ISSN No:-2456-2165

A Study on the Impact of Mass Rapid Transit on Land use Changes – A Case Study of Hyderabad Metro Rail Corridor

Konda Shashank[1]
Department of Architecture and Town Planning, Indian Institute of Engineering Science and Technology, Shibpur, Howrah

Arup Sarkar[2] (Professor)
Department of Architecture and Town Planning, Indian Institute of Engineering Science and Technology, Shibpur, Howrah

Abstract:- The development of mass rapid transit systems is considered as a promising solution for urban transportation challenges, such as traffic congestion. However, the introduction of new transportation infrastructure may also have significant impacts on land use patterns and transit-oriented development. This study focuses on investigating the impact of the Hyderabad Metro Rail Corridor on land use changes and current development patterns along major rail corridors. The study uses a mixed-methods approach, combining qualitative and quantitative methods to explore the impact of MRT on land use changes. The data collection process involved a review of relevant literature on the topic, a survey of households along selected site areas, a combination of satellite imagery analysis, field surveys, and interviews with key stakeholders. The study also conducted a spatial analysis of land use along the metro corridor using Geographic Information Systems (GIS) technology to map the relevant changes.

The findings of the study show that the most prominent changes include the emergence of new commercial and residential areas, the expansion of existing commercial and residential areas, and the transformation of formerly industrial areas into mixed-use developments. The study finds that the unplanned development around the metro stations can lead to various negative impacts, such as traffic congestion, environmental degradation. The study emphasizes the need for planning to manage the impacts of the Hyderabad Metro Rail Corridor on land use changes through proposed Floor Area Ratio around the selected study area. The planning should be proactive, inclusive, and sustainable, and should involve various stakeholders, such as the government, the private sector, and the local communities.

In conclusion, this study emphasizes the need for planning to manage the impacts of the Hyderabad Metro Rail Corridor on land use changes. The study highlights the need for planning to mitigate the chaotic development that might come up around the metro stations, and to promote sustainable and inclusive urban development. The study can serve as a valuable reference for urban planners, policymakers, and researchers who are interested in the relationship between transportation and land use in urban areas.

Keywords:- *Transit Oriented Development, Hyderabad Metro Rail, Land Use, Floor Area Ratio.*

I. INTRODUCTION

The top heavy urbanization and skewed population growth in large cities in India are causing major concern for increasing demand for urban mobility. In the year 2011, there were 4041 statutory towns, 3894 census towns, 475 UAs and 981 outgrowths in India. 377 million people lived in these 7935 towns/cities constituting about 31.2 percent of the total population, and the decadal growth of urban population was registered as 32.15 percent. Among these, about 160 million people lived in 53 million plus cities, which was 42.57 percent of total urban population, that experienced a decadal growth of 30.39 percent accommodating 30 million additional population in ten years. Number of vehicles in India rose from 0.3 million in 1951 to 141.1million in 2011. Personalized private vehicles such as cars and two-wheelers grew at Compounded Annual Growth Rate (CAGR) of 9.6 percent and 10.3 percent per annum respectively between 1999 and 2009, and highest rate was recorded in the metropolitan cities having a population of ten million or more (Sarkar 2018)[1].

To address this growing travel demand, railway based Mass Rapid Transit System (MRTS) or the Metro Railway as popularly known, was introduced in India way back in 1984 at Kolkata. Till date Metro railway was introduced in 15 cities, viz. Kolkata (1984), Delhi (2002), Bengaluru (2011), Gurugram (2013), Chennai (2015), Jaipur (2015), Lucknow (2016), Hyderabad (2017), Kochi (2017), Ahmedabad (2019), Nagpur (2019), Noida (2019), Kanpur (2021), Pune (2022) and Mumbai (2022).

Interaction between land use and transportation is observed to be a dynamic process that involves variations in spatial and temporal between the two systems (Aravantinos, 2000)[2]. While the evolution of transportation systems raises accessibility levels and hence promotes changes in land use patterns, changes in the land use system can affect the travel demand patterns and induce changes in transportation systems. Cervero & Kang (2011)[3] finds that

ISSN No:-2456-2165

Transit system alone is likely to be a necessary, but by itself insufficient factor in intensifying land-use development and increasing land values surrounding the station.

A cyclic influence of the market forces was found to be the most prominent factor in contributing to the development of the space surrounding the transit station, and in turn rail transit system encourages high density developments near the station which contributes to land use/land development decisions (Coleman 1993)[4]. A study conducted during the late 1970s in 15 cities in France, Germany, the UK, and Canada to see how trams and light rail stations affected home values, office rentals, and retail sales revealed a favourable relationship between land value and proximity to rail transit infrastructure (Hess & Almedia, 2007)[5]. Moreover, Gibbons & Machins (2004)[6] identified considerable increase in house prices after Jubilee's line extension in London in areas that are located within the line's influence zone.

The change of pace of urbanization on introduction of MRTS has been reported by many scholars over the years. Kundu and Ray (2014)[7] reported a change in the sky line in the suburb of Kolkata along with a substantial decrease of open spaces and water bodies after introduction and further on extension of metro corridor in Kolkata.

According to (Sheeba & Karthieyan, 2020)[8] the insertion of a metro station in Chennai has led to an increase in commercial land usage in all station influence zones. The rise in commercial land use is intended to take advantage of the metro station's impact and enhance revenue from the area's surrounding properties through leasing, taxation, and other means. It has been discovered that the proportion of residential and commercial land usage inside the effect zone is inverse. The level of interaction between the transit station and land use determines the extent of this inverse proportionality.

Due to the heavy reliance on the metro for commuting, it was found through price trend analysis that the influence of the metro on the cost of residential properties is high in low-income group locations and low in high income group areas. (Geetesh & Virendra,2022)[9]

(Anjani & Mahima, 2022)[10] have stated that majority of the smaller plots were amalgamated to boost the FAR for the construction of a high building that could accommodate a sizable population along Bangalore metro stations. Residential and commercial land use plots are being converted to mixed-use complexes with increased commercial floor space as the demand for commercial retail and office space increases.

- *Aim of the Paper*

Without adequate planning, there is haphazard development spreading along MRTS stations and inside their effect areas. To adequately direct future developments, a systematic study is therefore required to analyse the change in urban form along metro nodes and effect zones. Thus, there is a significant opportunity for the station area to see a dramatic transformation in urban form in terms of land use, building form, accessibility, and land value.

(Tzu-Ling, 2022)[11] argues that accessibility is considered to be one of the main factors in determining the location of businesses. With the increase of MRT operating years, the impact of MRT-induced commercial gentrification tends to expand, and the impact of MRT-induced commercial gentrification varies with the change of land use in the stations.

(Rashmi, 2009)[12] the quality of the area through which the metro corridor will pass has changed, this MRTS corridor would interconnect Gurgaon not only with Delhi but also with other NCR regional towns that are also planned to be connected with RRTS. Increased accessibility has put more pressure on the roadways, particularly the connecting stations. Ground plus 3 or 4 structures in residential localities have replaced non-descript single storied developments. Due to the high land value and connectivity, high density cooperative and builder's group housing have replaced individual plotted development and farm houses. The population density has raised to 220 PPH, which have led to a significant increase in the need for other infrastructure. The Increase in land value will continue manifold closer to road and nearer the stations, resulting in unplanned development.

The purpose of this article is to analyse the transit orient development patterns around a selected study area. The present work is an effort to identify the causes and impacts of metro on the surrounding land values, land use pattern to check the real impact of MRTS after its operation in Hyderabad.

II. MATERIALS AND METHOD

- *Data and Variables:*

This study used data from Hyderabad Municipal Area. The HMA covers 625 sq. km, and a population of 10.5 million by 2021 (Vani & Kamraju, 2018)[13]. Hyderabad is the capital of youngest state, Telangana in Union of India. The city has 3 metro rail corridors in the 1st phase, with 66 stations covering a length of 72 km extending within the city limits. The first two corridors of 52.4 km commenced in 2017 and became fully operational from 2019. As the influences of transit infrastructure usually occur before its commencement (Cao and Porter-Nelson, 2016)[14]. By using site selection criteria, the Ameerpet Interchange metro stations, which are identified as having a significant influence, have been the subject of an in-depth site assessment for this research that evaluated at the existing metro lines. This study tries to assess the existing land uses, land value changes and development potentiality around the selected metro station.

(Vincent et al., 2013)[15] while examining the influence of an urban form and land use on bus ridership in Montreal, used various buffer sizes (200m, 400m, 600m, 800m, and 1000m) to highlight the variation of influence surrounding the transit station. (Pol, 2002)[16] proposes the "Three

ISSN No:-2456-2165

Spheres" structural mode of influence surrounding the station and identifies that the First Sphere will have very strong vitality, second sphere will have Strong Vitality and the third sphere will have Marginal effect on vitality. According to National Transit Oriented Development (TOD) Policy (2017)[17] Government of India, the area in the immediate vicinity of the transit station, i.e., within a walking distance, having high density compact development with mixed land use to support all basic needs of the residents is called the influence zone of a transit station. It was observed that TOD Influence zone at station varies from 300 meters to 2000 meters, however the impact seems to be intense zone within 300 meters around the station the corridor. While 800 meters is considered as standard TOD zone and same is been referred for the site study according to the policy (UTTIPEC, 2012)[18].

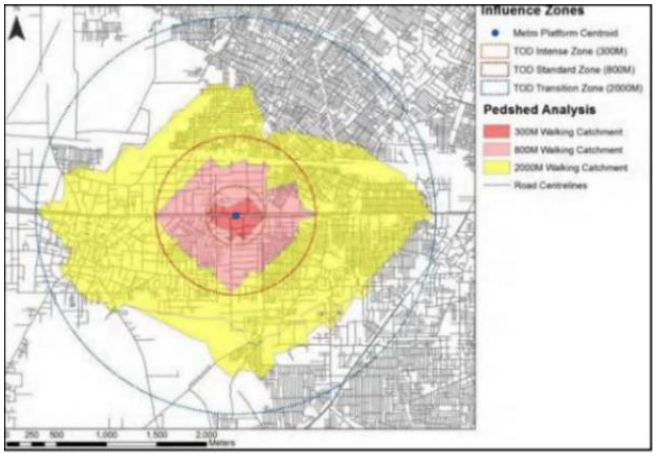

Fig 1 Metro Influence Zone at Hyderabad

A systematic review and descriptive research were carried out to access the land use around the metro station. It is based on primary surveys, land use surveys, in-person interviews including questionnaires. The blocks of flats that are completely and partially within the buffer zone are taken into consideration for the study. Initially, a significant volume of primary data on the nature and characteristics of the land use system was gathered, elaborated on, and illustrated in order to depict the current situation. In order to comprehend and analyse the anticipate the changes occurred in the area during the past 20 years, a Stated Preference (SP) survey was also conducted to the study area's residents. While the questionnaire research is based on sampling, the land use recording covers the entire area under consideration. Using the personal interaction technique, a total of 140 responses were collected.

➢ *Data Analysis:*

The land use survey and questionnaire were conducted between January and April of 2022. The gathered information was added to digital databases. First, a descriptive statistical analysis of each variable was conducted to determine the frequency with which it appeared in the sample. To arrive at few more important survey conclusions, pie charts and bar charts were created. The key findings from the data analysis are presented in this section along with the findings from the land use recording and the accompanying GIS mapping representation. Using tools like Arc Scene and Arc GIS, a buffer of 800 meters was mapped out around the Ameerpet metro station.

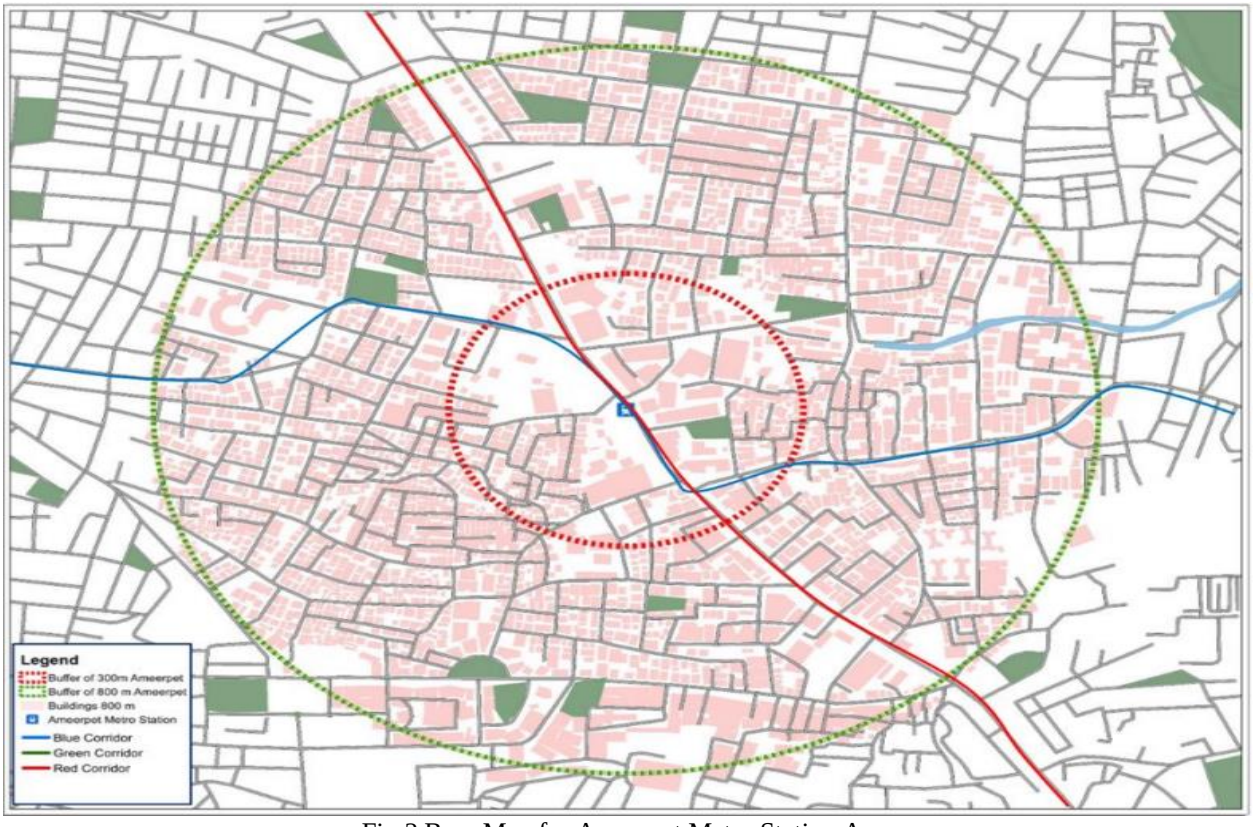

Fig 2 Base Map for Ameerpet Metro Station Area

Based on the TOD intensive zones, the base map features 800-meter and 300-meter buffers. The information obtained is also utilized to identify neighbourhood characteristics including building age, height, and floor-space index. The data regarding FAR is gathered from secondary sources like the master plans and City development plan for Hyderabad.

Utilizing detailed mobility plans and real-time transit data from the Telangana state open-source transit data source, the characteristics of the Hyderabad metro rail corridors were assessed. Also, in order to analyse price variations relating to the selected site neighbourhood and specific land use, the land values from the state revenue department for the past 20 years have also been reviewed.

III. INTRODUCTION TO THE STUDY AREA

As the Hyderabad metropolitan region grows at an exponential rate, transportation issues are becoming more prevalent. Traffic congestion and frequent traffic jams have become a common phenomenon in the core areas, and traffic gridlocks on major corridors are frequent. Recent developments like the International Airport, Outer Ring Road (ORR), Radial Roads, PV Narsimha Rao Expressway, Multimodal transportation system (MMTS), Hardware development park, Special Economic Zones (SEZ's) and the FAB city (Fabrication laboratories) are likely to mould a different travel pattern and distribution of the future population in the metropolitan area; and this was not contemplated in earlier traffic & transportation studies conducted by the REC Warangal, HATS (Hyderabad Area Transportation study) and DMRC for the study of metro rail before implementation of the project (HUMTA, 2015)[19].

The share of HMA's public transport is only at 51.5 percent leaving a big gap to the standard of 80 percent. Worse is that over the past decade this share is reducing at a phenomenal rate. This phenomenon was well recognized in the past and a number of attempts were made to improve public transport system by introducing (i) MRTS Phase – I; and (ii) Increase in the frequency of local buses (iii) MMTS. These enable access to possibilities, encourage urban economic activity, and promote social connection. Additionally, due to the pressure that this city's rapidly expanding population is imposing on its transportation infrastructure, accessibility, land use, and property value have all declined (Radha Krishna, 2015)[20].

- *Growth of Travel Demand in Hyderabad Metropolitan Area (HMA)*

DMRC (2008)[21] provided the foundation for forecasting future travel demand for the HMA. To forecast transportation demand, a four-stage transport planning process was used. This comprises trip generation, trip distribution, modal split and trip assignment. Table 1 shows the per capita trip rates adopted for the years 2003, 2011, and 2021. The increment over base year value has been carried using growth rates as adopted in Chennai, Bengaluru and Delhi for similar studies conducted by DMRC.

It was predicted (HUMTA, 2015) that, in 2003 the observed modal split between public, private, and intermediate public transportation is 45:45:10. With the introduction of the metro, the modal split in favour of public transportation and is expected to increase to 65 % by 2011 and 70 % by 2021.Currently city's transportation requirement is now largely met by bus transport (32%), rail based multi modal transport system (MMTS) (1.5%), Intermittent public transportation& taxi (18%), private vehicles (2 and 4 wheelers) (48.5%) from CTS Hyderabad.

Table 1 Per Capita Trip Rate at Hyderabad after DMRC (2008)

Year	PCTR Value
2003 (Observed)	0.73
2011	0.8
2021	0.90

- *Hyderabad Metro Rail Corridor:*

Hyderabad Metro Rail (HMR) is the world's largest metro rail project in Public Private Partnership (PPP) under a Built-Operate- Maintain-Transfer (BOMT) contract with project cost: 14,132 crores made using "gap funding" by government of India and L&T Limited (Darshit Mehta& Jagath Kumari Dungi, 2021)[22]. The phase-1 of HMR is proposed through three high density corridors. It is an elevated metro rail with modern, high-class metro stations every 1km of the route and are 66 metro stations in total. It is integrated with existing railway stations, the present suburban railway network and bus stations of the city.

The HMR is considered to be an urban rejuvenation and redesign effort to transform Hyderabad into a people-friendly green city with natural ventilation, sky-walks, ramps, & a host of commuter-friendly facilities and have the provision of street furniture, bicycle tracks, walkways & other NMT facilities (Kurup, 2015)[23]. The system is designed to cater to 50,000 Peak Hour Peak Direction Traffic (PHPDT) for Corridors I and III and 35,000 PHPDT for Corridor II (HMRL 2022)[24]. Figure 2 depicts the MRTS alignment at Hyderabad.

ISSN No:-2456-2165

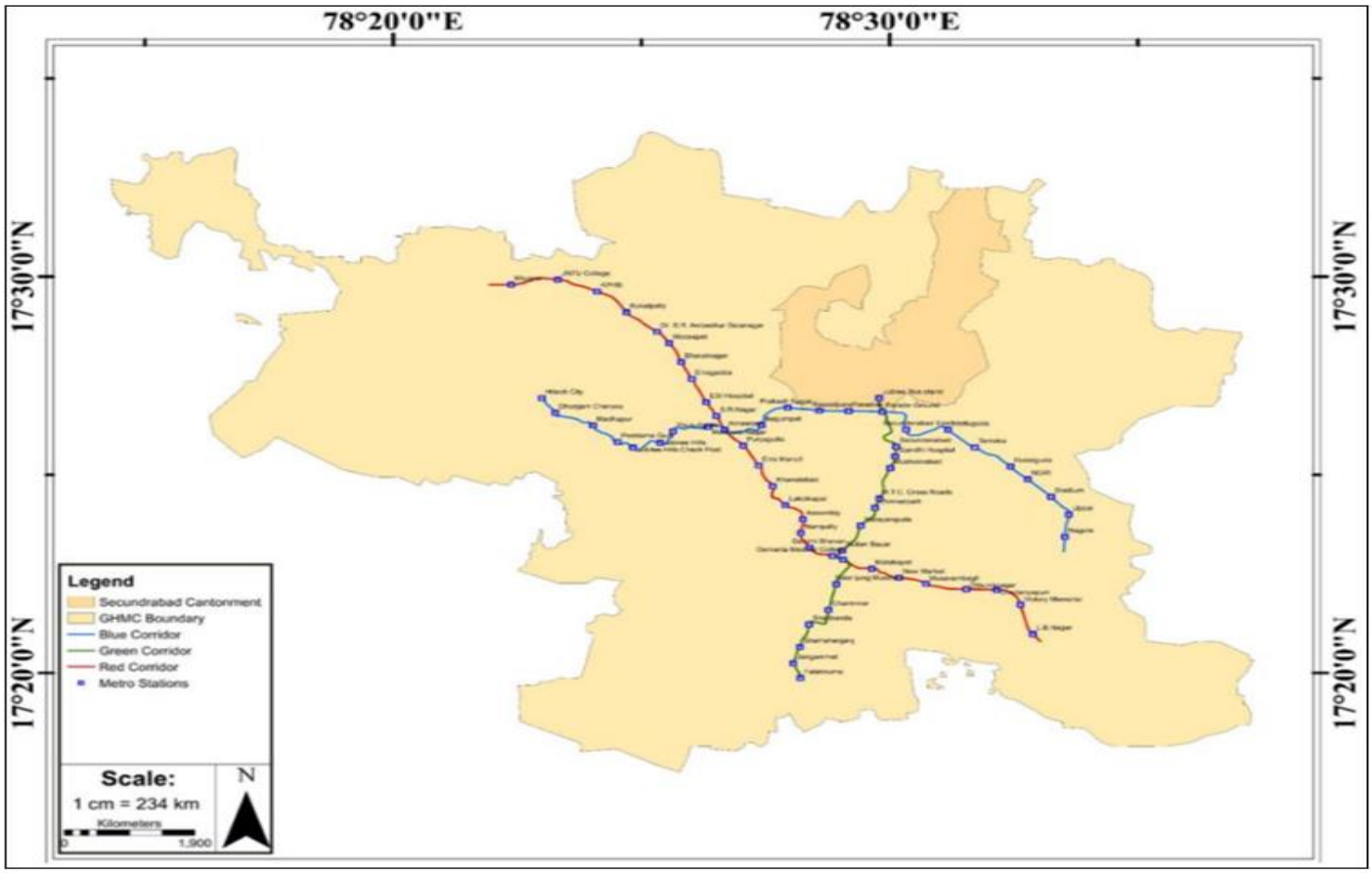

Fig 3 MRTS Alignment at Hyderabad

➢ *The MTRS Corridors that are being Installed in the First Phase (2012 – 2019) are:*

- *Corridor – 1 (RED) [Miyapur – LB Nagar, 29 Kms, 27 Stations]:*

Miyapur – JNTUH – Kukatpally – Balanagar – Moosapet – Bharat nagar – Erragadda – ESI – Ameerpet – Panjagutta - Irrummanzil – Khairatabad – Lakdi ka pul – Aseembly – Nampally – Gandhi bhavan – Osmania medical college – M.G.Bus stand– Malakpet – New Market – Musarambagh – Dilsukhnagar – Chaitanyapuri – Victoria memorial – L.B. Nagar.

- *Corridor – 2 (GREEN) [JBS – Faluknuma, 15 Kms, 15 Stations]:*

Jubilee Bus Station – Secunderabad railway station – Gandhi hospital – Musheerabad – RTC X road – Chikkadpally – Narayanguda - Sulthan Bazar – M.G.Bus Station.

- *Corridor – 3 (BLUE) [Nagole – Raidurg, 28 Kms, 24 Stations]:*

Shilparamam – Hitech city – Durgamcheruvu – Madhapur PS – Peddammatemple – Juilee Hills check post – Jubilee hills road No.5 – Yusufguda – Madhura nagar – Ameerpet – Begumpet – Prakash nagar – Rasoolpura – Paradise – Parade ground – Secunderabad – Mettuguda – Tarnaka – Habsiguda – NGRI – Survey of India – Uppal – Nagole.

➢ *Alignment of Proposed Hyderabad Metro Rail Corridor:*

In 1994, Government of Andhra Pradesh engaged RITES as sub-consultant for introduction of LRT on BOT basis. Three top consortia are short listed after advertisement. However, the attempt failed due to BOT partner wanted major concession and major cost, revenue estimates. In 1999, Japan trades external organisation, carried out a transportation and feasibility studies and recommended MRTS, for the proposed corridors. The following figure 2shows the forecasted transportation demand for the proposed corridors (PPAIF, 2010)[25].

The loading capacities on the proposed metro corridors is: corridor – 1 will have 41,360 PHPDT in 2011 and 49,632 PHPDT in 2021. corridor - 2 will have 15,000 PHPT in 2011 and 31,020 in 2021. corridor – 3 will have 12000 PHPDT in 2011 and 15000 PHPDT in 2021based on the analysis done by the Delhi metro rail corporation (DMRC 2008).

ISSN No:-2456-2165

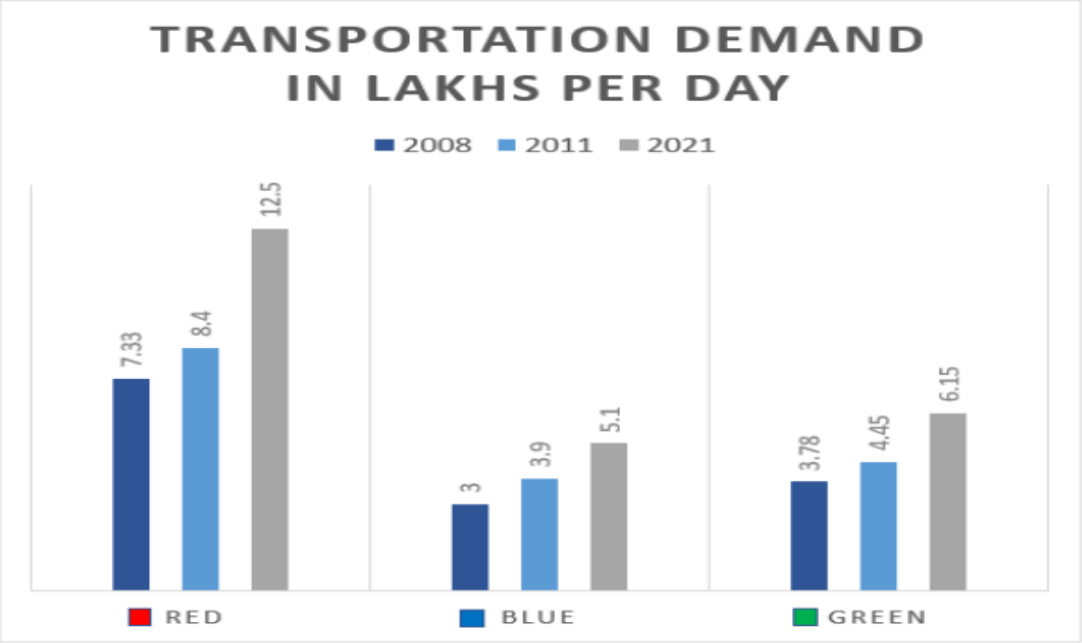

Fig 4 Projection of Transportation Demand

➢ *Metro Corridor and the Buffer Zone Under Consideration*

The metro corridor has been passing through the central business districts and extending to urban fringes for a better connectivity. There are 3 metro interchange stations and 6 metro terminals in phase -1 of HMRL.

Table 2 HMRL Metro Corridors and Interchange Metro Stations

S.no	Interchange Metro Stations	Metro Corridors
A	Ameerpet	L.B Nagar to Miyapur
B	Jubilee Bus Station	Hitech city to Nagole
C	Mahatma Gandhi Bus Station	J.B.S to Falaknuma

It is considered that the impact of metro rail is relatively high in the areas near metro interchange station than other station. The maps show the ward through which metro is passing.

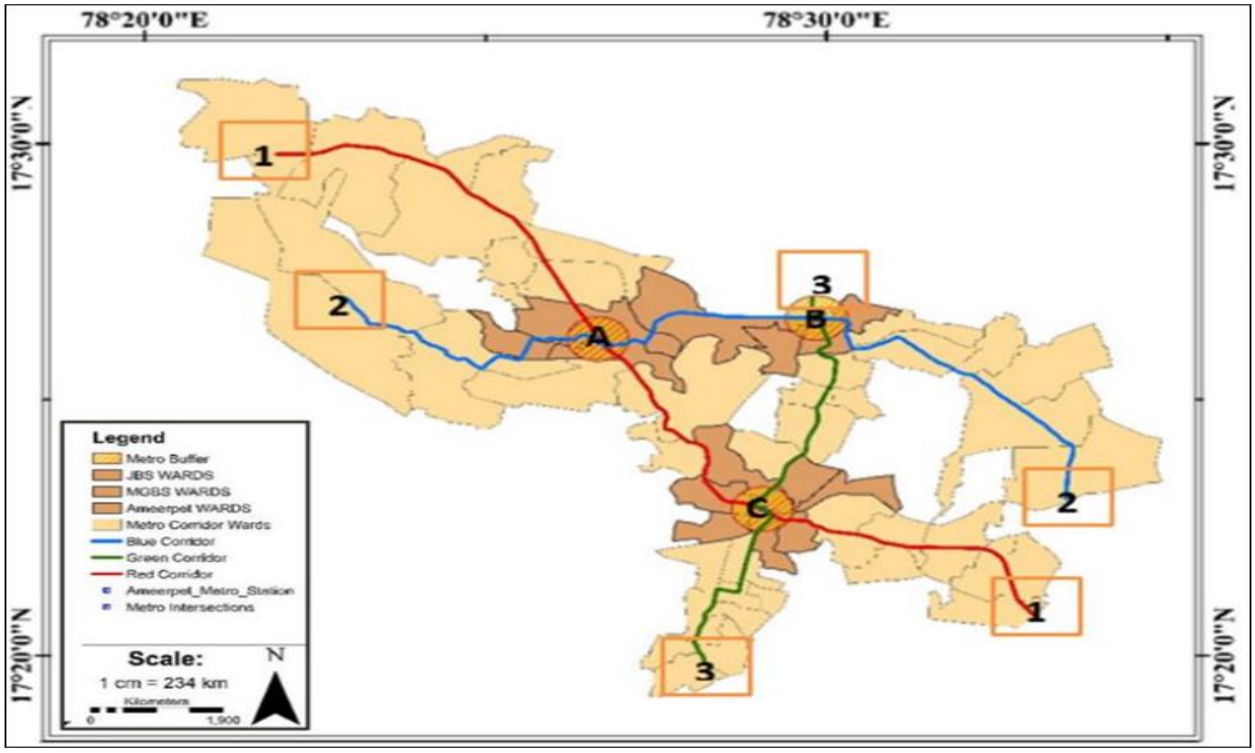

Fig 5 Ward Boundaries Around MRTS Corridors at Phase I with a Buffer of 2000 Meters

ISSN No:-2456-2165

A city has its unique approach for public transit enhancement and way forward for sustainable mobility such as MRTS. The metro rail operates according to the need, requirement of the public and it characterises varies accordingly. One such attempt is made to understand the characteristics of the Hyderabad metro rail using the google real time transit data from the Telangana state open-source transit data source. A total of 900 samples were collected for the duration of 1 year between June 2019 to May 2020. The following statistics also helps to understand the perception and travel demand of the metro rail passengers.

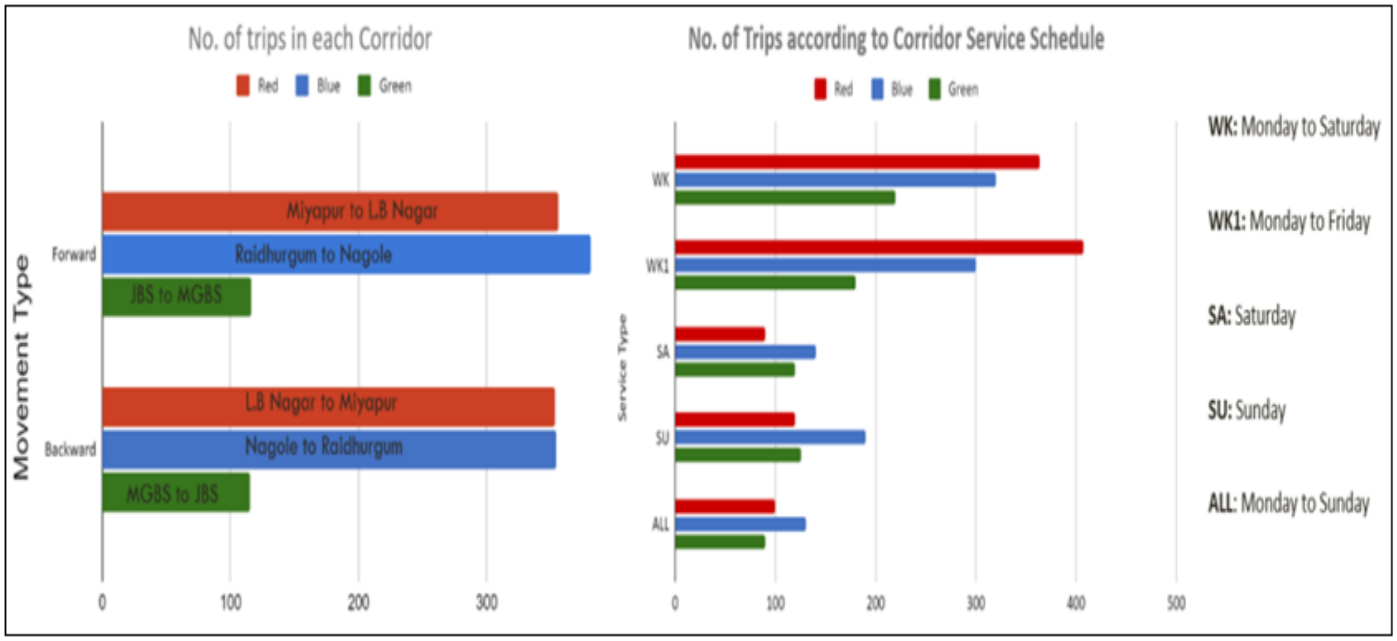

Fig 6 No. of Trips According (i) In each Corridor (ii) According to Corridor Service Schedule

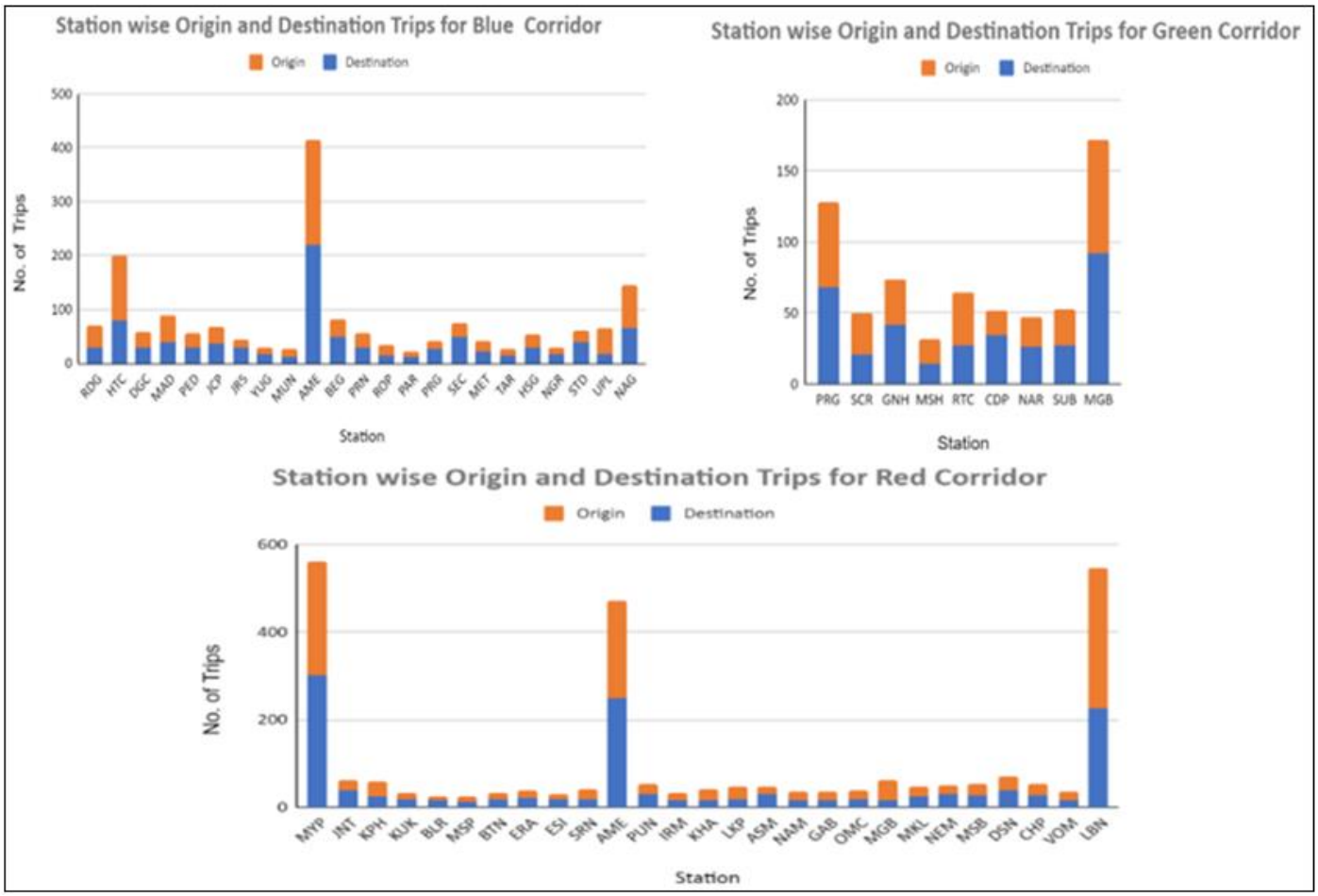

Fig 7 Station wise Origin and Destination for (i) Blue Corridor (ii) Green Corridor (iii) Red Corridor.

The three metro interchange stations are among the major hotspots in the city, improving connectivity to the urban fringes. Each area has unique characteristics making them different among themselves.

- *Ameerpet:*

This is predominantly a mixed and commercial area due to its nearness to the CBD. It has the highest passenger volume count according to the O-D studies. This area has a population density of 53884 person per sq.km and decadal of growth rate of 0.456 % from census year 2011.

- *M.G.B.S:*

This area has a bus terminal for inter and intra state public transportation attracting huge floating population. It has a passenger volume count nearly 60 % of the highest according to the O-D studies. This area has a population density of 65463 person per sq.km and decadal of growth rate of 0.481 % from census year 2011. It is one of the older and core areas of the Hyderabad city.

- *J.B.S:*

It has high to medium density residential areas along with government housing quarters and offices since it connects Hyderabad city to the Secunderabad cantonment. It has a passenger volume count nearly45 % the highest according to the O-D studies. This area has a population density of 42561 person per sq.km and decadal of growth rate of 0.381 % from census year 2011.

IV. RESULTS AND DISCUSSION

Ameerpet metro interchange station is selected among other considering the criteria's such as land use, nearness to CBD, accessibility, land values, population density, mobility pattern from the primary and secondary studies.

➢ *Ameerpet Metro Station Area Profile:*

The Ameerpet inter-change metro station is one of the largest metro stations in India with a sprawling premises over 200,000 square feet (19,000 m^2). This area is the largest commercial hub in Telangana for the training centers and educational institutions. It also a major destination for the shopping and working spaces attracting nearly 2 lakh floating population every day.

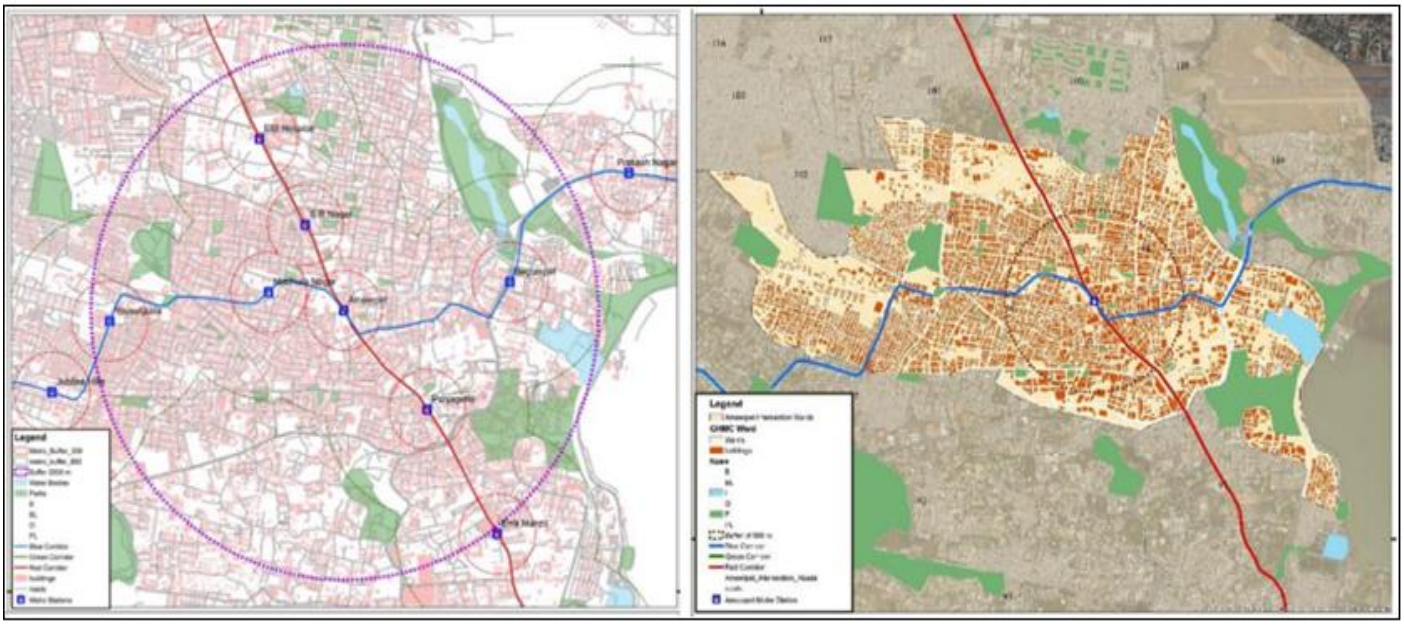

Fig 8 Ameerpet Metro Proximity (i) Ward Buffer of 800-Meter (ii) Buffer of 2000-Meter

It also has residential area with medium to high density residential neighbourhoods. These are mainly of high to middle income housing classes. It has many old buildings constructed in 1990's and are redeveloped and renovated considering the need. This boom for new constructions, amenities has exponentially increased after announcement of metro corridor. There are many educational and training institutions. Presence of several commercial and entertainment anchors in the vicinity through place making strategies attracts huge floating population.

➢ *Land use Analysis:*

From site study, the existing land use of combined commercial, mixed land uses are observed to be nearly equals to predominant residential built-up area in this buffer area (Balakrishnan et al. 2019)[26]. While the percentage of this combined built-up area increases with in the vicinity of 300-meter buffer. There are many government office spaces like HMDA, RBI, BSNL, UIDAI, ICDS within 300-meter buffer, while the commercial and mixed built up are not only across the spines and nodes but even along the sub arterials near to the vicinity.

As per master plan 2031, the major land use proposed in this area is multipurpose mixed land use. Also there have been increase in the road widths which prohibits the increase of setbacks and making it possible for improved FSI standards expecting the state building byelaws.

ISSN No:-2456-2165

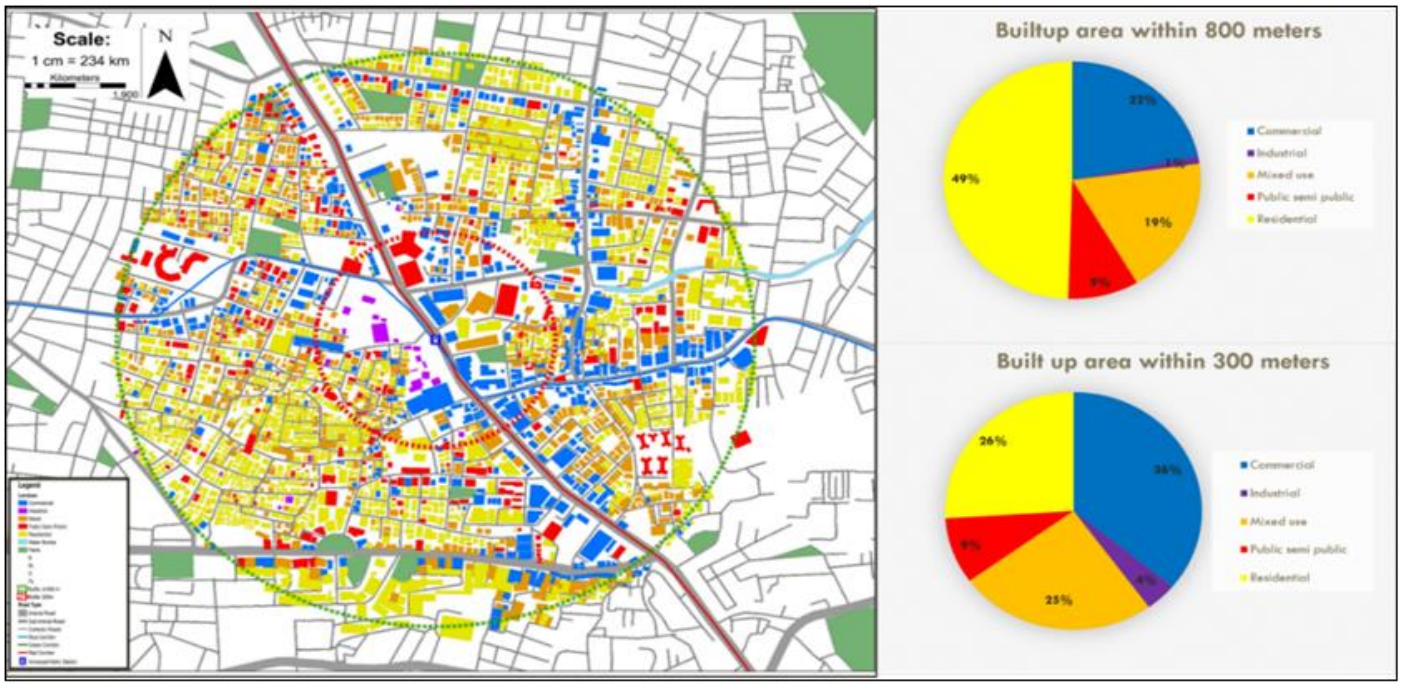

Fig 9 Existing Land use within 800-Meter Buffer

➢ *Land Use- Building Height Analysis:*

The nearly 20 % of the commercial, mixed-use buildings are high rise, were as only 6 % of the residential buildings are high rise more 6 floors and can be seen within 300-meter intense zone. Mixed buildings are having commercial usage up to G+2.

The 4-5 storey residential buildings are built in 1990's and most of them are under redevelopment, this trend of redevelopment is mostly towards high-rise mixed-use buildings. It is been noticed that these mixed-use zones are more of institutional, public semi-public, commercial setup. It can also be seen that the commercial buildings up to 4 floors are mainly shopping malls and multiplexes.

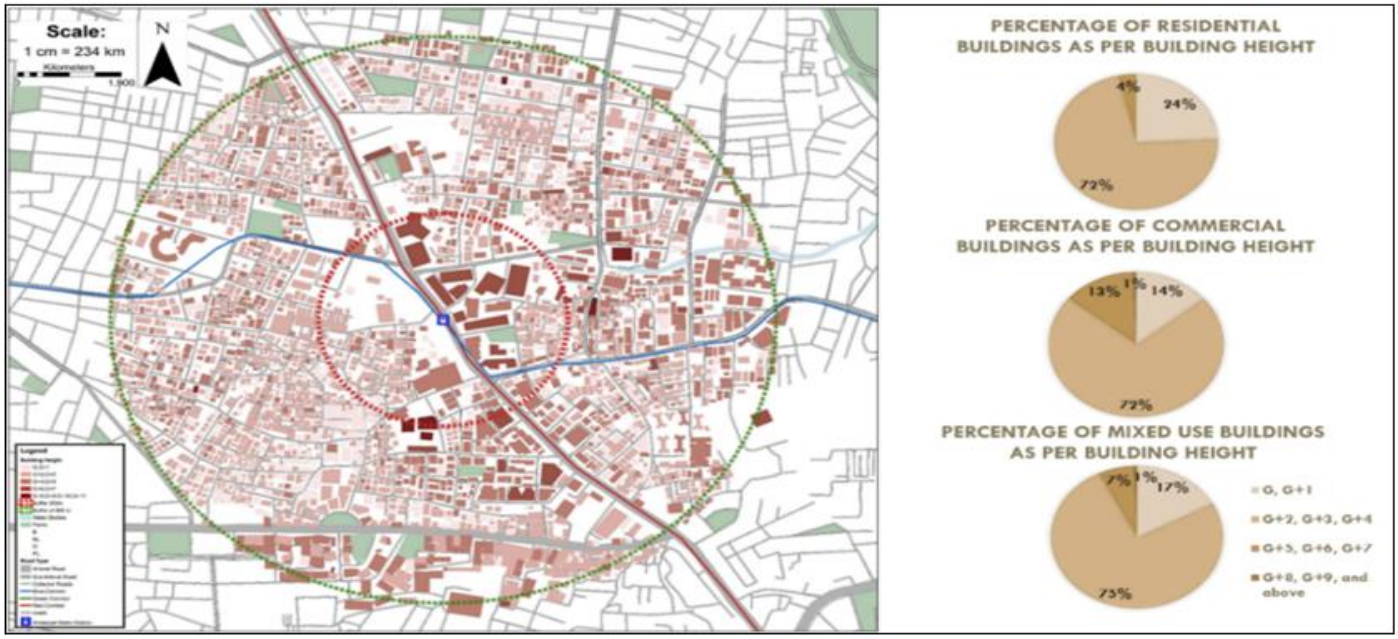

Fig 10 Existing Building Height within 800-Meter Buffer

➢ *Land Use- Building Age Analysis:*

The 34% existing residential buildings are constructed in 1990's and early 2000's. The most of these are the apartments and central government housing quarts. The 80 % of the existing mixed constructed in 1990's are redeveloped according to the current need. The majority of the new buildings constructed under redevelopment are having Ground and G+1 floor as commercial. The 70 % of the commercial spaces available is built in last 15 years, while 35 % out of which are built in last five years.

ISSN No:-2456-2165

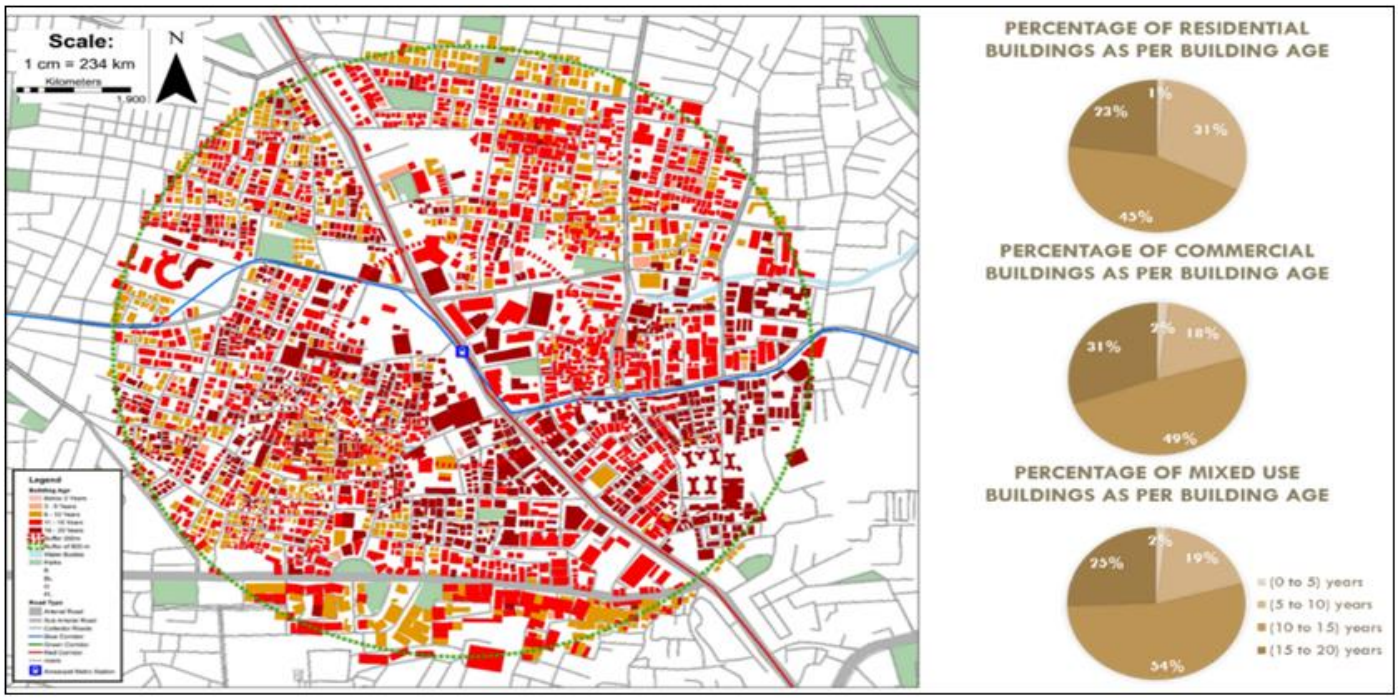

Fig 11 Existing Building Age within 800-Meter Buffer

➢ *Land Value Analysis:*

Land value are more in close vicinity to station, while increment is more as we drift away from metro station. However, this holds true only till a threshold distance of 800 meter. The prices are higher on the southern side of the metro. While highest consistency has been observed in the pots within the buffer of 250 to 500 meter. On northern side, land values are higher between 600 to 900 meters because of common vicinity between multiple stations. While on the southern side, land values are higher between 1000 to 1400meter, which is due to the central business districts factor.

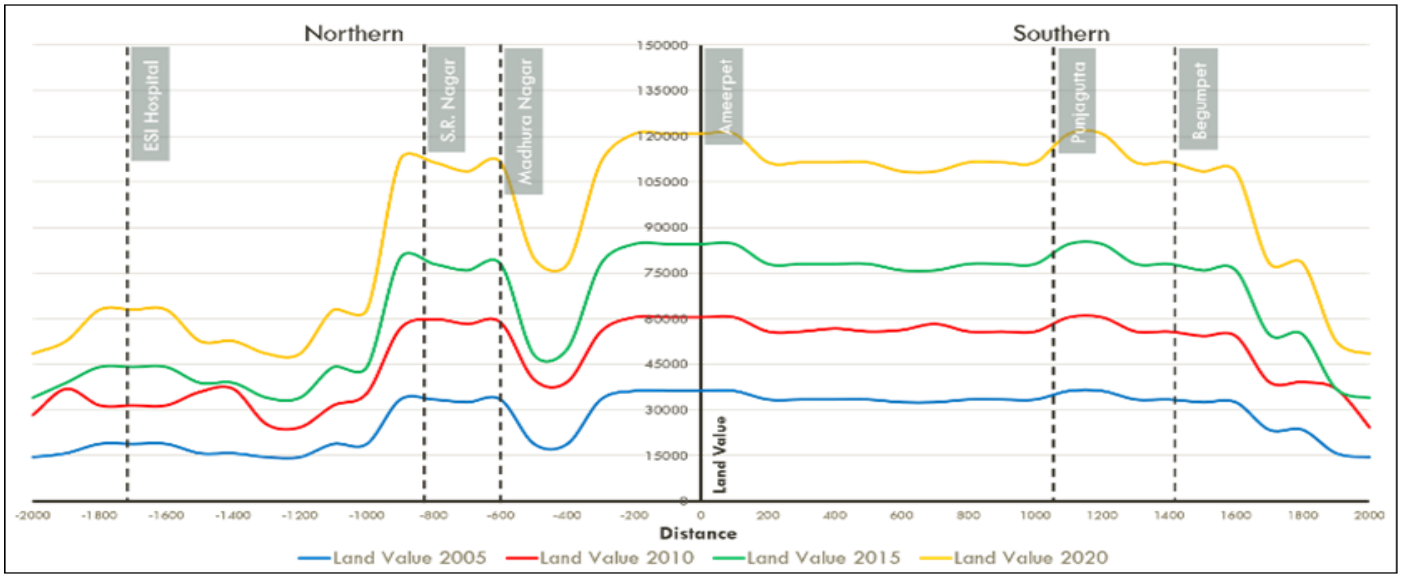

Fig 12 Land Value Variations for the 2000-Meter Buffer

➢ *Envisaged Development:*

The existing situation surrounding the Ameerpet station is not very welcoming since the allowable Floor Space Index as per norms of the HMDA development regulations is 1.7 but the currently existing FSI for residential development is between 2.75 to 2.95 and for commercial, mix use buildings it is between 3.25 to 3.48 and 2.85 to 3.2 respectively.

The reason for such mismatch is because of its strategic location and connectivity. While envisaging development trends for the next 10 years that too after the functioning of Ameerpet metro station, the impact will be immense with more violation of building norms if the proposed development regulations of the development authority is not changed, considering the current growth around the station.

ISSN No:-2456-2165

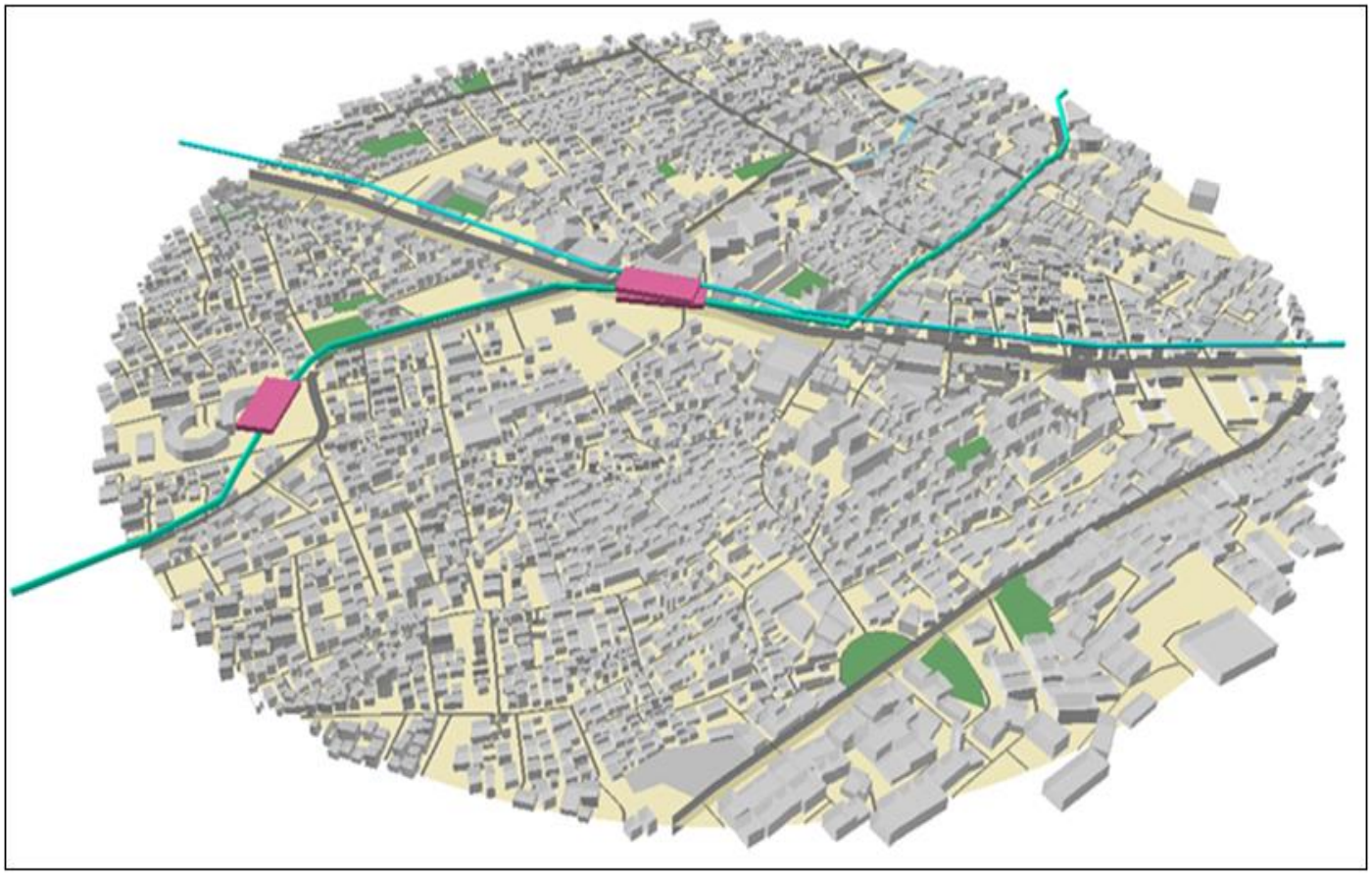

Fig 13 Ameerpet Metro Station 800-Meter Buffer

So, the envisaged development with respect to the built-up area the development regulations are worked out on setback requirements. It is based on the set back requirements given for the multi storied buildings to the other parts of the city. The details of which are shown in Tables 2 and 3.

Table 3 Proposed Development Regulations based on Minimum Setback for Residential use

Plot Size	FSI	Minimum setback	Built up area	Floors	Height
Up to 250 sq. m (12.5 m X 20 m)	1.9	1.5 M	9.5 X 17 = 162 sq. m	3	10.0 M
Up to 500 sq. m (20m X 25m)	2.4	2.5 M	15 X 20 = 300 sq. m	4	12.0 M
Up to 750 sq. m (25 m X 30 m)	3.5	3 M	18 X 24 = 432 sq. m	6	16.0 M
Up to 1000 sq. m (40 m X 25 m)	3.8	4 M	32X 17 = 544 sq. m	7	20.0 M
Up to 1200 sq. m (30 m X 40 m)	4.0	5 M	20 X 30 = 600 sq. m	8	22.0 M
Up to 1600 sq. m (40 m X 40 m)	4.8	6 M	28 X 28 = 784 sq. m	10	27.5 M
Up to 2000 sq. m (50 m X 40 m)	5.0	8 M	34 X 24 = 816 sq. m	12	33.0 M

Table 4 Proposed Development Regulations based on Minimum Setback for Commercial and Mixed use

Plot Size	FSI	Minimum setback	Built up area	Floors	Height
Up to 250 sq. m (12.5 m X 20 m)	2.3	1.8 M	9 X 16.4 = 148 sq. m	4	12.0 M
Up to 500 sq. m (20m X 25m)	2.7	3 M	14 X 19 = 266 sq. m	5	14.0 M
Up to 750 sq. m (25 m X 30 m)	3.2	4.5 M	16 X 21 = 336 sq. m	7	19.5 M
Up to 1000 sq. m (40 m X 25 m)	4.0	5 M	30 X 15 = 450 sq. m	9	25.0 M
Up to 1200 sq. m (30 m X 40 m)	4.6	6 M	18 X 28 = 504 sq. m	11	30.5 M
Up to 1600 sq. m (40 m X 40 m)	5.0	7.5 M	25 X 25 = 625 sq. m	13	36.0 M
Up to 2000 sq. m (50 m X 40 m)	5.2	9 M	32 X 22 = 704 sq. m	15	42.0 M

FSI to residential areas is allowed provided the minimum flat size is 60 sq. m, with no car parking facility. An increase in FSI is given for the commercial establishment as more violations are found only in the commercial spaces. According to Hyderabad's zoning and development regulations, multiple uses will be permitted on the selected site area as an incentive in the transit-oriented development zone on a plot of at least 2000 square meters.

ISSN No:-2456-2165

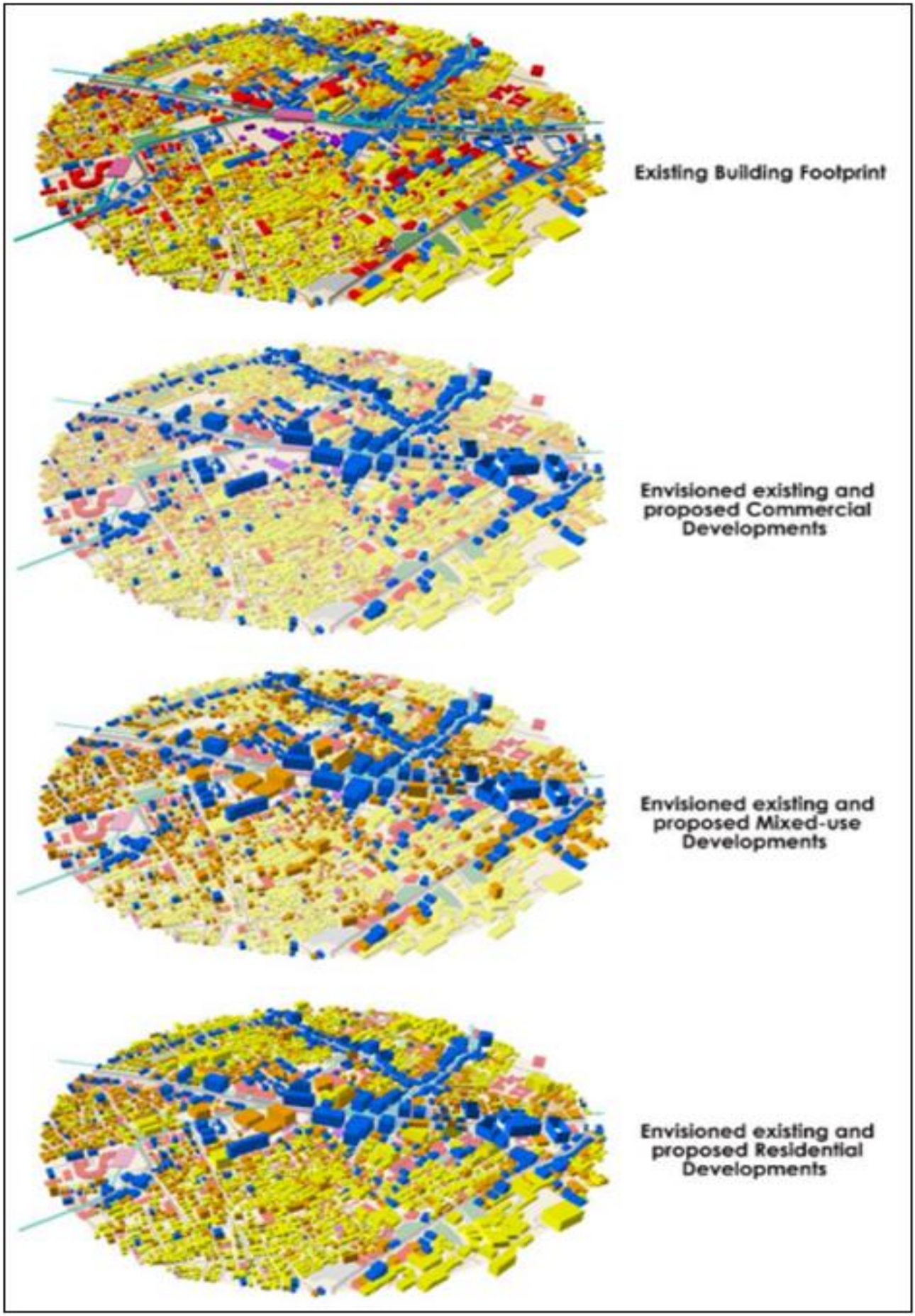

Fig 14 Envisioned Existing and Proposed Developments based on Improved FSI Standards

V. CONCLUSION

In this paper, the objective was to examine the expected impact of the existing metro line of Hyderabad and Ameerpet station in particular, on the land use of the area. This was accomplished by analysing the land use system statistically and by conducting a stated preference survey. The acquired data were analysed using GIS mapping, and the categorical data showed interesting inter-relationships that were previously described. The first 300 meters along the stations are where the metro's effects are most prominent. Each stations have different physical ranges of effect that varies from 800 meter to 2000 meter. The preferred type of land use immediately around the station is that of commercial and mixed-use developments. For which if the above-mentioned development regulations need to be followed meeting setback, FSI requirements, then development will be as envisaged. The kind of development and density regulations along the metro corridor are not mentioned in master plans. The current plan does not take consideration for high rise development along the metro corridor, which is necessary to revitalize the neighbourhood around the station. This proposed development will also necessitate supporting infrastructure such as water, sanitation, and electricity, as well as the widening of existing roads, will further enhance the growth of the area. The Ameerpet station and its surrounding areas will become a better place to live with the addition of all of the above-mentioned amenities. Similarly, all 66 existing stations along the Hyderabad metro rail corridor can be brought under planned and regulated development for the better quality of living of Hyderabad citizens.

REFERENCES

[1]. Sarkar, A. (2018). New Indian Urbanism: Emerging Issues on Sustainability and Urban Ecology, European Journal of Sustainable Development, 7 (3): 381-386. Doi: 10.14207/ejsd.2018.v7n3p381. Available at: https://www.researchgate.net/publication/354248918_New_Indian_Urbanism_Emerging_Issues_on_Sustainability_and_Urban_Ecology [Last accessed Dec 29 2022].

[2]. Aravantinos, A. (2000). Urban planning: Towards a sustainable development of the built environment, Symmetric Publications, Athens.

[3]. Cervero, R., & Kang, C. D. (2011). Bus rapid transit impacts on land uses and land values in Seoul, Korea, *Transport Policy*, 18 (1): 102-116.

[4]. Coleman, P. J. (1993). Dallas aea rapid transit Impact Study: A framework for assessing land use and development impacts, Southwest Region University Transportation Center. 1993

[5]. Hess, D.,B. & Almeida T.,M. (2007). Impact of proximity to light rail Rapid transit on station-area property values in Buffalo, New York. Urban Studies.vol. 44, no. 5 – 6, p. 1041 – 1068.

[6]. Gibbons, S. & Machin, S. (2004). Valuing Rail Access using Transport Innovations. Centre for economic performance, London School of Economics and Political Science. Available at: eprints.lse.ac.uk/19989/1/Valuing_Rail_Access_Using_Transport_Innovations.pdf [Last accessed Dec 29 2022].

[7]. Kundu, D. and Ray, T K. (2014). Impact of Extended Kolkata Metro Railway on its Surroundings and Commuters a case study from Tollygunge - New Garia, West Bengal, India, *Indian Journal of Spatial Science*, 5(2): 62-69.

[8]. D. Karthigeyan. and Sheeba Chander. (2020). Developmental Impact of Metro Station in its surrounding Land Use – A Case Study of Chennai Metro Rail Corridor. *International Journal of Advanced Research in Engineering and Technology*, Volume 11, Issue 4, April 2020, P. 92-99. Available at: https://iaeme.com/MasterAdmin/Journal_uploads/IJARET/VOLUME_11_ISSUE_4/IJARET_11_04_011.pdf

[9]. Geetesh Malhotra. and Virendra Kumar. (2022). Impact of Metro Rail Transit System on Residential Properties. *International Journal of Creative Research Thoughts,* Volume 8, Issue 5 May 2020, P. 1540. Available At: Https://Www.Ijcrt.Org/Papers/Ijcrt2005204.Pdf

[10]. Ar. Anjani Kumar Singh. and Ar. Mahima Thussu. (2022). Impact Of Metro Station on Surrounding Land Use: A Case Study of Bangalore Metro Rail Corridor. *Journal of Emerging Technologies and Innovative Research.* Volume 9, Issue 6, June 2022, p. 446 - 454. Available At: Https://Www.Jetir.Org/Papers/Jetir2206854.Pdf

[11]. Li Shan Su, & Tzu-Ling Chen (2022). Exploring the Spatial Impact of MRT Gentrification by Different Processes: Taipei City MRT Station. *International Conference on Urban Development, Regional Planning and Information Society*. pp. 947-952. Available At: https://archive.corp.at/cdrom2022/papers2022/CORP2022_128.pdf.

[12]. Rashmi Ashtt. (2009). Impact of Mehrauli-Gurgaon MRT Corridor and Strategies of Development. Institute of Town Planners, India. Vol, Journal 6 - 4, p. 82 - 93. Available At: https://www.itpi.org.in/uploads/journalfiles/oct2-2009.pdf.

[13]. M.Vani, and M. Kamraju. (2018). A study on growth and distribution of population in Hyderabad city. *Academia*. Available at: www.academia.edu/38724296/A_Study_on_Growth_and_Distribution_of_Population_in_Hyderabad_city.

[14]. Cao, X and Porter-Nelson, 2016. Real estate development in anticipation of the green line LRT in St.Paul, Minnesota. *Journal of Planning Educaation and Research.* Vol – 38, Issue – 4. Availabl at: https://doi.org/10.1177/0739456X17707811.

[15]. Vincent Chakoura & Naveen Elurua (2013), Examining the influence of urban form and land use on bus ridership in Montreal, Procedia - *Social and Behavioural Sciences, 2nd Conference of Transportation Research Group of India.*
[16]. Pol, Peter M. J. (2002), "The Economic Impact of the high-speed train on urban regions, Austria. *European Regional Science Association, 2002.*
[17]. National Transit Oriented Development (TOD) Policy 2017. *Ministry of Housing and Urban affairs, Government of India.*
[18]. UTTIPEC (2012). Transit Oriented Development. *Delhi Development Authority*, New Delhi, December, 2012, p. 3 – 4. Available at: http://uttipec.nic.in/ upload/uploadfiles/files/5320760375.pdf, [Last accessed Dec 29 2022].
[19]. HUMTA (2015). *Comprehensive Transportation Study.* Retrieved from Hyderabad Metro Developement Authority. Available at: www.hmda.gov.in/cts/, [Last accessed Dec 29 2022].
[20]. Radha Krishna. (2015). *Impact of MRTS on urban land: Case study o Delhi.* Roorkee: Department of Architecture and Planning, Indian Institute of Technology, Roorkee. P. Available at: shodhbhagirathi.iitr.ac.in:8081/jspui/image/pdf/web/ viewer.html?file=/jspui/bitstream/123456789/13837/ 1/G24838.pdf, [Last accessed Dec 29 2022].
[21]. DMRC (2008). Hyderabad metro rail executive summary of detailed project report (DPR). *Delhi Metro Rail Corporation.* Available at: hmrl.co.in/PDF/executive-summary.pdf, [Last accessed Dec 29 2022].
[22]. Darshit Mehta, Jagath Kumari Dungi. (2021). PPP for metro project: A case study of Hyderabad metro. *International Journal of Recent Technology and Engineering (IJRTE).*vol-10, Issue-2, July 2021, p. 51 – 52. Available at: www.ijrte.org/wp-content/uploads/papers/v10i2/A59210510121.pdf, [Last accessed Dec 29 2022].
[23]. Kurup, Rajmohan. (2015). Hyderabad metro: Redefining the City. *Traffic Infra Tech.* Available at: hmrl.co.in/articles/Trafficinfratech.pdf
[24]. HMRL (2022). Hyderabad Metro Railway Limited website. https://hmrl.co.in/project-description.html #:~:text=The%20three%20corridors%20spanning%2 0a,%3A%2028%20kms%3B%2024%20stations. [Last accessed Dec 29 2022].
[25]. PPIAF. (2010). Public private partnership projects in India - Compendium of case studies. *World Bank*, p. 121 – 124. Available at: www.pppinindia.gov. in/toolkit/pdf/case_studies.pdf, [Last accessed Dec 29 2022].
[26]. Bala Kishan, A., Ali,M. A. and Kamraju, M. (2019). Impact of urban growth on land use - land over in Hyderabad city. *Journal of Emerging Technologies and Innovativ Research (JETIR)*, May 2019, vol 6, Issue 5. Available at: https://www.jetir.org/papers/ JETIR1905945.pdf, [Last accessed Dec 29 2022].