Equity in Motion: A 3P Framework for Quantifying Gentrification along Delhi's Metro Spectrum

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Abstract: Metro infrastructure has accelerated urban gentrification, which takes different forms in different neighbourhoods based on their socio-spatial contexts and functional roles. Three strategically located Delhi Metro stations Kalkaji Mandir (interchange station), IIT Delhi (intermediate station), and Dwarka Sector 21 (terminal station) are the focus of this study's analysis of gentrification trends. Divergent paths of urban transformation are represented by Dwarka Sector 21, a transit gateway to the Indira Gandhi International Airport, IIT Delhi, an academic-institutional hub, and Kalkaji Mandir, a religious-transit nexus. This study examines land-use changes, policy interventions, and demographic shifts across these sites using Rigolon and Németh's (2019) 3P framework (People, Place, Policy). Data on housing affordability, migration drivers, and commercial densification are gathered using a mixed-methods approach that combines surveys (n=100 per site), focus groups (n=9 groups), and spatial analysis. A new Gentrification Score (GS) is calculated using Python-based algorithms that combine factors like changes in the change in rent, migration patterns, and change in building density. Initial results highlight the conflict between commercialisation and religious tourism in Kalkaji, the student-driven rental markets at IIT Delhi, and the booming luxury real estate market in Dwarka. In addition to promoting equity-sensitive transit policies that strike a balance between growth and cultural preservation, the study offers a scalable formula for measuring gentrification in cities in the Global South.

Keywords: Transit-oriented development (TOD); urban gentrification; socio-spatial equity; cultural displacement; gentrification score (GS), Delhi, India.

1. Introduction

In rapidly growing economies, transit infrastructure is becoming more and more linked to urban gentrification, a phenomenon that is changing cities all over the world. Although Delhi's metro system has sparked significant neighbourhood changes, there is ongoing debate regarding the changes' implications for equity. The present study examines the dynamics of gentrification in the vicinity of three crucial nodes of Delhi's metro system: Dwarka Sector 21, a terminal station that links the city to its international airport; IIT Delhi, an intermediate station anchored by a prestigious academic institution; and Kalkaji Mandir, an interchange station that combines religious and commercial functions. By embodying unique urban identities and gentrification drivers, each site provides a comparative lens through which to examine the ways in which transit infrastructure reconfigures socio-spatial equity. The IT spillovers from Nehru Place and religious tourism are two threats to Kalkaji Mandir, which is next to the ancient Kalkaji Temple. Located in an institutional area, IIT Delhi struggles with high-density residence halls and studentification. A planned sub-city with upscale skyscrapers and airport-connected business, Dwarka Sector 21 is a prime example of state-led transit-oriented development (TOD). Notwithstanding their variations, all three locations document gentrification's hallmarks: contested land-use changes, rising rents, and demographic turnover.

In addition to increasing urban mobility, the Delhi Metro's expansion has sparked real estate speculation, business redevelopment, and the influx of higher-income demographics (Dupont, 2011; Sharma & Joshi, 2020). Small businesses and long-term residents are frequently displaced by these processes, which raises concerns about social exclusion and the loss of local identities (Lees, Shin, & López-Morales, 2016). Critics draw attention to the unequal distribution of benefits and the marginalisation of vulnerable populations, while supporters contend that metro-induced development promotes economic growth and urban revitalisation (DDA, 2017). (Desai & Loftus, 2013). In the Global South, where complex socio-spatial dynamics and rapid infrastructure expansion collide, this study places Delhi's metro-driven gentrification within larger discussions on transit-induced urban change (Jain & Jadhav, 2022). The study compares Kalkaji Mandir, IIT Delhi, and Dwarka Sector 21 to examine how various land-use policies, institutional actors, and urban morphologies influence the gen-

trification's paths and equity outcomes. The paper's ultimate goal is to provide guidance for more inclusive transit-oriented development plans that strike a balance between social justice and growth.

The 3P framework—People, Place, Policy (Rigolon & Németh, 2019)—is used in this study to organise its investigation, as shown in Figure 1.

(1) People: Educational disparities, tenure shifts (owner vs. renter), and demographic profiling of migrants.

(2) Place: Spatial equity mapping and land-use analysis using GIS.

(3) Policy: Assessing how TOD incentives and Delhi's Master Plan 2041   contribute to the acceleration of displacement.

A Gentrification Score (GS) is created using Python, taking into account factors like migrant influx rates, FAR increases (e.g., 5.0 near Dwarka), and rental inflation (e.g., 1,892 INR in Kalkaji). Quantitative data is contextualised through surveys and focus group discussions, which record residents' feelings of inclusion and exclusion. Three gaps are filled by the study:

- lack of research comparing gentrification of different types of transit stations.
- the requirement for computer models in order to measure gentrification in non-Western environments.
- Policy blind spots in striking a balance between the preservation of cultural heritage and metro-led growth.

This paper seeks to inform inclusive transit policies for Delhi and other cities with comparable issues by placing equity at the forefront of discussions about urban development.
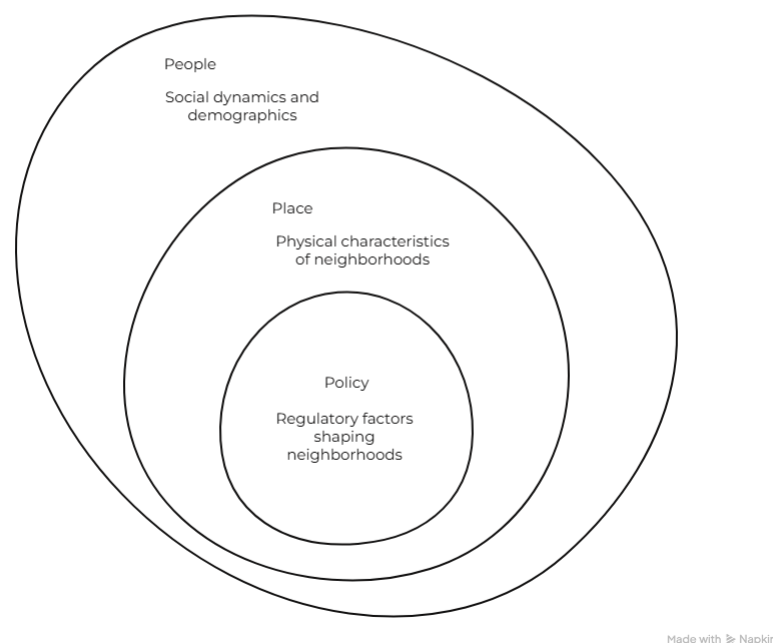

Socioecological Model of Gentrification

People
Social dynamics and demographics

Place
Physical characteristics of neighborhoods

Policy
Regulatory factors shaping neighborhoods

Made with Napkin

Figure 1. The 3P socioecological model of gentrification

2. Research Objectives

2.1 Analysis of Comparative Gentrification

The aim of this study is to examine how the functional roles of three different metro station typologies in Delhi—Kalkaji Mandir (interchange), IIT Delhi (intermediate), and Dwarka Sector 21 (terminal)—affect urban transformation through gentrification patterns.

2.2 Formulation of the Gentrification Score (GS)

In order to measure the level of gentrification in Global South transit corridors, a computational formula (GS) integrating variables like building change, rental inflation, and migrant influx rates was designed and validated using Python.

2.3 The 3P Framework Application (People, Place, Policy)

- People: To analyse how migration drivers (such as education and employment) vary among the three sites and profile demographic shifts, such as age, gender, and tenure status (owner vs. renter).
- Place: To map spatial disparities and land-use changes (using GIS), with an emphasis on land use mapping
- Policy: To identify gaps in equity-sensitive urban governance by assessing how Delhi's Master Plan 2041 and TOD policies affect gentrification.

2.4 Computational-Contextual Integration

To ensure a comprehensive understanding of the lived experiences of gentrification by triangulating quantitative data (such as GS scores and spatial trends) derived from Python with qualitative information from surveys and Focus Group Discussions (FGDs).

2.5 Policy Recommendations

To suggest equity-centred solutions that are suited to the particular gentrification factors of interchange, intermediate, and terminal transit nodes, such as mandates for affordable housing, heritage-sensitive zoning, and participatory planning models.
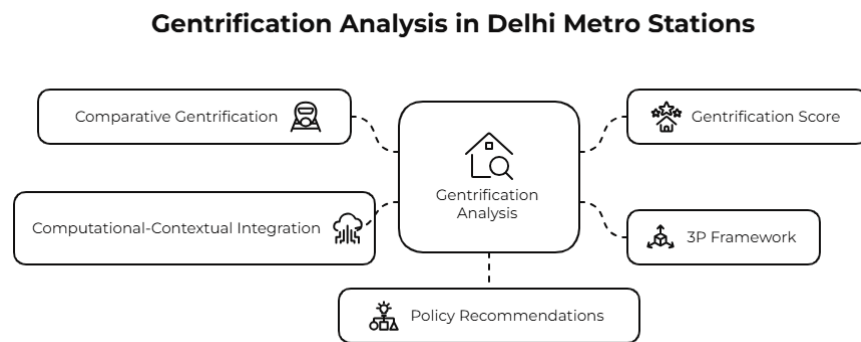

Figure 2. Research objective mapping

3. Research Methodology

An analysis of gentrification patterns in three Delhi Metro stations—Kalkaji Mandir (interchange), IIT Delhi (intermediate), and Dwarka Sector 21 (terminal)—is conducted using a mixed-methods research design that integrates quantitative and qualitative approaches within the 3P framework (People, Place, Policy). The approach is set up to handle the interaction of spatial, policy-driven, and sociodemographic elements influencing urban change.

3.1 Research Design

In order to triangulate results and improve validity, the study uses a convergent parallel mixed-methods approach, gathering and evaluating quantitative and qualitative data concurrently. The investigation is arranged into three pillars by the 3P framework:

- People: Changes in socio-demographics, factors that influence migration, and personal experiences.
- Place: Cultural displacement, spatial equity, and changes in land use.
- Policy: The effects of urban governance and transit-oriented development (TOD) policies.

3.2 Data Collection

3.2.1 Surveyss

a. Sample: 300 households (100 per site) were selected at random using stratified sampling, guaranteeing that 40% of the households were owners and 60% were renters, with a gender balance of 50% women.

b. Variables: i.   Demographic (age, gender, income, education); ii.   Housing (rental trends, tenure shifts, displacement fears); iii.   Metro usage (frequency, purpose).

c. Tools: KoBoToolbox is used for digital administration, guaranteeing real-time data aggregation.

3.2.2 Spatial Analysis

a. GIS Mapping: proposed land-use using QGIS, combining municipal records and Landsat satellite imagery.

b. Gentrification Hotspots: identified by changes in the Floor Area Ratio (FAR) and gradients in property values within an 800-meter radius of metro stations.

3.2.3 Python Analytics

a. Gentrification Score (GS): A computational formula integrating: Rent Score, Migration Score and Building Increase Score; b. Libraries Used: Pandas (data processing), Matplotlib (visualization).

3.2.4 Qualitative Methods

a. Focus Group Discussions (FGDs)

Participants: 9 FGDs (3 per site), each with 8–10 participants:

- Kalkaji: Temple trustees, informal vendors, long-term residents.
- IIT Delhi: Students, faculty, hostel administrators.
- Dwarka: Real estate agents, airport employees, students

b. Themes: Perceptions of gentrification, cultural erosion, and policy impacts.

c. Tools: Audio-recorded, transcribed

3.2.5 Data Integration & Analysis

a. Triangulation: Cross-validation of FGD narratives (displacement fears) and survey data (rent spikes) with GIS trends (e.g., commercial expansion).

b. 3P Framework Application:

- People: Statistical analysis (Python) of survey data to profile migrants and tenure shifts.
- Place: Spatial regression models (GIS) linking metro proximity to land-use changes.
- Policy: Content analysis of Master Plan 2041 and TOD policies, juxtaposed with stakeholder interviews.

3.2.6 Ethical Considerations

The sampling strategy prioritised inclusivity by oversampling marginalised groups, such as Kalkaji's informal vendors, and participants were given thorough briefings on the study's objectives, with their anonymity consistently preserved in all transcripts.
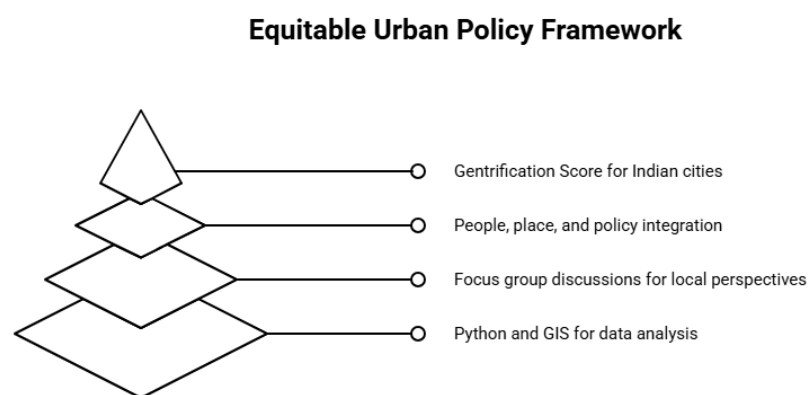

Equitable Urban Policy Framework

- Gentrification Score for Indian cities
- People, place, and policy integration
- Focus group discussions for local perspectives
- Python and GIS for data analysis

Figure 3. Methods layer diagram

4. Literature Review

4.1 Understanding the context

A complex process of urban development, gentrification entails converting a neighbourhood from one of low value to one of higher value. The inflow of affluent people into formerly underprivileged urban areas is what defines this phenomenon, which changes the neighbourhood's character, use, and environment. This procedure frequently entails the construction of new enterprises as well as the renovation and modernisation of the current housing stock, both of which raise property values. In addition to the creation of new businesses, this process frequently involves the renovation and modernisation of the current housing stock, both of which raise property values. Because of rising rents and an overall increase in the cost of living, gentrification may result in the displacement of the original, usually lower-income residents. As the most populated city in the world, Delhi's National Capital Region (NCR) offers a dynamic and complex case for gentrification research in

India. Gentrification is easily facilitated by Delhi-NCR's fast urbanisation and rising housing and infrastructure demands. (Varma & Modi, 2024)

Gentrification, as used in Western contexts, describes how urban neighbourhoods change as a result of capital inflows and shifts in the sociodemographic composition. Smith describes it as "the process by which central urban neighbourhoods that have seen economic decline and disinvestment undergo a reversal, with reinvestment and the in-migration of a well-off middle- and upper-middle-class population." Kennedy and Leonard also stress that gentrification "displaces lower-income residents of a neighbourhood, changing the essential character and flavour of that neighbourhood." The influx of wealthier populations and the displacement of lower-income residents are common characteristics of this process. However, when applying these frameworks to the Global South, particularly India, a critical re-evaluation is required. Due to land-use changes, rising rents, and real estate speculation, gentrification causes marginalized communities to be uprooted, undermining social networks and vital services (Rigolon & Németh, 2019). According to Uribe-Toril et al. (2018), gentrification is a complicated and multidimensional process with social, political, and economic facets. Its effects on social justice and urban development are hotly contested; some contend it improves amenities and stimulates the economy, while others highlight its drawbacks, including cultural homogenization, displacement, and the loss of affordable housing (Anguelovski et al., 2017; Rigolon & Németh, 2019). Gentrification alters a neighbourhood's social fabric in ways that go beyond economic and physical shifts, impacting locals' sense of place, identity, and community (Uribe-Toril et al., 2018).

Increased property values, new establishments and amenities aimed at higher-income inhabitants, the physical development of the neighbourhood's housing stock and infrastructure, and shifts in the neighbourhood's demographic makeup are some of the main characteristics that define gentrification (Venerandi et al., 2014). Cultural trends, economic restructuring, policy changes, and demographic shifts are some of the confluent factors that drive it (Richardson et al., 2019). Opportunities for profitable redevelopment may arise due to economic factors, such as the potential for higher ground rent and the depreciation of capital invested in older inner-city neighbourhoods (Smith, 1979). The demand for urban living may rise as a result of demographic changes, such as the expansion of the professional class and shifting household structures (Atkinson, 2004).

Although gentrification can revitalize a neighbourhood's economy and provide better amenities, it also has serious negative effects. Due to rising rents and property values, the process frequently results in the displacement of lower-income residents, undermining vital social networks and services (Atkinson, 2004). Because the influx of wealthier populations alters a neighbourhood's character and flavour, gentrification can also lead to the homogenization of urban communities (Richardson et al., 2019). Additionally, land-use changes and real estate speculation that put financial gain ahead of the needs of underserved communities are often the driving forces behind gentrification (Smith, 1979). Because of this, some people see the process as a kind of social and economic injustice that erodes the right to the city and exacerbates already-existing disparities. Finally, because gentrification is intricate and multidimensional, its effects on social justice and urban development need to be critically re-examined.

4.2 Gentrification and the Three Selected Metro Sites

Three different Delhi Metro stations—Kalkaji Mandir (interchange station), IIT Delhi (intermediate station), and Dwarka Sector 21 (terminal station)—are the subject of this review's analysis of gentrification. Every location offers a lens through which the complex effects of gentrification can be examined and serves as an example of distinct urban dynamics. In South-East Delhi, the Kalkaji Mandir metro station connects residential, business, and cultural areas by acting as a significant interchange between the Violet and Magenta Lines. Along with its improved connectivity, the station's advantageous location close to well-known landmarks like the Kalkaji Temple and Lotus Temple has raised local real estate demand and business activity. Better accessibility has sparked urban growth, drawing in student, higher-income inhabitants and new businesses two characteristics that are indicative of gentrification. The social fabric of the area may be altered and long-standing communities may be displaced as a result of these changes, which frequently occur in tandem with increases in property values and changes in the local demographic profile (Uribe-Toril et al., 2018).

The academic and research community surrounding the Indian Institute of Technology Delhi is the main target of the IIT Delhi metro station, which is situated on the Magenta Line. The station, which opened in 2018, improves access to residential and educational areas, increasing the area's appeal to professionals, investors, and students. A large university's presence can hasten gentrification by raising living expenses, boosting commercial development, and increasing housing demand. The neighborhood's identity may be altered and lower-income residents may unintentionally be marginalized by these processes, which mirror the larger socioeconomic and cultural changes brought about by gentrification (Uribe-Toril et al., 2018).

Connecting the Blue Line and Airport Express Line, Dwarka Sector 21 serves as a major terminal and interchange hub. The area has become a bustling urban center due to its close proximity to the Dwarka ISBT and Bijwasan railway station,

as well as commercial developments like the Pacific Mall and integrated hotel facilities. The construction of the station has attracted significant commercial interest and improved the area's allure for wealthy locals and businesses alike. This change is a sign of gentrification, a process in which new amenities and infrastructure raise property values and draw in a different socioeconomic group, sometimes at the price of affordability and established community networks (Uribe-Toril et al., 2018). The development and modernization of metro infrastructure have served as gentrification catalysts in Kalkaji Mandir, IIT Delhi, and Dwarka Sector 21. These developments present issues with affordability, community identity preservation, and displacement, even as they improve connectivity and spur economic growth. Together, these locations show how complicated and contentious gentrification is in modern urban India.

5. Focus Group Discussions: Voices from Kalkaji Mandir, IIT Delhi, & Dwarka Sector 21

Focus Group Discussions (FGDs) were held at three different transit nodes in Delhi: Kalkaji Mandir (interchange), IIT Delhi (intermediate), and Dwarka Sector 21 (terminal). These sessions brought rich qualitative insights into the lived experiences of residents and stakeholders navigating gentrification. The conversations demonstrated how perceptions of displacement, cultural deterioration, and the effects of policy are shaped by various urban identities, including religious, academic, and infrastructure-related ones.

5.1 Kalkaji Mandir: Clash of Sacred Spaces and Commercialization

Diverse viewpoints from important stakeholders demonstrate how sacred spaces and commercialisation interact in the Kalkaji Mandir area. Concerned that "the temple's sanctity is drowning in chaos," temple trustees (Trustee, 62) pointed to the growth of tourism-driven commercialisation and its degradation of the spiritual atmosphere. On the other hand, unofficial vendors, like a 48-year-old florist, expressed concerns about being displaced as a result of municipal "beautification" projects that prioritise branded shops, saying, "They call our stalls 'encroachments,' but we've sold flowers here for 30 years." Now, where are we going? Long-time residents (Resident, 55) expressed concerns about the deterioration of community cohesion as a result of the rising rents, which increase by an average of 1,892 INR every five years. They said, "Our children can't afford rents for stand-alone homes here anymore." Outsiders are catered to by new cafés, not us. This complex tension exacerbates tensions between cultural preservation and commercial development by highlighting Kalkaji's dual identity as an important religious centre and a vital transit hub.

5.2 The Indian Institute of Technology (IIT) Delhi: Studentification and Institutional Expansion

Studentification and institutional growth are putting a lot of strain on the IIT Delhi campus, resulting in a complicated interaction between community well-being and academic advancement. Students complain about housing scarcity and exorbitant rents, as demonstrated by a 21-year-old engineering student who writes, "Paying 15k INR for a shared hostel room? Off-campus housing is worse—landlords exploit us." A 54-year-old professor is among the faculty members who voice concerns about the "vanishing" peaceful academic environments brought on by commercial intrusion from recently drawn tech parks and startups. The infrastructure burden is further highlighted by hostel administrators (Administrator, 45), who claim that "Demand for hostels has tripled," requiring vertical expansion at the expense of green spaces. All of these viewpoints highlight the crucial realisation that, as it struggles with growing market pressures, IIT Delhi's academic ecosystem is finding it more and more difficult to strike a balance between its pursuit of innovation and the urgent needs of its community.

5.3 Dwarka Sector 21: Airport-Led Luxury and Displacement

According to the opinions of various stakeholders, Dwarka Sector 21 is a prime example of the complicated results of airport-led luxury development and the ensuing displacement. High-end commercial-residential complexes, on the Dwarka Expressway have overshadowed the middle-class housing, according to real estate agents (Agent, 38), who also point out that "DLF's luxury towers sell 'airport proximity' as a status symbol". A Floor Area Ratio (FAR) of 5.0 supports this trend, which shows that corporate aesthetics are prioritized. However, as airport workers complain, "My salary barely covers rent," this development creates a stark disconnect between affordability and transit-linked growth (Ground Staff, 29). This "world-class" side of Dwarka isn't for us. Furthermore, because of education-driven gentrification, students like a 19-year-old medical student are marginalized, saying, " Student housing and Coaching centres charge premium rents." Our own neighbourhood is too expensive for us. This collective realization shows that Dwarka's position as a terminal station forces brings in a lot of new and younger residents who have the spending capacity for the new neighbourhood while the older residents consider putting their homes on rent and move to other neighbourhoods or with their children post-retirement. The neighbourhood puts its corporate aesthetics ahead of equitable urbanism.

5.4 Key Findings from FGDs

Table 1 shows the mapping the main themes and findings from the FGD's.

Table 1. Mapping the main themes and findings from the FGD's

Theme	Kalkaji Mandir	IIT Delhi	Dwarka Sector 21
Cultural Erosion	Sacred-commercial conflict	Academic-commercial tension	Heritage erased for luxury
Displacement Drivers	Tourist infrastructure	Student housing demand	Airport-linked speculation
Policy Gaps	No heritage-sensitive zoning	Lack of affordable student housing	Exclusionary TOD policies

6. Survey Questions

The form's questions were divided into three categories: people, place, and policy (Table 2).

Table 2. Categorisation of Survey Questions According to Thematic Areas

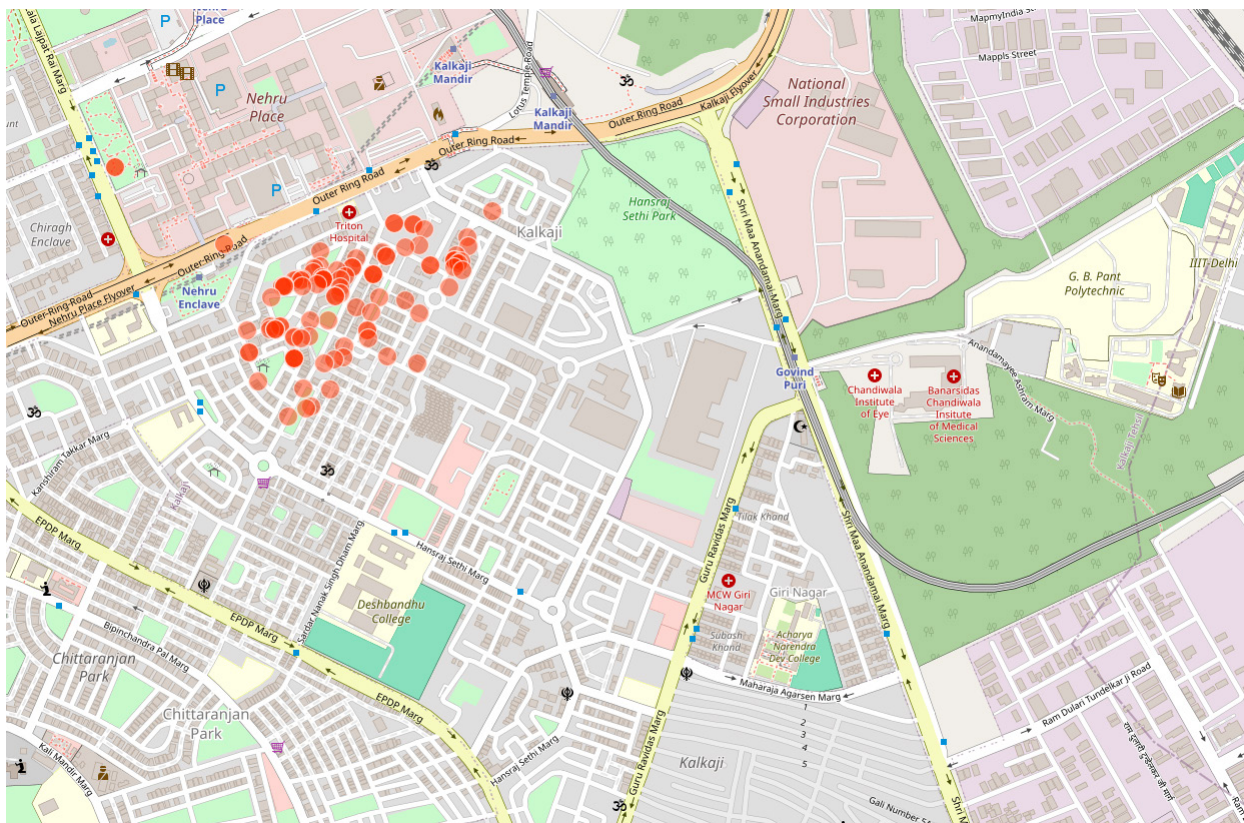|	Aspects of Discussion	Questions		
	Percentage of Migrant Population	Are you a Native Citizen? (N/Y)	What is the nature of your home region? (Urban/ Rural)	What is the Reason for Migration?
	College Degree Attainment	What is the level of education you have completed? (Below 10th Till 10th Till 12th Graduation Post Graduation)	What is the highest degree attained by a family member? (Below 10th Till 10th Till 12th Graduation Post Graduation)	
PEOPLE	Median Household Income	What is your household income? (Numerical Value)	How many members are earning members in the Family? (Numerical Value)	
	Median Household Size	What is your household size? (Numerical Value)		
	Median house value	What is the estimated value of your house? (Numerical Value)	What is the approx. area of your house? (Numerical Value)	Since when do you own this house? (Numerical Value)
	Employed Residents Occupation (%)	Under what employment category do you fall? (Employed in Formal Sector Employed in In-formal Sector Retired Unemployed)		
	Building Age	How old is the building you live in? (Numerical Value)		
	Building Condition of Old Structures	Are there any vacant home in the area (Y/N)	If Y, that what percentage? (Numerical Value)	
	Share of Home-Owners	Is your house owned or rented? (Option 1 or 2)		
PLACE	Share of Renters		How much has the rent increased over the last 5 years? (Numerical Value)	
	Median gross rent	What is the monthly rent you pay? (Numerical Value)	What is the approx. area of your house? (Numerical Value)	
	Improved structures, increased improvement activity, new construction	Is there any new construction taking place in the area? (Y/N)		
	Change in F.A.R	Have the number of homes increased in the area? (Y/N)	If Y, please mention the percentage increase. (Numerical Value)	
POLICY	Conversion of formerly industrial buildings to residential use	Has the nature or use of buildings changed? (Descriptive Input)		

Figure 4. Survey Map for the Kalkaji Mandir site, Showcasing the interface
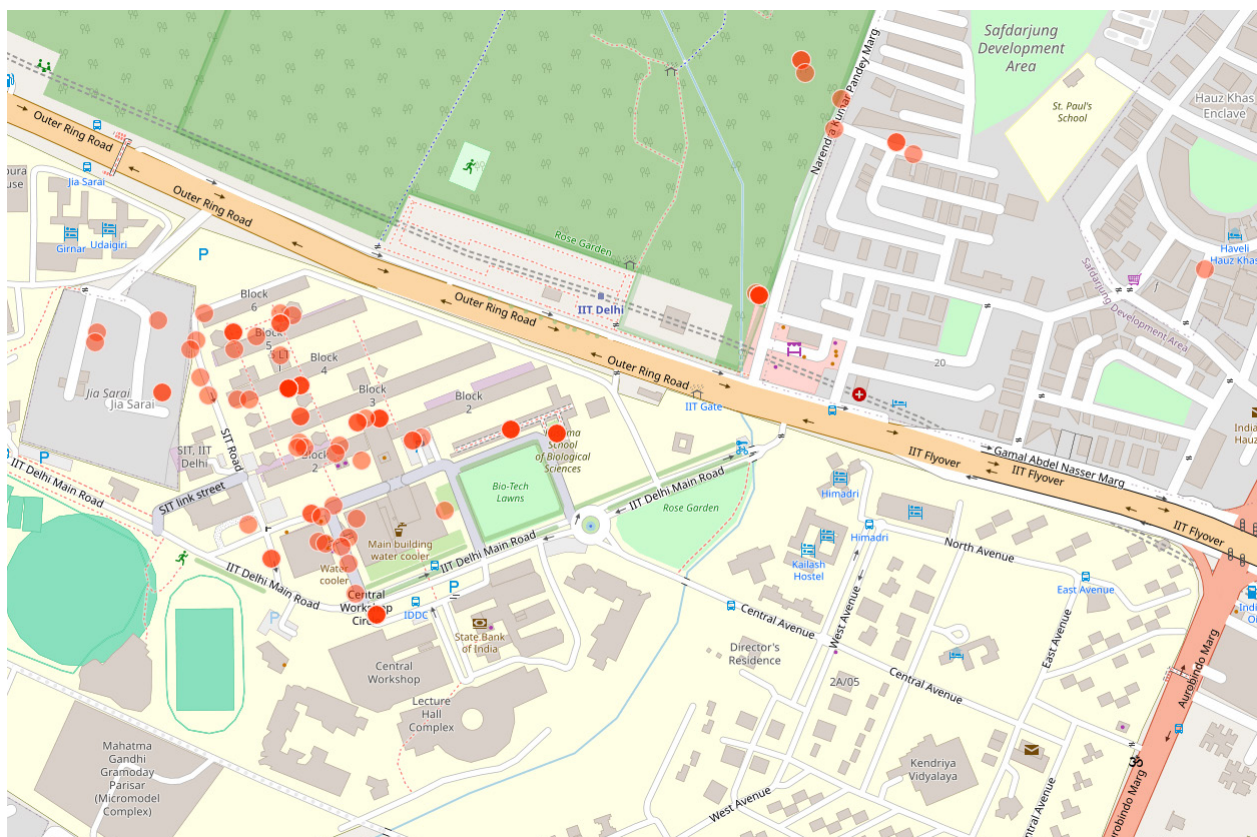

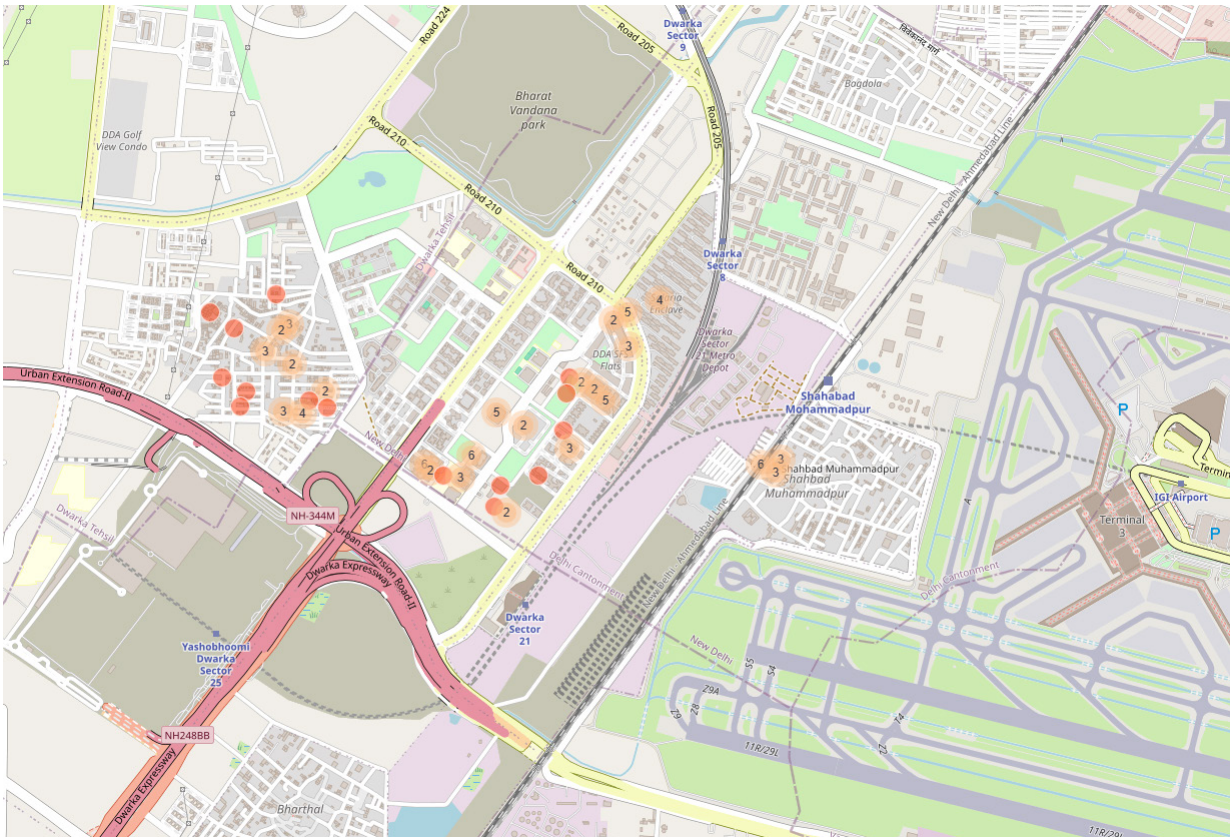Figure 5. Survey map for the IIT-Delhi site, Showcasing the interface

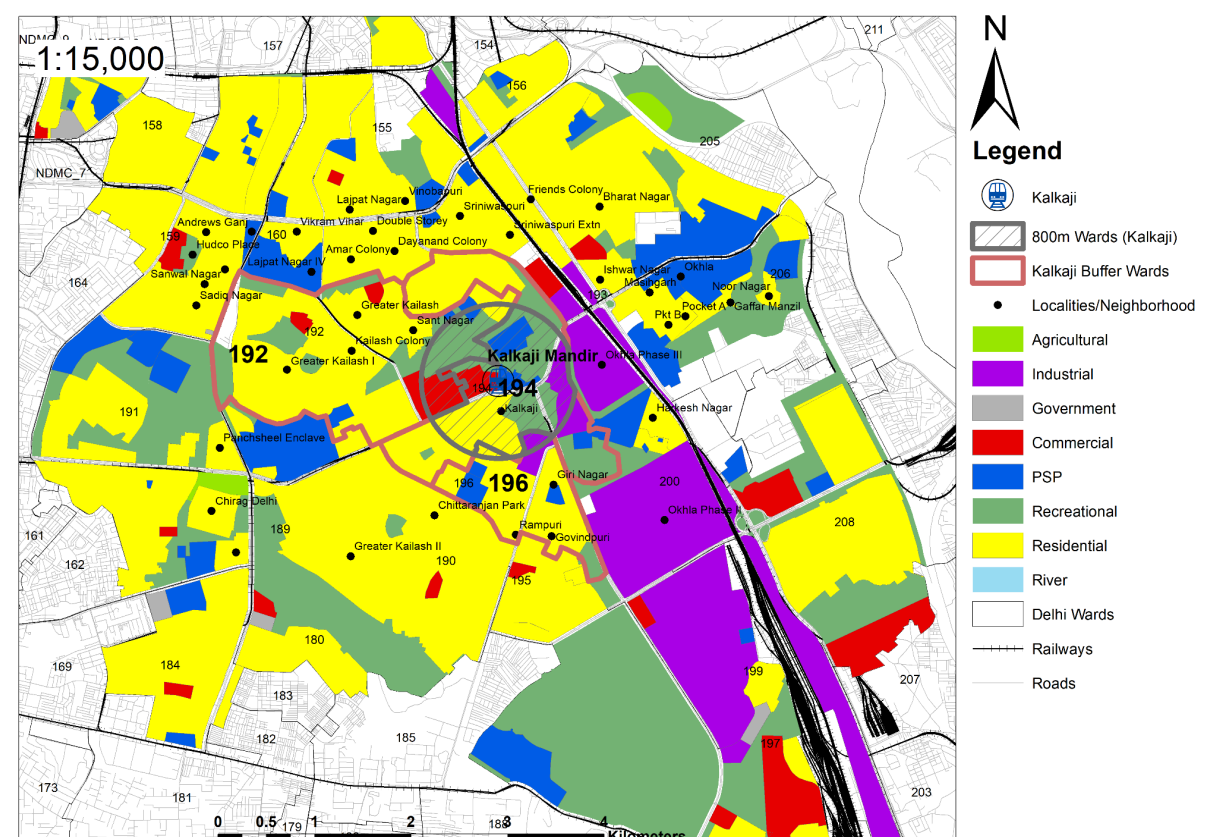**Figure 6. The survey map for the Dwarka Sector 21 site, Showcasing the interface**

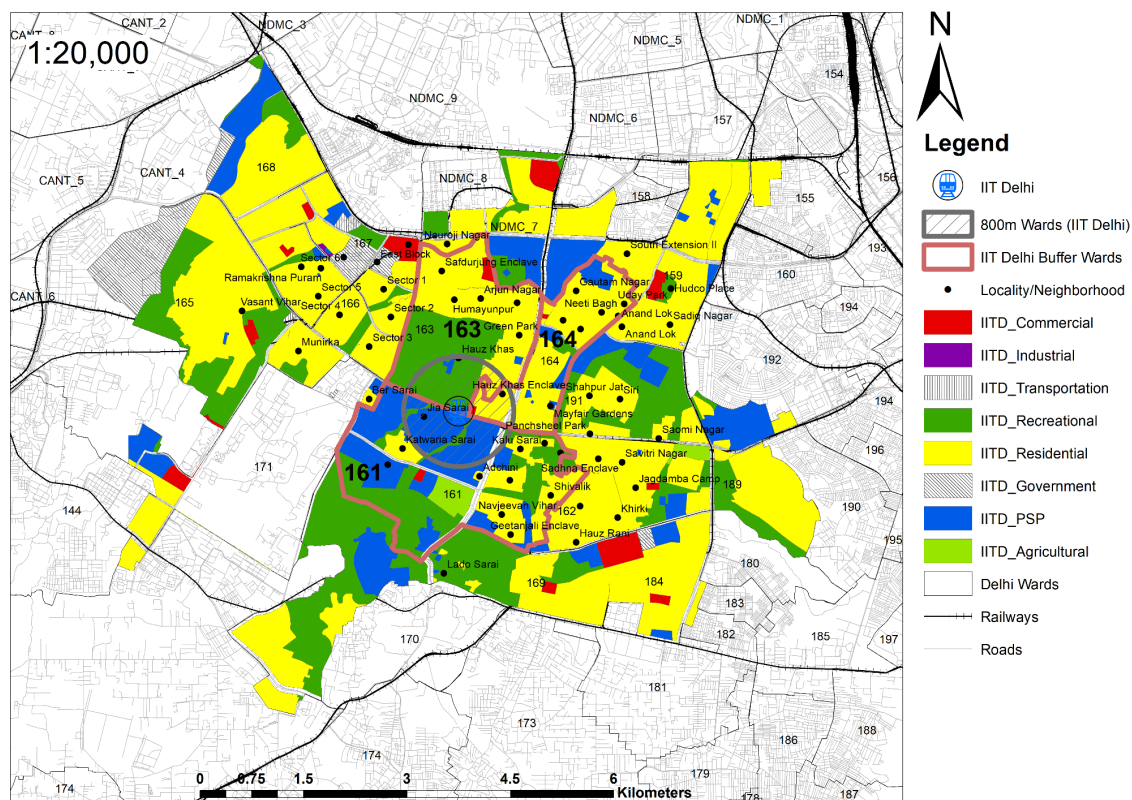**Figure 7. Land use map for the neighbourhood of Kalkaji Mandir**

Figure 8. Land use map for the neighbourhood of IIT-Delhi
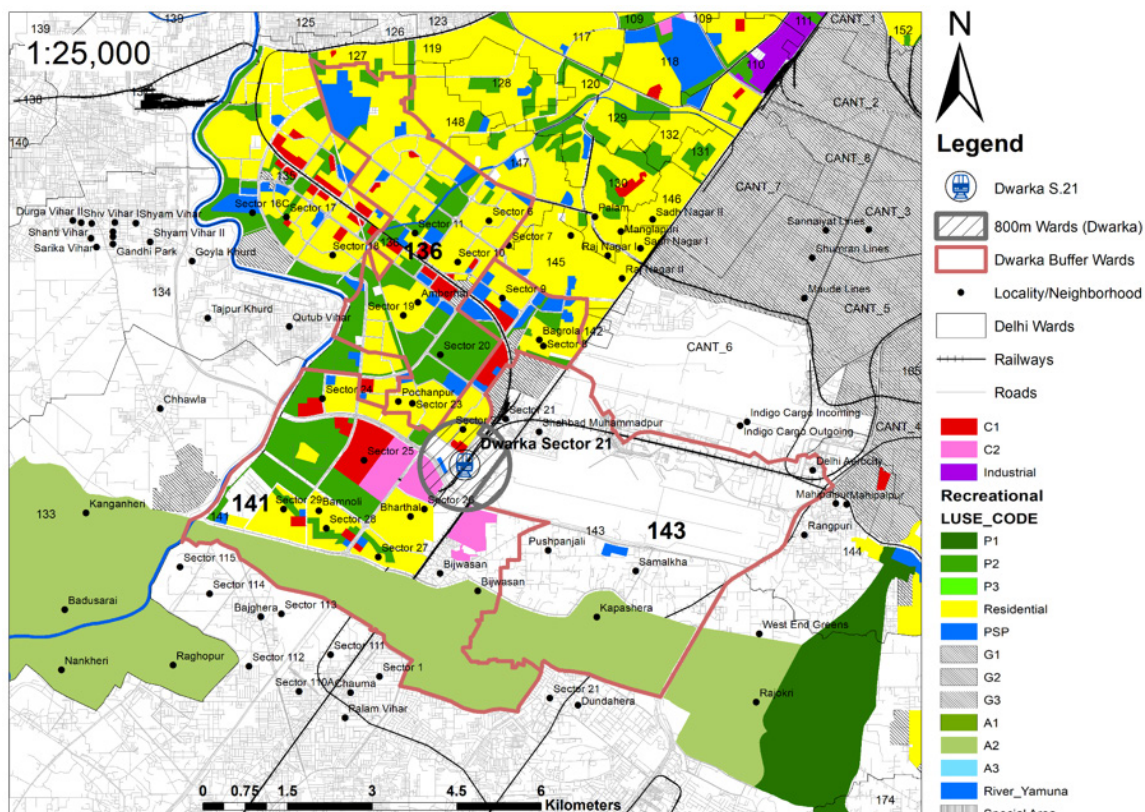

Figure 9. Land use map for the neighbourhood of Dwarka Sector 21

7. Land-use Inferences for All Three Sites

7.1 Kalkaji Mandir

With 53% of the land devoted to housing, the area is primarily residential, demonstrating its primary use as a place to live. With its 24% share, recreational land use indicates a high priority on amenities and open spaces, which enhances urban liveability. By improving access to neighbouring religious sites and promoting the expansion of tourism-related enterprises like restaurants and souvenir shops, the Kalkaji Mandir metro station has probably had a significant impact on the local economy and land use. This suggests that residential, commercial, and recreational uses are increasingly overlapping in mixed-use development. Thus, a subtle but noticeable change in land use patterns and neighbourhood character is being influenced by the area's cultural and religious significance as well as better transit connectivity.

7.2 IIT-Delhi

Residential, commercial, industrial, recreational, government, public semi-public, and agricultural land use categories make up the majority of the land use in the area (55%), followed by recreational (24%). This distribution emphasizes the neighbourhood's status as a predominantly residential area. By improving connectivity and enabling the expansion of auxiliary commercial and residential spaces designed to satisfy the needs of the student and faculty population, the IIT Delhi metro station has had an even greater impact on local development. This points to a slow transition to mixed-use development fuelled by better transit and institutional closeness.

7.3 Dwarka Sector 21

Residential, Commercial, Industrial, Recreational, Government, Public, Public Semi-Public, and Agricultural land uses are the most common in the area, accounting for 58% of all land uses, followed by Recreational at 20%. This makes it abundantly evident that the neighbourhood is predominantly residential. The development of a mixed-use zone that integrates commercial, residential, and institutional functions has been accelerated by the existence of the Dwarka Sector 21 metro station. The metro station has had a significant impact on the land use pattern as a major transit hub, promoting more dynamic and multipurpose urban development in the neighbourhood.

8. Survey Inferences for All Three Sites

8.1 Kalkaji Mandir

Due to its changing identity as a transit-commercial hub and a religious centre, Kalkaji is experiencing significant housing and demographic changes, which inevitably leads to conflicts between market-driven growth and heritage preservation. Due to the area's close proximity to educational institutions and IT hubs like Nehru Place, the area is becoming more and more populated with young, educated renters, with a mean age of 25.85 and 90% holding college degrees. Only 47% of the population has been in the area for more than 20 years, indicating significant displacement pressures, and this demographic shift is accompanied by high residential turnover. Even though 62% of respondents say there is a greater supply of housing, affordability is still a major problem for long-term residents. The rapid increase in rent, which has averaged 1,880 INR over the past five years, is mostly attributable to metro-induced commercialization, which includes mall revivals and the growth of fast-food chains. The area's cultural sanctity is further undermined by policy impacts that prioritize tourism and IT spillovers, such as Floor Area Ratio (FAR) hikes for mixed-use developments close to the temple. A 91% metro dependency highlights the significant impact of transit and its crucial role in changing Kalkaji's economic landscape.

8.2 IIT-Delhi

Due to its development into an academic-commercial nexus, IIT Delhi is undergoing significant academic gentrification and studentification, which in turn fuels exclusionary gentrification and marginalizes non-student populations. Only 23% of the population has been in the area for more than 20 years, indicating rapid demographic turnover. The area's demographics are characterized by an influx of young renters, with a mean age of 30.85 and 69% holding degrees. These individuals are primarily migrating for education and tech-related employment. Due in large part to the growth of tech startups and the increased demand for student housing, housing dynamics are characterized by severe rent inflation, with an average of 2,210 INR over five years. Older neighbourhoods have been displaced as a result of the 40% increase in housing, which is concentrated in high-rises (FAR 250–400). Transit-Oriented Development (TOD) policies in particular have transformed Hauz Khas Village by drawing more than 15 incubators within a one-kilometre radius and a number of high-end cafes. A moderate metro dependency of 45% indicates a continued reliance on walking and institutional shuttles for connectivity in spite of these advancements.

8.3 Dwarka Sector 21

In large part because of its status as a terminal station, Dwarka Sector 21 is experiencing a rapid, airport-led luxury transformation that is causing major demographic shifts and housing dynamics that prioritize speculative, elite-centric development and effectively erase its middle-class roots. Due to job and educational opportunities at the airport, the area is seeing a significant influx of young, skilled migrants, with a mean renter age of 32.17 and 68% holding degrees. Only 0.04% of the population has been in the area for more than 20 years, indicating rapid and widespread displacement. This demographic shift is accompanied by exceptionally low residential longevity. The proliferation of luxury towers (FAR 500) and large-scale commercial developments like malls have led to skyrocketing rents, with an average increase of 3,383 INR over five years—the highest increase of any site. The Radisson Blu and Aero City Mall are two examples of the high-income demographics that are primarily served by the reported 46% housing growth. Airport-linked commercialization has been expressly given priority over the supply of affordable housing in policy impacts, especially the Delhi Development Authority's (DDA) FAR 350+ auctions. Additionally, the region's primary role as a transit gateway rather than a cohesive residential hub is highlighted by its 66% metro dependency.

9. Python-Based Analysis of Survey Data and Formula Derivation

This study processed and integrated survey data from three different Delhi Metro locations Kalkaji Mandir, IIT Delhi, and Dwarka Sector 21 using a Python-based methodology. In the first step, pandas.read_excel was used to load data from several Excel sheets into a dictionary. The next steps involved robust data cleaning, which involved using df.dropna() to address missing values and numerically encoding categorical responses, like the reasons for migration. Lastly, to enable thorough cross-site analysis, site-specific DataFrames were concatenated.

The "Rent Score" was formulated to quantify the impact of rent inflation on gentrification within each site. This variable was calculated using the following normalization formula:

Rent Score = (Avg.rent increase on site-Min.rent across all 3 sites)/(Max. Rent Increase across 3 Sites - Min.Rent Increase across 3 Sites) × 100

This standardization allowed for a comparative analysis of rent inflation across the different study locations (Table 3).

Kalkaji Mandir:

$$\text{Rent Score} = \frac{1880.48 - 1445.45}{3392.93 - 1445.45} \times 100 = \frac{435.03}{1937.48} \times 100 = 22.45$$

IIT Delhi

$$\text{Rent Score} = \frac{2209.83 - 1445.45}{3382.93 - 1445.45} \times 100 = \frac{764.38}{1937.48} \times 100 = 39.44$$

Dwarka Sector 21

$$\text{Rent Score} = \frac{3382.93 - 1445.45}{3382.93 - 1445.45} \times 100 = \frac{1937.48}{1937.48} \times 100 = 100$$

Table 3. Rent Score for the three sites

Serial Number	Name of Site	Rent Score
1	Kalkaji Mandir	22.45
2	IIT Delhi	39.44
3	Dwarka Sector 21	100

The "Migration Score" was created to quantify the number of new residents moving into a particular area in order to measure demographic turnover (Table 4).

Migration Score = Percentage of Population constituted of Migrants

Table 4. Migration score for the three sites

Serial Number	Name of Site	Migration Score
1	Kalkaji Mandir	37
2	IIT Delhi	59.5
3	Dwarka Sector 21	54

The "Building Increase Score" quantifies the perceived growth in residential housing stock within a neighbourhood. This score is derived from the percentage of survey respondents who reported an increase in the number of homes in their area, relative to the total sample size for that specific location (Table 5).

Building Increase Score = Percentage of respondents that claimed the homes in the neighbourhood has increased.

Table 5. Building increase score for the three sites

Serial Number	Name of Site	Building Increase Score
1	Kalkaji Mandir	63
2	IIT Delhi	40
3	Dwarka Sector 21	46

10. Formula Derivation

The final Gentrification Score (GS) integrates these variables using weighted summation:

GS=(0.5×Rent Score)+(0.3×Migration Score)+(0.2×Building Score)

10.1 Weight Justification for Composite Gentrification Score

By giving each of its component variables a particular weight according to their perceived direct relationship to displacement and the sequential nature of urban change, the composite gentrification score was created. Since rent has a direct and statistically significant relationship with economic displacement, it was assigned the highest weighting (50%) in the study. Given its significance in predicting demographic churn, migration was given a 30% weighting; however, this weight was adjusted to take into consideration the multifactorial factors that influence migration outside of gentrification, such as job or educational opportunities. Lastly, Building Change received the lowest weight (20%), recognizing that physical changes in the built environment frequently occur as a result of underlying socioeconomic changes rather than as a prelude to them.

The Interpretation of the score for this was:

80-100- Advance Gentrification

60-79- Active Gentrification

40-59- Early gentrification

20-39- Potential gentrification

0-19- Limited Gentrification

This provided a more accurate prediction of the degree of gentrification in the area under study.

10.2 Data Processing and Python Workflow

Python was used to carry out the analytical process, mostly making use of the pandas and numpy libraries. Using pd.read_excel(sheet_name=None) to load and merge all pertinent sheets, survey data that was initially dispersed across several Excel sheets was combined into a single DataFrame. Rent values were subjected to min-max normalization for comparability across the various study sites. Pandas functions like mean() and value_counts() were used in conjunction with various numpy operations to perform subsequent statistical analysis, which included calculating individual scores.

10.3 Final Gentrification Scores for the Three Sites

Table 6 shows the final net scores for the three sites.

Table 6. Net Gentrification Score for the three sites

Serial Number	Name of Site	50% of Rent Score	30% of Migration Score	20% of Building Increase score	Gentrification Score	Net Gentrification Score
1	Kalkaji Mandir	11.225	11.1	12.6	34.925	35
2	IIT Delhi	19.72	17.85	8	45.57	46
4	Dwarka Sector 21	50	16.2	9.2	75.4	75

11. Inferences

11.1 Comparative Gentrification Dynamics

Different gentrification trajectories are significantly shaped by the functional classification of metro stations.

As a Terminal station, Dwarka Sector 21 demonstrated Active Gentrification (Gentrification Score [GS]: 76). This was primarily caused by luxury development connected to the airport, as shown by the Floor Area Ratio (FAR) of 500 towers and a significant increase in average rent of 3,383 INR. As a result, middle-class residents were quickly displaced, as evidenced by the incredibly low long-term occupancy rate of only 0.04%.

IIT Delhi, an Intermediate station, on the other hand, demonstrated Early Gentrification (GS: 46). With 62% of the population being renters, student-led migration and institutional-commercial spillovers—most notably, the presence of more than 15 tech incubators nearby—were the main drivers of this process.

Lastly, Kalkaji Mandir, functioning as an Interchange station, demonstrated Potential Gentrification (GS: 35). Here, cultural resistance seems to limit the degree of displacement as the region strikes a careful balance between protecting its religious legacy and adjusting to pressures from IT-commercial spillovers coming from Nehru Place.

11.2 Gentrification Score (GS) Efficacy

By giving priority to rent (50%), migration (30%), and building changes (20%), the GS formula successfully measured the intensity of gentrification. Its usefulness in Global South contexts was validated by the normalization of variables made possible by Python's pandas/numpy package (e.g., rent scores ranged from 35 to 76).

11.3 3P Framework Insights

People: All sites were dominated by younger, educated migrants (mean renter age: 25–32), but the drivers differed: mixed factors (Kalkaji), employment (Dwarka), and education (IIT Delhi).

Place: Kalkaji's temple-market hybridity contrasted sharply with Dwarka's commercial-residential towers (FAR 500), according to GIS.

Policy: Although Delhi's TOD policies (such as FAR hikes) increased gentrification, they lacked equity protections (such as requirements for affordable housing close to IIT Delhi).

11.4 Computational-Contextual Synergy

Complex and frequently concealed disparities across the sites were exposed by combining the quantitative Gentrification Scores (GS) with qualitative information from Focus Group Discussions (FGDs). The underlying reality of extreme elite-centric development in Dwarka, which resulted in the total displacement of original residents, was concealed by the high GS, which was indicative of significant gentrification. On the other hand, despite present indicators, Kalkaji's relatively low GS concealed latent risks resulting from increasing IT spillovers and growing tourist commercialization, indicating a potential for future gentrification.

12. Conclusions

This study makes a substantial contribution to the discussion of transit-led gentrification by demonstrating how different metro station typologies—interchange, intermediate, and terminal—determine different urban transformation routes in Delhi. Rent inflation is given priority (50% weighting) as the most direct and immediate indicator in the developed Gentrification Score (GS), which was produced through a thorough Python-based analysis and proved to be a reliable tool for estimating displacement risks.

Key findings illuminate these differentiated trajectories:

Terminal stations, exemplified by Dwarka Sector 21, accelerate active gentrification driven by infrastructure-linked speculation. This necessitates urgent policy interventions such as inclusionary zoning to safeguard affordability.

Intermediate stations, like IIT Delhi, are experiencing early gentrification stemming from academic-commercial spill-

overs. This demands targeted measures, including mandatory affordable student housing quotas.

Interchange stations, represented by Kalkaji Mandir, exhibit potential gentrification. Here, the imperative is for heritage-sensitive zoning policies that can effectively balance cultural preservation with economic growth.

Moreover, systemic policy gaps in Delhi's urban planning were brought to light by the implementation of the 3P framework, which most likely referred to a "People, Place, Policy" or comparable framework. Although Transit-Oriented Development (TOD) is specifically encouraged by the Master Plan 2041, it notably ignores important equity metrics like rent control and strong participatory planning procedures. The GS formula's computational rigor and the rich grassroots narratives obtained from Focus Group Discussions (FGDs) are combined in this study to highlight how urgent it is to put contextual urban governance strategies into place in order to successfully reduce displacement in rapidly growing Global South cities.

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