

## Article

# Effects of Urban Land-Use Planning on Housing Prices in Chiang Mai, Thailand

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**Abstract:** Chiang Mai is an emerging tourism-oriented city in Thailand. The booming tourism industry during the past decades has triggered significant expansion in its urban land area, resulting in a large number of newly-built residential communities appearing on unplanned land. In this study, we used multiscale geographically weighted regression (MGWR)-based hedonic price analysis to investigate 4624 housing transactions from 524 residential communities in Chiang Mai. This showed that the recent land-use planning in Chiang Mai has had unusual effects on housing prices; specifically, the effects of accessibility to hospitals, primary and secondary schools, green parks, and shopping malls could be ignored, demonstrating that local residents were well satisfied with land-use planning for high-quality medical and education sources and good living environments throughout the whole of Chiang Mai, and that no more land-use planning and investment on these facilities was needed. However, limited bus routes were only used for tourism and could not provide convenient routes for local residents, leading to their negative effects on housing prices in downtown areas, so the local government should lower the bus stop density in downtown areas and strengthen the transportation links between downtown areas and suburbs. Our study will not only support the urban land planning department of Chiang Mai to optimize residential communities and nearby facilities, but can also provide insights into housing price formation mechanisms in similar tourism-oriented cities in Thailand and beyond.



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**Keywords:** urban land planning; housing prices; neighborhood facilities; Chiang Mai

## 1. Introduction

Effective urban land planning can regulate the balance between supply and demand of urban land, determining the future land-use structure and development patterns of cities [1]. Compared with developed economies, the recent urbanization processes in emerging economies are severely constrained by the land carrying capacity, incomplete infrastructure, and simple economic structures. Urban housing is always the largest single expenditure for most local residents, so urban land-use planning should not focus only on triggering gentrification and urban commodification, it should benefit every resident, especially from the economically less favored urban groups. Well-planned land use can mitigate the imbalance of urban facilities and services, thereby playing a unique role in lowering and stabilizing housing transaction prices. Emerging economies urgently need to adopt reasonable land-use policies to optimize the internal structural features of residential communities and improve the fairness of accessibility to public facilities in order to achieve the healthy development of real estate markets.

Hedonic price analysis is a widely used economic approach for measuring the effect degrees of internal structural features and different accessibilities to various public facilities on housing prices, assuming that these public facilities are relatively independent and that the housing price is formed by residents' preferences on both internal structural features

and the accessibility degree to various urban facilities [2]. By modeling the formation mechanism of 626 median house prices of suburbs in Sydney, Australia, Abelson et al. [3] found that the distance from the Central Business District (CBD) and the coast was the most favorable factor explaining housing prices in Sydney. High housing prices mainly occurred in the eastern and northern suburbs close to the CBD and beaches of Sydney, and housing prices decreased as the distance to the CBD and the beach increased. Other favorable factors such as lot sizes, crime tendency, and public transport also had varying degrees of effect on housing prices. Yoo and Ready [4] used housing sales data in two counties in Pennsylvania, USA, to investigate the impact of farmland planning under an agricultural conservation easement contract. They found that protected farmland had different effects on property values in these two counties, and that there was spatial heterogeneity in the farmland effect on property values around the counties. Cao et al. [5] studied the spatial variation in resale prices in public housing in Singapore based on a dataset of smart card transactions. Their results identified that local land environmental features, including the distance to the nearest park, the distance to the CBD, and the distance to the nearest Mass Rapid Transport (MRT) station, could significantly affect public housing resale prices. Seo and Nam [6] examined the spatial pattern of subway accessibility on housing prices in Seoul, South Korea. They found that the preference of different economic classes for subway accessibility demonstrated spatial inconsistency. Families with relatively strong economic stability were more inclined to live away from the subway station for a more comfortable living environment, but middle-income families and those with less economic stability were more likely to seek convenient transportation in the neighborhoods. By mining the average housing prices of 13,160 residential communities in Shanghai, China, Gu et al. [7] studied the impacts of being able to walk to a hospital on housing prices. They found that proximity to small and medium-sized hospitals had an accessibility premium on housing prices, while proximity to large hospitals led to lower housing prices. Wen et al. [8] explored housing prices of 516 communities in Hangzhou, China, and found that the accessibility of primary schools significantly increased housing prices, while the accessibility of secondary schools had no effect on housing prices. Park et al. [9] explored the impacts of park accessibility on housing prices in Seoul, Korea, and found that the greater the ability to walk to a park, the higher the intrinsic value of the park in housing prices. Wang et al. [10] revealed the number of bus stops within a certain walking distance was positively correlated with housing prices in Cardiff, Wales, UK. Siripanich et al. [11] found that public transport services brought an increase in housing values, while being close to railways and gas stations did not. These results revealed the effects of land-use planning on housing prices in different cities, which can help and guide local government to undertake suitable land-use planning to mitigate negative effects originating from the imbalance distribution of urban facilities and services.

Chiang Mai is an emerging tourism-oriented city in the world. It has a beautiful natural environment and its land-use planning and policies have brought a low living cost and a high level of internationalization, attracting about 10 million foreign and domestic visitors for leisure and vacation every year, enabling Chiang Mai to experience a significant expansion of urban land area over the past decades [12,13]. Chiang Mai is not like many well-known tourism cities who face a dilemma that gentrification and massive tourism have triggered problems related to housing prices making them inaccessible for the local population. The booming tourism industry in Chiang Mai brings not only gentrification and commodification of urban unplanned land, but also provides employment opportunities and increases the incomes of local residents. At the same time, since Chiang Mai has abundant unplanned land sources and a very low population density, a large number of newly-built residential communities appearing on unplanned land during the past decades can mitigate the disruption effect of tourists for local residents. In order to avoid the appearance of socio-territorial exclusion or expulsion, land law in Thailand requires that foreigners are not allowed to purchase detached houses or occupy more than 49% of units in any apartment building, thereby ensuring local residents can afford residences at much

lower prices than foreigners. Local government has created a harmonious coexistence between local residents and short-term/long-term visitors, and their experiences will have great value for similar tourism cities in Thailand and other Asian countries.

Chiang Mai has a unique housing market formation mechanism, very different from well-known tourism cities. The effects of land planning on housing prices in Chiang Mai are still unknown. In this article, we conducted a study on land planning effects on housing prices in 524 communities across Chiang Mai, which covers almost all residences for sale in Chiang Mai. Due to the small size and similar internal structures inside any community in Chiang Mai, the residences in the same community generally have the same land environmental attributes or features, so we ignored the residential differences within the same community and explored the multiscale community-level effects of urban land planning (e.g., internal attributes and the accessibility to medical care, education, scenery, business, transport) on housing prices. This article was organized as follows: In Section 2, we give a brief introduction to the geography, environment, and economy of Chiang Mai. In Section 3, we describe how to use the MGWR-based hedonic price analysis to measure the effect degrees of internal structural features and different accessibilities to various public facilities on housing prices. In Section 4, we introduce the data source on housing transaction prices and urban infrastructure in Chiang Mai. In Section 5, we employ MGWR-based hedonic price analysis to mine all housing transaction data from 524 residential communities in Chiang Mai and explore multiscale effects of urban land planning in housing prices. Finally, in Sections 6 and 7, we give some discussion and conclusion. Our study will not only support the urban land planning department of Chiang Mai to optimize residential communities and nearby facilities, but also provides insights into housing price formation mechanisms in similar tourism-oriented cities in Thailand and beyond.

## 2. Study Area

Chiang Mai is located in the Chiang Mai Province in northern Thailand, and the whole city is surrounded by mountains. With suitable land-use planning and policy, rich history and culture, as well as beautiful scenery and pleasant climate, Chiang Mai is a highly regarded retirement destination, attracting many retirees from developed countries to settle, causing a boom in the local real estate market. As the second largest city in Thailand, Chiang Mai developed real estate relatively early, with residential areas and villas beginning to appear in the downtown area of Chiang Mai in the late 20th century. In the early 21st century, the civilized and livable urban land atmosphere made B&Bs and vacation homes popular investments, driving the development of resorts, villas, and serviced apartments. Since the 2010s, Chiang Mai's housing market has become more diversified, with commercial developments including shopping malls, hotels, and office buildings in addition to residential projects.

The main urban land area of Chiang Mai is shown in Figure 1. Most of the historic buildings are located in the ancient city. Due to the scarcity of land in the ancient city, there are no modern residential communities. Its downtown areas are located in the west and north of the ancient city, where Nimman Road is the most bustling area in Chiang Mai. The Maya center, Chiang Mai's famous shopping mall, is located in Nimman Road. The convenient commercial and living land environment has driven up housing prices, with the result that condominiums have become the main type of residence here. The northwest areas of Chiang Mai are mountainous, and there are almost no residences there. Chang Klan in the southeast of the ancient city owns Chiang Mai's night bazar and plenty of upscale hotels. Although Chang Klan lacks supermarkets and malls, it is not far from the main facilities in the ancient city and downtown areas. Hang Dong is in the south far away from the core areas of Chiang Mai, but it is home to most international schools. As suburbs with plenty of land, the main residence types in Hang Dong and Saraphi are detached houses. On the east bank of the Ping river is Chiang Mai's so-called new town. Most of the residential communities and infrastructure here are newly built.



**Figure 1.** Topography and urban areas of Chiang Mai.

### 3. Hedonic Price Analysis

Assuming that the housing price is formed by residents' preferences on both internal structural features and the accessibility degree to various urban facilities, hedonic price analysis is a widely used economic approach for measuring the effect degrees of land-use planning on housing prices and it reveals housing price formation mechanisms [2]. It takes internal structures and the accessibility to various facilities as explanatory variables and housing transaction prices as object variables. The original version of hedonic price analysis uses global multilinear regressions to establish the link between multiple explanatory variables and one object variable. Since embedding global regression into hedonic price analysis cannot capture spatial heterogeneity in land-use effects that are prevalent in the real estate markets, Brunson [14] introduced the geographically weighted regression (GWR) and embedded it to classic hedonic price analysis. Unlike invariant coefficients in global multiple regression, GWR allows regression coefficients to vary across space, thus providing a better capture of the spatial heterogeneity in the relationships between variables. Noticing that the closeness to some urban facilities always has a larger impact on the housing price, the GWR introduces a weight matrix to characterize the influence of neighboring facilities on housing price, where every entry in the weight matrix is generated by distance weighting or kernel function weighting. The GWR-based hedonic price analysis is formulated as

$$y_i = \beta_0(u_i, v_i) + \sum_j \beta_j(u_i, v_i)x_{ij} + \varepsilon_i,$$

where  $y_i$  is the housing transaction price at location  $i$  whose longitude and latitude are  $u_i$  and  $v_i$ , respectively;  $x_{ij}$  is the value of the  $j$ th explanatory variable  $x_j$  at location  $i$ , measuring the value of some internal structure feature (e.g., house age, furniture status) or the accessibility to some urban facility (e.g., hospital, school, park);  $\beta_j(u_i, v_i)$  is the regression coefficient of the explanatory variable  $x_j$ , reflecting local effect degree of the  $j$ th independent variable at location  $i$ ;  $\beta_0(u_i, v_i)$  is the intercept at location  $i$ , reflecting the location effect; and  $\varepsilon_i$  is the error.

As relationships between land-use attributes and housing transaction prices usually manifest at different spatial scales, Fotheringham et al. [15] relaxed the fixed bandwidth in GWR to multiple bandwidths and extend GWR into so-called multiscale geographically weighted regression (MGWR). MGWR dynamically adjusts the optimal bandwidth for each

independent variable to align with the spatial relationships at different scales. Compared to the GWR, the different bandwidth of independent variables in MGWR measures their scope of influence. The MGWR-based hedonic price analysis is formulated as

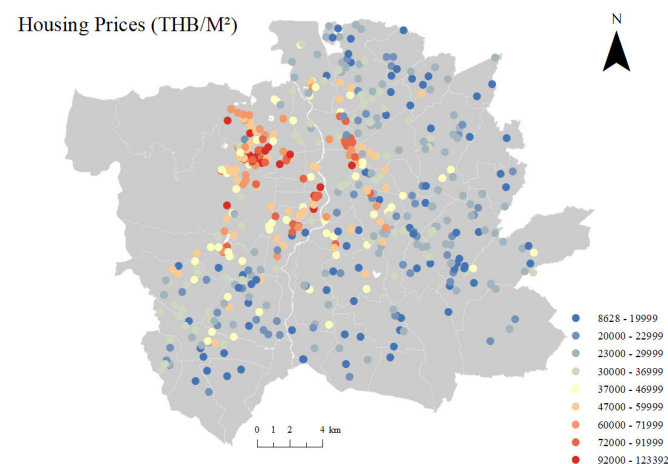
$$y_i = \beta_{bw0}(u_i, v_i) + \sum_j \beta_{bwj}(u_i, v_i)x_{ij} + \varepsilon_i,$$

where  $bw0$  and  $bwj$  indicate the bandwidth used for calibration of the intercept and the  $j$ th conditional relationship, respectively. The optimal bandwidths are typically calibrated by the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), or the corrected Akaike Information Criterion (AICc).

In this study, we explored the multiscale effects of urban land planning on housing prices in Chiang Mai, Thailand. The whole study consisted of three phases: (a) In order to make fair comparisons and improve interpretability, we initially standardized all explanatory variables. (b) In order to remove statistical insignificance, we employed stepwise regression to screen all explanatory variables in Chiang Mai. (c) We employed MGWR-based hedonic price analysis to model the community-level housing prices and use magnitude and spatial patterns of MGWR coefficients to evaluate the multiscale effects of land-use planning on housing prices.

#### 4. Data

Dot property and Fazwaz are two of the largest multilingual real estate transaction platforms in Thailand. They are both committed to providing users with fast and efficient services with authentic and reliable listings. From the two platforms, we extracted information on 4624 housing transactions from 524 neighborhoods in Chiang Mai, including location, housing prices, building age, and furnishing status. Since houses in the same community share the same spatial features and internal structure, we only studied the effect of housing consumer preferences at the community level. Housing prices in various communities in Chiang Mai varied greatly, ranging from 8628 THB/m<sup>2</sup> to 123,392 THB/m<sup>2</sup> (Figure 2). Nimman Road, Chang Khlan, and the new town on the east bank of the Ping River showed a high concentration of high housing prices since these areas are the main built-up areas of Chiang Mai. In addition, the northwest areas of Chiang Mai are mountainous, and there are almost no residences there.



**Figure 2.** Housing price distribution in Chiang Mai. Numbers are in Thai Bhat per square meter (THB/m<sup>2</sup>).

Housing transaction prices in Chiang Mai are possibly affected by various land-use attributes: primary and secondary schools are valued for the high quality of education they provide to children in nearby communities, so housing near these schools can receive added value due to the convenience of education. Chiang Mai is increasingly becoming a



retirement destination for Europeans and these new residents pay more attention to health, so that accessibility to medical facilities may increase residents' satisfaction with the houses and so then affect housing prices. Transport determines the travel efficiency of residents, and it may also plague residents' lives, e.g., bus stops are potential convenience factors, while train tracks and gas stations are potential negative factors due to noise and pollution. Pleasant landscapes cause a significant improvement in the living environment and quality, so they are preferred by all housing consumers. In terms of business facilities, supermarkets can provide residents with a full range of daily necessities, and shopping malls can provide more retail services and recreation. Unlike other cities, there are plenty of stalls near the ancient city walls selling high-quality and affordable products, which is a unique feature in Chiang Mai.

The OpenStreetMap is one of the largest, most complete spatial open datasets covering the entire globe and supplies detailed data of various urban infrastructures (e.g., hospitals, schools, parks, malls, etc.), so it is not difficult to obtain semantic information from OSM data. OSM data have been used widely to investigate various neighborhood impacts in real estate markets [16–20]. We collected facilities information from OSM data, including medical care (hospitals), education (primary and secondary schools), landscape (parks, Ping River), business (malls, supermarkets, ancient city walls), and transport (bus stops, gas stations, train rails). The housing consumer preferences for various attributes or facilities are closely related to their distances from the residences, so we adopted the idea of Liang et al. [21] and set up four thresholds based on the effective distance of the facilities (Table 1).

**Table 1.** Distance thresholds and associated scores.

Distance Threshold (m)	Hospital	Primary School	Secondary School	Park	Mall	Supermarket	Ancient City Walls	Score
$D_1$	1000	800	1000	1000	2000	1000	1500	5
$D_2$	1500	1150	1500	1500	2500	1500	2000	3
$D_3$	2000	1500	2000	2000	3000	2000	3000	1

For any community  $i$ , its distance score  $F_i$  on a specific facility is calculated as

$$F_i = \begin{cases} S_1 \times \left(1 - \frac{d_i}{d}\right), & d_i \leq D_1, \\ S_2 \times \left(1 - \frac{d_i}{d}\right), & D_1 < d_i \leq D_2, \\ S_3 \times \left(1 - \frac{d_i}{d}\right), & D_2 < d_i \leq D_3, \\ a \times \left(1 - \frac{d_i}{d}\right), & d_i > D_3, \end{cases}$$

where  $d_i$  is the minimum distance from community  $i$  to that facility,  $S_j$  is the score within the distance threshold,  $a$  is the attenuation factor,  $N$  is the number of communities in the service radius of the specific facility, and  $d = \max\{d_1, d_2, \dots, d_N\}$ .

## 5. Results

In this study, the average housing price (THB/m<sup>2</sup>) of each community was set as the dependent variable while two kinds of land-use attributes were taken as explanatory variables: internal attributes and accessibility to surrounding facilities (Table 2); we then explored the multiscale effects of land-use planning on housing prices in Chiang Mai.

After employing stepwise regression to screen all explanatory variables, eight variables were retained and five variables were omitted (Table 3). This demonstrated that land-use planning for hospitals, primary and second schools, gas stations, and train rail had effects that could be ignored on housing prices. Chiang Mai was rated the No. 1 city in Southeast Asia for the overall quality of healthcare by a consumer preference survey on the Numbeo website, and it had 37 international schools which provided high-quality bilingual education. Thus, many high-quality medical and education sources only served

for the urban population of 200,000, so that reasonable land-use planning for medical and education sources could lead to that its effects on housing prices could be ignored. On the other hand, as a famous tourist destination, Chiang Mai's pleasant land environment significantly reduced the negative effects (e.g., noise, pollution) brought by gas stations and train lines, so that house consumers were not concerned by negative effects brought by nearby gas stations and railways.

**Table 2.** Explanation of variables.

Category	Variables	Unit	Explanation
Dependent variable	Unit Price	THB/M <sup>2</sup>	Housing unit price
Internal attribute	Age	Year	House age of neighborhood
	Furniture	Point	Furniture of the neighborhood
Medical care	E_Hospital	Point	Distance score to general hospital
	E_PriSchool	Point	Distance score to prestigious primary school
Education	E_SecSchool	Point	Distance score to prestigious secondary school
	E_Park	Point	Distance score to park
Scenery	E_River	Km	Euclidean distance to the Ping River
	E_Mall	Point	Distance score to shopping mall
Business	E_Supermarket	Point	Distance score to supermarket
	E_CityWall	Point	Distance score to ancient city walls
	E_Bus	Point	Distance score to bus stop
Transport	E_GasStation	Km	Euclidean distance to gas station
	E_Rail	Km	Euclidean distance to train rail

**Table 3.** Results of stepwise OLS regression.

Variables	Coef.	Std. Err.	t-Value	P >  t	VIF	
Age	−0.182	0.036	−5.006	0.000	1.120	Included
Furniture	−0.095	0.016	−5.867	0.000	1.075	Included
E_Bus	−0.116	0.049	−2.382	0.018	1.009	Included
E_Park	0.082	0.035	2.321	0.021	1.997	Included
E_River	−0.145	0.033	−4.326	0.000	1.145	Included
E_Mall	0.099	0.025	3.947	0.000	2.188	Included
E_Supermarket	0.194	0.030	6.375	0.000	2.225	Included
E_CityWall	0.186	0.049	3.768	0.000	1.623	Included
E_Hospital						Omitted
E_PriSchool						Omitted
E_SecSchool						Omitted
E_GasStation						Omitted
E_Rail						Omitted

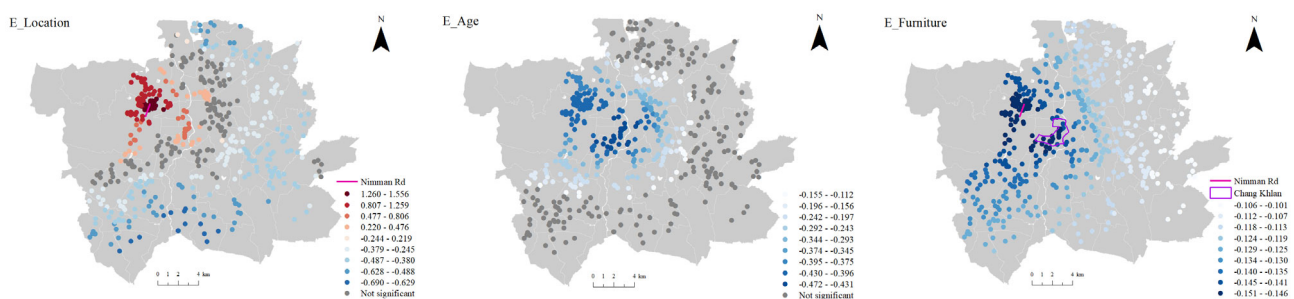
We used multiscale geographically weighted regression (MGWR) to reveal the effect patterns of land-use planning and its driving degrees on housing prices in Chiang Mai at the community level. The bandwidth (i.e., influence radius) of the explanatory variables in the MGWR ranged from 44 to 522 (Table 4). The bandwidths of Furniture, E\_Bus, E\_Park, and E\_Mall were around 500, close to the global scale, while the bandwidths of Intercept, Age, and E\_River were more localized. Moreover, the sign of the MGWR intercept revealed that the effects of location preference on housing prices had significant spatial heterogeneity; the sign of the MGWR coefficients revealed that the preferences of “close to supermarkets” and “close to the ancient city wall” had positive effects on housing prices, and house age, furniture status, bus stops, and the distance to the Ping River were negatively correlated with housing prices. The effect degree of all attribute preferences on house prices varied greatly in space.

**Table 4.** Summary statistics of MGWR results.

Variables	Bandwidth	Coefficients				
		Mean	STD	Min	Median	Max
Intercept	44	0.031	0.587	−0.705	−0.204	1.548
Age	164	−0.224	0.138	−0.460	−0.184	0.001
Furniture	499	−0.135	0.016	−0.162	−0.134	−0.104
E_Bus	522	−0.090	0.005	−0.098	−0.089	−0.080
E_Park	498	−0.012	0.010	−0.026	−0.015	0.020
E_River	194	−0.138	0.079	−0.316	−0.120	0.000
E_Mall	522	−0.001	0.008	−0.018	0.001	0.011
E_Supermarket	317	0.233	0.039	0.150	0.239	0.297
E_CityWall	330	0.048	0.027	0.011	0.041	0.102

### 5.1. Location and Internal Attributes

The intercept in MGWR modeling of housing prices in Chiang Mai revealed location preference effects which varied significantly in space (Figure 3). Downtown areas around Nimman Road showed significantly high housing prices. Nimman Road is the core road in downtown areas of Chiang Mai and is close to the main business district and Chiang Mai University, making life and work very convenient. Such convenience has brought a large demand from Thai and international residents, leading to an increase in housing prices. Moreover, the diverse and creative communities gives Nimman a unique cultural and artistic atmosphere, promoting the cultural value of residential communities and housing customer preferences, further increasing housing prices. Conversely, suburbs were negatively correlated with housing prices. The largest negative correlation occurred in the southern suburbs. Inadequate road conditions, public facilities, and network coverage as well as the lack of employment opportunities cause inconvenience to residents' life and work, weakening the attractiveness of suburban housing.

**Figure 3.** Intercept and MGWR coefficients of internal attribute variables.

Housing prices in Chiang Mai consistently demonstrated negative correlations with house age. The MGWR coefficients related to house age were statistically significant in built-up areas (e.g., downtown) but insignificant in suburbs. The housing type in the built-up areas was mainly condominiums, and limited unplanned land in these areas made new/young condominiums scarce. Due to the house quality and maintenance cost, the younger the house, the higher the housing price. Conversely, the housing type in suburbs was a detached house whose value includes the land value it occupies, leading to statistical insignificance on house age preference.

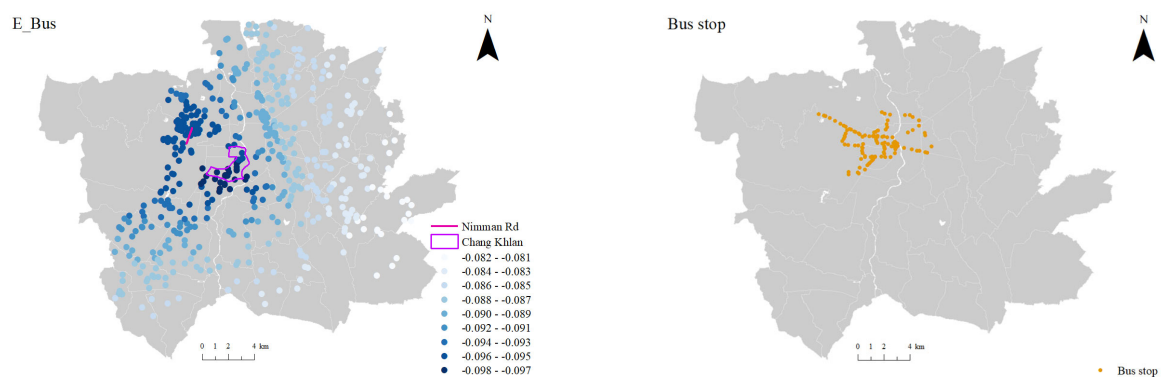
In contrast to house age, the effect of furniture status was revealed to have statistical significance throughout the whole of Chiang Mai. In our MGWR modeling, furniture status was grouped into three categories: fully furnished, partly furnished, and unfurnished. Since the fully furnished status was assigned to a lower value and the no furniture status was assigned to a higher value, the negative MGWR coefficient demonstrated that the fully furnished status increased housing prices. As a popular tourism and leisure destination, many residences in Chiang Mai were used for rental investment and short vacations,



meaning that furnishing status has affected the attraction of houses, and in turn increased housing prices. It is worth noting that housing prices near Nimman Road and in Chang Khlan were most affected by furnishing status. Due to the proximity to the ancient city and major attractions, condominiums near Nimman Road and in Chang Khlan were more preferred by international tourists and artists. These short-term visitors always require fully furnished properties, leading to higher effect degrees of furnishing status on housing prices.

### 5.2. The Accessibility to Bus Stops

Chiang Mai's bus service was launched in 2018 and all bus lines mainly pass through various attractions in built-up areas. Surprisingly, the MGWR coefficient of E\_Bus was revealed to be statistically significant across Chiang Mai but negatively correlated with housing prices (Figure 4). Chiang Mai's bus system was primarily set up for short-term tourists to reach major attractions. Limited numbers of bus stops cannot provide convenient travel for local residents, but bring noise and crowds, so the high density of bus stops in Nimman Road and Chang Khlan produced the largest negative effect on housing prices. Many commercial activities have always appeared on Nimman Road, meaning that a large number of tourists were often staying near bus stops, causing congestion and noise, which affects the living quality of the local residents. Chang Khlan is an area with dense hotels and hostels, attracting a large number of tourists due to its bustling markets and rich tourism resources. The bus stops primarily cater to the needs of tourists, but they have created an inconvenient living environment for local residents, and so have had significantly negative effects. Compared with Nimman Road and Chang Khlan, housing prices in the eastern and southern suburbs were less affected due to them being far from bus stops. Since the bus system did not operate in the suburbs, suburban residents mainly relied on other modes of transportation which meant that the accessibility to bus stops could be ignored regarding housing price in the suburbs.

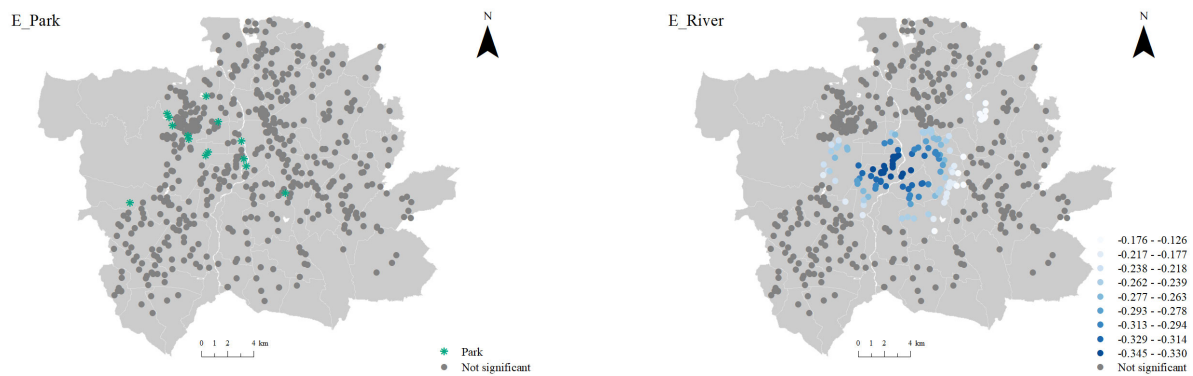


**Figure 4.** MGWR coefficients of bus stops and distribution of bus stops.

### 5.3. Land Scenery

Parks can provide urban green space, improve air quality, and increase the aesthetics of the city. It is worth noting that the park effects on housing prices were not statistically significant (Figure 5, left). Chiang Mai is known as a pleasant land environment. The rich ecological landscape significantly reduced the preference effect of parks on housing prices.

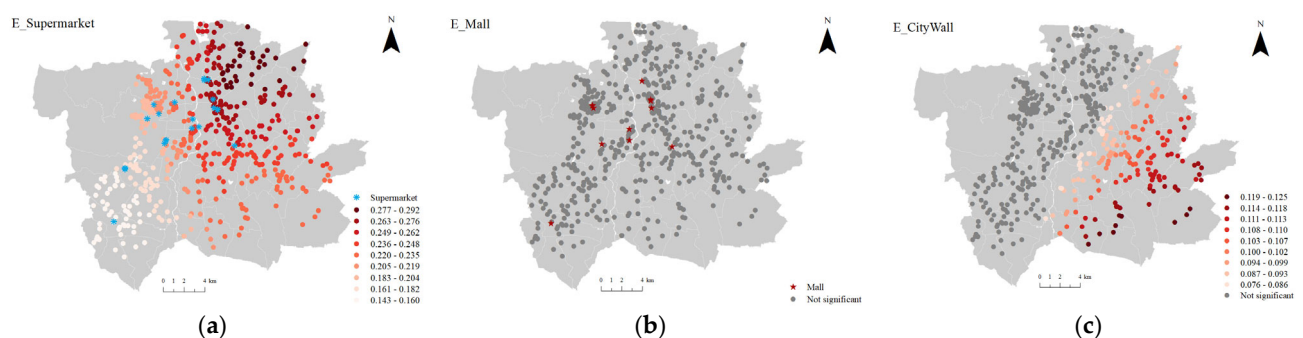
The effect of the Ping River on housing prices was not statistically significant in the areas far from the riverbank, but in the middle of Chiang Mai, the effect decreased with increasing distance from the riverbank (Figure 5, right). Many leisure and recreational facilities exist along the Ping River, such as walking trails, parks, restaurants, and cafes. These facilities added to the convenience, enjoyment, and preference of riverside living, thereby increasing the surrounding housing prices.



**Figure 5.** MGWR coefficients of E\_Park and E\_River.

#### 5.4. The Accessibility to Business Facilities

Supermarkets offer a broad selection of food, drinks, and home items closely related to residents' daily life. Our MGWR modeling of housing prices revealed that being close to supermarkets increased housing prices in nearby communities and its effect was statistically significant throughout the whole urban area of Chiang Mai (Figure 6a). Compared with southwestern areas, the housing prices in northeastern Chiang Mai were more sensitive to the preference for supermarkets. Many newly built communities have made the northeastern areas into the "new town" of Chiang Mai. Since most residents in these communities come from overseas, they are not familiar with Chiang Mai and even cannot speak Thai, so the accessibility to supermarkets can significantly promote convenience in daily life, leading to increases in housing price near the supermarket. Conversely, local Thai residents in southwest Chiang Mai always enjoyed a slower pace of suburban life. Except for supermarkets, these residents might buy food, drinks, and home items from the local markets. This significantly mitigated supermarket preference effects on housing prices.



**Figure 6.** Coefficients of business variables. (a) Supermarket. (b) Shopping Mall. (c) Ancient City Wall.

Shopping malls offer convenient shopping, dining, gym, and entertainment options, enhancing the quality of residents' life and driving commercial development in the surrounding area. However, in Chiang Mai, the effect of malls on housing prices was not statistically significant (Figure 6b). As a tourism-oriented city in Thailand, there are huge amounts of activities and entertainment options in Chiang Mai, so that a shopping mall was not a must in daily life and its effect on housing price could be ignored.

The walls of the ancient city are a symbol of Chiang Mai's history and culture. The unique location and cultural value have led to the development of the surrounding businesses. There are plenty of stalls near the ancient city walls selling high-quality and affordable products. Our MGWR modeling of housing price formation revealed that housing prices in the southeast suburbs were affected significantly by the ancient city wall preference. This was due to the inadequacy of commercial facilities and the relative lack of employment opportunities in the southeast suburbs.

## 6. Discussion

While many world-class metropolises, such as Barcelona, Paris, and Rome, have mature tourism service facilities, including convenient transportation systems and high-quality accommodation, these metropolises still face the problem of mass tourism, with various negative impacts on the environment and disruption for local residents. Chiang Mai can well avoid such the problem of mass tourism occurring in European metropolises. Chiang Mai has abundant unplanned land sources and a very low population density. Since a good environment is the main attraction of Chiang Mai, the local government pays significant attention to environmental protection in the rapid development of the tourism industry. At the same time, a large number of newly-built residential communities appearing on unplanned land during the past decades has mitigated the disruption of tourists for local residents.

As an emerging tourism-oriented city, Chiang Mai is part of a beautiful natural environment, attracting about 10 million foreign and domestic visitors for leisure and vacation every year. These visitors have brought a large amount of consumption, but do not compete for local employment opportunities in Chiang Mai. It is worth noting that the urban development in Chiang Mai does not only focus on triggering gentrification and urban commodification, but strives to benefit every resident. During the past few decades, due to weak agricultural and industrial sectors, the booming tourism industry has become the only driving factor for rapid economic development in Chiang Mai. It provides employment opportunities in Chiang Mai and increases the incomes of local residents. The demand from wealthy visitors drives the investment especially in high-quality education and medical facilities, benefiting local residents. Our study revealed that the accessibility to education and medical facilities had effects on housing prices which could be ignored, meaning that local residents were well satisfied with the land-use planning for high-quality medical and education sources across Chiang Mai. Local government has created a harmonious coexistence between local residents and short-term/long-term visitors, and their experience will have great value for similar tourism cities in Thailand and in other Asian countries.

Spatial justice involves the way resources are allocated across space and how spatial patterns of living influence, enhance, or confine people in their opportunities. The spatial justice/injustice during the urbanization process occurs not only in terms of income but also the quality of the environment, public facilities, access to transportation, and the quality of public services. The city administration should not be only interested in high-class local residents, tourists, foreign investors, and students, but should give every resident, including the poor and low-income groups, equal opportunities. By using MGWR modeling of housing prices, our results revealed the spatial heterogeneity of the impact degree of neighborhood facilities on housing prices in Chiang Mai, which originates from the imbalance of urban facilities and services and leads to spatial injustice during the urbanization process. Therefore, the land-use department in Chiang Mai should take necessary measures to guide future investment to reduce spatial heterogeneity and related spatial injustice. In particular, limited bus stops in Chiang Mai cannot provide convenient travel for local residents, but bring noise and crowds, so a high density of bus stops in downtown areas produced negative effects on housing prices. The local government should lower the bus stop density in downtown areas and strengthen the transportation links between downtown areas and suburbs.

## 7. Conclusions

Unlike the housing market in many large international cities, Chiang Mai's housing transactions are particularly dominated by tourism and overseas demands. With rapid expansion of the urban land area, Chiang Mai's housing transactions are not only driven by the needs of permanent residents, but also fluctuate with the international tourist environment. Chiang Mai's suitable land-use planning, pleasant natural landscapes, and developed cultural industries, as well as inadequate infrastructure, make the housing price formation mechanism particularly special.

Based on 4624 residential information sets in 524 communities in urban areas of Chiang Mai, we explored the multiscale effects of location and internal and neighborhood attributes on housing prices, including two internal attributes (house age, furniture status) and five types of facilities, including medical care (hospitals), education (primary and secondary schools), landscape (parks, Ping River), business (malls, supermarkets, ancient city walls), and transport (bus stops, gas stations, train rails). In order to remove statistical insignificance, we employed stepwise regression to screen all attributes and found that the accessibility to hospitals, primary and second schools, gas stations, and train rail could be ignored with respect to housing prices. After that, we employed MGWR-based hedonic price analysis to establish spatial multiscale relationships between eight statistically significant attributes and transaction prices and found the following:

- Among location and internal attributes, the effect of location preference on housing prices demonstrated the most significant spatial heterogeneity. Due to the convenience of living and working, housing customer preference resulted in a significant increase in the housing price in built-up areas and a significant decrease in the suburbs. The effect of house age was demonstrated to be negatively related to condominium prices in built-up areas and to be statistically ignorable for detached house prices. The effect of fully furnished properties demonstrated spatial homogeneity with statistical significance throughout the whole of Chiang Mai, but its degree was much weaker than that of location or age.
- Ø Among various nearby facilities, the accessibility to bus stops was demonstrated to be negative with housing prices in Chiang Mai. This originated from the fact that its bus system was primarily set up for short-term tourists and limited bus stops cannot provide convenient routes for local residents, but bring noise and crowds. In terms of land scenery, due to the pleasant environment and atmosphere, only the preference near the Ping River had some effects on house price. In terms of business facilities, the proximity to supermarkets brought housing price increases in nearby communities, while being close to a shopping mall did not.

Our results revealed the spatial heterogeneity of the effect degrees of neighborhood facilities on housing prices in Chiang Mai. It will not only support the urban land planning department of Chiang Mai to allocate land resources rationally in urban construction, promote spatial justice, and enable urban development to bring long-term positive impacts to residents and communities, but it can also provide insights into the housing price formation mechanisms in similar tourism-oriented cities in Thailand and beyond.

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## References

1. Xu, Y.; Song, W.; Liu, C. Social-spatial accessibility to urban educational resources under the school district system: A case study of public primary schools in Nanjing, China. *Sustainability* **2018**, *10*, 2305. [\[CrossRef\]](#)
2. Sheppard, S. Hedonic analysis of housing markets. In *Handbook of Regional and Urban Economics*; Elsevier: Boston, MA, USA, 1999; Volume 3, pp. 1595–1635.
3. Abelson, P.; Joyeux, R.; Mahuteau, S. Modelling House Prices across Sydney. *Aust. Econ. Rev.* **2013**, *46*, 269–285. [\[CrossRef\]](#)
4. Yoo, J.; Ready, R. The impact of agricultural conservation easement on nearby house prices: Incorporating spatial autocorrelation and spatial heterogeneity. *J. For. Econ.* **2016**, *25*, 78–93. [\[CrossRef\]](#)

5. Cao, K.; Diao, M.; Wu, B. A Big Data–Based Geographically Weighted Regression Model for Public Housing Prices: A Case Study in Singapore. *Ann. Am. Assoc. Geogr.* **2019**, *109*, 173–186. [\[CrossRef\]](#)
6. Seo, W.; Nam, H.K. Trade-off relationship between public transportation accessibility and household economy: Analysis of subway access values by housing size. *Cities* **2019**, *87*, 247–258. [\[CrossRef\]](#)
7. Gu, Z.N.; Tang, M.; Luo, X.L.; Feng, J.X. Examination of the impacts of hospital accessibility on housing prices: Heterogeneity across attributes, space and price quantiles. *J. Hous. Built Environ.* **2023**, *39*, 179–200. [\[CrossRef\]](#)
8. Wen, H.; Xiao, Y.; Hui, E.C.M.; Zhang, L. Education quality, accessibility, and housing price: Does spatial heterogeneity exist in education capitalization. *Habitat Int.* **2018**, *78*, 68–82. [\[CrossRef\]](#)
9. Park, J.; Lee, D.; Park, C.; Kim, H.; Jung, T.; Kim, S. Park accessibility impacts housing prices in Seoul. *Sustainability* **2017**, *9*, 185. [\[CrossRef\]](#)
10. Wang, Y.M.; Potoglou, D.; Orford, S.; Gong, Y. Bus stop, property price and land value tax: A multilevel hedonic analysis with quantile calibration. *Land Use Policy* **2015**, *42*, 381–391. [\[CrossRef\]](#)
11. Siripanich, A.; Rashidi, T.H.; Moylan, E. Interaction of public transport accessibility and residential property values using smart card data. *Sustainability* **2019**, *11*, 2709. [\[CrossRef\]](#)
12. Asasuppakit, P.; Thiengburanatham, P. System dynamics framework for sustainable infrastructure evaluation: Chiang Mai City and impacts from tourism. In Proceedings of the Asia-Pacific System Dynamics Conference, Senshu University, Tokyo, Japan, 22–24 February 2014.
13. Wanitchakorn, T.; Muangasame, K. The identity change of rural–urban transformational tourism development in Chiang Mai heritage city: Local residents’ perspectives. *Int. J. Tour. Cities* **2021**, *7*, 1008–1028. [\[CrossRef\]](#)
14. Brunsdon, C.; Fotheringham, A.S.; Charlton, M.E. Geographically Weighted Regression: A Method for Exploring Spatial Nonstationarity. *Geogr. Anal.* **1996**, *28*, 281–298. [\[CrossRef\]](#)
15. Fotheringham, A.S.; Yang, W.B.; Kang, W. Multiscale Geographically Weighted Regression (GWR). *Ann. Am. Assoc. Geogr.* **2017**, *107*, 1247–1265.
16. Klinkhardt, C.; Woerle, T.; Briem, L.; Heilig, M.; Kagerbauer, M.; Vortisch, P. Using OpenStreetMap as a Data Source for Attractiveness in Travel Demand Models. *Transp. Res. Rec.* **2011**, *2675*, 294–303. [\[CrossRef\]](#)
17. Chmielewska, A.; Ciski, M.; Renigier-Biłozor, M. Residential real estate investors’ motives under pandemic conditions. *Cities* **2022**, *128*, 1033801. [\[CrossRef\]](#)
18. Thackway, W.T.; Ng, M.K.M.; Lee, C.-L.; Shi, V.; Pettit, C.J. Spatial Variability of the ‘Airbnb Effect’: A Spatially Explicit Analysis of Airbnb’s Impact on Housing Prices in Sydney. *ISPRS Int. J. Geo-Inf.* **2022**, *11*, 65. [\[CrossRef\]](#)
19. Chen, S.; Zhuang, D.; Zhang, H. GIS-Based Spatial Autocorrelation Analysis of Housing Prices Oriented towards a View of Spatiotemporal Homogeneity and Nonstationarity: A Case Study of Guangzhou, China. *Complexity* **2020**, *2020*, 1079024. [\[CrossRef\]](#)
20. Rey-Blanco, D.; Zofío, J.L.; González-Arias, J. Improving hedonic housing price models by integrating optimal accessibility indices into regression and random forest analyses. *Expert Syst. Appl.* **2024**, *235*, 121059. [\[CrossRef\]](#)
21. Liang, X.J.; Liu, Y.L.; Qiu, T.Q.; Jing, Y.; Fang, F.G. The effects of locational factors on the housing prices of residential communities: The case of Ningbo, China. *Habitat Int.* **2018**, *81*, 1–11. [\[CrossRef\]](#)

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