USING GIS TO ANALYZE FACTORS AFFECTING THE APARTMENT PRICE. CASE STUDY: NEIGHBORHOOD OF HO CHI MINH METRO (LINE 1)

Nguyen Thi Cam Tien[1], Luu Dinh Hiep[2] and Le Thi Dung[2]

[1]Center for Developing Information Technology And Geographic Information System, Ho Chi Minh City University of Technology, 268 Ly Thuong Kiet Street, District 10, Ho Chi Minh City, Viet Nam
Email: tienntc.hcmut@gmail.com
[2]Faculty of Environment and Natural Resources, Ho Chi Minh City University of Technology, 268 Ly Thuong Kiet Street, District 10, Ho Chi Minh City, Viet Nam
Email: hiepld_gis@hcmut.edu.vn
3Faculty of Environment and Natural Resources, Ho Chi Minh City University of Technology, 268 Ly Thuong Kiet Street, District 10, Ho Chi Minh City, Viet Nam
Email: dzungle1105@gmail.com

ABSTRACT

This study will explore the affecting price of the apartment where the research scope covers a 20km radius from Metro line 1. The data collected includes information about 300 units of apartments from Biggee.vn website and the local authority. The six variables are discovered to be affecting the apartment price after screening and standardizing the data with ArcGIS Pro. The price maps generated as a result of this study are used to visualize the unit price distribution of apartments in HCMC and the surrounding area. It will also assist property managers and home buyers in making informed decisions regarding apartment investments.

1. INTRODUCTION

Along with urbanization sprawl, Ho Chi Minh City (HCMC) land fund is becoming increasingly scarce. As a result of rising overpopulation, the HCMC Government forces have developed a population mechanism of control as well as new policies for expanding regional planning. That is why, in recent years, HCMC has increased its investment in infrastructure, particularly Metro line 1. It is expected to lower the pressure of overcrowding by resolving travel demand. This is because travel time can be shortened; for example, getting into the heart of HCMC takes only about 10-15 minutes. However, the real estate value surrounding this construction has become unpredictable. This results in exorbitant prices and an unstable investment trend. Besides that, the majority of new apartment projects evaluation is still subjective and imposing. It depends on appraise experience and knowledge or even the appraiser's priority. Because of that, the real value of the real estate is a public concern. Therefore, understanding the factors affecting the apartment price is critical. This helps the market to develop and be stable. This topic will focus in-depth on the impact of location, properties of apartments, and construction projects on the prices of surrounding apartments by using GIS.

2. METHODOLOGY

2.1 Research objectives and methods

The research objective is to study the determinants of the apartment price and apply it to the real estate market in the neighborhood of HCMC Metro line 1. In this topic, the linear

regression integrated GIS method is used. Specifically, determining the impact of factors like the population density of the region, distance to the CBD, and Metro line together with project scale (construction area and the highest floor). Considering entire model, which is the most dominant contribution to the price of an apartment. Finally, quantifies in detail how the modeled proxies affect the regional price market that contributes to consolidating knowledge about the real estate market in this market. In other words, the given findings could be used as preparation for investors, planners, or accommodation developers.
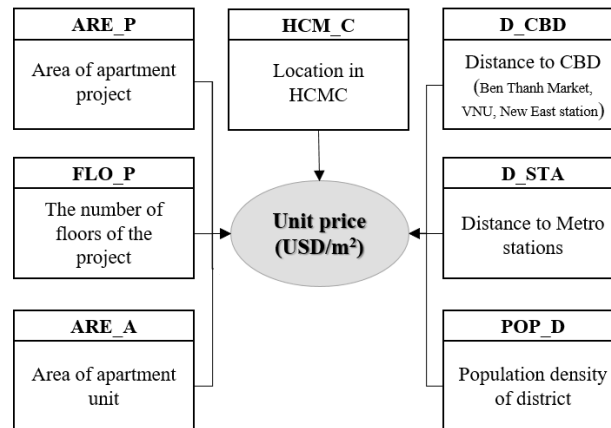

Figure 1. Research model

     The dependent variable is the average sale price of the apartment in a project measured in USD/m^2. This price is the market price that has been collected and surveyed from many sources by the Biggee.vn website during August 2020. The data collection process takes about one month, so macro-factors will have very little impact on the research model because the real estate market has not fluctuated much. The topic uses the Logarithmic model and the logarithm form of apartment price variable (LnPRICE) as the dependent variable. When the PRICE variable is expressed as logarithms, the coefficients which be explained as the percentage shift in price resulting from an additional unit of the independent variable (Seo et al., 2018).

2.2 Data procedure

     In this topic, 300 apartment projects in the vicinity of Ben Thanh – Suoi Tien Metro were surveyed and selected as a sampling population for the model. Data samples were collected in the research scope, commercial apartment projects located within 20 km of Metro lines

Table 1. Table of collected data description.

No.	Fields	Code	Unit	Description
A	**Variables**			
01	Price of the apartment (Dependent)	PRICE	USD/ m^2	The average price per unit of an apartment
02	The number of the floor of the project	FLO_P	floor	The highest floor in the apartment project
03	Area of project	ARE_P	m^2	The total area of the apartment project
04	Apartment unit area	ARE_A	m^2	Average apartment unit area or size
05	Location in HCMC	HCMC	dummy	Apartment project in HCMC
06	Distance to CBD	D_CBD	km	Distance to the nearest CBD point (Ben Thanh Market, VNU, New East station)

No.	Fields	Code	Unit	Description
07	Distance to Metro stations	D_STA	km	Distance to the nearest station of Ben Thanh - Suoi Tien metro line
08	Population density	POP_D	Per/km^2	Population density of district where apartment located
B	**Other information**			
09	Province		Text	Name of the province which apartment located
10	District		Text	Name of the district in which apartment located
11	Name of the project		Text	Name of the apartment project
12	X, Y		Double	The coordinate system of the apartment project

Following data collection, the project area was found that is the most heterogeneous variable. Therefore, the author group removes about 4% of the data sample in which four observations have the largest project area and eight ones have the smallest area, and 2.6% of apartment units having less than 45m^2 in size (8 observations). Elimination aims to optimize sample consistency and expect to limit bias in the regression process that could be caused by outliers. Finally, the size of the final sample is 280 observations.

3. FINDINGS AND DISCUSSION

As result from Table 2, it can be seen that the popular price ranges from 1,000–2,000 (USD/m^2), in which the most traded price is ~1,300 (USD/m^2). From the map, it can be seen that the prices of apartments in HCMC are very high (> 2,000 USD/m^2). And the crowd density is high surrounding Ben Thanh Market. Meanwhile, projects with lower prices have scattered distribution and been located in the neighborhood areas (10km away from the metro).

Table 2. Descriptive statistical table of 280 observations.

Variables	Unit	Min	Max	Mean	Median	Mode	Std
PRICE	USD/m^2	487.57	3,840.61	**1,646.93**	1,568.00	1,329.82	545.32
ARE_P	m^2	2,400.00	685,000.00	**41,064.51**	14,577.50	50,000.00	89,437.84
FLO_P	floor	5	50	**22.70**	22	18	7.41
ARE_A	m^2	45	167.85	**76.38**	70.50	60.00	21.61
HCMC	dummy	0	1	**0.85**	1	1	0.36
D_CBD	Km	0.81	17.56	**6.11**	5.81	-	2.85
D_STA	km	0.11	18.27	**4.81**	4.56	-	3.40
POP_D	Per/km^2	1,928.00	42,041.00	**14,259.16**	9,787.00	9,787.00	11,957.67

Out of 280 samples observed, the project has the smallest area of 0.24ha, and the largest area is 68.5ha. The average area of the project's sample is concentrated from 0.24 – 2.4ha.

These figures reveal a wide range gap of project area between the top and bottom points. Figure 2b shows that projects with size less than <2.4 ha account for most of the number of projects. Besides that, the project has the lowest floor of 5, the highest one is 50, the number of built popular floors is 20. The distribution of these apartments is broad across the research areas. For the project group with the number of floors above 32, it is found that clustered at the starting of the Metro line, district 2, and district 4 (HCMC). However, the Thuan An market (Binh Duong) is prominent with the appearance of many high-rise projects recently (Figure 2c).

Area of the apartment surveyed has ranged from 45 – 167.85m². Most of the area of the apartment is concentrated in the range of 55 - 75m². The popular area commonly chosen to buy an apartment is about 60m². There are 236 projects located in HCMC, accounting for 84.3% of the sample. The distance from 280 apartments to commercial and educational centers ranges from 0.81 - 17km, with an average distance of 6km. The shortest distance measured from the apartment to the nearest Metro station is 0.1km, and the furthest is 18km. It shows that within 1-5km around the metro line there is a high concentration of apartment projects (Figure 2d).
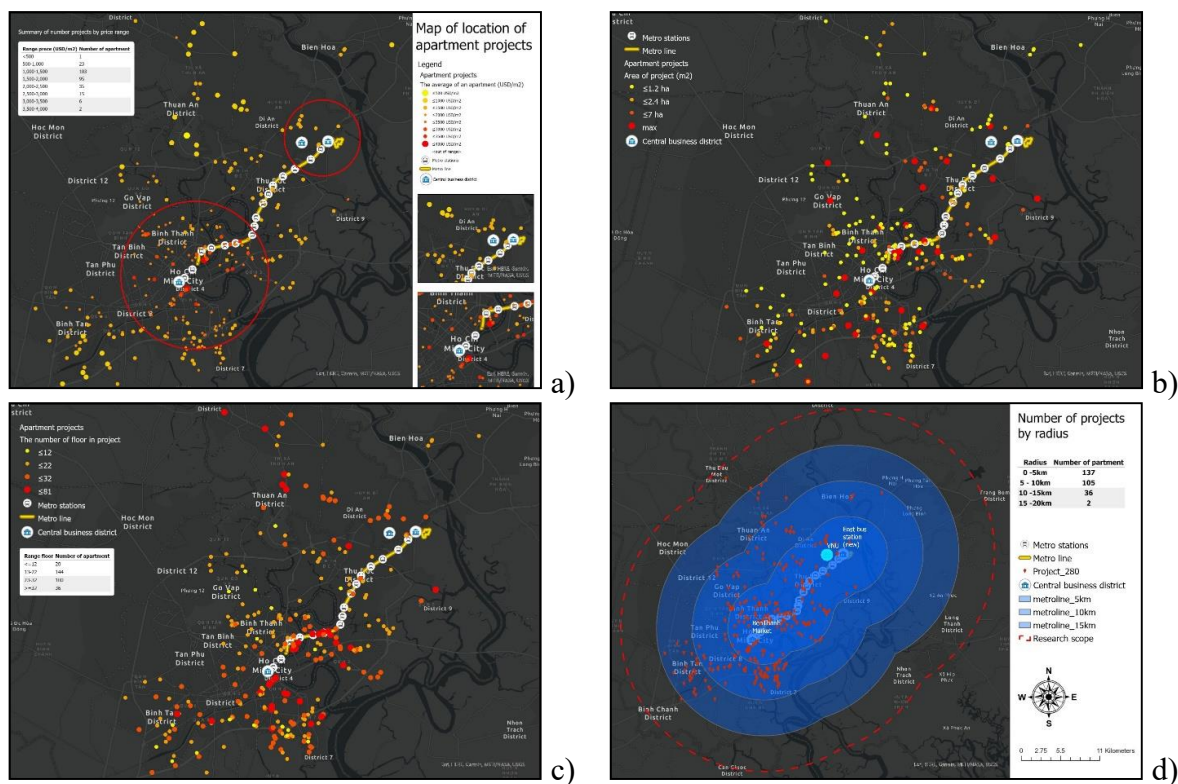

Figure 2. (a) Location of apartment projects by price, (b) Location of apartment projects by area of construction, (c) Location of apartment projects by the number of floors, (d) The apartment density by radius from Metro line 1

To explore possible combinations between the independent variables, the author will use the Exploratory Regression method. After analyzing, the variables HCMC, FLO_P, and ARE_A affect the price most, followed by POP_D, D_CBD, D_STA, and finally ARE_P. The group of project scale, the number floor of the project will have the biggest impact on the price of apartments. Meanwhile, the group explains the location factor, the project in HCMC will greatly affect the price. And finally, the area factor reflects the price. The remaining proxies of the location feature, also showing a huge effect on the price, > 80% as well. In contrast, a proxy represented the project size is the project area that exhibited a little effect (<20%). The model results show that with the seven variables, via the OLS regression, the proposed regression

models could be achieved a maximum of 61%. Data of 280 apartments were run OLS tool using ArcGIS Pro software, and gave the following results:

$$Ln(PRICE) = 4.607 - 0.023 * Ln(ARE\_P) + 0.396 * Ln(FLO\_P) +$$
$$0.207 * Ln(ARE\_A) + 0.285 * HCM\_C - 0.032 * D\_STA + 0.085 * Ln(POP\_D)$$
(1)

By IDW approach and mapping predicted metrics of each apartment resulted from OLS, the following maps are formed as Figure 3. The estimated zones having the highest price of the apartment are District 1,2 and Binh Thanh District, specifically the area surrounding Ba Son, Van Thanh, and Tan Cang stations of the Metro line. District 1, District 2, District 4, and Binh Thanh District (>2500 USD/m^2) are the zones with highly anticipated prices. Noticeably, house prices in District 9 and Thu Duc, part of Thuan An Town and Di An city, Bien Hoa city also reached 1,500 USD/m^2. The price of apartments along the Metro line is also estimated to be very high, ranging from 1,500 USD/m^2 to 3,000 USD/m^2, gradually decreasing from Ben Thanh Market to Suoi Tien Terminal station. Besides, there is a clear difference between HCMC and neighboring provinces for the level of the apartment price or the market preference.
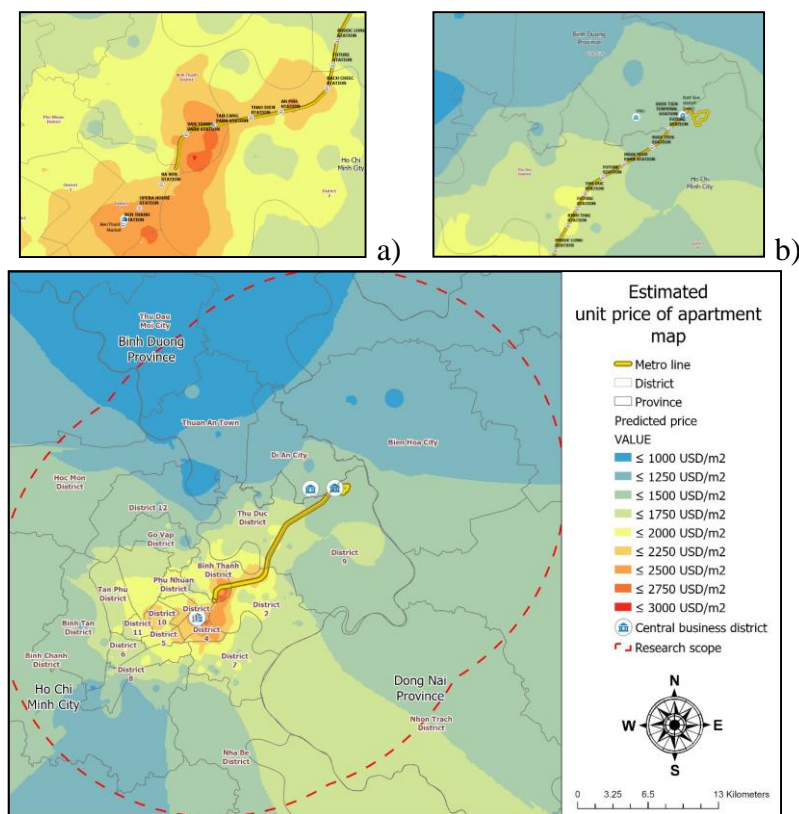

Figure 3. Estimated pricing map of apartments in HCMC and the neighborhood (a) Zone near the start point of Metro line 1, (b) Zone near the endpoint of Metro line 1

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the inheritance of the results of previous studies, the author has built a price regression function. By this quantitative method, six factors have been identified that impact apartment prices in the scope within a 20km radius from Metro line 1. With only six

explanatory variables, the model can contribute 61% to the estimate of prices. Specifically, apartment prices will increase by 1 USD/m^2 when there is a 1-unit increase by one factor in the multi-factors such as high-rise buildings, apartment area, or population density. Meanwhile, with the apartment product title "location in HCMC", the price can increase up to 28.5%. Also, the distance to the Metro stations or the CBD will reduce the price of the apartment, when more than 1km away from Metro, the apartment can reduce 3.2% of the value.

The location in HCMC has the most impact on the price of an apartment in the study area. The real estate located in HCMC will be higher than the rest of the area. Because HCMC is the largest economic hub in the country, owning an apartment in this area gives buyers more opportunities to access the education system, well-paid jobs, public facilities, and social benefits that this area brings. Besides, the location of the apartment compared to the Metro line 1 will affect the apartment price here. This is because it will save travel time, especially with large-scale transportation systems such as Metro will greatly aid in accessing other transport networks, or inter-regional trade connections (Binh Duong - Dong Nai - HCMC). Currently, the number of projects around this metro line is growing more and more, which also explains the rapid increase in house prices in this area. The size of the project has a strong impact on apartment prices. In particular, the projects have more height, the apartment price is higher. The area of the apartment has the strongest impact on the price. This is also keeping in line with reality because the size is an important factor forming the value of the real estate, following the ancient idiom "golden square". Real estate prices will be high for real estate with large acreage due to meeting the diverse uses of owners or in other words maximizing usability by optimizing use purposes.

Through the application of the pricing model to determine the factors affecting apartment prices in the study area, partly understand the factors that affect apartment prices, which is the most important one. Thereby, this helping market participants will estimate transaction prices by relying on strong factors such as apartment area, the number of floors of the project, distance to the nearest Metro station, position, and population density of the area in which the apartment is located.

5.2 Recommendations

In the process of reviewing previous studies, the author found has only collected a small piece of factors, there are still many variables that also have an impact on apartment prices as such as building quality; the interior of the apartment, internal utilities of the project or information about the developers and owners as well as macroeconomic change (interest, government policies, …) and so on. However, the datasets cannot meet this expectation because of difficulties in the process of collecting information and data about apartments. The other limitation is that the author does not re-examine the model and compare research results with previous studies in detail and reality data. These obstacles were recommended to solve in the next research.

6. REFERENCES

Aladwan, Z., & Ahamad, M. S. S. (2019). Hedonic Pricing Model for Real Property Valuation via GIS - A Review. *Civil and Environmental Engineering Reports*, 29(3), 34-47. doi:10.2478/ceer-2019-0022

Seo, D., Chung, Y., & Kwon, Y. (2018). Price Determinants of Affordable Apartments in Vietnam: Toward the Public–Private Partnerships for Sustainable Housing Development. Sustainability, 10(1). doi:10.3390/su10010197