Source: ASR Jantry Rates SUDA)

Percentage of Governments share is 25% of the Total Land

Amount paid by the Government to the owners = Rs (1080000 x 8450)

$$= Rs\ 912.6\ cr.$$

Assuming the Pre-market rate to be two times of jentri rate and excluding the area dedicated to road and other Infrastructure.

New cost of the land becomes =Rs (675000 x 16900) = Rs 1140.75 cr.

Net Benefit is the difference between pre market rate and amount paid by the government

Net Benefit = Rs (1140.75-912.6) cr

$$= Rs\ 228.15\ cr$$

Built up Area Calculation and Population Accomodation

Total Area of Final Plots = 270ha

Area sold to government = 108ha

Area back to owner = 162 ha

Considering average Dwelling Unit size as 100 sqm

Maximum occupancy is 70%

Average Family size is 4

Calculation of Average FSI

Area of plot within 250 m radius of roads having width ≥45m (4 FSI)   59.40 ha

Area of plot between (250-500) m radius of roads having width ≥36 m but <45m (3.6 FSI)
                                                                                 67.50 ha

Area of plot between (500-1000) m radius of roads having width <36 m (2.7 FSI)
                                                                                 143.11 ha

$$\text{Average F.S.I.} = \sum_{1}^{3} \frac{AF}{A} = \frac{(59.4\ ha*4) + (67.5\ ha*3.6) + (143.1\ ha*2.7)}{270\ ha} = \mathbf{3.2}$$

Total built-up area possible = 3.2*270*10000 m² = 86,69,700 m²

Total Dwelling Unit possible = 86697*0.7 = 60,688 DU

Total Population the area can accommodate = 60,688*4 = 2,42,752

Population Density = 2,42,752/270 = 899 persons per hactre

Considering maximum ground coverage to be 40% and the floor height to be 3m approximately the maximum height achieved = (86,69,700/ 1080000)

                                        = approximately 9m

                                        = 3Floors

Land Acquisition

As per chairman Railway Board 66% land is acquired ie 86% of total Project land in Gujarat and 22% of that in Maharashtra have so far been acquired for the Project. Land acquisition popularly means the acquisition of land for defined public purpose by a government agency from individual land owners, as authorized by the law after paying a government fixed compensation to cover losses incurred by the land owners from surrendering their land.In this case it is assumed that government purchases all the land from owners. The process can be undertaken by the state or through private initiatives, as of now most of the land acquisition is to be processed as per the RFCTLARR,2013. *(Source: URDPFI guidelines Volume-1)*

In this case it is assumed that government buys all the land in the initial stage Considering the share of road and other infrastructure to be 15% the fixed compensation that the government needs to pay is considered to be the rate of developed land for commercial purpose as and when the HSR will start functioning.

The amount government needs to pay to buy the entire land = Rs(2700000*8450)

$$= Rs\ 2281.5cr$$

Value Capture Mechanism through Augmentation of Additional FSI

Public action should generate public benefit, application of betterment levy and taxes which basically includes charges for Building Rights , property tax and tax increment finance also there is a provision for inclusionary zoning where certain amount of low income housing in exchange to construct market rate residential. The mechanism can be implemented through the augmentation of additional FSI. Considering the share of commercial, residential, psp and recreational land use to be 40% 40% 10% 10% respectively. The table below shows the proposed increase in FSI. The process was repeated for all six blocks.

Table 6 Proposed Increase in FSI

Proposed Increase in FSI				
Use	FSI	Used FSI	Proposed Increase in FSI	Balance FSI	Total Global FSI
Residential	2.7	0	2.7	5.4	5.4
Commercial	4	0	4	8	8
Mixed Use	3.6	0	3.6	7.2	7.2

(Source: Author)

The balanced FSI can be sell on in open market as built up area scheme provide by the Authority from time to time by which Authority is able to generate revenue for infrastructure development in the region and state revenue. According to the Employment density guide, *(Source: Employment Density Guide, pp 32-40)*

Employment generation = (Commercial BUA in sqm)/(Space required by 1 individual in office)
             = 864Ha (8640000sqm)/ 8 sqm   =1080000

The table below shows the Employment and Revenue Generated by increasing the FSI simentenously benefiting the Authority generating jobs and the revenue for other infrastructure in state.

Table 7 Employment and Revenue generation

Block	Plot Area (Ha)	Residential BUA (Ha)	Price per sqm as per Jantry (RS)	Commercial BUA (Ha)	Price per sqm as per Jantry (RS)	PSP BUA (Ha)	Price per sqm as per Jantry (RS)	Total Revenue Generated (Rs in Crore)	Total Employment Generation
A	21.6	46.65	6500	69.12	8450	15.55	7800	1008.57	86400
B	48.6	104.97	6500	155.52	8450	34.99	7800	2269.37	194400
C	56.7	122.47	6500	181.44	8450	40.82	7800	2647.61	226800
D	67.5	143.8	6500	216	8450	48.6	7800	2297.75	270000
E	32.4	69.98	6500	103.68	8450	23.32	7800	1512.86	129600
F	43.2	93.31	6500	138.24	8450	31.1	7800	2017.22	172800

(Source: Author)

Total Revenue Generated = Rs 11,753 cr

Amount spent by Govt for buying the entire land = Rs 2281.5 cr

Net Benefit is the difference between pre market rate of the global FSI and amount paid by the government.

Net Benefit = Rs 9471.5 crore

The figure below shows the proposed model as per the concept of Global FSI.

Figure 5 Proposed massing of the site as per the concept of Global FSI

From the above proposals it is seen that the proposal 2 with land acquisition model is much beneficial as compared to LPRR ie TP Scheme mechanism. Compensation for affected land and structures should be provided more than the prevailing market rates. In addition to the compensation for loss of land and assets, MoR/GoI should give priority to affected households for jobs in government departments in accordance with the qualification of the candidate. Disbursement of money should be done before the commencement of civil works. advance notice period should be served to the PAF. The figure below shows the skyline of the Proposed Densified area as per proposal-1 and proposal-2.
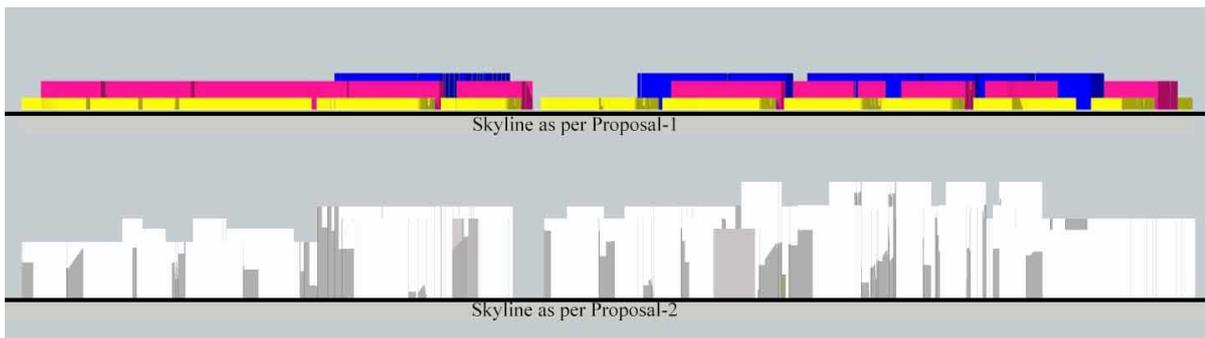

Figure 6 Comparision of Skyline as per the concept of Proposal 1 & 2

Regional Connectivity

Roads provide an unparalleled contribution to the development of the area and also access to different plots. This section will show the proposed DP roads as per DP2035 SUDA and the overall view of other roads planned in the area.
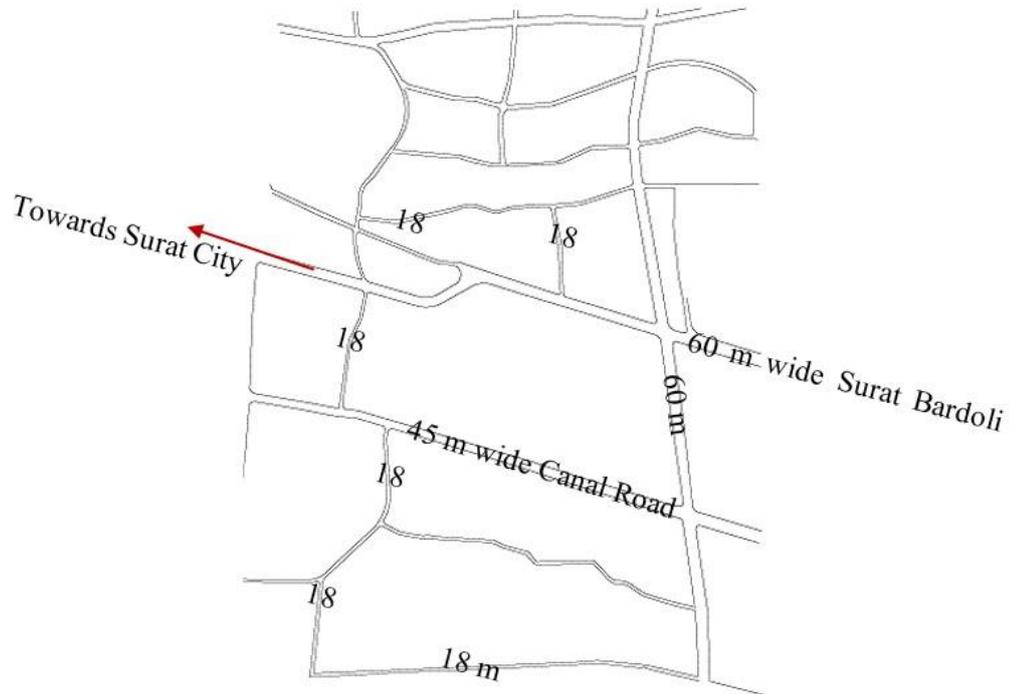
Figure 7 Road Network of the Site

Connectivity of International Airport to HSR

The proposed road length connecting the Surat International airport to the HSR Terminal is 23.6 km. The figure attached in the right shows the proposed location of the BRTS Stop. Advantages for the rider include faster travel time and easy interconnection with other public transport, while authorities may benefit from less highway and parking congestion, less pollution, and additional business opportunities. Additionally, the links will benefit both HSR Terminal and airport by drawing in more passengers via easy access.Saroli BRTS stop is situated on the Surat Bardoli Road. The same road goes through the Antroli and the transportation system can be extended to the Antroli. Since the HSR Station is elevated thus a BRTS Stop is proposed under the HSR Station on the Surat Bardoli Road whose width is 60m.

Figure 8 Proposed Location of Saroli Bus Stop

The figure below shows the GIS mapping for the proposed road linking the Surat International Airport and the Proposed HSR Terminal at Antroli via Saroli BRTS stop.
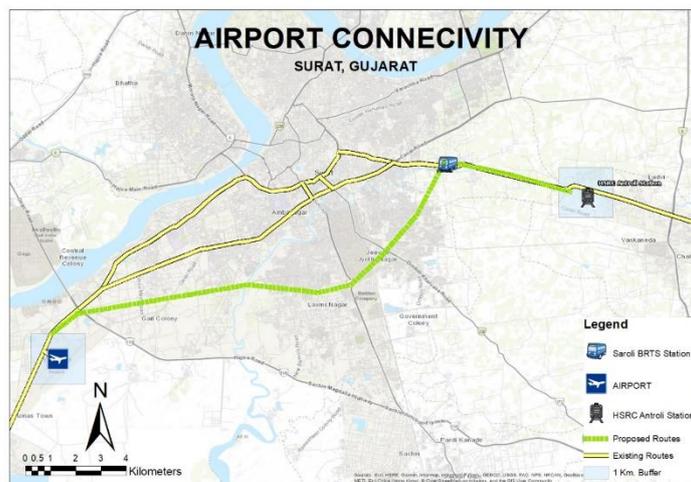

Figure 9 GIS mapping of proposed connectivity

Connectivity with major Industrial Hubs

The major locational factor of a transport terminal is obviously to serve a large concentration of population and or industrial activities & market area activities, representing a terminal's influence area.To enhance the city level commercial centres and corridors in the station area. There are five major Industrial areas that are identified those areas are Ankleshwar, Hazira, Navsari, Bardoli, at a distance of 59.8 km, 30.12 km, 27.71 km, 20.39 km respectively from the proposed HSR Terminal which act as growth centres to cater population and provide employment.The site is within 53 km radius from the proposed HSR Terminal. and when HSR will start functioning Transit Oriented Development zone around it, having redensified development will use the HSR as a catalyst. Hence it becomes essential to propose a connecting road which links HSR Terminal with the major Industrial Hubs. The figure below shows the GIS mapping for proposed road linking Industrial Hubs with HSR Terminal.

Figure 10 GIS mapping of proposed connectivity

Proposed Inner Ring Road

It is proposed for the intercity movement of the people of Surat, IRR is proposed with the clear junctions and staright connectivity, the road is also proposed on the peripherial to avoid long distance bridge. The prospective benefit of the IRR is to facilitate quick travel from different areas in the city. The proposed ring road is 21.7 km in length.

Figure 11 GIS mapping of proposed connectivity

Policy Framework

Table 8 Policy Framework

Policy Guidelines	Guiding Principles	Vision	Issues	Strategies	Relative studies
Complete Communities	Compact Development	Compact Development through Intensification	To encourage High Density Development in areas surrounding the HSR Terminal. To extend the benefit of incentives to other activity centers serving the station area with potential for growth.	Promote highest densities immediately around the HSR Terminal. Identity transit nodes and activity centers, serving the surrounding areas capable of supporting increased densities.	Station area Characteristics. Plot Size. Station Area Transformation. Building Heights Implication of the SUDA building bye law. Commercial establishment. Land Use. FAR.

| AMRUT | Retaining Area Character | Transformation through Uban Regeneration | To enhance the city level commercial centers and corridors in the station area.\n\nTo encourage Local Area Plan | Within a stretch of 800m Enhance Job density in the area.\n\nHorizontal and Vertical Mixing of commercial activities.\n\nCreate 10 min neighborhood for amenities | Learning from case studies. Identifying the growth stretch, Implication of DCR, study of Commercial establishments |

(Source: Author)

Conclusion and Future Scope

Based on the literature review and the proposals given it can be concluded that due to HSR service Spatial connectivity is the key for the development of the impact area sorrounding the HSR Terminal so a seamless integration of the station with the surrounding which should be both physical and perceptual . Also it is suggested to study the land use characteristics and potential of Antroli. This research is an inquiry aimed at understanding the characteristics of the surrounding area of a HSR Terminal and formulate planning strategies for the future development and access the city level impact by increasing the FSI on limited land resource available for development and accordingly a planning mechanism is proposed in line with the development of Antroli area due to the proposed HSR terminal. Based on the implementation mechanism the following conclusions can be made.

Table 9 Reforms aimed at steering Land use

Sr.No	Reforms	Public Policy aimed at steering Land use	conclusion
1	Spatial Reform	Compact Master Plan	a. Compaction of Urban Development limiting to future fabric & facilities.\nb. For the management and development of the complete HSR area development, an agency comprising of members from different local agencies like SUDA, SMC, Real Estate Union of Surat (RERA), etc key players of the Surat City.
		Zonal Plan	a. Neighborhood Area Plans with a particular local identity or development character.\nb. Analysis and Planning of potential neighborhoods through Community

			Participation i.e. Consistent Planning Guidance.
2	Institutional Reform	Amendment in DCR	a. Adopt transferable development rights (TDR) New set of development controls for mixed use, enhanced FAR and TOD applicability. b. Accommodation reservation, land use flexibility, and grant of additional FAR on Complete Community Projects ie the concept of Global FSI as used in BKC by MMRDA.
3	Economic Reform	Value capture Financing	a. Public action should generate public benefit b. Application of betterment levy and taxes Charges for Building Rights Property tax and tax increment finance.

(Source: Author)

Future Scope

The dissertation is carried out to study the impact of HSR Terminal on the surrounding area, the site is currently an agricultural land hence green field development will take place. Revenue and employment generation is taken into consideration.

As per the JICA Vol. 6, 127 house owners has to be resettled which is not included in the project. Resettlement action plan including providing housing, land and time frame with financial mechanism can be made, Details study of service parameters for increase in population in the surrounding area can be done, Parking details for increase in population, Transport orient development of HSR terminus, Detail Estimation can be done for implementation of TOD, Making Antroli a working District.

References

1. C.Beckerich, S.Benoit-Bazin, M.Delaplance. (2016) "Does High speed Rail affect the behaviour of firms located in District around central station? The result of two survey conducted in Reims in 2008 & 2014, World conference on Transport research-WCTR 2016 Shangha, 307-3034. www.sciencediect.com.

2. Chidambara (2010). Last Mile Connectivity (LMC) For Enhancing Accessibility of Rapid Transit Systems presented at TRANSED, 2012. New Delhi.

3. Delhi Metro Rail Corporation Ltd. (2011). Detailed Project report for DMRC.

4. Dr. Ravin M. Tailor, Ashwani Yadav. (2019) "Peripheral area development proposals for antroli high speed rail station". SVNIT, Surat.

5. Eidlin E. et al. (2007) 'A Comparative Analysis of High-Speed Rail Station Development into Destination and Multi-Use Facilities : The Case of San Jose Diridon'.

6. Eric Eidlin, Comparative analysis of High Speed Rail Station Development and Multi-Use Facilities: The Case of SanJose Diridon.

7. G.Raghuram ,P.D.Udayakumar.(2016) "Dedicated High Speed Rail Network in India", Indian Institution of Management Ahmedabad, WP.No 2016-03-58.

8. Ken Jong, "California High Speed Rail Passenger Experience Planning" The Institution of Engineering & Technology. California. www.theiet.org/transport.

9. S.L Shaw, Z. Fang, Shiwei Lu, Ran Tao. (2014) "Impact of high speed rail on railroad network accessibility in China." Journal of Transport Geography 40 (2014) 112. www.elsevier.com

10. Sanyal,S., Nagrath,S. and Singla,G. (2008). The Alternative Urban Futures Report Urbanisation & Sustainability In India: An Interdependent Agenda, WWF-India.

Guidelines

1. EMBARQ. (2015). Safe access Manual.

2. Employment Density Guide.

3. Joint Feasibility Report for Mumbai-Ahmedabad High Speed Railway Corridor, NHSRCL

4. Surat Municipal Corporation (2018) 'Comprehensive Mobility Plan Surat 2046'

5. Town and Country Planning Organisation Government of India Ministry of Urban Development (2015) 'URBAN AND REGIONAL DEVELOPMENT PLANS FORMULATION AND IMPLEMENTATION (URDPFI) GUIDELINES', vol. 1 & 2

6. UD & UHD, Govt. of Gujarat (2017) 'Comprehensive General Development Control Regulations - 2017'

7. UTTIPEC, DDA. (2010). Street design guidelines.