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Spatial Heterogeneity of Public Service Facilities in the Living Circle and Its Influence on Housing Prices: A Case Study of Central Urban Dalian, China

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Abstract: The spatial layout of public service facilities (PSFs) markedly influences residents' quality of life. Based on Baidu map data, spatial information on 27,552 PSFs across eight categories was collected for urban Dalian, China, and analyzed using the nearest neighbor index and nuclear density. Then, PSF accessibility across eight dimensions of residential quarters was calculated based on the cumulative opportunity method, and its impact on housing prices was analyzed. The results revealed the following: (1) The degree of spatial agglomeration for PSFs varied, with that of business facilities being higher than that of other public welfare facilities. The distribution of business facilities was characterized by a dense center and sparse periphery, whereas public welfare facilities were laid out in a relatively balanced "multi-center" distribution across the study area. (2) Significant spatial differences in the number and types of accessible resident facilities were identified. The number of accessible PSFs in the core area of central urban regions was large and the types were relatively complete, whereas the accessible PSFs in the western and northern marginal areas were limited in number, few in type, and lacking across certain categories, such as educational facilities and life services. (3) The spatial distribution of PSF accessibility was unbalanced. The accessibility of various PSFs in the Shahekou District was the highest, followed by that in the Zhongshan, Xigang, and Ganjingzi Districts. (4) The accessibility of educational, sport, and cultural facilities, and the total accessibility and greening rate of residential areas were the most significantly positively correlated with housing prices; however, the number of households in residential areas and the distances between residential areas and large shopping centers were significantly negatively correlated. Our findings will expand the research perspective of PSFs, provide a basis for meeting residents' needs and a rational allocation of PSFs, and provide references for people's decisions to buy houses.

Keywords: living circle; public service facilities; accessibility; house price; Dalian

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1. Introduction

The quantity, type, accessibility, and allocation efficiency of public service facilities (PSFs), including medical care, education, commerce, elderly care, and other types of infrastructure, are intrinsically linked to residents' quality of life. Scholars have primarily focused on facility location selection [1,2], accessibility [3–6], spatial equity [7], and socioeconomic effects [8,9]; however, within China, researchers have explored optimal layouts [10], spatial patterns [11], social differentiation [12], demand and satisfaction [13], as well as the factors that influence public service facility allocation [14].

For countries or regions with extensive urban construction and urban sprawl, a comprehensive, multifunctional, and vibrant urban space should meet the various needs of people as closely as possible and create a harmonious social atmosphere and colorful urban life. This idea is consistent with a concept known, specifically, as the CE which advocates the adoption of a high-density, mixed land development and uses a model to accommodate more urban activities in a limited space, to improve the utilization efficiency of PSFs and to reduce urban infrastructure. Additionally, it can counter urban sprawl, promote urban economic development and social and cultural activities, and is conducive to the revival of the inner city. It can also effectively reduce traffic and encourage walking, which is conducive to reducing energy consumption [15]. Compact cities have put forward new standards for the configuration of PSFs. The development model for compact cities should be tied to the accessibility of public transportation, and mixed functions of land should be adjusted at public transportation nodes, including PSFs and jobs [16]. For example, Japan creates a living environment that can obtain various functions such as living, shopping, and communication through walking to achieve the purpose of compact cities [17]. Shao et al. studied the relationship between land use and travel behaviors to enhance the quality of life of people [18]. Park et al. also proposed a study that entailed the detection of land use regulations in neighborhoods that present 15-min travel intervals in the United States through the lens of achieving sustainable travel. Such an approach is important because context-specific strategies are more effective at enabling a region to strategically develop its centers and achieve smart and sustainable goals [19]. Zhang et al. suggested that incorporating polycentric development and a neighborhood-life circle would lower vehicle use in Beijing [20].

A living circle is defined as a relative geographical space encompassing residents' daily life needs. The concept of a 15-min neighborhood/city has been widely discussed in both China and Western countries. According to the "people-oriented" concept, the aims of constructing urban living circles has changed from "speed" to "quality" over the past ten years, and the corresponding allocation of PSFs within these regions, as well as their influence, has become a topic of human geography research [21]. For example, Chai [22] categorized urban living circles into various types; further, other topics, including the equalization allocation of PSFs within living circles [21], accessibility [23,24], socioeconomic effects [25], social equity [26,27], location selection [28], and spatial patterning [29] have also been discussed. Specifically, Ma et al. [30] explored the spatial layout and accessibility of PSFs within the Shanghai living circle, Han et al. [31] discussed the spatial differentiation of PSFs in the Shahekou District of Dalian from the perspective of a 15-min community living circle, and Zhang et al. [32] analyzed the spatial distribution characteristics and accessibility of PSFs in the central urban area of Tianjin. Globally, the distribution of PSFs is uneven [33], presenting strong core-edge characteristics in Beijing [29]. Furthermore, the accessibility of these services is related to both the number and types of facilities in question. The spatial relationships within the scope of living circles and service facility accessibility present regional differentiation, with Beijing having high demand and poor accessibility [34]. Accordingly, the locations of PSFs should be selected to enhance social equality and efficiency [35]. Pozoukidou et al. proposed that a 15-min city should be built at a workable and bikeable human scale and meet the needs of people of all ages and abilities. Additionally, the study entailed an evaluation of three traditional planning principles to address 15-min city-linked-needs improvements that should be implemented in Portland (OR, USA), Paris (France), and Melbourne (Australia) [36]. Weng et al. proposed a modified method for measuring 15-min walkable neighborhoods. This method considered the walking demands of different pedestrian groups (i.e., the entire population, children, adults, and seniors) and applied it to Shanghai, China [37]. In the present study, the living circle is defined as the basic unit of residents' daily activities, that is, the public space that healthy adult residents can reach within 15 min (800 m) by walking from a place of residence in order to meet various needs.

The interaction among, and evolution of socioeconomic factors in urban residential spaces are central to human geography research [38]. For example, the spatial differentiation characteristics and factors that influence housing prices have become a recent focus of research attention. Housing is both a "consumer good" and "investment good", and it is influenced by numerous factors. Scholars have primarily focused on the relationships among the factors influencing housing and housing prices from the perspectives of supply and demand [39], urban resource agglomeration capacity [40], local finance and interest rates [41], as well as community structure characteristics [42]. Recently, some researchers have directed their attention towards the relationship between PSF accessibility and housing prices. For example, Luo et al. [43] examined the correlation between public service facility accessibility and housing prices in Wuhan. In addition, Li et al. [33] investigated the relationships among the accessibility of educational facilities, medical facilities, shopping facilities, transportation facilities, cultural/leisure facilities and housing prices among the streets of Beijing, revealing that the accessibility to PSFs impacted housing costs, with the accessibility to different types of facilities impacting the housing costs to different degrees. Further, it has been shown that the degree of influence of each factor on housing prices is spatially unstable, being dominantly controlled by urban location and administrative grade characteristics across research areas [40]. In addition to the quality of a house, people also focus on whether there are PSFs, such as schools and hospitals, accessible when theymake a decision to buy houses; these factors have important implications for determining geographical location and policy biases with respect to school districts and access to other PSFs in urban areas [33,40,43].

Accordingly, the spatial differences between comprehensive and subindustry PSFs, as well as their relationships with housing prices can provide important insights into socioeconomic distribution patterns and equity. Furthermore, the research scale of the impact of PSFs on housing prices is gradually shrinking from cities to more microspaces, such as streets [33,44–46]. Adopting point-of-interest (POI) data can provide more detailed results regarding this aspect. However, with many residential buildings as the basic unit, only a few studies have measured the impact of the configuration of PSFs and the impact of the accessibility of PSFs on housing prices. Therefore, at microscales (e.g., 15-min community living circles), it remains unknown how the number, type, and accessibility to urban PSFs impact housing prices. The present study examined the residential quarters of central urban Dalian, China to explore the spatial distribution characteristics of eight types of PSFs in a 15-min community living circle. The correlated spatial structures of urban PSFs were extracted for each living circle and the relationships among PSF accessibility and housing prices were interpreted to expand the research perspective of PSFs and provide a basis for meeting residents' needs and rational allocation PSFs and a reference for people's decisions to buy houses.

2. Data and Methods

2.1. Research Area

The research area included the Zhongshan, Xigang, Shahekou, and Ganjingzi Districts in the central urban area of Dalian, covering an area of 620 km^2, and maintaining a residential population of 2.9 million (Figure 1).

2.2. Data Sources

Based on the content of the "Research Report on Livable Cities in China" [47], the POI geographic location information data on residential quarters and PSFs in Dalian were extracted from the Baidu map open platform, and the data were screened and checked. Ultimately, 27,552 valid data points across eight categories were obtained (Table 1). Since residents may receive public services from neighboring administrative districts, roads and POI facilities $\leq$800 m outside the administrative boundaries of the four districts were included. The administrative boundary and traffic data for Dalian were derived from the sky map website of the Liaoning geographic information public service platform (https://liaoning.tianditu.gov.cn/, accessed on 16 December 2021). These data were corrected using the Dalian City Map issued by the China Map Publishing House in 2020. Housing-related data were acquired from the Anjuke database on 16 December 2021 (https://datong.anjuke.com/, accessed on 16 December 2021).

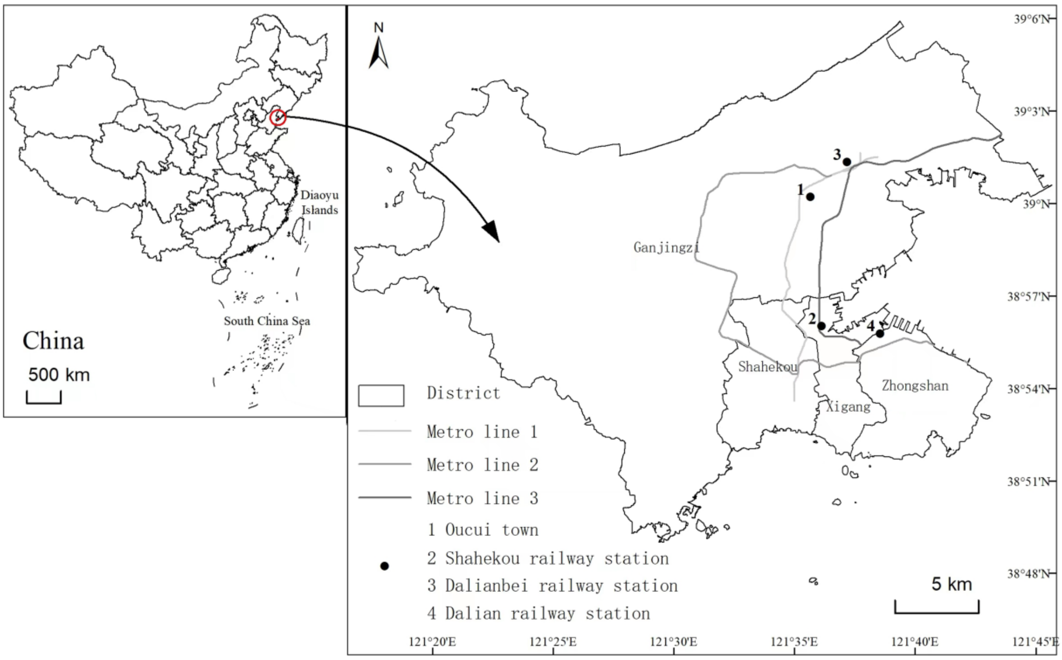

Figure 1. Study area location.

Table 1. Public service facilities by classification.

Category	Item	Quantity/Individual	Proportion/%
Shopping/ catering	Shopping malls, supermarkets, restaurants	16,334	59.28
Transportation	Bus station, subway station	1424	5.17
Educational	Kindergarten, primary school, middle school, and secondary vocational training school	945	3.43
Life service	Post office, beauty salon, laundry, bath, bank	4171	15.14
Physical fitness	Sports venues, chess, and card rooms, park squares	1461	5.30
Cultural/leisure	Theaters, libraries, comprehensive cultural centers	255	0.93
Pension facilities	Nursing homes and activity centers for the elderly	214	0.78
Medical	Pharmacy, clinic, health service center, hospital	2748	9.97
Total		27,552	100

2.3. Research Methods

Nearest neighbor and nuclear density analyses were used to investigate the spatial agglomeration characteristics of PSFs in Dalian. In accordance with the methods of Zhao [34], the cumulative opportunity method was used to calculate the accessibility level of various PSFs within a 15-min community living circle (i.e., an 800 m walk from the community). The calculation formulae employed for deriving these values are reported in Equations (1) and (2):

$$A_{i,s} = \sum_{j=1}^{n} f(i,j)S_j, \tag{1}$$

$$f(i,j) = \begin{cases} \frac{1}{0.5^{\beta}} & (d_{ij} \le 0.5) \\ \frac{1}{d_{ij}^{\beta}} & (0.5 < d_{ij} < r_{ij}) \\ 0 & (d_{ij} \ge r_{ij}) \end{cases} \tag{2}$$

where $A_{i,s}$ is the accessibility index of s PSFs available for i community within 800 m; S_j is the ability to acquire j PSFs for the community; $f(i,j)$ is an index with distance attenuation; β is the impedance coefficient; d_{ij} is the distance between the community and PSFs; and r_{ij} is the radius of the community living circle (800 m in the present study). Since the POI data cannot distinguish between the facility-level and scale, Zhao [34] set the service capacity of each facility, and the impedance coefficient to 1. Accordingly, in this study, the radius of the living circle was 800 m, and since the distance attenuation effect of facilities $\le$ 0.5 km could be neglected, 0.5 km was taken as the point of action for the horizontal distance attenuation of public service facility accessibility.

The entropy method was used to calculate the weight, where the comprehensive facility accessibility was calculated using the sum of single-class facility accessibility as the base, and the entropy weight as the exponent. Then, the entropy weight was calculated using the Shannon entropy index to reflect facility diversity [24] according to Equations (3)–(7):

$$\mathrm{A_i} = \sum\nolimits_{\mathrm{s}} \mathrm{A_{i,s}}, \tag{3}$$

$$\mathrm{P_i(s)} = \mathrm{A_{i,s}}/\mathrm{A_i}, \tag{4}$$

$$\mathrm{H_i} = -\sum\nolimits_{\mathrm{i}} [\mathrm{P_i(s)} \times \ln \mathrm{P_i(s)}], \tag{5}$$

$$\mathrm{Q_i} = \mathrm{H_i}/\ln \mathrm{m}, \tag{6}$$

$$\mathrm{AT_{i}} = \begin{cases} \mathrm{A_i^{Q_i}} & (\mathrm{A_i} \neq 0) \\ 0 & (\mathrm{A_i} = 0) \end{cases}, \tag{7}$$

where $\mathrm{A_i}$ represents the accessibility level arithmetic sum of various facilities within the community; $\mathrm{P_i(s)}$ is the ratio of access to s facilities, compared with the total facility access in community i; $\mathrm{H_i}$ is the Shannon quotient index; $\mathrm{Q_i}$ is the relative entropy weight of the community; m is the number of facilities (8 in the current study); and $\mathrm{AT_i}$ is the comprehensive accessibility level of all types of facilities within 800 m of the community.

3. Results

3.1. Spatial Distribution of Public Service Facilities

Using the nearest neighbor index to assess the balanced spatial distribution and structure of PSFs (Table 2), index values for the central urban area of Dalian were <1. Furthermore, all *p*-values were <0.001, and the spatial aggregation characteristics according to the Z-score were apparent. Simultaneously, the aggregation degree of various facilities varied, with the nearest neighbor index of shopping and catering being the smallest (0.189), indicating their relatively high aggregation and development. Comparatively, the nearest neighbor index of elderly care facilities was the largest (0.599), implying its scattered spatial distribution and low number of facilities; thus, no large-scale or strong agglomeration patterns or characteristics were observed.

Table 2. Agglomeration index for public service facilities and housing prices.

Facility	Expected Value	Observations	Nearest Neighbor Index	*p*-Value	*Z*-Value
Shopping/catering	116.081	21.940	0.189	0.000	−198.286
Transportation	320.325	130.234	0.407	0.000	−45.921
Educational	416.562	159.147	0.382	0.000	−36.341
Life service	219.425	44.424	0.202	0.000	−98.538
Physical fitness	401.530	156.750	0.390	0.000	−44.577
Cultural/leisure	755.041	366.671	0.486	0.000	−15.714
Elderly care	946.117	566.404	0.599	0.000	−11.232
Medical	266.178	65.642	0.247	0.000	−75.554

Comparing the nearest neighbor index values across the various public service facility types, it was observed, on the one hand, that the concentration degree of business facilities was higher than that of public welfare facilities; on the other hand, shopping, catering, and living service facilities were more evenly distributed owing to the relative ubiquitous market demand and capacity to generate profits. The nearest neighbor index values of transportation, education, sports, culture and leisure, and elderly care facilities were all >0.38, with a relatively weak degree of aggregation. As the number of such facilities was relatively small, a scattered distribution pattern was apparent, directly responding to the principle of fairness and equality when allocating these public welfare facilities. Among them, the concentration of medical facilities was high, which may have been because of the extensive selection of the sample data, where hospitals, health service centers, pharmacies, and clinics were all included.

3.2. Spatial Agglomeration of Public Service Facilities

The core density analysis method was used to measure the polar core position of public service facility spatial agglomerations, and a spatial distribution pattern map was generated (Figure 2). Dalian maintains a high degree of urbanization, with diverse and numerous PSFs; however, an imbalance in spatial allocation is apparent. Generally, PSFs tended to be concentrated in the Zhongshan, Xigang, and Shahekou Districts of the central city (i.e., Dalian), displaying "single center" characteristics. Different service facility types maintained various spatial forms and agglomeration patterns, for example, the spatial agglomeration trends of business facilities were more evident than those of public welfare facilities.

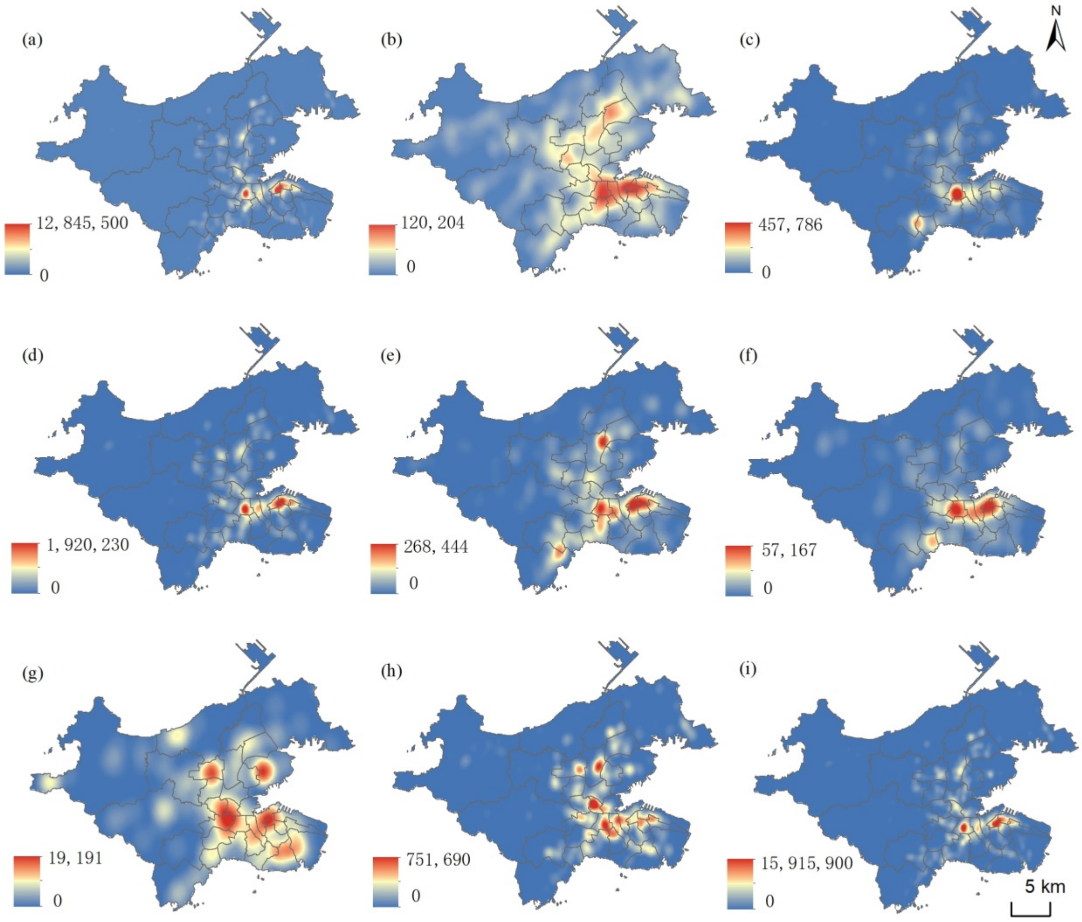

Figure 2. Spatial distribution of public service facilities: (**a**) Represents shopping/catering; (**b**) represents transportation facilities; (**c**) represents educational facility; (**d**) represents life services; (**e**) represents physical fitness; (**f**) represents cultural/leisure facilities; (**g**) represents elderly care facilities; (**h**) represents medical facilities; (**i**) represents total facilities.

The service threshold of business facilities (e.g., shopping, catering, and living services) was relatively low. As the population demand is high and the service radius is small, facilities driven by profits seek to distribute themselves close to densely populated areas. Correspondingly, shopping, catering, and life service facilities were located in areas with the greatest population, displaying a center-periphery layout, with the core presenting a high agglomeration, the streets surrounding the core forming a median area with an active social economy, and the marginal regions being deficient in facilities. Shopping and catering facilities formed two agglomeration areas and four secondary agglomeration areas. Living service facilities were highly concentrated near squares with a striped distribution, presenting a major agglomeration in the central city and scattered points in the periphery.

PSFs, such as elderly care, transportation, physical fitness, as well as medical care, showed a “multi-center” layout, which was relatively balanced and reflected the fairness of public service facility allocation. Among them, the distribution range of transportation facilities was the largest, with the blind area coverage being the smallest, reflecting the diverse and convenient supply of transportation to the population. A first-level core area of transportation facilities was located south of the central city, connecting Dalian and Shahekou railway stations in series, while extending east along Metro Line 2. A second-level core area was located to the north of the central city, with the Dalianbei railway station serving as the core, presenting a band-shaped distribution along Metro Lines 1 and 3. The core area of the central city has a large population, and a correlated high demand for transportation facilities; thus, the government has allocated more of these facilities in this region.

Second, Dalian maintains one of the highest average age levels in Northeast China, and the corresponding demand for old-age facilities is immense [48]. Elderly care facilities tend to be located in areas with beautiful environment, and the expansive and scattered layout of elderly care facilities can meet the community care needs of a portion of the elderly population to a certain extent. Elderly care facilities formed five agglomerated areas, and five secondary core areas were observed around parks. Generally speaking, elderly care facilities were distributed in spots abundant in superior natural conditions.

Conversely, medical facilities are point-like distributed, possibly owing to the independent occupation of large hospitals. Medical facilities are located around large hospitals forming three first-class hot spots, with some second-class hot spots distributed around. As the scale and service scope of the main medical facilities included here were relatively large, their distribution was fairly balanced over an extensive range. Metro Lines 1 and 2 connect critical hospitals in series, notably improving transportation and embodying the principle of public welfare facility equality.

The number of culture/leisure facilities and schools is relatively small, making it difficult for them to form large gatherings, and resulting in a belt-shaped gathering mode over the small-scale. Cultural and leisure facilities are based around Metro Lines 1 and 2 as the primary commuter routes, connecting Shahekou and Dalian Railway Station from west to east, forming a belt-shaped pattern of gathering areas. Educational facilities formed a first-class core area distributed along the central and east of Metro Line 2. In contrast, a second-class core area is distributed at the southwest of Dalian.

In addition, physical fitness facilities are centered at the Oucui Town and some squares forming a scattered distribution pattern four high-value areas. Overall, the spatial distribution of total service facilities is similar to that of shopping and catering facilities.

3.3. Analysis of Accessible Public Service Facilities to Residents

According to the statistical data of accessible PSFs in various residential areas, 45% of the areas present all eight types of public service facilities within a 15-min walk, 67% of residential quarters have $\geq$seven types of public service facilities within the same range, whereas 97% of residential quarters have $\geq$two types of these facilities. Notably, only 0.67% of residential quarters cannot reach any of these facilities within a 15-min walk. Overall, the accessible facilities in the community maintain traffic directivity, decreasing from the center towards the periphery (Figure 3a). Agglomeration areas are mainly concentrated around a horizontal and three vertical transportation networks with Metro Line 2 as the horizontal axes, and Metro Lines 1, 2, and 3 as the vertical axes, and extend south along the main traffic line. Furthermore, even Metro Line 2, where PSFs are the most concentrated, presents incomplete accessibility to all facility types in the surrounding residential quarters. Areas with less accessible public services are mainly distributed near Hongqi Street, Yingchengzi

Street, Gezhenbao Street, and Dalian Bay Street, which are located at the edge of central Dalian, with a relatively poor road network and community density.

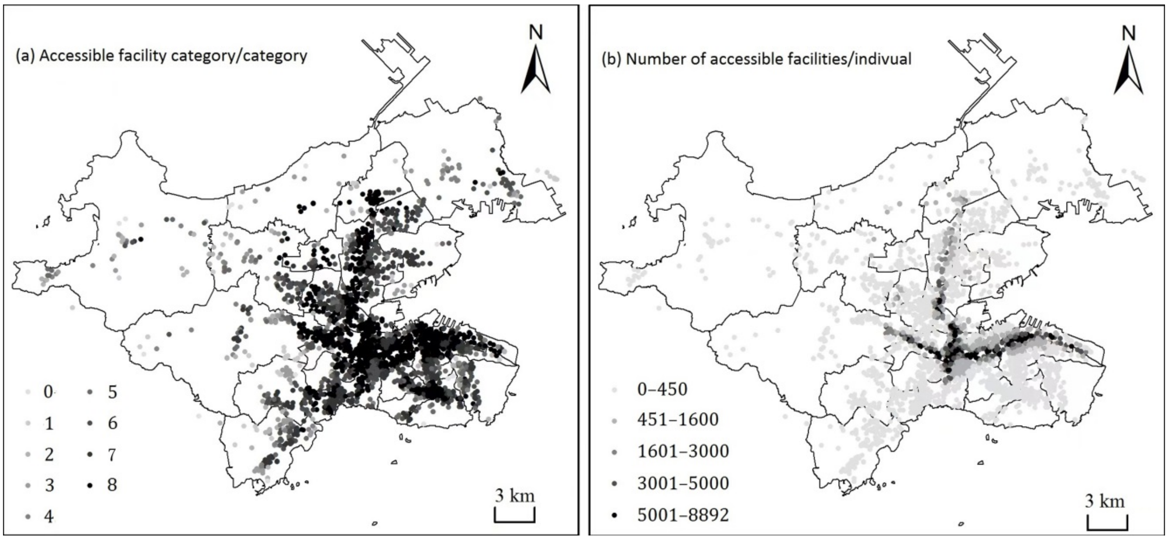

Figure 3. Accessible facilities for inhabitants of each residential area.

Locally, the number of accessible facilities in some residential communities is small and affected by various factors. For example, Happiness E Community is notably close to the commercial downtown but separated by the river and railway line; thus, residents cannot enjoy all types of PSFs, as only 367 specific facilities across six categories can be accessed within a 15-min walking distance.

Further attention was directed towards residential areas that had access to all types of PSFs, if there was a variety of accessible PSFs. Accordingly, the number of accessible facilities at the community level was examined, revealing that ≤8892 PSFs were available within a 15-min walk, with zero PSFs near 16 residential areas. The number of accessible facilities was then divided into five levels using natural breakpoints, among which the first, second, and third levels accounted for 89% of all communities, with accessibility to 0–3000 PSFs. Spatially, the number of accessible facilities in residential areas is relatively consistent with that of overall PSFs (Figure 3b). High-value areas are concentrated along Metro Lines 1 and 2, with the number of accessible PSFs in residential areas near Metro Lines 1 and 2 being higher than that in other areas, thereby, indicating that the traffic axis has a remarkable agglomeration effect on population and industry. The residential quarters of the western and northern streets have the least accessible facilities, whereas accessible facilities in some residential quarters only range from 0 to 450.

3.4. Accessibility of Public Service Facilities

The accessibility data of PSFs were employed to calculate the impacts of accessibility on housing prices. Accordingly, the following preconditions were set based on the ground conditions: no viaduct, one-way roads, left or right restrictions, and traffic times, walking speed estimated to be 53.33 m·min^{-1}, and total possible travel time considered to be 15 min. The accessibility of various PSFs in the central area of Dalian was calculated using the cumulative opportunity method according to Equations (1) and (2) (Table 3), and the natural discontinuous grading method was used for grade processing (Figure 4). The spatial distribution of public service facility accessibility in the central city was imbalanced and varied depending on the facility type. In terms of quantity, the following patterns emerged: catering and shopping > living services > medical facilities > sports and fitness > educational facilities > transportation facilities > cultural leisure > and elderly care facilities. The differences in distribution are closely related, indicating that the business service facilities significantly meet the needs of residents within their community living circle; however, public welfare service facilities need to be further explored.

Table 3. Mean public service facility accessibility of the central urban area in Dalian.

Administrative Area	Shopping/ Catering	Life Service	Elderly Care	Transportation	Physical Fitness	Medical	Educational	Cultural/ Leisure	Total Accessibility
Zhongshan	1216	316	4	41	77	88	45	20	39
Xigang	1102	271	6	43	65	111	52	20	50
Shahekou	1475	373	8	72	107	163	89	29	73
Ganjingzi	115	66	3	29	26	46	13	5	37

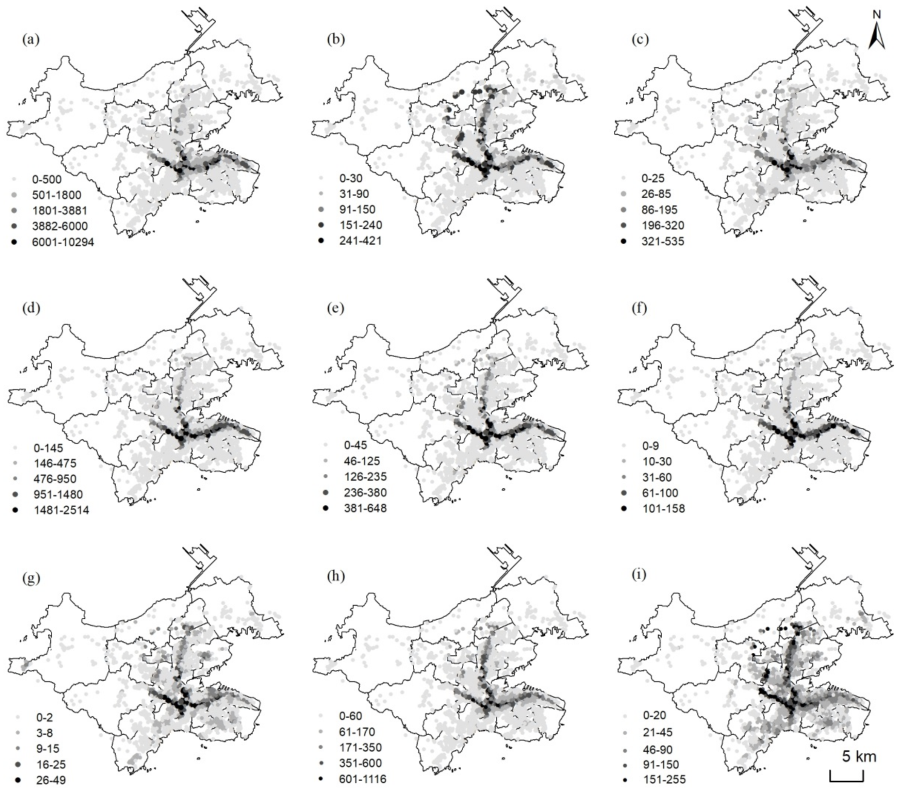

Figure 4. Public service facility accessibility within the central urban area of Dalian. (**a**) Represents shopping/catering; (**b**) represents transportation facilities; (**c**) represents educational facility; (**d**) represents life services; (**e**) represents physical fitness; (**f**) represents cultural/leisure facilities; (**g**) represents elderly care facilities; (**h**) represents medical facilities; (**i**) represents total facilities.

Regionally, the comprehensive accessibility of various PSFs in the Shahekou District was the highest, as it is a compound functional area. Next, the accessibility of shopping, catering, living services, sports and fitness, as well as that of cultural and leisure facilities in the Zhongshan District was higher than that in the other two districts, while the accessibility of elderly care, transportation, medical, as well as educational facilities in the Xigang District was greater than that in the other two districts. Overall, the accessibility of various service facilities in the Ganjingzi District was the poorest, indicating inequal accessibility.

Specifically, the accessibility to PSFs that are vital for living needs (e.g., shopping and catering, living services, sports and fitness, educational facilities, culture and leisure) relies on Metro Lines 1 and 2 to form a small range of high-value areas, north to the Huabei Road Community (Liu Jiaqiao), south to the Xinghai Caillette Mingzuo Community, west to the Xingda Fushan Community, and east to the Poly Tianxi (Phase II Xi'an) Community, creating a cross-shaped structure, with the accessibility gradually decreasing from the axes to peripheries outside of this range.

The high-value areas of elderly care, transportation, and medical facilities were relatively more prominent, reflecting fair public welfare allocation for these resources, as well as the environmental needs of the facilities themselves. Among them, the accessibility to transportation facilities was the largest, with high-value areas reaching Chinatown in the north, Xinghai Renjia in the south, Poly Xishan Linyu in the west, and the Poly Tianxi (Phase II Xi'an) Community in the east, presenting a scattered pattern of high-value areas, with Vanke Emerald Metropolis, Dahua Park Family, Vanke Charming City, and Ganjingli No. 6 Courtyard Community as the cores. The maximum overall accessibility was recorded in Huaye Rose Oriental Phase II, Shahekou District, and the minimum was observed in Ailishe Community, Ganjingzi District.

Elderly care facilities were centered around areas with natural environments and maintained an extensive spatial distribution range. The most high-value accessibility areas were recorded north of No. 2 Xinghua Road Community, south of Xinghai Renjia, west of Shengxin Park, east of Dalian Four Seasons Shangdong, with more scattered high-value areas centered around the Sakura North Park Community, Chinatown, Dahua Park Family, Paoya District 6, and the Zhen'an Holiday Coast. The maximum accessibility to elderly care facilities was observed in Huaye Rose Oriental Phase II, and the minimum was recorded in the MINI Impression Community.

The highest-value accessibility areas for medical facilities were located in Yuanyang Rongyu in the north, Xinghai Renjia in the south, Baoli Xishan Linyu in the west, and Jianguo Binyuan in the east, with Nanling New Town (Phase III South District), Paoya District 5, and Dahua Park Shijia forming the centers of the scattered high-value areas. The highest medical facility accessibility was observed in Huaye Rose Oriental Phase II, and the minimum was observed for 858 Home, both of which were located in the Shahekou District.

3.5. Impact of Public Service Facility Accessibility on Housing Prices

3.5.1. Variable Selection

Previously, it has been shown that community attributes, commercial location, traffic location, service location, and landscape location all impact housing prices in Nanjing City [49]. Elsewhere, Dong [41] and Zhang [50] concluded that population density, as well as urban infrastructure and social public services, impact housing prices. Notably, the number of residents in a community is related to the planning, scale, positioning, and grade of the community [51]. Considering the representativeness and availability of indicators, as well as the influence of community distance to the peak center on housing prices, 14 independent variables were selected for subsequent modeling, including: the logarithm accessibility to the eight types of PSFs, the comprehensive accessibility logarithm for PSFs, the logarithm of road network density, the logarithm of public service facility density, the number of households in the community, greening rate of the community, and logarithm of the distance between the community and nearest large shopping center. Thirteen large shopping mall gathering places, including Xi'an Road, Heishijiao, Chunliu, Qingniwa, Xianglu Reef, and Zhonghua Road were selected to represent the central shopping areas. The accessibility of various PSFs, road network density, and facility density were used to represent living locations, whereas the distance between the residential area and the nearest shopping center represented the commercial location, and the number of residential areas and greening rates described the characteristic location. The dependent variable was the logarithm of housing price.

3.5.2. Model Construction and Result Analysis

The logarithms between housing prices and living services, elderly care, and medical facility accessibility did not pass the significance test. After controlling for the architectural and commercial location characteristics of the residential areas, the accessibility of PSFs in each dimension was regressed against the housing prices; these results are presented in Table 4 (Logarithmic House Prices 1–6). Shopping/catering, transportation, education, sports, culture/leisure, and overall accessibility had the most significantly positive correlations with housing prices.

Table 4. Impacts of public service facility accessibility on housing prices.

Variable	The Logarithmic of House Price 1	The Logarithmic of House Price 2	The Logarithmic of House Price 3	The Logarithmic of House Price 4	The Logarithmic of House Price 5	The Logarithmic of House Price 6	The Logarithmic of House Price 7
The logarithm of shopping/ catering accessibility	0.004 ***						
The logarithm of traffic accessibility		0.007 **					
The logarithm of educational accessibility			0.007 ***				0.004 **
The logarithm of sports accessibility				0.011 ***			0.006 ***
The logarithm of Cultural/leisure accessibility					0.006 ***		0.004 ***
The logarithm of overall accessibility						0.009 *	
The logarithm of households	−0.019 **	−0.022 ***	−0.021 ***	−0.021 ***	−0.020 ***	−0.022 ***	−0. 020 ***
Greening rate	1.268 ***	1.256 ***	0.302 ***	1.286 ***	1.298 ***	0.265 ***	1.338 ***
The logarithm of the distance between the community and large shopping center	−0.060 ***	−0.065 ***	−0.050 ***	−0.056 ***	−0.056 ***	−0.065 ***	−0. 042 ***
Constant term α_0	9.978 ***	10.027 ***	9.915 ***	9.935 ***	9.968 ***	10.016 ***	9.824 ***
Sample size N	2422	2422	2422	2422	2422	2422	2422
Judgment Coefficient R_2	0.510	0.515	0.513	0.480	0.505	0.479	0.486
F statistic	67.44 ***	65.89 ***	70.81 ***	72.09 ***	71.23 ***	66.55 ***	50.596 ***

Note: ***, **, and * indicate that the impact of this variable on house prices is significant at the 1%, 5%, and 10% levels, respectively.

Regression analyses were conducted among the correlated variables to derive their actual impact on housing prices. The results showed that the *p*-values for the logarithms of road network density, public service facility density, overall accessibility to PSFs, shopping/catering accessibility, and accessibility to transportation facilities were >0.1 (i.e., not statistically significant). When excluding these variables and rerunning the model, it was found that the regression coefficients and test values of the remaining variables were nearly unchanged; thus, it was concluded that the eliminated variables did not have a significant impact on the model. The final results are shown in Table 4 (Logarithmic Housing Prices 1–7). For each group of models, the variables were significant, with the R^2 of the regression model fluctuating around 0.5, indicating the model's relative accuracy at characterizing the impact of each variable on housing prices.

Central Dalian is a mature city, with dense road networks. With the popularization of household cars, the dependence of residents on public transport has been gradually decreasing. Notably, standard supermarkets, convenience stores, small shopping malls, and restaurants can help meet the daily needs of residents, they account for a significant proportion of 15-min community living circles, and tend to be saturated; thus, small changes in shopping and catering are not likely to have a significant impact on housing prices. As the urbanization level of Dalian's central area is high, the preference of residents for high-quality education, sports leisure, and cultural entertainment projects can drive housing prices.

Specifically, the accessibility coefficient of educational facilities was significantly positive, as high-quality educational resources are critical social resources, especially within a 15-min community living circle. It is important for school-age students to be able to attend a local facility, and school selection is often a critical focus for real estate developers and buyers alike, aiming to provide a strong education and space for learning. Controlling for all other variables, for every 1% increase in educational facility accessibility, the average housing price increased by 0.004%.

The accessibility coefficient for physical fitness facilities was also significantly positive, in line with expectations. Here, parks, squares, and fitness locations were selected to represent physical fitness facilities in the present study. Parks and squares are often placed in desirable geographic locations as they enhance the living environment; thus, they and are the first choice for citizens' fitness and leisure. Similarly, fitness spaces have become an essential component of urban areas; they promote the reconstruction of urban social spaces. Accordingly, the vicinity of parks and squares are intensive areas corresponding with high housing prices. Controlling for all other variables, for every 1% increase in the accessibility of physical fitness facilities, the average housing price increased by 0.006%.

The accessibility of cultural facilities has a significant positive impact on housing prices at the level of 1%. Here, museums, art galleries, libraries, cultural activity centers, and theaters were chosen to represent cultural facilities, all of which are primarily distributed in the city centers, in convenient locations for residents to spend their free time. Controlling for all other variables, for every 1% increase in cultural facilities accessibility, the average housing price increased by 0.004%.

The impact of the number of residential households on housing prices was significantly negatively at the level of 1%, where the more homes in the community, the higher the population density, the less the available living space and comfort, and the lower the relative housing price. Controlling for all other variables, for every 1% increase in the number of community households, the average house price decreased by 0.020%.

The greening rate is an essential indicator of the comfort of living space environments, and an increase often corresponds to an increase in construction and maintenance costs for vegetation, thereby, increasing housing prices. The greening rate in downtown Dalian was significantly positively correlated with housing prices. For example, the residential areas near parks had high housing prices. Controlling for all other variables, for every unit increase in the greening rate, the average household price increased by 133.8%.

Commercial centers are also popular, economically active, and maintain convenient transportation. Commercial complexes, such as large shopping centers, increase the convenience of daily life; thus, the distance logarithm between residential areas and shopping malls was significantly negatively correlated with housing prices at the 1% level. Controlling for all other variables, for every 1% increase in the distance between the community and the nearest shopping mall, the average housing price decreased by 0.042%.

Finally, the impact of comprehensive accessibility on housing prices was investigated, and the results are shown in the "Logarithmic Housing Price 6" column of Table 4. Overall accessibility had a positive impact on housing prices, and it is significant at the level of 1%. Controlling for all other variables, for every 1% increase in overall accessibility, the average housing price increased by 0.009%.

4. Discussion

4.1. Agglomeration Characteristics of Public Service Facilities at the Microscale

The present study was performed at the community level, analyzing the PSFs within a living circle of 800 m from the community as the specific research object. Comparatively, most scholars have conducted analyses at the city, street, and community scales [44–46]; thus, the present study was carried out at a more detailed spatial scale to precisely assess the agglomeration characteristics of PSFs.

4.2. Extracting Factors Influencing Housing Prices

Previous research results have primarily focused on the influence of commercial location, transportation location [49], supply and demand [39], local finance, and interest rates [41] when assessing urban housing prices from a larger scale. Comparatively, the present study investigated the impact degree of public service facility accessibility on housing prices within an 800-meter living circle to help updated research perspective.

4.3. Limiting Factors

Notably, the community areas were divided by size (main entrance to exit), and thus, the internal road networks were inaccurately reflected, and actual accessibility is likely to vary. Furthermore, the POI data did not contain grade, scale, or quality information, and thus, did not account for the age and architectural characteristics of residential areas; this may also affect the calculation of housing prices. In future analyses, the weight of POI data should be considered to yield more detailed results and strengthen the conclusions surrounding the mechanisms influencing the spatial aggregation of PSFs.

5. Conclusions

Based on Baidu map data, the present study explored the spatial distribution characteristics of PSFs in downtown Dalian, China from the perspective of a 15-min community living circle. The relationships between facility accessibility and housing prices were explored as well, and the following conclusions were drawn:

(1) The PSFs in central urban Dalian are unevenly distributed, with more facilities in the Zhongshan, Shahekou, and Xigang Districts than those in the Ganjingzi District. The spatial aggregation of PSFs was evident, although the degree of agglomeration varied depending on the facility type, where the agglomeration of business facilities was higher than that of public welfare facilities. Market-led catering, shopping, and living service facilities formed a high-density region in the core area of the central city, displaying a center–periphery layout. Government-led public welfare services, such as elderly care, transportation, sports and fitness, and medical care were widely distributed, and displayed a multi-center layout with a relatively balanced distribution over the study area.

(2) Significant spatial differences in the number of facilities accessible and the primary urban traffic routes had a notable effect on population and industry agglomeration. Further, differences in public service facility accessibility were also recorded across

various communities, with more than two-thirds of residents able to obtain ≥seven types of PSFs within a 15-min walking distance. PSFs were notably limited along the Hongqi Street, Yingchengzi Street, Gezhenbao Street, and Dalian Bay Street, along the edge of Ganjingzi District.

(3) Based on the cumulative opportunity method and distance attenuation effect, the accessibility of various PSFs in the residential areas of central Dalian was calculated. The results showed that the spatial distribution of accessibility is unbalanced, with the distribution of business service facilities generally being higher than that of public welfare facilities. Accessibility for all types of PSFs was the highest in the Shahekou District, while that for operating PSFs in the Zhongshan District was higher than in the other two districts, and the accessibility of public welfare public services was greater in the Xigang District than that in the other two districts. Notably, accessibility for all types of PSFs was the most limited in the Ganjingzi District.

(4) By introducing the commercial areas and characteristic locations of the residential areas, the influence of the accessibility to various PSFs on housing prices were assessed, which revealed that access to education, sports, culture, and leisure facilities, as well as overall accessibility and greening rate of the residential area, had the most significant positive correlations with housing prices. In contrast, the number of households in the residential area and distance between the region and the nearest large shopping center were significantly negatively correlated with housing price.

Based on the aforementioned conclusions, greater efficiency and equality during the future urban planning of Dalian, including improving the utilization efficiency and reducing repeated construction of facilities, making corresponding supplements for missing facilities, and increasing the number and types of PSFs in the community living circles that are the least accessible, are highly essential to solve the contradiction between residents' needs and the unbalanced and insufficient facility configuration. Specifically, the investment in high-quality educational and medical resources must be strengthened in the marginal areas of the central city to markedly improve the current situation of public resources in the western and northern area of the Ganjingzi District; further, the accessibility and sharing of PSFs should be enhanced to help create optimal community living circles with sufficient access to facilities. Considering the effects of distance attenuation, the cumulative opportunity method can measure the accessibility of PSFs in the central urban Dalian more accurately and analyzes the impact of PSF accessibility on housing prices. Using accessibility indicators as explanatory variables for housing prices, which are in line with people's actual considerations when purchasing a house, this method can test people's preferences for different types of public service needs when purchasing houses.

The definition of the pedestrian scale and its use within the context of urban planning are of utmost importance. Future research should focus on ascertaining the influence of rail transit; delineating the service scope of PSFs on a larger scale, based on the distance which residents walk to rail transit; and finally, supplementing the elderly with a pick-up station, shuttle bus, and other facilities in the vicinity of rail stations. Overall, these approaches would be implemented to optimize the configuration of public welfare facilities, further optimizing the livelihoods of residents across various demographics. Another step that should be taken in future studies is to study the relationship between land use and travel behavior within Dalian. The goal of such a study would be to ensure that the region does not exceed the ecological carrying capacity of the environment it is built upon and limit the ecological environment carrying capacity, by establishing several compact development units based on a "concentrated decentralization" regional layout. This method entails fine-scale integration of transportation and land-use planning, construction of compact cities, construction of sustainable urban communities, and continuous upscaling of these approaches. Through different levels of centers, using the connection of transportation and development axes to change the layout of the city makes the population distribution orderly and even and mitigates the overuse of the central city. These initiatives are important to alleviate the pressure of overpopulation and reduce housing prices in central urban areas, to improve the utilization efficiency of PSFs in fringe areas, and to effectively prevent the spread of suburbanization. The present study provides new ideas for research regarding topics such as compact cities, sister cities, and smart cities.

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