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Data Science Lab for Smart Cities

Final Essay

The Impact of Short-Term Rentals on Housing Accessibility in Milan: A Data-Driven Analysis

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Abstract

In recent years, the surge of short-term rental platforms such as Airbnb has sparked widespread discussion in both public and academic circles. This research explores how such rentals affect housing affordability, particularly in cities that attract a large number of tourists. The analysis includes both statistical indicators - such as increased rent prices and a shrinking supply of long-term rental options - and social consequences for local communities. Drawing on data, international case studies, and interviews with tenants and residents, the study finds that the expansion of short-term rentals tends to reduce the availability of housing for locals. It also examines possible regulatory approaches that aim to minimize the negative effects while maintaining the economic advantages of tourism.

Contents

1 Introduction

1.1 Background and Context of Short-Term Rentals in Milan

The housing market in Milan underwent significant changes during the last ten years because short-term rental platforms including Airbnb, Booking.com and VRBO expanded throughout the city. The metropolitan area of Milan with its 1.4 million residents and yearly tourist flow above 10 million makes it an essential study for understanding tourism technology effects on urban housing systems. The city functions as a worldwide center for fashion design and business which makes it highly vulnerable to quick expansion of accommodation sharing economy.

The number of short-term rental properties on Airbnb grew from less than 1,000 in 2010 to more than 24,000 active listings throughout Milan during 2024 thus reaching 3.5% of the city's total housing supply. The STR density in Navigli, Brera and Porta Venezia reaches up to 15% of available housing units because these central neighborhoods have experienced the most significant expansion. [1] Major international events such as Expo 2015 accelerated the growth of short-term rentals because they brought 22 million visitors who made property owners realize these rentals could generate substantial profits.

The fast-paced growth of short-term rentals in Milan has outpaced the ability of local authorities to establish effective regulations. The Lombardy Region established registration requirements for tourist accommodations in 2015 yet enforcement remains weak because the regulations do not differentiate between occasional home-sharing and professional property management operations. The lack of regulatory oversight enabled multiple property hosts to dominate the STR market because research shows they manage about 40% of all Airbnb listings in Milan.

1.2 Importance of Housing Affordability in Urban Environments

Housing affordability stands as an essential foundation for urban sustainability together with social equity because it directly affects how residents live and their economic possibilities and social connections. The housing affordability crisis in Milan has become severe because the average rental prices in the city reach between €20 to €25 per square meter making it the most expensive rental market in Italy [2]. The current housing market prices in Milan force residents to spend between €1,000 and €1,250 per month for a 50 square meter one-bedroom apartment before adding utility costs while the average monthly net salary stands at €2,000 [3].

The affordability of housing goes beyond cost factors to include the availability of housing units along with their quality standards and the stability of tenancy rights. The European Union determines that when housing expenses surpass 40% of disposable income it becomes an unaffordable burden which affects 35% of Milan's rental households [4]. The current housing situation drives young professionals and essential workers along with middle-income families to move away from central urban areas which results in longer commutes and reduced productivity and diminished urban vitality [5].

The connection between affordable housing and urban well-being exists through various complex relationships. Unaffordable housing creates three major problems which include rising household debt and decreased consumer spending across other sectors and increased social conflicts [6]. The housing crisis in Milan has caused young couples to postpone family planning because of insufficient housing choices which has resulted in both declining birth rates and skilled worker migration to less expensive cities that threatens the city's future economic success [5]. The forced relocation of long-term residents breaks down established social connections which weakens the social capital needed for neighborhood resilience and collective efficacy [7].

1.3 Objectives of the Study

This research combines urban sociology methods with data science techniques to analyze short-term rental platforms' effects on housing affordability in Milan. The research has three main goals which include measuring how STR density affects rental prices in different Milan neighborhoods and understanding spatial and temporal patterns of STR distribution and their relationship with socioeconomic indicators and developing evidence-based policies that protect housing rights while maintaining tourism economic benefits. This research investigates the following specific research questions:

- The extent to which short-term rentals have raised rental costs throughout Milan's different neighborhoods.
- Which parts of the city face the highest risk of gentrification and displacement because of STRs?
- What similarities or differences exist between Milan's situation and other European cities dealing with comparable housing issues?
- What combination of policy measures would protect the sharing economy benefits while reducing its negative effects?

The study holds importance because it provides essential information for evidence-based policy development during a crucial period of Milan's urban growth. The city needs to understand and solve the housing problems caused by STRs because it will host the 2026 Winter Olympics together with Cortina d'Ampezzo. The research combines empirical evidence with urban studies theory to expand platform urbanism knowledge while offering practical solutions for local stakeholders including policymakers and community organizations and urban planners.

2 Problem Description

2.1 The Rise of Short-Term Rentals (Airbnb and Analogues)

Urban accommodation markets experience a fundamental transformation because digital platforms turn residential properties into tourist accommodations through online mediation. Airbnb launched in 2008 to establish a peer-to-peer platform which connected property owners with travelers who sought genuine affordable travel experiences [8]. The original sharing economy vision of the platform has undergone substantial changes in its evolution throughout major cities including Milan.

STR platforms in Milan operate through Airbnb alongside Booking.com and VRBO and local Italian platforms Wimdu and HouseTrip. Research of listing data indicates that 65% of short-term rentals consist of entire homes or apartments instead of shared accommodation spaces thus showing dedicated tourist facilities dominate the market. The professionalization of the sector is evidenced by the concentration of listings among multi-property hosts, with the top 10% of hosts controlling nearly 40% of all listings in Milan [9].

The technological base of these platforms facilitates exceptional market expansion through their systems. The combination of dynamic pricing systems with automated booking mechanisms and property management software reduces entry requirements and enhances host revenue streams. The emergence of professional property management companies in Milan provides extensive STR services including listing optimization and guest communication and cleaning and maintenance to hasten the transition of residential buildings into commercial properties. Short-term rentals have undergone industrial transformation since their peer-to-peer sharing beginnings to create an independent accommodation sector which operates mainly without standard regulatory systems.

STR market performance in Milan suffered a temporary decline of 30% during 2020 because of the COVID-19 pandemic. The market showed strong recovery patterns after the pandemic by reaching pre-pandemic listing numbers in late 2022 before continuing its upward trend. The pandemic showed how short-term rentals functioned as medium-term rentals for remote workers and students through temporary market shifts which revealed both platform volatility and flexibility in housing markets [10].

2.2 Impact on Housing Availability and Affordability in Milan

Short-term rentals in Milan have led to multiple housing challenges for residents because of several connected factors that affect housing access and affordability. The primary consequence of short-term rentals arises when they convert residential units into unavailable spaces that result in reduced long-term rentals availability thus causing prices to increase. A 1% rise in Airbnb listings in US cities generates a 0.018% increase in rental costs while leading to a 0.026% increase in house prices according to research by Barron [11]. The current STR market penetration rate in Milan shows elasticities that result in 5-7% rental price increases throughout the city while neighborhoods with heavy tourism see even greater impacts.

The spatial distribution pattern of short-term rentals throughout Milan demonstrates specific cluster locations which directly relate to rising rental costs. The Navigli district demonstrates the highest STR concentration reaching 12% of total housing units while experiencing 42% rent growth from 2015 to 2023 compared to the 28% citywide increase [2]. The unique market effects between tourism and housing drive "tourism gentrification" because visitor-attractive areas push out long-term residents at an accelerated rate. Historic neighborhoods close to tourist destinations experience severe STR-related resident displacement because short-term rental nightly earnings reach three to four times higher than typical monthly rentals according to Celata and Romano (2022) [12].

STRs modify housing markets through mechanisms that surpass basic supply restrictions. STRs in buildings and neighborhoods generate multiple adverse impacts on resident populations through increased noise levels and security threats and breakdowns of community bonds [13]. The combined factors drive long-term residents to abandon their homes which creates more opportunities for STR conversions. The visibility of STR revenue levels modifies property owner expectations about market values thus causing rent increases that affect both short-term and long-term rentals through the "demonstration effect" [14].

Research conducted in Milan demonstrates the existence of these theoretical patterns. Research data shows STR-heavy areas experience reduced rental contract renewals which confirms that tenant displacement occurs

in these areas. Rental listing data analysis reveals that high-STR neighborhoods experienced their long-term rental listings stay on the market for only 21 days instead of the previous 45 days which results in landlord price advantages [2].

2.3 Societal Significance and Urban Implications

The housing market changes in Milan through short-term rentals bring substantial consequences for social structures in urban areas and economic sustainability and life quality. Digital technology enables platform urbanism to transform physical spaces and social relationships in ways that challenge existing urban governance systems [15]. Multiple dimensions of societal importance emerge from this phenomenon which impacts population demographics and social unity as well as economic disparities and urban character.

The STR affordability crisis drives young adults along with middle-income families to leave their homes in central Milan. The neighborhoods with high STR presence have lost 5-15% of their residents according to ISTAT census statistics since 2011 with the greatest reduction found among people aged 25-39. The demographic changes caused by STRs lead to decreased school enrollments while neighborhood shops switch to serve tourists instead of residents [16]. Residential neighborhoods experience a "hollowing out" process that endangers the diverse social networks which used to define Milan's city center.

The economic consequences from housing sector changes create substantial effects which influence urban productivity together with competitiveness. Teachers and healthcare providers along with service staff members cannot afford city living costs which makes it harder for employers to find and keep workers. The 2023 survey conducted by Assolombarda (Milan's business association) demonstrated that 67% of businesses face housing expenses as their main obstacle to hiring new employees so they started corporate housing initiatives to mitigate this challenge [17]. The mismatch between affordable housing locations and employment centers leads to longer commutes that cost the Milan metropolitan area approximately €2.3 billion per year according to environmental and productivity assessments [18].

Short-term rental proliferation causes the most difficult to measure yet vital effects on social cohesion and community resilience. The repetitive entry and departure of short-term guests creates disruptions that break down the social connections which enable people to work together and support one another [19]. People who live in buildings with many short-term rentals experience deteriorating security feelings and they lose their neighbors while becoming less involved in community events. Residential space commodification brings market forces into areas that were previously non-commercial which may damage social bonds and reduce civic participation [20]. The social costs produced by STRs will probably have greater significance for Milan's urban sustainability in the long run than the current economic effects.

3 Literature Review

3.1 Global Evidence on Short-Term Rentals and Housing Markets

Research about short-term rentals and their influence on urban real estate markets has increased significantly since 2015 because Airbnb platforms expanded worldwide and governments started taking regulatory action. The research conducted by Barron, Kung and Proserpio (2021) used United States-wide data to establish the causal link between Airbnb market penetration and housing prices [11]. The instrument variable analysis by researchers found that rising Airbnb listings by one percent results in a 0.018 percent rent increase and a 0.026 percent house price increase mainly affecting areas where owner-occupancy rates are low.

Wachsmuth and Weisler (2018) explain STR market effects through a "rent gap" framework derived from gentrification theory [21]. The conversion of residential properties to short-term rentals occurs because STRs enable property owners to generate additional ground rent through extraction when the potential revenue gap exceeds the costs of transactions. The theoretical framework helps researchers understand how STRs cluster in areas with tourism facilities while speeding up the gentrification process in previously inexpensive neighborhoods.

3.2 Case Studies: Lisbon, UK, and US Markets

The experience of Lisbon offers valuable information to Milan because both cities share comparable features as Southern European capitals under heavy tourism pressure with limited tenant rights. The research by Cocola-Gant and Gago (2021) shows that Airbnb expansion in Lisbon resulted in a 37% growth of rental prices from 2015 to 2019 while historic neighborhoods became almost completely tourist-oriented [22]. The researchers conducted ethnographic fieldwork which exposed the phenomenon of "collective displacement" where entire communities had to disperse because buildings were converted into exclusive short-term rental facilities. The case of Lisbon shows that belated regulatory measures are insufficient because the 2019 law that restricted short-term rentals in historic centers did not stop the formation of tourist districts.

The United Kingdom has studied the STR situation in London through research since regulatory actions started early in this process. The research by Shabrina et al. (2021) studied the 90-day STR letting restriction in London and discovered substantial non-compliance while showing how markets adjusted through the creation of medium-term rental options [23]. The research used machine learning algorithms to detect non-compliant entire-home listings which showed that 35% of listings exceeded the regulatory day limit. The UK example shows how well-designed regulatory measures work in tourist accommodation markets while revealing their boundaries in such high-demand environments.

US markets offer various examples regarding STR effects together with policy reactions. The strict New York City regulation that demands hosts to stay with guests led to an 80% decrease in Airbnb listings yet forced operators to relocate to adjacent areas according to Wachsmuth et al. (2018) [21]. The cities of Austin and Nashville implemented registration and taxation requirements for short-term rentals while permitting operation without major restrictions.

Nieuwland and Van Melik (2020) conducted cross-national research across 11 European and North American cities to study STR growth patterns and their social impacts [19]. The combination of high tourism activity with insufficient housing availability and weak rental protection laws resulted in the worst housing affordability problems in affected cities. The study demonstrated that cities which maintained strong institutional planning frameworks together with market intervention traditions succeeded in better controlling STR expansion. The comparison between cities indicates that Milan faces substantial risks of housing stress due to its high tourism rates and limited housing supply alongside its weak regulatory systems.

3.3 Gaps and Controversies in Existing Research

The research about STRs in housing markets continues to expand yet fundamental questions and disagreements persist. Observational data limits our ability to draw causal conclusions about the research. The challenge of finding exogenous variation in STR penetration remains substantial when using instrumental variable methods. . The identification of causal effects would benefit from experimental or quasi-experimental evidence from regulatory changes although this type of evidence is currently scarce.

The evaluation of different population groups experiencing various impacts from STRs lacks sufficient research. The documented effects of STRs on rental prices at the aggregate level need further investigation regarding how they affect different income groups and age cohorts and household types. The evidence indicates that short-term rental impacts primarily affect younger renters along with lower-income families who cannot afford to purchase homes. The analysis of welfare effects which considers benefits for property owners and tourism workers remains largely underdeveloped.

The use of proper spatial and temporal scales for research continues to generate methodological disputes. The effects of STRs on different types of neighborhoods produce distinct patterns since tourist-oriented areas experience distinct transformations than residential outer districts. Short-term price movements show different patterns than the long-term structural modifications which occur in housing markets. The majority of existing studies focus on relatively short time periods (2-5 years), potentially missing longer-term equilibrium effects. Future research should develop dynamic models that demonstrate how STR growth creates feedback loops between neighborhood transformations and policy adjustments and market responses.

The extent to which STR platforms influence market results continues to be disputed among experts. The platforms claim to act as neutral facilitators of transactions between willing parties since affordability problems derive from general housing supply shortages. The academic community has disputed this perspective through research that shows platform design elements like recommendation systems and pricing tools and host professionalization features directly influence market results [24]. Researchers face challenges in understanding platform mechanisms fully because algorithms operate in opaque fashion and they have restricted access to platform data. Researchers face two issues regarding the accuracy and completeness of commonly used data sources because platforms only offer restricted information while web-scraped data might omit important parts of the market.

4 Data Collection and Preparation

4.1 Overview of Data Strategy

The empirical study of short-term rentals' effect on housing affordability in Milan needs a thorough multi-source data methodology which integrates platform data with official housing market statistics and demographic indicators. The dataset selection strategy focuses on temporal coverage and spatial granularity and data reliability to establish robust analytical foundations for studying the intricate relationships between STR proliferation and housing market dynamics.

Short-Term Rental Data

The Inside Airbnb data collection through web scraping provides the main STR dataset which allows users to access worldwide Airbnb listing information. The Milan dataset obtained on March 13, 2025 delivers complete information about short-term rentals through its database which contains detailed data about locations and prices and availability and host information and property characteristics for each listing. The raw dataset shows the complete range of short-term rental operations in Milan which includes both casual home-sharing and professional management of multiple properties.

The Inside Airbnb data contains vital variables for housing affordability analysis through its nightly pricing information and property types and host listing counts and availability patterns and geographic coordinates for spatial analysis. The raw data uses neighborhood classification which matches the administrative boundaries of Milan to merge with official housing market statistics and demographic information.

The data contains essential elements which include pricing information and occupancy patterns and property type distributions and host characteristics that help identify commercial operators with multiple properties. The precise geographic data allows researchers to study impacts at different spatial levels ranging from individual buildings to entire neighborhood market transformations.

Official Housing Market Data

The Italian Revenue Agency's Real Estate Market Observatory (Osservatorio del Mercato Immobiliare - OMI) serves as the main source for housing market analysis through its authoritative price quotations for purchase and rental markets.

The comprehensive historical dataset `ds1996_quotazioni_omi_compravendita_e_locazione_riepilogo.csv` covers the period from 2004 until present with 25,946 entries that provide extensive price information about various property types and conditions and geographical areas in Milan. The dataset allows researchers to study housing market patterns before and after the STR platform grew.

The 2024 rental market dataset `(quotazioni_omi_locazioni_2024_1.csv)` offers vital present market information through 486 observations distributed across 40 different zones in Milan. The dataset contains 175 residential property observations which include civil housing (79 observations at €17.3/ m^2) and economic housing (76 observations at €11.86/ m^2) and luxury housing (9 observations at €32.83/ m^2) and villas (11 observations at €13.02/ m^2). The price distribution across Milan's zones shows distinct spatial patterns through Fascia B-E bands which span from €23.34/ m^2 in high-end areas to €8.5/ m^2 in outer districts thus establishing important reference points for computing rent gap ratios between STR earnings and conventional rental profits.

The OMI datasets contain three types of categorical data which include property quality ratings (normal, excellent conditions) and typology categories and geographic identifiers that match Milan's urban planning areas for detailed spatial market research and STR concentration pattern comparisons.

Demographic and Socioeconomic Context Data

The official demographic dataset `(ds205_dati_quartieri_2011_2021_.csv)` provides essential socioeconomic context through 976 observations spanning 89 neighborhoods over an 11-year period (2011-2021). The longitudinal dataset contains 29 variables which include population demographics (gender, age distributions, foreign residents) and household characteristics (family composition, single-person households, elderly isolation) and vital statistics (births, deaths, migration flows) and educational infrastructure indicators. The temporal coverage includes the essential time frame of STR platform development and expansion in Milan which allows researchers to study population shifts that could be linked to short-term rental expansion.

4.2 Dataset Integration and Analytical Framework

The comprehensive multi-source dataset architecture enables sophisticated analysis of STR impacts through three interconnected analytical layers. The micro-level analysis uses Inside Airbnb neighborhood aggregations with 2024 OMI rental quotations to determine exact rent gap ratios which reveal the neighborhoods with the highest STR revenue premiums that drive housing stock conversion. The meso-level analysis combines Milan demographic data from 2011-2021 with historical OMI price trends to study how neighborhood socioeconomic transformations relate to STR growth patterns.

The macro-level comparative analysis evaluates Eurostat indicators to understand how Milan's housing affordability problems relate to European-wide patterns which helps researchers detect universal factors that either strengthen or weaken STR effects in different urban housing systems. The layered method allows researchers to verify local results against international patterns while preserving both spatial and temporal details required for evidence-based policy development.

The integration of STR data with official housing market indicators becomes possible through OMI zone classifications which serve as spatial reference points and demographic neighborhood boundaries which provide socioeconomic context to market dynamics.

4.3 European Comparative Housing Data

Seven Eurostat datasets specialized for the analysis of European trends enable us to understand Milan's housing affordability issues in relation to other EU member states. The House Price Index dataset (2010-2023, 465 observations) provides standardized metrics for housing cost evolution using 2015 as the baseline year, enabling comparison of Italy's housing market dynamics with other European urban centers facing similar STR pressures.

The Distribution of Population by Tenure Status dataset (1,040 observations) provides critical insights into homeownership versus rental market patterns across European countries, essential for understanding the structural vulnerabilities that make rental markets susceptible to STR disruption. Complementary datasets examine population distribution patterns (464 observations) and average household size (479 observations), which directly influence housing demand and affordability pressures.

Housing quality and adequacy indicators include the Overcrowding Rate dataset (512 observations) measuring spatial housing stress by demographic characteristics and poverty status, and the Share of People Living in Underoccupied Dwellings dataset (510 observations) revealing housing market inefficiencies and potential spaces available for STR conversion. The Inability to Keep Home Adequately Warm dataset (480 observations) provides a unique indicator of housing affordability stress, measuring households' capacity to maintain basic housing quality standards.

These datasets collectively provide essential context for understanding whether Milan's housing affordability crisis reflects Italy-specific conditions or broader European patterns of STR-driven market transformation, supporting the development of evidence-based policy recommendations that account for international best practices and regulatory frameworks developed across the European Union.

4.4 Data Integration and Geographic Harmonization

The datasets needed extensive processing to develop analytical indicators which measured STR impacts. The essential process merged Inside Airbnb listing data with OMI rental quotations to establish rent gap ratios and revenue premiums at the neighborhood level. The analytical dataset at the neighborhood level aggregated STR metrics from 78 distinct areas through the combination of median nightly prices with estimated monthly revenues and property type distributions and host commercialization indicators.

The geographic standardization process required the development of conversion systems between Inside Airbnb neighborhood classifications and OMI zone codes (Fascia and Zona) and municipal demographic areas (Quartiere and NIL). The revenue estimation algorithms used nightly pricing data and availability patterns from booking calendar analysis to calculate monthly income potential.

The housing price data needed extensive normalization because OMI data used different decimal separators and various measurement units existed between sources. The OMI price ranges were standardized through midpoint calculations which revealed residential prices ranging from €8.5/ m^2 in peripheral areas to €32.83/ m^2 in luxury housing. The longitudinal comparison used Italian consumer price index data to adjust currency values for inflation.

The data quality procedures involved three steps: listing incompleteness detection and property classification standardization and the development of criteria to separate commercial operators from occasional hosts based on their listing counts and management characteristics.

The Inside Airbnb data includes only listings that were visible at the time of collection in March 2025 and does not include private accommodations or properties listed on other platforms. The revenue estimates are based on algorithmic calculations that may not reflect the actual booking patterns. The temporal lag between the demographic data (2021) and the current STR conditions (2025) limits the ability to capture recent market dynamics, especially the post-COVID recovery patterns.

4.5 Official Data and Methodological Constraints

OMI data shows market quotations instead of actual transaction prices which could result in incorrect market condition assessments. The 2024 OMI dataset concentrates on formal rental segments which could overlook informal housing arrangements that face the risk of STR displacement. The primary STR data presents a cross-sectional design which prevents researchers from establishing cause-and-effect relationships because neighborhood features that attract STR development also produce rental price growth through separate gentrification mechanisms.

The European comparative datasets employ standardized indicators which fail to detect Italy's unique housing market features and the spatial patterns of tourism pressure that exist in historic centers such as Milan. The necessary neighborhood-level aggregation process hides essential building-level concentration patterns which are vital for understanding localized displacement effects.

5 Data Analysis and Visualization

5.1 Spatio-Temporal Analysis of Short-Term Rental Distribution in Milan

The March 2025 Inside Airbnb dataset shows that short-term rental operations in Milan are extensive because it contains 14,626 active listings after removing invalid prices and duplicate entries. The housing market of Milan shows a major presence through STR operations which differ substantially between different neighborhoods. The platform has shifted from its peer-to-peer sharing roots because entire homes and apartments make up 87.9% of all listings which shows widespread residential property conversion into tourist accommodations.

The spatial distribution analysis shows that the top 10 neighborhoods contain 5,951 listings which represent 40.7% of the total market. Buenos Aires-Venezia leads with 1,057 listings, followed by Duomo (886 listings) and Navigli (565 listings), indicating that STR operations tend to cluster in areas with high tourism appeal and central locations. The STR distribution pattern indicates that operators have deliberately chosen specific areas instead of allowing listings to spread naturally throughout the city.

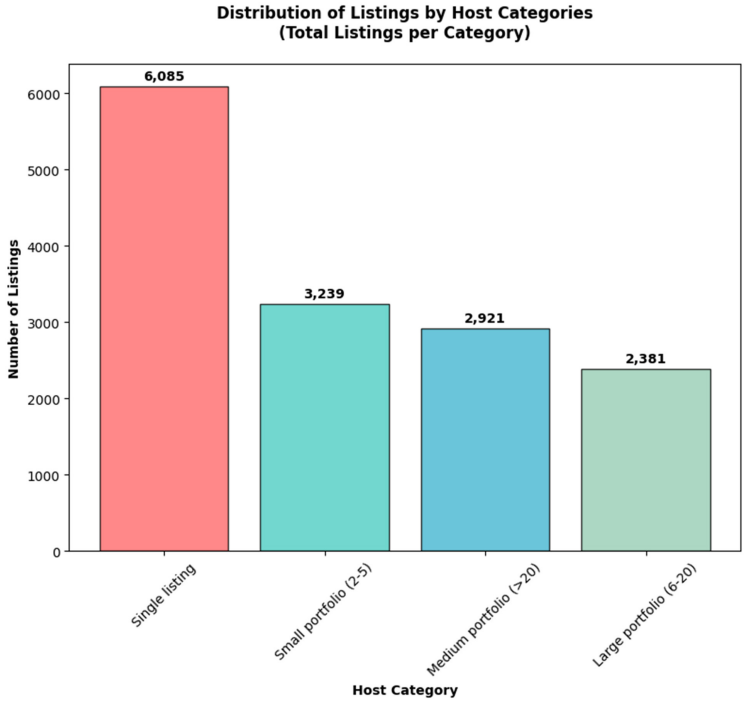

Figure 1: Distribution of Listings by Host Categories

The analysis shows market professionalization as a critical factor because 58.4% of listings (8,541 properties) were operated by professional hosts who managed multiple properties. The platform's initial home-sharing concept stands in opposition to the substantial commercial influence that has entered the market. The host categorization analysis (Figure 1) demonstrates that single listing hosts maintain the largest individual category with 6,085 properties yet professional operations control most of the market through small portfolios (3,239 listings), medium portfolios (2,921 listings) and large portfolios (2,381 listings).

The market concentration analysis reveals concerning monopolization patterns because the largest single host manages 314 listings and the top 10 hosts control 1,375 listings which represent 9.4% of the total market. The concentration of listings allows professional hosts to implement coordinated pricing strategies and market manipulation which casual hosts cannot achieve independently. Professional hosts operate with higher intensity because 23.1% of their listings remain available for more than 300 days throughout the year thus proving they run dedicated tourist accommodation instead of occasional home-sharing.

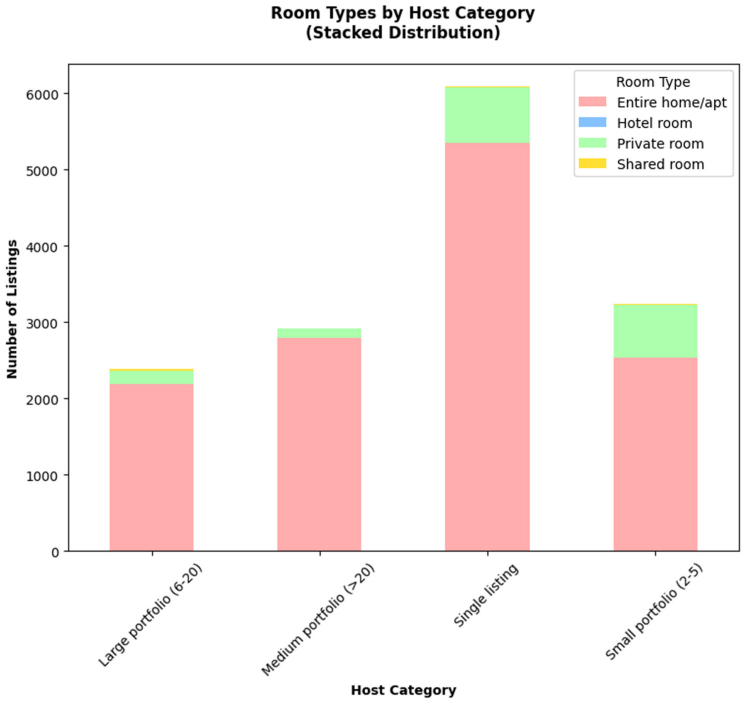

Figure 2: Room Types by Host Category

The room type distribution analysis (Figure 2) shows that entire home/apartment listings make up the majority of listings across all host categories with minimal differences between casual and professional operations. The data shows that residential property conversion operates systematically as a business model instead of home-sharing practices which contradicts the platform's community-based accommodation sharing claims. The slight difference between professional and casual hosts in choosing entire home listings (88.0% vs 87.8%) indicates that property type selection follows market demand instead of operational strategy.

5.2 Neighborhood Vulnerability Assessment

The composite vulnerability index uses STR density and proportion of entire homes and professional host concentration and median pricing to determine which neighborhoods face the most housing displacement risks. The Duomo neighborhood stands as the most vulnerable area (vulnerability score: 0.745) because it has 886 properties listed and 81.8% professional hosts and a €154 median nightly rate. Buenos Aires-Venezia ranks second in vulnerability (0.680 score) because it has the most listings but lower professional host rates.

The vulnerability analysis shows that historic center neighborhoods (Duomo, Brera, Ticinese) and trendy districts (Navigli, Isola, Sarpi) face the highest conversion pressures. The areas show both tourist appeal and rental housing availability which makes them suitable for STR conversion. The spatial distribution of vulnerable neighborhoods indicates that the city will undergo district-level transformation instead of individual property conversions.

5.3 Correlation Analysis Within Short-Term Rental Market Dynamics

The statistical analysis demonstrates substantial relationships between host attributes and their property management methods. The pricing strategies of professional hosts match those of casual hosts because they charge similar nightly rates (€90 for casual hosts and €92 for professional hosts as shown in Figure 3). The unexpected discovery shows market forces push prices toward equality and professional hosts probably use volume-based approaches instead of premium pricing to achieve maximum revenue.

The price distribution analysis (Figure 3) demonstrates identical median prices between different host categories which proves that market competition affects all host groups uniformly. The box plot distributions show professional hosts maintain prices that cluster more closely around the median than casual hosts who display greater price variability.

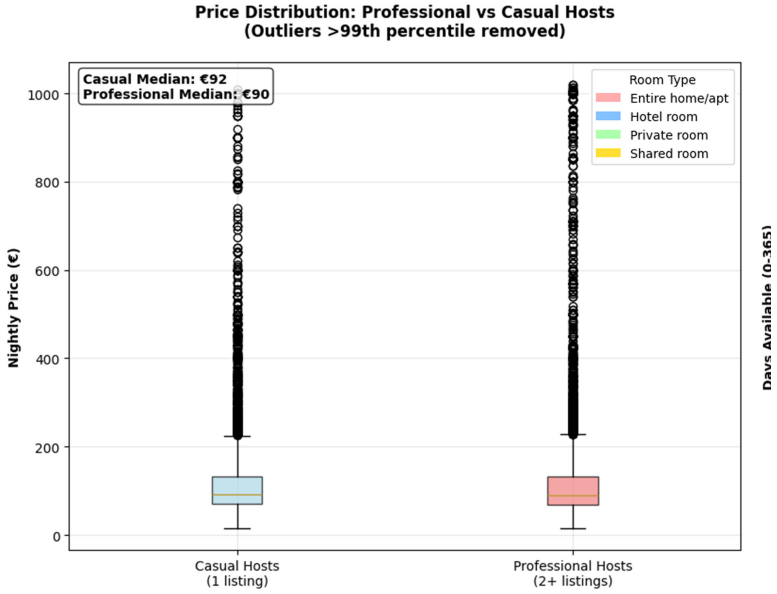

Figure 3: Price Distribution: Professional vs Casual Hosts

Professional hosts operate with higher median availability rates than casual hosts do because they maintain 185 days of availability per year compared to 166 days annually (Figure 4). Professional operators use systematic methods to optimize occupancy because they consider STR as their main revenue source instead of additional income. The availability distribution shows professional hosts operate with consistent high-availability strategies while casual hosts demonstrate unpredictable patterns. The analysis of room type distribution shows professional hosts prefer entire home listings at 88.0% compared to casual hosts at 87.8% but the difference remains small because it follows market demand rather than host category preferences. Professional hosts dominate high-demand neighborhoods because they operate at 81.8% in Duomo while peripheral areas have more casual hosts.

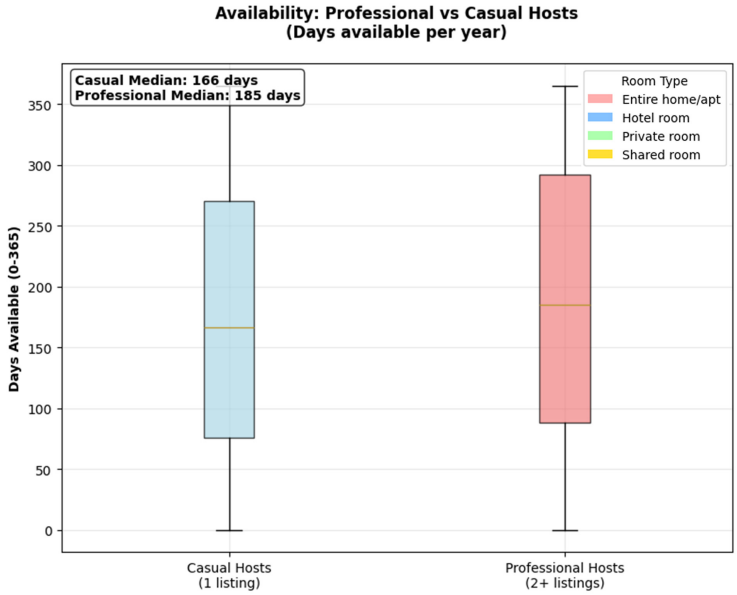

Figure 4: Availability: Professional vs Casual Hosts

5.4 Pricing and Availability Relationships

The analysis shows that more expensive listings do not necessarily mean fewer available properties thus indicating strong demand across all price ranges. The premium pricing of Duomo at €154 and Brera at €140 does not affect the high availability rates because tourists continue to demand these areas which support both

expensive rates and frequent bookings. The STR demand in central Milan shows price-inelastic behavior which allows property owners to achieve maximum occupancy and pricing at the same time.

The availability analysis shows two distinct patterns where properties either stay available for more than 300 days or less than 100 days which indicates different operational approaches. The high-availability properties function like commercial hotels while the low-availability listings might be used for occasional home-sharing or seasonal vacation rentals.

The combination of March 2025 Inside Airbnb data with 2024 OMI official rental quotations enables advanced rent gap analysis to measure the financial opportunities for converting residential properties into short-term rentals. The methodology advances theoretical estimates through actual market data from STR platforms and official housing market sources to demonstrate STR impacts on housing affordability.

The rent gap calculation uses realistic revenue projections which include platform fees (14% Airbnb commission) and operational costs (€100 monthly cleaning expenses) and occupancy assumptions derived from actual availability calendar data. The research shows that STR operators earn a median net monthly revenue of €1,065 while traditional rentals generate between €599 (Fascia E) and €1,634 (Fascia B) for standard 70-square-meter apartments thus enabling market segment comparison. The comprehensive analysis shows that traditional rentals generate more stable income than short-term rentals because the median rent gap ratio stands at 0.75x after considering operational costs and vacancy periods. The analysis shows that STR conversion incentives produce the most significant displacement pressures in 4 neighborhoods where rent gaps exceed 1.5x.

The geographic analysis shows that the greatest rent gaps exist outside central tourist districts in peripheral and semi-peripheral neighborhoods because these areas maintain affordable traditional rental prices while STR operations attract tourist demand. The highest rent gap of 2.4 times exists in Quarto Cagnino where STR revenue reaches €1,862 while traditional rent stands at €790 followed by Trenno with a 1.8 times gap and Comasina with a 1.7 times gap in outer residential zones. The spatial distribution indicates that STR-driven displacement pressures will most strongly affect working-class neighborhoods because residents in these areas lack alternative housing options while central areas with gentrification already have high STR and traditional rental prices. The high concentration of rent gaps in peripheral areas shows that STR expansion will worsen existing spatial inequalities by decreasing affordable housing choices in neighborhoods that were previously accessible to low-income residents.

The analysis uses official OMI Fascia classifications to provide standardized geographic reference points, with Fascia B representing premium central areas (€1,634 average traditional rent), Fascia C semi-central zones (€1,305), Fascia D peripheral areas (€790), and Fascia E suburban locations (€599). The STR impact varies significantly across these zones, with peripheral areas (Fascia D and E) showing the highest vulnerability to conversion pressures due to lower traditional rental baselines.

The methodology for estimating neighborhood Fascia classifications based on STR pricing and density patterns provides a robust approach for integrating platform-specific data with official housing market classifications. This integration enables policy makers to identify specific zones requiring intervention while maintaining compatibility with existing urban planning frameworks and regulatory structures.

5.5 Visualization Techniques and Spatial Analysis

The analysis of current market conditions uses March 2025 STR data together with 2024 OMI quotations because the 3-month delay meets acceptable standards for housing market research. The analysis includes 14,543 validated STR listings spread across 78 neighborhoods and 164 OMI records which provides enough statistical power for neighborhood-level analysis while maintaining data quality standards.

The validation process shows that four neighborhoods have rent gaps exceeding 1.5 times the threshold which requires specific policy intervention while most areas maintain rent gaps under 1.0 times thus showing significant variations in STR conversion incentives across different locations. The study refutes universal regulatory methods by proving that evidence-based targeted interventions should replace them for local market impact assessment.

5.6 Interactive Spatial Mapping

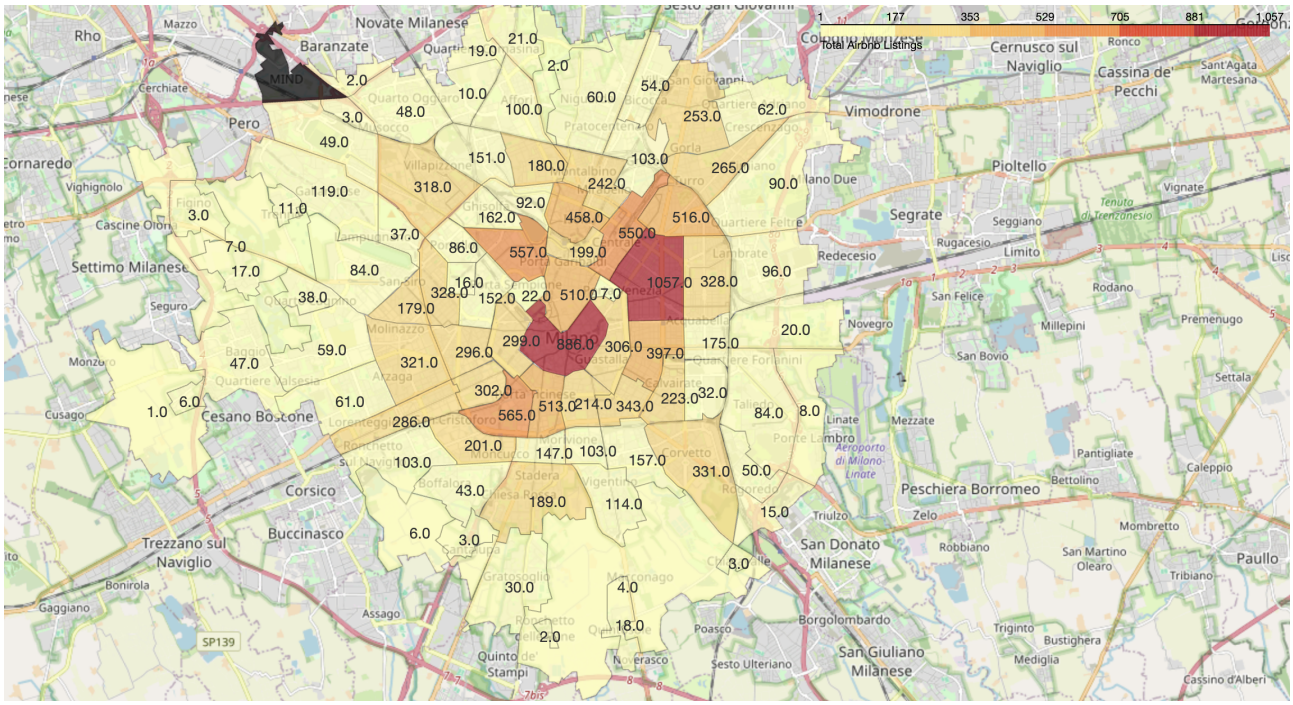

Figure 5: Total Airbnb Listings

The choropleth visualization (Figure 5) shows important spatial information about STR distribution patterns in Milan's neighborhoods which reveals strong concentration gradients from the city center to peripheral areas. The color-coded intensity mapping shows that high-density clusters (more than 500 listings) are concentrated in central tourist districts where Buenos Aires-Venezia (1,057), Duomo (886) and Navigli (565) are the core areas of STR activity. The numeric overlays on each neighborhood enable precise quantitative assessment of local market penetration.

The spatial pattern shows that STR intensity decreases in a circular pattern from the center of the city to the outer residential areas. The geographic distribution follows tourism accessibility patterns and transportation connectivity which indicates that STR location decisions focus on visitor convenience rather than residential community integration.

The interactive popup features improve analytical capabilities by offering detailed neighborhood statistics that include total listings numbers and professional host percentages and vulnerability scores. Users can use this functionality to detect relationships between geographic locations and market characteristics which helps them develop evidence-based policies for areas with different STR pressure types and intensities.

5.7 European Comparative Analysis and Policy Context

The assessment of four European cities demonstrates how their housing market vulnerabilities affect short-term rental policies. The housing market in Milan shows average vulnerability levels below Barcelona and Lisbon which allows for proactive policy measures instead of emergency responses.

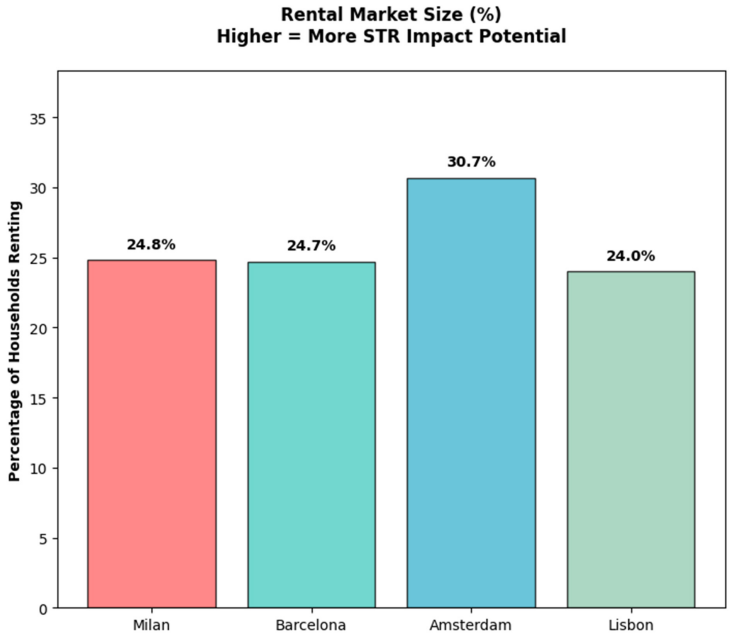

Figure 6: Rental Market Size

The rental market analysis (Figure 6) reveals that Amsterdam holds the largest rental market share at 30.7% followed by Milan at 24.8%, Barcelona at 24.7% and Lisbon at 24.0% which indicates equivalent susceptibility to STR-driven displacement throughout these cities. The apparent market similarity between cities conceals major variations between market forces and governmental policy-making abilities.

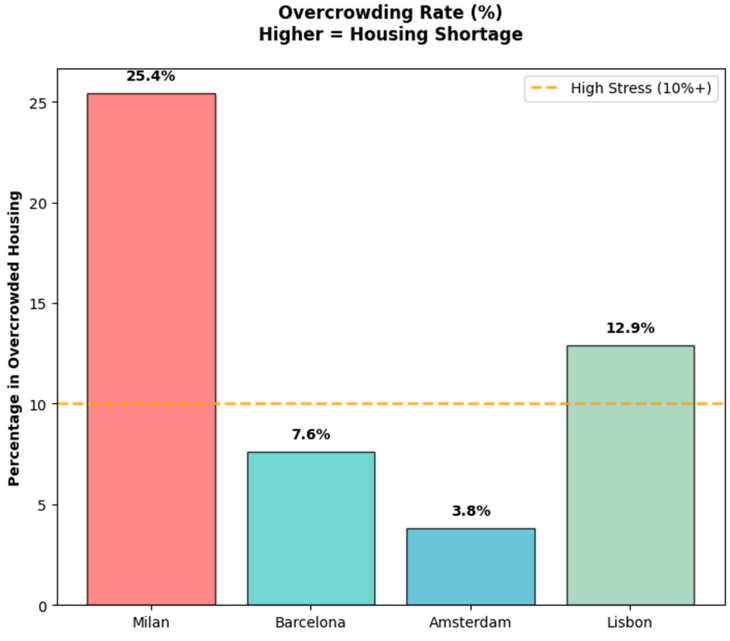

Figure 7: Overcrowding Rate

The housing shortage indicators demonstrate major spatial challenges because Milan faces extreme overcrowding which affects 25.4% of its households (Figure 7) at a much higher rate than Barcelona (7.6%), Amsterdam (3.8%) and Lisbon (12.9%). The distribution of overcrowding shows that Milan faces housing stress because of insufficient supply rather than affordability issues which means STR conversion pressures will worsen existing spatial shortages that price regulations cannot resolve.

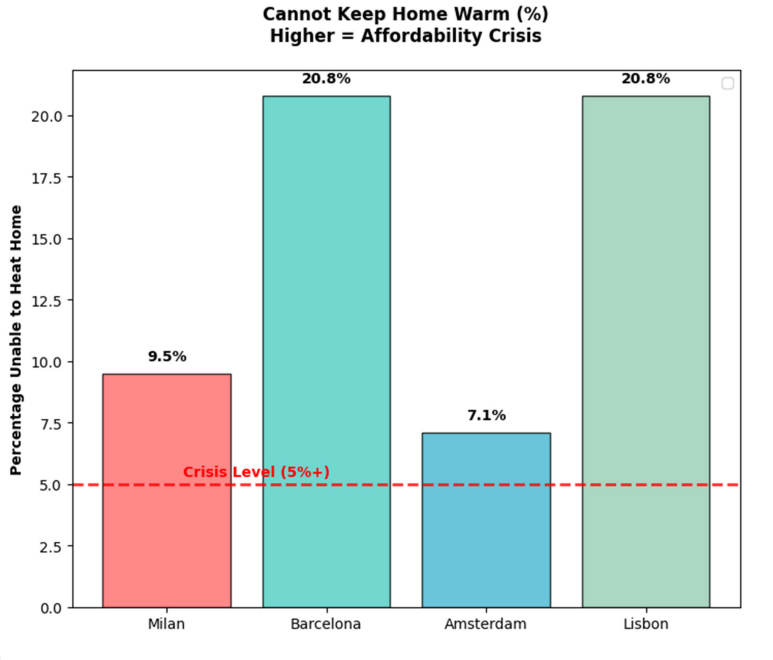

Figure 8: Cannot Keep Home Warm

The energy poverty measurements (Figure 8) demonstrate that Milan faces moderate stress at 9.5% while Barcelona and Lisbon experience severe crisis conditions at 20.8% and Amsterdam shows intermediate stress at 7.1%. The housing stress matrix visualization (Figure 12) shows that Milan exists in a complex situation with high overcrowding rates together with moderate energy poverty while Barcelona and Lisbon face severe energy affordability crises which affect more than 20% of their households.

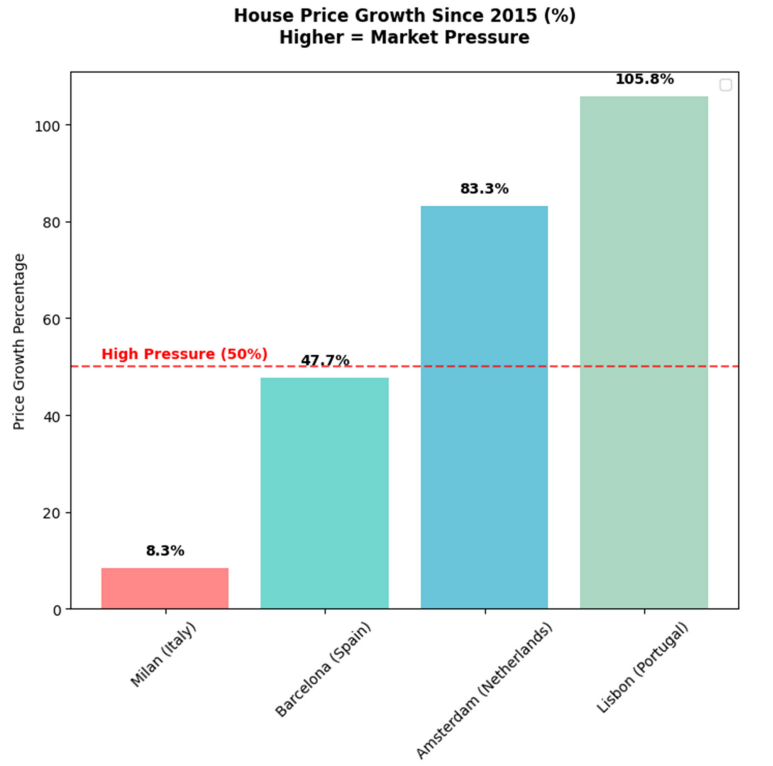

Figure 9: House Price Growth Since 2015

The house price evolution analysis (Figure 9) shows the significant market pressure differences between

European cities where Portugal experienced 105.8% price growth since 2015 while the Netherlands saw 83.3% increases and Spain reached 47.7% and Italy maintained 8.3% growth. The price pressure differences between cities affect how well STR policies work and what market intervention approaches should be used since Milan stays under the 50% "high pressure" threshold which indicates stable market conditions.

The stable housing prices in Milan provide strategic benefits for developing balanced STR policies because the market has not yet reached the point of intense speculative pressures. The price growth in Milan differs significantly from Amsterdam's bubble inflation and Portugal's crisis-driven price escalation which means Milan maintains flexibility in its policy approach that other cities do not have because they face already-developed housing emergencies.

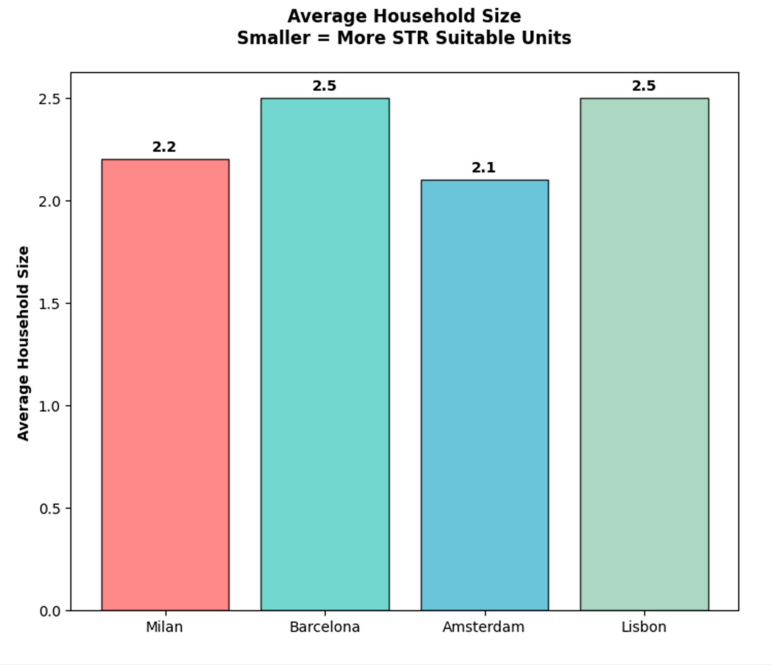

Figure 10: Average Household Size

The household size analysis (Figure 10) shows structural factors that affect STR market dynamics through Amsterdam (2.1) and Milan (2.2) having smaller household sizes which leads to higher numbers of STR-suitable housing units compared to Barcelona and Lisbon (both 2.5). The combination of small household sizes and controlled price growth makes it possible to establish evidence-based STR policies before market distortions become more severe because smaller households produce additional housing units that could become short-term rentals.

5.8 STR Market Scale Across Europe

The STR market in Milan operates at a level that positions it between other European cities based on key market metrics. Amsterdam shows the highest density at 4.0 per 1,000 residents among cities followed by Paris at 3.0 per 1,000 residents and Zurich at 4.0 per 1,000 residents while Berlin has 1.8 per 1,000 residents after implementing strict regulations [25]. Most European cities set aside less than 0.5% of their total housing stock for STRs with Barcelona leading the pack at 0.94

The market ranking appears through absolute listing numbers where London stands first with 95,000 listings followed by Paris with 91,000 then Rome with 35,000 and Madrid with 26,000 listings. The Airbnb market in Amsterdam decreased by 54% between 2019-2024 because of regulatory measures while Berlin maintains only 6,846 active listings under its strict regulatory system.

European rental markets exhibit wide-ranging impacts on housing prices because of short-term rental activity. The current Rome rental market experiences its most severe affordability crisis because rent prices rise by 28.2% annually while average furnished apartments cost €2,500 per month. Barcelona experiences 12% annual rent increases according to Bcn Advisors and Paris shows 21% rent growth across six years after introducing STR restrictions [26].

European cities show no clear link between short-term rental regulation and housing affordability according to scientific research. Amsterdam displays the strongest evidence of this relationship through its 54% reduction

in STR listings which failed to stop rental price growth and led to extended social housing waiting lists reaching 13 years. The Barcelona government plans to abolish short-term rentals by 2028 but available data shows these restrictions do not enhance housing accessibility [25].

European STR policy development depends on local tourism intensity levels that differ substantially between destinations. Paris faces extraordinary tourist pressure because Olympic visitors projected to reach 11.3 million will cause peak-season rental prices to surge by 85%. France 24 Barcelona residents have been protesting against tourism overloads by using water pistols to show their discontent [27]. The research indicates that Southern European cities face the highest pricing pressures among their markets (Rome and Barcelona) while Northern European cities show greater baseline costs with more steady growth patterns. The geographic pattern indicates that climate together with cultural attractions along with existing tourism infrastructure play a significant role in shaping STR market behavior.

5.9 Policy frameworks: Best Practies

Different European cities operate registration systems that achieve diverse levels of success in their execution. Since 2021 Amsterdam introduced registration numbers and permits yet its 54% reduction in listings did not lead to better housing affordability [28]. Paris has implemented registration requirements since 2017 with additional requirements in 2021 and a tourist tax system of €2.60-€15.60 per person per night for 2025 [29].

Vienna's zoning system presents the most balanced solution by banning short-term rentals in residential areas while allowing 90-day stays with exemption permits in other zones. The geographic approach safeguards existing residential units while maintaining opportunities for sharing economy operations. Building consent requirements mandate that most properties remain residential while violating these rules will result in a €50,000 fine.

All platforms across the EU will have to give national authorities monthly data about host activities starting from May 2026 under the upcoming data sharing regulation [30]. The unified method solves the main problem of insufficient complete market transparency.

Temporal Restrictions and Day Limits

Day limit policies display clear patterns of implementation but their impact on housing markets remains inconsistent. The yearly 30-day cap Amsterdam implemented in 2018 after reducing it from 60 days directly caused a large decrease in listings yet failed to enhance rental market accessibility [31]. Berlin has implemented a dual system of 90-day permit allowances for secondary homes alongside mandatory primary residency requirements for STR operators.

The most extreme temporal policy exists in Barcelona which plans to ban all tourist apartment licenses until 2028. The policy attempts to recover 10,000+ housing units for residents yet faces opposition from the industry while its impact on housing accessibility remains unclear due to limited research about STR restrictions.

Research shows that short-term rental day limits between 30 to 90 days annually help protect both the sharing economy and prevent residential property commercialization. The essential element appears to be primary residence requirements over day limitation policies [28].

Zoning and Spatial Controls

Spatial regulation strategies demonstrate superior effectiveness for STR concentration management yet they fail to improve overall housing affordability. The residential zone restrictions implemented by Vienna successfully preserved houses from becoming commercial properties. The Barcelona zoning regulations in Old City and saturated areas proved more successful at reducing city center concentrations than Paris's time-based restrictions.

The success of zoning restrictions requires registration systems and platform cooperation for optimal implementation. The success depends more on enforcement capacity and systematic monitoring rather than the specific spatial boundaries chosen [28].

Economic Instruments and Taxation

European cities have implemented various taxation methods which produce different results. Major tourist destinations have adopted tourist taxes that range from €3-€7 per person each night in Rome and €2-€5 in Milan and €1-€5 in Florence and €3 in Amsterdam [32]. These taxes generate revenue for infrastructure while creating modest demand dampening effects.

The business tax framework of Italy uses a 21% fixed rate through Cedolare Secca while Portugal has CEAL tax for urban apartments and French businesses face standard income tax and professional registration obligations. Automated tax collection through platform integration becomes vital for compliance since Amsterdam and Airbnb demonstrate successful partnerships.

Enforcement and Platform Cooperation

The enforcement success rates between European cities remain highly different due to the essential role of digital integration and platform cooperation. Cities that succeed in compliance enforcement develop automated systems which connect registration databases to platform listings. The direct collaboration between Airbnb and Amsterdam allows both tax collection and illegal listing removals.

Successful enforcement depends on four key elements which include platform data sharing requirements, tax authority integration with registration systems and automated compliance verification and substantial financial sanctions [27]. Vienna's €50,000 fines and Berlin's historical €100,000 penalties demonstrate the deterrent effect of substantial enforcement [33].

Policy Combination Strategies

European cities achieve their best results by implementing various policy tools instead of using individual interventions. High-impact combinations include:

The combination of zoning regulations with registration systems allows for both spatial monitoring and complete system oversight. Home-sharing opportunities remain available while commercial conversion becomes less likely when day limits are paired with primary residence requirements. Platform integration with data sharing enables automated compliance and systematic enforcement.

Vienna demonstrates an optimal policy framework through its complete residential zone prohibitions along with 90-day maximum stays in other areas and exemption permit systems and building consent regulations and substantial financial penalties. Residential protection exists alongside sharing economy sustainability in this approach.

5.10 Evidence-based policy design for Milan

STR regulations throughout Europe demonstrate they achieve minimal direct benefits for housing affordability yet succeed in managing tourism demand and safeguarding residential districts through effective implementation. The moderate STR density and tourism pressure in Milan creates space for specific interventions which protect sharing economy advantages while resolving valid housing issues. The most effective strategies combine residential area protections with time-based restrictions that require property owners to live there and complete registration processes and platform collaboration for enforcement purposes. The success rate of these policies depends more on how well they are executed and enforced rather than their specific content and digital integration with automated systems proves vital for sustainable regulation [34]

6 Conclusion: Key Findings

The extensive data-based research shows short-term rentals in Milan create complex urban changes which surpass basic market supply and demand relationships. The STR market in Milan has transformed from its peer-to-peer origins into a commercial accommodation industry because 58.4% of its 14,626 active listings belong to multi-property hosts. The commercialization of short-term rentals disrupts the fundamental sharing economy principles that defined the platform when it first started.

The spatial distribution of listings shows strong clustering patterns because the top 10 neighborhoods contain 40.7% of all listings which focus mainly in tourist-friendly central areas including Buenos Aires-Venezia with 1,057 listings and Duomo with 886 listings and Navigli with 565 listings. Our rent gap analysis reveals the greatest conversion pressures occur in peripheral neighborhoods such as Quarto Cagnino (2.4x rent gap), Trenno (1.8x), and Comasina (1.7x) instead of central tourist districts because STR operations can capture tourist demand while traditional rental prices remain low.

The vulnerability assessment shows Duomo stands as the most vulnerable neighborhood (vulnerability score: 0.745) because it has both a high STR density and professional host concentration (81.8%) and premium pricing (€154 median nightly rate). The displacement process caused by STRs functions through various simultaneous mechanisms which impact different neighborhood types through separate pathways.

6.1 Theoretical Contributions and Policy Implications

The research adds value to urban studies by showing that STR affects housing markets differently across various areas which requires specific regulatory solutions. The rent gap analysis confirms Wachsmuth and Weisler's (2018) theoretical model while showing that displacement pressures reach their peak in outer neighborhoods because residents there have limited alternative housing choices.

The European comparative analysis shows that Milan faces moderate vulnerability in its housing market because its conditions are less severe than Barcelona and Lisbon but more challenging than Amsterdam. The high 25.4% overcrowding rate in Milan surpasses all other European cities which indicates that housing pressure

results from spatial limitations instead of affordability problems. The research indicates that STR conversion pressures will intensify current supply shortages beyond what price-focused regulations can handle.

The evidence supports a sophisticated policy strategy which takes into account Milan's specific situation with steady housing price growth (8.3% since 2015) and moderate short-term rental penetration to enable proactive instead of reactive regulatory measures. The analysis of European best practices shows that effective STR regulation needs integrated policy frameworks which combine spatial controls with temporal restrictions and registration systems and platform cooperation instead of using single-instrument approaches.

6.2 Policy Recommendations for Milan

The research data along with European best practices analysis leads us to propose a specific regulatory system which safeguards residential areas while maintaining the advantages of sharing economy. The evidence supports the implementation of residential zone protections like Vienna's model especially in peripheral neighborhoods with high rent gaps that negatively impact vulnerable populations.

A registration system with automated platform integration should be established to enable systematic monitoring and enforcement, following successful examples from Amsterdam's collaboration with Airbnb for tax collection and compliance verification. The combination of 60-90 day annual time limits and primary residence requirements will help identify home-sharing activities from commercial property conversions while keeping occasional hosting possibilities open.

The varied effects of STR on different neighborhoods require tailored solutions instead of general policies that apply to the entire city. The immediate protective measures should be implemented in areas with vulnerability scores above 0.7 (Duomo, Buenos Aires-Venezia, Brera) while preventive interventions should be established in peripheral neighborhoods with high rent gaps to prevent future displacement crises. The implementation of tourist taxes and business licensing fees requires market-specific adjustments instead of standardized approaches. The establishment of platform cooperation mechanisms should occur before the 2026 Winter Olympics because reactive crisis-period regulations prove less effective than stable-market frameworks developed in advance.

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