



CASE STUDY

Valuation of urban green open space using the Hedonic price model

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ABSTRACT

BACKGROUND AND OBJECTIVES: Urban green infrastructure, specifically green open spaces, is becoming increasingly significant in rapidly urbanizing areas. These spaces offer environmental, social, and economic advantages to urban ecosystems, thereby increasing community health and well-being. However, their economic value is often overlooked in urban planning. This study aims to conduct an economic valuation of green spaces by introducing the hedonic price model to equip decision-makers with a thorough and informed perspective.**METHODS:** A questionnaire created through Google Forms was distributed through a social media survey conducted from March to April 2021. The data collected from 1592 respondents in Jakarta were analyzed through a cluster analysis using the statistical package for social sciences software. The hedonic price model with ordinary least squares regression was adopted to create a valuation model for the green spaces in 42 districts and 239 sub-districts across the five administrative cities.**FINDINGS:** This study empirically shows that parks and urban forests increase land prices by 9.2, 17.1, and 19.2 percent, while cemeteries decrease them by 15 to 37.6 percent. Unlike most hedonic price model studies on the global north countries, which can be found in the literature, this work does not establish statistically significant relationships among urban forests, parks, cemeteries within a 0–500 meter radius, and land prices in Jakarta, but examines the economic value of green spaces, including their impact on land values and tax revenues. The land value increase is caused by the implementation of a beneficiary zoning levy within a designated impact zone of 0.5–2 kilometers. This study suggests policy implications, including the exploration of alternative financing mechanisms and the consideration of public preferences in urban development and financing policies.**CONCLUSION:** The applicability of the hedonic price model in Jakarta's mature and privatized land market is confirmed in this work, proving the importance of considering environmental factors and green spaces in land transactions and conversion, property development, conservation, and urban green space design. The results provide valuable information to policymakers, property developers, and land use planners, thereby preventing the undervaluation of green spaces and facilitating informed decisions on planning and public investment. Urban and built environmental management can significantly benefit from these findings, particularly when considering the aspects of green space size, social functions, and ecosystem services to enhance Jakarta's planning and management practices.DOI: [10.22035/gjesm.2024.02.03](https://doi.org/10.22035/gjesm.2024.02.03)This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

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INTRODUCTION

Urban green infrastructure (GI), specifically green open spaces (GOS), is significant in rapidly urbanizing areas. Green spaces play a crucial role in providing environmental, social, and economic benefits to urban ecosystems and positively contribute to the health and well-being of communities, particularly in low- and middle-income countries facing rapid urbanization (Shuvo et al., 2020). The rapid urbanization of cities presents opportunities and challenges, striving to balance growth with sustainability, equity, and quality of life for all residents. Cities are experiencing rapid growth due to the expansion of urban areas, which alters the landscape characteristics and structure. The incorporation of GOS planning and policy-making serves as a strategic imperative in achieving a more nuanced comprehension of sustainable development (Setiowati et al., 2022^b). Urban GI and ecosystem services are important in making cities more resilient to climate change and natural disasters (Van Oijstaeijen et al., 2020). The issue of greenhouse gas emissions originating from industrial activities carries profound implications not only solely on a global scale in relation to climate change, but also on the sustainability of urban environments (Hashim et al., 2015). Urban areas often house industrial zones, and mitigating emissions is crucial for urban sustainability. GOS have become a valuable component that offers a complementary approach to emission reduction. Through strategic planning, GOS can contribute to emission mitigation and enhanced environmental quality and promote sustainable practices within an urban setting. The green information technology (IT) holds a significant potential for enhancing urban sustainability (Asadi et al., 2021). Its adoption encompasses eco-friendly practices and technologies across various sectors, which may be extended to the GOS development and management. The integration of Green IT and GOS aligns with the broader goals of urban sustainability, addressing factors like environmental quality, resource efficiency, and overall quality of life (Khoshnava et al., 2019). Living inside or near nature in urban environments provides well-being benefits (Fruth et al., 2019). The introduced GI and ecosystem services can enhance the resilience of cities to climate change and natural disasters (Van Oijstaeijen et al., 2020). Meanwhile, GOS constitute an integral facet of GI, representing a crucial urban

sustainability component. Their prominence has increased in significance because urban green areas yield a multitude of environmental and health benefits. This importance was underscored during the Coronavirus disease 2019 (COVID-19) pandemic, exacerbated by population expansion and urbanization that led to a diminishing availability of green spaces. Therefore, GOS planning excels as a strategy for realizing the overarching goal of sustainable urban development (Chiesura, 2004). Bertram and Rehdanz (2015) stated that the GOS concept provides ecosystem and cultural services and microclimate stabilization through air filtration or cooling to reduce the heat island effect (Bowler et al., 2010). The presence of GOS can also enhance carbon storage (Strohbach and Haase, 2012) and provide social, environmental, economic (Boone et al., 2009; Wendel et al., 2011), and psychological benefits for escaping the pressures and demands of urban life (Maller et al., 2006). The social benefits include improved mental and physical health, stress reduction, and relaxation (Konijnendijk et al., 2013; Setiowati et al., 2022^a). Urban GOS enhance the quality of life directly through recreational activities, sports, and social interaction (Kabisch and Haase, 2014; Setiowati et al., 2022a). Furthermore, GOS assume a beneficial role in promoting public health (Shuvo et al., 2020). The abovementioned findings show that GOS development can address various issues, including environmental justice, public health, and aesthetic and land value enhancement. The GOS concept enhances climate resilience by providing habitats for biodiversity and creating important externalities in policy design to ensure their sufficient presence in urban environments. GOS planning plays a key role in achieving sustainable urban development (Choumert and Salanié, 2008). Berlin and Leipzig in Germany target 6 meter square (m²) and 10 m² of GOS per capita (Kabisch and Haase, 2014), while the United Kingdom has access to at least 2 hectares (ha) of green space within a 300 meter (m) distance from residential areas (Handley et al., 2003). English Nature recommendations suggest that residents should live no more than 300 m from the nearest green space (Barbosa et al., 2007). Access among different social groups varies, with poorer and older individuals being the highest social groups to enjoy public GOS (Barbosa et al., 2007). The presence of GOS also offers diverse ecosystem services.

Accordingly, public preferences vary based on socio-demographic factors carrying different policy implications. According to the European Environment Agency, the recommended access is within a 15 min walk. Even though GOS have a significant economic value, the concept behind them is not considered in the urban planning decision-making process. Non-market goods or services play a fundamental role in economic valuation by encapsulating values beyond traditional market transactions (Abdullah *et al.*, 2011). An economic valuation must be conducted to provide decision-makers with a clear understanding of these values. In addition, the assessment of the economic value of GOS yields an overview of the ecosystem benefits generated by urban GI and serves as a basis for sustainable urban planning. Local governments require the economic value in the urban planning decision-making process. Indonesia has its Minister of Environment and Forestry Regulation No. 15 of 2012 on the Economic Valuation Guidelines for Forest Ecosystems (MEFR, 2012). Based on the MAASPNLAR (2022) on the GOS provision, one of the functions of GOS is to provide a land enhancement guarantee. The GI can be economically viable. As a commitment to the development, local governments conduct economic valuation (Van Oijstaeijen *et al.*, 2020). Furthermore, GOS provide ecosystem services that address disease, quality of life, and health (Wolch *et al.*, 2014). Physical activity and social interaction are the most important benefits provided by parks in relation to the quality of life (Artmann *et al.*, 2017). The GOS concept offers economic benefits through property values (Trojanek *et al.*, 2018; Zhang *et al.*, 2013). A monetary valuation is used to assess GOS through ecosystem services to meet environmental, social, and economic goals (Bockarjova *et al.*, 2020). Green space services tend to be less available when policy interventions are excluded (Smith *et al.*, 2002); hence, greening efforts in communities enhance environmental attractiveness without land acquisition (Franco and Macdonald, 2018). GOS include city parks, forests, golf courses, sports fields, and undeveloped land on the outskirts of cities (Brander and Koetse, 2011). Green landscapes are in high demand within most developed countries, and urban management is expected to prevent sprawling in centers and their adjacent regions (Cavallières *et al.*, 2009). However, assessing the GOS value is challenging due to their abstract nature. The benefits

of green space conservation policies are difficult to understand without economic value information. In the context of urban policy planning, economic valuation creates awareness of the importance of the economic value generated by urban GI. In Indonesia, studies on the concept remain limited, and the valuation approaches used are expected to increase. In terms of assessment, monetary valuation methods are being used to describe green space characteristics by capturing individual preferences (Tagliaferro *et al.*, 2013). Bateman *et al.* (2002) explained that various valuation techniques can be used to measure the total economic value of environmental services, including stated preference (SP) and revealed preference (RP). The SP method estimates the value placed on non-market facilities by individuals to obtain economic value estimates (Choumert and Salanié, 2008), while the RP method uses the actual market behavior as a basis for estimating implicit values and involves direct observation or substitute markets (Hanley *et al.*, 2016). The most commonly used RP methods are the travel cost method, the hedonic pricing method or hedonic price model (HPM), and averting behavior. The hedonic theory states that property price differences are based on variations in the property characteristics introduced by Rosen (1974) and Freeman (1979). The property plays an important role in the context of sustainable development, requiring measurement and equal growth distribution (Aziz *et al.*, 2021). It has economic significance for trade-off calculations, including untraded goods in the market (Freeman, 1979). Rosen (1974) also reported that a good can be broken down into the implicit marginal prices of each separate characteristic. The property value reflects an individual's willingness to pay for a better environmental quality (Tyrvaäinen, 1997). The assessment of green spaces through hedonic pricing is the most widely used approach (Czembrowski *et al.*, 2019; Daams *et al.*, 2019). In the context of this study, the HPM approach is selected as the most suitable valuation method for estimating public preference for urban GOS. However, note that other relevant approaches can also provide different insights into the GOS value and public preferences. The HPM technique uses econometric models to show preferences through the property market, particularly land prices, at a regional scale (Waltert and Schläpfer, 2010). The GOS value is calculated by

analyzing market prices, such as transportation and housing. In the HPM, the property value and the presence of GOS are linked to several variables, including distance, scenery, and accessibility (Choumert and Salanié, 2008). The method is widely used to calculate the value of green spaces by incorporating individual preferences in the property market context. Even though extensive studies have been previously conducted in Global North countries, limited analysis has been performed in developing countries under the Global South, including Indonesia. The Global North and South concepts are used to describe the social, economic, and political differences between countries in the northern and southern parts of the world. In China, Qu *et al.* (2020) found that the development of environmental facilities, such as parks, in less developed areas is associated with improved transportation quality and commercial services. Therefore, green spaces significantly affect the regional development. However, limited analyses have been conducted on the HPM application for valuation. Only two instances of usage were identified in Indonesia. One is by Yusuf and Resosudarmo (2009) for assessing the air quality in Jakarta, and the other is by Suparman *et al.* (2016) for evaluating piped clean water in both urban and rural areas. The present study develops a preference model for GOS in Jakarta, focusing on the park, urban forest, and cemetery categories. A valuation model is established herein using the HPM preference approach, adopting the property market as a proxy for estimating implicit values. A valuation model for GOS is investigated through the HPM preference approach that uses the property market as a proxy to estimate the implicit values in developing countries. This study seeks to uncover GOS preferences by examining the relationships among green space attributes, environmental amenities, residential structures, and land prices. The HPM technique enables the identification of public preferences based on the property prices at the regional level. This work specifically aims to investigate the relationships among green space attributes, environmental amenities, residential structures, and land prices using the HPM approach, estimate the effects of GOS on land values, and analyze the policy implications of urban GOS valuation. This study hypothesizes that proximity to various GOS attributes increases the land prices, and that these attributes have different

economic values. This work was conducted in Jakarta, Indonesia in 2023.

MATERIALS AND METHODS

Study area

The study was performed in Jakarta, which is the capital city of Indonesia (Fig. 1). Jakarta is a densely populated urban area that faces significant challenges in terms of environmental sustainability and quality of life. It is renowned for its rapid urbanization, elevated air pollution levels, and limited availability of green spaces. Understanding the dynamics of and perceptions on green spaces is crucial for developing effective urban planning strategies and enhancing the well-being of residents. As one of the world's megacities, Jakarta covers land and sea areas of 662.33 and 6977.5 kilometer square (km²), respectively. It has the highest density (20,618 people/km²) and total population (10,679,951 people) in Indonesia (Central Bureau of Statistics, 2023). The northern boundary is a 32 kilometer (km) coastline that serves as the estuary for 13 rivers, two canals, and two floodways. The majority of Jakarta Province's features lie below sea level during high tide, making certain areas susceptible to flooding caused by high rainfall and tidal waves. As depicted in Fig. 1, the western boundary of the study area is Banten Province, while its southern and eastern boundaries border West Java Province.

Data collection

Data were collected by distributing a questionnaire created through Google Forms. This questionnaire was distributed online in 2021 using various social media platforms. It comprised components related to residency, socioeconomic characteristics, and structural housing variables. This study targeted respondents from five administrative cities, namely South, North, East, West, and Central Jakarta, and included 239 out of the 261 neighborhoods. However, 22 neighborhoods did not have any respondents. These were six neighborhoods each in South, East, and West Jakarta and four in Central Jakarta. The final sample consisted of 1660 respondents representing the community in Jakarta Province. Fig. 2 presents the spatial data managed by the Jakarta Capital City Government (JCCG) through the "Jakarta Satu," which included parks, city parks, cemeteries, and urban forests.

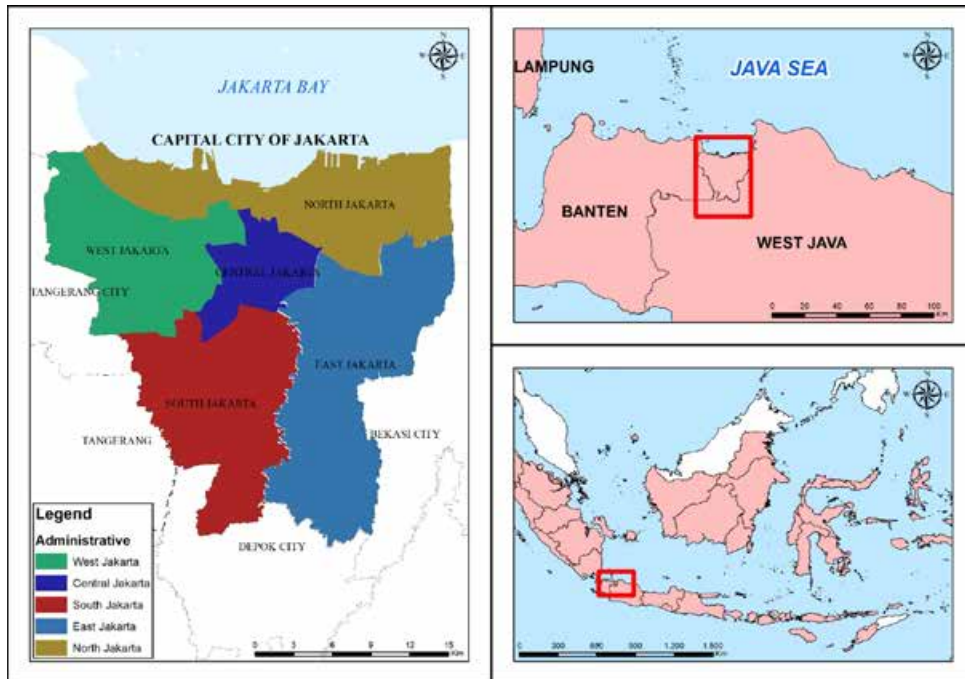


Fig. 1: Geographic location of the study area in Jakarta Capital City, Indonesia

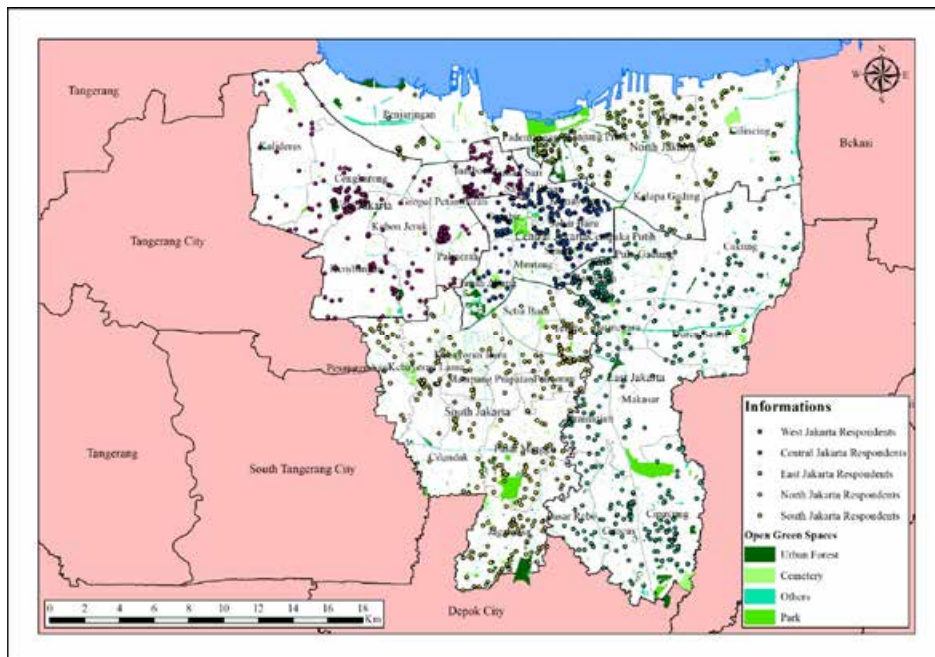


Fig. 2: Distribution of respondents and public GOS in Jakarta

Data analysis

After the data collection from 1660 respondents, a cluster analysis was performed using the Statistical Package for Social Sciences (SPSS) software to group respondents based on preference and reduce the data complexity. The dendrogram cluster analysis method, which is also known as hierarchical clustering, was used considering the socioeconomic characteristics of age, education level, occupation, and income. The dendrogram cluster analysis results using SPSS software showed the formation of two major clusters. Clusters 1 and 2 comprised 1592 and 68 respondents, respectively. Cluster 1 with 1592 respondents was employed to create the GOS valuation model using the HPM preference approach with ordinary least squares (OLS) regression. The “distances from residential dwellings to environmental facilities” attribute, including proximity to GOS, was measured using the geographic information systems (GIS) software considering the questionnaire results. The “environmental facilities” variable included distances less than 1000 m to the highways, less than 200 m to rivers, less than 200 m to roads, less than 500 m to train stations, and less than 9000 m to central business districts (CBDs). The “distances of urban GOS” attribute from residential locations to public green spaces for models I and II was also computed using the GIS software. In Model I, the urban GOS attribute encompassed distances from the respondents’ residential dwellings to parks, urban forests, and cemeteries, with a radius of less than 500 m. In Model II, the urban GOS were utilized as dummy variables for residential dwellings ranging from 0 to 2000 m, with subdivisions at 0–500, 500–1000, and 1000–2000 m for the park, urban forest, and cemetery categories.

This study commenced with an initial phase involving a cluster analysis of the questionnaire responses using the SPSS software. Moreover, the variables were used to construct the HPM with the independent variables of environmental facilities, house structural characteristics, and attributes associated with urban GOS. A spatial analysis through GIS software was performed to calculate the distances from each respondent’s residence to the GOS attributes and various environmental facilities. As independent variables, the environmental facilities relied on secondary data sources, including the number of public high schools, shopping centers, and population density.

The house structural attribute (clean water source) was derived from the questionnaire. In the next step, an OLS model statistical analysis was performed using SPSS for both models I and II. The final step involved a comprehensive descriptive analysis for assessing the estimated values associated with the GOS attributes based on the OLS coefficients and the average land prices. Fig. 3 illustrates the study framework.

Following Dahal et al. (2019), the land value (P_i) was used as a dependent variable, while the housing structure (S_{ij}), environmental facilities (N_{ik}), and urban green spaces (E_{il}) were treated as independent variables. The logarithmic form of the hedonic price function is presented using Eq. 1 (Dahal et al., 2019):

$$\ln P_i = \beta + \beta_j S_{ij} + \beta_k N_{ik} + \beta_l E_{il} + \varepsilon \quad (1)$$

where, β represents the intercept term; β_j , β_k , and β_l are the coefficients corresponding to the respective independent variables; and ε denotes the error term. The equation suggests that the land price logarithm is a function of the housing structure, environmental facilities, and urban green spaces, each with respective coefficients. The error term accounted for any unobserved factor or measurement error. A global model (OLS regression) was adopted herein using the land price market in Jakarta to estimate the implicit marginal prices of the housing structure attributes, environmental facilities, and urban green spaces. The implicit prices of each variable characterized the land price as an HPM function derivative. This refers to the land value representing the marginal prices of each variable. The environmental facility variables are not directly purchased and included in the land price, but the monetary value is shown through the prices paid by the buyers for the land. The equation for the implicit price function adopts this approach, where Z_i is the land attribute vector, using Eq. 2 (Dahal et al., 2019).

$$PZ_i(Z_i, Z_i - 1) = \frac{\partial P(Z)}{\partial Z_i} \quad (2)$$

where, PZ_i denotes the implicit price of the land attribute Z_i , and $\frac{\partial P(Z)}{\partial Z_i}$ represents the partial derivative of the price P to the attribute Z_i . This equation estimates the marginal implicit prices associated with each land attribute in the HPM context, namely models I and II at 640 and 1592 samples, respectively, with differences in the GOS criteria. Table 1 shows

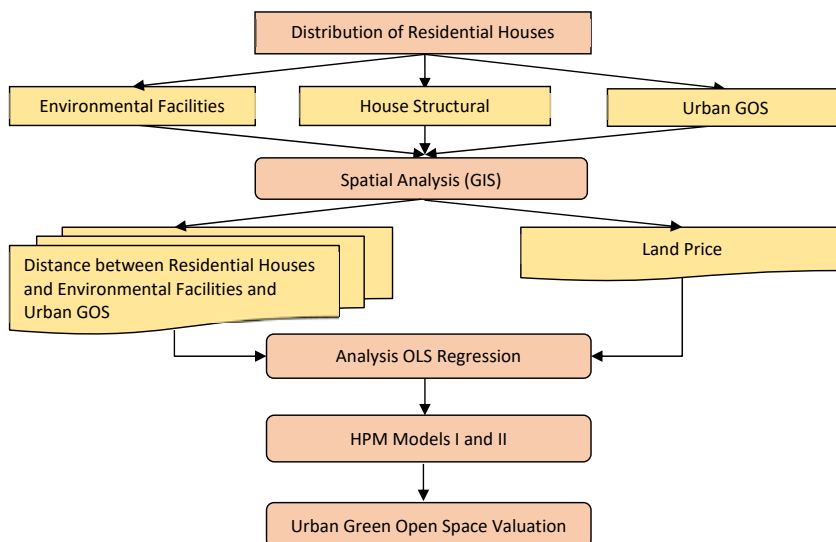


Fig. 3: Study framework

Table 1: Descriptive statistics

Variables	Model I		Model II	
	Mean	SD	Mean	SD
Intercept	15.6582	0.91708	15.7521	0.91550
Residential structure variable				
Clean water source as a dummy variable	0.4469	0.49756	0.4912	0.50008
Environmental/locational facility variable				
Number of public high schools	2.7922	1.67152	2.6376	1.65805
Number of the shopping center	17.0156	6.43152	16.7714	6.01814
Population density	23347.4891	16482.78474	25605.8304	18607.54882
Respondent's location	2.6063	1.36968	2.8536	1.40102
Distance to toll road (1000 m) as a dummy variable	0.4453	0.49739	0.4083	0.49167
Distance to the main road (200 m) as a dummy variable	0.1859	0.38936	0.1859	0.38917
Distance to train station (500 m) as a dummy variable	0.1000	0.30023	0.1043	0.30571
Distance to CBD (9000 m) as a dummy variable	0.5047	0.50037	0.5396	0.49859
Distance to the river (200 m) as a dummy variable	0.2875	0.45295	0.2808	0.44952
Urban GOS variable				
Urban forest				
Less than 500 m	78.4547	145.89117		
0–500 m as a dummy variable			0.1118	0.31523
500–1000 m as a dummy variable			0.1916	0.39367
1000–2000 m as a dummy variable			0.3386	0.47337
Park				
Less than 500 m	182.6344	177.34022		
0–500 m as a dummy variable			0.2494	0.43279
500–1000 m as a dummy variable			0.2739	0.44608
1000–2000 m as a dummy variable			0.3097	0.46250
Cemetery				
Less than 500 m	101.3172	159.79211		
0–500 m as a dummy variable			0.1420	0.34912
500–1000 m as a dummy variable			0.3656	0.48174
1000–2000 m as a dummy variable			0.3461	0.47588

a descriptive analysis of the mean and standard deviation (SD) using SPSS.

Waltert and Schl pfer (2010) underscored the propensity for regions endowed with comprehensive amenities to exhibit accelerated growth, suggesting the potential synergy between hedonic pricing studies and economic and regional migration models. This dynamic interplay, relationships among landscape amenities, developmental patterns, environmental policies, and property prices furnished a comprehension of landscape and economic governance. The escalating urban land and housing prices have assumed paramount significance, prompting policymakers to contemplate on regulatory interventions. These interventions entail the systematic multifarious determinants influencing the land and housing prices, which encompass the socioeconomic profile of the populace, proximity to urban cores and CBDs, accessibility to transportation networks, and proximity to urban facilities surrounding green spaces, parks, sports amenities, and healthcare centers (Mirkatouli *et al.*, 2018). Incorporating the role of both dependent and independent variables is important in augmenting the nation's economic value.

RESULTS AND DISCUSSION

Valuation of GOS using the hedonic price model

The variables in the valuation model analyzed using the HPM approach were the residential structure, environmental facilities, and urban GOS. The urban GOS valuation was formulated by following two steps with the OLS regression model implementation. The regression estimated the coefficient parameters of the independent variables to determine the positive or negative influence on the urban GOS valuation. The results analyzed the effect of the independent variables. The estimated coefficients indicated the positive or negative effect on the land prices. The OLS model adopted a semilog approach following the methodology used by Dahal *et al.* (2019). The data analysis using the SPSS yielded coefficient parameter estimates with varying degrees of influence. Not all independent variables produced statistically significant results. The estimation was obtained by multiplying the percentage with the average land price zoning. Classic assumption tests ensured that the data met the requirements. The normality test

performed using a P-plot graph reported that the data followed a normal distribution. Table 2 shows the description and expected signs of variables in the hedonic price model.

Dependent variable: Land price

The HPM typically employs property prices as a dependent variable; however, due to the unavailability of property data in Indonesia, this study utilized land prices, depicting a consistent approach with the previous HPM studies (Gao and Asami, 2007; Mirkatouli *et al.*, 2018). Land prices constitute a primary determinant of housing costs (Shen and Karimi, 2017). Yu (2010) elucidated that land prices and income influence property prices. Abelson (1985) posited that land prices are expected to feature as a variable in housing prices and estimated to be five times the housing price. A critical issue in urban areas is land scarcity (Zhong *et al.*, 2016). The confluence of limited land supply, escalating demand, and rural-to-urban migration precipitated rapid land and housing price increases. Accompanied by their marginal effects, the compatibility of buildings with green environments significantly affects land prices (Gao and Asami, 2007). Land is a requisite resource of all economic activities (Nichols *et al.*, 2013), rendering it a fundamental component in urban development and expansion (Li *et al.*, 2016). The land price is a dependent variable based on the National Land Agency of Jakarta Province and distributed zoning (Fig. 4). In the first stage, the multiplication of coefficients with 100 percent (%) yielded the results. In the second stage, the percentage was multiplied by the average land price zoning for the 1592 respondents, which was Rp10,900,575. The GOS externalities in urban planning and development policies are difficult to assess. The government of Jakarta and the city's private developers have not objectively included the GOS attributes in land pricing and spatial planning policies. The HPM offers an appropriate approach of estimating the external benefits of the urban GOS, contributing to land prices. This study explored the major impact of environmental elements influencing the land prices in Jakarta, Indonesia. A semilog approach OLS model was used by transforming the dependent variable (i.e., land price) in line with the work of Dahal *et al.* (2019).

Table 2: Description and expected signs of the HPM variables

Variable	Description	Expected sign	
		Model I	Model II
Dependent variable			
Land price	Zoning price of residential land based on data from the National Land Agency of DKI Jakarta Province		
Independent variable			
Residential structure			
Clean water source	Dummy variable, $s = 1$ for clean water source from the pipeline, $s = 0$ for clean water source non-pipeline	+/-	+/-
Environmental/location facilities			
Public high schools	Number of public high schools at the sub-district level	+	+
Shopping center	Number of shopping centers at the administrative city level	+	+
Population density	Population density per village	-	-
Distance to toll road	Dummy variable, $s = 1$ for residential locations within 1000 m from the toll road, $s = 0$ for residential locations beyond 1000 m from the toll road	+/-	+/-
Distance to road	Dummy variable, $s = 1$ for residential locations within 200 m from the road, $s = 0$ for residential locations beyond 200 m from the road	+	+
Distance to train station	Dummy variable, $s = 1$ for residential locations within 500 m from the train station, $s = 0$ for residential locations beyond 500 m from the train station	+	+
Distance to CBD	Dummy variable, $s = 1$ for residential locations within 9000 m from the CBD, $s = 0$ for residential locations beyond 9000 m from the CBD	+	+
Distance to river	Dummy variable, $s = 1$ for residential locations within 200 m from the river, $s = 0$ for residential locations beyond 200 m from the river	+/-	+/-
Location	Location of respondent's residence per administrative city (1, 2, 3, 4, and 5 for South, East, North, West, and Central Jakarta, respectively)	+/-	+/-
Green open space			
Distance to urban forest	Residential location to the nearest park within 500 m	+	
0–500 m	Dummy, $s = 1$ for residential locations within a distance of 0–500 m from the park, $s = 0$ for residential locations not within a distance of 0–500 m from the park		+
500–1000 m	Dummy, $s = 1$ for residential locations within a distance of 500–1000 m from the park, $s = 1$ for residential locations not within a distance of 500–1000 m from the park		+
1000–2000 m	Dummy, $s = 1$ for residential locations within a distance of 1000–2000 m from the park, $s = 0$ for residential locations not within a distance of 1000–2000 m from the park		+
Distance to park	Residential location to the nearest park within 500 m	+	
0–500 m	Dummy, $s = 1$ for residential locations within a distance of 0–500 m from the park, $s = 0$ for residential locations not within a distance of 0–500 m from the park		+
500–1000 m	Dummy, $s = 1$ for residential locations within a distance of 500–1000 m from the park, $s = 1$ for residential locations not within a distance of 500–1000 m from the park		+
1000–2000 m	Dummy, $s = 1$ for residential locations within a distance of 1000–2000 m from the park, $s = 0$ for residential locations within a distance of 1000–2000 m from the park		+
Distance to cemetery	Residential location to the nearest cemetery within 500 m	-	
0–500 m	Dummy, $s = 1$ for residential locations within a distance of 0–500 m from the park, $s = 1$ for residential locations not within a distance of 0–500 m from the park		-
500–1000 m	Dummy, $s = 1$ for residential locations within a distance of 500–1000 m from the cemetery, $s = 1$ for residential locations not within a distance of 500–1000 m from the cemetery		-
1000–2000 m	Dummy, $s = 1$ for residential locations within a distance of 1000–2000 m from the cemetery, $s = 0$ for residential locations not within a distance of 1000–2000 m from the cemetery		-

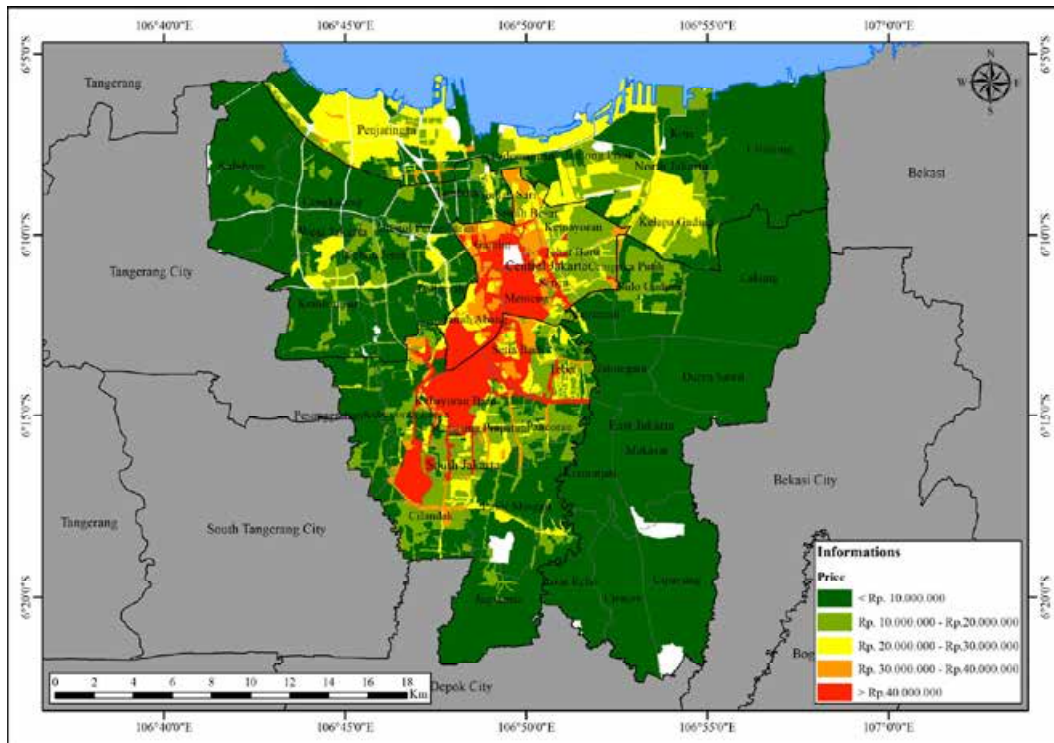


Fig. 4: Land price zoning in Jakarta

Independent variable

Urban GOS

Chiesura (2004) found a relationship between GOS and their ultimate contribution to an improved quality of life and the pursuit of sustainable urban development. Urban areas rich in greenery offer urban residents a serene and pleasant living environment (Sturm and Cohen, 2014). The GOS valuation model using the HPM estimated the community's preferences for urban GOS based on predetermined attributes. In this context, the valuation aimed to determine the economic value of urban GOS and the influencing factors. This model provides a community preference and assigns an economic value to these attributes in the urban GOS context. A better understanding of preferences provides a valuable guidance for policymakers in making decisions related to the development and management of urban GOS in Jakarta. In 2019, the JCCG input the spatial data of public GOS assets owned and managed by various departments into the Jakarta Satu website. The asset data showed that the total area of GOS was

approximately 5.1% of the total land area. Jakarta has also implemented the Regional Regulation Number 1 of 2012 Concerning Spatial Planning 2030, with the ambitious objective of reaching a 30% GOS in accordance with the provisions set forth in Law No. 26 of the Republic of Indonesia (Law, 2007).

Environmental facilities

According to previous studies, the environmental facility variables in the HPM model included school quality, average income, hospitals, crime rates, and demographics. These variables were developed from the number of public high schools per sub-district, shopping center, population density per village, respondent location, and distances to toll and main roads, train stations, rivers, and CBDs. An important characteristic of the surrounding environment is network connectivity or accessibility measured by main and toll roads, public transportation, and distance to the city center or CBDs. Moreover, transportation infrastructure variables have positive and negative impacts (Czebrowski and Kronenberg,

Table 3: Model summary

Model	R	R ²	Adjusted R ²	SE of the estimate	Durbin–Watson table (DW)	Durbin–Watson (D)
II	0.765	0.585	0.580	0.59354	1.908	1.912

2016; Kong *et al.*, 2017). The data on the number of public schools were obtained from the JCCG website.

Housing structure

The structural house from the questionnaire comprised the number of rooms, bathroom location, clean water source, and building size. Only the clean water source variable was input into the model during the valuation process. Respondents with non-pipeline and pipeline clean water sources accounted for 50.78 (843) and 49.25% (817), respectively. South and North Jakarta showed the lowest and highest portions of respondents with pipeline water sources, depicting values of 13.24 and 85.00%, respectively. The pipelines in South Jakarta are not distributed; hence, residents rely on groundwater as clean water. This limited availability in North Jakarta has led the majority of its population to prefer pipelines as a clean water source.

Hedonic price model OLS regression

The model was validated based on the classical assumptions encompassing tests for normality, multicollinearity, heteroskedasticity, and autocorrelation. Normality testing involves the use of a visual P-plot, indicating that the data distribution closely adhered to the diagonal axis signifying a normal distribution. In this study, the Durbin–Watson table (DW) for autocorrelation testing and the SPSS output yielded a D value of 1.912. Referring to the DW table at a 0.05 significance level, the DW value was 1.908. No autocorrelation was found within the testing range of $1.908 < 1.912 < 2.14$ (Table 3).

The test for multicollinearity was determined by the tolerance values and the variance inflation factor (VIF). The tolerance value measures the variability of the independent variable that cannot be explained by other independent variables. Accordingly, a low value corresponds to a high VIF value because $VIF = 1/\text{tolerance}$, indicating a high collinearity. The cut-off used is a tolerance value above 0.10 or a VIF below 10. Model II of the HPM approach showed a value above 0.10 and a VIF

below 10, showing the absence of multicollinearity. The heteroscedasticity test using a scatterplot graph revealed that the data points followed a diagonal axis, confirming a normal distribution. This model satisfied the classical assumptions and can be used to analyze the relationship between independent and dependent variables. The statistical analysis results also showed the relationship between urban green space variables and land prices in a specific context. The analyzed GOS variables and distance radius can have different effects on land prices. These observed effects vary depending on the complexity of other factors influencing the land prices and the specific urban environment characteristics. The variable insignificance may be influenced by unexamined factors or the utilized sample size. Therefore, further exploration and additional studies are important for understanding the relationship between urban GOS variables and land prices. Table 4 shows the estimates from the HPM models used to analyze the GOS monetary value.

Model I of the OLS approach using the HPM showed an R-squared (R²) value of 0.561 or 56.1%, depicting a moderately strong relationship using Eq. 3 (Dahal *et al.*, 2019). The independent variables collectively accounted for 56.1% of the land price variation. Model II yielded a higher R² value amounting to 0.585 or 58.5%. The independent variables were 58.5% of the land price variation, as obtained using Eq. 4 (Dahal *et al.*, 2019). Model I analyzed three GOS variables, namely urban forests, parks, and cemeteries, within a radius fewer than 500 m. Model II examined nine GOS variables, namely urban forests, parks, and cemeteries within the three distance ranges of 0–500 m, 500–1000 m, and 1000–2000 m represented as dummy variables.

$\ln \text{Land price} = 13,505 + 0.243 (\text{clean water source}) + 0.016 (\text{public high school}) + 0.060 (\text{shopping center}) - 4.640E-06 (\text{population density}) + 0.284 (\text{respondent's location}) - 0.091 (\text{toll road}) + 0.253 (\text{road}) + 0.048 (\text{train station}) + 0.639 (\text{CBD}) - 0.064 (\text{river}) + 5.444E-05 (\text{distance to urban forest less than}$

$$500 \text{ m}) + 0.000 \text{ (distance to park less than 500 m)} - 3.378E-05 \text{ (distance to cemetery less than 500 m)} + e \quad (3)$$

$$\begin{aligned} \ln \text{landprice} = & 13.636 + 0.096 \text{ (clean water source)} + 0.032 \text{ (public high school)} + 0.065 \text{ (shopping center)} - \\ & 4.711E-06 \text{ (population density)} + 0.262 \text{ (respondent's location)} - 0.049 \text{ (toll road)} + 0.206 \text{ (road)} + 0.000 \text{ (train station)} + 0.593 \text{ (CBD)} - 0.026 \text{ (river)} - 0.044 \text{ (distance to urban forest less than 500 m)} + 0.171 \text{ (distance to urban forest 500 m–1000 m)} + 0.192 \text{ (distance to} \end{aligned}$$

$$\begin{aligned} & \text{urban forest 1000 m–2000 m)} + 0.029 \text{ (distance to park less than 500 m)} + 0.092 \text{ (distance to park 500 m–1000 m)} - 0.020 \text{ (distance to park 1000 m–2000 m)} + 0.032 \text{ (distance to cemetery less than 500 m)} - 0.376 \text{ (distance to cemetery 500 m–1000 m)} - 0.150 \text{ (distance to cemetery 1000 m–2000 m)} + e \quad (4) \end{aligned}$$

The results indicated that only five variables in Model II had a significant relationship and provided negative and positive influences on the land prices. In Model I, the coefficient values for

Table 4: Estimates from the HPM models used to estimate the GOS monetary value

Variables	Coefficient		Coefficient	
	Model I	Model II	Tolerance value	VIF
Intercept	13.505	13.636		
Residential structure variable				
Clean water source as a dummy variable	0.243***	0.096***	0.796	1.256
Environmental/locational facility variable				
Number of public high schools	0.016	0.032***	0.672	1.489
Number of the shopping center	0.060***	0.065***	0.584	1.711
Population density	-4.640E-06**	-4.711E-06***	0.643	1.554
Respondent's location	0.284***	0.262***	0.550	1.819
Distance to toll road (1000 m) as a dummy variable	-0.091*	-0.049	0.820	1.219
Distance to the main road (200 m) as a dummy variable	0.253***	0.206***	0.922	1.085
Distance to train station (500 m) as a dummy variable	0.048	0.000	0.823	1.215
Distance to CBDs (9000 m) as a dummy variable	0.639***	0.593***	0.565	1.769
Distance to the river (200 m) as a dummy variable	-0.064	-0.026	0.890	1.123
Urban GOS variable				
Urban forest				
Less than 500 m	5.444E-05			
0–500 m as a dummy variable		-0.044	0.855	1.169
500–1000 m as a dummy variable		0.171***	0.693	1.443
1000–2000 m as a dummy variable		0.192***	0.723	1.384
Park				
Less than 500 m	0.000			
0–500 m as a dummy variable		0.029	0.735	1.361
500–1000 m as a dummy variable		0.092**	0.611	1.637
1000–2000 m as a dummy variable		-0.020	0.661	1.512
Cemetery				
Less than 500 m	-3.378E-05			
0–500 m as a dummy variable		0.032	0.910	1.099
500–1000 m as a dummy variable		-0.376***	0.510	1.961
1000–2000 m as a dummy variable		-0.150***	0.556	1.797
Model summary				
R-squared	0.561	0.585		
Adjusted R-squared	0.552	0.580		
N	640	1592		

Significance levels: ***0.01, **0.05, and *0.1

Table 5: Estimation of the effects of GOS on the land price in Model II

Variable urban GOS	Effects on land prices (%)
Distance to an urban forest 500–1000 m	17.1***
Distance to an urban forest 1000–2000 m	19.2***
Distance to park 500–1000 m	9.2**
Distance to cemetery 500–1000 m	-37.6***
Distance to cemetery 1000–2000 m	-15***

Significance levels: ***0.01 and **0.05

the GOS variables were not statistically significant and lacked a significant impact on the land prices. Dummy variables were used in Model II to analyze the spatial location of properties. The urban forest variable located between 500 and 1000 m from the residential area showed a 17.1% increase in the land prices. The highest influence was found in the urban forest with the 1000–2000 m distance, illustrating a 19.2% land price increase. For the parks, a significant influence in the 500–1000 m distance was observed with an average 9.2% land price increase. However, in other distances, the park category did not share any significant impact on the land prices. The cemetery variable decreased the land prices within the distance ranges of 500–1000 m and 1000–2000 m, depicting 37.6 and 15% of land price decreases, respectively. Model II represented residential locations within 0–500 m from the urban forest, showing a 0.044 coefficient, which negatively affected the land price. The parks did not have a significant influence within the two distance categories of 0–500 m and 1000–2000 m with coefficients of 0.029 and 0.020, respectively, thereby showing decreasing land prices. The cemetery variable yielded a positive coefficient, but was not significant in the 0–500 m distance with a 0.032 coefficient. The study did not confirm that all GOS aspects were equally desired by the land buyers in Jakarta. However, the impact of different GOS categories varied, aligning with the hypothesis. The HPM approach had limitations, including the possibility that not all independent variables have a linear relationship due to heterogeneity effects (Ligus and Peternek, 2016). Table 5 presents an estimation of the effects of GOS on the land price in Model II.

Other factors influencing the relationship between independent variables and land prices must be considered. The analysis of the housing structure variables showed that the “clean water source” with a positive coefficient of 0.096 was significant at the 99% level. Therefore, having access to clean water

from a public utility has a positive influence on land prices. Not all environmental facility variables had a significant positive impact. Shopping centers, locations of the respondents’ residences, public high schools, roads within a distance fewer than 200 m, and CBDs demonstrated significant positive coefficients on land prices, while population density showed a significant negative effect. The coefficients for the variables of shopping center, location, public high schools, roads within a distance less than 200 m, and CBDs with a 9000 m radius were 0.065, 0.0262, 0.032, 0.206, and 0.593, respectively, indicating positive influences on land prices. The population density variable yielded a negative and significant coefficient of 0.00000471, showing that a population density increase was associated with a land price decrease. The physical development pattern of Jakarta is initially directed within a 15 km radius of the National Monument (Jakarta Master Plan 1965–1985). Therefore, the highest land prices in Jakarta are concentrated in Central Jakarta following the land-use development pattern for commercial and office purposes. The highest coefficient influencing 59.3% of land prices was the distance to the CBD, which was consistent with the results obtained by Lewis (2007), showing that the increase in land prices per 1 km of distance to the CBD was 5.4%. This finding was also supported by Lewis (2007) and Mirkatouli et al. (2018), who suggested that proximity to the city center is a preference in selecting a place of residence. The analysis of environmental facilities confirmed that several variables do not have a significant relationship with land prices. The distance to the toll road less than 1000 m had a 0.049 coefficient with negative and insignificant effects. The distance to the train station less than 500 m showed a 0.0002 coefficient with positive and insignificant effects. The distance to the river within less than 200 m yielded a 0.026 coefficient with negative and insignificant effects on land prices. The key variables in constructing

the OLS valuation model for urban green spaces with a significant relationship with land prices were found to be clean water sources, location of the respondents' residence at the city level, roads, and presence of CBDs. Therefore, these variables significantly influenced the land prices in Jakarta. The subsequent step here was to estimate the value of urban green spaces based on the percentage effects derived from the OLS coefficients multiplied by the average zona land price. The highest increase in land prices was found in locations with a 1000 to 2000 m distance range from the urban forest, depicting an increase of Rp2,092,910. The second-highest and highest increments were observed in the 500 to 1000 m range, with increases of Rp1,863,998 and Rp1,002,853, respectively. Conversely, the highest decrement occurred in residential areas with 500 to 1000 m and 1000 to 2000 m distance ranges from the cemetery at Rp4,098,616 and Rp1,635,086, respectively. These findings were consistent with those of Kong et al. (2007), Tyrväinen and Miettinen (2000), and Samad et al. (2020). According to Morancho (2003), Larson and Perrings (2013), Anderson and West (2006), and Lutzenhiser and Netusil (2001), the land value increase in the presence of urban forests indicates that larger green spaces have a positive relationship. This finding was consistent with that obtained by Czembrowski and Kronenberg (2016), who stated that different types of green spaces have different impacts, and the strongest effect occurs in residential areas near the unique and popular Lagiewniki Forest. This finding was also in line with those of Czembrowski and Kronenberg (2016), whose results showed that parks and urban forests have a significant positive impact on property prices, while cemeteries decrease the variable. These results were consistent with those found by Tyrväinen and Miettinen (2000) and Larson and Perrings (2013), who found positive impacts on extensive forests and large parks. The negative impact of cemeteries on property prices was also found in the studies of Andersson et al. (2007), Raymond and Love (2000), and Anderson and West (2006). However, these findings were inconsistent with the results of Lutzenhiser and Netusil (2001) on their study area of Oregon, United States. They found that proximity to cemeteries does not have a significant relationship with the property prices. The current study provides evidence supporting the idea that the residential land

value can be influenced by environmental factors, such as GOS. The effects of specific GOS types can vary, and specific contexts must be considered in land value assessments. The land market in Jakarta is mature and capable of showing significant relationships between prices and structural, environmental/location, and GOS attributes. Differences also exist in the impact of proximity to certain GOS types. These include urban forests, parks, and cemeteries. The presence of cemeteries is an undesirable facility for land buyers in Jakarta. In models I and II using the HPM, no significant relationships were found among parks, urban forests, cemeteries, and land prices within a 500 m radius. Even though GOS have direct access to the community, pragmatic thinking in a hedonic behavior may be a factor influencing the result. The usage of a 500 m radius as a buffer takes reference from previous studies (Czembrowski and Kronenberg, 2016; Czembrowski et al., 2019; Daams et al., 2019) in Western countries. For example, the findings of Czembrowski and Kronenberg (2016), Melichar and Kaprová (2013), and Daams et al. (2019) showed a significant positive relationship between the percentage of greenery within a 500 m radius and the property prices in Finland, Prague, and Amsterdam, respectively. These findings were inconsistent with the results obtained by Tyrväinen (1997), who found a negative impact of living close to urban forests due to vegetation density. According to Kong et al. (2007), in Jinan (China), green spaces within a 300 m radius can increase property prices by approximately 2.1%. In conclusion, Western theories cannot always be directly applied to public spaces. Therefore, environmental factors and GOS can have complex and varied impacts on land prices. The social, cultural, and local policy contexts must be considered when trying to understand the relationship between GOS and land values in Indonesia. The greatest positive impact of the presence of urban forests and parks was in line with the results of several previous studies. The residents of Jakarta highly value direct access to urban forests and parks. The monetary valuation of GOS has become important in high-density residential environments in Jakarta, as found by Daams et al. (2019) who studied the metropolitan city of Amsterdam. Daams et al. (2019) investigated the distance from homes, finding that the estimate does not affect GOS beyond 1 km. The varying radius

division results were consistent with the findings of the estimated effects of GOS ranging from 7.1 to 9.3% within 0.25 km from the nearest green space from 1.7 to 2.3% within a distance of 0.75 to 1.0 km. With China as their study area, [Qu et al. \(2020\)](#) found a significant positive relationship between land prices and parks within the distance of up to 1600 m, but did not explain the relationship within the radius less than 500 m. The results were consistent with those of studies conducted in other developing countries. For example, [Biao et al. \(2012\)](#) stated that in Beijing (China), the value of properties lies within a distance of 850–1604 m from parks, with property prices increasing between 0.5 and 14.1%. [Islam et al. \(2020\)](#) found that, in Bangladesh, open spaces within 0–1000 m had a negative and insignificant relationship with house rental prices. [Sharma and Newman \(2018\)](#) reported in Bangalore (India), a negative relationship exists between the presence of parks and property prices. [Li et al. \(2021\)](#) found that, in Shenzhen (China), a negative relationship can be found between the presence of community parks within a 0–1000 m radius of residences. These findings complemented the limited literature on urban green space valuation in developing countries (e.g., [Aziz et al. \(2021\)](#)). Therefore, the HPM can be applied in the context of Jakarta, which has a growing and privatized land market. The results can provide policymakers and property developers with information on land transactions and conversion, property development, conservation, and ecologically sound urban green space designs. This study has implications for land use planning and public investment in densely populated areas like Jakarta. Green spaces often compete with other land uses and are undervalued by the public and their policymakers. These findings can prevent the undervaluation of green spaces and provide additional policymakers with information on the implicit value of green spaces, consequently enhancing the value of these areas. The development of Jakarta often overlooks the presence of green spaces, even though [Engström and Gren \(2017\)](#) showed a relationship between green spaces and health. Valuing green spaces can enhance our understanding of their benefits and provide support to city planners. This study is an important step in creating policy implications related to the monetary valuation of GOS for local governments. Local governments may increase their tax revenues by

developing, expanding, and maintaining GOS. This study makes a significant contribution to understanding the role of urban forests and parks in the context of Jakarta, showing their significant impact on land prices. However, further studies can be performed to deepen our understanding of GOS. Future studies can expand the GOS valuation by considering various aspects, such as the size of green spaces, related social functions, and ecosystem services, using comprehensive models with more variables. This will enrich one's understanding of the relationship between GOS and land value and provide a more comprehensive perspective on green space planning and management. For the valuation model development using the HPM approach, a large sample size is required at the regional scale to obtain significant relationships. The findings obtained here were in line with those of [Waltert and Schläpfer \(2010\)](#), who found more significant relationships in urban areas compared to rural or remote areas. At the provincial level, 12 significant independent variables were determined out of 19 used ones concerning land prices. The key variable in the OLS model was found to be the availability of clean water sources in residential areas, which has a significant positive influence on land prices. The presence of toll roads did not have a significant relationship at the provincial level; however, in Central Jakarta, this variable depicted a significant negative relationship with land prices, yielding a 37.4% coefficient. Empirical evidence showed that toll roads in Jakarta are located in border areas with other administrative cities, and that these areas tend to be dense and irregular. The presence of dense and irregular settlements affects the land price decrease. The population density variable statistically had a significant negative relationship with the land prices in the five administrative cities, even though the influence was relatively small. The presence of public high schools also had a significant relationship and a positive association with average land prices. The proximity to roads variable showed a positive and significant relationship at the provincial level. However, the variable with the highest influence was the distance from the residential areas to the CBDs, which exhibited a positive and significant relationship with land prices. The valuation of green spaces can be conducted through the HPM approach, which provides a better understanding of the economic

value of these spaces in enhancing the value of an area. Green spaces are not only seen as zoning areas or urban spatial patterns, but also as public investments with an economic value. Green spaces must be protected and developed in urban areas considering their environmental, economic, and social benefits. This study demonstrated that the presence of parks and urban forests can increase the land prices in Jakarta, which was consistent with the hedonic valuation literature showing the important role of green spaces as property price determinants (Daams et al., 2019). The HPM study provided an understanding of the dynamic interaction existing among the land prices, environmental amenities, housing structure, and GOS. The valuation model did not have a higher R^2 value compared to the provincial level, affirming that the HPM model can be applied at the regional scale, as stated by Waltert and Schlöpfer (2010) and Palmquist (2005). The paradigm on GOS also shifted as part of the GI concept with an economic value in enhancing the value of an area. However, the existence of green spaces is increasingly being threatened, with the high land prices posing a challenge in financing sustainable green space development. In developing GOS, creative thinking is needed to ensure the greening of public spaces to meet the needs of areas with a limited land availability. The GOS development is limited to the existing environmental quality, thereby requiring an understanding of how the distribution and functions provide the spaces' economic value. Cultural ecosystem services are becoming increasingly important with the population growth and the challenges of urban life.

Policy implications of the urban GOS valuation

As substantiated by the empirical investigations conducted by Setiowati et al. (2019) and Budiman et al. (2014), the annual decrement in the presence of GOS in Jakarta signifies a diminishing emphasis on GOS within the broader Jakarta metropolitan region. This discernment implied that the significance and the intrinsic value of GOS in the urban fabric may not have been afforded the requisite attention and appreciation. The stewardship of the GOS development in Jakarta transcends the realm of the local governmental authority and necessitates the active participation of a diverse array of stakeholders from the private sector. The target for private GOS in

Indonesia, which has been mandated to be provided by both the community and the private sector, is set at 10% in accordance with Law 26 of 2007 (Law, 2017). As suggested by Alterman (2012), the economic value of green spaces indicates the need for continued policies in valuing the green spaces integrated with the Land Value Captured (LVC) concept through land price increases and as alternative funding sources for public investments. The green spaces in Indonesia must be seen as infrastructure and public investments that generate an economic value in urban area enhancement. Therefore, the LVC concept has a potential and needs further development with the use of more parameters to explore the impact of urban green space accessibility on the area value enhancement. The study suggests the need for developing more urban forests, parks, and cemeteries in Jakarta with good landscape architecture and aesthetics. The existence of cemeteries in Jakarta is primarily marked by an unsettling and disorganized atmosphere, which is inadequately addressed by the JCCG. Mitigating the negative impact of cemeteries on land values requires the JCCG to improve the quality and management of cemeteries scattered throughout Jakarta to make them less ominous and more suitable for recreational activities. The increased willingness to pay drives policy changes and density zoning that benefit the land market by promoting optimal value and use. The results can benefit policymakers when building green space infrastructures, such as parks and urban forests, as maximum efforts in urban economic development. The results of this work can also be used as input in drafting the Presidential Regulation on Area Value Improvement Management in collaboration with the Coordinating Ministry for Economic Affairs and the Asian Development Bank. The sustainable development in developing countries requires a study that addresses strategic issues like green spaces. Environmental amenities are regarded as social infrastructure in developing countries. This study provides strong evidence that parks and urban forests have statistically significant positive effects on land price vicinity. The findings obtained are largely consistent with those of previous HPM studies in the Global North countries despite the differences in the captured effects within the 0–500 m radius. This study found no significant relationship between the presence of GOS within the 0–500 m radius and the

land prices in Jakarta, differing from most of the HPM studies found in the literature that utilized Global North countries as their study areas and showing a significant relationship within a 500 m radius similar to [Daams et al. \(2019\)](#) and [Czembrowski and Kronenberg \(2016\)](#) in line with the World Health Organization's standard of GOS presence from residential areas at 300 m. The results acquired in this work align with the findings of studies conducted in the Global South countries, which did not establish a significant connection to the land value within a 500 m radius of green spaces. This consistency was in line with the studies of [Biao et al. \(2012\)](#) for Beijing (China), [Islam et al. \(2020\)](#) for Bangladesh, and [Sharma and Newman \(2018\)](#) for India. In Jakarta, the GOS proximity showed a limited correlation with the determinants influencing visitation, as highlighted by [Setiowati et al. \(2023\)](#) in their work and in alignment with the findings of [Yen et al. \(2017\)](#) for Cambodia. The results contrasted the conclusions of [Andersson et al. \(2019\)](#) and [Honey-Rosés et al. \(2020\)](#), emphasizing the significance of accessibility related to user perceptions and visitation. This can be attributed to the culture of walking and the negative perceptions of dense vegetation among the public. Green space preferences vary between regions due to differences in quantity and quality, historical land use roles, attitudes, perceptions, and cultural contexts of communities. Different perceptions or preferences for ecosystem services are reflected in the willingness to pay for land units, which reflects the value of green spaces. Meanwhile, the positive externality of parks and urban forests on surrounding land prices depends on the community quality and utilization. The analysis of buffer zones can be a meaningful approach for assessing green spaces related to hedonic prices. The manifestation of the GOS value inherent in land prices serves the dual purpose of conferring benefits not just on private sector enterprises through the augmentation of returns on investments in residential or commercial ventures, but also offering substantive impetus to the overarching trajectory of urban economic expansion. The capitalized value in the land market benefits developers or private parties by allowing them to gain profits from housing or commercial development and urban planners and policymakers through strategic efforts of developing adequate and high-quality public green space provisions. The study findings contribute to the

design of scenarios for development, including housing construction. Analyzing the impacts as a source of information through the land market allows an examination of the spatial heterogeneity of preferences. This information is valuable for urban planners when considering the social value of green spaces. Future urban landscape designs should analyze the relationships in different scales (e.g., city level versus sub-district level). Understanding the heterogeneity of public preferences provides additional information that assists local governments in determining land prices. The findings have important implications for land use planning and public investment in Jakarta considering that green spaces compete with other land uses. The conservation of open spaces should be a pivotal consideration in urban planning decisions to augment environmental, cultural, and economic values as part of a broader strategy addressing societal concerns ([Dahal et al., 2019](#)). Accurate information on the monetary estimation of green spaces can assist policymakers in maximizing the well-being of the community and in developing attractive public investments. These indirect benefits attract the attention of local governments and stakeholders, encouraging them to formulate more effective strategies for the conservation and development of green spaces in budget allocation and urban planning. This study provides important steps in measuring the total benefits of GOS and analyzes interesting implications, such as increased tax revenue for local governments from specific GOS categories. The collaboration between local governments and the private sector aids in developing a property database system, including owner information as a data source for HPM studies. The presence of GOS provides diverse ecosystem services. Public preferences vary based on socio-demographic factors, which have different policy implications. Future studies can focus on the development of a more comprehensive HPM model by considering more variable factors and including more empirical analyses. The findings also recommend further study for analyzing the differences in the GOS categories and sizes driving positive externalities, depicting the "capitalization" of GOS land for property or nearby land value enhancement. This is in line with the results of [Franco and Macdonald \(2018\)](#), who showed a strategic role in the urban economy of developing countries,

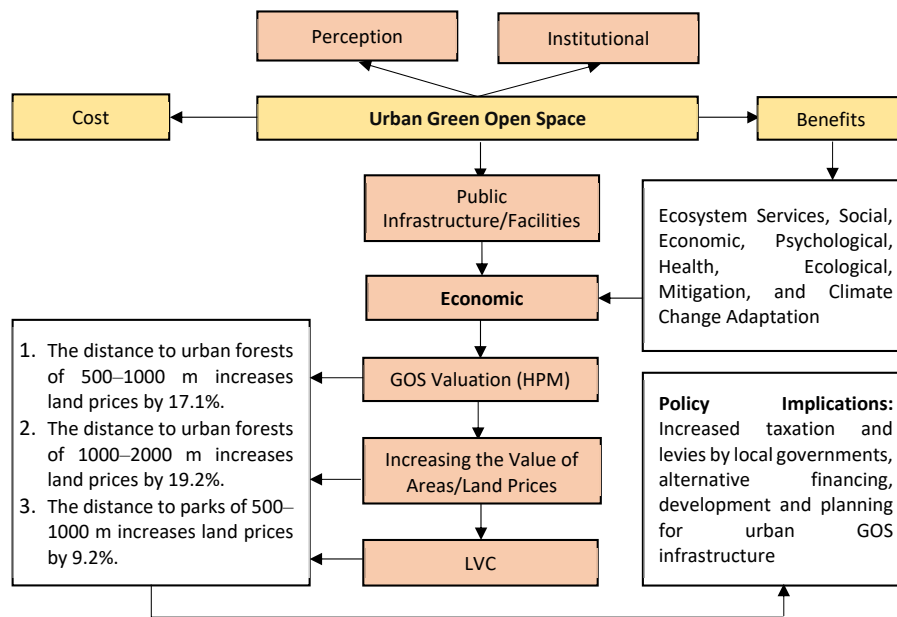


Fig. 5: Policy implications of the urban GOS valuation

particularly in Jakarta. The policy implications must investigate the importance of considering the role and diversity of public preferences regarding development and financing policies, cultural factors, and perceptions (Fig. 5).

The results of this study contribute to understanding urban forests and parks in Jakarta, which have significant impacts on land prices. This work examined the need to consider GOS in land value assessments and urban planning. The implications herein are extended to land use planning and public investments in green spaces, specifically in densely populated areas. Introducing the HPM into the development planning framework can significantly investigate urban planning. This work also acknowledged several limitations, including the limited representation of urban GOS in the Thousand Islands Regency, the sole consideration of land value in the HPM model, and the limited scope of the GOS variables. The generalization of findings to a broader population and other regions was conducted with caution. Future studies must prioritize the development of an exhaustive HPM for Jakarta, including a broader spectrum of the variable factors. This study suggests the need for further investigations to scrutinize nuances within the GOS categories and sizes, elucidating the drivers of positive externalities.

CONCLUSION

This study was conducted as a pioneering effort to use the HPM for the public GOS valuation in Indonesia, consequently establishing a novel and distinctive contribution to the field of urban economics and environmental valuation. The applicability of the HPM model was depicted in Jakarta's mature and privatized land market. The GOS development was found to hold a significant potential in addressing different issues, including environmental justice, public health, and aesthetic and increased land values. GOS effectively enhance climate resilience by providing habitats for biodiversity and supporting the physical and mental well-being of the community through recreational and sports facilities. The concept also creates important externalities in policy design to ensure sufficient presence in urban environments. This study offers valuable insights into the measurement of the benefits of GOS and examines interesting implications, including increased tax revenues for local governments based on specific GOS categories. Effectively developing GOS requires creative thinking to meet the needs of areas with a limited land availability. Moreover, GOS development requires an understanding of how distribution and functionality provide meaning and economic value. Cultural ecosystem services are becoming increasingly important in urban areas facing

population growth and challenges. The presence of parks and urban forests increases the land prices by 17.1 and 19.2%, respectively, while cemeteries decrease the variable by -37.6 to -15%. These findings provide policymakers and property developers with valuable information on land transactions and conversion, property development, conservation, and ecologically sound green space network designs. As regards the policy implications suggested, public GOS, such as urban forests and parks, enhance the property values and increase the local tax revenue. Jakarta and other major cities have explored alternative financing through LVC mechanisms to finance the development of urban forests and parks. The land value rate increase can be used as a reference to determine the LVC mechanisms (e.g., imposition of a Beneficiary Zoning Levy), depicting values of 9.2, 17.1, and 19.2% within the affected value area of 500–2000 m. This study did not find statistically significant relationships between the presence of GOS within the 0–500 m radius and land prices in Jakarta, setting it apart from the majority of HPM studies found in the literature, which used Global North countries as their study areas. The analysis of the housing structure variables showed that access to clean water from a public water utility positively influences land prices. Shopping centers, location of the respondents' residences, public high schools, roads within a distance fewer than 200 m, and proximity to CBDs were found to have significant positive coefficients on land prices. By contrast, population density showed a significant negative effect. The presence of urban forests and parks positively affects the land prices in Jakarta, indicating that residents highly value direct access to green spaces. Conversely, the presence of cemeteries negatively affects land prices, suggesting that the setup is an undesirable facility for land buyers. These results confirmed the importance of considering environmental factors and GOS in land transactions and conversion, property development, conservation, and urban green space design, providing policymakers, property developers, and land use planners with valuable information. Valuing green spaces prevents undervaluation and enhances one's understanding of their benefits, which leads to informed decisions on land use planning and public investment in green spaces. Further studies could explore the sizes of green spaces, social functions, and ecosystem services to deepen understanding on the value of GOS and

provide a more comprehensive perspective on planning and management. Larger-scale studies that include a wider range of regions must be conducted to obtain significant relationships in the valuation model using the HPM approach.

AUTHOR CONTRIBUTIONS

R. Setiowati conducted all the experiments, wrote the manuscript, and was the corresponding author. R.H. Koestoer as the corresponding author, participated in the interpretation of the results and revised the manuscript, and R.D. Andajani revised the manuscript.

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CONFLICT OF INTEREST

The authors declare that there are no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy, were observed by the authors.

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ABBREVIATIONS	DEFINITION
%	Percent
CBD	Central business district
COVID-19	Corona virus disease 2019
D	Durbin-watson
DW	Durbin-watson Table
GI	Green infrastructure
GIS	Geographic information systems
GOS	Green open space
ha	Hectare
HPM	Hedonic pricing method
IT	Information technology
JCCG	Jakarta capital city government
km	Kilometers
km ²	Kilometer square
LVC	Land value captured
m	Meter
m ²	Meter square
OLS	Ordinary least squares
people/km ²	People/ square kilometer
R ²	R-squared
RP	Revealed preference
Rp	Rupiah
SD	Standard deviation
SP	Stated preference
SPSS	Statistical package for the social sciences
VIF	Variance inflation factor

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