

Impact of Delhi Metro on Land Use: A Spatial-Temporal Study of Jahangirpuri

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Abstract—This study examines changes in land-use patterns around Jahangirpuri Metro Station, Delhi, between 2001 and 2021 within an 800 m study area. The analysis focuses on major land-use categories before and after the Metro's became operational start in 2009, including residential, commercial, industrial, recreational and transportation uses. The results indicate that residential use remained dominant and increased from 57.75% in 2001 to 63.30% in 2021, while commercial use increased from 1.31% to 2.10%. Recreational land declined from 9.93% to 4.59%, suggesting increasing development pressure and land-use intensification. The findings suggest that Metro accessibility has contributed to increasing urban activity and commercial diversification, although land-use has also been influenced by existing roads, market demand, and redevelopment and planning policies.

Index Terms—Impact of Metro, MRTS, Social impact of MRTS, socio cultural Impact of MRTS, Gentrification, Socio cultural Impact, economic Transportation systems Introduction

I. INTRODUCTION

Transportation and land use are closely related since improvements in accessibility can influence the location and intensity of urban activities [1,2]. The expansion of the Delhi Metro has improved accessibility of various areas in Delhi and has coincided with continued urban development [3,4]. However, the response of individual station areas is not only dependent on Metro accessibility but is also influenced by existing development, road connectivity, land availability, market demand and planning controls. This study investigates the land-use transformation around Jahangirpuri Metro Station from 2001 to 2021, with particular reference to

residential, commercial and other major land-use categories within an 800 m study area.

II. NEED OF THE STUDY

Station areas experience continual development pressure due to improved accessibility and increased movement of people and activities. Jahangirpuri provides an appropriate case study for examining such processes because the area was highly integrated and developed prior to the operation of the Metro from 2009. Comparing the land use in 2001 and 2021 enables the identification of changes in the land-use composition and urban intensity over a period encompassing development before and after the operation of the Metro.

III. AIM AND OBJECTIVES

AIM –

Conduct a comprehensive spatio-temporal analysis, investigate and quantify the direct and indirect impact of the Delhi Metro on surrounding land use patterns, and propose strategies to control the unorganized growth in the areas surrounding metro stations and metro lines.

OBJECTIVES –

- To Review literature on the Impacts of Metro Rapid Transit Systems (MRTS) on surrounding land use of Metro Station.
- Identify and analyse specific parameters related to the impact of MRTS on different land uses.
- Assess how MRTS has impacted different land use categories in the vicinity of Metro station over time.

- Conclusions & recommendations based on results & discussions.

IV. HYPOTHESES

Hypotheses 1

The evolution of the Delhi Metro has impacted nearby land use patterns, thus, changing residential to commercial uses along metro corridors and near the stations.

Hypotheses 2

Areas close to Delhi Metro Stations have seen a decline in open or vacant land, replaced by built-up infrastructure and urban services.

V. RESEARCH QUESTION

What effect has the Delhi Metro on surrounding land use from residential to commercial in the areas close to Metro station?

VI. STUDY AREA

Jahangirpuri Metro Station is located in North Delhi along the Yellow Line of the Delhi Metro. The station became operational in 2009, providing improved accessibility in the surrounding neighborhood.



Fig 1. Location of Jahangirpuri Metro Station, Delhi.

The study area adopted for this research is that of an 800 m radius around the Jahangirpuri Metro Station. The neighborhood contains predominantly residential development together with commercial, industrial, recreational, public/semi-public and transportation uses.

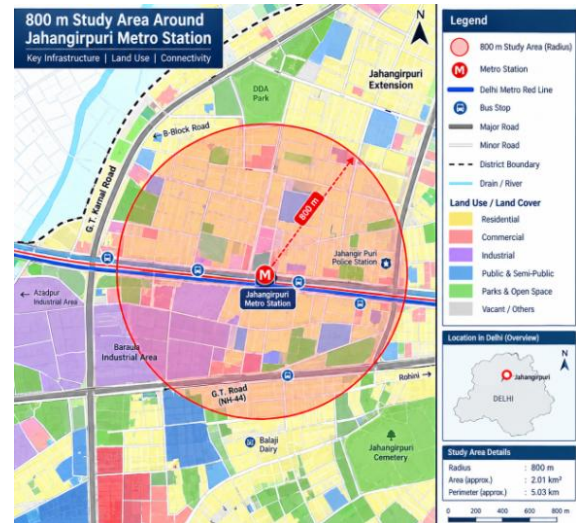


Fig 2. 800m Study Area around Jahangirpuri Metro Station.

VII. DATA AND ANALYTICAL APPROACH

The analysis compares the land-use situation in 2001, 2021 and 2024. The year 2001 represents the pre-Metro condition, while 2021 and 2024 represents the condition after the Metro operation.

The analysis utilizes land-use maps and quantitative land-use distribution data to identify changes in major land-use categories. The 2001, 2021 and 2024 land use and building use maps are compared spatially, while the percentage distribution provides a quantitative basis for interpreting the magnitude and direction of change.

The proposed 2041 land-use distribution is considered separately as a planning scenario and is not intended to be evidence of actual land-use change or as evidence of Metro impact.

VIII. SPATIAL LAND-USE ANALYSIS

Comparative Spatial Land-Use Pattern: 2001, 2021 and 2024 –

The land-use maps of 2001, 2021 and 2024 (shown below) illustrate the spatial transformation of Jahangirpuri from the study period. In 2001, the area was already an established urban neighbourhood, with residential land dominating at 57.75%, followed by industrial (23.71%) and recreational (9.93%) uses. By 2021, residential land remained the principal category and increased to 63.30%, while industrial land use increased to 28.00% and commercial land

increased from 1.31% to 2.10%. In contrast, recreational land declined considerably from 9.93% to 4.59%, while public/semi-public uses were relatively stable at around 1.5%.

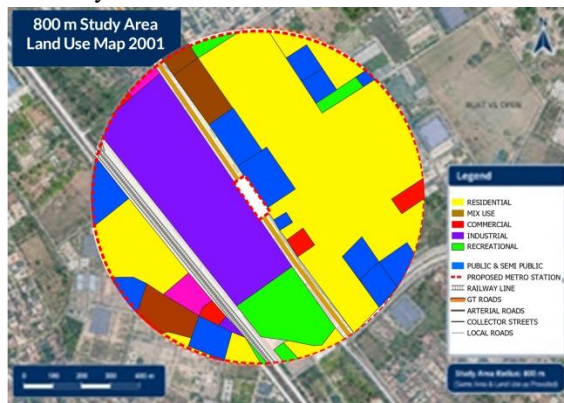


Fig 3. Land-Use Map of Jahangirpuri, 2001

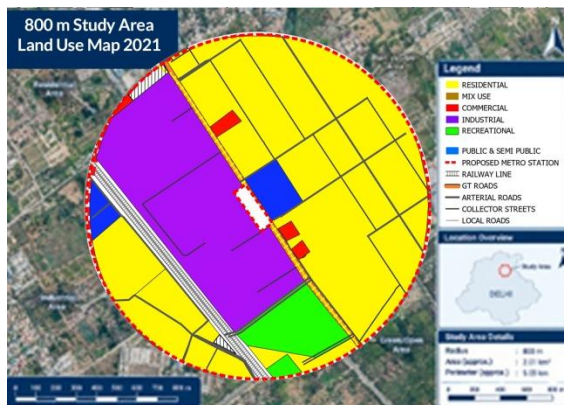


Fig 4. Land-Use Map of Jahangirpuri, 2021

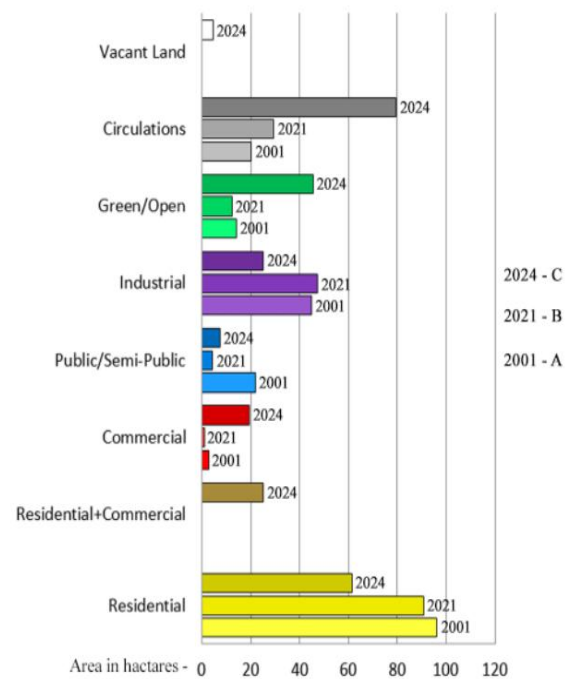


Fig 5 Building-Use Pattern of the Study Area, 2024

The comparison of the 2001, 2021 and 2024 building-use maps indicates a gradual intensification and diversification of land use within the study area, rather than a complete replacement of residential

development. The spatial changes observed across the three periods, supported by the quantitative land-use distribution, demonstrate the progressive expansion of commercial and other urban activities alongside the established residential structure. The 2024 building use map further highlights the recent pattern of development and provides a basis for understanding how improved accessibility, the existing road network and Metro-related development has influenced the evolving urban structure of Jahangirpuri.

Land-Use Distribution, 2001, 2021, 2024 (%)



Graph 1. Land-Use Distribution, 2001, 2021, 2024 (%)

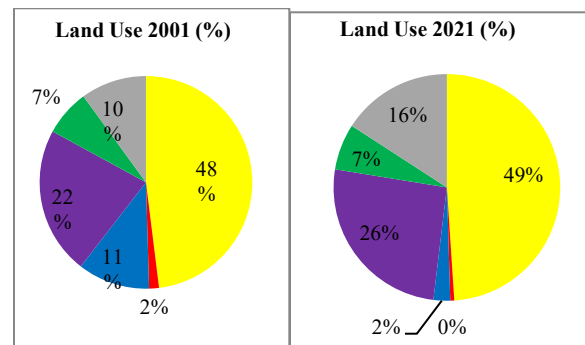


Figure X: Comparative Land-Use Composition of the Study Area, 2001, 2021

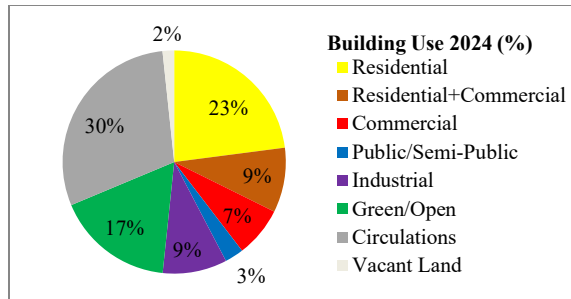


Figure X: Comparative Land-Use Composition of the Study Area 2024

The pie charts and Graph illustrate a clear change in the land-use composition of the study area between 2001, 2021 and 2024. The land-use distribution shows a gradual change in the internal structure of the study area between 2001 and 2021. Residential land remained the dominant category, increasing marginally from 90.20 ha in 2001 to 90.64 ha in 2021, representing an area gain of 0.44 ha (0.49%). Industrial land also recorded growth, increasing by 2.60 ha, from 44.90 ha to 47.50 ha, equivalent to 5.79% growth. Circulation showed a more pronounced increase of 9.35 ha, rising from 20.00 ha to 29.35 ha, with a growth rate of 46.75%. In contrast, public/semi-public land declined by 17.52 ha (79.93%), from 21.92 ha to 4.40 ha, while commercial land decreased by 1.95 ha (65.00%), from 3.00 ha to 1.05 ha. Green/open land also decreased by 1.90 ha (13.48%), from 14.10 ha to 12.20 ha, and group housing recorded a reduction of 5.84 ha, as no separately classified group housing area was recorded in 2021.

Between 2021 and 2024, the land-use pattern changed more substantially. Circulation recorded the highest absolute increase, rising from 29.35 ha to 79.36 ha, a gain of 50.01 ha or 170.39%. Green/open land increased by 33.44 ha (274.10%), from 12.20 ha to 45.64 ha. Commercial land also showed a major increase of 18.45 ha, rising from 1.05 ha to 19.50 ha, equivalent to 1,757.14% growth; the exceptionally high rate is influenced by the very small 2021 base. Residential land, in contrast, declined by 33.49 ha (36.95%), from 90.64 ha to 57.15 ha, while industrial land decreased by 22.50 ha (47.37%), from 47.50 ha to 25.00 ha. Public/semi-public land increased by 2.90 ha (65.91%), from 4.40 ha to 7.30 ha. In addition, mixed-use land emerged with 25.14 ha in 2024, while group housing reappeared with 4.30 ha

and vacant land accounted for 4.50 ha. Overall, the 2021–2024 period reflects a marked shift in land-use composition, particularly through the growth of circulation, green/open, commercial and mixed-use areas and the corresponding reduction in the recorded residential and industrial components.

IX. QUANTITATIVE COMPARISON OF LAND-USE CHANGE: 2001-2021

The quantitative comparison provides a clearer understanding of the extent and direction of land-use change between 2001 and 2021.

Table 1. Land-Use Distribution of Delhi, 2001 and 2021

Land-Use Profile of Delhi	Area 2001 ha	% of Total Area	Area 2021 ha	% of Total Area
Residential	30445	49	57124	55
Commercial	2591	4	5193	5
Public/Semi	4534	7	7507	8
Industrial	4534	7	5193	5
Green/Open	12955	21	16025	15
Circulations	7773	12	12820	12
Total	64777	100	103862	100

The comparison of land-use distribution between 2001 and 2021 provides a broader context for understanding urban development in Delhi. Residential land remained the dominant category, increasing from 49% to 55% of the total area, while commercial land increased from 4% to 5% and public/semi-public land from 7% to 8%. In contrast, industrial land decreased from 7% to 5%, while green/open areas declined from 21% to 15%. Circulation remained relatively stable at 12% during the period.

At the local level, the Jahangirpuri study area shows a different and more detailed pattern of land-use transformation. Residential land increased from 57.75% in 2001 to 63.30% in 2021, while industrial land increased from 23.71% to 28.00% and commercial land from 1.31% to 2.10%. Recreational land declined from 9.93% to 4.59%, while public/semi-public uses remained relatively stable at around 1.5%. These changes indicate increasing development intensity within the established urban structure of Jahangirpuri, particularly through the expansion of residential, industrial and commercial activities.

The Delhi-level data therefore provides the broader planning context, while the Jahangirpuri-specific analysis identifies the changes that have been occurring within the 800 m study area around the Metro station. The local changes suggest that Metro accessibility has contributed to increasing development intensity and diversification of activities, although the observed transformation is also influenced by existing road connectivity, market demand, redevelopment and wider development pressures.

Overall, the changes indicate that Jahangirpuri did not experience large-scale replacement of residential land; rather, the area underwent gradual development intensification and diversification of activities. The increase in residential, industrial and commercial uses, along with the decline in recreational land, reflects a changing balance between built-up and open uses within the study area. Metro accessibility has supported this process by improving connectivity and increasing the attractiveness of accessible locations, particularly where it interacts with existing roads, markets and development activity. However, the observed land-use transformation cannot be attributed to the Metro alone, as population growth, employment opportunities, market demand, and redevelopment and existing urban conditions have also contributed to the changes.

X. LAND-USE TRANSFORMATION AND DEVELOPMENT INTENSIFICATION

Residential-Commercial Transformation - The increase in commercial land from 1.31% to 2.10%, alongside residential growth from 57.75% to 63.30%, indicates commercial expansion within an increasingly residential and intensified environment rather than large-scale residential-to-commercial transformation. This pattern suggests increasing development activity and diversification of uses within the existing urban structure. The role of improved Metro accessibility is considered alongside other factors, including road connectivity, market activity, redevelopment and development pressure. Thus, the first hypothesis is supported in terms of increased commercial activity, but not widespread residential land conversion.

Building Age and Redevelopment - The building-age analysis indicates substantial recent redevelopment

within the study area, with approximately 99% of mapped buildings falling within the 0–10-year age category. This indicates that a large portion of the existing building stock is relatively recent, reflecting ongoing redevelopment and physical transformation of the neighbourhood. The pattern is consistent with increased development activity in an area with improved accessibility, although redevelopment pressure, market demand and existing urban conditions may also have contributed.



Fig 6. Building Age of Study Area

Building Height and Vertical Intensification - The building-height analysis indicates an increase in development intensity within the study area. Residential buildings that were predominantly G+2 have developed into G+3 structures, with newer developments reaching up to G+7. Commercial development has also become more vertical, with maximum building heights increasing from approximately G+5 to G+20. This pattern indicates increasing development intensity and redevelopment pressure, particularly in accessible locations. The observed vertical growth is consistent with the improved accessibility associated with the Metro, although market demand, land values, redevelopment and existing road connectivity also influenced the pattern.



Fig 7. Building Height of Study Area

Built-Up and Open-Space Transformation - The built-up and open-space pattern shows that the study area is predominantly developed, with built-up structures occupying most of the available urban land. Open spaces are distributed in smaller and relatively fragmented pockets across the study area. The concentration of development along the main road network and around accessible locations indicates a strong relationship between the existing urban structure and movement corridors. The pattern also highlights the limited availability and fragmented distribution of open spaces within the study area.



Fig 8. Built-Up and Open-Space Pattern of the Study Area

Road Network and Accessibility - The road network plays an important role in shaping movement and the distribution of activities within the study area. The map shows a hierarchy of major roads, arterial roads, collector streets and local roads connecting different parts of the neighbourhood with the Metro station. Development and activity are more concentrated along the principal movement corridors, while the internal streets provide access to predominantly residential areas. The relationship between the road network, built-up areas and open spaces indicates that accessibility is influenced not only by the Metro station but also by the existing street structure and road connectivity.



Fig 9. Road Network and Open Spaces in the Study Area

Taken together, the land-use, building-age, building-height, built-up and road-network analyses indicate that development around Jahangirpuri Metro Station has become more intensive and diversified over time. The changes are particularly evident in areas with better access to major roads and the Metro corridor. However, the spatial pattern does not indicate that the Metro alone determined land-use change; rather the Metro's accessibility interacted with the existing road network, redevelopment activity, market demand, employment opportunities and the established urban structure. The Metro has therefore appears to have acted as an accessibility-enhancing factor that has supported ongoing urban transformation within the study area.

XI. DISCUSSION

Jahangirpuri shows progressive urban intensification rather than major land-use restructuring. Residential use has increased from 57.75% to 63.30%, while commercial use has risen from 1.31% to 2.10%, indicating commercial growth within an expanding residential environment rather than widespread residential conversion.

The decline in recreational land from 9.93% to 4.59% has indicated increasing pressure on open and recreational spaces. Improved Metro accessibility has appeared to support this transformation, alongside road connectivity, markets, redevelopment, population growth and planning factors. Thus, the Metro is best considered as an important accessibility-related factor in a broader process of urban transformation.

The building-use pattern highlights the functional diversity and increasing development intensity of Jahangirpuri, providing an important basis for understanding the area's ongoing land-use transformation and its relationship with transportation and accessibility.

XII. KEY FINDINGS

- i. Residential use remained dominant, increasing from 57.75% in 2001 to 63.30% in 2021, indicating continued residential development rather than large-scale residential displacement.
- ii. Commercial and industrial uses increased, from 1.31% to 2.10% and 23.71% to 28.00%,

respectively, while recreational land declined from 9.93% to 4.59%, indicating increasing development pressure within the study area.

- iii. Recent redevelopment and vertical intensification is evident, with approximately 99% of mapped buildings in the 0–10-year age category and newer structures reaching higher building levels than the earlier development pattern.
- iv. Land-use and development changes are concentrated around accessible locations and major road corridors. Metro accessibility appears to have supported this intensification, alongside road connectivity, redevelopment and market forces.
- v. Future development should balance accessibility and growth with residential stability, open-space protection, public facilities and pedestrian infrastructure, maintaining the predominantly residential character of the study area.

XIII. CONCLUSION PLANNING IMPLICATIONS

The comparison of land-use patterns in 2001, 2021 and 2024 has shown that Jahangirpuri has experienced a gradual change in its urban structure within the 800 m area around the Metro station. Residential use has continued to be the dominant land use and has increased from 57.75% in 2001 to 63.30% in 2021. At the same time, commercial and industrial activities increased, while recreational and open spaces declined. This indicates that the area has not been subjected to a complete change in its land-use character; rather, existing uses have gradually become more intensive and diverse as the neighbourhood has developed.

The comparison of the three maps also shows that land-use change has not occurred uniformly throughout the study area. Changes are more visible along major roads and locations with better access to the Metro station, where commercial activities and redevelopment have become more prominent. The shift observed at individual locations has suggested that improved accessibility has influenced the way land is used, particularly by increasing the attractiveness of certain areas for commercial and mixed activities. Changes in building age and height, along with the reduction of green and open spaces, further support the overall pattern of increasing

development intensity. However, these changes are also related to road connectivity, market demand, redevelopment and existing planning conditions.

From a planning perspective, the findings suggest that Metro connectivity can encourage development and strengthen existing urban activities, but it can also increase pressure on available land and open spaces. The future management of Jahangirpuri therefore needs to balance development opportunities with the protection of residential areas, recreational spaces and pedestrian movement. Understanding the location, direction and extent of land-use shifts around the Metro station can help planners guide future development more effectively and support a more balanced and sustainable urban environment.

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