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A Study on the Relationship between Air Pollution and Housing Prices in Indian Metropolitan Cities

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ABSTRACT

This paper aims to examine whether air pollution has a significant impact on residential housing prices in Indian metropolitan cities, which include NCR, Mumbai, Kolkata, Bangalore, and Chennai. The data for both variables is from 2017 to the beginning of 2025. It uses secondary data from the Housing Price Index (HPI) and the Central Pollution Control Board (CPCB). This paper is purely a quantitative analysis, and compares the trends of PM2.5, PM10, NO_2, and Ozone, with the movements of the housing prices. The findings reveal that there is no direct correlation between the air quality and housing prices across the selected cities. However, factors such as infrastructural and connectivity development, employment opportunities, migration, etc., are found to play a significant role in the housing prices to experience an upward trend. The dependence on mainly two indices limits the scope of the study; however, it also highlights an important implication. Pollution does not affect the valuation of residential complexes. Therefore, there is little to no incentive for sustainable urban development. Measures like Government intervention, inclusion of social/environmental costs in the real estate business, could encourage eco-friendly and greener housing practices.

Keywords: *Air Pollution, Housing Prices, Metropolitan Cities, India, Correlation Analysis, Real Estate Market, Environmental Economics*

INTRODUCTION

In the urban sector, I believe the environmental conditions directly have an impact on the market forces in the real estate market. Despite India having a poor AQI (Air Quality Index), the residential real estate market continues to experience robust appreciation in demand and price. This holds true for metropolitan cities such as NCR (National Capital Region), Kolkata, Mumbai, Bangalore and Chennai. This raises a critical question: **Is pollution responsible for depreciating housing prices in Indian metropolitan cities, or are other factors driving this phenomenon?**

I assumed that beneficial environmental factors, such as cleaner air and surroundings, are ideally supposed to have a positive reaction from consumers regarding residential complexes. Whereas if the environmental conditions appear to be poor, it would lead consumers to drift away from acquiring or renting the property. The aim of this paper was to see if this assumption holds true in the context of India.

The city-level air pollution is measured annually through various pollutant indices such as Ozone, Nitrogen Dioxide, PM2.5 and PM10. The housing prices index is taken from 2017-2024. The goal was to see if increasing pollution would correlate with decreasing housing prices. This paper does not find any direct correlation between the two indices in the Indian context.

LITERATURE REVIEW

In 2018, Runqiu Liu, Chao Yu, Canmian Liu, Jian Jiang, and Jung XU examined a similar hypothesis, where they examined the effects of air pollution on housing prices across 20 districts in Chengdu, China and found a relatively negative correlation between environmental conditions and the housing prices[1]. The methodology includes cross-seasonal data, variables related to income, amenities and local population density, and analysis of haze pollution affecting per-square-meter housing prices.

[1] Liu, Runqiu, et al. "Impacts of Haze on Housing Prices: An Empirical Analysis Based on Data from Chengdu (China)." *International Journal of Environmental Research and Public Health*, vol. 15, no. 6, June 2018, p. 1161, https://doi.org/10.3390/ijerph15061161. Accessed 1 May 2019.

This study however was limited to a singular city which may not capture the change in market patterns over a period of time, or be applicable for every region. The research I have conducted is focused on Indian metropolitan cities such as NCR, Mumbai, Kolkata, Bangalore and Chennai, and I was curious to see if a similar negative pattern holds for India too.

A study by M.N. Murty and S.C. Gulati investigates how air pollution in the urban sector affects residential property in areas like Delhi and Kolkata. The methodology includes hedonic price model, where the property prices are molded as a function of characteristics such as neighborhood, socio-economic factors, amenities etc. They also conducted a study through a survey in the twin cities of Hyderabad and Secunderabad, and estimated the residents' Willingness to Pay (WTP). The result of this research mentions that there is a negative correlation between the two variables, highlighting that air quality is a critical factor when housing is being chosen. However the limitation includes that the data is from 2001-2003, whereas this paper deals with data from 2017-2025. Thus, a lot of changes must have happened since then. They have also conducted this research on the basis of WTP, which is subjective in nature and relies on factors such as awareness, financial ability, valuation of clean air, and personal priorities. Whereas, this study aims to find that correlation through quantitative analysis of the data from 2017-2025, and also explaining city-specific reasons on why the housing prices change over time. The study by M.N. Murty and S.C. Gulati relies on economic behavior; whereas I focus objectively[2].

In 2024, Donghown Ko and Seunghoon Park published a paper, confirming a positive correlation between air quality and housing prices[3]. This is based on the residential complexes in Seoul, South Korea. The methodology includes Random Forest and SHAP and is based on cross-sectional data. They have worked with a limited time frame and use data from 2021, rather than focusing on a period of time. This study only examines Seoul, South Korea which has a different urban sector compared to that of India. It is a developed nation so results pertaining to this city could not be applied the same for Indian cities since residents are driven more by income levels, infrastructure, awareness etc. One similarity includes that both the papers have compared the data of the real estate market and air quality as two different variables, measuring it with a quantitative approach rather than relying on surveys and subjective opinions of the residents.

METHODOLOGY

This paper investigates the correlation between air pollution and housing prices through a quantitative and time-series approach in each selected metropolitan area. The Housing Price Index was a reliable indicator, taking the base as January 2017 and continuing till March 2025. The Air Pollution Data is obtained from the Central Pollution Control Board (CPCB) from January 2017 to the beginning of 2025.

The data processing and analysis was done through Python to ensure consistency. The daily pollution data regarding PM2.5, PM10, Nitrogen Dioxide and Ozone were converted into monthly averages to match the frequency of the housing data. Each pollutant was indexed by setting the first non-zero monthly value to 100, to ensure uniformity and consistency. I have examined trends with both the datasets and assess the strength between both the variables and whether the influence of pollution is truly applicable.

The use of secondary data may pose slight inconsistencies due to different methods of data collection across the regions. This study does not include additional economic or social variables which were graphically represented. Both the analysis are confined strictly with respect to these two indices.

National Capital Region (NCR)

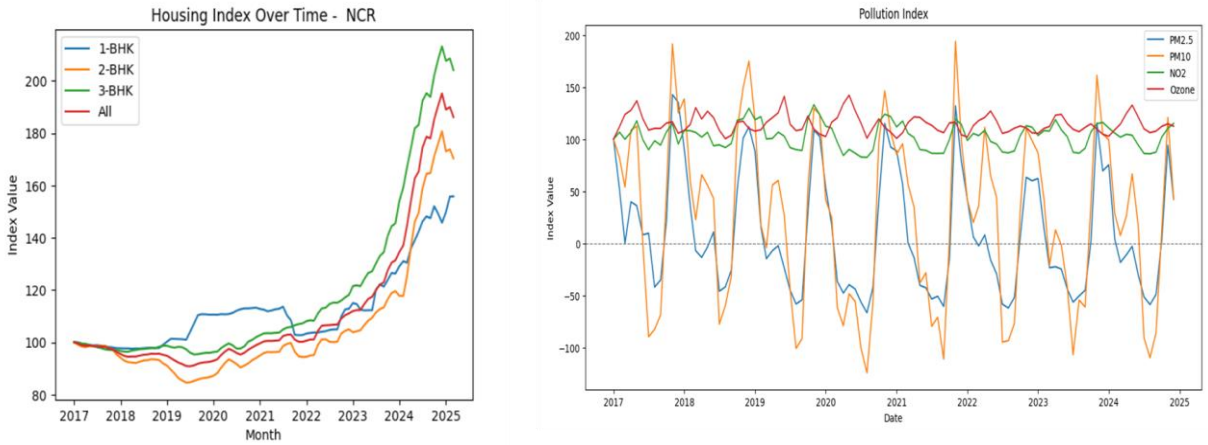

Figure 1: Index data of NCR. **(A)** Housing price index data of NCR. **(B)** Pollution Index Data of NCR.

Figure 1A conveys the Housing Price Index (HPI) for the National Capital Region (NCR).

[2] Murty, M., et al. *A Generalized Method of Hedonic Prices: Measuring Benefits from Reduced Urban Air Pollution**. 2004, www.iegindia.org/upload/publication/Workpap/wp254.pdf. Accessed 30 Oct. 2025.

[3] Ko, D.; Park, S. Investigating the Correlation between Air Pollution and Housing Prices in Seoul, South Korea: Application of Explainable Artificial Intelligence in Random Forest Machine Learning. *Sustainability* **2024**, *16*, 4453. https://doi.orgssessed/10.3390/su16114453

2017-2021: Prices had been relatively the same with small increases for a period of time.
2022 onwards: There is a significant rise in the prices and an upward trend is clearly visible. An article by Prestige Spring Heights, a residential apartment project agency stated that there is at least a 49% increase in the property prices ever since 2024[4], as also highlighted by the plot attached above.

What are the most likely reasons driving the HPI pattern?

Infrastructural Development: Projects like the Dwarka Expressway, Urban Extension Road, Regional Rapid Transit System, Greater Noida West etc. have had a considerable effect on the rise of housing prices. According to an article published by Mahendra Yadav in the Times of India[5], due to the Dwarka Expressway, the property prices have doubled since 2019. Such roads strengthen the mobility and connectivity of the people, and these areas become attractive places to live. This increases the effective city size, and commercial activities, which overall increase the demand. This ultimately leads to property values rising.
NRI interests: NCR is a region which attracts the Non-Resident Indians (NRI) population to a great level. It is a place for business, commerce, luxurious real estate, and a relatively high return on investment (ROI) since the year 2021[6]. There are favorable taxation choices NRIs can opt for like India's Double Taxation Avoidance (DTAA). The low exchange value of the Indian Rupee makes NCR an ideal area to reside and invest one's monetary assets in. This causes low home loans, high rental yield, and better access to certain amenities[4].

Figure 1B shows a strong seasonality within each year. The Pollution Index fluctuates, but there is no trend in the data, which shows consistency. Their levels have dropped in mid-2020, primarily due to the COVID-19 lockdown where there was little to none vehicular activity.
Each pollutant also exhibits a specific behavior.

a) Ozone index and Nitrogen Dioxide index moves at a steady rate with minor fluctuations and oscillations. NO_2 index lies between the range 70-110 and Ozone index between 100-120. Both the pollutants show persistence and are not easily affected by short term changes.
b) PM10 and PM2.5 indexes are highly volatile with sharp spikes and drops, reaching as high as 150 and 200, but there is no upward trend in the data and the spikes and drops are a result of the inherent seasonality.

Altogether, the Housing Prices show an upward trend from the year 2017-2024. However, the Pollution Index shows seasonality and no trend. Therefore, there is no correlation or alignment between the two. As the housing prices increase, it does not correspond to any structural change in the pollution levels despite factors like industrial development and NRIs interests.

Kolkata

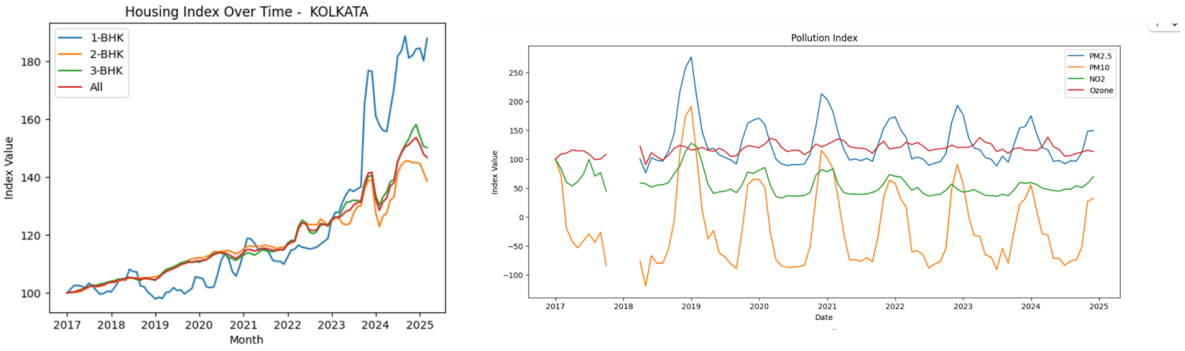

Figure 2: Index data of Kolkata. **(A)** Housing price index data of Kolkata. **(B)** Pollution Index Data of Kolkata.

Figure 2A conveys the Housing Price Index (HPI) for Kolkata.

2017-2021: There is an evident and steady rise in the housing prices across all the categories (1-BHK,2-BHK, 3-BHK)

[4] National Real Estate Developmental Council. "Business Standard-Delhi NCR Sees Steepest Surge in Property Prices, Rates Jump 49% in 1 Year | NAREDCO." *Naredco.in*, National Real Estate Developmental Council, 25 Feb. 2025, naredco.in/business-standard-delhi-ncr-sees-steepest-surge-property-prices-rates-jump-49-1-year. Accessed 18 Sept. 2025.

[5] Yadav, Mahendra. "Noida, Gurgaon, or Dwarka? This NCR Locality Leads with 98% Price Jump in 5 Years — Check How Property Prices Fared." *The Times of India*, The Times Of India, 24 Apr. 2025, timesofindia.indiatimes.com/business/india-business/noida-gurgaon-or-dwarka-this-ncr-locality-leads-with-98-price-jump-in-5-years-check-how-property-prices-fared/articleshow/120590082.cms. Accessed 18 Sept. 2025.

[6] Kreeva India. "Why Delhi NCR Is Best for NRI Investment in Indian Real Estate." *KREEVA Blog – Real Estate Developers in Delhi NCR*, 29 Jan. 2025, kreevaindia.com/blog/real-estate/nri-investment-in-indian-real-estate/?utm_source=chatgpt.com. Accessed 18 Sept. 2025.

2022 onwards: The prices were increasing at the beginning at a steady rate. The period between 2023 and 2024 is showing the prices to sky-rocket for 1-BHK apartments. Between the beginning of 2024 and the end of it, there is a degree of volatility and continues to remain higher than the period between 2017-2021.

What are the most likely reasons driving the HPI pattern?

a) **Migration and Access to Education:** The city of Kolkata is a hub of various refugees and migrants, spanning from regions across the continents. According to an article published on Times of India by Saibal Sen in 2019, 'Kolkata's migrant population is 8.3 lakh, roughly a fifth of the city's total population of 44.9 lakh..Among them 3.9 lakh are from states outside Bengal …Over 50% of the city's migrants are from Bihar; another 28% are from Uttar Pradesh, Jharkhand, and Odisha[7].

Multiple programs have been developed to satisfy the housing needs of lower and middle-class income groups. For example, in Kolkata, the Nijashree Housing Scheme, a government-subsidized flat program allocates approved households flats at reduced prices. Although the aim of a program such as this is to enhance affordability by its targeted demographic (e.g. low-income), it undoubtedly has the potential to create spillover effects generally in the housing market. With the introduction of a subsidy, demand is ultimately increased. Once subsidies are introduced, even with limited subsidized units available, consumers will be encouraged to turn to the general housing market lending a general increase in prices. The government would now be faced with higher subsidy prices, even with the higher demand, and again would subsequently alter the price of housing leading to more elevated prices across the market.

Kolkata is also a city which consists of a rich diverse educational institutions like Presidency, St.Xaviers, Jadavpur University etc. The youth appear to have a grasp of a city and access the various elements. This reason automatically relates to housing prices surging as people from various places come to improve their livelihood.

In Figure 2B above:

PM2.5 levels fluctuate generally between 90-120 during most months, but spikes significantly in the winter months to around 200-280, indicating extremely poor air quality that season.

PM10 index experiences drastic spikes and drops, its maximum value goes as high as 200 and also drops to 0. Whereas, NO_2 index rises slowly and experiences certain fluctuations and remains between the range of 40-100. Both these pollutants experience a drop during 2020, due to COVID lockdown likely because vehicular activity was at its minimum. This shows seasonality and no trend.

Ozone index experiences a stable flow across the years, and does not exhibit volatile behavior at any instant.

Kolkata's Housing Price Index and Pollution Index do not show any direct correlation. The Housing Price Index increases but is not likely due to rising pollution as the plots show that pollution levels have not exhibited an upward trend over the years, and the spikes and dips have been a result of the inherent seasonality in the data. Factors such as migration, better opportunities and affordability do not associate with the environmental conditions, and are more concerned with the socio-economic factors.

Mumbai

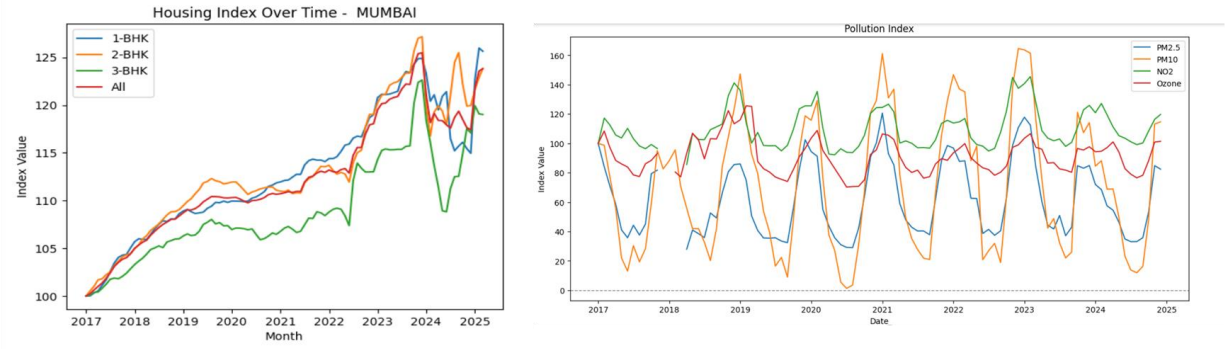

Figure 3: Index data of Mumbai. **(A)** Housing price index data of Mumbai. **(B)** Pollution Index Data of Mumbai.

Figure 3A conveys the Housing Price Index (HPI) for Mumbai.

2017-2021: The Housing Index shows a gradual rise across all the categories. The 1BHK and 2BHK rise from 100 in 2017 to 112-115 by 2021. The 3BHK line lagged behind, and rose soon after, it is between the range of 107-110.

2022 onwards: This period reflects volatility and prices accelerate between 2022 and 2023. The 1BHK and 2BHK lines experience spikes in 2023 and cross the 125 index, showing a greater demand for small residential complexes. The 1BHK and 2BHK keep rising until the end of 2024, the 2BHK line does lag in the year 2024. The prices for 3BHK had taken a dip in the beginning but also experienced a rise in 2024 for an unknown cause.

What are the most likely reasons driving the HPI pattern?

[7] Jul 24, Saibal Sen / TNN /, and 2019. "More Migrants to Kolkata from Other States than Districts | Kolkata News - Times of India." *The Times of India*, 24 June 2019, timesofindia.indiatimes.com/city/kolkata/more-migrants-to-city-from-other-states-than-districts/articleshow/70354414.cms. Accessed 18 Sept. 2025.

a) **Land Scarcity and Redevelopment Projects[8]:** Mumbai is a city which is surrounded with water on three sides. Expansion of areas is not considered easy, as compared to cities like Delhi and Kolkata. Mumbai is geographically limited and there is an evident scarcity of land. Thus, due to the inability to expand areas, existing land is restructured to fit the demand and needs of the people. Old societies and complexes are broken down to make space for new buildings with more flats and amenities. This pushes the prices for the areas which were restructured like Dadar, Andheri, Chembur etc.

Mumbai is also a hub for slums and underdeveloped areas where people live in unsanitary conditions. 40% of the Mumbai population consists of the people living in slums. There are redevelopment projects like the Dharavi Redevelopment Project which replaces the slums with luxurious apartments and has significantly influenced the property values in Sion and Matunga.

In Figure 3B:

The PM2.5 index shows peaks and troughs throughout the years. It goes as high as 120 and falls to a minimum value of 30. PM10 index ranges from near 0 to above 160, which indicates strong vehicular pollution is prevalent in the city.
The NO_2 index ranges between 90-120 and Ozone index exhibits relatively stable behavior as compared to others, between 80-110 with only minor fluctuations and there is no trend observed.

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From the year 2017-2021, the Pollution Index shows a seasonality but that does not lead to an impact on the housing prices. There is no trend in the Pollution Index, but it is observed in the Housing Price Index. This does not indicate a direct correlation, and socio-economic factors outweigh pollution in influencing housing demand.

Bangalore

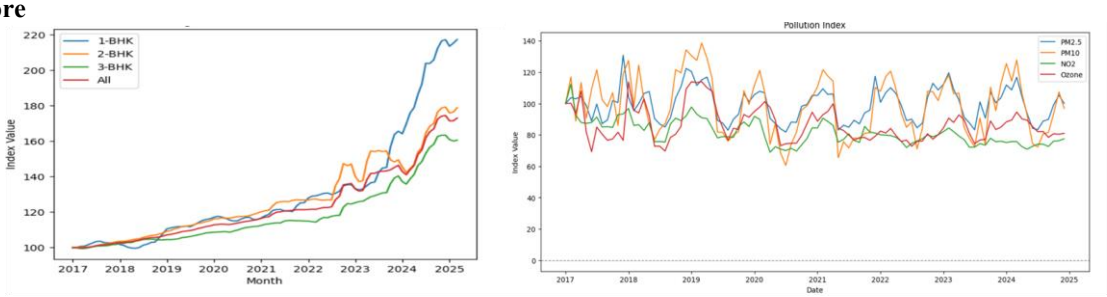

Figure 4: Index data of Bangalore. **(A)** Housing price index data of Bangalore. **(B)** Pollution Index Data of Bangalore.

In Figure 4A:

2017-2021: 1BHK, 2BHK and 3BHK are increasing from 100 to 120-25 across. It relatively shows a gradual and balanced growth. It can be tied to employment and migration.
2022 onwards: Housing prices have exhibited a rising pattern, particularly for the 1BHK flats. By the end of 2024, the 2BHK units also grew significantly and reached 180, while the 3BHK units lagged and reached at most 160. This indicates that affordability was not restricted in the case of smaller units. Post COVID era, there was an expansion of areas like the Electron City, Whitefield and Outer Ring Road[9]. There was major investment expenditure which was transforming Devanahalli into a 'real estate hub'[10], generating a larger demand for housing.

What are the most likely reasons driving the HPI pattern?

a) **Employment and Migration:** Bangalore is known as the 'Silicon Valley' of India as it hosts companies like Infosys, Wipro, TCS and other tech companies. This boom of employment and establishment of start-ups allowed an influx of people to enter the city and seek housing. Unlike Kolkata and Bombay, where housing prices are driven by lack of land and traditional buyer pattern, Bangalore is mostly youth-driven which ultimately causes rents to also skyrocket. Projects like the Namma Metro expansion, Peripheral Ring Road etc. have become 'housing hotspots'

[8] JLL Homes. "JLL Homes - Residential Properties in India, New Projects/Resale Properties." *Jllhomes.co.in*, 23 Sept. 2025, www.jllhomes.co.in/blogs/from-old-to-gold-how-redevelopment-is-lifting-the-face-of-residential-real-estate-in-mumbaipune-?utm_source=chatgpt.com. Accessed 18 Sept. 2025.

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[10] Datta, Souptik. "Bengaluru Real Estate: Is Devanahalli the IT Capital's Gurugram in the Making? | Real Estate News." *Hindustan Times*, 28 Mar. 2025, www.hindustantimes.com/real-estate/bengaluru-real-estate-is-devanahalli-the-it-capital-s-gurugram-in-the-making-101743083075788.html. Accessed 7 Oct. 2025.

b) **NRI Demand and Lifestyle appeal:** Bangalore is seen as a safer decision than Bombay[11] and Delhi[12] for NRIs, the property prices are less. At the same time, Bangalore exhibits a pleasant climate and peaceful culture which makes it even more appealing to reside in this city.

In Figure 4B:

PM2.5 and PM10 continue to exhibit regular spikes. The PM2.5 index stays between the 80-120 range for most of the year, and the PM10 index shows volatility between the range from 60 to 140. There are strong seasonal peaks and can be accounted for as particulate pollution but there is no significant trend observed.

For Bangalore, there is improvement in the NO_2 line over time. There is a gradual dip from 90 in 2017 to 70-80 by the end of 2024. This suggests improvement measures may have been taken to tackle pollution. In the case of Ozone index, it remains mostly stable and ranges from 70-100. This shows consistency and does not exhibit drastic variation.

However, these pollution trends have not affected the housing demand. Thus, showing no direct correlation between the Housing Price Index and Pollution Index.

Chennai

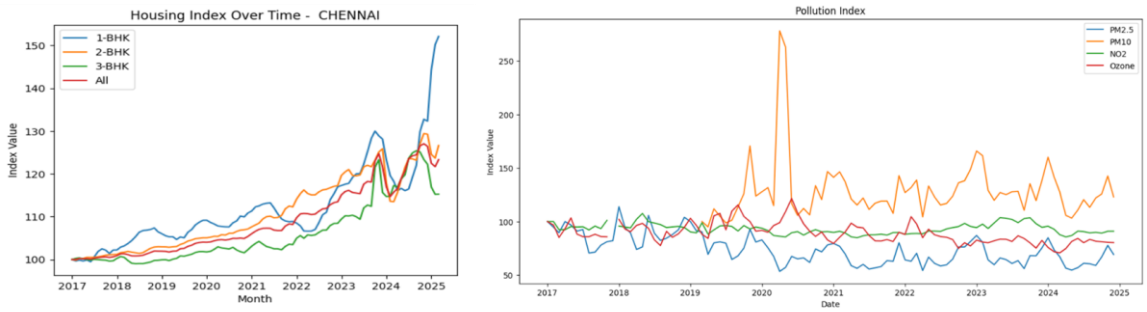

Figure 5: Index data of Chennai. **(A)** Housing price index data of Chennai. **(B)** Pollution Index Data of Chennai.

In Figure 5A:

2017-2021: From 2017 to 2021, Chennai's Housing Price Index increased gradually from about 100 to roughly 112-115. This shows a moderate advance in housing demand stemming from organic population growth and consistent urbanization, without price turbulence. The increases remained continually stable without significant jumps, implying a relatively balanced market throughout that time.

2022 onwards: The index experienced a major rise following 2022, particularly for 1-BHK units, which rose above 150 by early 2025. 2-BHK and 3-BHK units peak around 130 and approximately 125, respectively. This dramatic increase suggests a recovery of demand after the COVID-19 pandemic, growing attraction to more affordable smaller units, and generally rising prices of construction materials and financing.

Why is there a rise in the HPI?

Chennai's rise in HPI includes common reasons like infrastructure and connectivity boost; there has been a considerable expansion of metro lines and corridors. It is a hub for ITs and a city where there is job growth, causing demand for residential complexes to increase. Since there is land scarcity, new supply has to expand into suburban areas, which often comes at a premium as it requires land acquisition, infrastructure build-out etc. Therefore, developers will just pass along that cost in prices.

In Figure 5B:

The PM2.5 index has remained stable between the range of 60-100, with occasional fluctuations but there is no long-term rise.

The PM10 index is the highest among all the pollutants and shows a spike in 2020.

The NO_2 index is relatively steady between 90-105 and there are mild increases during certain periods.

The Ozone index has mostly fluctuated between 80-100, without any major shifts.

However, these pollution trends have not affected the housing demand. Thus, showing no direct correlation between the Housing Price Index and Pollution Index in Chennai.

Conclusion

From the above study, we can see that there is no direct correlation between the housing prices and air quality across the five major cities of India. The residents' choices are driven more by factors which affect and improve their life like employment opportunities,

[11] Real, HT. "Bengaluru Surpasses Mumbai, Ranks 4th Globally among 46 Cities in Premium Property Price Growth | Real Estate News." *Hindustan Times*, 18 Aug. 2025, www.hindustantimes.com/real-estate/bengaluru-emerges-as-a-global-luxury-real-estate-hotspot-ranks-4th-in-prime-housing-growth-mumbai-6th-and-delhi-15th-101755504328430.html#google_vignette. Accessed 7 Oct. 2025.

[12] Financial Express. "The Financial Express." *Financialexpress.com*, Financial Express, 8 Sept. 2025, www.financialexpress.com/business/industry-whats-driving-realty-boom-in-bengaluru-hyderabad-even-as-mumbai-ncr-go-cold-antique-lists-out-top-trends-3970875/. Accessed 7 Oct. 2025.

economic boost, connectivity, NRI interests etc. The limitation which exhibits is that this paper consists of missing variables, it did not take into account factors such as income level, population density, socio-cultural interests, and purely relies on data from two separate indexes – The Housing Price Index and The Pollution Index. This paper relies on recent data, making the observations more relevant to the present day and age.

One major learning includes that there needs to government intervention and implementation of policies. Since pollution does not affect the valuation of the residential complexes, there is no pressure on the real estate market to adopt sustainable practices and green housing as consumers will buy or rent property irrespective of the air quality. There needs to be stronger policy formulation to address and curb further environmental degradation. It is important to note the social costs, which is the cost borne by society due to industrialization, urbanization or modernization is not taken into account when it comes to house prices and business costs as they are considered 'side effects' of development. Thus, those costs should also be considered when cities are being planned. Currently, a builder can establish a house in a polluted area and demand a higher price. However, if the government enforces strict action to help the environment and include those specific costs, it will force the builders to consider the air quality too.

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