

Impact of Metro on Urban Morphology and Para Transport System of Hyderabad

Gowni Pranay Kumar

Department of Urban Planning, Lovely Professional University, Phagwara, Punjab, India

Corresponding author: [pranaypintu28\[at\]gmail.com](mailto:pranaypintu28[at]gmail.com)

Abstract: *Metro rail was created as a rapid transport system to improve connections, provide a more pleasant travel experience, and reduce commute times. The introduction of metro rail in Hyderabad is seen as a 'coming of age' in the city's transformation into a world-class city, resulting in increased demand for it as a mode of transportation in the city. The metro is anticipated to be a green and structurally sound mode of urban transportation, with the primary purpose of reducing traffic congestion by encouraging people to take public transportation. Metro rail helps to divert a substantial amount of current passengers carried from the road toward the metro, as well as fulfill a portion of future passenger demand. The influence of colonialism and globalization on Hyderabad's urban morphology will be studied in this research. The urban morphology hypothesis gives a lens through which to examine history in order to determine how it has shaped a city's shape and size. It begins with the city plan and follows how it has changed over time, along with how the city has changed in relation to the current plans and socioeconomic realities. The major goal of the research paper is to investigate the role of the Hyderabad metro rail in urban development, with a focus on safety, convenience, time savings, inclusion, and equity among people. Hyderabad's metro train system is the largest public-private partnership project in the world. The study paper examines how Hyderabad's metro rail system connects to several metropolitan corridors for greater efficiency and connectivity to the city's outskirts. The research also looks at how the introduction of metro rail in Hyderabad has affected the paratransit system and its income. Metro rail, for example, pushes the city to become more sustainable, but it also raises a variety of challenges, such as traffic congestion. This study investigates people's traffic problems throughout the metro building era.*

Keywords: colonialism, corridors, globalization, rapid transport system, public-private partnership, Sustainable, Para Transit system, urban morphology.

1. Introduction

With a land area of 650 sq. km, Hyderabad is a megacity. 950 km² of municipality space and kilometers of the urban environment. In 2015, it would have an estimated population of around 8.5 million people, which is expected to increase to 10.4 million by 2022. Nearly three million customized vehicles travel the streets of Hyderabad at every given time, yearly twenty million automobiles pass through.

Every day, A total of 8 million motorized journeys are planned, but only about three million of these are made utilizing public transit. As a result of the substantial use of individual mobility, the municipality faces a number of challenges such as traffic congestion, bottlenecks, high pollution levels, and much-increased fuel consumption.

Urban morphology of human settlements, their form and the processes that lead to their formation and evolution. The term "urban morphology" refers to a system for systematically and thoroughly describing the built environment. The Convention school of thought started with a look at city plans. To evaluate urban morphology, three components of analysis are required: the town plan, building form patterns, and land-use patterns.

In recent times, it was established that a city's transport network seems to have a direct impact on its population's mobility, security, and health. India's urban transportation growth has proved to be a challenging task. That's also partly related to cities growth and until recently, to state and national government's misguided support of private mobility.

The Hyderabad Metro Rail Project, often known as HMR, is a new metro line that aims to enhance the livelihoods of city dwellers. The metro is planned to be a green and structurally sound form of urban transportation, with the primary objective of decreasing traffic congestion by continuing to take public transportation. By creating a feeling of order and hygiene, as well as allowing the cross expansion of a diverse city, metro rail will dramatically change our cultural environment

2. Research Objectives

- To investigate the spatial changes that occur in Hyderabad, determine the exact change over time.
- What socio-demographic profile is served by the metro rail?
- What role does the metro play in reducing urban congestion?
- Researching the current state of the demand for public transportation Metro Rail in Hyderabad.
- Research the past and current state of Hyderabad's urban transportation system.
- To determine the influence of Metro Rail operations on Hyderabad's paratransit holders.

Urban Morphology

The urban morphology provides a thorough knowledge to evaluate history in order to determine how it has shaped a city's size and shape. The urban build-up, often known as urban extent, is a key statistic for measuring urban sprawl. The purpose of LULC change assessment is to gain a clearer understanding of dynamic land changes. Land cover change evaluation utilizing remote sensing data provides necessary

to comprehend the ongoing problem of urban sprawl. The phrase "land usage" refers to the manner in which land is managed.

The study of urban morphology, in especially, focuses on the observed movement between north-south and east-west directional morphology, as well as the causes of this transition. The hugenumber of mixed pixels makes urban remote sensing tricky.

Peri-urbans are forming on the edges of large urban cores, within a manageable commute of the metropolis, on a regular basis. The periurban area, which has in Hyderabad is the result of informal planning practices, is characterized by mixed land use. Grey region informal planning techniques produce problems in the peri-urban region. The Hyderabad Municipal Development Authority (HMDA) is assessing the extent and structure of the urban area, as well as the pace of change, across the study period.

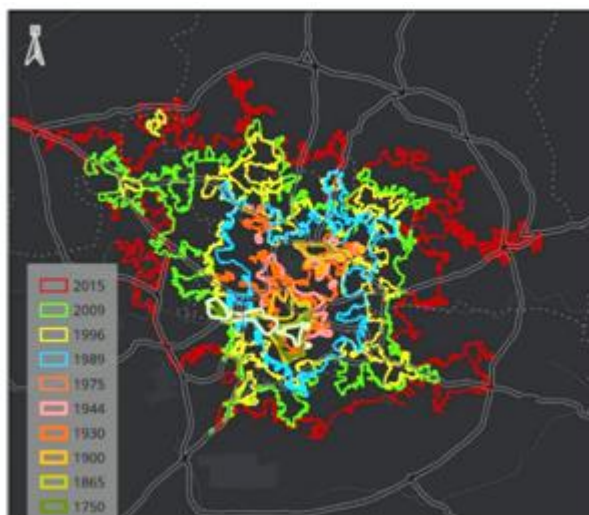


Figure 1: Urban sprawl map from 1750-2015

The plan foresees a shift in urban growth towards the city's western outskirts, Hyderabad 2031 is guided by seven guiding principles developed from global planning theory and experience. Many people believed that the seven fundamental themes were transit development, urban development boundary, outer areas expansion, delivery of goods, and ecologically becoming significant.

The Hyderabad metropolitan region's population is nine million, with a significant rise to sixteen million by 2031. The concept of various nuclei is proposed to help disperse stress from middle or main nuclei to a larger area. The urban-rural continuum refers to the progressive shift in urban development intensity from the city core to the outskirts. An inflow of residents living in the city core would be too much for the city to handle. The inner-city continuum approach tries to plan development with the assumption that the urban-rural periphery will continue to be a transition zone among rural communities and urban districts.

The most prevalent tool for environmental preservation is zoning. Previous corridors may need to be built with such a green zone to safeguard residential communities from

pollution issues. Industrial zones are constructed in such a way that adequate treatment facilities can be clustered together to conserve money on infrastructure. Hyderabad encompasses the region. The development plan covers the city Centre, the fringe, and the enlarged rural region.

Spur and Interest of metro rail explaining shift of the mode:

The Hyderabad metro provides travelers with a range of physical and conceptual benefits to switch from their previous mode of transportation. In this section, we'll look at a few of those tangents and interests.

1) Cost

Cost is the primary and most important element that determines transportation system selection in overall, and especially in urban centers. When compared with other methods of transportation, metro rail strives to make transportation more inexpensive. It's impossible to ignore the reality that switching from private transportation like private cars to metro rail saves money on vehicle ownership. According to studies, the total route price, which incorporates metro and feeder fees, has risen. The metro's implementation will reduce carbon emissions to some extent by replacing electricity for petrol and diesel, as well as relieve traffic road congestion. In terms of environment and health, the public will gain from lower pollution levels.

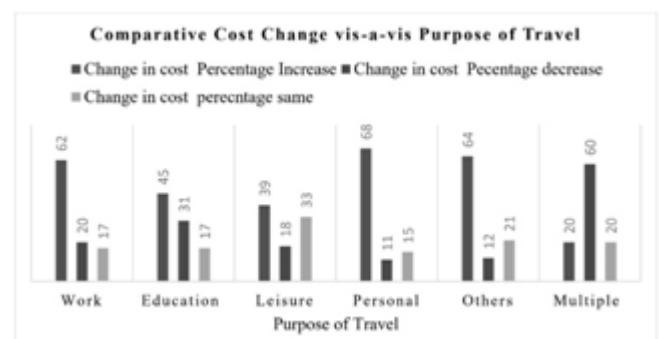


Figure 2: Cost comparisons based on the reason of trip

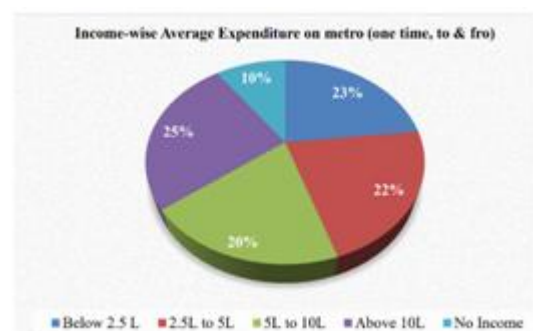


Figure 3: Average Expense by Income in relation to Trip Purpose

2) Connectivity

The metro requires less time than other forms of transport.

3) Convenience

- Reliable and Secure Travel
- Mental and Physical Health

Who does the Metro Serve?

The HMRL, DMRC, and some other metro railway lines were still not developed for a single type of customer, but they do tend to cater to a particular socioeconomic class. Our poll backs this up to a significant extent. What drives the aspiration class and middle and upper classes to select metro amenities over other means of transport and some other classes which don't have access to it, such as the middle class, is the greater question.

Is it possible to rely on HMRL to give a solution to the looming 'Urban Traffic Congestion'? It could be good to look at the link between road congestion and higher customer use of metro trains. Despite the small sample size of our survey, this suggests that train services may have an impact on commuter behavior when transferring from another mode of transportation.

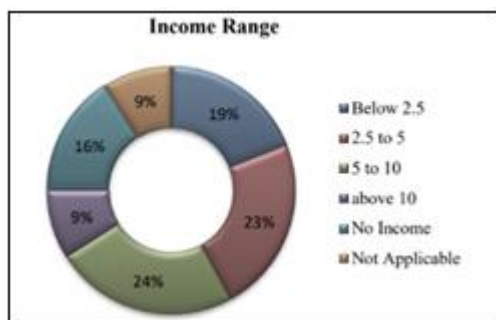


Figure 4: The Commuter's Income Range

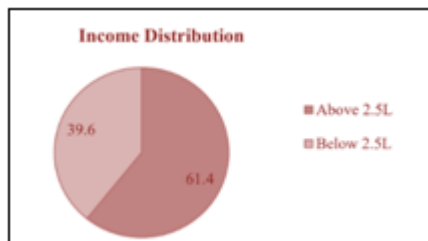


Figure 5: Below 2.5 lakh rupees and above 2.5 lacs

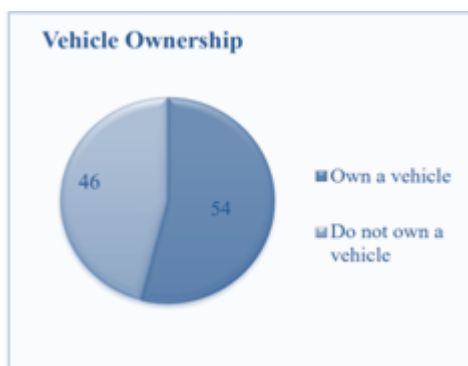


Figure 6: Vehicle's ownership

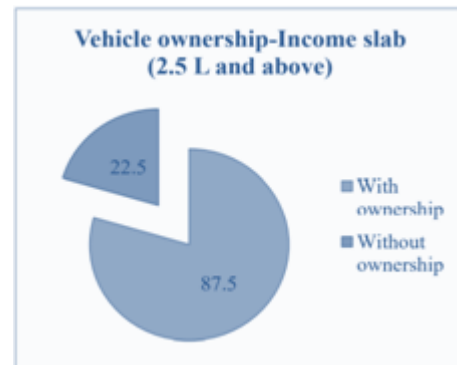


Figure 7: Income and Vehicles Ownership

62 percent of the clientele, for example, earn and over 2.5 lakh annually. In 88 percent of all situations, commuters have their own vehicle. Surprisingly, despite having a car, a large section of the clientele chooses to use the mass transit system.

This is evident from the start in Hyderabad. The Hyderabad Metro's maximum fare is Rs 60, which really is semi, and this unpleasant situation drives many customers away from the metro, diminishing its customer base.

Vision

The purpose of a Hyderabad Metro Rail network is to revitalize the city by revamping routes and modifying how people travel from one end to another end. The system is constructed so that each terminal is only one kilometer apart, ensuring that everyone can use the metro. However, when it comes to implementation, there are significant flaws in the HMR project. This section addresses the challenges of end to end connection as well as government transportation.

- 1) Metro and Income level.
- 2) Feeder transport and last-mile connectivity

Past Traffic Condition before Commencement of Metro Rail

Traffic surveys were conducted in Hitech City area in Hyderabad, to determine the necessity for grade separation just at an intersection, as well as for the road network of flyover projects and metro development.

For the specified signalized intersection in Hitech City, a video study is conducted at the intersection and 800 meters distant, stretching to 200 meters. For this 200m, the free flow, congestion density, freeflow speed, and the speed density correlation, were calculated.

Traffic Characteristics for Road Stretch:

The footage was captured on Jan 20, 2021, to calculate the variety of automobiles available at the Hitech city-junction, Considering the performance of a 200-meter road at an approximate distance of 800meter from a signal for traffic

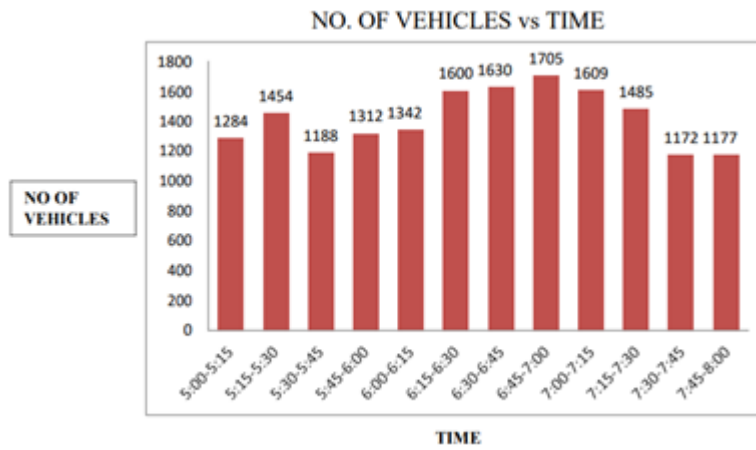


Figure 8: The graph above depicts the number of automobiles in a 15-minute span

Table 1: Before the metro, there were several sorts of vehicles in various time scenarios.

TIME	2 WHE	A-3	A-4	C/J/V/T	Mini		Mini		Tractor		Cycle	TOTAL
					BUS	LCV	LCV	Tractor + Trailer				
5:00-5:15	745	96	153	164	8	61	46	9	0	0	2	1284
5:15-5:30	985	103	94	138	6	53	51	24	0	0	0	1454
5:30-5:45	659	152	83	196	9	49	26	14	0	0	0	1188
5:45-6:00	752	128	153	173	5	42	48	11	0	0	0	1312
6:00-6:15	852	135	141	139	13	26	23	13	0	0	0	1342
6:15-6:30	1085	142	139	143	4	38	42	7	0	0	0	1600
6:30-6:45	1129	101	129	186	8	49	21	6	0	0	1	1630
6:45-7:00	1043	176	149	206	7	71	53	0	0	0	0	1705
7:00-7:15	996	143	119	249	10	49	41	2	0	0	0	1609
7:15-7:30	883	184	98	218	1	58	36	7	0	0	0	1485
7:30-7:45	726	126	83	173	0	21	29	13	0	0	1	1172
7:45-8:00	803	109	21	143	6	39	39	17	0	0	0	1177
TOTAL	10658	1595	1362	2128	77	556	455	123	0	0	4	

NO OF VEHICLES Vs TIME DURATION (FOR PEAK HOUR)

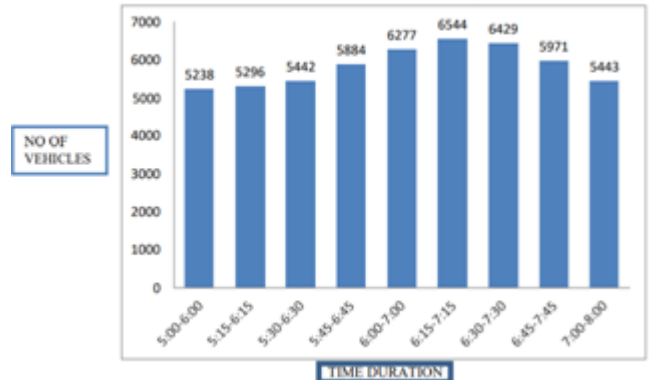


Figure 10: Graph shows Time duration to the number of vehicles

NO OF VEHICLES Vs SPEED OF VEHICLES

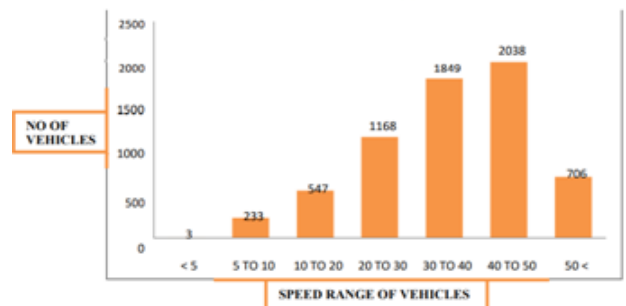


Figure 11: Graph shows speed range of the vehicles to number of vehicles

NO. OF VEHICLES Vs TYPES OF VEHICLES GRAPH

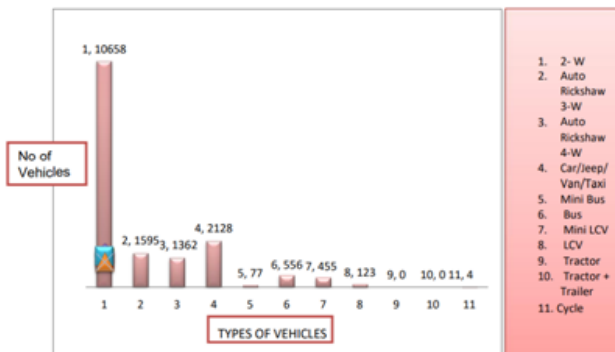


Figure 9: The graph depicts the ratio of vehicle numbers to vehicle kinds

The speed and density graph was essentially a linear line, thus the calculation was done using Greenshields' macroscopic stream model's calibration technique. To utilize this approach for any stream of traffic, the boundary data, particularly the freeflow speed and congestion density must be obtained. This must be gathered by a field survey, which is referred to as the calibration procedure. Although true free flow flow speed and congestion density cannot be determined directly in the field. they can be estimated using linear relationship. The equation $y = a + bx$, where y denotes density k & x denotes speed v .

$$a = \bar{y} - b\bar{x}$$

$$b = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^n (x_i - \bar{x})^2}$$

NO OF VEHICLES	AVG SPEED	(xi - x)	(yi - y)	(xi - x)(yi - y)	(xi - x)2
575	35.94	101.5714286	4.39142857	446.0436735	10316.7551
781	30.49	307.5714286	1.05857143	-325.586327	94600.18367
349	43.59	-124.4285714	12.0414286	-1498.29776	15482.46939
276	49	-197.4285714	17.4514286	-3445.41061	38978.04082
953	20.54	479.5714286	11.0085714	-5279.39633	229988.7551
380	41.28	-93.42857143	9.73142857	-909.193469	8728.897959
473.4285714	31.54857143			-11011.8408	398095.102
X	Y				

B = -0.0276, A = 44.64

Then $v = 44.64 - (0.0276)k$

Where v = velocity and k = density

As a result, we have Free Flow Speed (V_f) is 44.64 km/hr.

Congestion density = 1618 Vehicles/Km then Free Flow = 4516 Vehicles/hr/lane

LOS	Control Delay per vehicle (seconds per vehicle)
A	≤ 10
B	$>10-20$
C	$>20-35$
D	$>35-55$
E	$>55-80$
F	>80

Capacity Analysis:

$s(g/C) = c$ as a result, $s = 1900$ vehicle/hr

The green clearance light is 25 seconds in length, whereas the yellow and red clearance displays are just 5 seconds long. The amount of time that was lost was 4 seconds. In one hour, there are Thirty cycles.

$C = 3600 / 30 = 120$ seconds

$g = G + Y + R_c$ $t_L = 26$ seconds

$g/c = 26 / 120 = 0.216$ is the green effective ratio.

The saturated flow rate is multiplied more by green effective

ratio to determine the capacity of the approach.

Cycle duration = 120 sec

$c = 1900$ vehicle/hour

$0.216 = 412$ vehicle/hour

26 seconds is the effective green time.

Delays

$C = s * (g/C) = 1900$ vehicle/hour * (26 sec/120 sec) = 412 vehicle/hour,

where c is the approach or lanes occupancy, s represents the saturated flow velocity, and g/C represents the effective green ratio.

The volume surpasses the capacity in every cycle. For first cycle, the Queue service time is (g_s)

$g_s = vr / (s - v)$

$= (0.250) (98) / ((0.528) (0.250))$

$= 88.12 \text{ sec} \approx 89 \text{ sec}$

As a result, this verifies our hypothesis.

Therefore, after all calculations & delays, the total time is 61.3 seconds.

LOS

LOS E indicates capacity activities, in which cars are packed closely together and movement among traffic flows is very constricted, as either a response. The physically and emotionally comfort of the driver is insufficient.

Table 2 shows the LOS of motor vehicles at signalized intersections.

NO OF VEHICLES	AVG SPEED	(xi - x)	(yi - y)	(xi - x)(yi - y)	(xi - x)2
575	35.94	111.5714286	4.39142857	446.0436735	10316.7551
781	30	317.5714286	1.05857143	-325.586327	94600.18367
349	43.59	-134.4285714	12.0414286	-1498.29776	15482.46939
276	50	-207.4285714	17.4514286	-3445.41061	38978.04082
953	20.54	489.5714286	11.0085714	-5279.39633	229988.7551
446	43	-103.42857143	9.73142857	-909.193469	8728.897959
483.4285714	32.54857143			-11041.8408	318045.102
X	Y				

Present Traffic Condition after Commencement of Metro Rail

A video survey was taken at the junction at 800 meters away, extending to 200 meters, for the indicated junction with a signal. The speed-density relationship, as well as the free flow of vehicles, congestion density, and freeflow

speed for such a 200meter were found.

Table 3 shows various sorts of cars in various time scenarios following the metro

TIME	2 WHE	A-3	A-4	C/J/V /T	Mini BUS	BUS	Mini LCV	LCV	Tract or	Tractor + Trailer	Cycle	TOTAL
5:00-5:15	753	103	159	168	10	67	49	11	0	0	2	1322
5:15-5:30	992	109	99	142	8	59	56	30	0	0	0	1495
5:30-5:45	666	158	87	199	11	52	31	19	0	0	0	1223
5:45-6:00	759	126	159	181	7	48	54	18	0	0	3	1355
6:00-6:15	859	142	149	144	15	29	28	16	0	0	0	1382
6:15-6:30	1095	149	143	149	6	43	47	9	0	0	0	1641
6:30-6:45	1136	109	135	192	11	54	28	9	0	0	1	1675
6:45-7:00	1048	184	149	206	7	71	53	0	0	0	0	1705
7:00-7:15	999	149	119	249	10	49	41	2	0	0	0	1609
7:15-7:30	893	194	98	218	1	58	36	7	0	0	0	1485
7:30-7:45	728	116	83	173	0	21	29	13	0	0	1	1172
7:45-8:00	809	119	21	143	6	39	39	17	0	0	0	1177
TOTAL	10658	1595	1362	2128	77	556	455	123	0	0	4	

As a result, the Free Flow Speed is 49.32 km/hr.

Congestion density = 1419 Vehicles/Km (for 2 lanes)

Free Flow = 8748 Vehicles/hr/2 lane

= 4374 Vehicle/hr/lane

The combination of the saturated flow rate as well as the effective and sustainable ratio is used to calculate the capacity of an approach. Cycle duration = 120 sec, effective green time = 26 sec, $c = 1900 \text{ vehicle/hr} \times 0.216 = 412 \text{ vehicle/hr}$

Delays

It validates what we already knew. After all calculations and delays, the total time is 54 seconds.

LOS

As a conclusion D. LOS D implies a capacity operation wherein cars are close together and mobility within the stream of traffic is extremely limited. The driver's physical and mental well-being is insufficient.

3. Conclusion

Hyderabad has cultivated a reputation as a strategically located, multilingual cosmopolitan metropolis in order to have success in industries such as IT and commerce. The Hyderabad Metro Rail could be considered as a big public relations project for the city. The metro, according to the research, will reduce road congestion, emissions, and increase travel comfort including all people by providing new choice. This is in line with the SMART city philosophy, which prioritizes quality of life, accessibility, and sustainability.

When comparing the former traffic scenario to the current traffic scenario, changes in characteristics for the rollout as well as at intersections can be seen in the investigated area.

As a result, it can be seen that the Hitech city junction had LOS E in 2013, however the level of service has now changed to D in Hitech city. We noticed an increase in free flow speed, vehicle flow, and a decrease in jam density and vehicle delay time. Vehicle capacity, on the other hand, remains constant and is expanding day by day.

From para transport surveys we observed that income of the para transport vehicles decreased due to commencement of metro rail operations in Hyderabad. Many of the People are traveling through metro rail for covering a long distance within short time. This may Also affect income of the Rtc buses travelling long distances along the path of metro rail. Advantages of having metro rail project is we can minimize Pollution level in the city, reduces time, traffic decongestions and road safety etc. Due to this metro rail construction the width of the road is decreased so road widening should be done to avoid accidents. Mainly metro rail operations affected 40% income of para transportation systems.

The metro is considered a gender-neutral space that helps to improve cities and communities. While it has been suggested that women be given priority in seats and coaches, it has also been discovered that the presence of security authorities, including metro officials, leaves the area exposed to the general public to a large extent.

Metros customer is limited to salaried, middle-class citizens, eliminating daily wage earners, due to the increasing price of rail tickets. Similarly, so because surrounding infrastructure, including such paths and feeder facilities, wasn't created in concert with the overall set-up, the metro may not be equipped to accommodate all those with disabilities. In the not-too-distant future, the metro will be enlarged.

Residents will benefit from the creation of business centers within the stations, which will provide them mostly with transit. By infusing cultural themes and social problems into its aesthetics and construction, integrating painters and celebrities, the metro's outstanding profile may be used to provide a platform for people meeting. The Hyderabad Metro Rail is an essential element of the country's huge urbanization project, which seeks to make metropolitan areas accessible to everybody. As the project progresses, there's a significant likelihood that existing complaints will be addressed, and Hyderabad residents will deserve good service.

The Hyderabad master plan 2020 marks the beginning of world urban planning, while the Hyderabad master plan 2031 completes the objective of making Hyderabad an internationally significant metropolis. Master Plan 2031 is a comprehensive, technically solid, and practical strategy for the city of Hyderabad. Future analysis and a reduction in spatial approaches are both goals.

References

- [1] "Accessible and Inclusive Urban Development". (2015, June 11). United Nations. Retrieved from http://www.un.org/disabilities/documents/COP/cosp8_desa_forum_on

- _urban_developm ent_cn. pdf
- [2] Annual Report. (2018). Kolkata Metro Rail Corporation Ltd. Retrieved from http://www.kmrc.in/annual_report.php
- [3] Burns, N. & Grove, S. K. 2003. Understanding nursing research (3rd ed.). Philadelphia: Saunders Company. "Ensuring Equity". (2006). *Economic and Political Weekly*, 41 (16), 1492-1492. Retrieved from <http://www.jstor.org/stable/4418097>
- [4] Ghanate, N. (2017, December 30). Hyderabad: Metro ridership stabilising. Deccan Chronicle. Retrieved from <https://www.deccanchronicle.com/nation/currentaffairs/301217/hyderabad-metro-ridership-stabilising.html>
- [5] Hyderabad Metro Rail Project – An Overview". (2017). *Rail Analysis India*. Retrieved from <http://railanalysis.in/articles/hyderabad-metro-rail-project-overview/>
- [6] "HyderabadMetroRailLimited". (n. d.). *KnowMoreAboutProject*. Retrieved from <http://hmrl.telangana.gov.in/know-more-about-project.html>
- [7] Kropf, K. (2018). The handbook of urban morphology. K. Kropf, (Ed.). O'Reilly Media Company.
- [8] S, S. (2017, November 24). Keolis, the driving force of Hyderabad Metro Rail. *Telangana Today*. Retrieved from <https://telanganatoday.com/keolis-the-driving-force-of-hyderabad-metro-rail>