

Valuing Neighbourhood Soundscapes in Urban Housing Markets: Evidence from Karachi

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Noise pollution in Karachi has already exceeded WHO-recommended environmental thresholds. It causes sleep disturbances, hearing impairment, stress, and anxiety. However, there is a lack of evidence on how these effects transferred into housing market. This study extends a conceptual framework and empirically explores household data on perceived neighbourhood soundscapes and self-reported housing values. We estimate hedonic pricing models to examine how the presence of natural and non-natural soundscapes around respondent's residence affects housing values. This study conducted a primary data survey of 507 respondents affiliated with the Institute of Business Administration (IBA), Karachi. Using hedonic regression results, this study is the first to confirm the effect of natural and non-natural soundscapes on housing values, along with structural, locational, and neighbourhood attributes. The results recommend designing and installing soundproof windows in homes and developing better urban planning and management policies to ensure a good quality of life in Karachi.

JEL Classification: R21, R31, R23, Q53, I18, Q51

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1. INTRODUCTION

Megacities in Pakistan, for instance Karachi, have witnessed environmental degradation such as reduction of green spaces as a negative externality due to unplanned and unmanaged urbanisation (Asian Development Bank, 2024 Mehdi, et al. 2011, Qureshi, et al. 2010). The presence of green spaces is well-documented to provide benefits to human health and mental well-being via interaction with nature (Alvarsson, et al. 2010, Hedblom, et al. 2014, Uebel, et al. 2022). The possible pathways of such interactions are based on visual stimuli and soundscapes that are responsible for improving human health and mental well-being (Ratcliffe 2013, Smalley, et al. 2022). In particular, bird sounds are

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related to improving mental well-being by reducing stress and anxiety and improving attention recovery, among other benefits (Ratcliffe, et al. 2020).

Merchant, et al. (2015) defines soundscapes as “all the sounds in a particular area at a specified time”. Urban areas frequently face anthropogenic soundscapes that are higher than natural soundscapes owing to the high population density. For instance, Karachi is one of the most populous cities in Pakistan, with a population of over 21 million in 2026 and annual growth rate of 4.03 percent (World Population Review, 2026), anthropogenic soundscapes are potentially higher than natural ones. Recognising the existence of anthropogenic soundscapes, the World Health Organisation (WHO) announced noise as a pollutant in 1972. The WHO also provides a benchmark for the level of noise, which, if exceeded, can lead to health losses.

Following that benchmark, studies conducted in several cities in Pakistan, particularly Karachi, have shown alarming levels of noise pollution that are responsible for lower quality of living in urban areas (Mehdi, et al. 2011, Nadeem, et al. 2024, Siddiqui, et al. 2015). Prior research in Karachi and other metropolitan cities of Pakistan has found that such noise pollution has led to potential hearing impairment, lack of quality sleep, and enhancement of stress and anxiety in Pakistan (Khan, et al. 2010, Latif, et al. 2023, Zaidi, 1989).

Considering the effects of rapid urbanisation, lower green spaces, rising population densities, and noise exposure on mental well-being, this study aims to explore how these factors affect housing values in an urban area because house price reflects amenities and disamenities around it. A large body of literature using hedonic models provides empirical evidence that structural, locational, and environmental attributes have a significant effect on housing values (Ali, et al. 2015, Ahmed, et al. 2020, Hussain, et al. 2019). Nevertheless, to our knowledge, these studies have limited consideration of neighborhoods and soundscapes in housing market of Pakistan.

International and few local studies using hedonic models do consider negative externality such as noise pollution (Akbar & Altaf, 1995, Bravo-Moncayo, et al. 2023, Dekkers & Van der Straaten, 2009, Kalim, et al. 2014, Latif, et al. 2023), and on the other hand literature supports positive effects of natural sounds on mental well-being (Smalley, et al. 2022, Ratcliffe, et al. 2013, Ratcliffe, et al. 2020, Uebel, et al. 2022). However, exploring both soundscapes is still missing in the context of a developing country, like Pakistan. Therefore, the major contribution of our study is to expand the traditional conceptual framework of the hedonic model and empirically test with survey data on perceived neighbourhood natural and non-natural soundscapes and self-reported housing values along with traditional housing attributes of respondents in Karachi.

This study has two key objectives. First, it aims to extend the traditional conceptual framework of hedonic models to explain the determinants of housing value with soundscapes. Second, to empirically estimate the effects of soundscapes, that is, natural and non-natural, on self-reported housing values. Section 2 describes the literature review, and Section 3 explains the conceptual framework of the study. Section 4 defines the data and methodology, followed by Section 5, the theoretical and empirical framework. Section 6 provides the results, and Section 7 concludes with limitations and future research.

2. LITERATURE REVIEW

Literature using hedonic models to define housing values is quite common in various cities of Pakistan, such as Islamabad, Rawalpindi, Faisalabad, Lahore, and

Karachi. Considering hedonic model, house values are defined by structural and non-structural attributes of a house. Despite differences in coefficients, almost every study finds out positive effects of structural attributes on housing values (Akmal, et al. 2023, Asif, et al. 2022; Hussain, et al. 2019; Wahid, et al., 2023). The increase of structural attributes raises housing values, for instance number of rooms and floors, area, restrooms, car parking, lobbies, kitchens, garages, lawns, and access to clean drinking water, drainage facilities, and availability of electricity and gas on property (Aziz & Anwar 2019; Khan, et al. 2023, Shabana et al., 2015, Shakeel, 2016.).

On the other hand, non-structural attributes, proximity to environmental and non-environmental amenities, also have similar nature of relationship across cities. A common phenomenon found in these studies is called distance decay hypothesis in major cities of Pakistan. It is defined as the distance to amenities from a house increases so it reduces the house value. For instance, proximity to bus stops, city centers, roads and parks have positive effects on housing values. While proximity to dumpsites and open sewer, creating foul smells, poor air quality, contaminated water has negative effect on housing values (Akmal, et al. 2023, Hussain et al. 2019, Sheikh, 2016, Wahid, et al. 2023,). Conversely, Ahmed, et al. (2020) found contradictory results in Karachi related to non-structural attributes effects on housing values. Their study found that the increase in the number of schools and hospitals causes negative effects on housing values in their surroundings. Secondly, proximity to industrial areas is generally considered to have negative effects on housing values, due to noise and water pollution, but their study found positive effect. It is possible to have a positive effect because proximity to industrial zones helps in securing employment opportunities despite having negative environmental externalities.

Our study is different from other hedonic studies as it considers more locational, neighbourhood, and environmental attributes that were missing in literature. For example, our study considers proximity to airports, railways, police stations, educational institutes such as school, college, universities, and neighbourhood attributes such as presence of traffic lights, neighbourhood quality, and other environmental attributes affecting housing values in Karachi. Along with that, this study explores how natural and non-natural soundscapes affect housing values in selected areas of Karachi city. Significant amounts of studies are available that have found noise pollution from transport in Karachi has exceeded the acceptable level defined by WHO in 1972 (Mehdi, et al. 2011, Zaidi, 1989). Because of this exceedance, a few recent studies have found the effect of noise pollution on quality of life, i.e., sleep disturbance, stress, anxiety and other problems.

Majority of international literature focuses on the negative externality of noise pollution on housing values (Bravo-Moncayo, et al. 2023, Dekkers & Van der Straaten, 2009), and on the other hand positive effect of natural soundscapes such as bird chirping, focuses on its effect on mental well-being not on housing market (Alvarsson, et al. 2010, Hedblom, et al. 2014, Hammoud, et al. 2022, Morrison, et al. 2021, Ratcliffe, et al. 2013, Ratcliffe, et al. 2020, Uebel, et al. 2022). However, there are no previous studies that consider how both soundscapes affected housing demand using the Hedonic model, especially in Pakistan. Therefore, this study contributes to literature by addressing this vital gap in environmental economics literature.

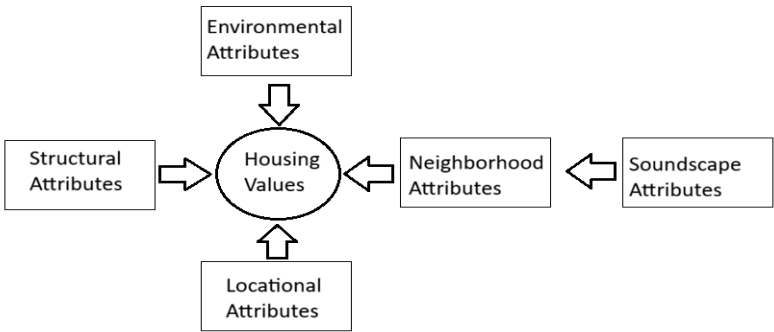
3. CONCEPTUAL FRAMEWORK

Based on a previous literature review, the hedonic model is well renowned for understanding effects of house structure, environmental amenities as well as disamenities

in the neighbourhood, along with locational attributes of nearby amenities (Ali, et al. 2015, Chau & Chin, 2003, Hussain, et al. 2019, Rosen, 1974, Roback, 1982). Conversely, little attention to our knowledge has been given to acoustic environment of residential neighbourhoods. Each house depending on its location exposes residents to different soundscapes that capture the auditory dimensions of neighbourhood environmental quality, i.e., continuously auditory experience. For instance, pleasant soundscapes such as bird sounds from nearby parks may enhance perceived residential quality, but anthropogenic noises such as traffic or construction may reduce residential desirability. How these natural and anthropogenic soundscapes effects housing values in Pakistan is still not clear. Incorporating, these indicators show the acoustic environment experienced in residential neighbourhoods, which can influence residents perceived quality of life and thus be capitalised into housing values.

To our knowledge very few papers have measured noise pollution levels at different cities of Pakistan. Few of these have also considered qualitative measures, like descriptive statistics to relate with sleep disturbances and stress (Kalim, et al. 2014, Latif, et al. 2023, Nadeem, et al. 2024, Siddiqui, et al. 2015). However, there are no previous studies that incorporate soundscapes, natural and non-natural, in the Hedonic model conceptual framework. Therefore, key contribution of our study is to extend the conceptual framework of the Hedonic model using soundscapes, natural and anthropogenic. Although, evidence of positive and negative psychological well-being effects from natural and anthropogenic sounds exists in literature, empirically how residents avoid or get attracted to houses does not exist previously. In Fig. 1, for understanding readers we have added two new subcomponents of neighbourhood attributes and soundscapes to expand the Hedonic conceptual framework.

Fig. 1. Conceptual Framework



4. DATA & METHODOLOGY

In this study, we reviewed literature to prepare a semi-structured questionnaire. It took almost 6 months to prepare the final questionnaire from October 2023 to March 2024. The questionnaire was shared with experts from University of Glasgow to get their feedback. Before conducting the final survey, we used a screening survey to identify respondents from Institute of Business Administration (IBA) based on two inclusion criteria. These criteria are respondent must be 18 years or older participants and living outside of Karachi University premises. These IBA respondents belonged to three categories, namely, students, faculty and staff.

During screening, pilot tests and final survey, we cared about consent of voluntary participation, anonymity of response, and highlighting no conflict of interest with incentives of participation. This study was approved by the Ethical Board of IBA before conducting the screening and final survey. The questionnaire also provided an incentive of 1000 Pakistani Rupees to the participants who met the above criteria. The questionnaire consists of questions related to housing characteristics, soundscapes experienced by respondents at their respective homes, and their socio-demographic characteristics.

It is important to highlight that survey asked respondents about their approximate housing values of their dwellings. The given housing values, dependent variable, are perception or knowledge based on the market value rather than actual house values. Despite following common techniques in literature of inquiring house values from respondents, it is likely that these values may have measurement error. Therefore, it is crucial to interpret these values cautiously.

The data collection follows two steps. First, we contacted every possible participant via email and word of mouth to find out relevant participants during screening. It helped us to get information of 741 respondents during screening. During the second step, based on screening, the relevant participants were ordered alphabetically and randomly contacted via emails to share venue of data collection randomly. The challenges during data collection were related to collecting data from staff due to lack of time availability. Despite difficulties, we collected a targeted sample of 507 respondents. The following Table 1 specifically provides details of sociodemographic and housing characteristics of respondents.

4.1. Summary Statistics

Table 1
Summary Statistics for the Variables

Variable	Description	Mean	Std. Dev.
Structural Attributes			
House Value	A continuous variable showing PKR value of house respondent is living.	26,500,000	21,400,000
Number of Bedrooms	A continuous variable showing number of bedrooms in the respondent's house.	3.594	1.821
Number of Restrooms	A continuous variable showing number of restrooms in the respondent's house.	3.589	2.074
Solar	A dummy variable showing people who have solar at their house versus no solar base category.	0.176	0.381
Gas	A dummy variable shows people who have gas supply at their house versus no gas base category.	0.854	0.353
Water Supply	A dummy variable shows people who have water supply at their house versus no water supply base category.	0.751	0.433
Locational Attributes			
Commercial	A dummy variable showing type of residence, i.e., commercial against base category of residential area.	0.288	0.453

Distance within 1 Km	grocery	A dummy variable showing people who are living near to grocery stores i.e., within 1km against respondents who have access to stores but greater than 1 km.	0.607	0.489
Distance within 1 Km	school	A dummy variable shows people who are living near to schools i.e., within 1km against respondents who have access to schools but greater than 1 km.	0.377	0.485
Distance within 1 Km	college	A dummy variable showing people who are living near to college i.e., within 1km against respondents who have access to college but greater than 1 km.	0.118	0.323
Distance within 1 Km	university	A dummy variable showing people who are living near to university i.e., within 1km against respondents who have access to university but greater than 1 km.	0.067	0.250
Distance within 1 Km	hospital	A dummy variable showing people who are living near to hospital i.e., within 1km against respondents who have access to hospitals but greater than 1 km.	0.199	0.400
Distance within 1 Km	bus stop	A dummy variable showing people who are living near to bus stops, i.e., within 1km against respondents who have access to bus stop but greater than 1 km.	0.383	0.487
Distance within 1 Km	police	A dummy variable showing people who are living near to police station i.e., within 1km against respondents who have access to police station but greater than 1 km.	0.146	0.353
Distance rail within 1 Km		A dummy variable showing people who are living near to railway i.e., within 1km against respondents who have access to railway but greater than 1 km.	0.020	0.139
Distance within 1 Km	airport	A dummy variable showing people who are living near to airports, i.e., within 1km against respondents who have access to airports but greater than 1 km.	0.010	0.099
Distance within 1 Km	post office	A dummy variable showing people who are living near to post office i.e., within 1km against respondents who have access to post office but greater than 1 km.	0.105	0.306
Distance bank within 1 Km		A dummy variable showing people who are living near to bank i.e., within 1km against respondents who have access to bank but greater than 1 km.	0.521	0.500
Environmental Attributes				
Trees		A dummy variable shows people who agree with the number of trees more than 6 in their neighbourhood.	0.254	0.436
Distance Park within 1 Km		A dummy variable showing people who are living near to park i.e., within 1km against respondents who have access to park but greater than 1 km.	0.523	0.499

Distance within 1 Km	Kachra	A dummy variable showing people who are living near to open air dumping site i.e., within 1km against respondents who have live far from dumping site, i.e., greater than 1 km.	0.304	0.46
Open Air Burning		A dummy variable showing respondents who responded that they witness open air burning often in their neighbourhood	0.347	0.477
Choked pipes		A dummy variable showing respondents who responded that they witness choking of sewer pipes often in their neighbourhood	0.371	0.483
Neighbourhood & Soundscape Attributes				
Poor road		A dummy variable showing respondents who responded poor quality of roads in their neighbourhood	0.390	0.488
Streetlight		A dummy variable showing respondents who responded having access to streetlights in their neighbourhood	0.781	0.414
Crime		A dummy variable showing respondents who responded that they hear about crime incidents in their neighbourhood	0.641	0.48
No garbage collection		A dummy variable shows respondents who responded that they witness no garbage collection in their neighbourhood	0.020	0.139
Hear birds often		A dummy variable shows respondents who hear birds chirping often where they live.	0.850	0.357
Hear traffic often		A dummy variable shows respondents who hear traffic often where they live.	0.560	0.497
Hear construction often		A dummy variable shows respondents who hear construction often where they live.	0.408	0.492
Respect neighbourhood		A dummy variable shows respondents who agree with people in my neighbourhood respect each other and accept others who are like them.	0.740	0.439
Friendly neighbourhood		A dummy variable shows respondents who agree with most people in my neighbourhood are friendly, they are concerned with interest of others and help each other.	0.744	0.437

Trust neighbourhood	A dummy variable shows respondents who agree with most people in my neighbourhood can be trusted, they would not take advantage of me, and if were in trouble, they would come to my aid.	0.807	0.395
Noisy chowks	A dummy variable shows the number of people living within 1km of a noisy chowk.	0.391	0.488
Sociodemographic Characteristics			
Income less than 32 thousand Rupees	Household with income less than 32 thousand PKR	0.150	0.355
Income Between 32 to 50 thousand Rupees	Household with income between 32 to 50 thousand PKR	0.161	0.368
Income Between 50 to 1 lakh Rupees	Household with income between 50 to 1 lakh PKR	0.210	0.404
Income Between 1 to 3 lakh Rupees	Income between 1 to 3 lakh PKR	0.114	0.318
Income Between 3 lakh Rupees or more	Income more than 3 lakh PKR	0.020	0.139
Primary	Primary education completed	0.030	0.160
Secondary	Secondary education completed	0.167	0.373
Bachelors	Bachelor's degree completed	0.590	0.492
Master's or higher	Masters of PhD degree completed	0.204	0.400
Male	Respondents who answered gender question	0.680	0.466
Student	Respondents who responded as student	0.556	0.497
Employed	Respondents who responded as working	0.617	0.486

The summary statistics provide details about each variable in our data given in Table 1. First, we explain housing characteristics followed by sociodemographic characteristics of respondents. After explaining the sociodemographic characteristics of respondents, we are focusing on summary statistics for housing characteristics. The mean value of houses is 26,500,000 PKR which is quite high because Karachi is a metropolitan city. Usually, house values in urban areas are comparatively higher than rural areas. Quite interestingly, standard deviation is also high which reflects that are houses that are not only above the mean but also below it. Such deviation in prices reflects that Karachi also has a marked differences in house values in different districts or neighbourhoods. On average, respondents are living in houses that have more than 3 bedrooms and restrooms. The access to utilities shows that respondents have higher levels of access to gas supply, followed by water supply and solar. Considerably, solar has lowest mean because access to solar is voluntary and individual decision subject to their income.

The mean of proximity variables tells us that out of total respondents, 52 percent live within 1 km of park, 60 percent live within 1km of a grocery store, 37 percent live within 1 km of schools, 11 percent live within 1 km of college, 6 percent of respondents live within 1 km of a university, 19 percent of respondents live within 1 km of hospital, 38 percent of respondents live within 1 km of bus stop and 14 percent of respondents live within 1 km of a police station, 2 percent of respondents live within 1 km of railway, 1 percent of respondents live within 1 km of airport, 10 percent of respondents live within

1 km of post office, 52 percent of respondents live within 1 km of bank, and 30 percent of respondents live within 1 km of an open air dumping site, i.e., '*Kachra Kundi*' in Urdu language.

For neighbourhood quality, 39 percent of respondents described poor road quality, 78 percent of respondents agreed with access to streetlight, 34 percent agreed with witnessing open air burning, 37 percent agreed with choked sewer pipes. Apart from that, 64 percent agreed with hearing about crime incidents, and 2 percent agreed with no garbage collection in their neighbourhood. For other neighbourhood variables, 74 percent agreed for living in a neighbourhood in which people respect and have friendly ties with each other. In addition, 80 percent of respondents agreed with the trust of people in their neighbourhood.

For environment and soundscape attributes, 85 percent, 56 percent, and 40 percent of people agreed with they hear bird chirping, traffic, and construction often at home. For trees 25 percent of respondents agreed with they have 7 or more than 7 trees inside or outside their house. Finally, 39 percent of respondents from our sample agreed that they live within 1km of noisy chowks or noisy places.

After explaining housing attributes, we discuss sociodemographic characteristics of sample. Income is an important determinant for defining respondent's housing. Based on income categories, majority of people, 21 percent, belong to the category of 50 thousand to 1 lakh Pakistani Rupees (PKR), followed by 32 to 50 thousand PKR income categories. For lower income groups, there are 15 percent of respondents who earn less than 32 thousand PKR, and upper income groups, 11 percent earn between 1 to 3 lakhs PKR, and only 2 percent more than that. The sample study consists of respondents affiliated with students, faculty, and staff from IBA Karachi. Therefore, majority of students, 55 percent of sample, while 61 percent are employed. Among student's 32.3 percent responded employed and 67.7 percent are unemployed, whereas all faculty and staff responded employed. For educational characteristics of respondents, many respondents, 58 percent, have completed their bachelor's degree, followed by 20 percent completing their master's or higher degree. Based on gender and employment, majority of respondents in our sample, i.e., 68 percent, are male.

4.2. Limitations

This study collects data from students, faculty, and staff affiliated with the Institute of Business Administration (IBA), Karachi. Although, this data collection sampling strategy allowed us to collect data efficiently, it may not fully represent the diverse Karachi housing market. For instance, students' participation is higher than other sub-categories, but students report housing values based on their family residences than their own independent ownership. Similarly, there are considerable differences in income and educational levels among sub-sample categories of students, staff, and faculty but it may not be sufficiently capturing urban and sub-urban population of Karachi. Therefore, results from this study should be considered as perceived housing values rather than precise actual market valuations. Prior studies also used self-reported housing values to estimate relationship between structural and non-structural attributes with housing values (Ali, et al. 2015, Asif, et al. 2022, Khan, 2015, Shakeel, 2016).

Along with that, this study conducts analysis on cross-sectional data and based on perceived environmental characteristics. For instance, soundscape responses are based on respondents' perception based of their own dwelling. We did not have resources and logistic support to estimate noise pollution across city. These limitations hinder causal

interpretation of results. Therefore, future studies must consider time series real market values of houses and collect spatial detailed sound measurements at housing locations to better understand soundscapes effects on housing market of Karachi.

5. THEORETICAL AND EMPIRICAL FRAMEWORK

Building on Lancaster's (1966) consumer theory and Rosen's (1974) framework, the hedonic pricing model is specified as follows, as given in the literature (Ali, et al. 2015, Chau & Chin, 2003, Hussain, et al. 2019).

$$HV_i = f(SA_i, LA_i, EA_i, NSA_i) \quad (1)$$

where HV_i shows housing value in Pakistani Rupees (PKR) reported by respondent 'i', SA_i is a vector of structural attributes, and LA_i , EA_i , NSA_i , are vectors of non-structural attributes of locational, neighbourhood and soundscape, and environmental attributes.

The structural attributes include variables that define physical attributes of houses, namely, number of rooms, restrooms, access to utilities for instance water, gas and solar. The non-structural attributes include vectors of locational attributes which include residential type such as commercial, distance to grocery stores, schools, colleges, universities, police station, bus stop, post office, hospital, and airports. The environmental attributes include availability of parks, open air waste dumping, open air burning waste, and choking of sewer lines. The neighbourhood attributes include road quality, garbage collection, streetlight, crime, and having social ties with neighbors in the form of respect, trust, and friendly relation. Along with that, neighbourhood attributes include the novel attributes of soundscapes at residential location are natural and non-natural soundscapes of birds chirping, traffic and construction sounds, respectively. These soundscapes incorporate the broader environmental quality experienced within residential neighbourhoods. These soundscapes are like other environmental amenities or disamenities which reflect acoustic conditions that influence residents' comfort, stress levels, and overall quality of life. Therefore, individuals' housing preferences and willingness to pay for residential properties are reflected through auditory experiences. Following equation 2 adds soundscape variables in the conventional hedonic framework to account for neighborhood characteristics that may influence housing values.

$$\begin{aligned} \log(HV_i) = & \beta_0 + \beta_1(\text{Number of bedrooms})_i + \beta_2(\text{Access to water supply})_i + \\ & \beta_3(\text{Access to gas supply})_i + \beta_4(\text{Presence of Solar})_i + \\ & \beta_5(\text{Commercial Residential Type})_i + \beta_6(\text{Distance to Grocery Stores})_i + \\ & \beta_7(\text{Distance to Schools})_i + \beta_8(\text{Distance to colleges})_i + \beta_9(\text{Distance to Universities})_i + \\ & \beta_{10}(\text{Distance to Hospital})_i + \beta_{11}(\text{Distance to Bus stop})_i + \\ & \beta_{12}(\text{Distance to Police Station})_i + \beta_{13}(\text{Distance to Railway Station})_i + \\ & \beta_{14}(\text{Distance to Airports})_i + \beta_{15}(\text{Distance to Post Office})_i + \\ & \beta_{16}(\text{Distance to Banks})_i + \beta_{17}(\text{Trees})_i + \beta_{18}(\text{Distance to Park})_i + \\ & \beta_{19}(\text{Open Air Dumping})_i + \beta_{20}(\text{Open Air burning})_i + \beta_{21}(\text{Choking of Sewer pipes})_i + \\ & \beta_{22}(\text{Poor Road Quality})_i + \beta_{23}(\text{Streetlight})_i + \\ & \beta_{24}(\text{No Garbage Collection})_i + \beta_{25}(\text{Crime})_i + \beta_{26}(\text{Respect Neighborhood})_i + \\ & \beta_{27}(\text{Trust Neighborhood})_i + \beta_{28}(\text{Friendly Neighborhood})_i + \\ & \beta_{29}(\text{Hear Birds Often})_i + \beta_{30}(\text{Hear Construction Often})_i + \\ & \beta_{31}(\text{Hear Traffic Often})_i + \beta_{32}(\text{Noisy Places})_i + \xi_i \end{aligned} \quad (2)$$

The identification strategy used in this study is a regression model. For robustness of results, we used two models which have only slight difference in structural attributes. Both models follow empirical Equation 2, but only the number of restrooms is added in place of the number of bedrooms. The details of results from both models are given in the next section.

6. RESULTS

In this section, the regression model includes a large number of explanatory variables compared to the sample size for capturing a wide range of housing, neighbourhood, and environment characteristics given in Table 1. Despite rich number of variables, it is possible that our analysis may have potential omitted variables and other sources of bias in our estimated coefficients. Therefore, results analysis should be interpreted as associations rather than causal effects. Secondly, these models' results are based on housing value perceptions among the respondents affiliated with the Institute of Business Administration (IBA) that may not accurately reflect urban population of Karachi. For multicollinearity, we found moderate or low multicollinearity among variables for both models. Results of Variance Inflation Factor (VIF) for both models are given in the Appendix 2. Full regression results of both models are given in the Appendix 1 and abridged results are given in the following Table 2.

Table 2
Regression Results for Hedonic Model

Variables	(1) Log (house value)	(2) Log (house value)
<i>Structural Attributes</i>		
Number of Bedrooms	0.19084*** (0.01905)	
Number of Restrooms		0.22406*** (0.01556)
Solar	0.19034** (0.08700)	0.15393* (0.07881)
Gas	0.27690*** (0.10152)	0.25384*** (0.09281)
Water Supply	0.30605*** (0.08358)	0.21211*** (0.07702)
<i>Locational Attributes</i>		
Commercial	-0.32337*** (0.07240)	-0.20353*** (0.06739)
Grocery Store within 1 km	0.17134** (0.07043)	0.12619* (0.06453)
School within 1 km	-0.19937*** (0.07551)	-0.22155*** (0.06892)
Police Station within 1 km	0.02213 (0.09772)	0.14729* (0.08870)
<i>Environmental Attributes</i>		
Availability of Park within 1 km	0.34378*** (0.06762)	0.29760*** (0.06208)
<i>Neighbourhood & Soundscape Attributes</i>		
Friendly Neighbourhood	-0.14998* (0.08965)	-0.10355 (0.08213)
Hear birds often	-0.22090**	-0.16602**

	(0.08997)	(0.08251)
Chowks	-0.12687*	-0.11883*
	(0.06910)	(0.06324)
Constant	15.71325***	15.64518***
	(0.18442)	(0.16732)
Observations	484	484
R-squared	0.4572	0.5498

Note: Full regression results with insignificant variables of both models are available in Appendix 1.

Regression results from Hedonic models given in Table 2 are not causal effects but show positive or negative association with reported housing values by respondents. Table 2 provide insightful findings related to structural attributes, locational attributes, neighbourhood attributes, environmental attributes, soundscape attributes. Our results from both models particularly agree with most of previous literature such as Ahmed, et al. (2020), Wahid, et al. (2023) and other prior hedonic studies conducted in other cities of Pakistan confirming structural, locational, neighbourhood attributes effects on housing values. The important contribution of this study lies in investigating the relationship of new attributes from environmental, neighbourhood, and soundscape attributes to housing values. However, the coefficients are found to be higher than previous studies. The R-square from second models is higher than model 1. It means that explanatory variable “number of restrooms” in second model explain variation in housing values better than “number of bedrooms” in model 1. Presence of more restrooms in a house increases convenience for joint families that could be a possible reason for higher R-square values.

6.1. Structural Attributes

Structural attributes increase housing prices significantly. They directly affect a property’s functionality, convenience, and appeal to potential buyers. For instance, access to utilities of gas and water significantly increases house values by 25-27 percent and 21-30 percent respectively. Considering other structural attributes, the number of bedrooms and restrooms in a house increases house size which positively correlates with house values. We considered both separately because conceptual relationship between both could potentially bias the results. Results describe that with the increase of one additional bedroom and restroom housing values increase by 19 percent and 22 percent, respectively.

Comparing model 1 and 2, the key difference is number of bedroom variables in model 1 and number of restrooms is added in model 2. The model 2 has higher R-squared value (0.54) than model 1 (0.46) which suggests that the higher number of restrooms explains a greater proportion in housing values within the sampled households. One of potential reasons behind this is number of bedrooms usually varies less across houses of similar size, but the presence of additional restrooms may indicate higher household convenience especially in joint family system.

This makes quite sense as there are differences in rent and housing values in the actual market if we compare, for instance, two bedrooms with a three-bedroom house or an apartment with an additional restroom. Along with that, houses which have access to solar systems have 15 to 19 percent higher property values than who don’t have it. In this case, solar acts as an asset and it reflects some income effect. People with solar systems are living in houses with significant differences in property values as compared to people who don’t have solar supported electricity supply. Therefore, having a solar system in a house has higher value compared to those who don’t have it.

6.2. Locational Attributes

Locational attributes are also related to housing values as mentioned in the literature. We found only three important factors from locational attributes which affect housing values. Firstly, residential type affects housing values. For example, housing values decrease by 20 to 33 percent if these are in a commercial area as compared to residential areas. Homes located in commercial areas are generally less desirable for residential purposes due to noise, pollution, and a lack of privacy. In a city like Karachi, a house situated in a busy commercial area like Saddar might be less appealing to families looking for a quiet residential environment. In contrast, homes in purely residential areas like Gulshan-e-Iqbal or DHA tend to be more valuable, as they offer a more peaceful and family-friendly atmosphere. Secondly, the presence of a school near to respondent's house reduces its value. Results show that houses that have access to schools within 1 km have 19 to 22 percent lower housing values as compared to houses far from schools. It is a surprising result but a potential reason for that can be associated with traffic jams that increase delays while commuting. Similar results are found in Ahmed, et al. 2020, where presence of higher number of schools and hospitals reduces housing values in nearby surroundings by 9 percent and 13 percent, respectively. The potential reason provided by Ahmed, et al. 2020, is congestion and overcrowded areas. Therefore, our results show negative school proximity effect, ranging from -19 to -22 percent, is significantly larger than most other proximity variables in the model. This indicates that the congestion externality has a substantial economic impact rather than being marginal. Thirdly, unlike schools, locational amenities such as grocery stores and police station have longer and flexible operating hours which can be potential reason for less traffic congestion and positive effects on housing values.

Similarly, access to grocery stores is also an important factor that affects housing values. Results found that people who live near grocery stores, i.e., within 1 Km, have 12 to 17 percent higher housing values than their counterparts, i.e., who live more than 1 Km away. Its potential reason can be people consider access to nearby grocery stores so that it saves the time required in fulfilling daily necessities. In addition, access to police station within 1 km increases house values by 14 percent as compared to houses away from 1 km in model 2.

6.3. Environmental Attributes

Results from the environmental attributes also describe unique relationship with housing values. Results show that housing values increase by 29 to 34 percent if people have access to a park within 1 km of their house. Many people love to stay in a peaceful environment, and parks are the best place for this. Living closer to a park enhances the quality of life by offering residents a place to relax, exercise, and enjoy nature, making nearby properties more desirable. However, environmental pollution related to frequent choking of sewage, open air dumping, and open air burning of trash does not have significant effect on housing values. One potential reason for insignificant results is that the sample of respondents does not find such problems in their locality. Secondly, we have a sample of respondents that are affiliated with IBA institution that may not fully represent households across Karachi. The sample may also have similar income levels. Thirdly, the effect of these disamenities such as open-air dumping or burning of trash may affect housing values if respondent is living next to it. Respondents living very close to these sites may have higher exposure to negative visual stimuli by watching such sites or odor smells have effect housing values. However, our sample may not have respondents very close or next to these sites.

6.4. Neighbourhood and Soundscape Attributes

Neighbourhood and soundscape attributes provide very few factors responsible for affecting housing values, for instance poor road, streetlight, no garbage collection, and neighbourhood social quality has no significant effect on housing values. Another surprising result we found is that respondents who live in a friendly neighbourhood where people support each other are 15 percent cheaper than their counterparts.

The aspect that are not incorporated in Pakistan's housing literature, particularly, the addition of perception-based soundscape variables help us to analyze how the acoustic environment of residential neighbourhoods contributes to housing values. From Soundscape attributes we found another surprising relationship of people who hear frequently birds chirping have 16 to 22 percent lower housing values than who don't hear frequently. These results contrast with present literature that associates bird songs with positive effect on mental wellbeing such as stress reduction, and enhanced environmental perception (Ratcliffe, et al. 2013, Hedblom, et al. 2014, Uebel, et al. 2022). These unexpected negative associations between bird chirping and housing values may reflect measurement limitations, as the binary variable "Hear bird frequently at their dwelling" does not distinguish between bird species and sound quality. It is important to highlight this difference because presence of bird songs in green spaces is considered positive while scavengers may not. Secondly, this negative association may signal unobserved neighbourhood characteristics rather than direct effects of bird sounds. For instance, frequent bird chirping could be associated with poor waste management, or vacant plots, which could possible lower housing value. As we know, Karachi city is facing huge solid waste management problems. Therefore, inquiring about birds may have caused misunderstanding among respondents. Third, there could be cultural and environmental differences such as findings from Western or European soundscape studies may not translate exactly in the South Asian countries where there is huge urban mismanagement, differences in ecology and species composition.

Another important variable in soundscape attributes is presence of noisy places, i.e., '*chowks*' in Urdu language, on housing values. Previous studies by Zaidi, (1989), Khan, et al. (2010) and Mehdi, et al. (2011) confirm rise of traffic noise pollution over time. These studies have also confirmed that traffic noise pollution has reached the level of hearing impairment² in different regions of Karachi. However, these studies didn't study how it affects housing values in Karachi. Results from our study is one step forward that reflects that respondents that are living within 1km of chowks are having 13 percent lower prices of housing as compared to people who live greater than 1 km. One potential reason for that is vehicular noise near chowks disturbs people their sleep leading to increasing stress and mental issues. We can't directly compare coefficients of noise pollution from Bravo-Moncayo, et al. 2023, and Dekkers and Van der Straaten, 2009, due to measurement differences. However, these studies also support that noise pollution, +5 db noise, from aircraft and vehicular traffic reduces house values from 2.5 percent to 4 percent and 1.5 percent to 3 percent, respectively.

7. CONCLUSION

This research conducts a thorough investigation of the elements that influence housing prices in Karachi, Pakistan, focusing on both structural and non-structural features, as well as innovative aspects such as perceived soundscape attributes. The findings are consistent with

² As per WHO the hearing impairment occurs when noise reaches to 110 db.

most of the previous literature on the effect of structural, locational, and neighbourhood characteristics on house values, while also providing new information about environmental and perceived soundscape aspects under neighbourhood attributes. The main contribution of this study is to incorporate perceived soundscape characteristics under neighbourhood attributes into a hedonic pricing framework in a developing megacity context. The structural attributes, such as the total number of bedrooms, bathrooms, and access to utilities such as gas, water, and solar energy all have a substantial positive impact on property values. Locational features have a mixed effect; proximity to groceries raises values, but proximity to schools lowers them, most likely due to noise pollution from traffic and congestion during office hours' time and overcrowded areas. Unlike schools, grocery stores and police stations have longer and flexible operating hours leading to less traffic congestion and noise pollution but positive effects on housing values. Along with that, residential types of housing, for instance houses in commercial areas significantly reduce their house prices.

Neighbourhood factors such as friendly neighbourhoods significantly reduce their house prices. Surprisingly, we found unexpected impacts of sounds characteristics as compared to prior literature that acknowledges positive effect of bird songs on mental well-being (Hedblom, et al. 2014, Ratcliffe, et al. 2013, Ratcliffe, 2015, Uebel, et al. 2022). Notably bird chirping is associated with decreased house prices, potentially due to measurement errors, or owing to unwanted bird species, bad living conditions due to waste-related disamenities in Karachi. It is also possible because of cultural-ecological differences that limit the applicability of Western or European soundscape findings given in above studies. Finally, houses within 1 km of chowks lead to expected results of lower housing values than houses greater than 1 km. The presence of houses near chowks increases their exposure to traffic noise which causes sleep disturbances and other associated mental issues. Therefore, our study is one step forward in supporting the traditional idea of noise pollution from traffic varies at different places, i.e., chowks. Previous studies provide evidence of alarming levels of noise pollution from traffic in Karachi (Khan, et al. 2010, Mehdi, et al. 2011, and Zaidi, 1989). This study demonstrates that soundscapes significantly influence housing values in emerging megacities. It emphasises the importance of acoustic environments in urban planning and property valuation. For unexpected negative effect of birds chirping on housing values needs further clarification from future studies. The findings have policy recommendations for noise regulation, installing soundproof windows, green space preservation, and sustainable urban development. By integrating soundscape variables into hedonic models, this research advances understanding of environmental determinants of property prices.

Despite these conclusions, it is important to highlight limitations of this study and future work. First, this study has heterogeneous sample based on socio-demographics, but the sample is purely based on students, faculty, and staff affiliated with the Institute of Business Administration (IBA), Karachi. Hence, it may not fully capture diverse Karachi housing market. Second, the responses about housing values are based on perceived housing values rather than precise actual market valuations. Third, this study conducts analysis on cross-sectional data and based on perceived environmental characteristics. For instance, soundscape responses are based on respondents' perception based of their own dwelling. We did not have resources and logistic support to estimate noise pollution across city. These limitations hinder causal interpretation of results. Therefore, future studies must consider time series real market values of houses and collect spatial detailed sound measurements at housing locations to better understand soundscapes effects on housing market of Karachi.

APPENDIX

Table 3

Appendix 1: Full Regression Results Model 1 and 2

Variables	(1) Log (house value)	(2) Log (house value)
<i>Structural Attributes</i>		
Number of Bedrooms	0.19084*** (0.01905)	
Number of Restrooms		0.22406*** (0.01556)
Solar	0.19034** (0.08700)	0.15393* (0.07881)
Gas	0.27690*** (0.10152)	0.25384*** (0.09281)
Water Supply	0.30605*** (0.08358)	0.21211*** (0.07702)
<i>Locational Attributes</i>		
Commercial	-0.32337*** (0.07240)	-0.20353*** (0.06739)
Grocery Store within 1 km	0.17134** (0.07043)	0.12619* (0.06453)
School within 1 km	-0.19937*** (0.07551)	-0.22155*** (0.06892)
College within 1 km	0.17704 (0.11147)	0.10853 (0.10220)
University within 1 km	-0.06739 (0.13293)	-0.04698 (0.12162)
Hospital within 1 km	0.08957 (0.08688)	0.04538 (0.07950)
Bus stop within 1 km	-0.06862 (0.07352)	-0.03853 (0.06703)
Police Station within 1 km	0.02213 (0.09772)	0.14729* (0.08870)
Railway Station within 1 km	-0.22920 (0.27549)	-0.28402 (0.25189)
Airport within 1 km	-0.08662 (0.36110)	-0.17339 (0.33029)
Post office within 1 km	0.04187 (0.11913)	0.02894 (0.10902)
Bank within 1 km	0.04841 (0.06972)	0.02741 (0.06369)
<i>Environmental Attributes</i>		
Trees	0.09482 (0.07637)	0.06448 (0.06997)
Availability of Park within 1 km	0.34378*** (0.06762)	0.29760*** (0.06208)
Open Air Waste Dump within 1 km	0.02968 (0.07530)	0.03656 (0.06888)
Open Air Burning of Waste	-0.10674	-0.07552

	(0.06896)	(0.06306)
Choked Sewer pipes	-0.04820	-0.05673
	(0.06954)	(0.06356)
<i>Neighbourhood & Soundscape Attributes</i>		
Poor roads	0.02837	0.02430
	(0.07313)	(0.06693)
Streetlight	-0.02707	-0.00476
	(0.08168)	(0.07479)
No garbage Collection	-0.17426	-0.17237
	(0.23352)	(0.21370)
Crime	-0.11143	-0.09445
	(0.06979)	(0.06385)
Respect Neighbourhood	0.12975	0.12689
	(0.08700)	(0.07959)
Trust Neighbourhood	0.02358	-0.00760
	(0.09925)	(0.09089)
Friendly Neighbourhood	-0.14998*	-0.10355
	(0.08965)	(0.08213)
Hear Birds often	-0.22090**	-0.16602**
	(0.08997)	(0.08251)
Hear Traffic often	0.03630	0.02107
	(0.06815)	(0.06227)
Hear Construction often	0.04938	0.03640
	(0.06699)	(0.06132)
Chowks	-0.12687*	-0.11883*
	(0.06910)	(0.06324)
Constant	15.71325***	15.64518***
	(0.18442)	(0.16732)
Observations	484	484
R-squared	0.4625	0.5498

Table 4

Appendix 2: Model 1 Variance Inflation Factor (VIF)

	VIF	1/VIF
Trust Neighbourhood	1.599	.625
Friendly Neighbourhood	1.576	.635
Respect Neighbourhood	1.524	.656
Distance Rail within 1 km	1.448	.691
Distance Airport within 1 km	1.394	.717
Distance School within 1 km	1.393	.718
Water Supply	1.369	.73
Distance College within 1 km	1.35	.741
Gas	1.349	.741
No Sweeping	1.339	.747
Poor Road	1.331	.751
Distance Bus Stop within 1 km	1.329	.753
Distance Post Office within 1 km	1.326	.754
Distance Bank 1 km	1.27	.788
Number of Bedrooms	1.269	.788
Distance Hospital within 1 km	1.265	.791
Distance Police within 1 km	1.264	.791

Distance Kachra 1 km	1.263	.792
Witness Burning	1.24	.807
Witness Choked pipes	1.237	.808
Distance Grocery within 1 km	1.234	.81
Streetlight	1.233	.811
Hear Traffic Frequently	1.194	.837
Distance Park within 1 km	1.192	.839
Noisy Chowks	1.188	.842
Crime	1.166	.857
Solar	1.156	.865
No Garbage Collection	1.154	.867
Distance University within 1 km	1.141	.877
Hear Construction Frequently	1.134	.882
Trees	1.131	.884
Commercial	1.127	.888
Hear Birds Frequently	1.096	.912
Mean VIF	1.281	.

Table 5

Appendix 2: Model 2 Variance Inflation factor (VIF)

	VIF	1/VIF
Trust Neighbourhood	1.601	.625
Friendly Neighbourhood	1.579	.633
Respect Neighbourhood	1.522	.657
Distance Rail within 1km	1.445	.692
Distance Airport within 1km	1.392	.718
Water Supply	1.388	.72
Distance School within 1km	1.385	.722
Distance College within 1km	1.355	.738
Gas	1.346	.743
No Sweeping	1.338	.747
Poor Road	1.331	.751
Distance Post Office within 1km	1.325	.754
Distance Bus Stop within 1km	1.319	.758
Number of Rest Room or Washrooms	1.308	.764
Distance Bank within 1km	1.265	.79
Distance Hospital within 1km	1.264	.791
Distance Kachra within 1km	1.262	.793
Distance Police within 1km	1.244	.804
Witness Burning	1.238	.808
Distance Grocery within 1km	1.237	.808
Witness Choked Pipes	1.234	.81
Streetlight	1.234	.81
Distance Park within 1km	1.2	.834
Hear Traffic Frequently	1.19	.84
Noisy Chowks	1.188	.842
Crime	1.166	.858
Commercial	1.165	.858
No Garbage Collection	1.153	.867

Distance University within 1km	1.14	.877
Hear Construction Frequently	1.134	.882
Trees	1.133	.883
Solar	1.133	.883
Hear Birds Frequently	1.101	.909
Mean VIF	1.282	.

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Conflict of Interest The authors state that they have no professional or personal affiliations or relationships that might compromise, or appear to compromise, the impartiality of the research reported in this article.

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