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An Investigation of the MRTS Corridor and Its Impact on the Urban Land Influence Area: A Case Study of Delhi Metro Rail

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***Abstract* - Mass rapid transit system is regarded as the optimal solution for a congested urban transit corridor. Primarily, MRTS influences land values, accessibility, travel patterns, and land use. It has the potential to expand access to remote regions and stimulate urban redevelopment. Conversely, in the absence of well-planned MRTS nodes, disorderly urban transformations ensue due to sensitive accessibility and, as a consequence, land valuation escalates, ultimately succumbing to market forces. As a consequence, disorder and congestion ensue, and instantaneous progressions transpire along the MRTS corridor and within their area of influence. The purpose of this study is to determine the causes and effects of Metro on the land values and land use patterns in the locality area as A Case Study of Delhi Metro Rail. The character composition of the area chosen for the research is entirely distinct from that of other regions where metro rail has been installed. This area includes several metro stations, including Lakshmi Nagar, Nirman Vihar, and Preet Vihar. In this study primary data collection is conducted through the utilization of GIS and Erdas Imagine software to map the existing land use of the area, in addition to conducting field surveys. Prior to commencing the primary survey, a handheld GPS was utilized to gather location data and conduct intelligence. The methodology utilized was predominately based on a comparison between the designated corridor before and after the construction of the metro. By analyzing this case study, the research will enable policymakers and planners to assess the effects of MRTS and develop strategies for the future.**

Keywords: MRTS, Land Use, Land Value, Transit Oriented Development, Metro Rail.

1. Introduction

The metro rail, also known as a mass rapid transit system (MRTS) is becoming more and more popular all over the world, including India introduced to solve the intercity transportation problems. At present MRTS has been operating in more than 150 cities of the world and is likely to be introduced in many more cities, in near future. MRTS with increased accessibility and mobility, gradually bring dynamic changes in the activity patterns, distribution of people and land use etc. Metro rails are that use a separate right-of-way from other forms of transportation in cities. Typically, the right-of-way is subterranean or raised above street level. MRTS design is inextricably linked to urban planning. Its presence alters the viewpoint, influencing land usage, land value and overall urban experience. Architects must work together with urban planners to ensure that MRTS participates seamlessly into the existing urban structure.

2. Need of the Study

- MRTS is predicted to have a substantial impact on accessibility, traffic patterns, land usage, and property prices, among other factors; it may help with urban redevelopment by making formerly inaccessible places more accessible.
- The increased accessibility of unplanned MRTS nodes leads to disorderly changes in urban environments and therefore, it increases land value and makes market-driven takeover easier.

3. Objectives of the Study

1. The Primary Objective is to analysis the impact of the MRTS zone, based on various parameters in the Influence Area of Delhi Metro Rail
2. Analyse the effects of the Delhi Metro rail MRTS on the land use, land value, and population density of urban areas etc.

4. Methodology

The methodology needs investigating study area characteristics such as existing connectivity and accessibility, existing land use, existing land value, and existing development regulations. This, combined with literature such

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as MRTS and TOD, will provide an impact assessment of MRTS on the study area when compared to the study area's characteristics in terms of land use between 2014 and 2023.

4.1 MRTS & TOD Parameters

- **Density** - Density is a measure of the intensity of land usage; it represents the link between the number of people and the amount of land they occupy. It is often stated as the number of people per acre.
- **Land Use** - Various land uses influence traffic patterns. Land use rules and development practices may influence mobility preferences. Several transport demand management solutions require direct changes to land-use patterns. The feasibility and effectiveness of MRTS influenced by land use characteristics that impact travel.
- **Accessibility** - "Accessibility is a term has been used by planners, engineers and others quite freely." Various writers have defined accessibility, which is difficult to assess depending on how the impedance or function factor is calculated.
- **Land Value** - Land value is determined by the economic concept of highest and best use, which yields the greatest net return over time. The property's worth is determined by its structural qualities, land value, and rental value (all of which are influenced by land use and location).
- **Transit** - Oriented Development (TOD) - TOD focuses on compact mixed-use construction along the metro rail corridors and MRTS systems encourage transit-oriented development, enhancing accessibility and structure.

4.2 Case Study Area

- **Delhi Metro Project**

The Delhi Metro is a mass rapid transit system which serves Delhi and its adjoining satellite cities, such as Ghaziabad, Faridabad, Gurugram, Noida and Bahadurgarh, in the National Capital Region of India. The system consists of 10 colour-coded lines serving 256 stations with a total length of 350.42 kilometres (217.74 Mile). It is India's largest and second oldest metro rail system. The metro has a mix of underground, at-grade, and elevated stations using broad-gauge and standard-gauge tracks. The metro makes over 4,300 trips daily.

East Delhi, often known as Trans Yamuna, is an administrative district of India's National Capital Territory of Delhi. It is surrounded by the Yamuna River to the west, North East Delhi to the north, Ghaziabad District of Uttar Pradesh state to the east, and Gautam Buddha Nagar District of Uttar Pradesh on the south. According to the 2011 census, East Delhi has a population of 1,707,725, which is nearly equivalent to that of the Gambia or the US state Nebraska. This places it 284th in India (out of 640). The district has a population density of 26,683 per square kilometer. From 2001 to 2011, its population grew at a pace of 16.68%. East Delhi has a sex ratio of 883 females to 1000 men's and an 88.75% literacy rate.

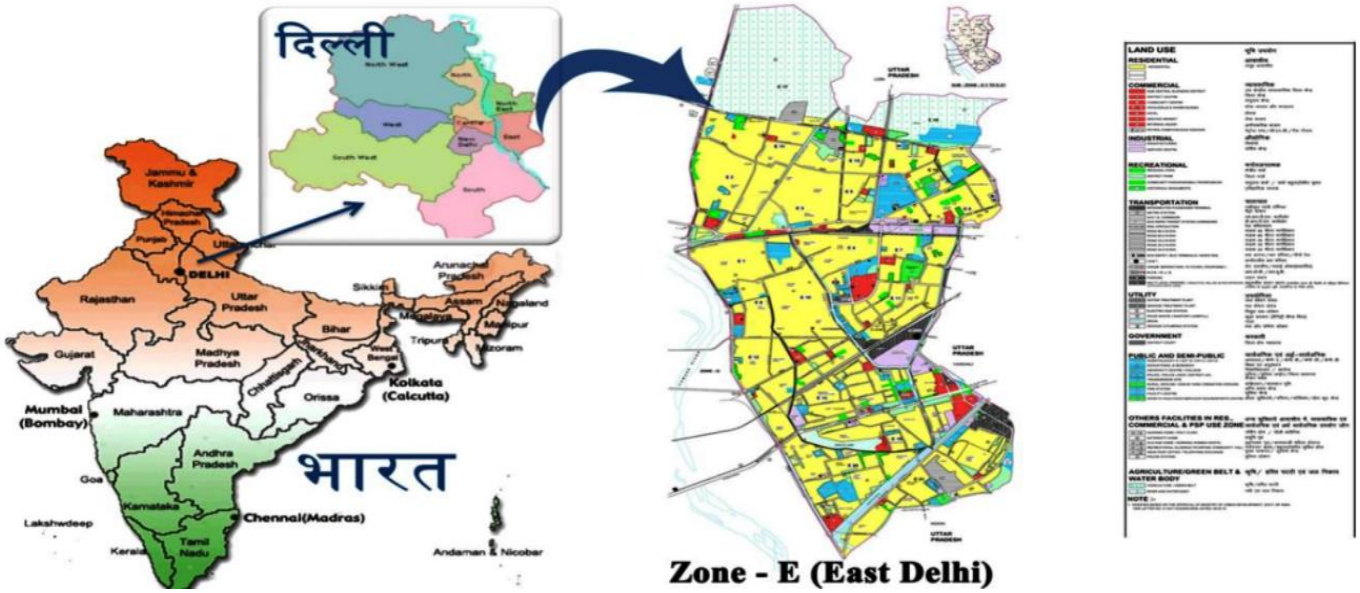

Figure 1: Case Study Area

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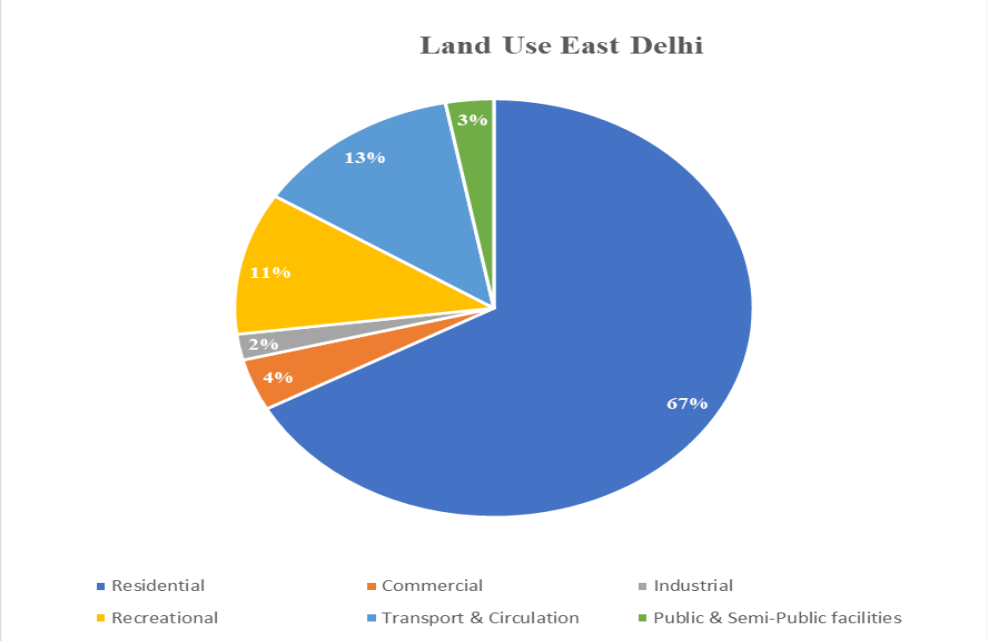

Figure 2: Land Use of East Delhi

- **Study Area Characteristics**

The study area has three distinct types of metro stations, each with its own set of activities centered on their own nodes. The three metro stations are Lakshmi Nagar, Nirman Vihar, and Preet Vihar. The total length of the route is 3 km, while the distance between two metro stations is 1 km. The area of effect that I am considering extends from a minimum of 0.3 km to a maximum of 0.8 km on both sides of the metro line. Regarding the quality of metro stations within the research zone, it can be seen that each metro station is surrounded by distinct land use patterns. The overall area of the influence zone is 2.63 square kilometers and is determined by the 3-kilometre metro line, which includes all three metro stations.

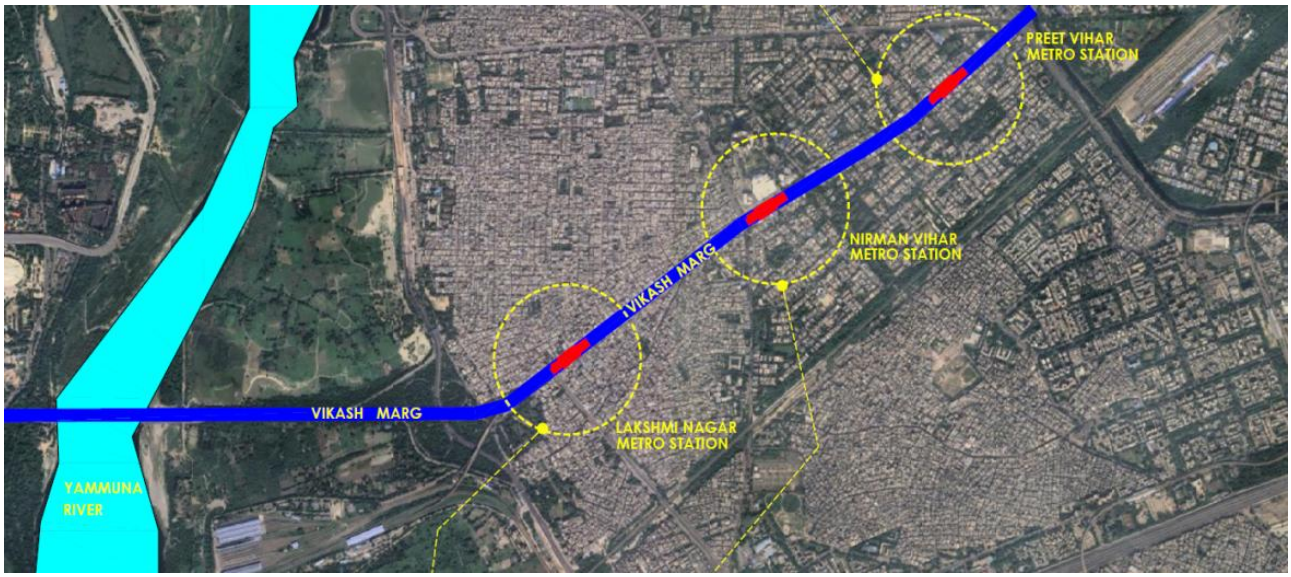

Figure 3: Study Area & influence Zone

5. Analysis and Result

A comparison of the land use structure at different periods 2014 and 2023 was done using GIS tools to determine the land use changes that occurred in this area after the Delhi Metro rail Project.

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- **Changes in Land Use**

Table 1: Comparative analysis of Land use of the study area of 2014 & 2023

Land-use	2014 Area (sq.km.)	Age %	2023 Area (sq.km.)	Age %	±change of age %
Residential	1.57	60.38	1.42	54.61	-5.77
Commercial	0.43	16.53	0.53	20.38	3.85
Institutional	0.15	5.69	0.20	7.69	2.00
Mixed Use	0.21	8.17	0.31	11.93	3.76
Open	0.24	9.23	0.14	5.39	-3.84
TOTAL	**2.60**	**100**	**2.60**	**100**	

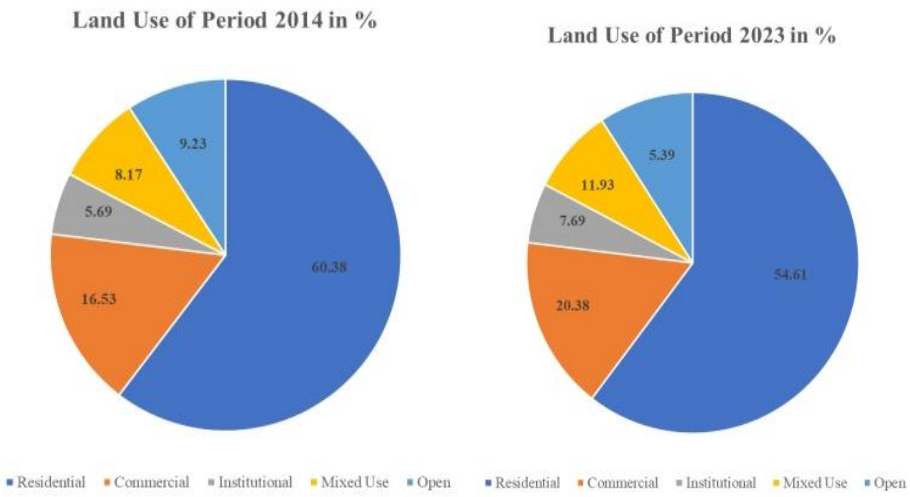

Figure 4: Change in Land-Use of the study area

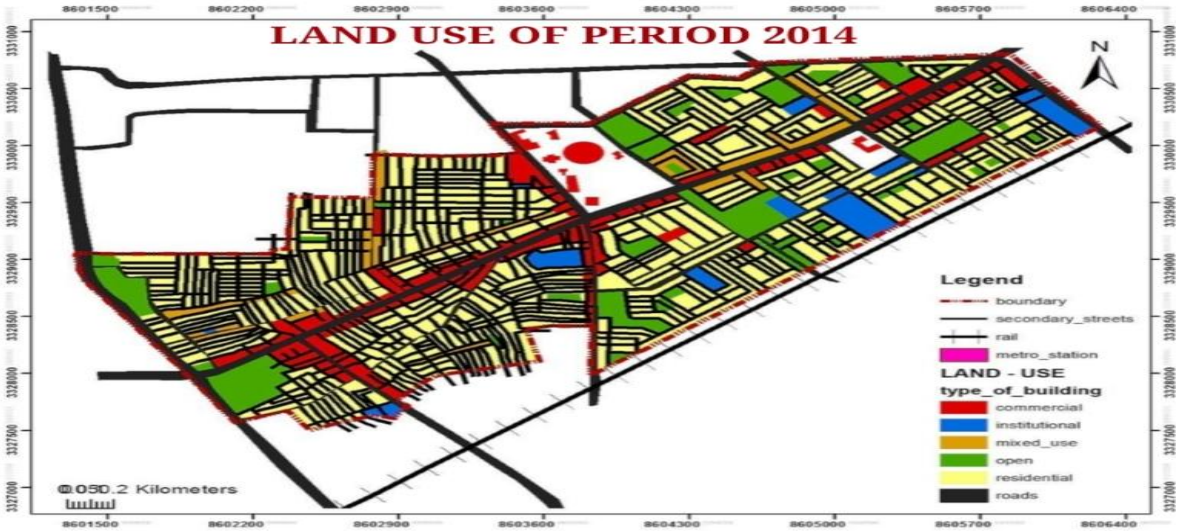

Figure 5: Change in Land-Use Patterns of period 2014

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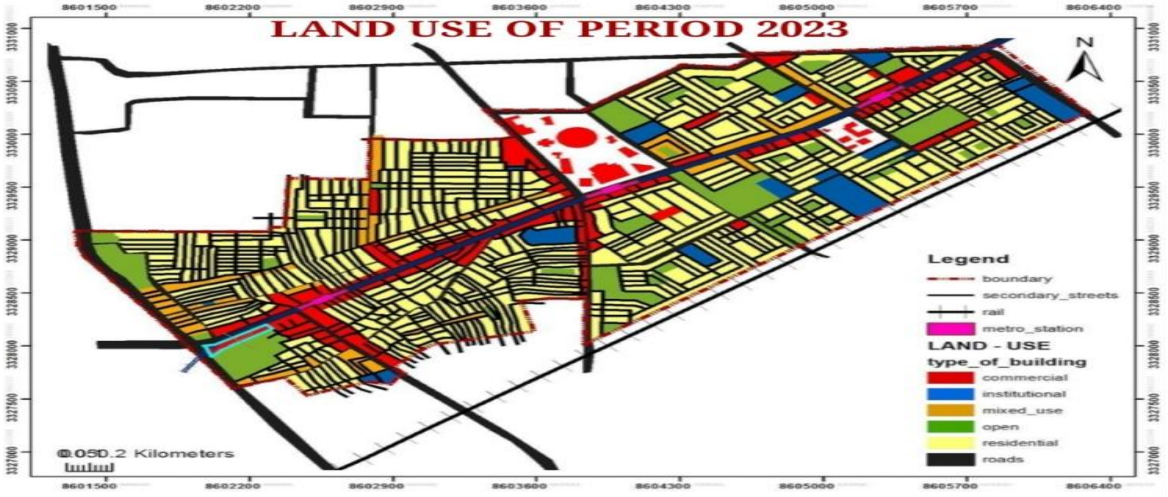

Figure 6: Change in Land-Use Patterns of period 2023

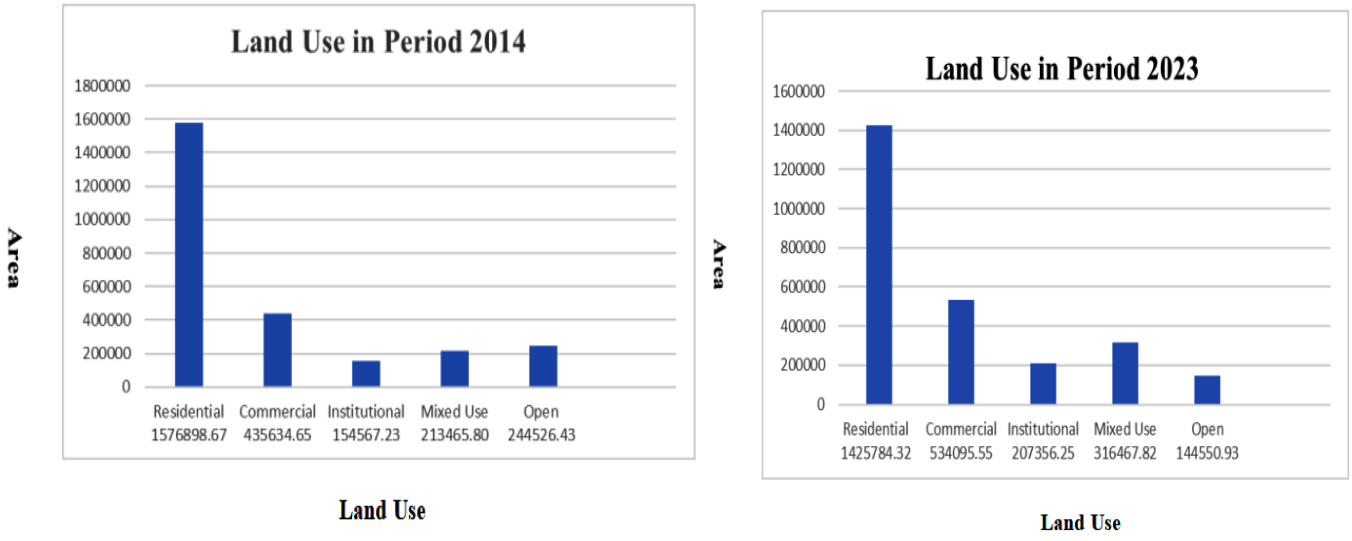

Figure 7: Change in Land-Use of period 2014 & 2023

- **Change in Building Height**

The constructed form of commercial areas has changed significantly since the Delhi Metro's launch. In 2014, the primary height of residential neighborhoods was 15 meters (G+5), and it remains so today, although some structures near to the Delhi Metro route have reached 18 meters (G+7). When it comes to commercial buildings, the typical heights were 25 meters G+9 and 65 meters G+15, but the maximum height has since risen to 85 meters G+20 or more. The most significant transformation has happened in the commercial constructed form. Prior to the Metro's construction, the streets were mostly residential, but practically all of them have since been commercialized owing to the possibilities of profit in commercial marketplaces. Also, some new buildings, such as a commercial shopping mall with a height of 17 meters G+9 and two basements, and multistory residential flats with the same far but a height of 30 meters G+12, are already in existence.

Table 2: Analysis building heights in Period 2014 & 2023

Building Height	2014 Area (sq.km.)	Age %	2023 Area (sq.km.)	Age %	±% age change
OPEN	0.24	9.23	0.14	5.38	-3.85

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6.0 meters	0.047	1.80	0.047	1.80	Nil
9.0 meters	1.982	76.23	1.15	44.23	-32.00
12.0 meters	0.215	8.26	0.415	15.98	7.72
15.0 meters	0.089	3.56	0.76	29.23	25.67
21.0 meters	0.00	0.00	0.018	0.69	0.69
33.0 meters	0.0033	0.14	0.0060	0.23	0.09
65.0 meters or more	0.020	0.78	0.064	2.46	1.68
TOTAL	**2.60**	**100**	**2.60**	**100**	

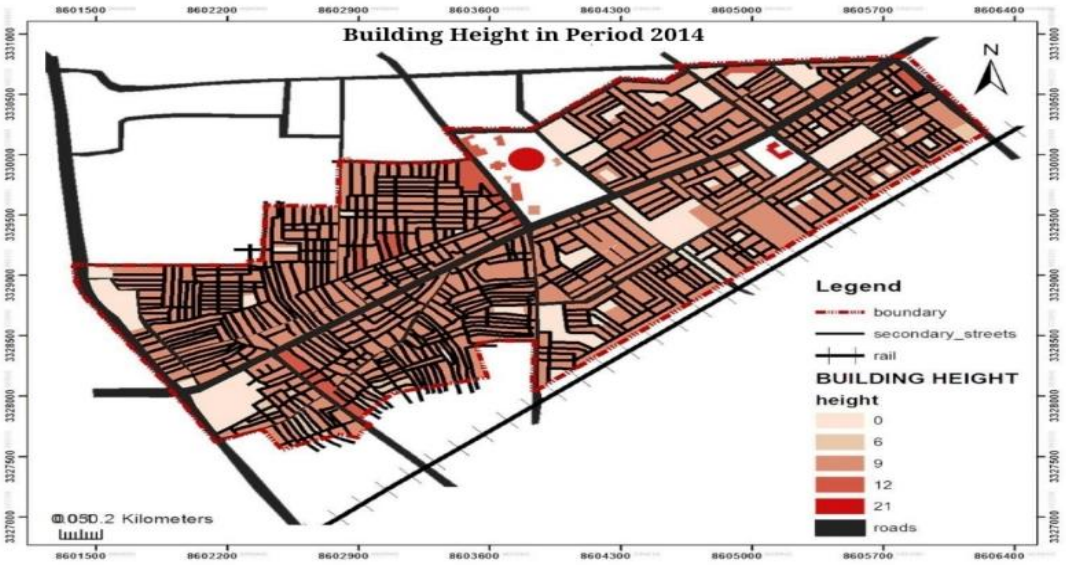

Figure 8: Building heights in Period 2014

Figure 9: Building heights in Period 2023

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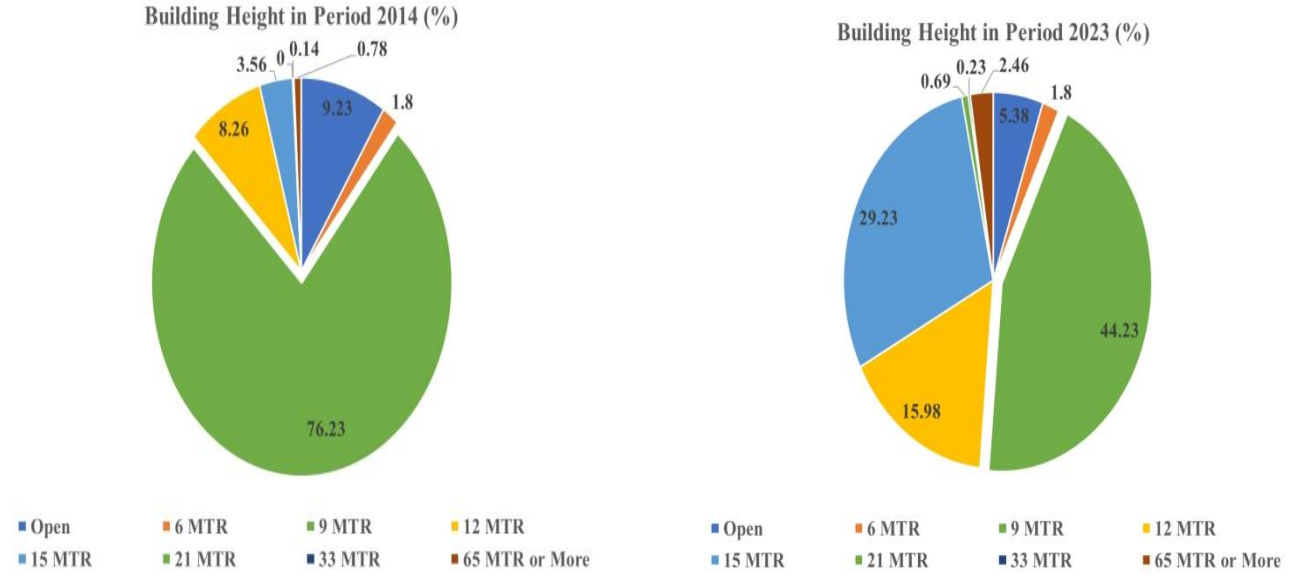

Figure 10: Analysis Building heights in Period 2014 & 2023

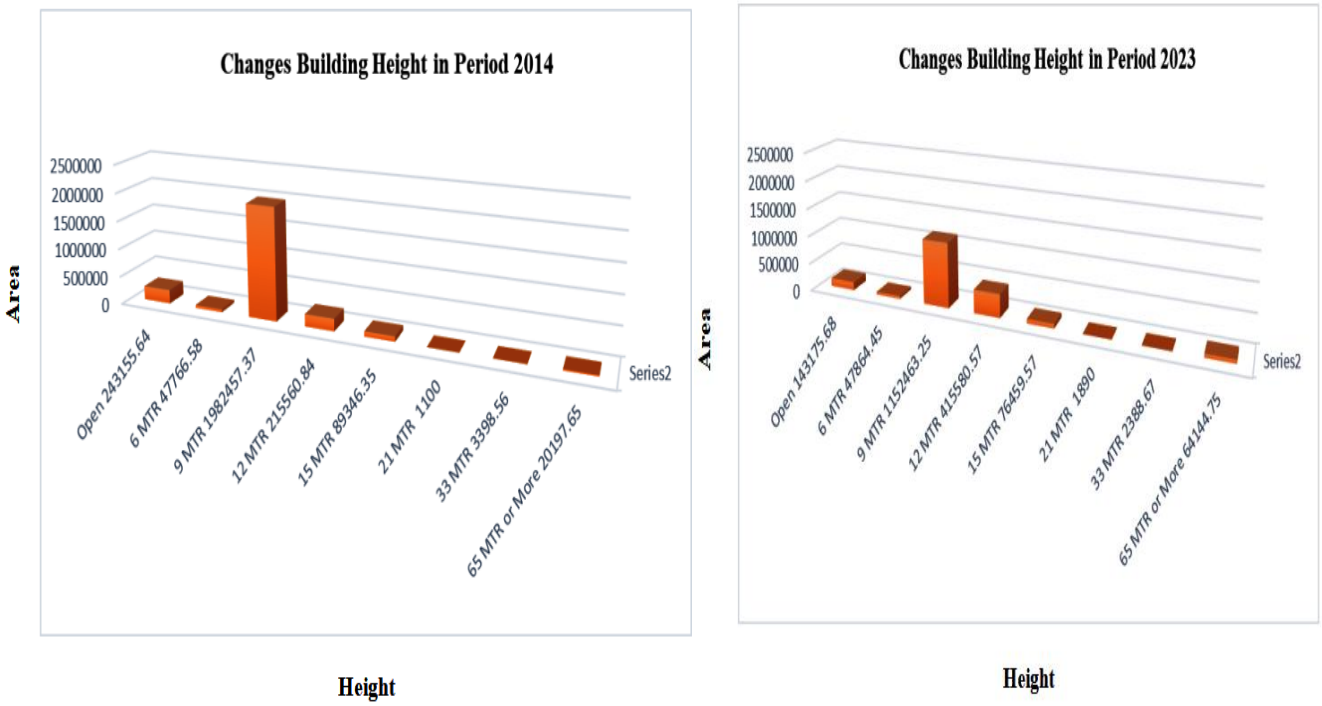

Figure 11: Changes Building Heights in Period 2014 & 2023

- **Change in Land Value**

Nirman Vihar Station has the highest commercial value. The commercial value in the area has increased by almost 200%. Retail showrooms and businesses are sprouting up throughout the whole span. Preet Vihar station area has a high residential value. This is due to the projected residential development that may occur after the completion of the metro. This area's residential value has increased by 150% and also the Lakshmi Nagar metro station vicinity has seen a mixed shift in residential and commercial value.

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Table 3: Result of Comparative Analysis of Land Value of Study Area from Period 2014 and 2023

ZONE/ RATES	Laxmi Nagar Metro Station (2014)	Laxmi Nagar Metro Station (2023)	Preet Vihar Metro Station (2014)	Preet Vihar Metro Station (2023)	Nirman Vihar Metro Station (2014)	Nirman Vihar Metro Station (2023)
Residential	15-35 K/sq.ft.	25-45 K/sq.ft.	20-40 K/sq.ft.	50-60 K/sq.ft.	15-25 K/sq.ft.	20-30 K/sq.ft.
Residential Rent	5-10 K/sq.ft.	20-30 K/sq.ft.	25-35 K/ sq.ft.	35-45 K/ sq.ft.	15-25 K/sq.ft.	20-30 K/sq.ft.
Apartment	5-10 K/sq.ft.	20-30 K/sq.ft.	5-10 K/sq.ft..	30-40 K/sq.ft.	15-25 K/sq.ft.	20-30 K/sq.ft.
Apartment Rent	5-10 K/sq.ft.	20-35 K/sq.ft.	5-10 K/sq.ft.	30-40 K/sq.ft.	15-25 K/sq.ft.	20-30 K/sq.ft.
Commercial	5-10 K/sq.ft.	10-20 K/sq.ft.	10-15 K/sq.ft.	15-20 K/sq.ft.	20-30 K/sq.ft.	40-60 K/sq.ft.
Commercial Rent	20-25 K/sq.ft.	50-100 K/sq.ft.	15-20 K/sq.ft.	30-60 K/sq.ft.	35-45 K/sq.ft.	70-90 K/sq.ft.

- **Result of Comparative Analysis of the All Parameters**

Impact on	2014	2023
Land Use	The whole area included mostly of residential zones, interspersed with some commercial areas, all of which had the same floor area ratio (FAR) and building heights. Mixed land use was limited to the proximity of local markets.	The combination of easy access to transit and the development around the station may have resulted in a shift in land use. Many recently constructed commercial buildings have implemented varying Floor Area Ratio (FAR) and height regulations. The residential buildings located along the corridors and nearby streets have been transformed into commercial or mixed-use properties.
Land Value	The land value was equivalent to that of comparable places without a metro facility. The circle rates were initially identical, and over time, they increased in a parallel and uniform manner.	The subsequent result of the alteration in Land-Value would be increase in the value of land in the proximity of the stations in comparing to the inside area of the area. Residential structures are being converted into commercial buildings, leading to a shift in land value.
Building Height	Most structures were G+3 to G+9 storeys, with only some few commercial buildings above this height. The consistent distribution of height made the area uniform.	Most residential buildings are still G+2, but some new apartment buildings have G+7 and G+12 storeys after Metro, resulting in increased building height with the same FAR. Major commercial buildings have increased their heights from G+9 to G+20, and most have added one or two floors, resulting in more commercial space in the study area.
Accessibility	There was only one route that connected this area to the central of Delhi.	The establishment of the Delhi metro and two new highways that link to the central Delhi region improved connectivity.

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6. Conclusions

The master plans do not include any provisions or regulations governing the kind of development or density along the metro route. The current design lacks provisions for high-rise construction along the Metro corridor, which is necessary for the revitalization of the communities around the Metro station. The open regions have been neglected without any consideration. The development authorities neglect the concerns of open regions. There is no available parking spaces save for the parking at the metro station. The corridor has had the most significant influence from the subway inside the first 300 meters. The physical extent of the influence varies across various stations, ranging from 500 meters to 1.5 kilometers. However, the impact seems to be more pronounced at the terminal stations. The optimal land use in the immediate vicinity of the station nodes is mixed-use development. Prior to proposing a transportation corridor in a specific location, it is essential to take into report these factors in the master plan. The methods used in this research will also facilitate the evaluation of the effects of MRTS on other significant factors such as socio-economic conditions, demographics and the environment.

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