



Research article

## Assessing the Influence of Housing Attributes on Rent in the Urban Context of Khulna

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### ABSTRACT

Rapid urbanization pressure is one of the major challenges of city corporation authorities in Bangladesh. House rents have become a major concern in Bangladesh. However, few studies have assessed the value of housing characteristics in the housing market in the southern region of Bangladesh. Hence, this study examines the value of housing characteristics on house rent in Khulna City, considering 180 respondents. The hedonic pricing method has been used to examine the value of four housing characteristics—structural, location, transportation, and neighborhood in the housing market. The study found that these housing characteristics explain the variation in housing rents significantly. Structural attributes—A shift of floor materials from tile to cement decreases house rent by 0.062 %, while a 1% increase in the number of rooms boosts house rent by 0.171%. Neighborhood characteristics—one discrete unit increase in a 5-point fire extinguishing system improvement scale from very poor to very good turnout, a 2.8% rent increase. Structural and neighborhood characteristics significantly influence the rental prices of both planned and unplanned areas. Further analysis showed that the rent of planned residential areas is more sensitive to noise pollution and school distance, whereas unplanned areas are more sensitive to income, bus stops, and the number of bedrooms. Furthermore, this study calculates the value of house attributes in the housing market of Khulna City. This study suggests that improving housing characteristics increases house rent, which in turn attracts effective urban planning and zoning regulations.

### Introduction

Housing is one of life's most fundamental needs, and a fair standard of living is dependent on a reliable source of affordable and suitable housing. It has become an indicator of the economic condition of a nation (Cui et al., 2018). There is a scarcity of affordable housing in many places that causes demand-supply imbalances and costs. In response to urbanization, demand for rental accommodation has increased remarkably over the last 20 years (Wang et al., 2021). Housing affordability has become a key issue in many parts of the world, with housing costs surpassing the income growth. Since housing is one of our fundamental requirements, the Sustainable Development Goals (SDGs)-2030 has set goals and guidelines for urban planning to serve cities with expanding populations (Saraswati and Rohman, 2020; Odubola and Adeyeemi, 2017). To achieve the eleventh aim of the SDGs, many nations have taken the initiative to provide housing to low-income people (Saraswati and Rohman, 2020). For this reason, scholars around the world have begun to show interest in the housing market (Wen et

al., 2014). Since then, many studies have used the hedonic price model to dispassionately assess the factors influencing home rental costs (Hussain et al., 2019). Further investigation and in-depth analysis of the determinants are required to estimate the impact on house rental prices in Khulna.

The amount of money that tenants must pay to rent a house is regarded as the house rental price (Decker, 2021). They differ based on different dwelling types in a city (Wang et al., 2021). Housing can be differentiated based on both qualitative and quantitative characteristics because of its uniqueness (Marco, 2008). Housing prices and rents vary depending on both microeconomic and macroeconomic factors (Lo et al., 2022). Long-term influences on the real estate market come from macroeconomic factors, whereas short-term influences come from microeconomic factors (Phatudi and Okoro, 2022). These microeconomic variables include neighborhood, structure, transportation, and economic and social characteristics (Macro, 2008; Adegoke, 2014; Akay et al., 2017; Kahveci and Sabaj, 2017; Odubola and

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Adeyeemi, 2017; Cui et al., 2018; Rezaeian, 2019; Darfo-Oduro, 2020; Mekonen, 2022). Human preferences are impossible to monitor, but we can determine what people want based on their financial limitations (Kryscynski et al., 2020). The hedonic price model can be used to assess the relative weight of the factors that influence rent increases or decreases, which follows the consumer theory of classical economics (Kahveci and Sabaj, 2017). According to consumer theory, people make financial decisions based on their unique tastes and financial limitations (Bakry et al., 2021).

The global real estate market was valued at 3.69 trillion USD in 2021 and is projected to reach 5.22 trillion USD by 2030, with a compound annual growth rate (CAGR) of 5.2% (Statista Real Estate, 2021). The United States is the most competitive real estate market, expected to generate 395.40 billion USD in 2023 with an annual growth rate of 2.15% (Statista Industry Insights, 2022). Europe follows, with London as the top investment city, and Germany's market valued at 1.8 trillion USD (Balemi et al., 2021; Nyikos and Ermasova, 2022). In terms of revenue, the United States ranks first, Germany second, and South Korea third (Statista Research Department, 2022), indicating Asia's growing role. The demand for housing in Asia has increased significantly in recent years (Galster and Lee, 2021), particularly with the development of South Asian countries (Sharma et al., 2021). The Asia-Pacific real estate industry is forecasted to reach 2465.25 billion USD by 2025 with a 3.0% CAGR, driven mainly by China, Japan, and India, which contribute nearly 82% of the region's market. In India alone, approximately 70 million people are employed in this sector (Statista Real Estate, 2022).

As the Population density of Bangladesh is extremely high, housing demand is increasing daily (Khan et al., 2021). Approximately 28% of the population dwells in urban centers, indicating that cities and towns in Bangladesh are essential for national growth (Ahmad, 2014). Urban services in Bangladesh are inadequate (Afroj et al., 2021). In Bangladesh's six largest metropolitan areas (Dhaka, Chittagong, Khulna, Rajshahi, Barisal, and Sylhet), approximately 35% of the people live in slums (Ahmad, 2014). The government of Bangladesh has encouraged private investment in the real estate industry to reduce housing demand in the country's rapidly expanding urban population (Jha et al., 2013). The recently inaugurated Padma Bridge boosts the housing prospects of Khulna City, as it directly connects with the capital city, Dhaka. The demand for housing has increased since Khulna started being industrialized and house rental prices started to increase. In the last two years, house rents in Khulna City have increased significantly, which has been a burden for lower- and middle-income groups (Farzana et al., 2023). For this reason, this study seeks to understand the dynamics of the house rent market of Khulna and provide insights for policymakers, landlords, and tenants in decision-making related to house rent. The objective of this study was to estimate the impact of house rent determinants in Khulna City.

In Khulna, house rent is frequently set through negotiation, assumptions, or subjective judgement, which leads to disputes and dissatisfaction on both sides. A systematic study can identify the key determinants of

house rents in Khulna. To determine how transportation affects housing rent, Rahman et al. (2021) conducted a thorough study in Khulna and concluded that structural elements are the primary determinants, and transportation characteristics have a substantial impact on house rental pricing. Property values, locational attributes, and land-use characteristics are inferior to those of other characteristics. Islam et al. (2020) conducted research to assess the significance of environmental features in the housing market. Due to high demand, there is a scarcity in the supply of housing, which forces us to sacrifice important environmental amenities.

The absence of standardized rules and lack of transparent data on house rent in most cities, including Khulna, has widened the door to arbitrary decisions by homeowners on rent (Rondinelli and Veronese, 2010). Although a few studies on rental prices have been documented in Bangladesh, research has been conducted on the factors influencing house rent in Khulna City (Alam et al., 2021, Farzana et al., 2023). The existing literature is bound by the landlord or property owner perspective, failing to integrate these multiple dimensions: structural attributes, transportation accessibility, location dynamics, and neighborhood characteristics. Furthermore, while some stress individual factors, investigations of the combined effects, especially with a primary concentration on structural factors, are less covered. Therefore, this lack of comprehensive analysis calls for detailed research that can provide a nuanced understanding of the rental pricing mechanism in Khulna City.

## Materials and Methods

### Study Area and Survey Design

Khulna is ranked the third most populous city in Bangladesh (Haque et al., 2022). The urban region encompasses a total land area of 50.61 square kilometers (Morshed et al., 2022). According to Marshall and Rahman (2013), intra-district migration has significantly increased over the past 15 years, owing to the availability of various economic facilities. Khulna is experiencing rapid growth, with the emergence of new residential blocks alongside preexisting residential areas (Alam, 2023). The primary regulatory agency in charge of regulating urban growth and expansion in the city of Khulna is the Khulna Development Authority (KDA). As per their plan, KDA has successfully constructed six residential areas, three of which are designated for low-income communities residing on the outskirts, while the remaining three are intended for all income groups in the central city area.

The three residential communities of Nirala, Sonadanga, and Boyra, which had various income levels, were chosen for our study. These three entities exhibit nearly all attributes of a meticulously designed residential zone. Three unplanned residential areas were also selected: Moylapota, South-central road, and Tutpara. These three will represent the unplanned (building permitted by the KDA, but zone is unplanned) residential areas. As these unplanned residential blocks prevailed in the core city area, they were selected. As mentioned earlier, Khulna is a populated city in which people live in unplanned areas because of their job location. They want to live near their job location, and the three unplanned areas are close to the major job hub of Khulna City. These are the main reasons

for selecting unplanned areas alongside planned residential areas.

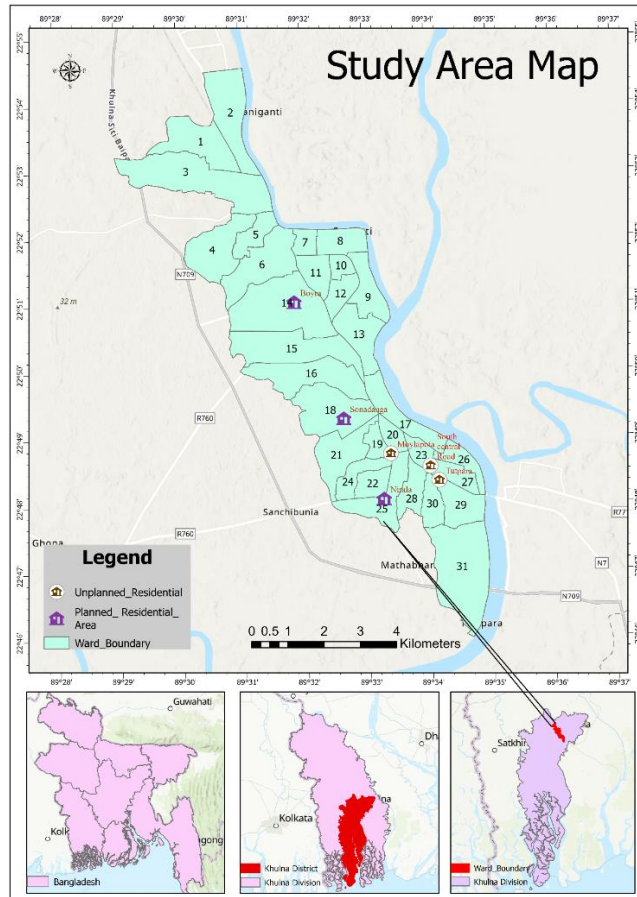


Figure 1: Study area map (Khulna City Corporation)

The objective of this study was achieved using primary data. Primary data were collected through a field survey, using a comprehensive questionnaire. This study used multistage sampling.

First, Khulna City was selected for convenience. Next, three planned and three unplanned blocks were selected. Then, from each mentioned area, respondents were selected proportionally using systematic random sampling. Thirty respondents were selected from each area and 180 respondents were selected in total. To fulfill this criterion, we systematically selected 30 multistoried buildings. We randomly selected 30 roads and surveyed the fifth building of each road for the planned areas. In the case of unplanned areas, we selected every fifth building along the roadside (because unplanned areas do not have any specific roads). As the second and third stories are considered the best for living in Khulna City, either second- or third-story tenants were surveyed using a semi-structured questionnaire consisting of both closed and open-ended questions. Because of office hours (9:00 AM to 5:00 PM) and security (after 8:00 PM), we obtained a very short time (5:00 PM to 8:00 PM) per day for the survey. Therefore, we hired six experienced enumerators to collect data. We surveyed household heads because they used to deal with house owners and play decision-making roles when choosing a house.

**Analytical Framework**

Table 1 presents the dependent and independent variables, with the unit of measurement used in the interview schedule. The table consists of two main sections. The first section is the dependent variable, and the second is the explanatory variable. The second section comprises five subsections. The expected relationship between the endogenous and exogenous variables is also mentioned in the table. Here, the predictand is the house rent, which is measured in the BDT per month. It is expected that the regressand are affiliated with household income, structure, location, transportation, and neighborhood attributes. Basic Microeconomic Theory suggests that households with higher incomes tend to spend more on housing (Huggett and Ventura, 2000).

Following this theory, we expect that higher-income households prefer to rent expensive houses, indicating a strong positive association between rent and household income. Household size can also positively affect house rent, as more rooms are required for more people. Occupation type may have a positive or negative effect on rent.

Household income and the structural attributes of houses affect house rent (Cui et al., 2018). Five variables—age of residence, number of rooms, number of washrooms, garage, and floor materials—are considered to measure the effect of structural characteristics on house rent. Here, the number of rooms, number of washrooms, floor materials, and garages are expected to positively impact house rent, while age of residence is expected to have a negative impact. Alongside location consists of distance from school, major employment centers, hospitals, and parks that have a negative relationship with house rent. People always want to stay close to schools, hospitals, major employment centers, and parks because three of the four are almost always connected with the basic needs of humans (Islam et al., 2020). Distance from the basic material market/staple can also negatively affect rents. On the other hand, transportation consisting of bus stops, train stations, easy bikes, and rickshaw stops also has an impact on house rent (Hopkins, 2018). This distance may have both positive and negative correlations with rent (Singla & Bendigiri, 2019).

Finally, neighborhood-related variables—fire extinguishing system, ventilation, noise pollution, robbery/thief case, snake/frog infestation, dog nuisance water logging, problems caused by slanders, land fill, sports facilities, government water supply, and government waste disposal services—affect house rent. With urbanization, open spaces for playing have been decreasing. Sports facilities are highly valued in urban areas (Islam et al. 2020). Ventilation is of significant importance for open air inside apartments. The density of people is increasing in urban areas as they migrate from rural to urban areas (Wen et al., 2014). Both internal and external environments are becoming important in determining house rent. Water logging is one of the worst problems faced by the people of Khulna in rainy seasons (Rahman et al., 2021). Security is the thing that each household wants because this is the precondition for living in the place safely. All variables are covered in Table 1 with definitions, units of measurement, and expected signs (relationship with dependent variables).

**Table 1:** List of Variables with Explanation

Category	Variable	Variable definition and quantization	Sign	References
<b>Dependent Variable</b>				
	House Rent	BDT per month		
<b>Explanatory Variables</b>				
<b>Demographic Information</b>	Income	Households' income in BDT per month	+	Islam et al. (2020)
	Household size	Number of members in respondents' family.	+	Author's compilation (2023)
	Occupation	Occupation of head of household. 0=non-Govt; 1= Govt.	±	Author's compilation (2023)
<b>Structure</b>	Age	Age of the building in years	-	Cui et al. (2018); Wen et al. (2014)
	Rooms	Number of rooms (living, dining, bedroom) in the residence	+	Cui et al. (2018); Wen et al. (2014)
	Washrooms	Number of washrooms in the residence	+	Wen et al. (2014)
	Floor materials	Main material on floor, 1=ceramic, 2=tile; 3=cement, 4=others	+	Wen et al. (2014)
	Garage	If the residence has a garage, 1=yes; 0=no	+	Wen et al. (2014)
	Storey	In which storey is the apartment (2 <sup>nd</sup> or 3 <sup>rd</sup> storey)	±	Author's compilation (2023)
	<b>Location</b>	Major employment center	Distance from nearest major employment center in meter	-
School		Distance from nearest school in meter	-	Author's compilation (2023)
Hospital		Distance from nearest hospital in meter	-	Author's compilation (2023)
Park		Distance from nearest park in meter	-	Author's compilation (2023)
Shopping Centre		Distance from nearest shopping center in meter	-	Author's compilation (2023)
Basic material market		Distance from basic material market in meter	-	Author's compilation (2023)
<b>Transportation</b>	Bus stop	Distance from nearest bus stop in meter	±	Cui et al. (2018)
	Easy bike and Rickshaw stop	Distance from nearest stop in meter	±	Author's compilation (2023)
	Train station	Distance from nearest train station in meter	±	Cui et al. (2018)
<b>Neighborhood</b>	Fire extinguishing system	Quality of fire space (5-point scale)	+	Author's compilation (2023)
	Ventilation	The quality of ventilation in the house (5-point scale)	+	Islam et al. (2020)
	Sports facilities	Distance from at least a small playground in meter	-	Islam et al. (2020); Wen et al. (2014)
	Nature of road surface	The quality of the surface road (5-point scale)	+	Author's compilation (2023)
	Government water supply	The quality of the govt. water supply (5-point scale)	+	Sopranzetti (2015)
	Government waste disposal services	Condition of waste disposal service (5-point scale)	+	Author's compilation (2023)
	Water Logging	Waterlogging condition nearby (5-point scale)	-	Islam et al. (2020)
	Land Fill	Landfilling by waste (5-point scale)	-	Islam et al. (2020)
	Noise pollution	Degree of noise in the house (5-point scale)	-	Author's compilation (2023)
	Robbery/Thief case	Frequency of robbery or thief case in the area (5-point scale)	-	Author's compilation (2023)
	Incidence of Snake/Frog Infestation	Respondent Perception (5-point scale)	-	Author's compilation (2023)
	Dog nuisance	Respondent Perception (5-point scale)	-	Author's compilation (2023)
Perceived Problem of Slanders	Respondent Perception (5-point scale)	-	Author's compilation (2023)	

**Theoretical Framework**

Diverse characteristics are inherent in housing and distinguished by their unique composition. The hedonic pricing process involves assigning value to various components of multidimensional commodities (Xiao & Xiao, 2016). Each attribute has an inherent worth. Utilizing the hedonic price model facilitates the establishment of a correlation between the attributes of goods and their corresponding prices (Soler et al., 2019). House rental prices serve as the dependent variable in the present study, while a variety of factors related to their location, accessibility, neighborhood, and construction constitute the explanatory variables. The hedonic pricing strategy maximizes a household's utility function within a given budget ceiling and then uses that maximum to determine the marginal willingness to pay for various dwelling qualities (Xiao and Xiao, 2016).

In the hedonic model, the utility function of a typical household is:

$$U = U(\ell, H, N, T, L) \quad \text{(Cui et al., 2018) (1)}$$

The inquiry  $\ell$  pertains to the location or source of the composite good index. The variables H, N, T, and L represent the distinct attributes of a house, neighborhood, transportation, and location, respectively. The objective is to optimize the utility of households, as expressed in Equation (1), while adhering to budget constraints.

$$I - CPc - R = 0 \quad \text{(Cui et al., 2018) (2)}$$

The variable  $R$  denotes monthly income, whereas  $CPc$  refers to the prices of consumption goods included in the index and represents monthly house rents. The hedonic pricing approach posits that residential property pricing is contingent on discrete characteristics. Construction of houses intended for sale is not prevalent in Khulna City (Sowgat et al., 2016). However, the rental of apartments within these constructed houses is a commonly observed practice within the city. Studies indicate that the cost of renting a house is contingent upon various factors, including, but not limited to, the structural, neighborhood, location, and transportation attributes (Kauko, 2003). Consequently, the function that governs the determination of rent can be expressed as:

$$R = R(H, N, T, L) \quad (3)$$

And budget constraint,

$$I - CPc - R(H, N, T, L) = 0 \quad (4)$$

To enhance the efficiency of the utility function, it is imperative to compute the derivative of Equation (1) in relation to the modified budget constraint, as illustrated in Equation (4). This process enables derivation of the implicit price for each neighborhood attribute.

$$\frac{dR}{dQ} = \frac{dU/dQ}{dU/dC} \quad (5)$$

The marginal rate of substitution (MRS) between neighborhood qualities, indicated as N, and a composite good index, defined as C, is given by Equation (5). This equation shows how MRS works. The MRS is equal to the

rate at which households can trade N for C in the housing market, according to this equation (Islam et al., 2020). The current research uses equation (5) to assess the impact on value addition and reduction of neighborhood characteristics, such as home internal environment, exterior environment, ventilation, sports facilities, waterlogging, and landfills. These characteristics include the internal and external environments, ventilation, and waterlogging.

Equation (5) shows marginal rate of substitution (MRS) between neighborhood qualities (N) and a composite good index (C). MRS equals the housing market's N-C exchange rate. This study estimates equation (5) to determine how neighborhood factors, including house internal environment, exterior environment, ventilation, sports facilities, waterlogging, and landfills, affect value addition and decrease.

**Econometric Model Estimation**

According to Sopranzetti (2015), the hedonic price method can be linear, logarithmic, semi-logarithmic, or box-cox. Therefore, we checked the nature of the dependent variable in both level and log form. We checked the detailed summary statistics of the dependent variable, house rent, in both log and level form. We also checked for skewness and kurtosis.

Most of the literature suggests a logarithmic dependent variable as it smoothens the data distribution (Islam et al., 2020). This logarithmic form of the dependent variable helps compute the demand elasticity of the independent variables.

The relationship between housing rent and neighborhood attributes N, as well as a composite good index C, is shown in Equation (5). Equation (5) can be reformulated as a population regression function in the following manner:

$$R_i = X_i\alpha + \varepsilon_i \quad \text{(Islam et al., 2020) (6)}$$

The subscript  $i$  designates households, while  $R_i$  represents the natural logarithm of monthly house rent (Islam et al., 2020). The set of independent variables, denoted as Vector  $X_i$ , comprises composite goods C and neighborhood attributes N, which include housing and other relevant features of the neighborhood. The vector  $\alpha$  represents the coefficients that require estimation, whereas  $\varepsilon_i$  denotes the stochastic error term. Equation (6) can be simplified as follows:

$$R_i = \alpha_0 + \alpha_1(\text{income}) + \alpha_2H_{ij} + \alpha_3N_{in} + \alpha_4T_{it} + \alpha_5L_{im} + \varepsilon_i \quad \text{(Islam et al., 2020) (7)}$$

The variable *income* denotes the monthly income of the primary respondent. The variable H denotes the structural characteristics of a building, including its age, number of rooms and washrooms, floor materials, and garages. The variables T, L, and N are utilized to represent distinct attributes related to transportation, location, and neighborhood. T pertains to transportation attributes, such as proximity to bus and train stations, while L pertains to location attributes, such as proximity to major job centers, schools, hospitals, parks, and other relevant amenities. Lastly, N pertains to neighborhood attributes such as the

fire extinguishing system, ventilation, sport facilities, waterlogging, water supply, robbery, noise pollution, and landfills. The marginal effect of each neighborhood variable on house rent, derived from equation (7), and a threshold neighborhood characteristic are used to calculate the WTP.

**Econometric Model selection**

To determine the most appropriate functional form for hedonic pricing models, both log-log and log-level specifications were evaluated across the overall, planned, and unplanned datasets using a combination of diagnostic tests and model selection criteria. Specifically, the models were assessed using the Ramsey RESET test for functional specification, the Breusch-Pagan (BP) test for heteroscedasticity, Variance Inflation Factors (VIF) for multicollinearity, and model fit statistics, including the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC).

**AIC and BIC**

After finalizing the logarithmic dependent variable, we have two options: log-log and log-level form. In this study, both the log-log and log-level hedonic regression models were estimated using the aforementioned explanatory variables. For the log-log model, both the dependent and explanatory variables are transformed into natural log form. However, as suggested by Islam et al. (2020), dummy and discrete (Likert scale) independent variables are not transformed into a natural log form. In the log-level model, only the dependent variable, namely house rent, is taken in natural log form, and all other independent variables are taken in level form.

There were some continuous explanatory variables: income, age of houses, distance from major job center, distance from school, distance from hospital, distance from park, and number of rooms. Except for the above-mentioned variables, all were either dummy or categorical variables. These variables were converted into a logarithmic form for the log-log hedonic regression model. The log-level hedonic regression model is simple, as only the dependent variable is transformed into a logarithmic form, and all other variables remain as usual.

After running log-log and log-level models, we consider a model based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) (Islam et al., 2020).

$$AIC = -2 \times \ln(\text{likelihood}) + 2 \times K \tag{8}$$

$$BIC = -2 \times \ln(\text{likelihood}) + \ln(N) \times K \tag{9}$$

Here, the likelihood is the maximized value of the likelihood function reported in equations (8) and (9), K denotes the number of parameters to be estimated, and N denotes the number of observations. Both were used to determine the fitness and complexity of the regression model. A relatively lower AIC and BIC score indicated a better model of the dataset (McCord et al., 2014). We used  $2 \times K$  and  $\ln(N) \times K$  to measure the complexity of the model. In addition, the value of  $R^2$  was used to check the model's goodness of fit. A higher  $R^2$  value indicates a

higher goodness of fit, while lower AIC and BIC scores indicate a higher goodness of fit, meaning that the explanatory variables can explain the dependent variable more accurately.

**Ramsey RESET Test**

The Ramsey Regression Equation Specification Error Test (RESET) assesses whether the selected functional form of the regression is correct. This is achieved by introducing the fitted values into the regression equation (such as squares or cubes). If these added terms are statistically significant, this indicates that the model omits important nonlinearity or interactions.

$$\hat{y} = \beta_0 + \beta_1 X + \beta_2 \hat{y}^2 + \beta_3 \hat{y}^3 + \varepsilon \tag{10}$$

(Rubaszek and Rubio, 2019)

Here,  $\hat{y}$  refers to the fitted values from the previous model, and the test evaluates whether the inclusion of  $\hat{y}^2$  and  $\hat{y}^3$  significantly improves the model. A significant F-statistic (p-value < 0.05) indicates a functional misspecification (Ramsey, 1969).

**Breusch-Pagan Test (BP Test)**

The Breusch-Pagan test is used to detect heteroscedasticity, which occurs when the variability of the residuals is not constant across observations. This test regresses the squared residuals from the main model against a set of independent variables:

$$\hat{u}^2 = \alpha^0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \alpha_k X_k + v \tag{11}$$

(Cui et al., 2018)

Subsequently, the test statistic was calculated as

$$BP = n \times R^2 \tag{12}$$

where  $\hat{u}^2$  represents the squared residuals from the primary regression,  $R^2$  is the coefficient of determination from the auxiliary regression, and n is the sample size. A significant p-value (typically < 0.05) indicates the presence of heteroscedasticity. In this study, the BP test was applied to both log-log and log-level models to ascertain whether the assumption of homoscedasticity was upheld. The models that pass this test yield more reliable coefficient estimates.

**Variance Inflation Factor (VIF)**

VIF was used to identify multicollinearity among the independent variables. Multicollinearity occurs when explanatory variables are highly correlated, which can increase standard errors and distort the statistical significance of the coefficients.

The formula is

$$VIF_j = 1 \div (1 - R_j^2) \tag{13}$$

(Cui et al., 2018)

Where  $R_j^2$  is the R-squared value obtained by regressing the jth independent variable on all other independent variables. Generally, a VIF value greater than 10 is considered a problem (Gujarati, 2004), although some researchers have suggested a conservative threshold of 5. In this study, VIF was calculated for all models to

assess multicollinearity. An average VIF below 5 and no individual VIF above 10 indicate an acceptable level of multicollinearity.

**Results**

This study concentrates on the factors affecting housing rents in Khulna City. To cover Khulna city, the authors chose three residential and non-residential areas, as there are both residential and non-residential areas in Khulna city where people used to live. In this section of the paper,

a short description of the respondents as well as the factors affecting house rent are given.

**Respondent’s Characteristics**

Table 2 presents the respondents’ age distribution, income level, and household size. Almost 65% of respondents were 31–50 years old. In terms of income, the two groups are equal, at 20000–30000 and 30000–40000 BDT per month. The mean monthly income of the respondents was almost 41000 BDT per month.

**Table 2:** Respondent’s Characteristics

Variables	Age	Frequency	Percentage
Age Distribution	21-30	15	8.33
	31-40	61	33.89
	41-50	57	31.67
	51-60	32	17.78
	61-70	14	7.78
	71-80	0	0.00
	81-90	1	0.56
Income Distribution	<b>Income</b>	<b>Frequency</b>	<b>Percentage</b>
	10000-20000	4	2.22
	20000-30000	44	24.44
	30000-40000	44	24.44
	40000-50000	38	21.11
	50000-60000	16	8.89
	60000-70000	20	11.11
	70000-80000	8	4.44
	80000-90000	3	1.67
90000-100000	1	0.56	
100000+	2	1.11	
Household Size	<b>Size</b>	<b>Frequency</b>	<b>Percentage</b>
	2-4	137	76.11
	5-7	37	20.56
	8-10	6	3.33

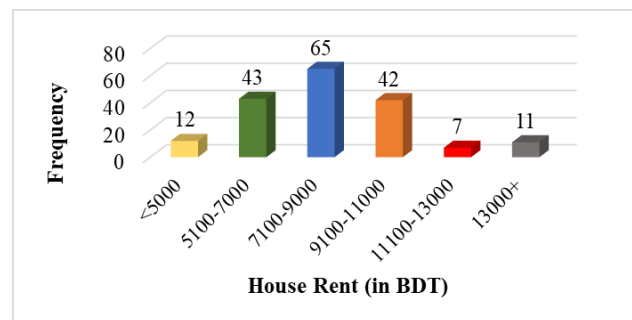
As mentioned, most households in Khulna are nuclear families. According to Table 2, approximately 76% of respondents' household size is less than four, whereas four people's income is below 20000 BDT per month, which indicates that respondents are affluent.

Most of the respondents had completed tertiary education. Surprisingly, none of them were from the primary level and only six percent were from secondary education. Thus, we can conclude that most respondents living in residential and nonresidential areas were educated

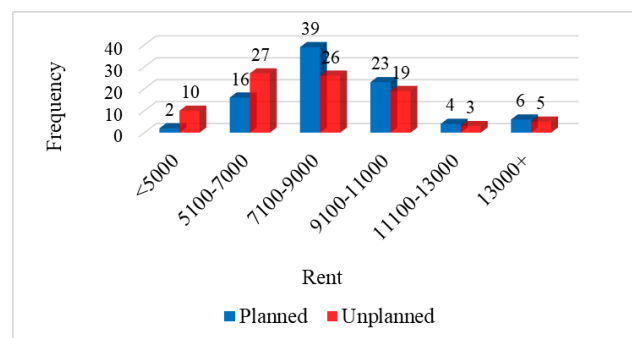
**Determinants of House Rent**

Figure 2 presents the house rent categories by frequency. House rents were generally between 7100 and 9000 BDT per month, which is approximately 36% of the total respondents. There are only seven houses where the monthly income level is 11100–13000 BDT per month. From the table, we can conclude that most of the houses in Khulna city have a reasonable rental price, as 5000–9000 BDT is an affordable rent. If we consider the characteristics of a house, then we find that the amount is normal compared to other cities.

Figure 3 shows the rent difference between the residential and non-residential areas. It is observed that the house rent in a planned area is slightly higher than the rent in an unplanned area.



**Figure 2:** Overview of House Rent



**Figure 3:** Rent (in BDT) of Planned and Unplanned areas

In planned areas, most of the house rent is 7100–9000 BDT per month, whereas in unplanned areas, the house rent is about 5100–7000 BDT per month. However, most house rent of both planned and unplanned areas is 5100–11000 BDT per month group, where planned rent is higher in the 9100–11000 BDT per month group and unplanned rent is higher in the 5100–7000 BDT per month group.

**Hedonic Price Model Selection**

Table 3 presents the indications for selecting the model between log-level and log-log. We have already mentioned the AIC and BIC score, R2 value, Ramsey RESET test, VIF, and Breusch-Pagan test in the methodology section.

In the methodology section, we mentioned that a high R2 value indicated a good fit. A high R2 value indicates that the explanatory variables can better explain changes in the dependent variable. The data criteria reflect the complexity and fitness of the model for the dataset.

Table 3 shows the AIC, BIC, and R2 values for the overall, specifically planned, and unplanned areas. In both

the planned and unplanned cases, the AIC and BIC scores of the log-level model were smaller than those of the log-log model. The R2 values in the log-level model for both the planned and unplanned areas were higher than those in the log-log model. However, we cannot draw any conclusions from the data on planned and unplanned residential areas. We have performed more tests to ensure that it is not possible to make a decision based only on AIC and BIC.

For the overall model, the log-log specification showed slightly improved AIC and BIC values; however, it failed the RESET test ( $p = 0.0263$ ), indicating a functional misspecification. In contrast, the log-level model passed the RESET test ( $p = 0.0996$ ), suggesting a correctly specified functional form while also maintaining acceptable AIC and BIC scores, with no evidence of multicollinearity or heteroskedasticity. Therefore, the log-level form was retained for the overall model.

**Table 3:** Overview of Model

	Overall		Planned		Unplanned	
	Log-Level	Log-Log	Log-Level	Log-Log	Log-Level	Log-Log
<b>AIC</b>	-336.669	-338.436	-176.365	-172.971	-202.195	-122.437
<b>BIC</b>	-237.688	-239.454	-98.871	-95.477	-124.701	-44.942
<b>R<sup>2</sup></b>	0.907	0.908	0.921	0.917	0.961	0.855
<b>Reset</b>	0.0996	0.0263	0.0089	0.0163	0.9582	0.2450
<b>VIF</b>	2.27	2.23	2.69	2.58	3.49	3.14
<b>BP</b>	0.2241	0.7053	0.0611	0.3932	0.4553	0.2374

In the case of the planned area model, both specifications failed the RESET test, but the log-level model displayed a better fit based on the AIC and BIC. One variable (fireplace) in the log-level model exceeded the VIF limit of 5, although the overall average VIF remained within the acceptable limits. The Breusch-Pagan test also indicated heteroskedasticity ( $p = 0.0611$ ). The log-level model has been cautiously accepted, and multicollinearity has been noted as a limitation.

For the unplanned area model, the log-level specification progressed ahead of all evaluation metrics. It showed exceptional specification (RESET = 0.9582), no heteroskedasticity (BP = 0.4553), and had significantly lower AIC and BIC values. A single VIF problem was identified for the bedrooms, but the overall multicollinearity was within the acceptable limits. The log-level form was the most suitable option for an unplanned segment.

This finding highlights the importance of adapting the functional form to the data structure of each market segment. While the overall model needed a balance between fit and specification, the segment-specific models

clearly benefited from customized log-level forms. This separate approach increases the accuracy of the estimates and maintains diagnostic robustness, aligned with recommendations from the hedonic pricing literature.

**Hedonic Price Model**

The hedonic pricing model is commonly used to determine the prices of products based on their characteristics, which ultimately creates utility. In the housing sector, because each housing unit has different features, the hedonic pricing model is particularly useful for analyzing how these features affect rent.

Table 4 presents the results of the hedonic pricing model estimated using log-level specifications, where the dependent variable is the natural log of rent, and the explanatory variables are in their original level form. This allows us to interpret the coefficients as the estimated percentage change in rent for a unit change in each explanatory variable while keeping everything else constant. The list shows that a few features significantly determine house rents in Khulna City.

**Table 4:** Determinants of house rent: A Hedonic Pricing Approach (Log-Level)

Log of Rent	Overall		Planned		Unplanned	
Explanatory Variable	Coefficient	SE	Coefficient	SE	Coefficient	SE
Household Size	.002	.006	.014	.009	-.005	.006
Occupation	-.031**	.015	-.015	.021	-.014	.02
Income	0	0	0	0	0	0
<b>Structural Characteristics</b>						
Building Age	-.004***	.001	-.005***	.001	.001	.001
No. of Bedroom	.039*	.02	.007	.026	.097***	.034
No of Washroom	.111***	.022	.086***	.03	.134***	.038
Floor Materials	-.069***	.019	-.027	.025	-.084***	.026
Garage	-.014	.023	.022	.031	-.079**	.032
<b>Location Characteristics</b>						
Distance from major business center	0**	0	0*	0	0***	0
Distance from nearest school	0**	0	0***	0	0	0
Distance from nearest hospital	0	0	0	0	0	0
Distance from nearest park	0	0	0	0	0	0
Distance from closest shopping	0	0	0	0	0	0
Distance from basic material market	0***	0	0***	0	0	0
<b>Transportation Characteristics</b>						
Distance from nearest bus stop	0	0	0	0	0	0
Distance from nearest available auto rickshaw	0	0	0	0	0	0
Distance from closest rail station	0*	0	0**	0	0	0
<b>Neighborhood Characteristics</b>						
Fireplace	.021*	.012	.008	.016	.014	.016
Ventilation	-.007	.012	-.016	.016	.013	.015
Sports facilities	.018	.011	.02	.015	.016	.016
Road surface	.005	.011	-.014	.018	.008	.013
Water supply	.03**	.012	.02	.018	.03**1	.014
Waste disposal	.005	.012	-.007	.019	.01	.012
Water logging	-.043***	.012	-.009	.018	-.045***	.015
Land fill	-.019**	.008	-.057***	.015	-.013	.009
Noise pollution	-.015	.01	-.052***	.015	-.01	.012
Robbery/thief	-.011	.009	-.026	.019	.005	.009
Snake/frog	.003	.01	.028	.019	-.002	.011
Dog nuisance	-.009	.009	-.011	.012	-.002	.011
Slanders	-.011	.008	.002	.011	-.012	.011
Constant	9.009***	.131	9.343***	.208	8.843***	.156
Observations		180		90		90
R <sup>2</sup>		0.907		0.921		0.961

Significance at: \*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

The impact of these features varies slightly between the planned and unplanned residential areas. Overall, the model explained a high proportion of changes in house rents ( $R^2 = 0.907$  in total, 0.921 for planned areas, and 0.961 for unplanned areas).

Occupancy was negatively related to house rent at the 5% level of significance. If occupancy changes from 0 (public sector) to 1 (government), keeping all other variables constant, the predicted house rent decreases by approximately 3.1%. This indicates that government officials tend to prefer to live in houses with relatively lower rents.

The age of a house is important at the 1% level, and negatively affects rent prices. For each additional year a house is older, it is estimated that rent decreases by about 0.4%, suggesting that newer homes attract renters who are willing to pay higher rents. The number of bedrooms is significant at approximately 10% overall and 1% in less

populated areas. Adding multiple bedrooms boosts the total rent by approximately 3.9% and 9.7% in less populated areas, reflecting a strong preference among renters for larger homes in those areas.

The number of washrooms in all the areas was highly significant (1%). Each additional washroom increases the house rent by approximately 8.6% in planned areas and 13.4% in unplanned areas. This indicates that tenants value the convenience of additional toilets and are willing to pay a higher rent.

The type of flooring material significantly impacts house rent within a 1% range, especially in unplanned areas. A change in the type of flooring material results in a 6.9% decrease in house rent, whereas in undefined areas, it leads to an 8.4% decrease. This indicates that tenants regard certain flooring materials as less desirable and adjust their willingness to pay accordingly.

Distance from major business centers has a significant impact on rental prices, with an overall effect of 5% and 10% in planned areas and 1% in unplanned areas. Although the estimated coefficients are quite small, their statistical significance suggests that even minor changes in distance from major business centers are associated with measurable changes in rental prices. This reflects tenants' continued preference for proximity to central commercial areas.

The distance from schools was significant overall at the 5% level and at the 1% level in the planned area. Although the estimated impact per unit distance appears small in numerical terms, the level of significance indicates that proximity to schools plays an important role in determining the rent for homes, particularly for families with school-going children.

Distance from the basic materials market generally shows a significant positive effect on rent at the 1% level, particularly in planned areas. Although the coefficient values were numerically small, the level of significance reflected a real relationship. In Khulna City, it has been observed that residences located farther from the basic materials market (which are often near waste disposal centers) typically demand higher rent. Among the characteristics of transportation, the distance from the railway station was significant at a level of approximately 10% overall and 5% within the planned area. The estimated effect is small in magnitude but statistically significant, indicating that proximity to the railway station affects housing rents, likely because of the neighboring characteristics around the station area.

The quality of the fireplace is positively related to the rent of the house and is significant at an overall level of 10%. The quality of the fireplace increases the rent by approximately 2.1% for each unit improvement (for instance, moving from 'low' to 'medium'), which highlights the tenants' valuation of this amenity.

The quality of the water supply significantly affects rental prices by 5%. An improvement in the quality of water supply correlates with an approximately 3% increase in rental prices, highlighting the importance of reliable and high-quality utilities. Conversely, flooding had a negative and significant effect on rental prices at the 1% level. For each unit increase in flooding severity, rental prices decreased by approximately 4.3%. Tenants urgently seek to avoid flood-prone areas and are willing to adjust prices and pay accordingly.

The presence of landfill has a substantial and negative impact on house rent at a rate of 5% in areas where dumping is prevalent, and at a rate of 1% in planned areas. When the issue of landfill escalates, house rents decrease by approximately 1.9%, indicating residents' concern for a clean environment. Noise pollution is only significant in planned areas, where increasing noise pollution reduces housing rents by approximately 5.2%. Other neighboring factors, such as incidents of theft/crime, air circulation, sports facilities, waste disposal, and road surfaces, do not exhibit statistically significant effects in this model.

The impact of various characteristics on housing rents differs significantly between planned and unplanned residential areas. In unplanned areas, the number of bedrooms has a particularly strong positive effect on rent,

with each additional bedroom increasing the rent by approximately 9.7%, whereas in planned areas, this effect is statistically insignificant. Similarly, the number of garages has a significant negative impact on housing rent in unplanned areas (-7.9%), whereas there is no significant effect in planned areas.

Distance from the primary business center significantly influences rental prices in both planned and unplanned areas. In unplanned areas, the impact is particularly strong and significant at the 1% level, although the magnitude is small, indicating a higher sensitivity of the tenants to their location. Distance from schools exhibits a highly significant influence in planned areas (1%) compared to an insignificant impact in unplanned areas.

Distance from basic material markets in planned areas is significant (1%), but not in unplanned areas, indicating that tenants in planned areas are more sensitive to the proximity of such markets, possibly due to greater diversity in housing options.

Among the characteristics of neighborhood environments, noise pollution significantly affects rental prices in planned areas (-5.2%), indicating that residents in these areas may be more sensitive to environmental quality. Flooding negatively affects rental prices in both planned and unplanned areas. In unplanned areas, the impact is larger and considerably significant (-4.5%), whereas in planned areas, the effect is relatively smaller and less important.

Overall, the distinction between planned and unplanned residential areas indicates that tenants in unplanned areas tend to place greater emphasis on certain structural amenities such as bedrooms and garages. Tenants in planned areas are more sensitive to criteria related to location and neighborhood welfare, such as proximity to schools, noise pollution, and distance from basic material markets.

## Discussion

The results of this study reveal that structural and surrounding characteristics significantly influence the rental levels of houses in Khulna City, where some differences are observed between planned and unplanned areas. Structural features, such as building age and number of bathrooms, were consistently significant among the models. Notably, an increase in the number of bathrooms substantially raises house rents, while older buildings command lower rents. These findings are consistent with those reported by Islam et al. (2020), Rahman et al. (2021), and Cui et al. (2018) emphasize the role of internal quality in determining housing prices.

Distance from job centers and markets has a significant negative impact on rental prices, indicating that proximity to economic centers enhances housing prices. In addition, issues related to waterlogging and the quality of floor materials have adversely affected rental prices (Chau and Chin, 2003; Islam et al., 2020; Fikire, 2021), which is consistent with the literature (Cui et al., 2018; Islam et al., 2020). Fire safety measures and adequate water supply were associated with higher rent, highlighting the importance of safety and essential services in rental valuation.

In contrast, transportation-related variables (such as bus stops and distance from railway stations) were less

influential, particularly in unplanned areas, where these variables often lose statistical significance. This pattern suggests that tenants in unplanned areas may prioritize immediate residential conditions over locational advantages, as noted by Cui et al. (2018).

The analysis further indicates that the determinants of rent in the planned and unplanned housing markets differ. While structural and neighborhood characteristics are predominant in both cases, unplanned areas exhibit a strong influence of fundamental amenities and safety features (Islam et al., 2020), reflecting the diverse nature of housing demand in these regions (Ahmad, 2014).

It should be noted that although log-level models have been demonstrated to provide an excellent fit and functional representation based on AIC, BIC, and RESET tests, some minor limitations have been observed. Specifically, the planned area model exhibited boundary heteroskedasticity (BP test,  $p \approx 0.061$ ) and had issues with the functional form (RESET test,  $p \approx 0.009$ ), which necessitates a cautious analysis of its coefficients. Furthermore, while multicollinearity was generally acceptable in both planned and unplanned models, some variables (e.g., fireplace and bed) displayed high VIF values, which should be considered during the analysis of their individual effects.

This study's results have several policy implications. Urban planners and housing developers should focus on attracting higher rents and improving housing conditions by enhancing structural quality, improving water supply, ensuring effective drainage to reduce flooding, and increasing neighborhood safety (Morshed et al., 2022; Singla and Bendigiri, 2019). In unplanned areas, targeted interventions to provide basic services and security features can maximize housing quality. Overall, the differences between the planned and informal segments indicate a need for contextual housing policies that consider the specific preferences of tenants.

## Conclusions

This study investigates the determinants of housing rents in the city of Khulna using a hedonic pricing model that incorporates both log-log and log-level specifications. Following a comprehensive evaluation based on the model fit (AIC and BIC), functional specification (RESET test), diversity estimation (BP test), and multicollinearity diagnostics (VIF), the log-level model was selected as the most appropriate specification.

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In comparison to location and transportation features, characteristics related to construction and neighborhoods have been identified as the primary determinants of house rent, especially outside planned areas. The analysis further demonstrates that planned and unregulated housing markets exhibit varying sensitivities to various factors. In unregulated areas, improvements to basic amenities, drainage, and surrounding security may have a greater impact on rental price levels. By contrast, in planned areas, structural development and proximity to service clusters are the primary drivers of rent. It should be noted that while log-level models have generally provided good specifications, some minor limitations regarding model specification (RESET test) and heteroskedasticity (BP test) have been observed in the models for planned areas, which suggests that their coefficients should be analyzed with caution.

Based on this insight, policymakers should prioritize enhancing structural quality, improving basic amenities, such as water supply and drainage, and strengthening neighborhood security in unplanned housing areas. There is a need for a distinctive urban housing policy capable of responding to the unique characteristics of both planned and unplanned areas, which would help improve housing outcomes and integrate rental quality. Future research could investigate spatial patterns, longitudinal trends, or tenant preferences to enhance our understanding of the evolving housing market in Khulna.

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## Conflict of Interest

The authors declares no conflict of interest.

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