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Application of Hedonic Pricing Model and Geographic Information System on Property Valuation in Yogyakarta

Nurisqi Amalia[1*], Nur Aini Yuniyarti[2], Fatima Putri Prativi[3]

Email: [1*]nurisqi.amalia@ugm.ac.id, [2]nur_ay@ugm.ac.id, [3]fatimaputri94@mail.ugm.ac.id,

[1,2,3]Universitas Gadjah Mada, Indonesia
* *Corresponding Author*

Abstract

This study aims to: 1) identify the differences in housing choices between Generation Z (students) and the previous generation (parents or guardians); 2) determine the factors influencing housing purchase decisions; and 3) map the areas of interest for Universitas Gadjah Mada (UGM) students based on price. The research employs a combination of the Hedonic Pricing Model (HPM) and Geographic Information System (GIS), a method that remains limited in the field of property research. The findings reveal that significant factors affecting property prices are building area and location, with the majority of UGM students choosing to reside in Ngaglik District, Sleman Regency. Sleman Regency is also the predominant area where UGM students purchase housing in Yogyakarta. Key attributes influencing UGM students' housing decisions include a safe neighbourhood, residential environment, and distance from waste centers. This research contributes valuable information to property appraisers regarding property price distribution in Yogyakarta and its influencing factors, and provides crucial insights for effective decision-making and policy implementation in regional economic development planning, especially in less popular areas.

Introduction

The appraisal of a property is an essential activity for individuals based on their specific interests, such as property transactions, rentals, collateral, and so forth. The Indonesian Appraisal Code of Ethics (KEPI) point 3.7 states that valuation is a work process to provide estimates and opinions on the economic value of an object of valuation at a certain time (KPSPI, 2018). An appraiser

is the person who performs the appraisal work. An appraiser is someone who has the qualifications, abilities, and experience in conducting appraisal practice activities to obtain economic value in accordance with the field of expertise as seen at KEPI point 3.6.a (KPSPI,2018). In accordance with the General Concepts and Principles of Appraisal (KPUP) point 14.1 in KPSPI (2018), there are three main approaches used in the appraisal process, namely the Market Approach, Income Approach and Cost Approach. The analysis of property appraisal is closely related to the existence of demand and supply. These three approaches are employed to derive the value, not to determine the factors influencing the value of a property, serving as a means to identify the level of demand in the market.

The Hedonic Pricing Model (HPM) is one of the popular approaches used to determine these factors. HPM is a measurement technique developed from the attribute (characteristic) theory proposed by Lancaster in 1966 (Fauzi, 2004). HPM is frequently used to investigate the effects of different price characteristics of such commodities, such as housing, land, art, and electronic items, as well as to examine the relationship between heterogeneous commodity qualities and prices (Liang & Yuan, 2021). Zakaria & Fatine (2021) used the Hedonic Pricing Model (HPM) to model the price index and identify the variables that influence Moroccan real estate prices. The settlement area and the placement of real estate (land, houses, villas, and flats) were found to have a substantial impact on real estate prices. Using information from social media, HPM can also be used to pinpoint the elements that influence real estate pricing. Two factors that have a significant impact on a property's price are its proximity to healthcare facilities and employment opportunities in the area according to Lirong et al. (2019) that monitoring housing rental prices based on social media: An integrated approach of machine-learning algorithms and hedonic modelling to inform equitable housing policies. Another research that integrates the performance of the Hedonic Pricing Model (HPM) with Geographic Information System (GIS) can also reveal determining factors for land values (Gatheru & Nyika, 2015). The results of the six studies indicate that land area, accessibility to the bypass, and proximity to elementary schools are key attributes in determining land prices. GIS is closely related to the spatial domain, enabling the capture, management, analysis, and display of spatial data. GIS was employed to assist in collecting data on attributes influencing land prices (Gatheru & Nyika, 2015). The two methods used represent an effective combination to enhance data accuracy in determining prices.

Universitas Gadjah Mada (UGM) is the oldest and one of the most sought-after universities in Yogyakarta. The year 2022 marks the transition from online to offline learning, which can be referred to as the year of the return for students to engage in face-to-face learning on campus. In that year,

UGM admitted a total of 9,833 new students, as quoted on the university's website (Republika, 2022). The significant number of new students poses the potential for an increased demand for residential housing in Yogyakarta, especially for students coming from outside the city. The decision to purchase a house by new students may be influenced not only by the students themselves but also by the considerations of their parents. Between students and parents (guardians), there may be shared preferences regarding the determining factors of home purchase, but conversely, differences may exist due to the distinct generational perspectives of the two parties. The Indonesian population is split into six generations by the Central Statistics Agency (BPS): millennials, baby boomers, gen X, post generation z, and pre-boomers. The generation born in 2013 and later is known as post-Gen Z. Gen Z is the group of people born between 1997 and 2012. Born between 1981 and 1996, the Millennial generation comprises those people. Gen X refers to those who were born between 1965 and 1980. The generation known as Baby Boomers was born between 1946 and 1964. Those who were born prior to 1945 are known as Pre-Boomers.

This study is a continuation research of Gatheru & Nyika (2015) and Marzukhi (2015). The extension focuses on three aspects: 1) The property analyse in Gatheru & Nyika (2015) is land while this research examines residential houses. The rationale for changing the property type assumes that houses are meant for habitation, considering various comfort elements; 2) Modification of independent variables in the Hedonic Pricing Model (HPM) based on Gatheru & Nyika (2015) , Juliana & Riyanto (2022), Tam et al. (2022), and Wong (2011); 3) This research combines modifications from Gatheru & Nyika (2015) with Marzukhi (2015), where Marzuki's research utilizes GIS to map properties based on their prices.

This research has three focus objectives: 1) to identify the differences in residential housing choices between Generation Z (students) and previous generations (parents or guardians); 2) to determine the factors influencing the decision to purchase residential housing; and 3) to map the preferred areas for UGM students based on prices. Based on the stated objectives, this research has a contribution for property appraisers in understanding the determinants and distribution of property prices in Yogyakarta and provides consideration for the government in developing economic areas in Yogyakarta.

Literature Review

According to Monson (2009), Making a prediction model is the main goal of applying the Hedonic Pricing Model (HPM). Certain features, like how much an atrium influences a buyer's interest

in a building, have a value that cannot be directly observed. HPM is a useful tool for quantifying the influence of traits or qualities on real estate transaction prices. This model is developed using coefficients generated from regression analysis. The model market prices are a function of both tangible and intangible attributes. The following equation shows this illustration:

Market Price = f (Tangible & building characteristics, other influencing factors)

What is meant by "other influencing factors" here refers to those sold in an unreasonable market (not used in the analysis).

Developers, real estate firms, owners, and operators use HPM as an alternative to real estate assessment to determine the features of buildings in increasing the possible value. This can provide crucial information in making future decisions and assist all parties in better understanding the economic dynamics surrounding the asset.

The structure of the analysis of characteristics or attributes is determined based on which characteristics are measurable and the adequacy of the sample. Alternative attributes that can be measured are the Commercial Property Index (CPPI), use of energy-saving components, fitness center, culinary center, atrium, land area, parking space, environment, renovation year, proximity to public transportation center, year of built, class/type, and Consumer Price Index (CPI).

Next, Geographic Information System (GIS) is a combination of three fundamental elements: system, information, and geographic. Therefore, understanding these three basic elements is crucial in comprehending GIS. By examining its fundamental elements, it is evident that GIS is an information system or a system that emphasizes geographic information. The term geographic is a part of spatial (space). These two terms are often used interchangeably or interchangeably to the extent that a third term, geospatial, arises. In the context of GIS, these three terms have the same meaning. The word geographic refers to something that is associated with the Earth, denoting a two- or three-dimensional surface. "Geographic information" refers to data concerning locations on Earth's surface, as well as information regarding an object's position on the planet's surface and characteristics of the planet's surface that have known or given positions. A geographic information system (GIS) is defined as a computer-based system or technology designed to gather, store, process, analyze, and integrate data and information about an object or phenomenon in relation to its location or existence on the surface of the Earth (World Agroforestry Centre, 2008).

Data input, data output, data management, and data manipulation and analysis are among the subsystems of GIS. Data Input is Gathering and preparing spatial and attribute data from diverse sources is the responsibility of this subsystem. In addition, it is in charge of changing the original data

formats into those that GIS uses. Data Output is subsystem displays or generates outputs of the entire or partial database, both in softcopy and hardcopy forms, such as tables, graphs, maps, and others. Data management is spatial and attribute data are arranged into a database for convenient access and editing. Data Manipulation and Analysis is establishing what kinds of information the GIS is capable of producing. This subsystem additionally models and manipulates data to generate the desired information.

Method

This research uses primary data obtained directly from UGM students who come from outside Yogyakarta Province and buy houses in Yogyakarta for college purposes. The approach used in this research is a quantitative approach using a combination of the Hedonic Pricing Model (HPM) and Geographic Information System (GIS). The HPM method was chosen to model and determine the determinants of property prices in Yogyakarta and GIS is utilized to map the property sales areas preferred by UGM students based on the selling prices. The HPM method is used to estimate the value price of amenities for different groups (Cetintahra & Cubukcu, 2015). The main use of the hedonic pricing method is to identify pricing factors based on the premise that prices are determined by both internal and external characteristics of goods and services (Febriansya et al., 2020). Thus, the use of the HPM model is very appropriate to identify factors that influence the decision to buy a house in Yogyakarta. Similarly, the use of spatially-based GIS is very appropriate to be used in this study to map the locations that are of interest to respondents in buying houses in Yogyakarta. This study uses several variables referenced from several previous studies. The variables modified from previous research are building area and year of construction. In previous studies, it has been investigated that building area and year of build have a positive influence on house prices (Wong, (2011); Sirmans, (2006); Schläpfer (2015); Kuntz (2014); Davis (2007)).

Result and Discussion

In the study, the respondents were students of Gadjah Mada University. After distributing questionnaires to Gadjah Mada University students who bought houses in Yogyakarta for college purposes, 31 respondents were obtained consisting of students with class years 2015 to 2023 (see Fig.1).
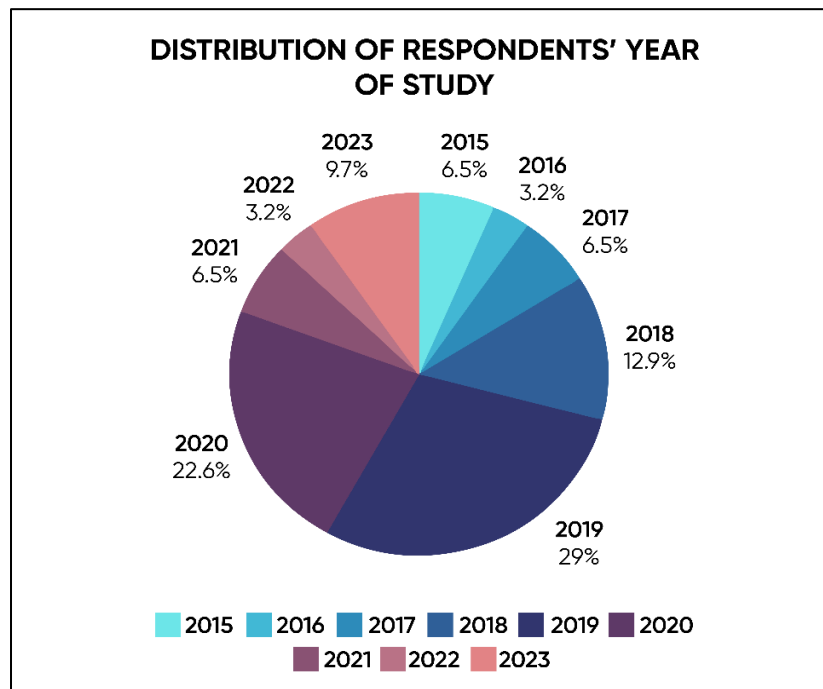
Source: Processed data (2023)
Fig. 1. Distribution of Respondents' Year of Study

From 31 respondents (see Fig.1), there is a distribution of several years of students, including students with the class of 2015 are 6.5% of the total respondent population, students with the class of 2016 total are 3.2% of the total population, students with the class of 2017 contributed 6.5% of the total population, then students with the class of 2018 total are 12.9% or 4 people, students in the class of 2019 are 29% of the population, students in the class of 2020 are 22.6% of the total population, as well as three other class years, namely the class of 2021, class of 2022, and class of 2023, each contributing to the total population of 6.5%, 3.2%, and 9.7%. From the data collected, it can be concluded that students of Gadjah Mada University with the class year 2019 were the most respondents who bought houses for the purpose of studying in Yogyakarta, amounting to 29% of the total respondents or around 9 respondents. In the second place, the most respondents who own a house in Yogyakarta for college purposes are students of Gadjah Mada University in class year 2020 at 22.6% or 7 respondents. Then, the third top order is filled by students of class 2018 with a proportion of 12.9% or 4 respondents.

Table 1. The Difference Between The Offer Price and The Purchase Price

Data	The Difference Between The Offer Price and The Purchase Price of The House (%)
Data 1	4%
Data 2	6%
Data 3	4%
Data 4	1%
Data 5	2%
Data 6	2%
Data 7	14%
Data 8	10%
Data 9	3%
Data 10	2%
Data 11	2%
Data 12	7%
Data 13	8%
Data 14	1%
Data 15	1%
Data 16	11%
Data 17	8%
Data 18	5%
Data 19	12%
Data 20	4%
Data 21	10%
Data 22	4%
Data 23	13%
Data 24	10%
Data 25	7%
Data 26	8%
Data 27	3%
Data 28	7%
Data 29	6%
Data 30	5%
Data 31	21%
Average Price Difference	6%

After collecting data on respondents who fulfilled the criteria shown in Table 1, the offer price and purchase price of the housing purchased by respondents for the purpose of studying in Yogyakarta were obtained. When sorted from data 1 to data 31, 1% to 21% is the range of the

difference between the offer price and the purchase price of the housing that was acquired, it can be concluded. The average discrepancy between the offer price and the cost of the house that 31 UGM students bought so they could study in Yogyakarta is 6%. This average figure is reasonable in terms of valuation theory, because on average the difference between the offer price and the purchase price is 5%-10%.

To find out the attributes that influence the decision to buy housing, 16 attributes of UGM students' preferences in purchasing housing in Yogyakarta for the purpose of studying are given as shown in Figure 2. Each respondent can choose more than one attribute related to things that influence the decision to buy housing in Yogyakarta. From the data collected, it is found that UGM students who buy housing in Yogyakarta for the purpose of studying choose the first attribute of a safe neighborhood chosen by 17 respondents. In the second and third order with the same proportion of 13 respondents chose the residential environment and neighborhood away from the waste center that would affect UGM students who bought housing in Yogyakarta for the purpose of studying.
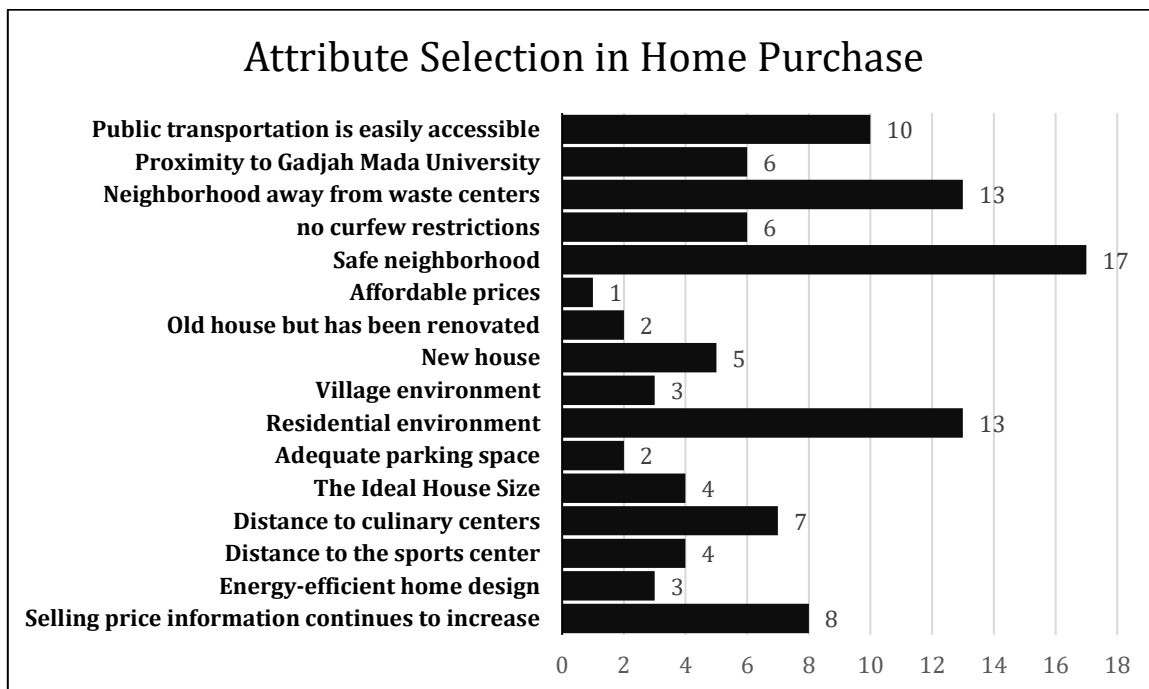
Source: Processed data (2023)
Fig. 2. Attribute Selection in Home Purchase

Leisure is a fundamental thing for humans who are looking for in choosing things related to being owned in the long run (Tse, 2002). The needs of the community in choosing a place to live are long-term decisions that must be well thought out. This is a big decision for the community in choosing a

residence with good comfort, because it will be occupied for a long time and is expected to be passed on to the next successor. In addition, a comfortable residence can be related to a safe environment, an environment away from pollution sources (Zambrano-Monserrate (2019);Lamond (2010)), an environment away from rivers (Schleich, 2009), an environment away from disaster sources (Murdoch, 1993), and so on. This is also in line with research conducted by that the decision to buy a house, one of the factors is a safe environment in the first place (Zambrano-Monserrate (2019); Rice (2020); Morland (2002); Samarasinghe (2010)) and an environment far from waste disposal is a factor considered by buyers in buying a house (Speyrer (1991); Kauko (2002); Eshet, 2007)).

Statistically, a simultaneous test was conducted. The purpose of the simultaneous test is to ascertain whether the independent variables have a joint or simultaneous influence on the dependent variable. The F Test's rules are H0 is rejected and H1 is accepted if the significance value of Prob < α = 0.05, indicating that the independent variable significantly affects the dependent variable and The independent variable does not significantly affect the dependent variable if the significance value Prob > α = 0.05, rejecting H1 and accepting H0.

The decisions that have a significant impact on the dependent variable (property price) are X1 (building area) and X4 (location), as can be seen from Table 2, which displays the test results. The significance values produced by X1 (0.0061 < α = 0.05) and X4 (0.019 < α = 0.05) demonstrate this. Thus, it can be said that the location and building area of a property affect its price at the same time. This is consistent with the findings of the study carried out that location affects the price of property (Morland (2002); Quang (2020); Li, (2019); Deboosere (2019)). The results of research that building area related to land area affects the price of property in line with the results of this study (Gatheru & Nyika (2015); Sirmans (2006); Wright (2008); Lee (2009)).

Table 2. F-Test Result

Variable	Coefficient	Probability
Constant	-1.86	0.3067
Building Area (X1)	2,470,369	0.0061
Condition (X2)	63,410,147	0.513
Year of Built (X3)	9,287,865	0.3018
Location (X4)	2.22	0.019

Table 2 shows that the constant is 1.86 and negative (C). A unidirectional influence between the independent and dependent variables is indicated by the negative sign. This demonstrates that the value of the property price is -1.86 if the building area (X1), condition (X2), year of build (X3), and location (X4) are all zero. 2470369 is the coefficient of variable X1. In other words, assuming ceteris

paribus, an increase in variable X1 (building area) will result in an increase in Y (property price) of 2470369. 63410174 is the coefficient of variable X2. This indicates that, assuming ceteris paribus, an increase in variable X2 (Condition) will result in an increase in Y (property price) of 63410174. 9287865 is the coefficient of variable X3. According to the ceteris paribus assumption, it means that for every increase in variable X3 (Year of Build), property price Y will increase by 9287865. The coefficient of variable X4 is 2.22. It means that every increase in variable X4 (Location), it will increase Y (property price) by 2.22 assuming ceteris paribus.
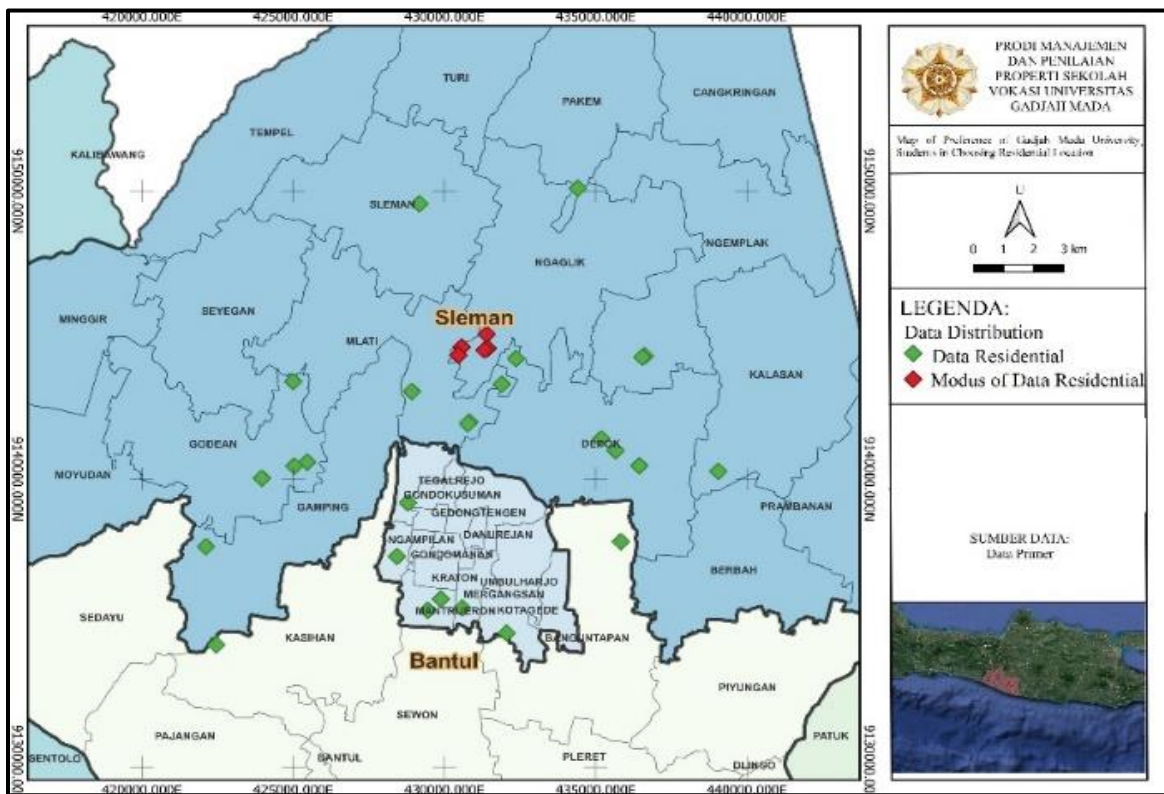
Source: Processed data (2023)
Fig. 3. Mapping UGM Students' Preferences for Housing in Jogja

In the collection of questionnaires, the location of residences purchased by UGM students for the purpose of studying was obtained. It can be seen in Figure 3 that there are 31 distribution points of residential locations in this study. The distribution of residential location preferences consists of 2 majority districts, namely Sleman Regency and Yogyakarta City. UGM students who bought houses in Sleman Regency were 25 respondents and UGM students who bought houses in Yogyakarta City were 6 respondents. Of the two districts/cities selected, there is a sub-district that is the choice of the

majority of UGM students in buying housing in Yogyakarta for the purpose of studying, namely in Ngaglik District, Sleman Regency with a total of 5 respondents. There are two other sub-districts that are second and third in the choice of location for UGM students in buying housing, namely Depok District and Godean District, each of which is the choice of location by 4 respondents. The results of mapping the location of UGM students' demand in buying houses can be concluded that the potential area for developers and property agents in marketing houses to UGM students is in Ngaglik District. Ngaglik sub-district is a sub-district that is still located close to the UGM campus area, besides that the area has complete facilities and the price of the house offered is not that expensive, so this is very convincing if the Ngaglik sub-district is a potential area for UGM students to buy a house.

Conclusion

Based on this study, building area and location have a major impact on property prices. The data collected and analysis indicate that most UGM students in the 2019 class purchase housing to pursue their studies in Yogyakarta, with a typical discrepancy between the offer price and the actual cost of the house being six percent. The majority of UGM students who purchase housing in Yogyakarta reside in Sleman Regency, specifically in Ngaglik District, which has emerged as the most popular choice among students seeking a college residence. Key factors influencing their housing decisions include residential surroundings, safety in the neighborhood, and proximity to waste disposal sites. This research contributes to regional economic development planning by providing insights into the distribution of property prices in Yogyakarta and the factors influencing these prices. These insights are valuable for government decision-making and policy formulation, especially in less desirable areas of the Yogyakarta region. Future research could further explore these dynamics to enhance the understanding and application of property valuation in similar contexts.

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