Proceedings

Gentrification and the 15–Minute City: Tensions between Proximity, Sustainability and Spatial Justice in Contemporary Urban Transformation

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Abstract: This study examines the relationship between urban proximity, as promoted by the 15–minute city (FMC) model, and gentrification in Madrid, Spain. Using composite indicators and geospatial analysis, it reveals a centre–periphery gradient in pedestrian accessibility overlapping with gentrification dynamics. While the FMC seeks sustainability and quality of life, in unequal contexts it may reinforce exclusionary trends. The findings highlight the need for redistributive policies and regulatory mechanisms to ensure the FMC fosters spatial justice instead of deepening inequalities. The study provides a methodological framework for analyzing complex urban interactions.

Keywords: 15–minute city (FMC); Gentrification; Spatial Analysis; GIS; Spatial Justice

1. Introduction

In recent decades, cities have undergone transformations linked to climate change, demographic pressure and the search for a better quality of life. In this context, proximity has become a structuring principle of urban models aimed at reducing motorized travel and ensuring daily access to essential services.

The FMC, popularised by Carlos Moreno [1], proposes polycentric neighbourhoods where daily needs can be met on foot or by bicycle. However, attributes such as the quality of public space, security and the provision of services can also encourage processes of land revaluation and social displacement [2,3].

The aim of this study is to analyse how urban proximity can coexist with gentrification dynamics [4], using the city of Madrid as a case study.

2. Conceptual Framework and Area of Study: FMC vs Gentrification

Gentrification is an urban process that combines capital reinvestment, sociodemographic substitution and commercial reconfiguration of neighbourhoods [5]. The FMC model promotes pedestrian accessibility and the decentralisation of basic urban services [3]. Their coexistence depends on institutional and real estate factors.

Madrid is an ideal setting, combining a dense, well–established historic centre with poorly accessible suburbs. Studies on gentrification in the capital [6,7] show social displacement in neighbourhoods such as Embajadores and Justicia, where residential, tourist and cultural attractions are profoundly transforming the urban structure.

3. Methodology

The study adopts a quantitative and spatial approach, carried out in two phases: (i) design of composite indicators and (ii) geospatial analysis using Geographic Information Systems (GIS).

3.1. Design of Composite Indicators

3.1.1. Gentrification Indicator

It was constructed at the district level based on three groups of variables: (i) sociodemographic characteristics -average age, educational level, nationality, family structure-; (ii) economic factors -income, public investment, land use-; and (iii) the housing market-price variations and tourist accommodation. Following an ETL, the variables were standardised (z-score), smoothed using the *tanh* and synthesized using Principal Component Analysis (PCA), obtaining a normalised index [8], scaled between 0 and1.

3.1.2. 15–Minute Accessibility Indicator

To estimate pedestrian accessibility, the walkable network derived from OpenStreetMap was used. Using Dijkstra´s algorithm, distance of 1,200 m (≈ 15–minute walking isochrones) were defined, calculating coverage by district. The proportions were integrated into a synthetic index derived from PCA and scaled between 0 and 1.

3.2. Geospatial Analysis (GIS)

Gentrification and accessibility indicators were integrated (Figure 1a–b). A 3 x 3 bivariate choropleth (Figure 2c), which enabled the identification of combined types of proximity and displacement. In addition, a pedestrian network density analysis was performed using *Kernel Density Estimation* (KDE) (Figure 2d) to assess local connectivity. Finally, the neighbourhoods of Embajadores (Lavapiés) and Justicia (Chueca) [6] were selected as representative cases due to their urban centrality and socio–demographic dynamics.
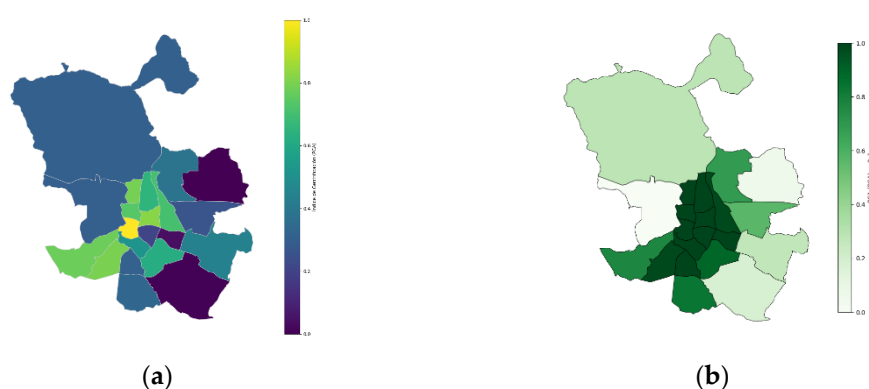

(**a**) (**b**)

Figure 1. Spatial patterns by districts in Madrid: (**a**) **Synthetic Gentrification Index (PC1, 0–1)**; (**b**) **15–Minute Accessibility Index (0–1);**
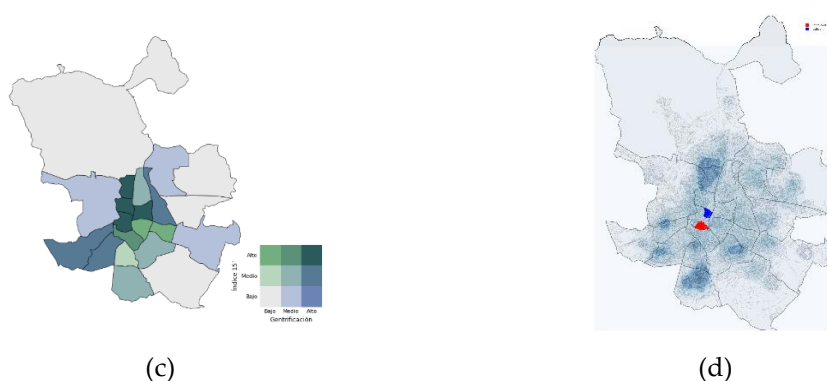

(c) (d)

Figure 2. Spatial patterns by districts in Madrid: (**c**) **Bivariate 3 x 3 Map; Gentrification vs Accessibility 15–minute. (d) Spatial density of walkable network and location of Embajadores and Justicia neighbourhoods.**

4. Results

The indicators show differentiated spatial dynamics.

The accessibility index reflects a marked centre–periphery gradient [1,9]: central districts have higher levels of pedestrian coverage and connectivity, while peripheral areas have structural deficits.

The gentrification index shows a different pattern, although partially overlapping [6]. Embajadores (Lavapiés) and Justicia (Chueca) stand out for their high socio–demographic replacement and real estate pressure, associated with price increases, the proliferation of tourist accommodation and the transformation of the commercial fabric.

The bivariate classification allows four types to be identified:

- High accessibility / High gentrification: historic centre, where proximity coexists with social displacement;
- High accessibility / Low gentrification: resilient areas that maintain population diversity despite their urban appeal;
- Low accessibility / High gentrification: transitional areas where property development precedes the provision of services;
- Low accessibility / Low gentrification: suburbs with low transformation and accessibility deficiencies.

The bivariate map shows spatial coincidence of both processes in central districts, with particular intensity in the Distrito Central. The outskirts, on the other hand, combine low values on both indicators, while the intermediate areas reflect a temporal sequence in which real estate pressure precedes the provision of urban services.

Overall, the results illustrate that the relationship between proximity and gentrification is neither linear nor homogeneous [10,11], but rather depends on specific socioeconomic and territorial contexts.

5. Discussion

The findings confirm that urban proximity does not automatically imply spatial justice [10]. In central districts, high accessibility is combined with gentrification dynamics that reinforce urban rent capture [5] and residential displacement. This result coincides with previous research that warns of the paradox of proximity policies [9,12] applied in unequal contexts.

Furthermore, the analysis shows that real estate pressure can anticipate improvements in urban services, which calls into question the idea that accessibility acts as a protective factor. The FMC, conceived as a technical strategy to reduce motorized mobility, should be reinterpreted as a political and social project that incorporates criteria of territorial equity [11]. Recent studies also underline that proximity alone does not guarantee inclusiveness, as lifestyle patterns and socioeconomic profiles condition the real usability of 15–minute environments [13]. This reinforces the need to integrate distributive justice and behavioural dimensions into the design of proximity–based planning modes.

Key instruments include affordable housing linked to urban development gains, regulation of tourist rentals, inclusive zoning and commercial stabilisation funds. These measures will enable decoupling accessibility from expulsion processes [14] and ensure that the FMC contributes effectively to social sustainability. However, its success depends on a distributive and stable governance framework that transcends the local level.

6. Conclusions

The study demonstrates that the FMC model represents an opportunity to move towards more sustainable and healthier cities; however, its implementation in unequal contexts may reinforce processes of gentrification and exclusion [1,4].

The results in Madrid confirm the territorial patterns described above, with contrasts in accessibility between central and peripheral areas [6]. The relationship between these two phenomena, far from being uniform, reflects complex urban dynamics where accessibility can act as both a driver of equity and displacement depending on institutional and market frameworks [10,12].

Methodologically, the framework used is effective for diagnosing complex urban patterns and anticipating transformation dynamics. In terms of public policy, the FMC must be accompanied by institutionalized safeguards to ensure that proximity does not become a new factor of exclusion [11], complementing the operational instruments mentioned above.

In summary, urban proximity offers a promising framework, but only if accompanied by institutional criteria for territorial equity and stable regulatory mechanisms will it be able to translate into real progress towards spatial justice [4,1,14].

7. Future Work

With a view to future research, three priority areas are proposed:

1. Comparative extension: apply the methodology to other cities with diverse regulatory and socio–economic frameworks [10], to verify the validity and transferability of the model;
2. Temporal analysis: incorporate broader longitudinal series [11] that allow modelling of historical evolution and anticipating future displacement scenarios;
3. Methodological refinement: explore non–linear models and unsupervised clustering techniques to identify hybrid urban typologies of accessibility and gentrification, also integrating mobility data and empirical validation.

These lines will enable the consolidation of a more robust, dynamic analytical framework that can be applied to diverse urban contexts, helping to link local planning with criteria of sustainability and spatial justice.

Conflicts of Interest: The authors declare no conflict of interest.

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