buildings

MDPI

Article

Study on the Demand and Supply of Cultural Space for Different Groups of People from the Perspective of Sustainable Community Development: A Case Study from the Hanzhong Section of the Hanjiang River Basin, China

Feng Zhang [1,2], Pei Zhang [1,*], Miao Wu [2], Tiantian Wang [2], Liyue Gao [2] and Yonghui Cheng [2,3]

[1] School of Architecture, Xi'an University of Architecture and Technology, Xi'an 710055, China; zhangfeng@thupdi.com
[2] Northwest Branch, Beijing Tsinghua Tongheng Urban Planning and Design Institute, Xi'an 710076, China; wumiao@thupdi.com (M.W.); wangtiantian-xb@thupdi.com (T.W.); gaoliyue@thupdi.com (L.G.); chengyonghui1@stumail.nwu.edu.cn (Y.C.)
[3] College of Urban and Environmental Sciences, Northwest University, Xi'an 710127, China
* Correspondence: zhangpei@xauat.edu.cn

Abstract: Cultural space (CS) holds significant importance for inheriting regional culture, serving people's lives, and boosting sustainable community development. In this study, based on the research case of the Hanzhong section of the Hanjiang River Basin (HSHRB), the demand and supply matching relationships between three groups of people, namely residents, employees, and tourists, and four types of CS—memorial or religious space (MRS), cultural heritage space (CHS), cultural facilities space (CFS), and cultural industries space (CIS)—is analyzed, with communities as the units. Findings: (1) The CS demand–supply matching relationship exhibited the spatial distribution characteristics of high value balance in urbanized areas, significant lag in suburban supply, and low value balance in rural areas. (2) For the CS demands of residents, employees, and tourists, the total supply was in a substantial shortage, in general balance, and in significant surplus, respectively. (3) There were significant differences in the fairness and adequacy of the demand–supply matching of the four types of CS, with MRS and CHS more equitable and better able to meet the needs of different regions and populations. (4) Six community types with significantly different demand and supply characteristics were classified based on the demand–supply relationship within the community and the supply environment of neighboring communities. They presented a spatial structure of circles outward in the order of high-value-balanced communities, deprived communities, insufficient-supply communities, low-value-balanced communities, and shared communities, with urbanized areas as the core. Deprived communities and shared communities have shown spatial dynamics of urban expansion and village decay, respectively, and they require urgent attention. The study employs a more systematic categorization of CS supply and a more diverse perspective of demand entities, offering new evidence for the equitable distribution of cultural resources among heterogeneous groups and regions. Ultimately, it presents strategies for optimizing demand and supply as well as policy recommendations for community governance, bringing fresh insights into promoting sustainable community development.

Keywords: population needs; cultural space; demand–supply matching; the Hanzhong Section of the Hanjiang River Basin; sustainable community development

check for updates

Citation: Zhang, F.; Zhang, P.; Wu, M.; Wang, T.; Gao, L.; Cheng, Y. Study on the Demand and Supply of Cultural Space for Different Groups of People from the Perspective of Sustainable Community Development: A Case Study from the Hanzhong Section of the Hanjiang River Basin, China. *Buildings* **2024**, *14*, 987. https://doi.org/10.3390/buildings14040987

Academic Editor: Humberto Varum

Received: 23 February 2024
Revised: 22 March 2024
Accepted: 31 March 2024
Published: 2 April 2024

Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

Cultural space (CS) is an important carrier that carries spiritual and cultural values, consolidates urban emotional memory, and serves the cultural life of residents [1]. It is an important part of urban space [2]. At a time when culture has become the global consensus

on competitiveness [3], CS is increasingly becoming a key element in improving the quality of life of residents, promoting sustainable community development, and leading urban innovation and prosperity [4]. People's fundamental needs in production and living have shifted from the material level to spiritual and cultural levels, and the demand for community construction and urban development has also shifted to the culture-led demand for high quality, diversity, and connotation focus. As the elementary unit of urban public activities, community is both the source of vitality of cultural creativity and the core carrier that carries residents' cultural needs and determines residents' happiness and sense of belonging. Cities have to provide more public cultural services for social groups to create an urban environment suitable for living and working, and CS—playing an important role in that regard—has become a valuable asset in cities [5]. However, in the context of the continuous growth of cultural demand, the limited supply of CS leads to a significant imbalance and mismatch between demand and supply, and the contradiction between demand and supply intensifies spatial inequality, directly affecting the living standards and quality of different social groups. The question of how to provide fair and equal public cultural services by optimizing the supply of CS to meet the growing spiritual and cultural needs of different groups is a key proposition for the sustainable development of cities and communities. On that account, systematically studying the demand and supply patterns of CS from the perspective of the needs of different groups with community as the research unit is of great significance for comprehensively understanding the spatial matching relationship between the demand side and the supply side of CS, optimizing the spatial distribution of public resources, and enhancing the well-being of community residents.

Scholars have now carried out extensive discussions on CS. Some have analyzed its concepts and connotations, promoting the continuous expansion of the connotation [2], characterized by a gradual expansion and deepening from cultural heritage to cultural venues, cultural creativity, cultural facilities, and cultural industries [6]. Therefore, it is necessary to make a systematic study of the change of connotation. According to different research perspectives, there are diverse classifications of CS: monumental and daily CS classified by needs [7], historical and modern CS classified by chronological order [8], macro-, meso-, and micro-CS classified by spatial level [9], as well as high- and low-value CS classified by value [1]. Despite the diversity of classification methods and different standards, all classifications highlight the value and significance of CS [10], which lays a theoretical foundation for the systematic classification of CS in this paper. The quantitative evaluation of the demand and supply of CS has gradually received attention in recent years; this involves the evaluation of supply index [8], accessibility [11], and fairness [12,13] at the supply level, and mainly covers different perspectives such as population satisfaction [14] and population preference [15,16] at the demand level. With the deepening of research and the advancement of practice, the difference between the demand and supply of CS has attracted attention, but the study on spatial matching based on combined CS demand and supply is still in its infancy. Demand–supply matching is usually employed to evaluate the level and fairness of public services, and has been applied by a large number of scholars to the study of ecological and cultural system services [17], urban green spaces [18], public service facilities [19], and other research objects; methodologically, it is mainly adopted in the coupled degree of the coordination model [20], quadrant diagrams [21], bivariate mappings [16,22], the difference between demand and supply [23], demand–supply ratios [18,19], and bivariate spatial autocorrelation [24,25]. Established study methods have revealed the sign of quantitative research on CS, which brings methodological reference to the study of CS demand–supply matching. This study aims to go beyond the primary exploration of CS in existing studies to systematically investigate its demand–supply matching relationship.

While these studies have initially built up the basic idea of the study of CS demand and supply, there are still some deficiencies. As far as the study object is concerned, most studies available have focused more on a certain type of CS, such as cultural heritage space [26], cultural facilities space [21,27], and cultural industries space [28,29], while ignoring the

systematic nature of CS, and fewer studies have carried out a systematic evaluation of the whole constituted by each type of CS, thus affecting the comprehensiveness of the research on the supply of CS. For the demand of the study, most of the studies only analyze the demand of one group of people, with less consideration for the differences in the demand preferences of different groups; in fact, CS is different from other public services, and the service targets include residents, as well as employees and tourists. The cultural services provided by CS have gradually taken up an important position in the production, life, and leisure of residents, employees, and tourists. As for the operationalization of demand and supply studies, most studies have only dealt with the demand–supply relationship within the research unit, while few have realized the sharing of the surrounding area, ignoring the public attributes of CS. Therefore, to break through the limitations of existing demand–supply studies of the type of CS supply, user groups, and the incomplete consideration of resource sharing among communities, this study takes all types of CS as research objects to study the CS supply at the same time. By fully considering the CS demand of the three groups of people—that is, residents, employees, and tourists—and by increasing the sharing research between study units, this paper ultimately explores the matching between the demand and supply of different groups of people and various types of CS, with a view to enhancing the systematicity and diversity of the CS research.

In addition, the available studies have fully recognized the importance of the matching between demand and supply for the planning and management of CS, but the majority of these studies are conducted at the scale of metropolitan areas, provinces, cities, and developed urbanized regions, with cities and streets taken as units. They are mostly qualitative judgments based on preliminary quantification and cannot further guide the optimization and management of CS. On the scale of CS research, in fact, it is necessary to ensure the consistency of cultural origins in the study area and highlight the spatial heterogeneity of cultural spatial distribution as much as possible, so as to explore the law of demand and supply with reliability and richness. A river basin is a composite area of intertwined natural, administrative, and economic zones composed of hydrographic units; the internal units are characterized by geographic unity, structural wholeness, and cultural similarity [30]. Choosing a river basin as the research scope is suitable for systematic study of CS. The Hanjiang River Basin is one of the birthplaces and growth cradles of Chinese civilization, and its Hanzhong section in Shaanxi Province holds an important position in China's cultural pattern. A systematic study of the law of demand and supply of its CS plays an important role in passing on the historical lineage and enhancing the well-being of the residents. And the approach of this study, based on the community as a unit, can reveal the demand and supply patterns of CS at a more subtle level, and can also be closely integrated with community governance to push sustainable development of the community. Therefore, to address the shortcomings of the extensive research scale and the extensive research unit, the present study takes the watershed as the research scale and the community as the research unit, and tries to comprehensively identify the type of community in terms of the relationship between demand and supply within the community, as well as the sharing among neighbors around the community. This study will help in putting forward more refined CS planning and management opinions.

Based on a case study of the Hanzhong Section of the Hanjiang River Basin (HSHRB), this paper performed the following: quantitatively analyzes the demand and supply of CS in 2038 community units housing three groups of people; reveals the matching between demand and supply of different groups of people under the diversified CS; delineates six types of communities that represent their own demand–supply relationship and the neighboring supply environments; further puts forward suggestions to guide the construction and management of community units. This study aims to (1) quantitatively assess the CS demand and supply of community units in the HSHRB and explore the spatial distribution pattern; (2) reveal the matching between the demand and supply of CS for the three types of people by bivariate fitting analysis, difference analysis, and spatial autocorrelation modeling; (3) comprehensively define and classify the different types of

communities by taking into account the sharing of resources among the communities, as well as the community's own demand and supply for CS and the supply environment of the neighboring communities, and then put forward proposals on the planning and management of CS in a more refined manner.

2. Materials and Methods

2.1. Research Area: The Hanzhong Section of the Hanjiang River Basin (HSHRB), China

Situated in Central China, the Hanjiang River—the largest tributary of the Yangtze River—emerges as a pivotal cradle of human civilization, encapsulating the genesis and evolution of Chinese culture. The Hanshui culture—developed from the Hanjiang River Basin—is a regional culture that forms a part of traditional Chinese culture, with strong local characteristics that integrate the multilateral cultures of Bashu, Jingchu, Central Plains, and Qin. The study of CS demand and supply in the Hanjiang River Basin is of great significance for the inheritance and promotion of the Chinese culture. In addition, the Hanjiang River Basin, with its rich cultural layers and diverse cultural types, demonstrates the complexity of CS evolution, and the study of its CS demand–supply relationship will provide valuable experiences and models for other regions, making it an ideal example for studying the CS evolution in China. This paper delineates the HSHRB as the focal research area to maintain cultural homogeneity throughout the study (Figure 1).

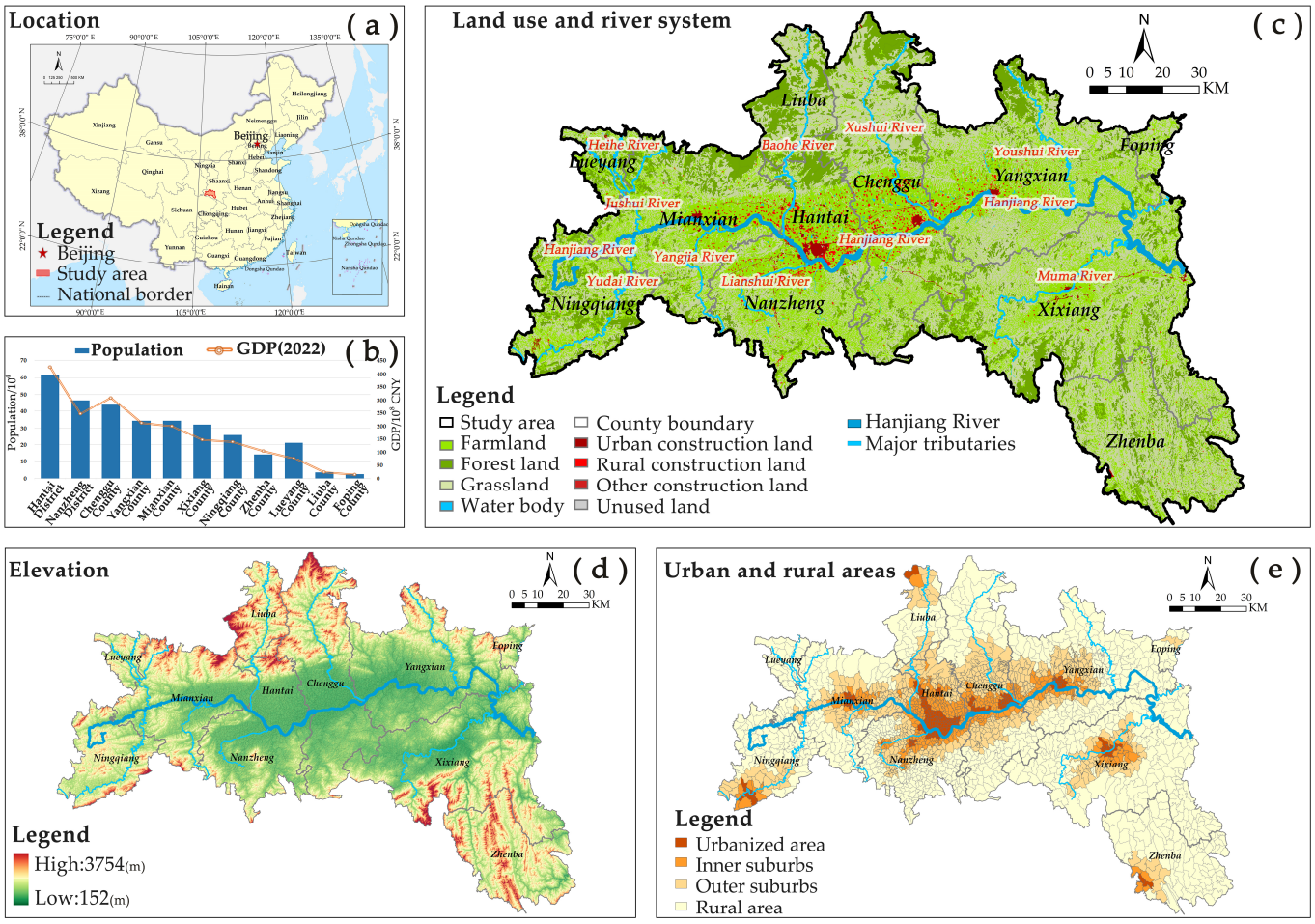


Figure 1. Study area: (**a**) Location of the Hanzhong Section of the Hanjiang River Basin (HSHRB) in China. (**b**) Comparison of population size and GDP across the districts and counties within the study area. (**c**) Land use types in 2020. (**d**) Elevation. (**e**) Urban and rural areas.

Employing hydrological analysis via ArcGIS, this study delineates the HSHRB's spatial extent—13,160.85 km^2. Flanked by the Micang Mountains to the south and the Qinling Mountains to the north, the basin's core is an alluvial plain. It includes the Hanjiang River's main stem and ten principal tributaries: Yudai River, Baohe River, Xushui River, Lianshui River, Youshui River, Ziwu River, Muma River, Jushui River, Heihe River, and Yangjia River. The main stem of the Hanjiang River flows through the center of two district-level administrative units, Hantai District and Nanzheng District, and the center of three county-level administrative units, Mianxian County, Chenggu County, and Yangxian County. Its tributaries flow through six county-level administrative units, that is, Lueyang County, Liuba County, Ningqiang County, Xixiang County, Foping County, and Zhenba County, in Hanzhong City. The study area involves a total of 2038 communities. The region's spatial configuration is distinguished by a seamless urban to rural gradient, centered around the river system, showcasing a progressive diminution in CS density and population.

2.2. Data Acquisition

Establishing a database of CS demand and supply will enable more accurate and convenient demand and supply assessments [31] and will optimize the correlation between the assessment of the current situation and the optimization strategy [32]. Based on core indicators, this study has constructed a service population database, a CS database, and a basic information database.

2.2.1. Service Population Database

Mobile signaling data are characterized by large sample size, fast data update, accurate spatial positioning, and detailed crowd attributes [19], allowing for an accurate record to be made of the spatiotemporal trajectory of the population and enabling the identification of crowd portraits. In the monitoring of human dynamic activities, mobile signaling data have been shown to have good reliability, practicality, and applicability [33,34], leading to their being promoted as innovative tools in human geography, urban planning, and social science research [35,36]. In this paper, we used the mobile signaling data collected by China Unicom operators in May 2023 with an accuracy of 250 × 250 m to identify the spatial distribution and number of residents, employees, and tourists in each community unit.

2.2.2. CS Database

According to the urban cultural land classification methods proposed by scholars, such as Wang Shusheng [1], Gao Yuan [2], and Zhao Ziliang [11], this study classes CS into five types: cultural and spiritual marking space, memorial or religious space (MRS), cultural heritage space (CHS), cultural facilities space (CFS), and cultural industries space (CIS). Cultural and spiritual marking space embodies national spiritual values and has supply capacity for all communities with the highest cultural value; so, it is omitted in calculating demand and supply in the community units in this paper. Accordingly, the CS types studied in this paper are MRS, CHS, CFS, and CIS.

Points of interest (POIs) are extensively utilized in facility layout studies [37], yet they fall short in fully covering historical spatial data [38]. This paper, based on Amap POI data (https://lbs.amap.com/, accessed on 9 May 2023), systematically integrates CS by utilizing multiple data sources: *The Atlas of Chinese Cultural Relics—Shaanxi Book (Volume I and II)*; a list of major historical and cultural sites protected at the national level; a list of cultural relic protection sites in Shaanxi Province; a list of cultural relic protection sites in Hanzhong City; *The Famous Scenic Spots and Historical Sites in Hanzhong Section*; a list of historical buildings in Hanzhong over the years. Consequently, a comprehensive CS database was formed, comprising a total of 2758 CS (Table 1).

Table 1. Types and number of CS.

Classification of CS		Connotation	Quantity (Sites)
Type	**Value**		
Cultural and spiritual marking space	Value of national spirit	Land occupied by natural landscapes and humanistic identity of great cultural significance and spiritual marking value in the course of the development of the country, region, and city, and with a high degree of socio-psychological identity.	11
Memorial or religious space (MRS)	Memorial and religious value	Land for memorial services and cultural heritage education activities.	545
		Land for religious activities in accordance with the law.	
Cultural heritage space (CHS)	Historical and cultural value	Land occupied by historical and cultural heritage with conservation value and open spaces with important historical and cultural significance, etc.	1251
Cultural facilities space (CFS)	Value of public cultural services	All types of land, premises, and community cultural centers that meet the daily needs of residents for public cultural life.	369
Cultural industries space (CIS)	Industrial economic value	Exhibition sites, cultural study units, and related radio and media organizations with cultural exploration, inheritance, creativity, and transformation as their dominant business.	571

2.2.3. Basic Information Database

In addition to the two most important databases of population and CS, it is also necessary to collect information on the vector ranges of community units, land use data (LUCC), socioeconomic statistics, various types of activity POIs data, road network and bus stops data, river and water systems, topography, and geomorphology. The vector ranges and LUCC data are obtained from the Resources and Environmental Sciences and Data Center, Chinese Academy of Sciences (http://www.resdc.cn/, accessed on 12 January 2023). The POIs of various activity facilities, road network, bus stops, and river system data are sourced from the AMap Open Platform (https://lbs.amap.com/, accessed on 9 May 2023). The terrain and landforms data are sourced from the geospatial data cloud platform (https://www.gscloud.cn/, accessed on 11 May 2023).

2.3. Research Methods

By exploring the patterns and rules of demand and supply of CS, this study constructs a technical route that includes data collection and cleaning, indicator construction and quantitative assessment, demand and supply analysis, and spatial mapping (Figure 2). The quantitative evaluation of CS demand and supply is the core of the study of the CS demand–supply pattern. This paper determines the demand–supply evaluation index system of CS in terms of potential demand and actual supply based on the connotation of CS. In terms of potential demand, the three most commonly used and critical indicators include population, business type, and land use [23,39,40]. Human beings demand spiritual and cultural life all the time [41]. Therefore, this paper measures CS demand based on population density (PD) as the basic index; activity intensity (AI) of commerce, enterprises, and tourism represent business formats, as auxiliary indexes for measuring CS demand; land development intensity (LDI) is used as the correction index [42,43]. In actual supply, the CS distribution density determines the material basis of supply, and the accessibility determines the convenience of access to the supply [44]. Only by combining the two can we comprehensively determine whether CS is effectively supplied [45], so as to reflect the CS organization and management abilities of an area more objectively. Therefore, this study chooses two indexes—CS distribution density (CSD) and accessibility (ACS)—to measure supply (Table 2). Considering the fair accessibility of different travel modes to different groups [46], this paper measures the degree of accessibility of private and public

transportation trips in terms of both road network density (RND) and bus stops density (BSD) in an integrated manner.

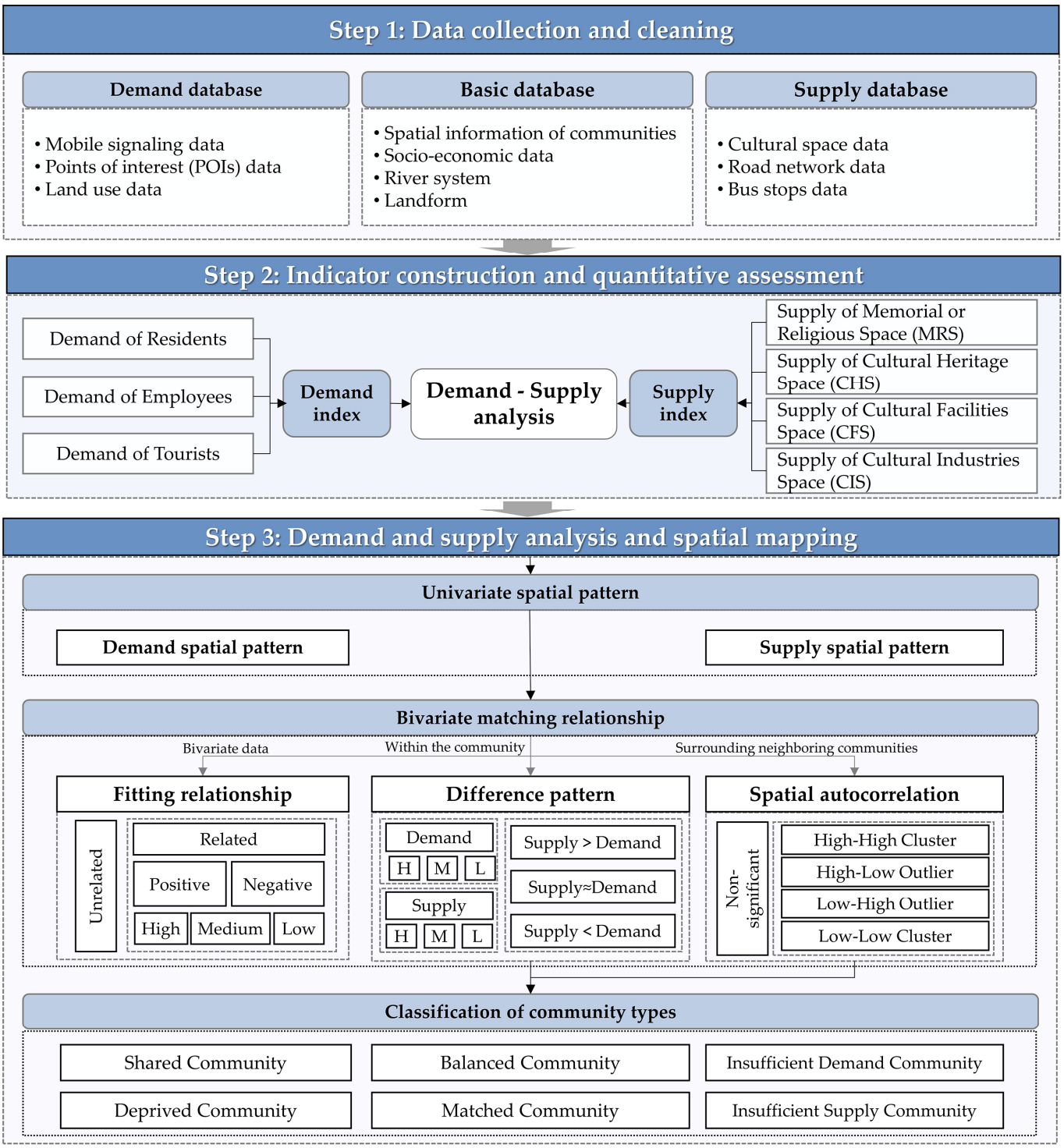


Figure 2. Technical route.

Table 2. Demand and supply index system.

	Index	Classified Index	Index Connotation
CS demand index	Population density (PD)	Residential population density	Population per unit area. A larger value indicates a greater demand for CS by the population.
		Employed population density	
		Tourist population density	
	Activity intensity (AI)	Business activity intensity	Number of active POIs per unit area. A larger value indicates a greater concentration of crowd activity and a greater potential demand for CS.
		Enterprise activity intensity	
		Tourism activity intensity	
	Land development intensity (LDI)	Land development intensity	The area of developed and built-up land per unit area. A larger value indicates a greater potential demand for CS by the population.
CS supply index	Cultural space density (CSD)	Memorial or religious space (MRS) density	Number of CS per unit area. A larger value indicates a greater supply of CS.
		Cultural heritage space (CHS) density	
		Cultural facilities space (CFS) density	
		Cultural industries space (CIS) density	
	Accessibility (ACS)	Road network density (RND)	The road length and the number of bus stops in the unit area are normalized and then averaged. A larger value indicates greater accessibility to CS within the unit.
		Bus stops density (BSD)	

After measuring the cultural spatial demand index and supply index, respectively, this study comprehensively presents the bivariate spatial pattern of demand and supply by means of bivariate fitting relationship, bivariate difference, and bivariate spatial autocorrelation. Specifically, the bivariate fitting relationship between demand and supply is to first determine whether there is a statistical relationship between demand and supply, and the statistical relationship between the two is the basis for subsequent research. The difference between demand and supply is a reflection of the matching of demand and supply within the community through the difference between the demand and supply values within the community. Bivariate spatial autocorrelation primarily measures the match between demand within a community and the supply environment of neighboring communities around it and presents the potential for inter-community supply sharing. After determining the correlation between CS demand and supply, the characteristics of the demand–supply relationship of community CS can be judged based on the matching of demand and supply within the community, the significance of the difference between demand and supply within the community, and the sharing capacity of the supply of neighboring communities; the communities within the study area can be classified into different types depending on the characteristics of the demand–supply relationship.

2.3.1. CS Demand Evaluation

To control the extreme differences across communities on a single evaluation factor, we logarithmically transformed PD, AI, and LDI. And to eliminate the quantitative differences and negative values after logarithmic transformation among the three major factors of PD, AI, and LDI, they were normalized. This is calculated as:

$$D_j = N\left[\ln\left(PD_j\right)\right] * 0.5 + N\left[\ln\left(AI_j\right) * 0.3 + N\left[\ln\left(LDI_j\right)\right] * 0.2 \quad (1)$$

where D_j is the demand index for CS of the j-th community, with a value range of [0, 1]; a larger value of D_j represents a larger demand for CS. N is normalization, with a value range of [0, 1]. $\ln x$ is a logarithmic conversion process to x. PD_j represents the density

of population served by CS in the j-th community. When identifying the demands of the residential, employment, and tourist populations, the residential population density, employment population density, and holiday peak day population density are, respectively, used. When identifying the total demand, the sum of the population densities of the three types of people is used. AI_j is the AI of the j-th community; when identifying the demands of the residential, employment, and tourist populations, the commercial POI density, enterprise POI density, and recreational POI density are used, respectively, to characterize the intensity of tourism activities. LDI_j represents the level of land development in the j-th community, expressed as the ratio of developed and built-up land areas to its total area.

2.3.2. Evaluation of CS Supply

Different types of CS vary in the value and scope of services. MRS serves a significantly larger area than the other types, evidenced by the fact that it takes the surrounding neighboring communities into account in addition to its own. Therefore, this paper defines that, when calculating the supply of MRS in a community, its distribution within the community is calculated based on a comprehensive consideration of its presence in the neighboring communities around it. To calculate the CS supply in the three categories of CHS, CFS, and CIS, the search radius for CS is determined based on a 10 min walking distance for residents, based on domestic and international research and study experience [47]. According to previous scholars' studies on the distance of residents' daily walking paths, the community itself and the 800 m buffer zone are taken as the spatial search scope to identify the CS supply [48]; full consideration is given to the radiation effect on this community of CS within 800 m outside the community (Figure 3).

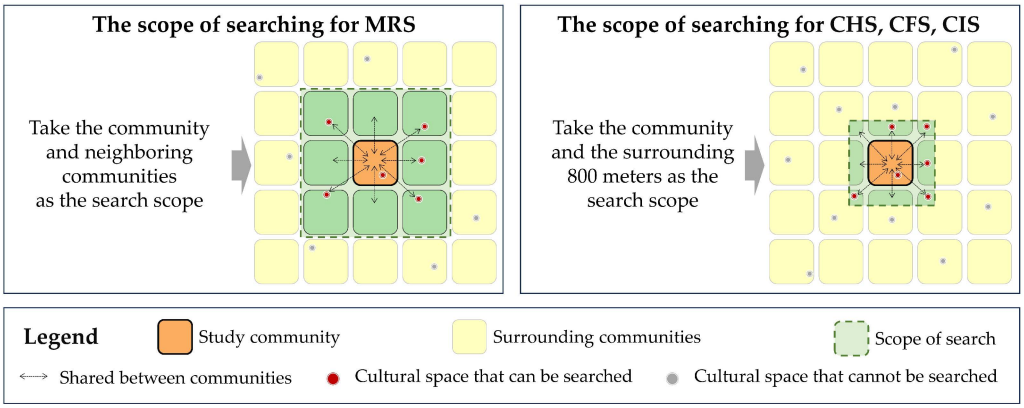


Figure 3. Scope of search for all CS types.

The CS supply index is calculated as follows:

$$S_j = N\left[ln\left(CSD_j\right)\right] * 0.7 + N\left[ln\left(ACS_j\right)\right] * 0.3 \quad (2)$$

$$A_j = \frac{N\left(RND_j\right) + N\left(BSD_j\right)}{2} \quad (3)$$

where S_j is the index of CS supply in the j-th community. CSD_j is the distribution density of CS in the j-th community; the distribution density of the corresponding category of CS is used for identifying the provision of each type of CS, and the sum of the distribution densities of the four types of CS is used for identifying the total CS supply. ACS_j is the accessibility to transportation in the j-th community, which is computed from the road network density RND_j and the bus stops density BSD_j.

2.3.3. Analysis of the Demand–Supply Matching Pattern

Due to the need to comprehensively evaluate the development level of the two systems of demand and supply within the community, the size of the differences between

the two systems, and the relationship between the demand within the community and the surrounding community supply environment, we selected the following methods: the bivariate fitting relationship, bivariate spatial difference analysis, and bivariate spatial autocorrelation methods. This choice came after a comprehensive evaluation and comparison of the advantages and disadvantages of the coupling coordination model, matrix diagram, supply–demand difference, supply–demand ratio, and bivariate spatial autocorrelation methods. In addition, we also extended the application of bivariate spatial autocorrelation method in the field of supply–demand study from the perspective of spatial clustering to neighboring community sharing. We will not elaborate on the calculation of bivariate fitting relationships in this paper.

(1) Bivariate spatial difference analysis

The bivariate spatial difference between demand and supply [25], also known as the matching index [20], is used to measure the relationship between CS demand and supply within a community. The calculation is as follows:

$$R = \frac{S - D}{(S_{max} + D_{max})/2}, \begin{cases} 0.6 < R \leq 1, \ Significant\ supply\ surplus \\ 0.2 < R \leq 0.6, \ Supply\ surplus \\ -0.2 \leq R \leq 0.2, \ Basic\ balance \\ -0.6 \leq R < -0.2, \ Insufficient\ supply \\ -1 \leq R < -0.6, \ Significant\ insufficient\ supply \end{cases} \quad (4)$$

$$|R| = \begin{cases} |R| \leq 0.6, \ Non - significant\ difference \\ |R| > 0.6, \ Significant\ difference \end{cases} \quad (5)$$

where R is the difference between demand and supply of the study unit, S is the supply, and D is the demand. S_{max} is the maximum value of the standardized supply index and D_{max} is the maximum value of the standardized demand index.

(2) Bivariate spatial autocorrelation

The bivariate spatial autocorrelation Moran's I index is commonly used to show bivariate spatial clustering [49]. It can be used to analyze the relationship between the demand for CS in a community and its supply in neighboring communities. The calculation is as follows:

$$I_i = \frac{(x_i - \overline{x})}{S^2} \sum_{j=1, j \neq i}^{n} w_{ij}(y_j - \overline{y}) \quad (6)$$

where I_i is the Moran's I index of bivariate local spatial autocorrelation between demand and supply of research unit i; x_i is the demand index of research unit i; $\overline{x}$ is the average of the demand index of all study units. y_j is the supply index of community j; $\overline{y}$ is the average of the supply index of all study units. S^2 is the variance of x_i; w_{ij} is a spatial weight matrix based on the adjacency relation of space Queen. In the results of the analysis (Bi-LISA map), the high–high cluster (H-H) represents high-demand neighborhoods surrounded by high supply, the high–low outlier (H-L) represents high-demand neighborhoods surrounded by low supply, the low–high outlier (L-H) represents low-demand neighborhoods surrounded by high supply, and the low–low cluster (L-L) represents low-demand neighborhoods surrounded by low supply.

2.3.4. Classification of Community Types

Based on the principle of fully considering CS demand and supply sharing between communities, the technical process of classifying community types is developed by synthesizing the demand–supply relationship within the community, the significance of the difference between demand and supply, and the supply environment of neighboring communities, as shown in Figure 4.

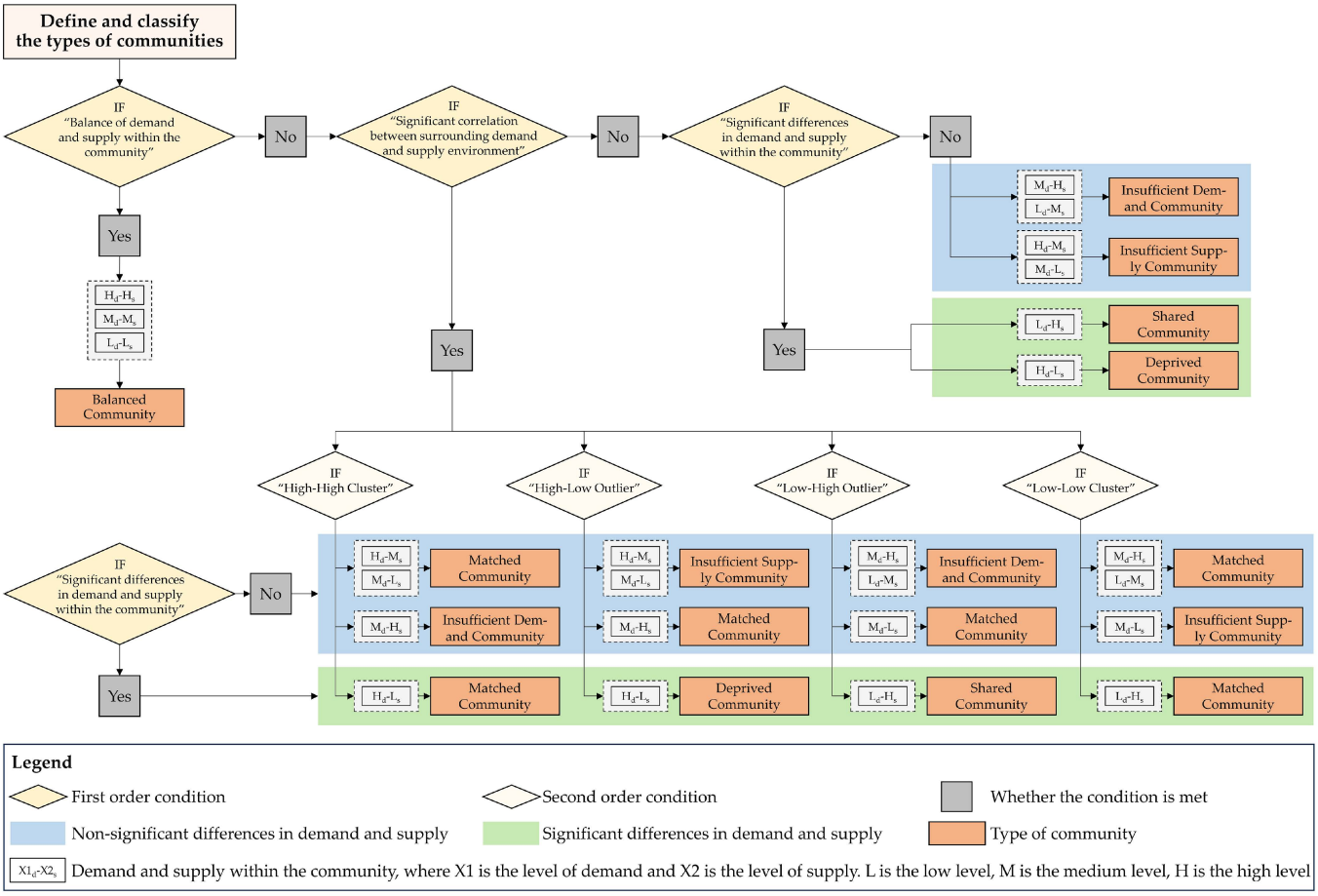


Figure 4. Technical process for defining and classifying the types of communities.

Based on the bivariate spatial difference analysis, a binary map of demand and supply that simultaneously characterizes the difference between demand and supply and the level of demand and supply is further developed [50]. According to the geometric interval classification method, the demand and supply indexes of CS are classified into three categories: low (0–0.33), medium (0.33–0.67), and high (0.67–1). Based on the "3 × 3 color matrix", the demand and supply indexes are mapped into a "demand and supply binary graph", and nine binary mapping types are finally formed: low demand–low supply, low demand–medium supply, low demand–high supply, medium demand–low supply, medium demand–medium supply, medium demand–high supply, high demand–low supply, high demand–medium supply, and high demand–high supply.

According to the division of technical processes by community type, coupled with the bivariate mapping and Bi-LISA map of demand–supply, and the significance of the difference between CS demand and supply, the communities within the study area are classified into six types of communities. The order from significant surplus of supply to balanced demand and supply to significant shortage of supply is as follows: shared communities, insufficient-demand communities, balanced communities, matched communities, insufficient-supply communities, and deprived communities.

3. Results

3.1. CS Demand

The three columns of the small graphs in Figure 5 show the calculation process and the results of the CS demand indices for the three groups of people—residents, employees, and tourists, respectively. The graph at the bottom, the spatial distribution of the overall demand index, is derived from the CS demand indices of the three groups.

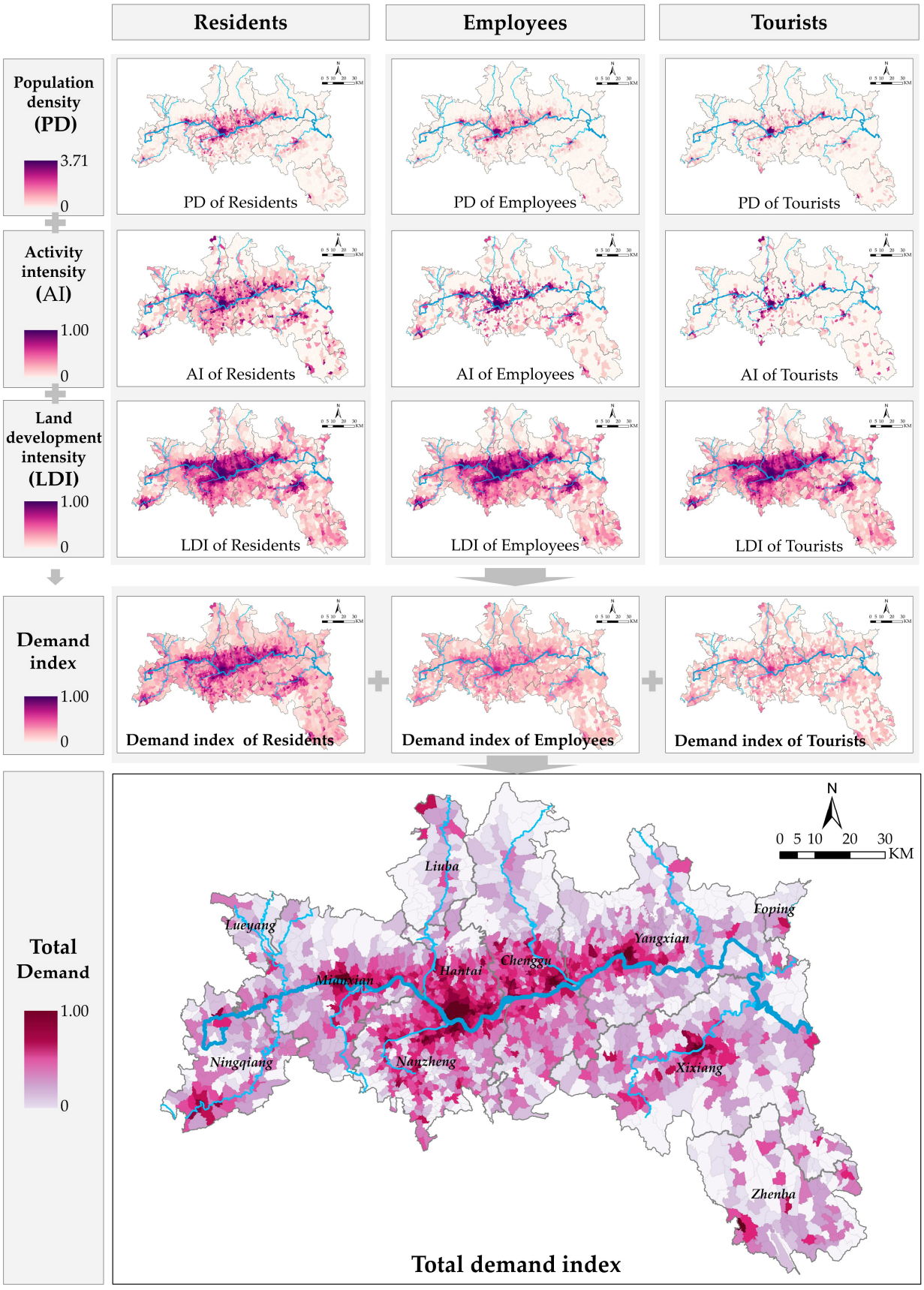


Figure 5. Spatial distribution of CS demand.

There are 237, 1180, and 621 communities with high, medium, and low demand for CS within the research scope, respectively, accounting for 11.63%, 57.90%, and 30.47% of the total number, respectively. The demand index for community CS exhibits a circular spatial structure with the urbanized areas along the main stream of the Hanjiang River and some of its tributaries as the core and gradually decreasing towards the periphery. High-demand communities are mainly in the urbanized areas of four districts and counties, namely Mianxian, Hantai, Chenggu, and Yangxian; medium-demand communities are distributed at the periphery of high-demand communities, in a banded and continuous distribution along the main stream of the Hanjiang River and its first-class tributaries; low-demand communities are mainly in the rural areas. Ideally, the most efficient allocation of public cultural resources can be achieved by targeting the CS supply according to the demand index.

We analyzed the differences in the demand for CS among different groups. Our findings indicate that the demand indexes of the residents, the employees, and the tourists decreased in order, and there were obvious differences in the spatial distribution of the demand among the three groups. The residents had the highest demand for CS in the urbanized areas of various districts and counties, forming a medium–high-demand gathering area in the plains. The demand of the employees decreased from urbanized areas to suburbs and then to rural areas, and the demand index in each area was lower than that of the residents. The demand of tourists for CS was concentrated in urbanized areas, and there were a large number of communities in suburban and rural areas without the demand of tourists. Similar studies have also noted the differences in needs among different social groups [51] and have accordingly determined the focus of resource planning and management based on needs preferences to balance the interests of broader social groups and reduce social inequalities [52].

3.2. CS Supply

The small graphs in Figure 6 show the calculation process and results of the supply indices of the four CS types: MRS, CHS, CFS, and CIS. The supply indexes for the four CS types were used to produce the bottom graph, that is, the spatial distribution of the overall supply index.

There are 202, 847, and 989 communities with high, medium, and low supply of CS within the research scope, accounting for 9.91%, 41.56%, and 48.53% of the total number, respectively. The index of the supply of community CS showed a spatial gradient characterized by the urbanized areas in each district and county as the core, exhibiting a significant decrease towards the periphery. High-supply communities were mainly in the urbanized areas of the districts and counties north of the main stream of the Hanjiang River; medium-supply communities were mainly in the suburban areas north of the Hanjiang River and formed a medium-supply contiguous belt; and low-supply communities were heavily distributed in the outer suburb and rural areas. Similar patterns have been found in studies of the layout of related public utilities, such as educational resources [53] and recreational facilities [54].

The supply indexes for the four types of CS are, in descending order, MRS, CHS, CFS, and CIS. MRS and CHS are significantly better spatially balanced than CFS and CIS. MRS and CHS supplies showed similar spatial distribution characteristics, presenting a gradual decrease from the urbanized areas of each district and county to the periphery; this was found to be higher in the areas north of the main stream of the Hanjiang River than in the southern areas. The supply of CFS and CIS showed a polarized distribution between urban and rural areas, with their spatial distribution primarily concentrated in urbanized areas, and almost no supply of CFS and CIS in suburban and rural areas.

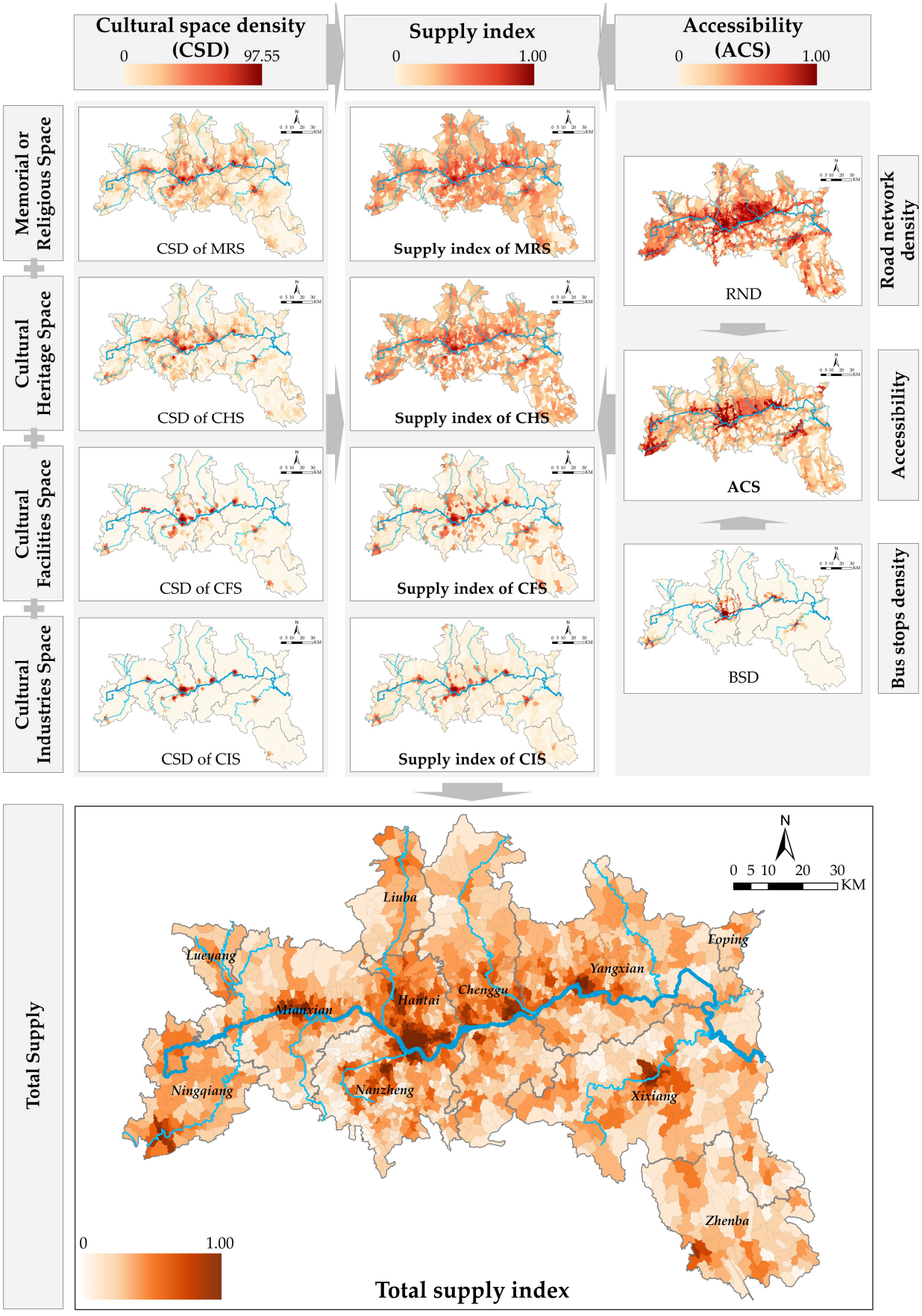


Figure 6. Spatial distribution of CS supply.

3.3. Demand and Supply Matching Pattern

3.3.1. Demand–Supply Bivariate Fitting Relationship

The scatter plot matrix of demand–supply can reflect the correlation between the demand of three groups and the supply of the four types of CS (Figure 7). The results showed that there was a significant positive correlation between CS demand and CS supply for all groups, i.e., communities with high demand from all groups of people had high supply indexes.

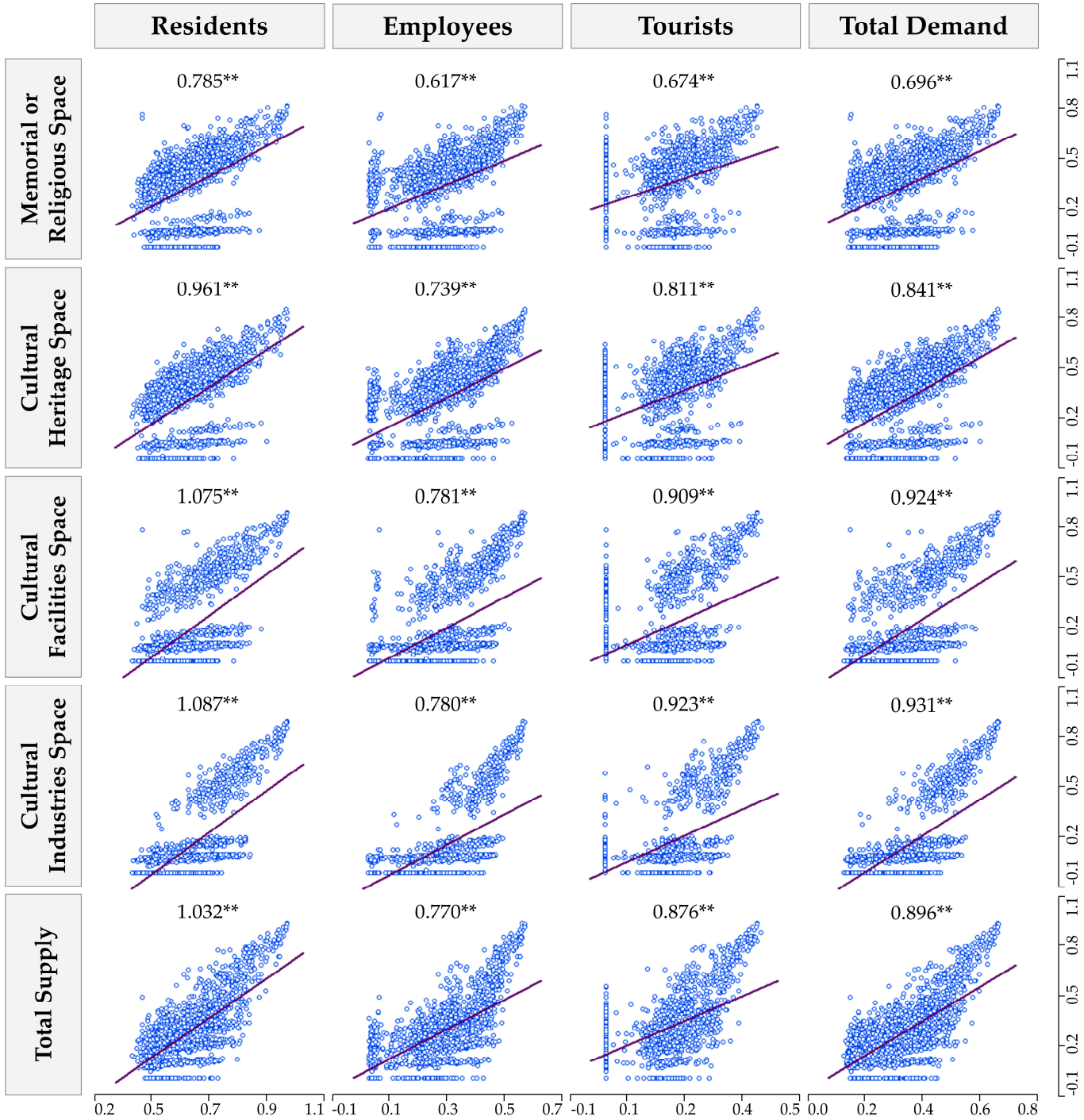


Figure 7. The scatter plot matrix of demand–supply. Note: ** indicates that the correlation is significant at a confidence level of 99%.

3.3.2. Demand–Supply Bivariate Difference Distribution

Figure 8 systematically displays the demand and supply difference for each community within the study area. The four columns represent the differences between the CS demand index and supply index for three groups of people and the total people, respectively. The five rows represent the differences in results between the supply index and demand index for four types of CS and the total CS.

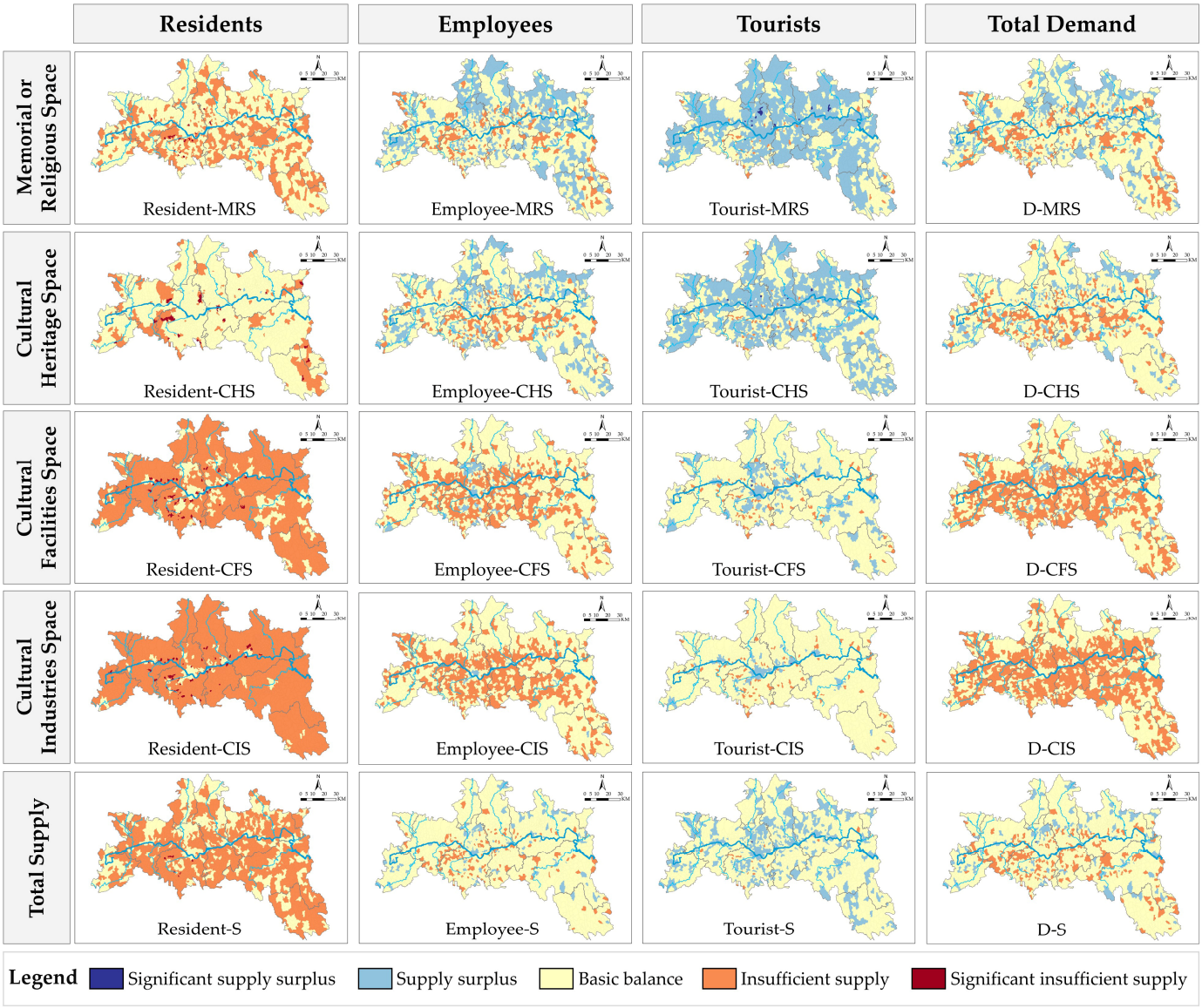


Figure 8. The bivariate spatial difference matrix of demand–supply.

The difference between overall demand and overall supply in the HSHRB of communities was dominated by demand–supply balance and lagging supply. There were 1562 communities with balanced demand and supply, accounting for 76.64% of the total number of communities; 337 communities with lagging supply, accounting for 16.54% of the total number of communities; 134 communities with surplus supply, accounting for 6.58% of the total number of communities; and 5 communities with a significant surplus of supply, accounting for 0.25% of the total number of communities. Communities with balanced demand and supply were evenly distributed spatially; communities with lagging supply were mostly scattered in the suburbs and rural areas south of the main stream of the Hanjiang River; and communities with surplus supply were in a small number of

outlying rural areas. The difference between the demand and supply of CS for residents, employees, and tourists was characterized by lagging supply, balanced demand and supply, and surplus supply. The specific details for this are outlined below.

For residents, the supply of CS was dominated by failure to meet demand on the whole. There were 603 communities with a balance between demand and supply, accounting for 29.59%; 1424 communities have lagging supply, accounting for 69.87%; 10 communities have a serious supply lag, accounting for 0.49%; 1 community has a surplus supply. Communities with balanced demand and supply were mainly in the urbanized areas of districts and counties, and along local tributaries of the Hanjiang River; communities with lagging supply were mainly in suburban and rural areas; and a small number of communities with serious lagging supply were in the suburbs north of the Hanjiang River. The demand–supply relationship between four types of CS and the residents shows significant differences. Specifically, there was a balanced distribution of communities with balanced demand and supply of MRS, and a balanced distribution of communities with lagging supply, but more in the south than in the north; CHS is dominated by communities with balanced demand and supply. The CFS and CIS supply was largely balanced with demand in urbanized areas, but generally lagged in other areas; there were also some communities with significantly lagging supply on both sides of the main stream of the Hanjiang River and on the edges of urbanized areas.

For employees, the supply of CS was dominated by matched demand and supply. There were 1677 communities with demand–supply balance, accounting for 82.29%; 216 communities have lagging supply, accounting for 10.6%; a total of 144 communities have surplus supply, accounting for 7.07%; only 1 community has a significant surplus of supply. Communities with balanced demand and supply were evenly distributed; those with lagging supply were scattered in the suburbs and southern rural areas; and those with surplus supply were dispersed. Specifically, MRS and CHS were characterized by a balanced distribution of communities with balanced demand and supply; additionally, they had a concentrated distribution of communities with surplus supply in the north and scattered distribution of communities with lagging supply in the south; CFS and CIS saw a large number of communities with lagging supply, mainly in the central and southern regions.

For tourists, the supply of CS was dominated by the balance of demand and supply and surplus supply. There were 1387 communities with balanced demand and supply, accounting for 68.06%; a total of 629 communities with surplus supply, accounting for 30.86%; 21 communities with lagging supply, accounting for 1.03%; and only 1 community with significant surplus supply. Communities with balanced demand and supply were evenly distributed in suburban and rural areas; those with surplus supply were mainly along the main stream of the Hanjiang River and local tributaries; and those with lagging supply were in a small number of suburban areas. Specifically, MRS and CHS were generally in surplus supply, and even communities with significant surplus supply came into being in the suburbs north of the Hanjiang River; CFS and CIS were more commonly found in communities with surplus supply in urbanized areas, but were dominated by demand–supply balance communities in suburban and rural areas.

Looking at different CS types, the matching between MRS supply and overall population demand was dominated by a demand–supply balance, lagging supply, and surplus supply. The communities with balanced demand and supply were distributed evenly, those with surplus supply were concentrated in the north, and those with lagging supply were dispersed in the central and southern parts. CHS was similar to MRS, but there were fewer communities with surplus supply in the north and more communities with lagging supply in the south. CFS was dominated by communities with lagging supply which were widely distributed in suburban areas; CIS supply was similar to that of CFS.

3.3.3. Demand–Supply Bivariate Spatial Autocorrelation

We established a spatial weight matrix based on the GeoDa spatial analysis tool and calculated the global Moran's I between the CS demand of three groups of people and the CS supply environment of four types. As shown in Table 3, Moran's I between CS demand and CS supply environment for all groups was positive and significant at the 0.001 level, a finding that reveals a significant positive spatial autocorrelation between them. In addition, Moran's I values of CS supply environment and population demand vary from high values to low values for residents, employees, and tourists. This result shows that the spatial supply environment of CS has the highest positive correlation with the demand of residents, followed by the employees, and the spatial positive correlation with the demand of tourists is the lowest.

Table 3. Global Moran' I of the supply of CS and population demand.

	Residents	**Employees**	**Tourists**	**Total Demand**
MRS	0.386 **	0.360 **	0.307 **	0.372 **
CHS	0.429 **	0.383 **	0.333 **	0.403 **
CFS	0.506 **	0.440 **	0.403 **	0.476 **
CIS	0.596 **	0.517 **	0.479 **	0.562 **
Total Supply	0.594 **	0.528 **	0.472 **	0.562 **

Note: ** indicates that the correlation is significant at a confidence level of 99%. The mathematical expectation E[I] of Moran's I index is −0.0263.

Figure 9 systematically presents the relationship between the demand within each community and the CS supply environment of its surrounding communities within the study area. The four columns, respectively, represent the relationship between the CS demand index for three groups of people and the total number of people, and their surrounding supply environments. The five rows represent the relationship between the supply environment of four types of CS, the total CS supply environment of the surrounding communities, and the internal demand of the community.

According to the local bivariate spatial autocorrelation analysis, the spatial relationship between CS demand–supply environments can be categorized into four types: HH clusters, HL outliers, LH outliers, and LL clusters. In the spatial autocorrelation analysis of total CS demand and total supply environment, there were more communities in HH and LL clusters, totaling 601, accounting for 29.49% of the total. According to the spatial distribution, the total CS demand–supply environment showed a clear spatial circling structure, with urbanized areas as the concentration of HH clusters, and rural areas as the concentration of LL and HL clusters. Rural areas had a generally low CS provision environment, characterized by a mixed distribution of cultural service development areas and cultural-provision-lagging areas, and a low likelihood of sharing CS provision between communities.

As for the CS demand–supply environment of residents, the LL clusters had the highest number of communities, followed by the HH clusters. The HH clusters were mainly in the urbanized areas, while the LL clusters were in the rural areas. There were significant differences in the demand–supply environments for the four types of CS for residents living in different regions. The northern part of the main stream of the Hanjiang River was dominated by LL clusters, while the southern part was characterized by a mixture of LL and HL clusters. The HH clusters in the clustering results for the residents living in the inner suburbs with the MRS, CHS, CFS, and CIS demand–supply environments decreased in that order; on the contrary, the LL clusters in the clustering results for residents in the outer suburbs with the MRS, CFS, CIS, and CHS demand–supply environments increased in that order.

For the CS demand–supply environments of employees, the communities in LL and HH clusters were the majority. In the north bank of the main stream of the Hanjiang River,

CS demand–supply environments were highly similar for employees, mainly dominated by LL and HH clusters; while the south bank was dominated by low-supply clusters with LL and HL clusters staggered in distribution. In addition, there were significant differences in the demand–supply environments for CS for employees in the suburbs, especially between inner suburbs and outer suburbs, with great differences in the distribution of HH and LL clusters.

For the CS demand–supply environments of the tourists, the largest number of communities was found in HH clusters, followed by LL and HL clusters. In urbanized and rural areas, the four types of CS demand–supply environments showed a higher similarity for tourists, while in suburban areas, this similarity was at a low level. Specifically, in urbanized areas, the demand–supply environments of the four types of CS for tourists were all HH clusters; meanwhile, in rural areas, LL and HL clusters were in a staggered distribution. In the inner suburbs, the HH clusters for the MRS, CHS, CFS, and CIS demand–supply environments for the tourists were gradually decreasing; meanwhile, in the outer suburbs, the tourist population and the CHS and CIS demand–supply environments were dominated by HL and LL clusters.

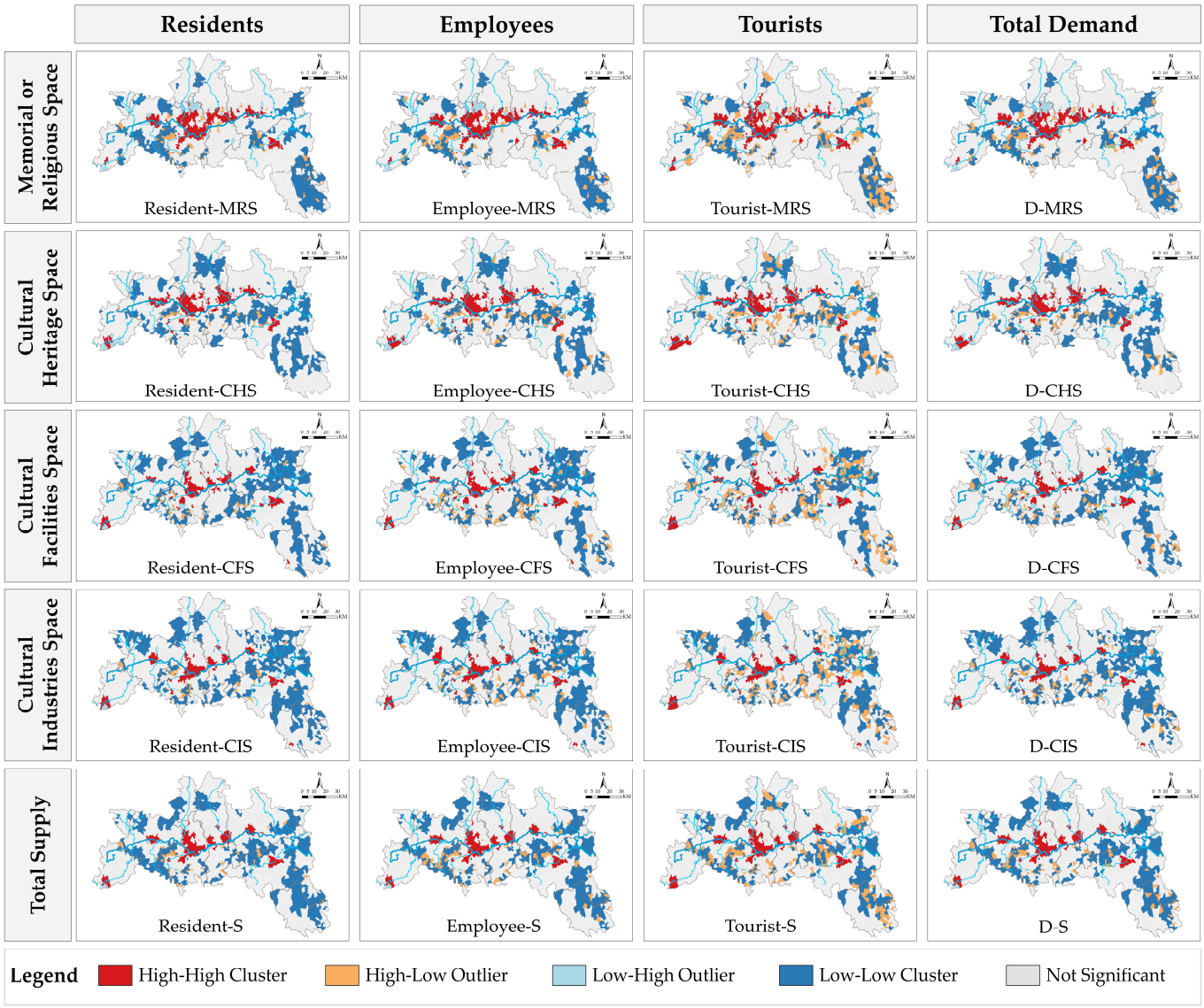


Figure 9. The BI-LISA map matrix of demand–supply.

3.4. Spatial Distribution of Community Types

The study area as a whole was dominated by balanced communities, with relatively few other types of communities (Table 4). Different types of communities showed distinct characteristics in geographic spatial distribution (Figure 10). Balanced communities showed a concentrated distribution in urbanized areas and a balanced distribution in suburban and rural areas. The deprived communities were mainly concentrated in the periphery of the dense areas of balanced communities, especially in the suburban areas. Under-supplied communities were primarily found in suburban and rural areas, with more under-supplied communities in the south than in the north, and more in the plains than in the mountains. Shared communities were predominantly located in rural areas in the south of the Hanjiang River; meanwhile, in the north, they tended to be concentrated in the outer suburbs; in addition, shared communities were more concentrated in mountainous areas, especially those close to the plains. The insufficient-demand communities were concentrated within a 5 km radius around the main stream of the Hanjiang River and its tributaries—the Baohe River and the Xushui River—which were generally located in the suburban areas. There were relatively few matched communities, with no clear pattern in their spatial distribution.

Table 4. Statistics on the number of communities by type.

Community Type	Quantity (Number)	Proportion (%)
Balanced communities	1167	57.26
Insufficient-supply communities	548	26.89
Deprived communities	151	7.41
Shared communities	130	6.38
Insufficient-demand communities	39	1.91
Matched communities	3	0.15

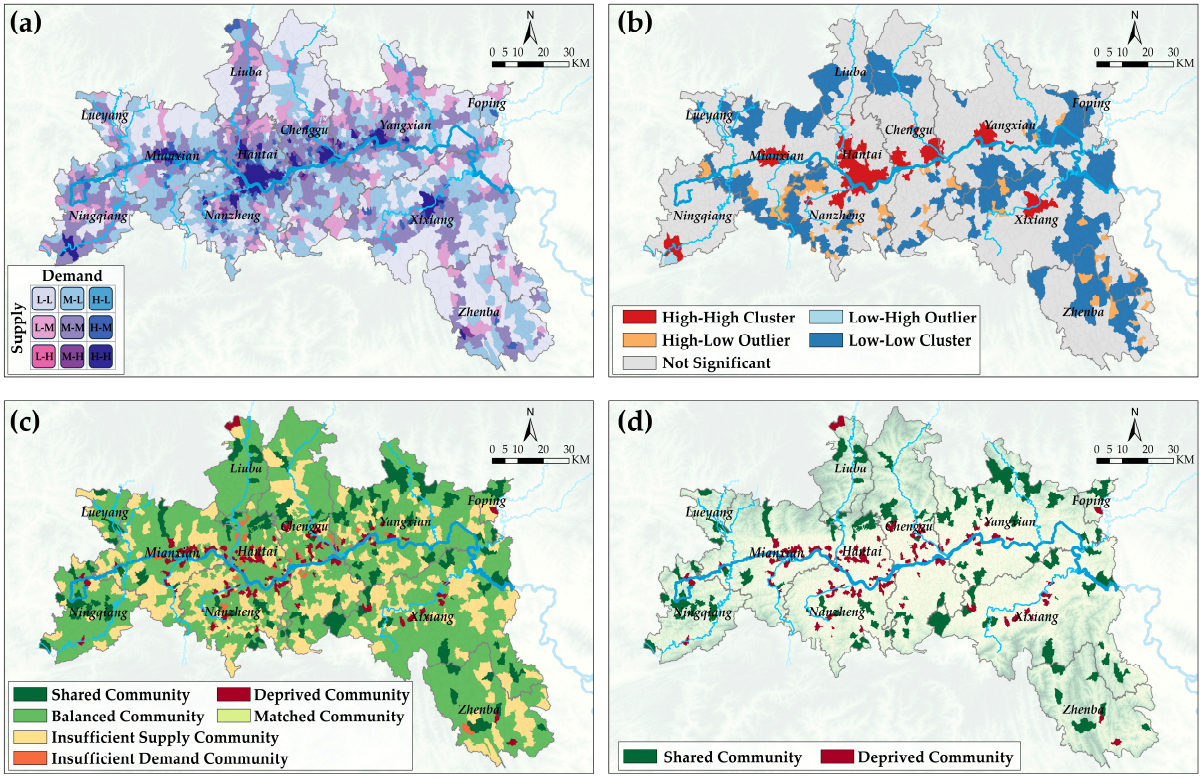


Figure 10. Spatial patterns of demand and supply for CS at the community scale ((**a**) bivariate mapping of demand and supply; (**b**) Bi-LISA map of demand and supply; (**c**) classification of communities; (**d**) key communities).

4. Discussion

4.1. Temporal and Spatial Differences in CS Demand–Supply Relationships

4.1.1. In Urban and Rural Areas, the Demand–Supply Relationship of CS Manifested as a High-Value Balance and a Low-Value Balance, Respectively, While a Significant Shortfall in CS Supply Was Observed in Suburban Areas

Although there were large numbers of balanced communities in both urbanized and rural areas, their demand–supply structures were quite different. From the perspective of the difference between demand and supply, both urbanized areas and rural areas showed that the demand and supply of internal CS in a large number of communities were largely balanced. However, from the perspective of a demand–supply environment, the urbanized area was a cluster of "high-demand and high-supply environments", and the rural area was a cluster of "low-demand and low-supply environments". According to the results of the analysis of the difference between demand and supply and the environment of demand and supply, urbanized areas were balanced, with high values of demand and supply for CS; meanwhile, rural areas were balanced, with low values of demand and supply. Despite the large difference in the level of demand for CS between urbanized areas and rural areas, the supply of CS was balanced with their demand at a corresponding level, indicating China's idea of placing CS according to local conditions.

Suburban areas were where the demand and supply for CS presented the most significant challenges. The difference between demand and supply within the community showed a general undersupply of CS in the suburbs; meanwhile, the demand–supply environment indicated a lack of significant correlation between the demand for CS and the supply environment in the suburbs. This demonstrated minimal potential for CS sharing between neighboring communities. In addition, according to the demand–supply relationship within the community and the demand–supply environment around the community, it was not possible to solve the problem of insufficient supply in the suburbs by CS sharing between neighboring communities. And an analysis of the spatial distribution of community types showed that the "deprived communities" with the most significant demand and supply problems were located in suburban areas. Guo [55] and Chang et al. [56] also found similar results when studying public health services and green space cultural services; that is, service quality in urban fringe areas decreased significantly. It is closely related to the Standard for Urban Residential Area Planning and Design currently enforced in China [57], where cultural facilities in both urbanized and suburban areas are provided based on the size of the residential population. However, since the suburbs usually have a larger employed population, the actual population to serve far exceeds the residential population, and the facilities provided solely according to the residential population struggle to meet the actual demand. The suburbs should be the focus of attention in future CS planning and management and even basic services of all kinds.

4.1.2. The Supply of CS in the Historical Category Shows a Good Fairness, but the Supply of Modern CS Is Significantly Polarized

MRS and CHS were mostly produced in the historical period as historical CS, and their supply shows a good fairness. Historic CS are in a balanced distribution, and the vast majority of communities have a supply of historic CS. According to the relationship between the demand and supply of CS, historical CS generally meets the demand for CS in different regions and for different populations, and there is a surplus supply for tourists. This result is consistent with the research conclusion of Coscia [58] and Du Cros et al. [59] on the relationship between demand and supply of CHS in Italy and China.

CFS and CIS were mostly born in modern times and are modern CS, and their supply is significantly polarized in both space and population. Zhao [60], Zhang [61], and Li et al. [62] also pointed out that China's public cultural facilities show significant spatial imbalance and spatial agglomeration characteristics. In spatial distribution, the existing modern CS are mainly located in urbanized areas, and there are a large number of communities in the suburbs and rural areas that do not have a supply of modern CS. An analysis of the demand

and supply of modern CS in different regions showed that the lagging supply was more pronounced in rural and suburban areas than in urbanized areas. From the viewpoint of the relationship between the demand and supply of different groups of people and modern CS, there are different degrees of insufficient supply of modern CS to meet the needs of the residents, employees, and total population groups; the most prominent problem is that of insufficient supply for residential needs.

The significant differences in equity and the demand–supply relationship between historical CS and modern CS stem from the cultural facilities distribution principles in different periods of China. In ancient China, great importance was attached to the reverence for heaven and Earth and reverence for ancestors, with memorial and sacrifice facilities commonly found in both cities and villages [63]. As a result, the layout of historical CS is largely unaffected by the level of socioeconomic development, maintaining a balanced distribution. On the contrary, modern CS does not tend to be balanced and fair over time. The reason is that China's long-term adherence to the "dual structure" development model has resulted in a differentiated infrastructure supply system for urban and rural areas in terms of land and capital, which has increased the polarized differences in the supply of modern CS between urban and rural areas. In addition, modern CSs are generally laid out in a top–down fashion, and their public attributes often give way to economically oriented commercial development in the course of urban construction and development, resulting in a general lagging behind of the demand for them; this is especially the case for the demand of the people living in the expanding areas of the city.

4.2. Typical Characteristics of Different Types of Communities

4.2.1. Spatial Distribution of the Six Types of Communities Shows Significant Circling Characteristics

The six types of communities were in a circle structure in spatial distribution as a whole, with high-balance demand–supply communities dominated in urbanized areas, insufficient-supply and low-demand–supply-balanced communities dominating in peripheral suburbs, and some shared communities appearing in rural areas. A similar spatial concentric pattern has been observed in India [64], yet this conclusion is not consistent across all urban studies. For example, Zeng's study on Chicago, USA, reveals a grid-like spatial structure [65], and Bahriny's research on Tehran, Iran, demonstrates a more complex spatial structure closely related to politics, society, and urban management [66]. Specifically, urbanized areas are found to be the places where balanced communities with high values of both demand and supply for CS gather; suburban areas are generally deprived communities with severely insufficient supply; outer suburbs were a mix of insufficient-supply and balanced communities; rural areas are dominated by balanced communities with low values of both demand and supply for CS; and rural areas in mountainous regions are concentrated zones of shared communities with significant surplus supply. There were found to be fewer insufficient-demand communities and shared communities, and no separate spatial circles were formed. This result agrees with the findings of Liu, Goudsmit, and Yu et al.; specifically, Liu concluded that communities in more urbanized central areas are more livable [67]; Goudsmit evaluated the accessibility of cultural facilities in newly built areas in Hong Kong and came to the conclusion that the lack of cultural facilities in suburban areas affected the quality of life of the residents [68]; Yu analyzed the spatiotemporal evolution of cultural heritage in rural areas of China and found the same pattern, suggesting that the land in rural areas in mountainous regions was abandoned, with a low level of cultural heritage utilization [69].

4.2.2. The Internal CS Demand–Supply Relationship and External CS Supply Environment of the Six Types of Communities Hold Significant Differences

The supply of CS within the shared community was significantly higher than the demand, and this is the case in an environment where the supply was significantly higher than the demand, so there was a high surplus of CS supply. Demand for CS within deprived communities was significantly higher than supply, and their neighboring communities

all had a significantly insufficient supply, so there was a large gap in the supply of CS in deprived communities. The demand and supply of CS within the balanced community were comparatively balanced. The CS within the matched community was imbalanced in demand and supply, but the cross-community demand–supply balance was achieved by sharing between neighboring communities. The supply of CS within the insufficient-supply community failed to meet demand, with the lack of CS supply being greater than the CS supply that could be shared among the neighboring communities; also, there was still a gap in the supply of CS after accepting CS sharing from its neighboring communities. The supply of CS in the insufficient-demand communities was higher than the demand, and after sharing the supply of CS with their neighboring communities, there was still a surplus supply (Figure 11). Other studies have looked at such areas with rich cultural resources and explored community-based cultural resource management models for sustainable development [70,71].

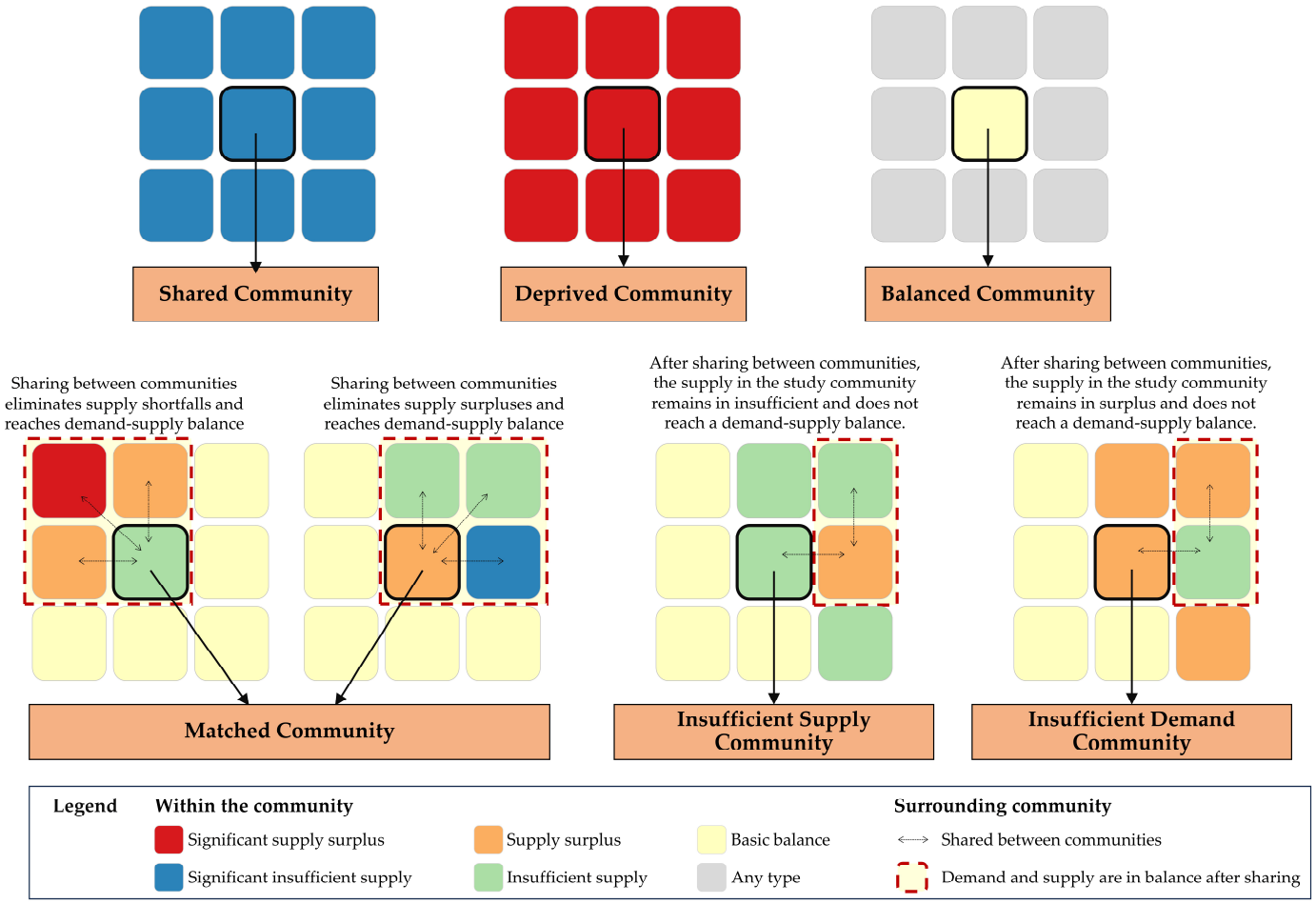


Figure 11. Demand–supply matching characteristics of the six types of communities.

4.2.3. Deprived Communities and Shared Communities Showed Urban Expansion and Village Decline, Respectively

Deprived communities presented the spatial dynamics of urban expansion and growing population demand, and they are key areas for new CSs in the future. Deprived communities were mostly located in the outer suburbs of urbanized areas, around high-demand and high-supply clusters. This may be caused by the fact that cities are in the development stage of outward expansion. The outward expansion of cities indicates an increase in the number of people and a simultaneous increase in the demand for CSs, but not enough CSs have been built in the short term; this alludes to the fact that the construction of CSs tends to lag behind the construction and development of other elements in the

expansion of Chinese cities. This conclusion is similar to the research of Ghasemi et al. [72], who argued that the rate of meeting demand for urban services in Iran is always lower than that of demand emergence.

The spatial distribution of shared communities characterized the spatial trend of village decline and represents an area that should be given prioritized attention in future community planning. The shared communities exhibited a clear geographic preference for space; all of them are in mountainous areas. Comparison of the indicators of the shared community revealed that the shared community had many MRS and CHS left over from history, and the supply capacity of these MRS and CHS was much higher than the current demand for CSs in the community; this indicates that the current demand of the people in the community is much lower than the demand in the past. These shared communities may appear to be "hollow villages" in the future. Future community planning should focus on enhancing the needs of the people within the shared community or furthering the potential for established shared CS supply.

4.3. Implications for Optimizing the Demand–Supply Relationship of CS and Promoting Sustainable Community Development

A dynamic balance between demand and supply is ideal for the high-quality development of cultural services [73], which can help enhance the inclusiveness and diversity of facilities and promote the sustainable development of communities [74]. Based on the studies of the heterogeneity of demand–supply matching between the three groups of people and the four types of CS—as well as the characteristics of demand–supply relationships in six types of communities—this paper provides categorized CS planning and management optimization ideas from the perspectives of demand and supply matching types and community types. Additionally, it proposes policy recommendations for building a participatory CS management platform.

4.3.1. Building a Matrix for Optimizing the Demand and Supply of CS Based on the Types of Demand and Supply, to Improve the Coupling of Demand and Supply in a Refined Manner

As mentioned earlier, there are different types and degrees of imbalance in the current match between the supply of the four types of CS and the demand of the three types of people. Proposing demand and supply adjustment suggestions at the overall level has little effect in optimizing the demand–supply relationships. This paper considers the construction of CS demand and supply optimization matrix based on their different matching types according to different demand–supply matching relations and characteristics (Figure 12), so as to realize the refined optimization of demand–supply coupling.

The matrix of optimization of demand and supply in CS contains seven measures, which are—in order of urgency—the following: adjustment of supply structure, adjustment of supply quantity, elimination of surplus supply, optimization of demand–supply environment, improvement of supply quality, optimization of supply quantity and structure, and optimization of demand and supply quantity and structure. The measures to optimize demand and supply from the perspective of the needs of different population groups are laid out in the following paragraphs.

For the residential population, the first measure is to increase the supply of modern CSs in combination with their demand and spatial distribution, so as to solve the problem of the lagging supply of modern CS; the second measure is to further improve demand–supply matching by means of the modernization, opening, and sharing of historical CSs, so as to optimize the environment for their supply and demand.

For the employed population, the core problem lies in the insufficient feedback of CS supply on their demand. It is necessary to comprehensively adjust the supply structure, attach importance to the demand of the employed population for all types of CSs, and optimize the supply structure of CSs in the light of their demand and spatial distribution. As employees are mainly in the suburbs, emphasis should be placed on improving the

provision of CSs in under-provisioned and deprived communities in the suburbs to meet their needs.

For the tourist population, the first measure is to release the surplus supply capacity of historical CSs to meet the demand of more tourists by boosting the accessibility of CSs [75], especially for insufficient-demand communities and shared communities in rural areas; the second measure is to improve the quality of the supply of modern CSs to enhance the attractiveness of regional CSs, to provide support for the elimination of surplus historical CSs, and to enable the supply of historical CSs to be better matched with the demand for contemporary CS.

The ultimate goal is to optimize the spatial allocation of CS resources by adjusting supply volume and supply structure under different matching relationships [76,77]. Additionally, by improving supply capacity and unlocking supply potential—while expanding the demand structure [78]—we can facilitate the sustainable operation of CSs, thereby reaching a higher level of dynamic balance between demand and supply.

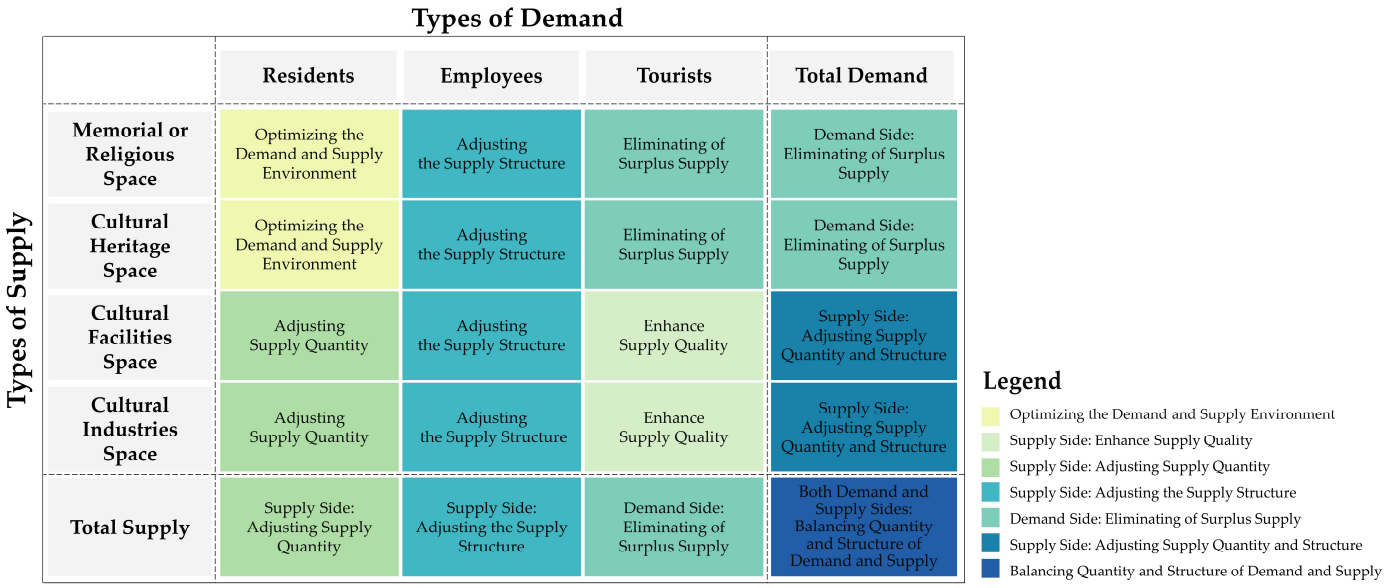


Figure 12. Optimization matrix of CS demand and supply.

4.3.2. Proposing CS Planning and Management Ideas according to Community Types and Systematically Optimizing the Demand–Supply Relationship

The matrix system for optimizing CS demand and supply demonstrates ideas for adjusting to different demands and different supplies; meanwhile, ideas for optimizing demand and supply at the specific community level can be implemented, relying on the six types of communities. Community-level optimization ideas are more efficient than national solutions and can ensure that sustainable community systems are well managed and maintained [79,80]. Therefore, this study proposes CS planning and management suggestions at the regional and community levels based on the six community types identified earlier, so as to optimize the relationship between demand and supply of regional CS in a comprehensive manner.

At the regional level, the first approach is to improve the mechanism of supplying CS from top to bottom according to the users and the type of CS; the second is to build a mechanism of sharing CS at the regional level, to realize the matching of demand and supply across communities; the third is to guide and encourage the broad participation of social forces in the construction of CSs—relying on high-quality supply from the government—to integrate and improve the quality and operational efficiency of CS.

At the community level, CSs should be precisely supplied by filling shortcomings, digging up stock, and improving quality [81,82] (Figure 13). For shared communities, the focus is on improving the quality and accessibility of CSs and directing demand towards

shared communities, mainly by the tourist population. For deprived communities, it would be appropriate to try to increase CSs and perform functional transformation and cultural shaping of existing CSs or related abandoned industrial spaces—according to the characteristics and use preferences of the population [83,84]—while optimizing and improving those that are currently underutilized. Balanced communities should continuously optimize and perfect their CSs to maintain the balance between demand and supply. Matched communities should innovatively construct a cross-community CS sharing mechanism, and maintain the demand–supply balance at the regional level. Insufficient-supply communities should effectively strengthen the allocation of community CS, promoting a balance between demand and supply in the quantity and structure of CS supply, while carrying out functional renovation of existing CSs in accordance with the characteristics and preferences of the community's CS users. Insufficient-demand communities should perform the following: build cross-community mechanisms for sharing CSs; share established CSs at a higher level; optimize the pattern of matching demand and supply for CSs at the regional level; meanwhile, they should give full play to the supply potential of CSs by attracting more people with high demand through measures such as upgrading the quality and accessibility of surplus historical CSs and carrying out modernization and renovation for them.

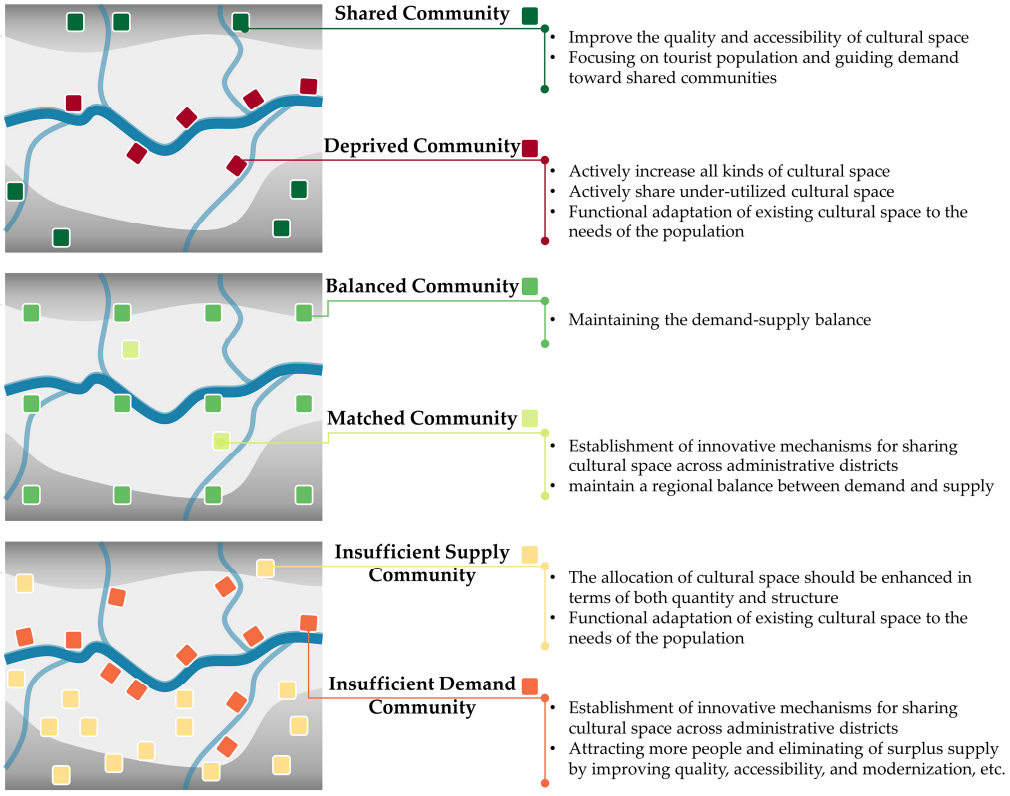


Figure 13. Suggestions on CS planning and management of different community types.

4.3.3. Building a Participatory CS Planning and Management Platform for the Sustainable Development of Community Public Space Planning

In the face of the current challenges in community development—especially in achieving efficient matching of CS demand and supply, enhancing community participation and cooperation, promoting resource sharing, and promoting sustainable community development—it is particularly critical to construct a CS planning and management platform that integrates a multi-party participation mechanism, digital management and evaluation, policy support and incentive mechanism, and continuous optimization and iteration. By establishing a platform for multi-stakeholder participation, the multi-party participation mechanism collects data on the needs and suggestions of different parties by both online and offline means. Digital management and evaluation enables the construction

of a transparent and trustworthy information management system through blockchain technology [85], real-time monitoring of changes in demand and supply by means of big data technology, and the introduction of public space information model (PSIM) technology to boost planning efficiency. Policy support and incentives require government incentives and related policies such as financial subsidies and tax benefits and encourage active community participation. Continuous optimization and iteration, by regular community survey and data analysis, allow for the evaluation of the efficiency and satisfaction of CS use, and spread the concept of smart CS through IoT, AI, and other technologies to improve the efficiency of space use and user experience. The platform will help to improve the connectivity of different parts of the planning and management process, from identifying public space issues to implementing strategies and solutions, thereby improving their feasibility.

The key to achieving the platform's goals lies in the introduction of a range of strategies and technologies to facilitate the participation of a wide range of stakeholders, including community members, CS providers, government departments, businesses, and non-governmental organizations. Such strategies include enabling community members to participate directly in CS planning and feedback through various channels, such as workshops, online forums, and public consultation sessions, to ensure that the planning is more in line with the actual needs of the community; introducing Building Information Modeling (BIM) technology for CS presentation in the form of 3D models, to facilitate a more intuitive understanding of the spatial layout and functions of the space for all participating parties and improve the efficiency of planning and design; making the planning process more interactive [31,32], experiential, and playful by means of virtual reality (VR) and augmented reality (AR) technologies, enabling community members to participate in the design and planning in an intuitive manner; and enabling active and experiential learning for community members in controlled environments in a gamified manner. These approaches will help governments and planners to develop optimized solutions that are better suited to the actual needs and preferences of target users [86]. The government and enterprises can undergo precise planning with the data and analysis tools provided by the platform for the best allocation of spatial resources.

The construction of this participatory cultural spatial planning management platform will enable data-driven decision making, simplify the decision-making process, and improve the efficiency of demand and supply optimization. It requires close collaboration between governments, communities, and technology providers, as well as the active exploration and application of new technologies. It is expected that the implementation of this platform will create a more dynamic, interactive, and inclusive community cultural ecosystem and continuously enhance community cohesion and sustainable development.

4.4. Limitations

Although this study reveals the matching between demand and supply of CSs and provides valuable insights for the planning and management of CSs, some limitations remain to be solved. First of all, the community is the fundamental unit of human life. This study, based on the community as the research unit, can more accurately identify and evaluate the needs of people for CSs, help to identify more subtle differences between the demand and supply of CS in different communities, and thus enhance the pertinence of CS planning and management suggestions. However, it has an insufficient understanding of the nested relationship between the demand and supply pattern of CS and its similarities and differences among the administrative scales of river basin, district, county, sub-district, and community. The methods of multi-scale space nesting and social network analysis can be considered to explore the influence and difference of demand–supply relationship of CS at different scales in future study. Secondly, this study explores the demand and supply of CSs from the perspective of the needs of residents, employees, and tourists. However, the mobile phone signaling data used in this paper failed to cover all the individuals in the study area (the study population was about 80% of the total), and the differences in the preferences for and the amount of demand for various types of CSs among groups of

different ages, occupations, economic status, family structures, and cultural and religious backgrounds were not taken into account in the study. The precise identification of demand preferences in this paper needs further improvement. Particle swarm optimization [78] and decision tree models in machine learning can be introduced in future study to analyze the demand preferences of different populations, so as to identify demands more accurately. Finally, this study has systematically constructed a system for identifying and evaluating CSs; however, due to the limitation of data acquisition, only the average service scope of each type of CS has been taken into consideration. In fact, there are differences in the scale, carrying capacity, and scope of influence of each one of the CS types, and more accurate results of demand and supply evaluation can be gained from more refined follow-up studies.

5. Conclusions

This paper systematically constructs a quantitative demand and supply assessment framework. This framework includes three population demand dimensions: residents, employees, and tourists. It also comprises four CS supply dimensions: MRS, CHS, CFS, and CIS. Moreover, the paper, using the basin as the research scale and communities as the research unit, analyzes the matching relationship between demand and supply of CSs in 2038 community units within the HSHRB. It synthesizes the demand–supply relationship within the communities and the supply environments of the neighboring communities to develop a technical process for classifying community types. Ultimately, the article proposes strategies for optimizing the supply and demand of cultural spaces and suggestions for constructing a participatory cultural space planning and management platform. This paper conducted an empirical study on the HSHRB, enriching the theoretical understanding and technical methods of CS demand and supply, and providing scientific basis for the high-quality development of cultural services.

Findings: (1) Generally, the matching between demand and supply of CS in the HSHRB showed spatial circle characteristics of high value balance in urbanized areas, lag in suburban supply, and low value balance in rural areas. (2) The demand–supply matching varied significantly among the three groups of people. The demand of residents for CSs was beyond the current supply level, exhibiting a lag in supply on the whole; the demand of employees for CSs was in a basic balance with their supply; the demand of tourists for CSs was lower than the supply, characterized by an overall surplus in supply. (3) The matching between the supply of the four types of CS and population demand showed significant spatial heterogeneity. The urban–rural balance and spatial equity of historical CSs are better than those of modern CSs. The supply of MRS and CHS is more equitable and can better meet the needs of all regions and populations, while the supply of CFS and CIS is more polarized and generally lagging, reflecting the practical problem of needing to effectively transform surplus historical CS supply and increase modern CS supply. (4) The internal CS demand–supply relationships and external CS supply environments among the six types of communities are significantly different; they present a spatial circle structure, where high-value-balanced communities, deprived communities, insufficient-supply communities, low-value-balanced communities, and shared communities appear in an order which shows the urbanized areas as the core, reaching out to the periphery. Deprived communities and shared communities have shown the spatial trends of urban expansion and village decay, respectively, which should receive urgent attention. In view of the imbalance between demand and supply, this study explores the optimization matrix of CS demand and supply based on a variety of demand and supply relations, aiming to investigate the dynamic balance of CS demand and supply and regional coordination. It also puts forward ideas for optimizing CS planning and management based on the six community types and proposes policy suggestions for building a participatory CS planning and management platform.

The study employs a more systematic categorization of CS supply and a more diverse perspective of demand entities, revealing inequities in the distribution of cultural

resources among heterogeneous groups and regions. Additionally, it presents strategies for optimizing demand and supply as well as policy recommendations for community governance, bringing fresh insights and empirical references into promoting sustainable community development. Furthermore, the research contributes new perspectives and a systematic methodology to the field of public space studies, aiming to offer inspiration and guidance for conducting demand and supply research of public spaces in any country or region. Looking ahead, future research could endeavor to conduct similar studies in different regions for comparison, continuously enhancing the scientific rigor and accuracy of the demand and supply assessment system. By incorporating factors related to CS management and operation, it seeks to explore dynamic and long-lasting evaluation mechanisms, thus contributing to the further optimization of planning and management for various urban spaces.

Author Contributions: Conceptualization, F.Z. and P.Z.; methodology, F.Z., T.W. and Y.C.; software, T.W. and L.G.; validation, F.Z. and M.W.; formal analysis, T.W. and L.G.; investigation, F.Z. and T.W.; resources, F.Z.; data curation, M.W.; writing—original draft preparation, F.Z., M.W., T.W. and L.G.; writing—review and editing, F.Z., M.W. and Y.C.; visualization, T.W. and L.G.; supervision, P.Z. and F.Z.; project administration, P.Z.; funding acquisition, F.Z. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by National Key R&D Program of China (grant number 2022YFC3802804) and Specialized Study on Han Cultural Heritage Development in Hanzhong City.

Data Availability Statement: The number, type, and distribution of the population are sourced from mobile signaling data provided by China Unicom operators (accessed from 1 May 2023 to 31 May 2023). The cultural spatial data are compiled by the author based on various materials: *The Atlas of Chinese Cultural Relics—Shaanxi Book (Volume I and II)*; a list of major historical and cultural sites protected at the national level; a list of cultural relic protection sites in Shaanxi Province; a list of cultural relic protection sites in Hanzhong City; *The Famous Scenic Spots and Historical Sites in Hanzhong Section*; a list of historical buildings in Hanzhong over the years. The LUCC data and vector ranges of Hanjiang River Basin are obtained from the Resources and Environmental Sciences and Data Center, Chinese Academy of Sciences (http://www.resdc.cn/, accessed on 12 January 2023). The POIs of various activity facilities, road network, bus stops, and river system data are sourced from the AMap Open Platform (https://lbs.amap.com/, accessed on 9 May 2023). The terrain and landforms data are sourced from the geospatial data cloud platform (https://www.gscloud.cn/, accessed on 11 May 2023).

Conflicts of Interest: The authors declare that they have no conflicts of interest.

References

1. Wang, S. A Study on Cultural Land System Planning. *City Plan. Rev.* **2018**, *42*, 76–82.
2. Gao, Y.; Wang, S.; Zhang, L. Review on Progress and Prospect of Urban Cultural Space and Cultural Planning. *Urban Plan. Forum.* **2019**, *63*, 43–49. [CrossRef]
3. Kourtit, K.; Nijkamp, P. Urban Cultural Vanguards Why Culture Matters for Urban Success. *J. Urban Manag.* **2022**, *11*, 198–213. [CrossRef]
4. Culture Urban Future: Global Report on Culture for Sustainable Urban Development. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000246291 (accessed on 19 March 2024).
5. Caprotti, F.; Cowley, R.; Datta, A.; Broto, V.C.; Gao, E.; Georgeson, L.; Herrick, C.; Odendaal, N.; Joss, S. The New Urban Agenda: Key Opportunities and Challenges for Policy and Practice. *Urban Res. Pract.* **2017**, *10*, 367–378. [CrossRef]
6. Grossi, E.; Sacco, P.L.; Blessi, G.T. Cultural, Creative, and Complex: A Computational Foundation of Culture-Driven Urban Governance. *Cities* **2023**, *140*, 104437. [CrossRef]
7. Zhang, M.; Xiao, Z. Platform-Mediated Live Musical Performance in China: New Social Practices and Urban Cultural Spaces. *Geoforum* **2023**, *140*, 103723. [CrossRef]
8. Montalto, V.; Tacao Moura, C.J.; Langedijk, S.; Saisana, M. Culture Counts: An Empirical Approach to Measure the Cultural and Creative Vitality of European Cities. *Cities* **2019**, *89*, 167–185. [CrossRef]
9. Wei, W.; Liu, C.; Zhang, S.; Wang, B. Creating and Shaping Cultural Spaces in International Cities: Take London, New York, Paris and Tokyo as Cases. *Urban Plan. Int.* **2020**, *35*, 77–86+118. [CrossRef]
10. Wu, L.; Zhang, X. Multidimensional perspective of "cultural space" research at home and abroad. *J. Southwest Minzu Univ.* **2016**, *37*, 7–12.

11. Zhao, Z.; Li, X.; Xu, Y.; Yang, S.; Jiang, Y.; Wang, S. Evaluating Spatial Accessibility of Cultural Urban Land Use by Using Improved 2SFCA Method in Xi'an, China. *Heliyon* **2022**, *8*, e11993. [CrossRef] [PubMed]
12. Wang, S.; Zhang, Y.; Xu, Y.; Yan, S. A Quantitative Analysis of Inequality of Urban Cultural Space Distribution in Xi'an. *Sci. China Technol. Sci.* **2019**, *62*, 502–510. [CrossRef]
13. Zhang, Z.; Tang, X.; Wang, Y. Evaluation of the Intergenerational Equity of Public Open Space in Old Communities: A Case Study of Caoyang New Village in Shanghai. *Land* **2023**, *12*, 1347. [CrossRef]
14. Getzner, M. Urban and Rural Preferences for Cultural Policies and Infrastructures. *Cult. Trends* **2020**, *29*, 378–399. [CrossRef]
15. Yang, Y.; Duan, W. An Interpretation of Landscape Preferences Based on Geographic and Social Media Data to Understand Different Cultural Ecosystem Services. *Land* **2024**, *13*, 125. [CrossRef]
16. Sun, X.; Liu, H.; Liao, C.; Nong, H.; Yang, P. Understanding Recreational Ecosystem Service Supply-Demand Mismatch and Social Groups' Preferences: Implications for Urban–Rural Planning. *Landsc. Urban Plan.* **2024**, *241*, 104903. [CrossRef]
17. Hegetschweiler, K.T.; De Vries, S.; Arnberger, A.; Bell, S.; Brennan, M.; Siter, N.; Olafsson, A.S.; Voigt, A.; Hunziker, M. Linking Demand and Supply Factors in Identifying Cultural Ecosystem Services of Urban Green Infrastructures: A Review of European Studies. *Urban For. Urban Green.* **2017**, *21*, 48–59. [CrossRef]
18. Liu, B.; Tian, Y.; Guo, M.; Tran, D.; Alwah, A.A.Q.; Xu, D. Evaluating the Disparity between Supply and Demand of Park Green Space Using a Multi-Dimensional Spatial Equity Evaluation Framework. *Cities* **2022**, *121*, 103484. [CrossRef]
19. Song, L.; Kong, X.; Cheng, P. Supply-Demand Matching Assessment of the Public Service Facilities in 15-Minute Community Life Circle Based on Residents' Behaviors. *Cities* **2024**, *144*, 104637. [CrossRef]
20. Yan, S.; Chen, H.; Quan, Q.; Liu, J. Evolution and Coupled Matching of Ecosystem Service Supply and Demand at Different Spatial Scales in the Shandong Peninsula Urban Agglomeration, China. *Ecol. Indic.* **2023**, *155*, 111052. [CrossRef]
21. Deng, Y.; Liu, J.; Luo, A.; Wang, Y.; Xu, S.; Ren, F.; Su, F. Spatial Mismatch between the Supply and Demand of Urban Leisure Services with Multisource Open Data. *ISPRS Int. J. Geo-Inf.* **2020**, *9*, 466. [CrossRef]
22. Liu, Z.; Huang, Q.; Yang, H. Supply-Demand Spatial Patterns of Park Cultural Services in Megalopolis Area of Shenzhen, China. *Ecol. Indic.* **2021**, *121*, 107066. [CrossRef]
23. Zhao, Y.; You, W.; Lin, X.; He, D. Assessing the Supply and Demand Linkage of Cultural Ecosystem Services in a Typical County-Level City with Protected Areas in China. *Ecol. Indic.* **2023**, *147*, 109992. [CrossRef]
24. Zhang, Y.; Liu, Y.; Zhang, Y.; Liu, Y.; Zhang, G.; Chen, Y. On the Spatial Relationship between Ecosystem Services and Urbanization: A Case Study in Wuhan, China. *Sci. Total Environ.* **2018**, *637–638*, 780–790. [CrossRef] [PubMed]
25. He, G.; Zhang, L.; Wei, X.; Jin, G. Scale Effects on the Supply–Demand Mismatches of Ecosystem Services in Hubei Province, China. *Ecol. Indic.* **2023**, *153*, 110461. [CrossRef]
26. Yan, W.; Liu, S. Built Equality and Sustainable Urban Cultural Space: A Case Study of Quanzhou, China. *Buildings* **2023**, *13*, 2337. [CrossRef]
27. Zhang, S.; Xu, S.; Wan, D.; Liu, H.; Zhao, L.; Guo, L.; Ren, J. Equalization Measurement and Optimization of the Public Cultural Facilities Distribution in Tianjin Central Area. *Sustainability* **2023**, *15*, 4856. [CrossRef]
28. Santagata, W. Cultural Districts, Property Rights and Sustainable Economic Growth. *Int. J. Urban Reg. Res.* **2002**, *26*, 9–23. [CrossRef]
29. Shen, J.; Chou, R.-J.; Zhu, R.; Chen, S.-H. Experience of Community Resilience in Rural Areas around Heritage Sites in Quanzhou under Transition to a Knowledge Economy. *Land* **2022**, *11*, 2155. [CrossRef]
30. Wang, G.; Chen, T. Research Progress on Spatial Optimization of Rievers Basins. *City Plan. Rev.* **2023**, *47*, 101–113.
31. Rajabi, M.S.; Radzi, A.R.; Rezaeiashtiani, M.; Famili, A.; Rashidi, M.E.; Rahman, R.A. Key Assessment Criteria for Organizational BIM Capabilities: A Cross-Regional Study. *Buildings* **2022**, *12*, 1013. [CrossRef]
32. Rajabi, M.S.; Rezaeiashtiani, M.; Radzi, A.R.; Famili, A.; Rezaeiashtiani, A.; Rahman, R.A. Underlying Factors and Strategies for Organizational BIM Capabilities: The Case of Iran. *Appl. Syst. Innov.* **2022**, *5*, 109. [CrossRef]
33. Lin, Y.; Zhou, Y.; Lin, M.; Wu, S.; Li, B. Exploring the Disparities in Park Accessibility through Mobile Phone Data: Evidence from Fuzhou of China. *J. Environ. Manag.* **2021**, *281*, 111849. [CrossRef] [PubMed]
34. Chin, K.; Huang, H.; Horn, C.; Kasanicky, I.; Weibel, R. Inferring Fine-Grained Transport Modes from Mobile Phone Cellular Signaling Data. *Comput. Environ. Urban Syst.* **2019**, *77*, 101348. [CrossRef]
35. Arribas-Bel, D. Accidental, Open and Everywhere: Emerging Data Sources for the Understanding of Cities. *Appl. Geogr.* **2014**, *49*, 45–53. [CrossRef]
36. Miller, H.J.; Goodchild, M.F. Data-Driven Geography. *GeoJournal* **2015**, *80*, 449–461. [CrossRef]
37. Yue, Y.; Zhuang, Y.; Yeh, A.G.O.; Xie, J.-Y.; Ma, C.-L.; Li, Q.-Q. Measurements of POI-Based Mixed Use and Their Relationships with Neighbourhood Vibrancy. *Int. J. Geogr. Inf. Sci.* **2017**, *31*, 658–675. [CrossRef]
38. Santos, F.; Almeida, A.; Martins, C.; Gonçalves, R.; Martins, J. Using POI Functionality and Accessibility Levels for Delivering Personalized Tourism Recommendations. *Comput. Environ. Urban Syst.* **2019**, *77*, 101173. [CrossRef]
39. Wei, W.; Ren, X.; Guo, S. Evaluation of Public Service Facilities in 19 Large Cities in China from the Perspective of Supply and Demand. *Land* **2022**, *11*, 149. [CrossRef]
40. Schirpke, U.; Meisch, C.; Marsoner, T.; Tappeiner, U. Revealing Spatial and Temporal Patterns of Outdoor Recreation in the European Alps and Their Surroundings. *Ecosyst. Serv.* **2018**, *31*, 336–350. [CrossRef]
41. Nixon, S.; Gay, P.D. Who Needs Cultural Intermediaries? *Cult. Stud.* **2002**, *16*, 495–500. [CrossRef]

42. Paracchini, M.L.; Zulian, G.; Kopperoinen, L.; Maes, J.; Schägner, J.P.; Termansen, M.; Zandersen, M.; Perez-Soba, M.; Scholefield, P.A.; Bidoglio, G. Mapping Cultural Ecosystem Services: A Framework to Assess the Potential for Outdoor Recreation across the EU. *Ecol. Indic.* **2014**, *45*, 371–385. [CrossRef]
43. Wang, Y.; Huang, H.; Yang, G.; Chen, W. Ecosystem Service Function Supply–Demand Evaluation of Urban Functional Green Space Based on Multi-Source Data Fusion. *Remote Sens.* **2022**, *15*, 118. [CrossRef]
44. Pasaogullari, N.; Doratli, N. Measuring Accessibility and Utilization of Public Spaces in Famagusta. *Cities* **2004**, *21*, 225–232. [CrossRef]
45. Grunewald, K.; Richter, B.; Meinel, G.; Herold, H.; Syrbe, R.-U. Proposal of Indicators Regarding the Provision and Accessibility of Green Spaces for Assessing the Ecosystem Service "Recreation in the City" in Germany. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* **2017**, *13*, 26–39. [CrossRef]
46. Tahmasbi, B.; Mansourianfar, M.H.; Haghshenas, H.; Kim, I. Multimodal Accessibility-Based Equity Assessment of Urban Public Facilities Distribution. *Sustain. Cities Soc.* **2019**, *49*, 101633. [CrossRef]
47. Wang, H.; Huang, J.; Li, Y.; Yan, X.; Xu, W. Evaluating and mapping the walking accessibility, bus availability and car dependence in urban space:A case study of Xiamen, China. *ACTA Geogr. Sin.* **2013**, *68*, 477–490.
48. Li, Z.; Zhen, F.; Xu, H. Evaluation of Spatial Allocation between Supply and Demand for Elderly Service Facilities Based on Multi-Source Data: A Case Study of Nanjing. *Mod. Urban Res.* **2022**, *37*, 8–15+23.
49. Florax, R.J.G.M.; Van Der Vlist, A.J. Spatial Econometric Data Analysis: Moving Beyond Traditional Models. *Int. Reg. Sci. Rev.* **2003**, *26*, 223–243. [CrossRef]
50. Shen, J.; Du, S.; Huang, Q.; Yin, J.; Zhang, M.; Wen, J.; Gao, J. Mapping the City-Scale Supply and Demand of Ecosystem Flood Regulation Services—A Case Study in Shanghai. *Ecol. Indic.* **2019**, *106*, 105544. [CrossRef]
51. La Rosa, D.; Takatori, C.; Shimizu, H.; Privitera, R. A Planning Framework to Evaluate Demands and Preferences by Different Social Groups for Accessibility to Urban Greenspaces. *Sustain. Cities Soc.* **2018**, *36*, 346–362. [CrossRef]
52. Wei, H.; Fan, W.; Wang, X.; Lu, N.; Dong, X.; Zhao, Y.; Ya, X.; Zhao, Y. Integrating Supply and Social Demand in Ecosystem Services Assessment: A Review. *Ecosyst. Serv.* **2017**, *25*, 15–27. [CrossRef]
53. Lu, W.; Li, Y.; Zhao, R.; He, B.; Qian, Z. Spatial Pattern and Fairness Measurement of Educational Resources in Primary and Middle Schools: A Case Study of Chengdu–Chongqing Economic Circle. *Int. J. Environ. Res. Public Health* **2022**, *19*, 10840. [CrossRef] [PubMed]
54. Chen, T.; Hui, E.C.-M.; Lang, W.; Tao, L. People, Recreational Facility and Physical Activity: New-Type Urbanization Planning for the Healthy Communities in China. *Habitat Int.* **2016**, *58*, 12–22. [CrossRef]
55. Guo, L.; Bao, Y.; Li, S.; Ma, J.; Sun, W. Quality Analysis and Policy Recommendations on the Utilization of Community Basic Public Health Services in Urban and Suburban Shanghai from 2009 to 2014. *Environ. Sci. Pollut. Res.* **2018**, *25*, 28206–28215. [CrossRef] [PubMed]
56. Chang, J.; Qu, Z.; Xu, R.; Pan, K.; Xu, B.; Min, Y.; Ren, Y.; Yang, G.; Ge, Y. Assessing the Ecosystem Services Provided by Urban Green Spaces along Urban Center-Edge Gradients. *Sci. Rep.* **2017**, *7*, 11226. [CrossRef] [PubMed]
57. Wu, H.; Wang, L.; Zhang, Z.; Gao, J. Analysis and Optimization of 15-Minute Community Life Circle Based on Supply and Demand Matching: A Case Study of Shanghai. *PLoS ONE* **2021**, *16*, e0256904. [CrossRef] [PubMed]
58. Coscia, C.; Pasquino, F. Demand Analysis Models to Support Cultural Tourism Strategy: Application of Conjoint Analysis in North Sardinia (Italy). *Land* **2023**, *12*, 2150. [CrossRef]
59. Du Cros, H.; Bauer, T.; Lo, C.; Rui, S. Cultural Heritage Assets in China as Sustainable Tourism Products: Case Studies of the Hutongs and the Huanghua Section of the Great Wall. *J. Sustain. Tour.* **2005**, *13*, 171–194. [CrossRef]
60. Zhao, K.; Cao, X.; Wu, F.; Chen, C. Spatial Pattern and Drivers of China's Public Cultural Facilities between 2012 and 2020 Based on POI and Statistical Data. *ISPRS Int. J. Geo-Inf.* **2023**, *12*, 273. [CrossRef]
61. Zhang, F.; Courty, P. The China Museum Boom: Soft Power and Cultural Nationalism. *Int. J. Cult. Policy* **2021**, *27*, 30–49. [CrossRef]
62. Li, T.; Zhao, Y.; Kong, X. Spatio-Temporal Characteristics and Influencing Factors of Basic Public Service Levels in the Yangtze River Delta Region, China. *Land* **2022**, *11*, 1477. [CrossRef]
63. Lakos, W. *Chinese Ancestor Worship: A Practice and Ritual Oriented Approach to Understanding Chinese Culture*; Cambridge Scholars: Newcastle upon Tyne, UK, 2010; pp. 120–146.
64. Saitluanga, B.L. Spatial Pattern of Urban Livability in Himalayan Region: A Case of Aizawl City, India. *Soc. Indic. Res.* **2014**, *117*, 541–559. [CrossRef]
65. Zeng, C.; Song, Y.; He, Q.; Shen, F. Spatially Explicit Assessment on Urban Vitality: Case Studies in Chicago and Wuhan. *Sustain. Cities Soc.* **2018**, *40*, 296–306. [CrossRef]
66. Bahriny, F.; Bell, S. Patterns of Urban Park Use and Their Relationship to Factors of Quality: A Case Study of Tehran, Iran. *Sustainability* **2020**, *12*, 1560. [CrossRef]
67. Liu, J.; Bi, H.; Wang, M. Using Multi-Source Data to Assess Livability in Hong Kong at the Community-Based Level: A Combined Subjective-Objective Approach. *Geogr. Sustain.* **2020**, *1*, 284–294. [CrossRef]
68. Goudsmit, I.; Nel, D.; Lin, S. Evaluating the Quality of Life in Hong Kong's New Towns in Relation to Accessibility and the Distribution of Community and Cultural Facilities: A Case Study of Tung Chung. *J. Urban Manag.* **2023**, *12*, 295–309. [CrossRef]

69. Yu, H.; Verburg, P.H.; Liu, L.; Eitelberg, D.A. Spatial Analysis of Cultural Heritage Landscapes in Rural China: Land Use Change and Its Risks for Conservation. *Environ. Manag.* **2016**, *57*, 1304–1318. [CrossRef] [PubMed]
70. Keitumetse, S.O. Cultural Resources as Sustainability Enablers: Towards a Community-Based Cultural Heritage Resources Management (COBACHREM) Model. *Sustainability* **2014**, *6*, 70–85. [CrossRef]
71. Plieninger, T.; Dijks, S.; Oteros-Rozas, E.; Bieling, C. Assessing, Mapping, and Quantifying Cultural Ecosystem Services at Community Level. *Land Use Policy* **2013**, *33*, 118–129. [CrossRef]
72. Ghasemi, K.; Behzadfar, M.; Borhani, K. Spatial Analysis of Leisure Land Uses in Tehran: Assessing Inequity Using the MARCOS Method within a GIS Framework. *Heliyon* **2023**, *9*, e19691. [CrossRef] [PubMed]
73. Chen, J.; Jiang, B.; Bai, Y.; Xu, X.; Alatalo, J.M. Quantifying Ecosystem Services Supply and Demand Shortfalls and Mismatches for Management Optimisation. *Sci. Total Environ.* **2019**, *650*, 1426–1439. [CrossRef] [PubMed]
74. Alexander, K.; Brown, M. Community-based Facilities Management. *Facilities* **2006**, *24*, 250–268. [CrossRef]
75. Rajabi, M.; Habibpour, M.; Bakhtiari, S.; Rad, F.; Aghakhani, S. The Development of BPR Models in Smart Cities Using Loop Detectors and License Plate Recognition Technologies: A Case Study. *J. Future Sustain.* **2023**, *3*, 75–84. [CrossRef]
76. Ourang, S. Water Resources Management Optimization and Development of Sustainable Agriculture, Case Study: Pakdasht Plain. *J. Agric. Sci. Bot.* **2017**, *1*, 18–22. [CrossRef]
77. Ourang, S. Water Resource Optimization, a Path toward Sustainable Development. *Nutr. Food Sci. Int. J.* **2018**, *4*, 555645. [CrossRef]
78. Ourang, S.; Ourang, A. Optimizing Power Balance and Communication Links in Microgrids: A Clustering Approach Using Particle Swarm Optimization. *Asian J. Soc. Sci. Manag. Technol.* **2024**, *5*, 275–281.
79. Roseland, M. Sustainable Community Development: Integrating Environmental, Economic, and Social Objectives. *Prog. Plan.* **2000**, *54*, 73–132. [CrossRef]
80. Plevoets, B.; Sowińska-Heim, J. Community Initiatives as a Catalyst for Regeneration of Heritage Sites: Vernacular Transformation and Its Influence on the Formal Adaptive Reuse Practice. *Cities* **2018**, *78*, 128–139. [CrossRef]
81. Li, J.; Krishnamurthy, S.; Pereira Roders, A.; van Wesemael, P. Community Participation in Cultural Heritage Management: A Systematic Literature Review Comparing Chinese and International Practices. *Cities* **2020**, *96*, 102476. [CrossRef]
82. Fabbricatti, K.; Boissenin, L.; Citoni, M. Heritage Community Resilience: Towards New Approaches for Urban Resilience and Sustainability. *City Territ. Archit.* **2020**, *7*, 17. [CrossRef]
83. Wang, S.; Duan, W.; Zheng, X. Post-Occupancy Evaluation of Brownfield Reuse Based on Sustainable Development: The Case of Beijing Shougang Park. *Buildings* **2023**, *13*, 2275. [CrossRef]
84. Ghasemi, M.; Rajabi, M.; Aghakhani, S. Towards Sustainability: The Effect of Industries on CO_2 Emissions. *J. Future Sustain.* **2023**, *3*, 107–118. [CrossRef]
85. Morteza, A.; Ilbeigi, M.; Schwed, J. A Blockchain Information Management Framework for Construction Safety. In *Computing in Civil Engineering 2021*; American Society of Civil Engineers: Orlando, FL, USA, 2022; pp. 342–349. [CrossRef]
86. Ilbeigi, M.; Bairaktarova, D.; Morteza, A. Gamification in Construction Engineering Education: A Scoping Review. *J. Civ. Eng. Educ.* **2023**, *149*, 04022012. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.