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Assessment of the Impact of Basic Public Service Facility Configuration on Social–Spatial Differentiation: Taking the Zhaomushan District of Chongqing, China

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Abstract: Objectively assessing the impact of various basic public service facilities on social–spatial differentiation has become a prerequisite for promoting urban social integration and development. However, in practice, the configuration of basic public service facilities is not always conducive to social integration, especially at the microscale. Effectively measuring the inhibitory or aggravating effects of various basic public service facility configurations on social–spatial differentiation has become a challenge. Based on the assumption that the configuration of basic public service facilities has inhibitory and aggravating effects on social–spatial differentiation, this study selected two types of objects: social space and basic public service facilities to refine the research elements. Using spatial and statistical analysis methods such as ecological factors, clustering, correlation, mediation, and superposition analysis, a framework was constructed to evaluate the impact of basic public service facility configuration on social–spatial differentiation and take the Zhaomushan area in Chongqing, China, as a typical case for verification. The study found that registered residence, income, employment location, and residential density are still the main factors of social–spatial differentiation in the study area. The main factors contributing to the differentiation of basic public service facilities are elderly care and housing security, public transportation and green space access, education and employment security, and small-scale medical and health facilities in the study area. In the eight principal factor pairs after the superposition of two differentiation spaces, six pairs showed weakened spatial differentiation, while two pairs showed intensified spatial differentiation. This indicates that the allocation of basic public service facilities will simultaneously inhibit and exacerbate social–spatial differentiation, but the inhibitory effect is significantly stronger than the exacerbating effect. Among them, public transportation and green parks are the main types of facilities that mainly exacerbate social–spatial differentiation. This dual effect is specifically reflected in the change in the spatial adaptation position of social space and basic public services, the weakening of the original social space differentiation boundary and the emergence of new differentiation boundaries simultaneously, and the multicenter composite form of social space. In the future, quantitative evaluation based on research frameworks can provide scientific basis for constructing spatial adaptability strategies for the supply of basic public service facilities and social production and life, such as adjusting the distribution, scale, and spatiotemporal relationship between basic public service facilities and residential communities in a reasonable manner. This is crucial for promoting social integration.

Keywords: basic public service facilities; social–spatial differentiation; inhibition effect; social integration; urban planning

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1. Introduction

1.1. Background

The scale and speed of global social–spatial transformation in recent decades have led to a fundamental reconfiguration of the urbanization process. Under the globalization of capital, labor, and culture, cities around the world have observed an increase in social–spatial inequality [1,2]. The inequality in social space can significantly lead to the widening gap between rich and poor, exacerbating the differences in economic status, social status, and cultural quality among different social groups, and triggering social conflicts. Promoting social integration is of great significance for sustainable urban development.

Social space, as a geographical area where certain social groups live and produce, describes the dual attributes of people in social relationships and regional space, reflecting the complex combination of characteristics of human social behavior and living space. The most common form is community [3,4]. The so-called social–spatial differentiation is manifested at the social level as differences in the integration feelings of individuals or groups in their social class and social space; in terms of regional space, it manifests as differences in individual and group attributes, namely differences in daily activities and spatial isolation [5,6]. The changes in social space are not only limited to the spontaneous migration of individuals but also influenced by the choice of job and residential space under market leadership and the active and passive migration under government leadership. At present, suppressing social–spatial differentiation mainly relies on government policy measures to promote the aggregation or diffusion of social groups in geographical space. However, after practice, it often exhibits "duality", such as projects facing vulnerable groups are mostly distributed in poorly developed areas, which to some extent exacerbates the gathering of vulnerable groups; the income regulation and resource redistribution represented by the configuration of basic public services, such as the popularization of education and healthcare, have narrowed the gap in resource acquisition.

1.2. Literature Review

In the 1920s and 1930s, Park cited theories of human ecology and urban ecology to study urban social–spatial structure, which is seen as the beginning of research on social–spatial differentiation [7]. In the 1980s, Castells pointed out in the theory of network society that social systems have a constructive effect on urban spatial environment [8]; Hemach found that cultural differences, racial segregation, and population redistribution policies are important influencing factors for social–spatial differentiation [9]; Yu and Xu found that compared to European and American countries, race is not the cause of social–spatial differentiation in China, but the degree of population aggregation and cultural and occupational composition are the main influencing factors [10,11]. During this period, the academic community has generally recognized the dialectical relationship, interaction, and influencing factors between economy, society, and material space. Entering the 21st century, research content tends to focus more on the role of people in social space, the mutual influence mechanism between material space and social space, and the trend of social–spatial differentiation at different scales [12,13].

In terms of the role of people in social space, Bofulin pointed out that the flow and aggregation of people are the foundation for the formation and change of social–spatial differentiation [14]. Kidokoro found that the degree of gentrification and differentiation in the Tokyo worker community is highly autocorrelated in local space [15]; Huang found a significant correlation between the population and the type of residential space [16]; Qiang found that the number of social areas formed by migrant workers in cities is stable, their internal attributes are constantly changing, and social–spatial differentiation tends to be clear and concentrated [17]; Sheng found that there is a significant differentiation in the spatial distribution of employment and housing among graduates from low-income universities in Beijing [18]; Bi found that the working and living space and registered residence of the population are closely related to the distribution of primary and secondary schools [19]. As the connotation of social space expands to include the space where

residents' daily behaviors involve, stay, and feel, research has begun to focus on the social space and specific behaviors of specific populations [20,21]. For example, Gu proposed a conceptual framework for integrating social space into people's feelings [5]. This type of research believes that the essence of social–spatial differentiation is the differentiation of human social relationships and social activity structures. These studies of social space that focus on the attributes of the population continue the view that urban social space is a spatial representation of social class structure and can effectively analyze social problems.

In terms of the mutual influence mechanism between material space and social space, the material spaces that attract people to move and settle are mainly divided into three categories: residence, employment, and basic public services. The spatial-temporal overlap of individuals in these spaces is a prerequisite for social interaction, and these material spaces are also considered important elements in promoting social integration. In addition to the commonly concerned occupational and residential spaces, the importance of basic public service spaces is highlighted [22,23]. Liu and Xiao discovered in the early 21st century that strengthening public service investment around communities with social–spatial differentiation can promote social stability and integration [24]. Research works on the configuration of physical spaces, such as park green spaces, transportation systems, medical facilities, and educational facilities, specifically targeting different social groups have found that the spatial configuration of basic public service facilities can have a positive impact on the evolution of social space [25–31]. On the contrary, a small number of studies have found that the configuration effect of basic public services has shown an opposite state to the original intention. Wang pointed out that basic public education services did not significantly alleviate relative poverty, while basic labor and employment services and basic housing security services actually exacerbated the degree of relative poverty. Exploring the impact of basic public service configuration on social space has become a future research focus [32].

In terms of research scale, Carvalho and Netto found that social–spatial differentiation can occur within differentiated regions [33]; Zheng believes that the built environment at the microscale has more influence on the evolution of social–spatial structure than social and economic conditions [34]; Chai believes that social differentiation can also occur within the social district units divided in macro research, such as the isolation between users of different houses in mixed residential areas, which can form a micro social–spatial structure [35]. These studies have found a trend of further differentiation within differentiated social spaces within specific populations and spaces.

Early research methods were mainly based on empirical qualitative analysis. After the advancement of computer technology and population survey statistics technology, research methods based on multivariate statistics and spatial analysis technology began to be applied [36,37]. Analysis methods such as geographic information systems, human dynamic models, spatial syntax, type morphology, social network analysis, clustering methods, etc., began to deepen traditional research methods. Emphasizing the visual expression of social space helps to deeply understand the composition, structure, and evolution process of social space. The factor ecological analysis method based on demographic data is a representative objective assignment method, which has been applied in the study of social–spatial differentiation in large cities in countries such as the UK, France, Poland, etc. [37]. Factor ecological analysis, as a statistical analysis method, lacks a sufficient explanation of the formation mechanism of social–spatial structure models and easily overlooks the impact of spatial factors on social–spatial differentiation [38]. In order to further study the mechanism of social–spatial differentiation, research combining superposition analysis and coupling analysis of urban material spaces is gradually increasing [16]. At present, multisource big data provide the possibility for obtaining data from various analysis methods mentioned above. As the research perspective of social space shifts from material space to behavioral and sensory space, there is an increase in research on analyzing social–spatial structure using big data such as population trajectory and distribution [17,21,37]. The addition of individual data is of great help in reducing the statistical data errors of individual needs and

feelings and can more accurately depict social groups. For example, data containing basic and behavioral information of individuals such as social software check-in, bus swiping, and map check-in greatly expand the possibility of social–spatial analysis [39].

1.3. Knowledge Gaps, Novelty, and Significance

In summary, in terms of research content, as the service demand of the population expands, the material space that provides basic public services has become a key focus compared to the previous focus on work and housing space. The role of basic public service facilities in the distribution of social groups and the reshaping of social space has become a new research direction. However, current research mainly focuses on the relationship between a certain type of public service facility and social–spatial differentiation, and there is insufficient research on the social–spatial differentiation effect of comprehensive basic public service facility configuration. In terms of research scale, communities and streets, as the main scales for the implementation of basic public service facilities, have begun to experience further social–spatial differentiation. However, there is currently insufficient research on the correlation between social–spatial differentiation at microscales such as communities and streets and the configuration of basic public service facilities. In terms of research methods, factor ecological analysis is currently a representative objective assignment method that can extract spatial main information. By combining multiple statistical and spatial analysis methods and obtaining research data through multisource big data, individual data, and research visits, it is possible to provide a more in-depth explanation of the impact of comprehensive basic public service facility configuration on social–spatial differentiation.

Therefore, we aim to construct a comprehensive evaluation framework to understand and evaluate the impact of the comprehensive configuration of basic public service facilities on urban social–spatial differentiation. And the evaluation framework constructed by the research institute is universal and developmental, and the overall logic of the evaluation framework can be applied in many cities. At the same time, it can also optimize the elements in the framework by combining the management and operational characteristics of different cities. In addition, the overall research results can provide scientific basis for constructing spatial adaptation strategies between the supply of basic public service facilities and social production and life, which is of great significance for promoting social integration.

2. Methods

2.1. Research Ideas

The study will assume that the comprehensive configuration of basic public service facilities has inhibitory or aggravating effects on social–spatial differentiation and select two objects: social space and basic public service facilities, and subdivide the research elements. Select typical case sites and analyze the social–spatial differentiation characteristics, basic public service facility differentiation characteristics, and two types of differentiation superposition characteristics of the case sites to verify the hypothesis (Figure 1).

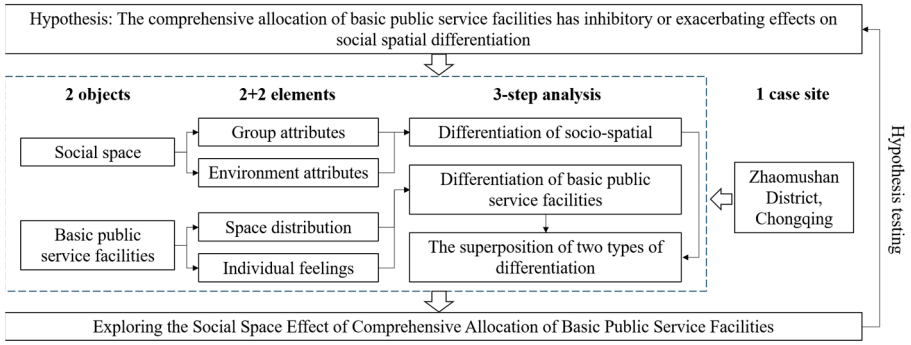

Figure 1. Research ideas.

2.2. Elements and Measurement System

Research selects two types of elements: group attributes and environmental attributes to describe the differentiation of social space. Among them, group attributes include natural attributes and social attributes, with natural attributes referring to the age, gender, health status, etc., of the population. Social attributes refer to the family structure, education level, income, occupation, ethnicity, etc., of the population, which serve as the criteria for dividing social groups. The environmental attributes refer to the total population, residential density, population density, registered residence, employment location, and other attributes related to the environment as the criteria for dividing social space.

Research selects elements from two aspects: spatial distribution and individual perception, and combines them with a standardized selection of 8 types of facilities, including public transportation, basic education, healthcare, culture and sports, elderly care, housing security, employment and entrepreneurship, and parks and green spaces, for measurement [40]. At present, basic public service facilities are mostly configured based on the concept of a community living circle, and the 15-min walking range (i.e., 750 m) is considered as the boundary distance for obtaining basic public services in the community. Regarding spatial distribution, the study takes the number of facilities within a 15-min walking range from the entrance and exit of a residential quarter, as well as the nearest facility distance, as quantitative indicators (schools and affordable housing have special characteristics, and the quantitative indicators may vary accordingly). Considering the "quality" and "quantity" of basic public service facilities at the microscale, the individual feelings of service recipients will use facility satisfaction, facility acquisition, and facility usage frequency as quantitative indicators [41] (Figure 2).

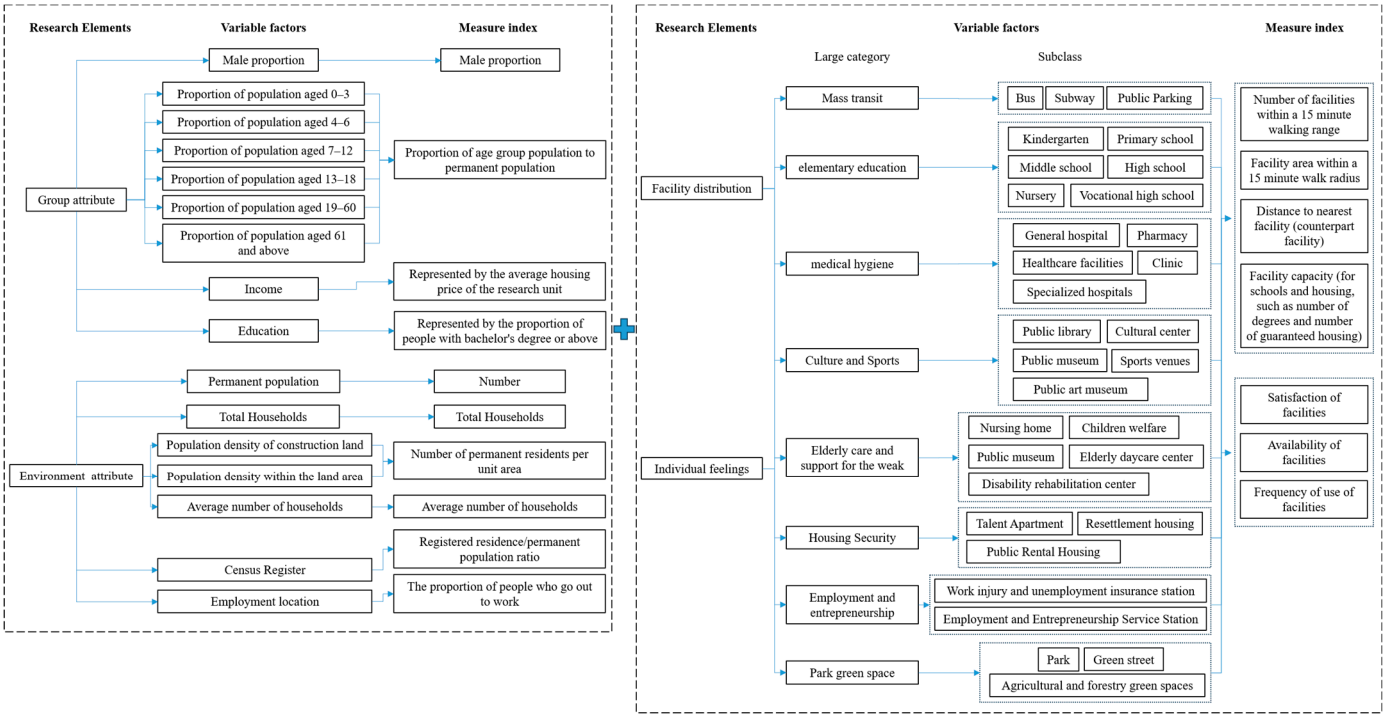

Figure 2. Elements and measurement system.

It should be noted that the Elements and Measurement system constructed in this study has universality and development potential. This is reflected in the fact that the selected elements and measurement system in the study can be universally applicable to most cities, but based on the differences in systems and management of different cities, the indicators in the elements and measurement system can be further optimized, such as adding or removing some indicators. Therefore, relatively speaking, the advantage

of the elements and measurement system constructed in research lies in the ability to comprehensively consider the impact of the type, service space, service quality, and other comprehensive states of basic public service facilities on social–spatial differentiation, rather than just focusing on a certain type of facility. At the same time, this will also increase the basic workload of research, which requires collecting and processing more complex data. But collecting and processing these complex pieces of information will also help us further understand the differences between cities in the future.

2.3. Data

The research data involve three categories: statistical, spatial, and behavioral data. Statistical data are mainly obtained from demographic data. Spatial data include land use information, POI (Point of Interest) and AOI (Area of Interest), and other information attached to POI and AOI. Behavioral data include questionnaire surveys and checking in on Weibo, as well as collecting data from school districts and other auxiliary analyses (Table 1).

Table 1. Data source and purpose.

Type	Source and Name	Use
Statistical data	2020 Village and Town Planning Information Database	Obtain demographic data for each community
	2020 National Land Change Survey Database	Obtain current land use status
Spatial data	Bigemap GIS Office (v25.5.0.1)	Obtain high-definition satellite images and road networks
	Baidu Map Open Platform: AOI and POI	Obtain distribution of residential quarter and facilities
	Anjuke website: housing prices, number of households	Obtain housing prices and number of households in residential quarter
Behavioral data	Survey questionnaire: 451 valid questionnaires	Obtain facility satisfaction and accessibility
	Visits and discussions: 32 people	Auxiliary data analysis
	Check-in on Weibo	Obtain facility usage frequency
Other information	"Chongqing Local Treasure" official account and school enrollment tweets	Obtaining school district information

Due to the different dimensions of the original data, they are not comparable in factor ecological analysis and require data standardization. One of the commonly used methods for data standardization is z-score standardization (Equation (1)), also known as standard deviation standardization. The standardized data show a standard normal distribution, with a mean of 0 and a standard deviation of 1.

$$Z = \frac{(X - \mu)}{\sigma} \quad (1)$$

In the formula, Z represents the standardized data; X is the original data; μ is the mean of the original data; σ is the standard deviation of the original data. It should be noted that the reciprocal of the selected distance between a residential quarter and basic public service facilities is standardized to meet the evaluation criteria. The population data calculation process uses the proportion of the population to the permanent population.

2.4. Calculation and Analysis Methods

Firstly, in response to the differentiation of social space and basic public service facilities, factor ecological analysis is used to extract the main factors. Then, R-type clustering, hierarchical clustering, Euclidean distance measurement, and sum of squares of deviations are used to analyze the differences of the main factors in geographical space, in order to divide different types of social zones. Then, for the superposition of the two types of differentiation, Kendall correlation coefficient was used to analyze the main factor correlation of the two types of differentiation, and intermediary analysis was used to analyze the direct and indirect effects of the main factors. Finally, based on the differences between the two

types of differentiation and stacking, the different characteristics after stacking are analyzed from three levels: "point, line, and surface". The specific calculation principle and process are as follows:

Factor ecological analysis can extract overlapping information from a large number of variable factors with certain correlation relationships and then synthesize them into several main factors to replace the original variables for accurate prediction and decision support. The calculation can be represented by a matrix, assuming that there are n original variables (X_1, X_2, …, X_n), the correlation testing (based on the research sample, Bartlett's sphere test method is used) and the standardization processing (mean adjusted to 0, standard deviation adjusted to 1) should be performed on these original variables first. Then, it is represented by a linear combination of k factors ($f_1, f_2, \ldots, f_k$). Finally, after calculating the matrix to extract the main factor, perform orthogonal rotation, interpretation, renaming, and visualization on the main factor (Equation (2)).

Cluster analysis can reveal the degree of influence of main factors in geographical space and divide social space into different types of social zones, more intuitively describing the differentiation characteristics of social space. The research selects R-type clustering and hierarchical clustering methods, and based on the Euclidean distance measure and the sum of squares of deviations of the calculated samples, gradually merges them to obtain a tree-like clustering map. After confirming the number of results for social zones, the results of social zone division are named, connected, and visualized.

Kendall correlation analysis is based on hierarchy and is more suitable for handling nonlinear data. The Kendall correlation coefficient is more suitable for testing the relationship between spatial differentiation factors of basic public service facilities and social–spatial differentiation factors (Equation (3)).

Intermediate analysis is the direct or indirect correlation mechanism between observed independent and dependent variables identified and explained through intermediary variables. When the independent variable X directly affects the dependent variable Y, it is called the direct effect of X–Y. When the influence of the independent variable X on the dependent variable Y is achieved through a mediating variable M, it is called the indirect effect of X–Y, and M is the mediating variable between X and Y. The calculation process involves fitting three models (Equations (4)–(6)). If the effect of X on Y is originally significant but becomes insignificant after controlling for M, it indicates that the mediation of M on X–Y is completely mediated. If c' only partially decreases relative to c, it is a partial mediator. The calculation of mediating effects in this article involves the product of parameters, and the distribution does not satisfy the normal assumption. Therefore, bootstrap self-sampling is used to obtain confidence intervals and p-values.

Spatial overlay analysis is based on the results of cluster analysis. Firstly, the load values of the two differentiated main factors are subtracted and added according to the spatial distribution (Equations (7) and (8)) to identify the main mismatch locations (involving two types of basic public service configuration states: priority and lag). Then, identify the boundaries of two types of differentiation and the weakened or strengthened boundaries after the superposition of the two types of differentiation. Finally, the two differentiated social zones are overlaid to obtain a new differentiated social space affected by the differentiation of basic public service facilities.

$$\begin{cases} X_1 = a_{11}f_1 + a_{12}f_2 + \cdots + a_{1k}f_k + \varepsilon_1 \\ X_2 = a_{21}f_1 + a_{22}f_2 + \cdots + a_{2k}f_k + \varepsilon_2 \\ X_3 = a_{31}f_1 + a_{32}f_2 + \cdots + a_{3k}f_k + \varepsilon_3 \end{cases} \quad (2)$$

In the formula, X_1, X_2, ..., X_n are the original variables; a_{11}, a_{12}, …, a_{1k} represent the weight coefficient between X_1 and each factor ($f_1, f_2, \ldots, fk$), and so on; ε refers to a special factor that represents the loss of raw variables that cannot be explained by the factor, with a mean of 0.

$$R = \frac{4P}{m(m-1)} - 1 \quad (3)$$

In the formula, R is the Kendall correlation coefficient; P is the logarithm of statistical objects with consistent size relationship between two attribute values; m is the number of statistical objects.

$$Y = i_1 + cX + \varepsilon_1 \tag{4}$$

$$Y = i_2 + c'X + bM + \varepsilon_2 \tag{5}$$

$$M = i_3 + aX + \varepsilon_3 \tag{6}$$

In the formula, i_1, i_2, i_3 represent the intercept term of the model, ε_1, ε_2, ε_3 represent the residual term of the model; c is the direct effect of X on Y; c' is the indirect effect of X on Y after controlling for the mediating variable; a is the effect of X on M; b represents the effect of M on Y after adjustment.

$$\varphi_a = F_n - F'_N \tag{7}$$

$$\Phi_a = F_n + F'_N 3 \tag{8}$$

In the formula, φ_a is the degree of differentiation mismatch in spatial unit a, and the higher the absolute value, the more mismatched the two types of spaces; Φ_a is the apparent degree of superposition differentiation of spatial unit a, and the higher the absolute value, the more obvious the differentiation; F_n is the main factor of social–spatial differentiation, and n is the sequence number of its main factor; F'_N is the main factor for spatial differentiation of basic public service facilities, and N is the sequence number of its main factor.

3. Study Area

The Zhaomushan area in the Yubei District, Chongqing, China, is located at 106.5° E and 29.6° N, and the region has basically entered a stable development state. In terms of economic conditions, Dazhulin Street has the highest GDP, Renhe Street is at a moderate level, and Kangmei Street has the lowest, showing a gradient state. In terms of residents' richness, Kangmei Street is the second public rental housing community in Chongqing, with a large number of residents and overall low income as the main characteristics, but neighboring Renhe Street and Dazhulin Street are the gathering areas of high-quality residential areas and industrial headquarters bases, with overall high income for residents. The selection of these three streets as the study area is typical. The 19 communities within the study area (actually 20, as there are no residential areas in the Kangzhuangmeidi 1 community, they will be merged with the Kangzhuangmeidi 2 community for calculation) will be used as spatial units for social–spatial differentiation research and characterization. To more accurately depict the role of basic public service facilities in social–spatial differentiation, each residential quarter within the study area will serve as a spatial unit for the study and characterization of basic public service facility differentiation (Figure 3).

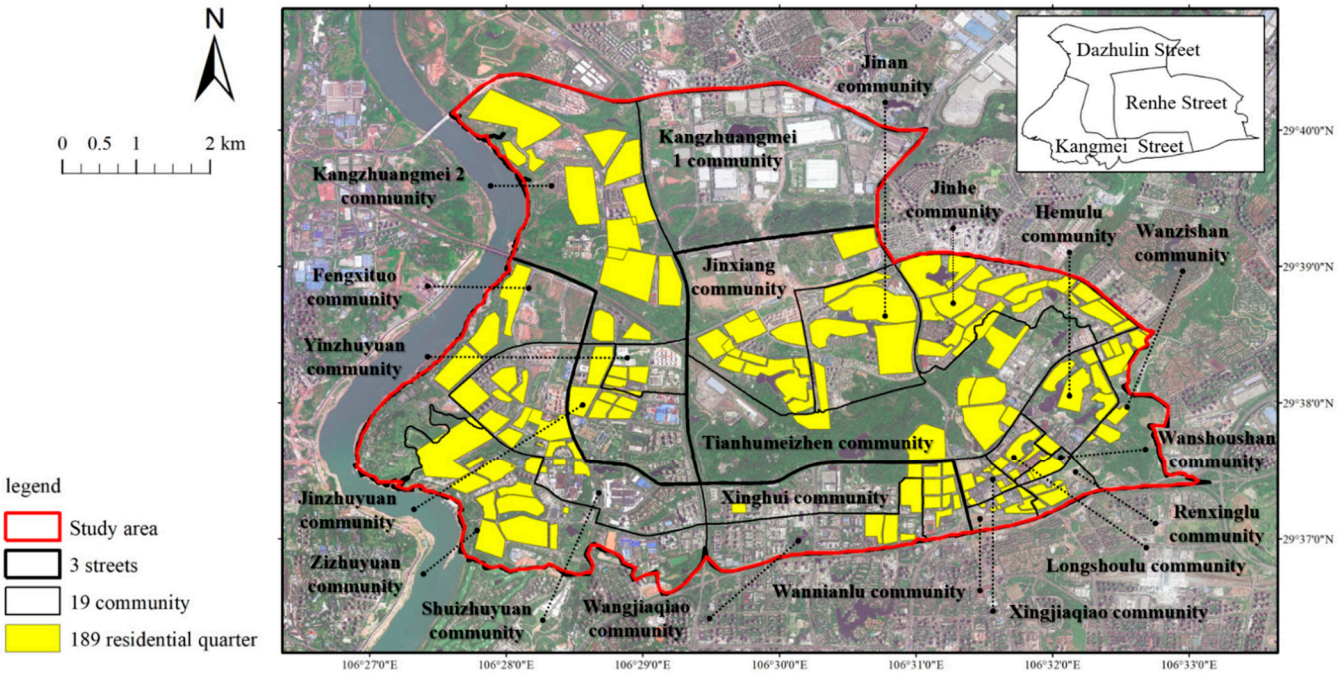

Figure 3. Study area.

In terms of social space, the core of the registered residence population and the permanent population are located on the east and west sides, respectively, with dislocation. High-population-density areas contain a high proportion of the migrant population, and under the restrictions of the registered residence policy, the access to basic public services in these areas is weak. The average number of households is mainly 2–3, distributed in the central region. The spatial units with an average number of households exceeding 10 are the Jin'an community and the Renxing Road community, mainly caused by a large quantity of high-density joint renting. The social groups in these spatial units have obvious characteristics of low income and low education. In terms of age distribution, the young and middle-aged labor force is concentrated on the south side, the underage population is concentrated on the north side, and the migrant workers are concentrated on the north side. There are more permanent residents who settle in the south side of the young and middle-aged labor force, and this group of people has a periodic phenomenon of family separation where they gather on work days and return to their families on rest days. The retired population is concentrated in the central and southern regions, while infants and young children are mainly distributed in the northern region. Overall, there are differences in the spatial distribution of social groups with different attributes within the study area, and there have been social–spatial differentiation characteristics, with more obvious differences on the north and south sides (Figure 4).

In terms of basic public service facilities, the distribution of facilities in the study area is significantly uneven, concentrated on the south and east sides, forming a core on the west and middle sides. In general, the current configuration of basic public service facilities is consciously inclined to areas with high population density and low registered residence registration population, which makes the distribution of eight types of basic public service facilities present spatial heterogeneity and local spatial agglomeration, and the overall distribution is concentrated on the southern and central annular area (Figure 5).

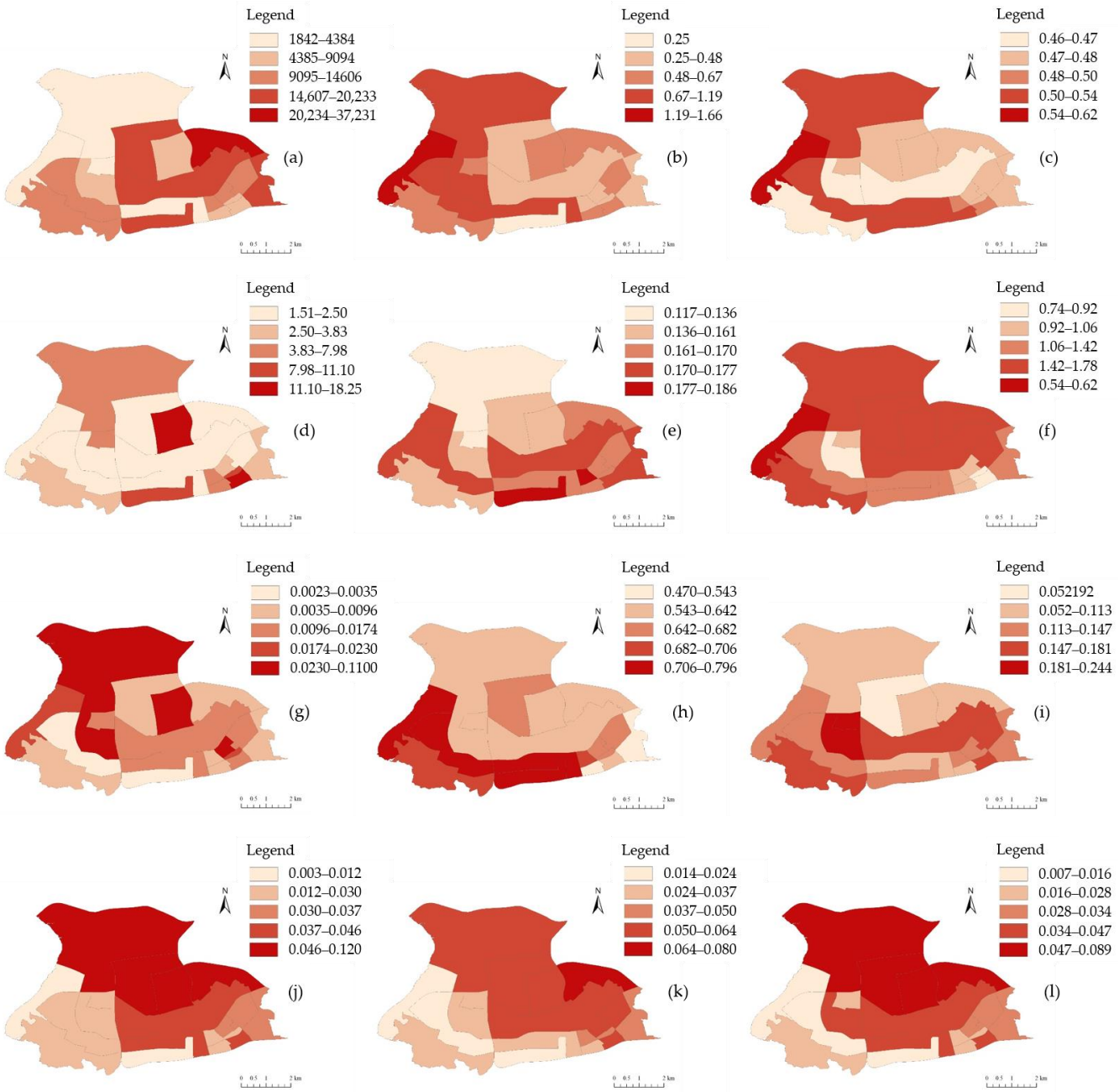

Figure 4. Social space: (**a**) Distribution of permanent population; (**b**) Registered residence/permanent population ratio distribution; (**c**) Male proportion distribution; (**d**) Distribution of average household size; (**e**) Distribution of educational levels; (**f**) Income level distribution; (**g**) Distribution of the proportion of migrant workers; (**h**) Distribution of the proportion of young and middle-aged labor force population; (**i**) Distribution of the proportion of retired population; (**j**) Distribution of infant population proportion; (**k**) Distribution of the proportion of primary school age population; (**l**) Distribution of the proportion of kindergarten age population.

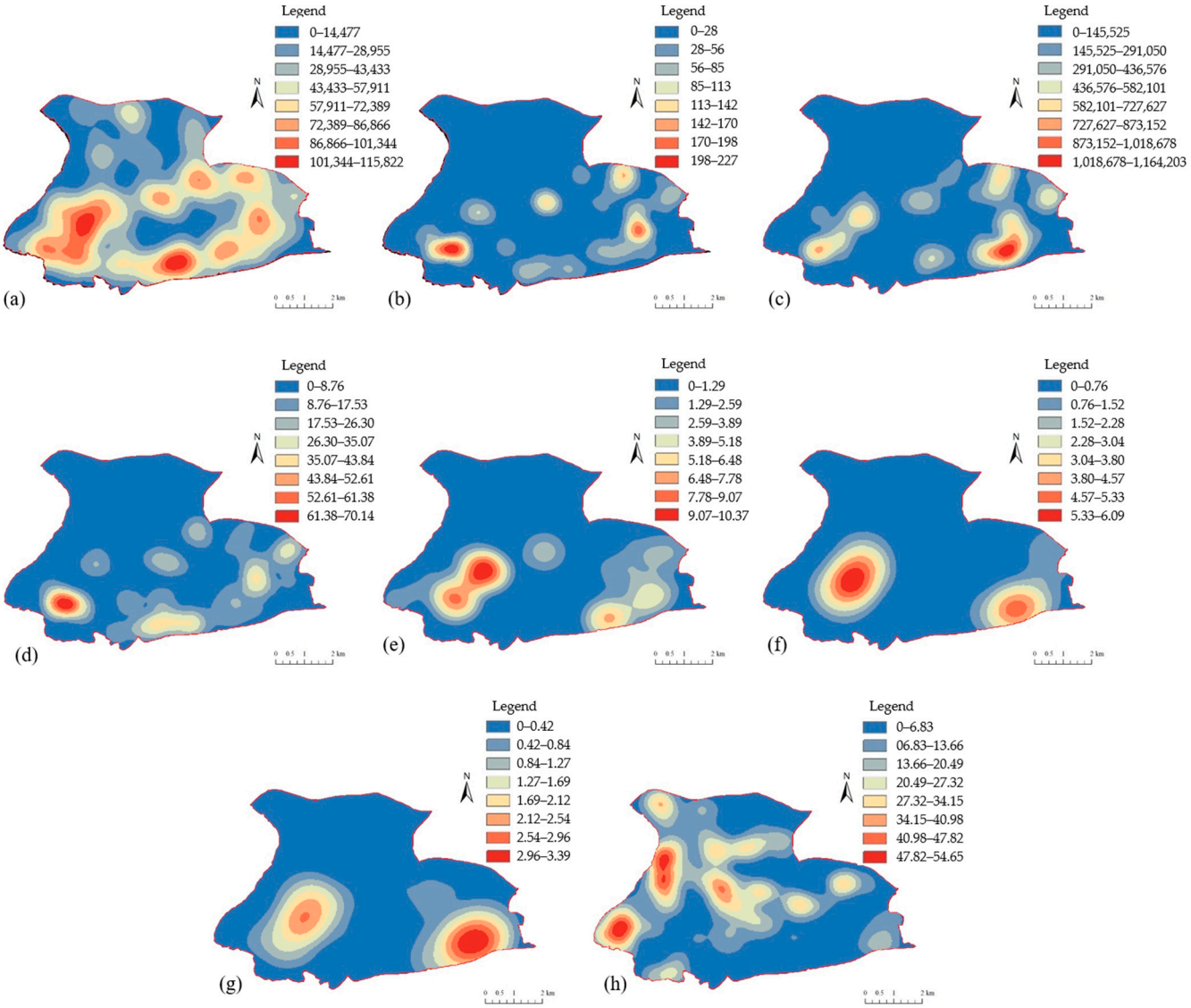

Figure 5. Density distribution of basic public service facilities: (**a**) public transportation; (**b**) elementary education; (**c**) medical hygiene; (**d**) culture and sports; (**e**) elderly care and support for the weak; (**f**) housing security; (**g**) employment and entrepreneurship; (**h**) park green space.

4. Results

4.1. Characteristics of Two Types of Differentiation

Based on the score coefficients of variable factors, the three main factors F1, F2, and F3 of social–spatial differentiation were extracted, which are children aged 0–12, low income and high residential density, and local employment. The cumulative contribution rate of the variance of the three main factors reached 76.835%. Extract the four main factors F′1, F′2, F′3, and F′4 for the differentiation of basic public service facilities, namely elderly care and housing security, public transportation and green space access, education and employment security, and small medical and health facilities. The cumulative contribution rate of variance of the four main factors is 76.835%. Among them, F1 accounts for 26.261%, and F′1 accounts for 26.456%, respectively, which are the core factors for the differentiation of social space and basic public service facilities in the case area.

In terms of spatial distribution of main factor scores, F1 is mainly concentrated in the Kangzhuangmeidi community on the north side (Figure 6a), F2 is mainly concentrated in the Fengqituo community on the southeast side (Figure 6b), and F3 is mainly concentrated in the Jinzhuyuan community in the middle (Figure 6c); F′1 is mainly concentrated in a

small number of residential areas on the south side (Figure 7a); F′2 is mainly concentrated in residential areas on the southeast and central sides (Figure 7b); F′3 is mainly concentrated in residential areas on the northwest and southeast sides (Figure 7c); F′4 is mainly concentrated in residential areas on the southeast side, with a few distributed on the southwest side (Figure 7d). Overall, there are obvious differentiation characteristics between social space and basic public service facilities.

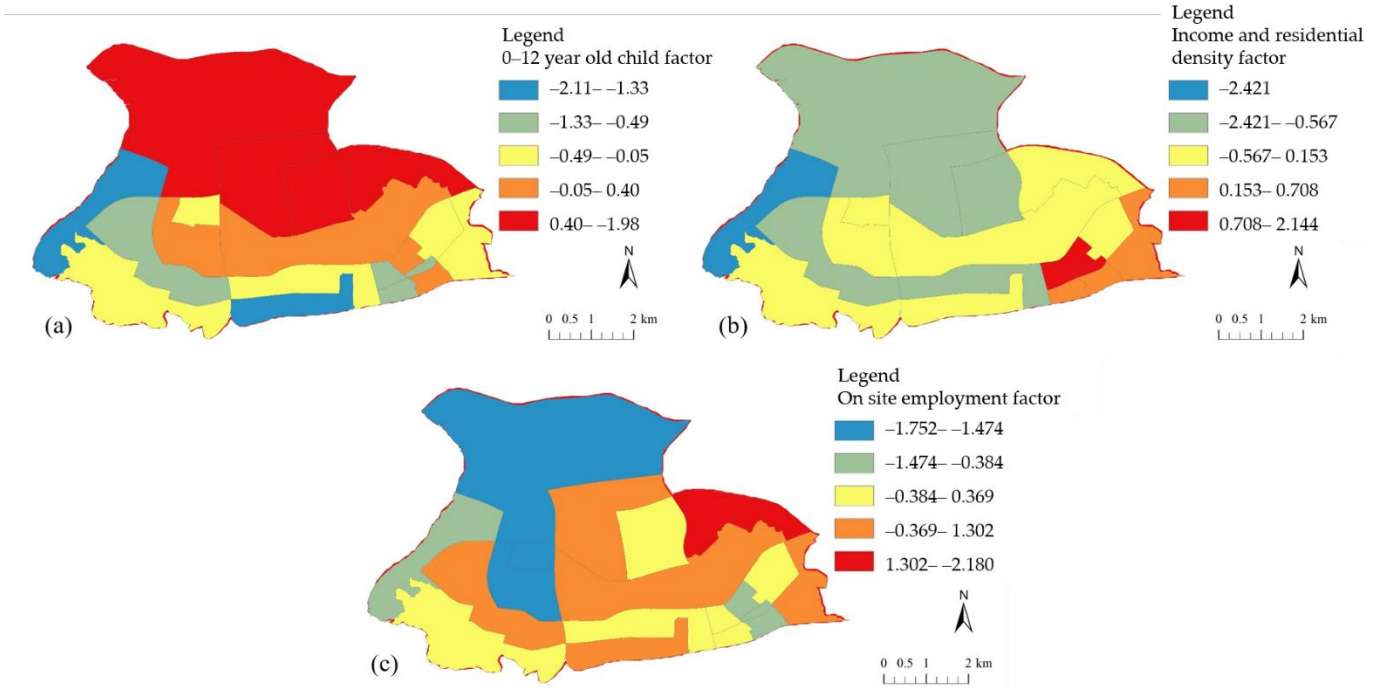

Figure 6. Main factors distribution of social–spatial differentiation: (**a**) Children aged 0–12; (**b**) Income and residential density; (**c**) On-site employment.

Cluster calculation divides the social space of the study area into four types of social areas (Figure 8a): non-child population settlement area, migrant population settlement area, local employment and children settlement area, low-income population settlement and high-density settlement area, which respectively contain 8, 3, 3, and 5 spatial units (i.e., community). The basic public service facilities in the study area are also divided into four types of social zones (Figure 8b): dense areas of public transportation and park green space, weak areas of public transportation and green space acquisition, weak areas of compulsory education and employment security, and dense areas of small medical and health facilities, which respectively include 81, 45, 28, and 35 spatial units (i.e., residential quarter). The spatial distribution of the four types of social zones based on social–spatial differentiation shows a continuous distribution feature, while different "hot and cold regions" appear inside. This indicates that similar social groups have clustering and differentiation characteristics in the region, and there is still a further differentiation trend in the differentiated social space. The four types of social zones based on the differentiation of basic public service facilities are roughly distributed in contiguous areas, but there are a small number of "isolated" and "mixed" social zones.

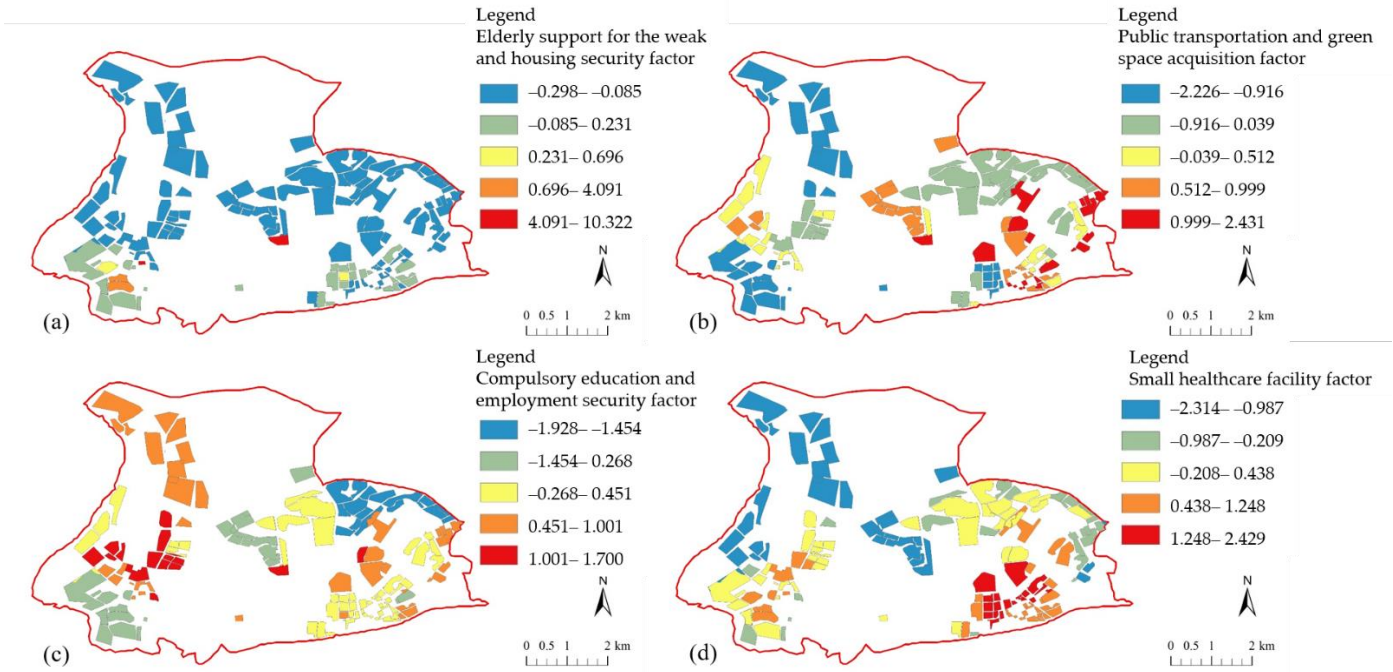

Figure 7. Main factors distribution of the differentiation of basic public service facilities: (**a**) Elderly care support and housing security; (**b**) Public transportation and green space acquisition; (**c**) Education and employment security; (**d**) Small healthcare facility.

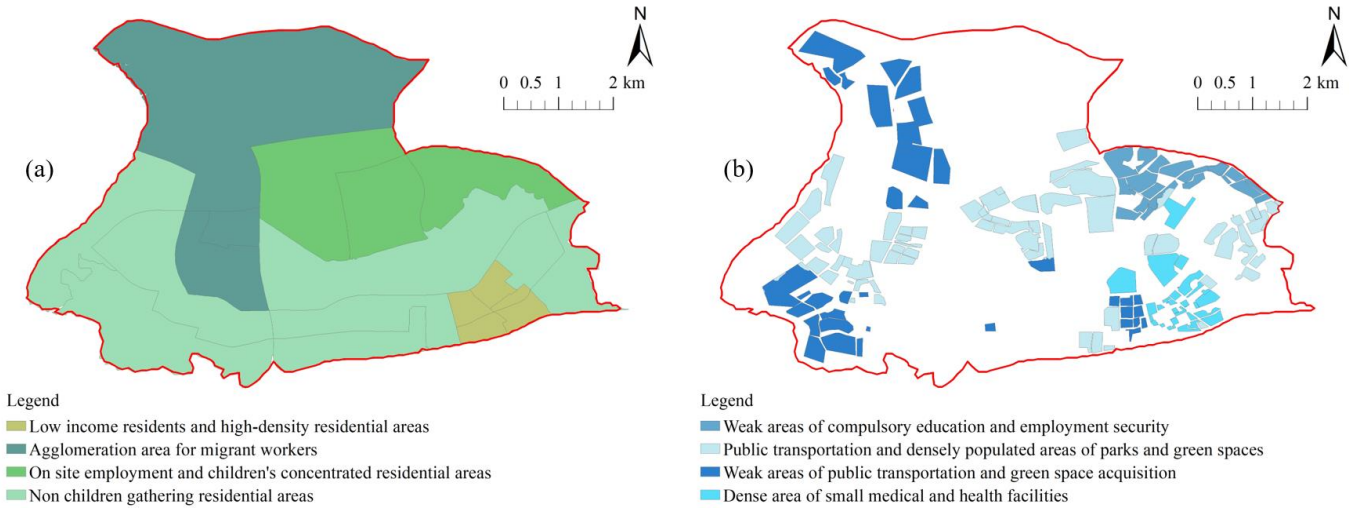

Figure 8. New social zones formed by clustering: (**a**) based on social space; (**b**) based on basic public service facilities.

4.2. Correlation between Two Types of Differentiation

Taking residential quarters as research units, correlation calculations were conducted on two types of differentiation main factors, and it was found that the comprehensive indicator F of social–spatial differentiation main factors and the comprehensive indicator F′ of basic public service facility differentiation main factors have a significant correlation (Table 2). Explain that there is a direct or indirect correlation between the two types of differentiation in the study area, indicating a certain degree of synchronicity. According to the results of intermediary analysis (Table 3), among the four pairs of main factors with the highest correlation, in the process of local employment and basic public service facilities, registered residence, employment location, and income level are completely intermediary (these three indicators have a significant differentiation effect on basic public service

facilities in the case area). In the process of interaction between income and residential density and basic public service facilities, the population density of construction land has a significant masking effect, and controlling this indicator enhances the differentiation effect of basic public service facilities. It shows that the correlation between the differentiation of basic public service facilities and social–spatial differentiation can be summarized as the correlation between the spatial configuration of basic public service facilities and registered residence, income, employment place, and residential density.

Table 2. Two different principal factor correlation matrices.

		Comprehensive Indicators (F′)	Elderly Care and Housing Security (F′1)	Public Transportation and Green Space Acquisition (F′2)	Compulsory Education and Employment Security (F′3)	Small Medical and Health Facilities (F′4)
Comprehensive indicators (F)	correlation coefficient	−0.134 **	0.114 *	0.198 **	−0.477 **	−0.016
	Significance (2-tailed)	0.008	0.024	0.000	0.000	0.747
	N	189	189	189	189	189
Children aged 0–12 (F1)	correlation coefficient	−0.395 **	−0.208 **	−0.172 **	−0.199 **	−0.244 **
	Significance (2-tailed)	0.000	0.000	0.001	0.000	0.000
	N	189	189	189	189	189
Income and Residential Density (F2)	correlation coefficient	0.392 **	−0.035	0.422 **	−0.040	0.402 **
	Significance (2-tailed)	0.000	0.494	0.000	0.431	0.000
	N	189	189	189	189	189
On-site employment (F3)	correlation coefficient	−0.217 **	0.289 **	0.099 *	−0.413 **	−0.129 *
	Significance (2-tailed)	0.000	0.000	0.049	0.000	0.011
	N	189	189	189	189	189

** At the 0.01 level (2-tailed), the correlation is significant; * At the 0.05 level (2-tailed), the correlation is significant.

Table 3. The mediating effect test results of social–spatial differentiation indicators.

Principal Factor Pair	The Mediating Role of Social–Spatial Differentiation Indicators	Inspection Conclusion
On-site employment (F3) and elderly care and housing security (F′2)	F3 → registered residence/permanent population ratio → F′2	complete mediation
	F3 → Proportion of migrant workers → F′2	complete mediation
	F3 → Proportion of labor force population aged 19–60 → F′2	The mediating effect is not significant.
	F3 → Income level → F′2	complete mediation
On-site employment (F3) and compulsory education and employment security (F′4)	F3 → registered residence/permanent population ratio → F′4	complete mediation
	F3 → Proportion of migrant workers → F′4	The mediating effect is not significant.
	F3 → Proportion of labor force population aged 19–60 → F′4	The mediating effect is not significant.
	F3 → Income level → F′4	complete mediation
Income and Residential Density (F2) and Public Transport and Green Space Acquisition (F′3)	F2 → Income Level → F′3	masking effect
	F2 → Land use area population density → F′3	partial mediation
	F2 → Population density of construction land → F′3	masking effect
	F2 → Proportion of labor force population aged 19–60 → F′3	partial mediation
Income and Residential Density (F2) and Small Healthcare Facility Factor (F′4)	F2 → Income Level → F′4	The mediating effect is not significant.
	F2 → Land use area population density → F′4	partial mediation
	F2 → Population density of construction land → F′4	masking effect
	F2 → Proportion of labor force population aged 19–60 → F′4	masking effect

4.3. Difference Position after Stacking

Among the eight pairs of main factors with the highest correlation, subtracting the load values of spatial unit main factors (differentiation state) revealed that the locations where basic public service facilities and social space were misaligned were concentrated

on the north, west, and southwest sides (Table 4). Among them, the number of spatial units for social matching services in the eight main factors is less than the sum of "low society high service" and "high society low service", indicating that the social–spatial differentiation of basic public service facilities in the case study area is very obvious. At the same time, the Kangzhuangmeidi community, located on the north side, exhibits a significant mismatch between "high children low public services". Among various public services, the mismatch between compulsory education and employment security is relatively low. It can be seen that the basic public service facility configuration has already responded to the population structure of the area, but its role in alleviating social–spatial differentiation is not sufficient. On the contrary, by adding the main factor load values of spatial units (degree of differentiation), it was found that the phenomenon of social–spatial differentiation weakened overall after adding basic public service facilities (Figures 9 and 10). However, in F2 and F′3, F2 and F′4, the degree of social–spatial differentiation intensified, and the locations where basic public service facilities were isolated from social space were distributed in the southeast and central parts (Table 4).

Table 4. The state and degree of social–spatial differentiation by overlaying basic public service facilities.

Principal Factor Pair	Number of Spatial Units (Differentiation State)			Number of Spatial Units (Degree of Differentiation)	
	Low Society High Service	Social Matching Services	High Society Low Service	Intensified Spatial Differentiation	Weakening of Spatial Differentiation
Children aged 0–12 (F1) and Elderly Care and Housing Security (F′1)	4	92	112	80	128
On-site employment factor (F3) and Elderly Care and Housing Security (F′2)	57	90	61	100	108
Children aged 0–12 (F1) and Public Transport and Green Space Access (F′2)	78	59	71	75	133
Income and Residential Density (F2) and Public Transport and Green Space Acquisition (F′3)	59	97	52	119	89
Children aged 0–12 (F1) and Compulsory Education and Employment Security (F′3)	58	79	71	84	124
On-site employment (F3) and Compulsory Education and Employment Security (F′4)	74	70	64	75	133
Children aged 0–12 (F1) and Small Healthcare Facilities (F′4)	55	78	75	76	132
Income and Residential Density (F2) and Small Healthcare Facilities (F′4)	113	54	41	127	81

4.4. Boundary Changes after Stacking

Taking residential quarters as spatial units, after stacking, it was found that the overlap degree of the two types of differentiated boundaries was relatively high, and the proportion of common boundaries was the largest, which indirectly proves that the configuration of basic public service facilities is often driven by social needs. The configuration of basic public service facilities can weaken the boundaries of social–spatial differentiation.

For example, after overlaying the boundaries of public transportation and park green areas, the boundaries between the original on-site employment, children's settlements, and migrant workers' settlements are weakened, indicating that public transportation and park green services provide the possibility for the transfer of short-term migrant workers.

Services located on the weakened boundaries can provide the possibility for residents on both sides of the boundary to have contact. However, the configuration of basic public service facilities can also create new differentiation boundaries in social space, such as in non-children's settlements on the southwest and southeast sides. The difference in public transportation and park green space services leads to new internal differentiation, exacerbating the possibility of social–spatial differentiation. In addition, calculations have found that in the boundary space (which is actually a strip space with a certain width, with a buffer zone of 50 m as the width and 25 m as the strip space), basic public service facilities are massively clustered in the weakened and newly added boundary areas, indicating a strong correlation between the distribution of weakened and newly added boundaries in local social space and the configuration of basic public service facilities (Figure 11).

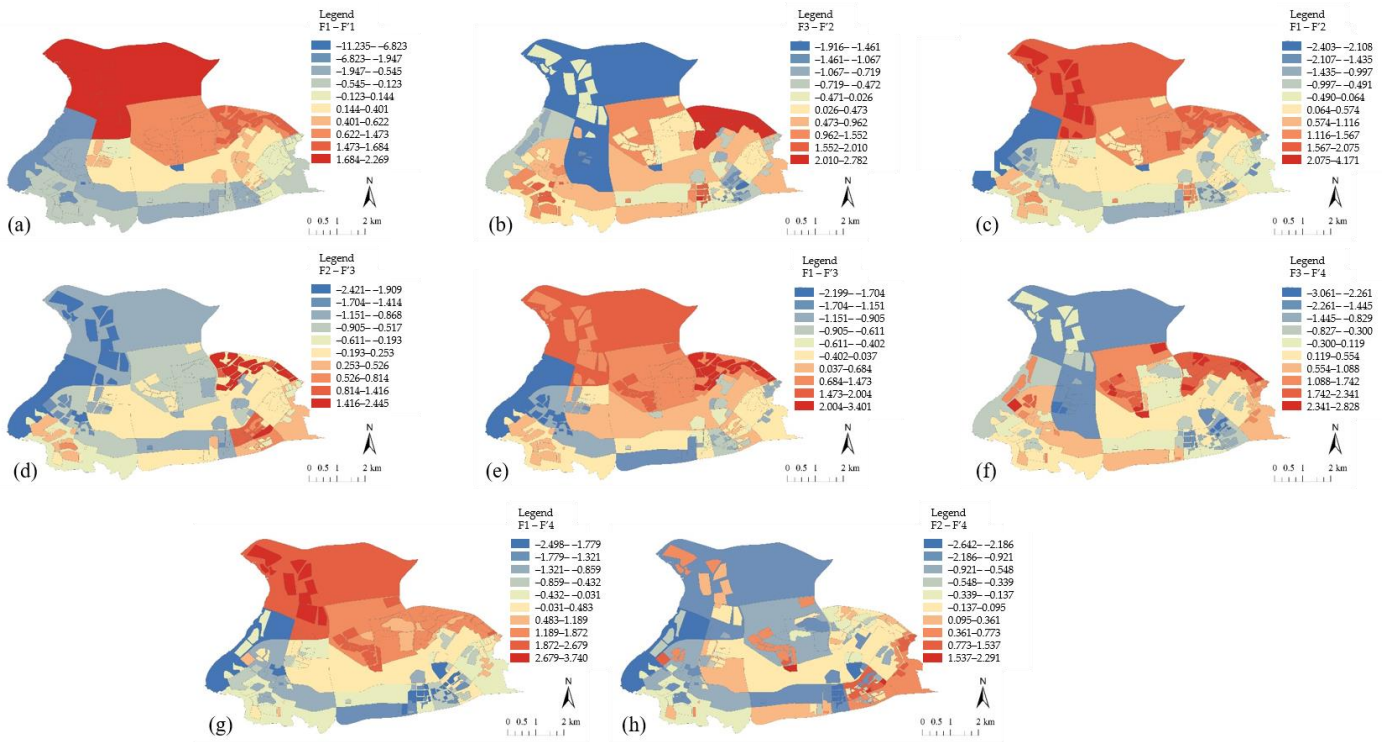

Figure 9. Identification of Misalignment Points between Basic Public Service Facilities and Social Space: (**a**) factor for children aged 0–12 (F1) and factor for elderly care and housing security (F′1); (**b**) on-site employment factor (F3) and elderly care support and housing security factor (F′2); (**c**) 0–12-year-old children factor (F1) and public transportation and green space acquisition factor (F′2); (**d**) income and residential density factor (F2) and public transportation and green space acquisition factor (F′3); (**e**) 0–12-year-old children factor (F1) and compulsory education and employment security factor (F′3); (**f**) on-site employment factor (F3) and compulsory education and employment security factor (F′4); (**g**) children aged 0–12 (F1) and small healthcare facilities (F′4); (**h**) income and residential density factor (F2) and small healthcare facility factor (F′4).

4.5. New Social Zone after Stacking

Using residential quarters as spatial units, overlay two types of differentiated social zones and identify eight new zones of social spaces under the influence of basic public service facility differentiation (Figure 12). Based on the name and distribution of the new partition, extract the areas where basic public service facilities are compatible with social space, areas where basic public service facilities are mismatched with social space, areas where social space new partitions are connected and clustered, and areas where social space new partitions are abnormally embedded.

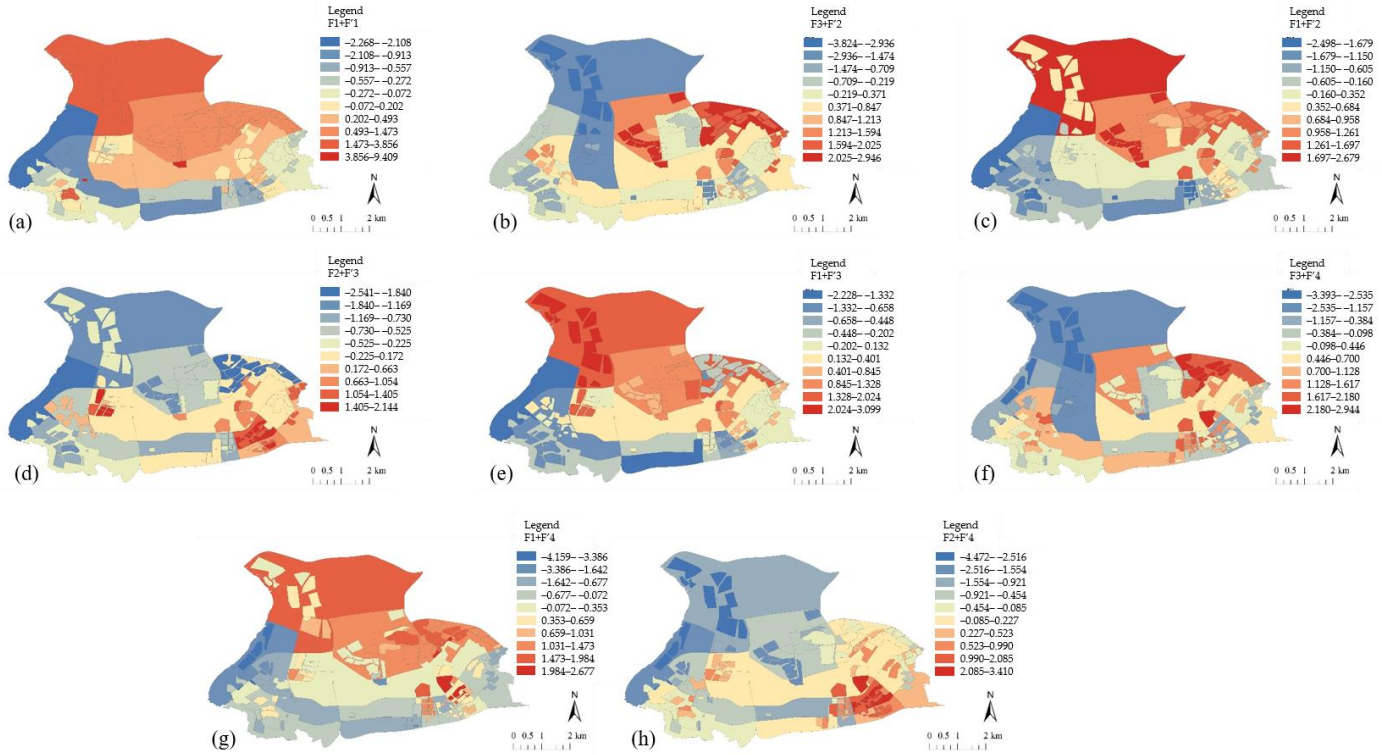

Figure 10. Identification of isolation points between basic public service facilities and social space: (**a**) factor for children aged 0–12 (F1) and factor for elderly care and housing security (F′1); (**b**) on-site employment factor (F3) and elderly care support and housing security factor (F′2); (**c**) 0–12-year-old children factor (F1) and public transportation and green space acquisition factor (F′2); (**d**) income and residential density factor (F2) and public transportation and green space acquisition factor (F′3); (**e**) 0–12-year-old children factor (F1) and compulsory education and employment security factor (F′3); (**f**) on-site employment factor (F3) and compulsory education and employment security factor (F′4); (**g**) factor for children aged 0–12 (F1) and small healthcare facilities (F′4); (**h**) income and residential density factor (F2) and small healthcare facility factor (F′4).

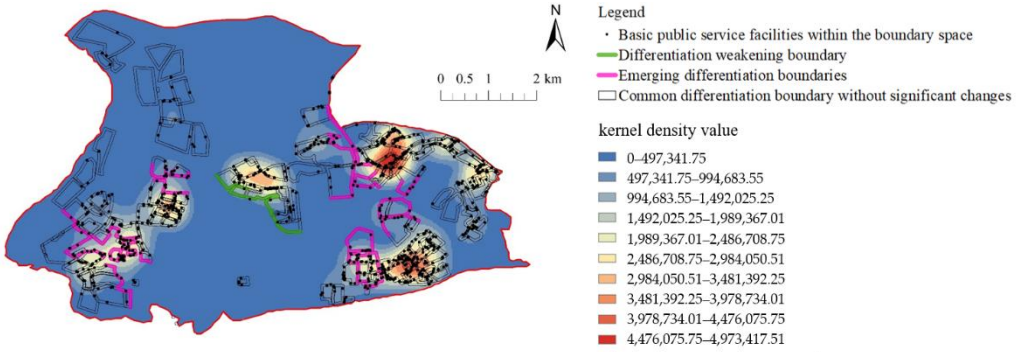

Figure 11. Differentiation boundary characteristics after overlaying basic public service facilities.

Among them, the basic public service facilities and social space adaptation area includes two types: public transportation and park green space intensive areas for the non-child population and public transportation and park green space intensive areas for migrant workers. The mismatch between basic public service facilities and social space includes two types: areas with weak compulsory education and employment security, areas with local employment and children's settlements, areas with weak access to public transportation and green spaces, and areas with concentrated migrant workers. The new division of social space includes two types of contiguous gathering areas: public transportation, densely populated parks and green spaces, areas for local employment and children's settlements,

and areas with weak access to public transportation and green spaces, areas for non-children's populations. The abnormal integration areas of the new social space zoning include two types: dense public transportation and park green spaces, low-income and high-density residential areas, dense public transportation and park green spaces, and non-children's residential areas. Overall, under the influence of the configuration of basic spatial service facilities, social–spatial differentiation has begun to take on a multicenter and composite form around the main public service facilities.

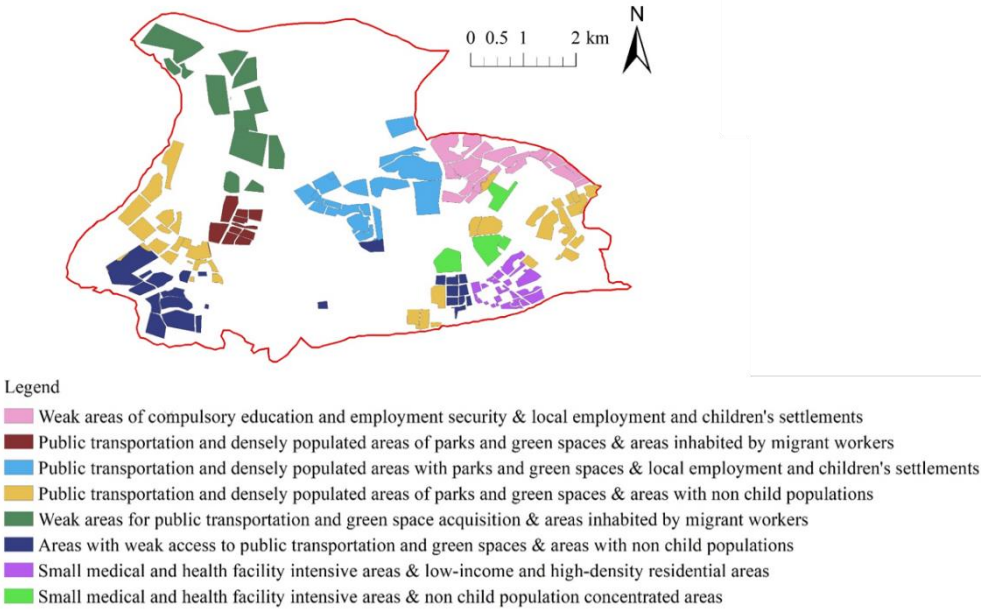

Figure 12. New zoning characteristics of social space after overlaying basic public service facilities.

5. Discussion

5.1. Coexistence of Positive and Negative Impacts

Compared to previous studies that have focused more on the inhibitory effect of basic public service facilities on social–spatial differentiation [25–31], this study found that the comprehensive configuration of basic public service facilities has a significant dual effect on social–spatial differentiation (Tables 5 and 6). The comprehensive configuration of basic public service facilities will still alleviate social–spatial differentiation, but the main factors of social–spatial differentiation such as public transportation, healthcare, and park green spaces will also show an increasing trend. These negative effects are beginning to receive attention [32]. It should be emphasized that the configuration of basic public service facilities plays a significant role in improving existing social–spatial barriers, strengthening spatial continuity of population usage behavior, and weakening residential isolation caused by factors such as housing prices [38]. At the same time, the differentiation of basic public service facilities is highly consistent with the differentiation boundary of social space, and the weakened and newly added social space differentiation boundary has the characteristics of small scope and local occurrence. However, the differentiation of local basic public service facilities will further exacerbate social–spatial differentiation within the already differentiated areas, creating new social–spatial boundaries at the microscale, and exacerbating internal social barriers. The research results confirm that the comprehensive configuration of basic public service facilities can improve social–spatial differentiation on an overall level, but more attention needs to be paid to the spatial configuration mode of basic public service facilities to strengthen social integration effects and weaken social differentiation effects.

Table 5. The impact of different basic public service facilities on the social–spatial differentiation of different dominant factors.

Basic Public Service Facilities	The Main Factor of Social–Spatial Differentiation			
	Income	**Residential Density**	**Children Aged 0–12**	**Employment Location**
Mass transit	exacerbate	exacerbate	mitigation	no significant impact
Compulsory education	no significant impact	no significant impact	mitigation	mitigation
Elderly care and support for the weak	no significant impact	no significant impact	mitigation	no significant impact
Culture and sports	no significant impact	no significant impact	no significant impact	no significant impact
Employment security	no significant impact	no significant impact	mitigation	mitigation
Housing security	no significant impact	no significant impact	mitigation	no significant impact
Medical hygiene	exacerbate	exacerbate	mitigation	no significant impact
Park green space	exacerbate	exacerbate	mitigation	no significant impact

Table 6. The impact of different basic public service facilities on different types of social–spatial boundaries.

Basic Public Service Facilities	Types of Social–Spatial Differentiation Boundaries				
	Income	**Residential Density**	**Non-Child Population**	**Child Population**	**Employment Location**
Mass transit	weaken	weaken	weakened/added	weakened/added	weakened/added
Compulsory education	no significant impact	no significant impact	no significant impact	weakened/added	weakened/added
Elderly care and support for the weak	no significant impact	no significant impact	no significant impact	no significant impact	no significant impact
Culture and sports	no significant impact	no significant impact	no significant impact	no significant impact	no significant impact
Employment security	no significant impact	no significant impact	no significant impact	weakened/added	weakened/added
Housing security	no significant impact	no significant impact	no significant impact	no significant impact	no significant impact
Medical hygiene	no significant impact	no significant impact	added	no significant impact	no significant impact
Park green space	weaken	weaken	weakened/added	weakened/added	weakened/added

5.2. Multicenter and Composite

On the one hand, the introduction and popularization of basic public services have changed the functions of urban space, and residents' living and employment areas have gradually shifted from a relatively independent and concentrated state to a state of composite commercial, industrial, residential areas and basic public service facilities. The configuration of basic public service facilities and their land provides a material spatial basis for the composite characteristics of social space. For example, in the study area, facilities such as schools, hospitals, and parks occupy important positions in spatial distribution, in order to regulate the phenomenon of fixed social group distribution locations and lack of spatial connections. On the other hand, with the increase in basic public service facilities, the types and distribution of facilities have become increasingly complex. Different facilities are distributed in different areas of the city, which have different attractiveness to different social groups with different needs. This has a crucial impact on the flow and distribution of the urban population. When people choose space, they will more thoroughly consider the conditions of education, medical care, transportation and other facilities. This leads to a multicenter form of social space after overlaying basic public service facilities, with each center centered around different types of service facilities, forming its own characteristics and advantages. This multicenter form can avoid resource monopoly problems caused by excessive concentration of basic public services, meet the universal needs of urban residents, and improve social–spatial distribution by promoting organic dispersion of cities [37,38]. But after dispersion, it may also bring new social isolation problems to local areas, further inducing differentiation within already differentiated social areas, and this phenomenon is now being paid attention to (Figure 13).

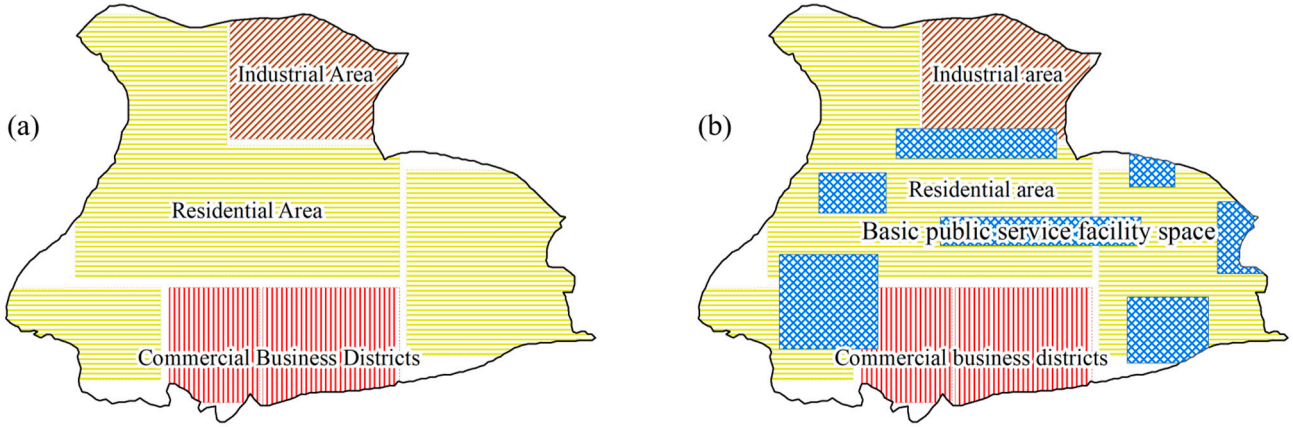

Figure 13. The configuration of basic public service facilities can improve the functional isolation of urban space: (**a**) before configuration; (**b**) after configuration.

6. Conclusions

The configuration of basic public service facilities is an important measure to promote social integration at present. Based on the current research deficiencies, this study considered social space research samples at the microscale of residential communities, constructed an analysis and measurement framework, and explored the social–spatial effects and mechanisms of basic public service facility configuration. This is beneficial for a comprehensive understanding of the significance of basic public service facility configuration and the construction of spatial adaptation strategies between basic public service facility supply and social production and life; promoting social integration has practical value.

Research has found that income, employment location, residential density, and public services are the main indicators for the differentiation of basic public service facilities and social space. The main factors contributing to the differentiation of basic public service facilities are elderly care and housing security, public transportation and green space access, education and employment security, and small-scale medical and health facilities in the study area. The impact of basic public service facility configuration on social space differentiation is bidirectional, but the inhibitory effect of basic public service facility allocation on social–spatial differentiation is stronger than the exacerbating effect. This is specifically manifested in the eight pairs of main factor pairs formed by overlaying basic public services and social space differentiation, of which six pairs show weakened social space differentiation and two pairs show intensified social space differentiation. Therefore, the configuration of basic public service facilities can help improve the phenomenon of social space differentiation as a whole, but the local differences in some facility configurations still exacerbate the differentiation of social space and its interior, such as public transportation and green parks. The bidirectional impact of the configuration of basic public service facilities in space is manifested as a change in the attributes of social space and the differentiation state of basic public services. The number of spatial units that are suitable or not suitable for the two will change, which will further weaken or intensify the differentiation degree between some spatial units and surrounding social–spatial units. Changing the boundaries of social–spatial differentiation, the weakening of existing differentiation boundaries and the emergence of new differentiation boundaries will coexist, and basic public service facilities will gather in large numbers in weakened and newly added boundary areas, gradually presenting a multicenter and composite form in social space, promoting organic dispersion of cities, improving social–spatial distribution, but also further inducing differentiation within already differentiated social spaces.

In the research process of social–spatial differentiation and basic public service facility differentiation, there are shortcomings in terms of samples, elements, data volume, etc., which are worth further exploration. Subsequent research will increase the selection of social–spatial differentiation factors, including policies and information transmis-

sion in environmental attributes, and physical conditions in group attributes, in order to comprehensively characterize social–spatial differentiation, improve the applicability and development of the research framework, and provide scientific basis for constructing spatial adaptation strategies for basic public service facilities supply and social production and life.

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