

Calculating Land Price in Ho Chi Minh City- A Case Study in Tan Phu Area

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Abstract—Land price is a very important information to many fields and objects. Ho Chi Minh City where has a very complex process of urban development so land price is extremely necessary to invest and manage and Tan Phu area is considered a typical case study. Besides, the development of GIS technology and its application have promoted many strengths in land management including land price. Aiming to manage land price and real estate market effectively, the study had successfully defined a formula for calculating the intermediate value between the state land price and the market land price, and this intermediate land price was calculated with a set of weight values of indicators that impacted to land price in the study area by AHP. From that, we had defined the distances between the market and state land price as well as setting a tool for calculating the intermediate land price on Web base for study area by using integration of GIS and WebGIS. The results showed that the land price calculator has the ability to calculate exactly intermediate land price, which is quite closely to the market price (up to 91,79%). Moreover, these results have also met the requirements of looking up and managing land price of officials and citizens. Thereby, it can be seen that the application of GIS techniques in general and the Hierarchical Analysis Process (AHP) method in particular bring better results than the previous manual methods.

Index Terms—Land price, land price calculation formula, land price calculation tool, WebGIS.

I. INTRODUCTION

Information has played a very important role to many fields and objects which are related in our society, the differences of State land price and the market land price always create many challenges as well as make strong impacts on many aspects of life and socio-economic in Ho Chi Minh City. Tan Phu area is a very strong urbanization region of Ho Chi Minh city where is received a lot of interests to develop from both

enterprises and Governmental sectors with the large-scale policies of planning and investment in local and neighbouring areas. According to Thanh Tran Thi Ngoc (2009), those above reasons have had land price always fluctuated strongly. Due to that reason, identifying the interval value between State land price and the market land price is very importance. In addition, the current real estate market develops very fast and lacks transparency; at the same time, the incomplete land information system has not fully promoted its potential in management and utilization. Therefore, in order to maintain the accuracy and trustfulness of land price information when getting them live on Website for the need of officials and citizens, building a tool for calculating the intermediate land price as well as building a land price database for the study area becomes extremely necessary. Nowadays, the development of applying GIS technology has brought many strengths in land and real estate management, including the issues of land price. In order to manage land price well, it is necessary to have a tool which helps calculating and looking up land price effectively, as well as clarifying information, minimizing negative impacts and supporting effectively the management of real estate market (Toan Le Nguyen, 2013).

The study was carried out to find out the intermediate price between the market land price and State land price. From that, the study also built a formula and a tool for calculating this intermediate land price on Web-based to support effectively the management of land price and real estate market in Tan Phu area. In the new context, administrative merger mechanism, transforming the three-tiered into a two-tiered system government affected a lot of fields and factors. Moreover, this is the premise to successfully build E-government and smart city with the general trend of

nation and world in the context of The Fourth Industrial Revolution is booming strongly now

II. METHODOLOGY

The basis of estimating the intermediate land price is based on the results of building the State land price map in 2018 of Tan Phu District (Duy Nguyen Thanh, 2018). Accordingly, this map was built in accordance with the regulation of the Ministry of Natural Resources and Environment on land price data standard (include in spatial data and attribute data). In addition, the sources of input data included in: (1) The State land prices in Tan Phu area which were stipulated by the People's Committee of Ho Chi Minh City in Decision 51/2014/QĐ-UBND and Decision 30/2017/QĐ-UBND; and (2) Some market land prices have been referenced from reliable sources such as: land prices were posted on the reputable websites as well as surveying and interviewing experts, officials and residents in locality. This is the basis for estimating the intermediate land price accurately and bringing this land price closer to the market price; on the other hand, contributes to increase the reliability of the tool in the process of calculating land price. Thus, the input data sources to build a WebGIS system to manage and look up land price information are completely reliable and complies with the current regulations on land price data standards. Therefore, this system is completely suitable for the requirements and can connect with other systems which belong to the current e-government model.

During the implementation process, research has used many methods: Documents and data collection; Field investigation; experts' interview; Analysis, statistics and synthesis; Integrating of GIS and WebGIS; and Analytic Hierarchy Process Group Decision Making (AHP-GDM). In which, two main methods are as below:

Method of integrating GIS and WebGIS: Applying MicroStation SE, AutoCad, ArcGIS 10.5, Google Map, PostgreSQL, Bootstrap and JavaScript programming language to build land price database and tool to calculate land price on Web-base.

The Method for Analytic Hierarchy Process Group Decision Making (AHP-GDM): is used in environment of group decision to calculate the weight

of factors that affect to land price (Vinh Tran Thi Thanh, 2013).

III. RESULTS AND DISCUSSION

3.1. Applying AHP-GDM to calculate the effected weights

Identify the factors which affect to land price: Including 4 main elements, each element can have many small constituents (Hung Tran Thanh, 2012):

Land parcel: frontage width (CRMT), legal, business capacity (KNKD), current land use (SDĐ_HT), planning land use (SDĐ_QH);

Transportation: Among the current criterias in calculating land price (according to the regulations of the Ministry of Natural Resources and Environment), transportation is chosen as a special criterion because it involves in many important factors which determine the value of land parcels and properties on land. Therefore, this criterion is often analyzed independently and separated from the infrastructure criteria. These criteria include in: planning the boundaries of roadway, road cover, flooding, hierarchy of urban roads (PC_ĐĐT) including: trading and service (TMDV), center (TT) and other roads;

Distance to the center of infrastructure (KC_CSHT): it is the distance that people in an area move to the center of that area. This information is the divergent variable. It is different for each parcel and is only available when the user selects or clicks on the parcel on the website. At this time, the system will automatically measure the distance to the center of the respective area, and then it will refer to the ranges of values which are divided as follows: below 300m, 300m-500m, 500m-1000m, over 1000m;

Urban subdivision (PKĐT)

Getting the information of parallel comparison from the expert: According to chosen elements, we can design the questionnaire by following-up with a parallel comparison of the experts who have a decade of knowledge about locality's characteristic or in real estate industry such as real estate agent, senior real estate specialist, local residents (10-15 years of appearances), and local officials.

Table 1. Results of expert's evaluation on the level 1 element

i	j	1	2	3	4	5	6	7	8	9	10
Parcel	Transportation	2	4	1/6	5	2	4	3	7	2	1/4
	Distance to infrastructure center	1/5	1/4	4	6	3	2	3	5	1/4	5
	Urban subdivision	3	1/3	6	4	8	3	5	3	1/6	6
Transportation	Distance to infrastructure center	1/6	2	2	1/7	1/2	5	4	1/4	3	3
	Urban subdivision	4	5	3	2	7	4	6	1/2	2	1/4
Distance to infrastructure center	Urban subdivision	7	9	2	3	1/6	3	1/2	3	2	5

Table 2. Results of expert's evaluation on the level 2 element of parcel

i	j	1	2	3	4	5	6	7	8	9	10
Frontage width	Legal	2	3	2	3	1/6	2	4	4	2	3
	Business capacity	1/6	2	4	1/4	5	4	3	3	3	1/3
	Current land use	1/5	1/4	1/3	2	2	3	2	1/6	3	2
	Planning land use	1/2	1/3	1/7	2	1/6	1/3	1/5	1/4	1/3	1/7
Legal	Business capacity	1/7	2	1/5	1/2	1/5	2	1/4	2	1/2	1/6
	Current land use	1/3	3	1/2	1/6	1/3	4	1/3	3	1/5	1/7
	Planning land use	3	1/5	2	1/2	1/4	1/4	1/2	1/5	1/3	1/2
Business capacity	Current land use	2	2	1/3	3	2	1/2	3	5	4	2
	Planning land use	1/2	1/2	2	4	4	1/4	1/4	3	2	3
Current land use	Planning land use	2	3	4	1/2	1/5	4	4	3	2	1/3

Table 3. Results of expert's evaluation on the level 2 element of transportation

Comparison		Evaluation result of each expert									
i	j	1	2	3	4	5	6	7	8	9	10
Boundaries of roadway	Road cover	2	1/4	5	1/2	4	7	3	1/5	4	5
	Flooding	3	5	1/4	3	3	3	5	1/2	2	5
	Hierarchy of urban roads	5	1/2	2	4	2	5	2	6	3	4
Road cover	Flooding	4	1/3	7	2	2	3	1/5	1/3	1/4	1/3
	Hierarchy of urban roads	3	6	5	2	1/3	2	3	2	5	6
Flooding	Hierarchy of urban roads	1/3	5	2	3	4	1/7	5	4	3	7

Table 4. Results of expert's evaluation on the level 3 element

Comparison		Evaluation result of each expert									
i	j	1	2	3	4	5	6	7	8	9	10
Trading and service	District center	5	2	7	2	1/5	3	4	6	4	3
Trading and service	Other roads	7	5	6	6	2	4	5	4	6	4
District center	Other roads	2	4	6	4	4	6	2	3	2	2

Decentralize affected factors to land price into 3 levels (1,2,3) to calculate the global weight by hierarchical

tree with total weight-W is the multiplication of component weight.

Table 5. The weight of affected factors to land price

Level 1 Factor	W1	Level 2 Factor	W2	Level 3 Factor	W3	TSTC-W
Parcel	0.3841	Frontage width	0.3297	–	–	0.071
		Legal	0.1550	–	–	0.042
		Business capacity	0.2214	–	–	0.093
		Current land use	0.1970	–	–	0.081
		Planning land use	0.0959	–	–	0.095
Transportation	0.2490	Roadway	0.4152	–	–	0.102

		Road cover	0.2464	–	–	0.061
		Flooding	0.2283	–	–	0.056
		Urban subdivision	0.1121	Trading and service	0.6159	0.017
				District center	0.2771	0.007
				Other roads	0.1070	0.003
Distance to infrastructure center	0.2448	–	–	–	–	0.244
Urban subdivision	0.1221	–	–	–	–	0.122
Total						1.000

Calculate weights by using AHP-GDM and assign values to each level, then calculate the coefficient for

each parcel by multiplying the weight with the assigned value in Table 6

Table 6: Decentralize the factors and assigned values

Criteria	Hierarchy	TSTC-W (%)	Assigned Value
Frontage width	$\geq 3\text{m}$	7.13	1
	$< 3\text{m}$	–	0
Legal	Enough	–	2
	Not enough	4.23	1
	None	–	0
Business capacity	Very convenient	–	3
	Convenient	9.37	2
	Less convenient	–	1
	Inconvenient	–	0
Current land use	Residential land	–	1
	Non-residential land	8.13	0
	Mixed land	–	2
Planning land use	Residential land	–	1
	Other land	9.54	0
Roadway	$> 20\text{m}$	–	2
	$\leq 20\text{m}$	10.29	1
	$\leq 7\text{m}$	–	0
Road cover	Asphalt	6.13	2
	Concrete	–	1
	Gravel, soil, stone	–	0
Flooding	Non-flooded	5.69	1
	Flooded	–	0
Trading and service	Belong to commercial-service road	1.72	1
	Not belong to commercial-service road	–	0
District center	Belong to the central road	0.77	1
	Not belong to central road	–	0
Other roads	Belong to another road	0.30	1

Criteria	Hierarchy	TSTC-W (%)	Assigned Value
	Belong to commercial-service or central road	–	0
Distance to infrastructure center	≤ 300m	–	3
	300–500m	24.48	2
	500–1000m	–	1
	≥ 1000m	–	0
Urban subdivision	Central area	12.21	2
	Urban district	–	1
	Suburban district	–	0

3.2. Building formula to calculate land price

Identify the coefficient of difference between state and market land price (K_i). The survey results of 25 streets in Tan Phu District showed that the difference between these two types of prices in local area was not according to general regulations. The State land price have low differences and relatively equal among areas, while the market land price fluctuates strongly along the route due to the influence of the surrounding positioning poles. This fact showed that the State land price was listed in 2014 remains many unreasonable points.

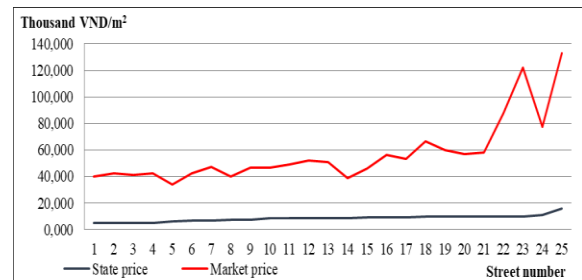


Chart 1. The difference between State land price and market land price

Zoning land value in the case study area into 3 sub-regions (corresponding to 3 regions of value: ≥ 80 , $50 - 80$ and < 50) to calculate the reliability of the data set (unit of million VND).

Table 7. Results of calculating the reliability of areas Unit: million VND/m²

Sub-Area	Standard Deviation	Error Range	Lower Bound	Upper Bound	Difference Coefficient K_i (times)
1	22.9127815	11.5954673	102.6711994	125.8621340	10.0492
2	7.8369880	2.9561289	56.4142414	62.3264993	6.2810
3	5.0252225	1.7690110	41.4245374	44.9625593	6.1713

Building formula to calculate land price

According to Phe Hoang Huu and Patrick Wakely (2000), land price changes according to two trends: global and local. Global change will be associated with current state of the economy, the position of the whole region or inflation; land price increase or decrease depends on the financial capacity to invest into the real estate market, investors' expectations or the money devaluation. In contrast, the local change is due to the change of one of the positional factors that constitute the land price of each land value region. Accordingly, among the four main groups of positional factors that constitute the land price (land parcel, transportation,

distance to the center of infrastructure and urban subdivision), factor distance to the center of infrastructure and factor urban subdivision are usually stable because these two factors are associated with planning projects and economic development of the Government. Therefore, the change of land price will depend on the other two groups of factors, so the formula to calculate land price is determined as follows (Duy Nguyen Thanh, 2018):

$$P = P_{NN} * (1 + H)$$

$$\text{With: } H = H_{TB} * K_i + H_{GT} * K_i + H_{KC_CSHT} + H_{PKBT}$$

In which:

- P_{NN} : is the State land price

- H : is the total coefficient which is create by the weights multiply with the assigned value of factors
- H_{TD} : is the coefficient of land parcel group
- H_{GT} : is the coefficient of transportation group
- H_{KC_CSHT} : is the coefficient of the group of distance to the infrastructure
- H_{PKDT} : is the coefficient of urban subdivision group

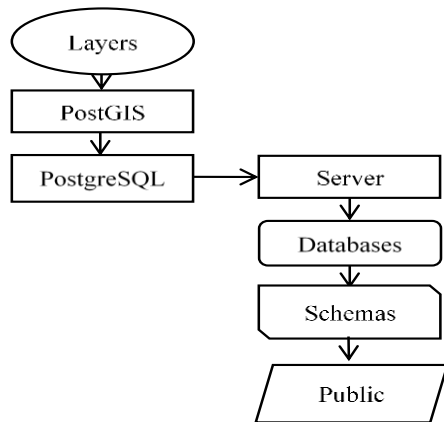


Diagram 1: Process to build database

- K_i : is the deviation coefficient between the State land price and the market land price for each region

3.3. Apply WebGIS in building tools to calculate land price

- Build database PostgreSQL/ PostGIS according to Diagram 1.
- Display map layers on Geoserver according to Diagram 2.

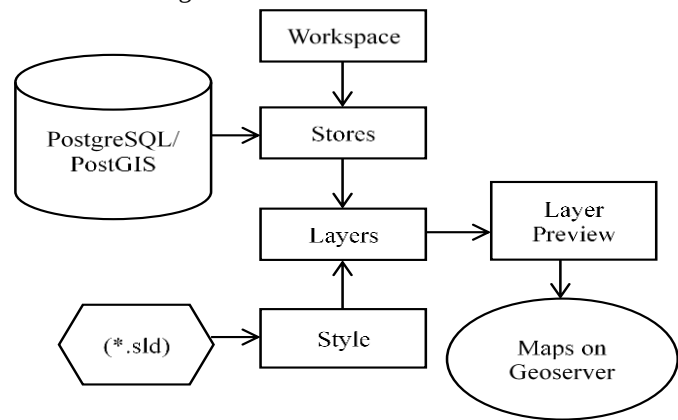


Diagram 2: Process to display maps on Geoserver

Building tool for calculating land price on Web base

- Interface of the website is displayed on Leaflet platform, with main function is calculating land price.
- Actions: click on each parcel on the map to display the interface of land price information and press button "*Tính*" ("*Calculate*") for system to calculate land price and show the results. The system will automatically get information from the map, then combine with the function that automatically calculates the frontage width and the distance to the center of infrastructure to add the formula and shows the results of land price.

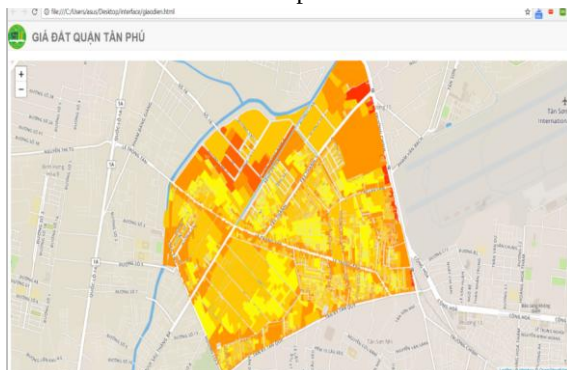


Figure 2. Interface to display parcel information

THÔNG TIN THỬA ĐẤT	
Tỉnh/Thành:	Hồ Chí Minh
Quận/Huyện:	Tân Phú
Phường/Xã:	Tây Thạnh
Số tờ:	185
Số thửa:	50
Diện tích:	163.7 m ²
Mã loại đất:	ODT
Chức năng hiện trạng:	Đất ở
Chức năng quy hoạch:	Đất ở
Bảng giá theo tuyến đường:	10000 (Nghìn đồng/m ²)
Giá đất Nhà nước:	11000 (Nghìn đồng/m ²)
Khu vực:	3

Figure 3. Interface to display the calculated result of land price

Test the tool's efficient and evaluate

According to the results of land price calculation on 25 streets that surveyed, the interval between market and calculated price is no longer as high as the State price (with the average difference is 91,79%). This is an appropriate price which ensures the interests of both State and citizens. This result showed that the appropriate level and the computability of the tool is quite high.

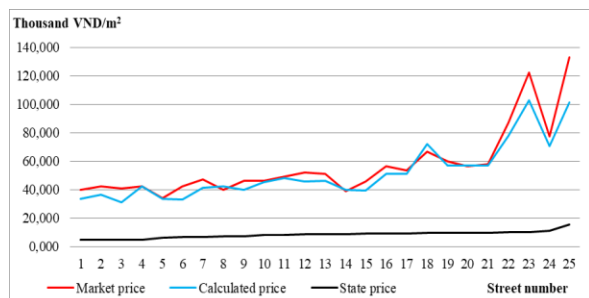


Chart 2. The difference between calculated price with market price and State price

IV. CONCLUSION

Tan Phu is an area where the urban development process has carried out quite complicated. So, land price always fluctuates strongly and brings many negative affects to the development process of real estate market. Therefore, an effective system to support calculating, searching and managing land price is very necessary.

The method of hierarchical analysis (AHP-GDM) in environment of group decision is an effective method for quantifying the relevant factors such as: economic and social, ... The research results have identified a set of weights and the affect values of the land price impact indicators in locality, which is the most important part in building the formula to calculate land price.

Nowadays, GIS and WebGIS are the popular technologies. They are the means to connect users with the specialized information which requires a lot of expertise knowledge. Applying WebGIS has helped the land price calculation formula to be more complete. It is possible to calculate the criteria which the normal way is difficult to collect. The study has successfully built a tool that has the ability to calculate exactly intermediate land price, which is quite closely to the market price (up to 91,79%). Moreover, the results have also met the requirements of looking up and managing land price of officials and citizens. Thereby, it can be seen that the application of GIS techniques in general and the Hierarchical Analysis Process (AHP) method in particular bring better results than the previous manual methods.

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