buildings

MDPI

Article

Research on the Spatio-Temporal Differentiation Characteristics and Factors of Typical Square Cities in China from the Perspective of Human Settlements

Jiaji Gao [1,2], Songbo Li [3,*], Dongqi Sun [4,*], Yingjia Zhang [5] and Xueming Li [6]

1 School of Art & Design, Dalian Polytechnic University, Dalian 116300, China; gaojiaji@dlpu.edu.cn
2 Central Academy of Fine Arts, Beijing 100102, China
3 Teachers College, Shenyang University, Shenyang 110044, China
4 Key Laboratory of Regional Sustainable Development Modeling, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing 100101, China
5 College of Architecture and Urban Planning, Guizhou Institute of Technology, Guiyang 550003, China; 20160740@git.edu.cn
6 Human Settlements Research Center, Liaoning Normal University, Dalian 116029, China; lixueming@lnnu.edu.cn
* Correspondence: 0825lisongbo@sina.com (S.L.); sundq@igsnrr.ac.cn (D.S.)

Abstract: Taking Dalian, a typical square city in China, as an example based on data from remote sensing images, questionnaires, spatial statistics, social economy, etc., 48 squares in the main districts were constructed from the perspective of human settlements in order to build five systems: nature, humanity, society, residence and support. The aim was to explore the spatio-temporal differentiation characteristics and their driving mechanism. The results show the following: (1) The index system was constructed based on the human settlements perspective, and PCA was used to comprehensively evaluate it. Four principal component factors were extracted, and their cumulative contribution rate is 78.701%. On this basis, city squares were divided into four types: comprehensive square, recreational square, commercial service square and traffic square. (2) Using Mapinfo to visualize the square space, and taking the People's Square as the center, the squares from the Tsarist Russia and Japanese colonial rule time periods were mainly distributed within 5 km, mostly in the direction of NE-SEE. During the construction of New China, city squares were distributed in all directions of the city, mainly between NE-SE and NNW-SSW. (3) ArcGIS was used to create an analysis chart of square service scope. Compared with 1999, it was more concentrated in central cities in 2016, and the service scope was relatively small. However, a square with high popularity has a wider influence. (4) The formation and evolution of the spatial pattern of city squares are affected by many factors, such as nature, economy, society, politics, ecological environment and technology. In the planning and development of city squares, Dalian should pay full attention to human settlements perpectives and add luster to the development of livable cities.

Keywords: city squares; human settlements; factor analysis; spatial analysis; Dalian

Citation: Gao, J.; Li, S.; Sun, D.; Zhang, Y.; Li, X. Research on the Spatio-Temporal Differentiation Characteristics and Factors of Typical Square Cities in China from the Perspective of Human Settlements. *Buildings* **2022**, *12*, 727. https://doi.org/10.3390/buildings12060727

Academic Editors: Baojie He, Ayyoob Sharifi, Chi Feng and Jun Yang

Received: 18 April 2022
Accepted: 23 May 2022
Published: 27 May 2022

1. Introduction

Public space is one of the important indicators to measure living quality. Streets, squares and other public spaces are major elements of urban environments [1]. Reflecting the city's culture and spiritual civilization, city squares are public, artistic and vigorous in the open space system of modern cities. With the development of society, the living standards of residents are continuously improving, and peoples' requirements for urban living environments are also increasing, such as work, rest, public services, culture and entertainment [2–4]. Therefore, through the planning and construction of city squares, it is of great value to create a modern intelligent living space with ecological health, a

beautiful environment that is comfortable and quiet, and cultural life for urban planning and construction and the residents' daily living environment [5].

At present, city square research adopts different forms of data sets, from basic surveys to network data [6], in order to analyze their public space vitality, urban design, political and cultural characteristics [7,8]. The research also aims to analyze the daily behavior, psychological attribution, material use and environmental awareness of higher-level square users, as well as the interaction of multiple levels, such as internal factors surrounding configuration and the internal and external constraints of the square [9,10]. At the same time, research results are integrated into the square's function, structure, design and discipline of different time-space dimensions [11]. In the historical background of urban development, scholars in different fields have different meanings on the research of city squares. They believe that city squares not only refer to the part of social public land that is not occupied by buildings, but also to the part that is built on the general layout of the city and connected with urban roads [12]. Squares can also hold political activities and gatherings. They have the function of being a "home" and an "urban living room" [13]. Scholars at home and abroad describe city squares with different cultural connotations, and design concepts from different perspectives.

In terms of the spatial dimensions of a square, scholars have analyzed and evaluated the important factors of the square itself—the comfort index provided by local areas [14] and peoples' space usage under environmental climate factors [15]. They consider that square vegetation plays a key role in dry cities [16], and a calculation model has been developed based on it. Such considerations can ensure and strengthen better square design and urban environmental function [17]. In addition, scholars use existing and developed applications to elaborate the accessibility of the square [18,19], and solve the problems of passenger backlog and traffic congestion [20,21]. Aiming at the users, researchers describe daily leisure [22], behavior characteristics [23] and social life changes of the residents around the square [24]. They also investigate some human behavior relations and psychological factors in the social interaction between public square design and residents [25,26]. Square design and public perception are used to study the virtual and image cognition [27,28]. The linkage between physical and political planning, internal design and traffic flow also affects the development of a city. Cultural connotations and new trends in urban development are studied under the modern city square concept in inheriting the changes of spatial form and function of the traditional city square [29]. The importance of square construction to urban image is studied from the perspective of city square design and image construction [30]. Meanwhile, from the perspective of plant landscape design and green space change in city squares [31,32], research on the impact and significance of squares on cities and human activities pays more attention to urban space, human settlements and leisure, regional accessibility and other fields [33,34]. The research results and contents involve the definition, evolution, function, form and cultural perception of city squares [35,36]. They have good reference value for improving the environmental design of the inner space of the square, and meeting the needs of humanized space. However, research on city squares from the perspective of human settlements still needs to be further studied.

City squares are an important carrier of human settlements. Based on the five systems from the perspective of "human settlements", it is particularly necessary to systematically study city squares from multiple dimensions. By constructing the evaluation index system of city squares using methods of factor analysis, cluster analysis and spatial statistics, this paper takes a famous square city—Dalian as an example, and makes a more comprehensive analysis based on the development and construction of city squares. The aim of this paper is to provide experience and reference for the construction of city squares, and improving the urban environment. This analysis not only provides a new perspective for the research of city squares, but also promotes the designs of spatial environment of squares in major cities in China to be more humanized, so as to meet the needs of surrounding residents for city squares. At the same time, in theory, the research focus of human settlements extends

from residential spaces to public spaces, with wide radiation and great influence, widening the function and means for improvement of human settlements.

2. Data and Methods

2.1. Research Area

As an economically developed port city in the coastal area of Northeast China (Figure 1), Dalian has developed rapidly in trade, industry, tourism and other industries. The construction of city squares is combined with various elements, such as urban buildings, economy, culture and tourism transportation, with a large number and different properties; hence, the expectation for the spatial construction of the main urban area of Dalian is for something that is reasonable and perfect [37]. Therefore, this paper takes 48 squares in the main urban area of Dalian as the research objects, and studies a series of functional properties with important practical significance and value, such as square function, service scope, spatial distribution and overall planning in different time periods.

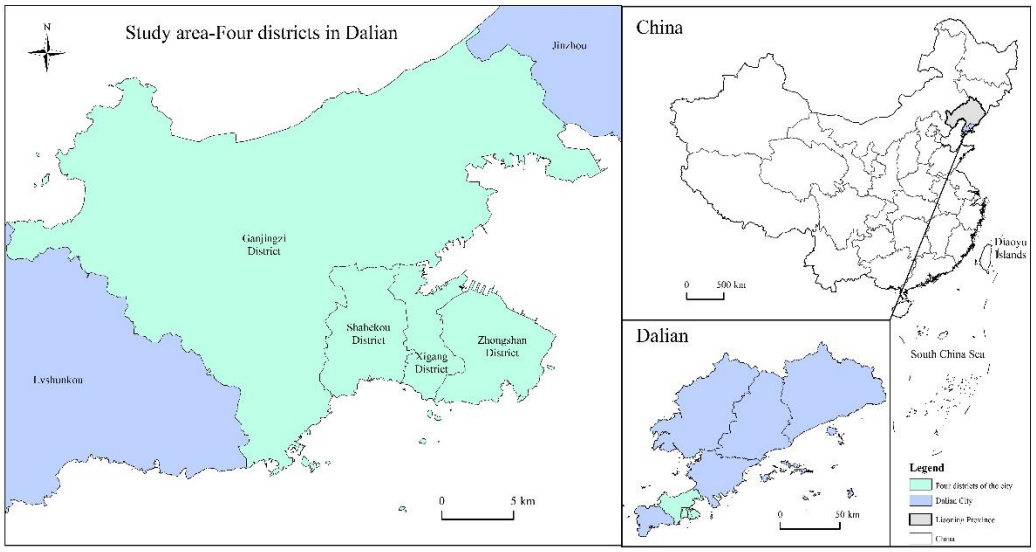

Figure 1. The location of study area.

2.2. Data Sources

In order to fully evaluate and study the classification, characteristics and current situation of city squares, this paper makes a comprehensive evaluation of them from objective and subjective basic data. Among them, the subjective data are mainly aimed at the permanent residents of Dalian. In the form of questionnaire surveys, the data of 13 criteria layers in the 5 systems are collected in order to investigate and understand the residents' satisfaction with each indicator in each square. The total effective rate of the questionnaire is 81.4%. Meanwhile, the objective data are mainly based on GIS spatial analysis function to process geo-spatial data. The data description is shown in Table 1.

2.3. Methods

While analyzing residents' judgments on the square, it is also necessary to further combine the problem indicators of the objective physical environment. Therefore, combining the subjective and objective evaluation indicators of city squares from the perspective of human settlements can accurately describe the classification of functional types of city squares.

Table 1. Data Description and Sources.

Types of Data	Data Characteristics	Data Sources
Remote sensing image	images of Landsat5 TM and DEM	Computer Network Information Center (http://www.gscloud.cn/, accessed on 30 April 2022)
Building data	plot ratio, site coverage	Dalian Land Natural Resources and Building Management Board
Status of land usage	green area, green coverage rate	Dalian Land Natural Resources and Building Management Board
Traffic network data	mainly include railways, subways, high-speed rails, urban roads of different levels, and urban transportation facilities (bus stations, subway stations)	Dalian Plan Bureau
Service Facilities	schools, medical facilities, catering facilities, entertainment facilities, etc.	Purchase of Google Earth images and research projects
Social statistics	population density, housing prices	Dalian Land Natural Resources and Building Management Board
Administrative division data	data from country, province, city, county and street	Dalian Land Natural Resources and Building Management Board

This paper combines the current academic research of scholars at home and abroad from the perspective of human settlements, and takes the specific characteristics of Dalian city square and the elements closely related to residents' life as the basics. Combined with qualitative and quantitative analysis methods, 28 square evaluation indicators related to human settlements are selected in 5 systems [38], following the principles of unity, comprehensiveness, people-orientedness and dynamics. The aim of this is to build a comprehensive classification indicator system of city squares from the perspective of human settlements, as shown in Table 2.

Principal Component Analysis and Cluster Analysis are used to analyze city squares. Principal Component Analysis (PCA) is an important method in multivariate statistical analysis. It aims to adopt the idea of dimensionality reduction, in order to simplify many variables with certain correlation into a new set of relevant comprehensive indicators. This method has been widely used in practical problems. The research objects are classified according to certain standards, so that the objects in a group have the highest similarity, while there are great differences between groups.

Table 2. Comprehensive index system of human settlements systems in Dalian city squares.

Target Layer	Criterion Layer	Index Layer	Target Layer	Criterion Layer	Index Layer
Natural system	Ecosystem (X1)	Per capita public green area (vector)	Live system	Education culture (X8)	Number of schools and training institutions within the scope (vector)
		Green coverage (vector)		Residential system (X9)	Degree of Old and New Housing (questionnaire)
	Natural landscape (X2)	Number of scenic spots (vector)			Land Price Network (Social Economic Data)
		Distance to mountain and sea (vector)			Floor area ratio (vector)

Table 2. *Cont.*

Target Layer	Criterion Layer	Index Layer	Target Layer	Criterion Layer	Index Layer
Humanity system	Resident composition (X3)	Education (questionnaire)	Support system	Exercise and Fitness (X10)	Number of sports facilities (vector data)
		Family composition (questionnaire)			Number of sports fields (vector)
		Age (questionnaire)		City Medical (X11)	Number of hospitals, community service centers, and pharmacies (vector)
	Mental index (X4)	Sense of belonging (questionnaire)		Business service (X12)	Number of cinemas, restaurants, cafes, bars, KTV (vector)
		Sense of happiness (questionnaire)			Basic cost of living (vegetables, fruits, grain, oil) (questionnaire)
		Sense of security (questionnaire)		City traffic (X13)	Residents' public traffic attendance (questionnaire)
Society system	Security system (X5)	Public security management (questionnaire)			Number of bus and subway stations (vector)
		Police Station (Vector)			Parking convenience (questionnaire survey)
	Education (X6)	Number of places for cultural activities			
		Cultural living standard (questionnaire)			
	Guarantee system (X7)	Employment status (questionnaire)			
		Leisure and entertainment convenience (questionnaire)			

3. Results and Analysis

3.1. Comprehensive Evaluation of City Squares

3.1.1. Principal Factor Analysis

Based on 2.1., this paper constructs a comprehensive classification index system of 48 city squares in the main area of Dalian from the perspective of human settlements. It also quantifies 28 indicators, and finally makes multivariate statistical analysis on the last 13 criterion layers with the help of SPSS (IBM SPSS Statistics 20.0 (New York, America), https://www.ibm.com/cn-zh/products/spss-statistics, accessed on 30 April 2022) software. The specific process is as follows: firstly, the quantitative indicators of 13 criteria layers are used as the data benchmarks, and they are standardized to construct the data matrix. After that, SPSS software is used to select "Analysis", "Dimensionality Reduction" and "Factor Analysis" for PCA, judge the cumulative contribution rate value according to the obtained results, and determine the number of principal components in PCA according to the results of factor analysis, as shown in Table 3.

It can be seen from Table 3 that four principal component factors are extracted from the comprehensive classification results of city squares obtained by PCA. The eigenvalues of the first four common factors are 5.779, 2.024, 1.352 and 1.077 in turn. The variance contributions corresponding to them are 44.452, 15.567, 10.400 and 8.283%, respectively, and the cumulative contribution rate is 78.701%. At the same time, it can be seen that the four principal component factors reflect most of the information provided by the original indicators to a certain extent. It shows that this paper has certain value and significance in selecting indicators.

Table 3. Comprehensive evaluation of city squares from the perspective of human settlements.

Ingredient	Initial Eigenvalue			Extract the Sum of Squares and Load			Rotate the Sum of Squares and Load		
	Total	Variance%	Accumulation%	Total	Variance%	Accumulation%	Total	Variance%	Accumulation%
1	5.779	44.452	44.452	5.779	44.452	44.452	5.398	41.522	41.522
2	2.024	15.567	60.019	2.024	15.567	60.019	1.683	12.945	54.467
3	1.352	10.400	70.419	1.352	10.400	70.419	1.635	12.580	67.047
4	1.077	8.283	78.701	1.077	8.283	78.701	1.515	11.655	78.701
5	0.803	6.176	84.877						
6	0.553	4.255	89.132						
7	0.415	3.193	92.325						
8	0.331	2.547	94.872						
9	0.243	1.868	96.740						
10	0.172	1.320	98.060						
11	0.150	1.154	99.214						
12	0.070	0.542	99.756						
13	0.032	0.244	100.000						

According to the load matrix and eigenvalues calculated in Table 4, the four principal component factor scores and comprehensive scores of each square are calculated. Finally, the comprehensive evaluation results of the square are calculated according to the four principal component scores (Table 5).

Table 4. Square comprehensive evaluation principal component factor load matrix.

Variable	1	2	3	4
(X1)	−0.345	−0.234	0.318	0.652
(X2)	0.119	0.432	0.681	−0.160
(X3)	0.342	0.538	−0.437	0.465
(X4)	−0.095	−0.639	0.474	0.151
(X5)	0.825	−0.107	0.286	−0.125
(X6)	0.102	0.595	0.350	0.474
(X7)	0.594	0.604	−0.058	−0.171
(X8)	0.889	−0.212	−0.055	0.003
(X9)	0.887	−0.212	−0.114	0.221
(X10)	0.926	−0.063	0.176	−0.043
(X11)	0.865	−0.264	−0.003	−0.067
(X12)	0.842	0.264	0.214	−0.038
(X13)	0.764	−0.349	−0.268	0.245

Table 5. Comprehensive evaluation results of city squares (principal component analysis).

Squares	Total Scores	Squares	Total Scores	Squares	Total Scores	Squares	Total Scores
Youhao	2.09	Navy	1.15	Xinan	−0.46	Ocean	−1.05
Zhongshan	1.98	Garden	1.12	Wenyuan	−0.51	Yingke Stone	−1.07
Renmin	1.91	South of Railway Station	1.08	Huanan	−0.53	Hudiao	−1.08
Shengli	1.78	Kaixuan	0.99	Xueyuan	−0.54	Xiangzhou Road	−1.12
Shengliqiao	1.75	Wusi	0.92	Tianhe	−0.56	Dalianmen	−1.15
Sanba	1.65	Wuyi	0.57	Malan	−0.87	Shanluan	−1.16
Olympic	1.58	Gangwan	0.47	Bayi Road	−0.91	Donggang Musical Fountain	−1.27
Minzhu	1.58	Donghua	0.44	Xinghai	−0.91	Airport	−1.34
Xiwang	1.51	Qiuzhi	-0.11	Digital	−0.99	In front of Zhoushuizi Railway Station	−1.52
Jiefang	1.49	Fumin	-0.16	Huale	−1.03	Jinwan	−1.52
Erqi	1.28	Xianglujiao	-0.27	Xuri	−1.03	Shidao Street	−1.91
Dongguan	1.24	Jinsanjiao	-0.33	Qixing	−1.04	Houyan	−2.13

3.1.2. Classification of City Squares

The results of PCA are processed by cluster analysis, and four types of city squares are obtained. They are named uniformly with the actual situation of the square. Meanwhile, they are divided into four types: comprehensive square, recreational square, commercial service square and traffic square (Figure 2). The details are shown in Table 6.

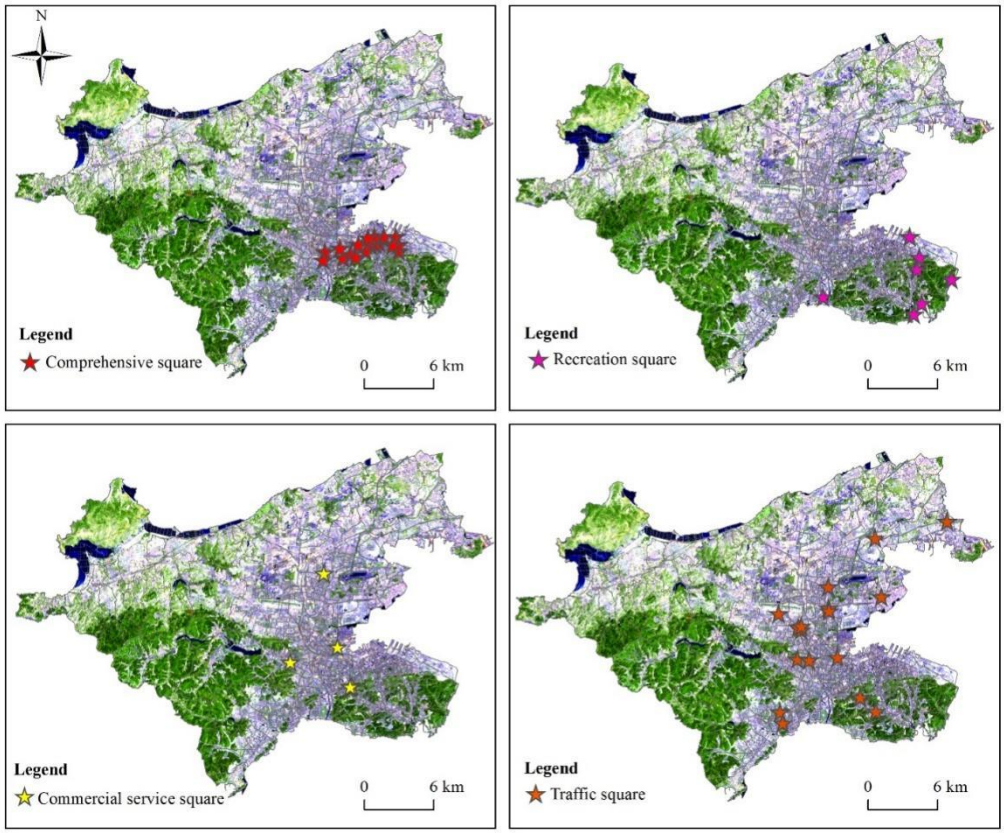

Figure 2. City squares classification spatial distribution.

Table 6. Classification of city squares based on the perspective of human settlements.

Classification	Squares	Number	Statistics	Main Factor 1	Main Factor 2	Main Factor 3	Main Factor 4
Comprehensive square	Olympic, Jiefang, Navy, Xiwang, Kaixuan, Shengliqiao, Renmin, Erqi, Garden Square, Minzhu, Gangwan, Wuyi, South of Railway Station, Dongguan, Sanba, Zhongshan, Youhao, Shengli, Wusi	19	Mean value	2.42	0.33	0.27	−0.09
			Standard deviation	0.85	0.89	0.89	0.86
Recreational square	Ocean, Hudiao, Xinghai, Huale, Xuri, Donggang Musical Fountain, Shanluan	7	Mean value	−2.40	2.02	−0.81	−0.68
			Standard deviation	0.28	0.53	0.51	0.94
Commercial service square	Malan, Huanan, Xiangzhou Road, Qiuzhi, Wenyuan	5	Mean value	0.04	−1.64	−1.78	−0.33
			Standard deviation	0.42	0.80	0.63	0.85
Traffic square	Jinwan, Houyan, South of Zhoushuizi Railway Station, Dalianmen, Shidao Street, Yingke Stone, Bayi Road, Xueyuan, Digital, Airport, Fumin, Tianhe, Donghua, Jinsanjiao, Xianglujiao, Qixing, Xinan	17	Mean value	−1.73	−0.71	0.55	0.47
			Standard deviation	1.05	0.96	1.24	1.08

1. The comprehensive square

The mean value of the first principal component factor of the first type of city squares is 2.42, which is positive. It is much larger than the values of the other three principal factors. The characteristics of it are the most prominent, indicating that the spatial environmental characteristics are as follows: convenient transportation, developed commercial economy, complete medical facilities, relatively sound safety system. These can meet most of the needs of residents in their daily lives. Therefore, this type of city square is named as the comprehensive square. These types of squares are mostly located in the public center of Dalian, that is, the old city center, meaning that these areas have high economic development levels such as finance, commerce, and trade. In terms of spatial distribution, there are many squares in the clustered distribution, andnd these squares cross the Zhongshan, Xigang and Shahekou Districts along Renmin Road, Zhongshan Road and Metro Line 2. In other words, they are located around the business district. Generally speaking, the spatial distribution of this type of city square presents a certain "aggregation", mostly along the traffic trunk lines or at the intersection of multiple trunk roads; that is, the traffic accessibility level is high. The terrain is flat, far from the sea, close to hospitals and schools, and the density of buildings and population is high. Therefore, these squares have good topographic conditions and are suitable for residents to live.

2. The recreational square

The mean value of Main Factor I of the second type of city squares is −2.40, the value of Main Factor II is 2.02, and the scores of principal components III and IV are negative and small. These indicate that this type of city square is inversely proportional to the scores of Main Factors I, III and IV, and directly proportional to the scores of Main Factor II. That is, this type of square has a good natural landscape and safety system. This type of city square is scattered in space, surrounded by the sea. There are fountains, sculptures, amusement facilities and other places here, with certain artistic charm value. Therefore, these city squares are named recreational squares. Generally speaking, although the second type of city square is relatively scattered in space, they are all close to the sea and mountains, with beautiful scenery. Most entertainment places are distributed here and far from the commercial center. They integrate leisure and entertainment, which can reflect the modern living standard of the city. At the same time, they are also the primarily selected square for tourists and permanent residents.

3. The commercial service square

This type of city square is directly proportional to Main Factor I, inversely proportional to the other three factors, and its negative value is large. Although such city squares' Main Factor I in this area are positive, their values are small. Meanwhile, the values of Main Factors II, III and IV are negative and relatively small. Therefore, it shows that the natural system of this type of square is poor in space, the square green area and natural landscape are small, and the surrounding traffic and commerce are relatively developed. The spatial distribution has no certain law, but it is close to the scope of community service. Therefore, this type of city square is named the commercial service square. Such squares cover a small area and contain many leisure, entertainment, shopping, catering, construction and other living service facilities nearby, playing important roles in their urban space.

4. The traffic square

The mean values of Main Factors I and II of this type of city square are negative, and their values are −1.73 and −0.71, respectively. The values of Main Factors III and IV are positive, and their values are 0.55 and 0.47, respectively. These indicate that this type of city square is negatively correlated with Main Factors I and II as a whole, while positively correlated with Main Factors III and IV. Meanwhile, the correlations between this type of square and Main Factors I and III are higher than those of Main Factors II and IV. These city squares are scattered in space. Generally speaking, these squares are mostly traffic hub

stations, with many traffic trunk lines nearby, and the level of traffic accessibility is high. Therefore, this type of city square is named the traffic square.

3.2. The Characteristics of Spatio-Temporal Patterns of City Squares

3.2.1. Analysis of Spatial Differences between City Squares

ArcGIS10.2 spatial database of Dalian city squares is used to visualize the distribution of 48 city squares in Dalian. The spatial distribution of Dalian city squares is relatively scattered, especially in Ganjingzi District, since its spatial distribution is the most scattered. This paper uses MapInfo (MapInfo Pro v2021.1 (New York, America), https://www.precisely.com/product/precisely-mapinfo/mapinfo-pro, accessed on 30 April 2022) software and takes the People's Square, where the People's Government of Dalian municipality is located, as the center. A 1-kilometer equidistant buffer zone and 16 direction fan-shaped partitions are created. It shows the square distribution in 16 directions with a difference of 1 km for each circle centered on the People's Square (Figure 3). It can be seen that the farthest distance from the People's Square is 16 km, which is in the direction of NNE. The squares in Tsarist and Japanese periods are mainly distributed within 5 km, mainly in the directions of NE, NEE, SEE, SWW and W. In terms of quantity, the number of squares in the NE-SEE direction is in the majority. In the construction period of New China, city squares appeared in all directions of the city. This was a benefit originating from the development of society and economy, the expansion of the city and the opening of policies. The distribution direction is mainly between NE-SE and NNW-SSW, and the other directions are sporadic.

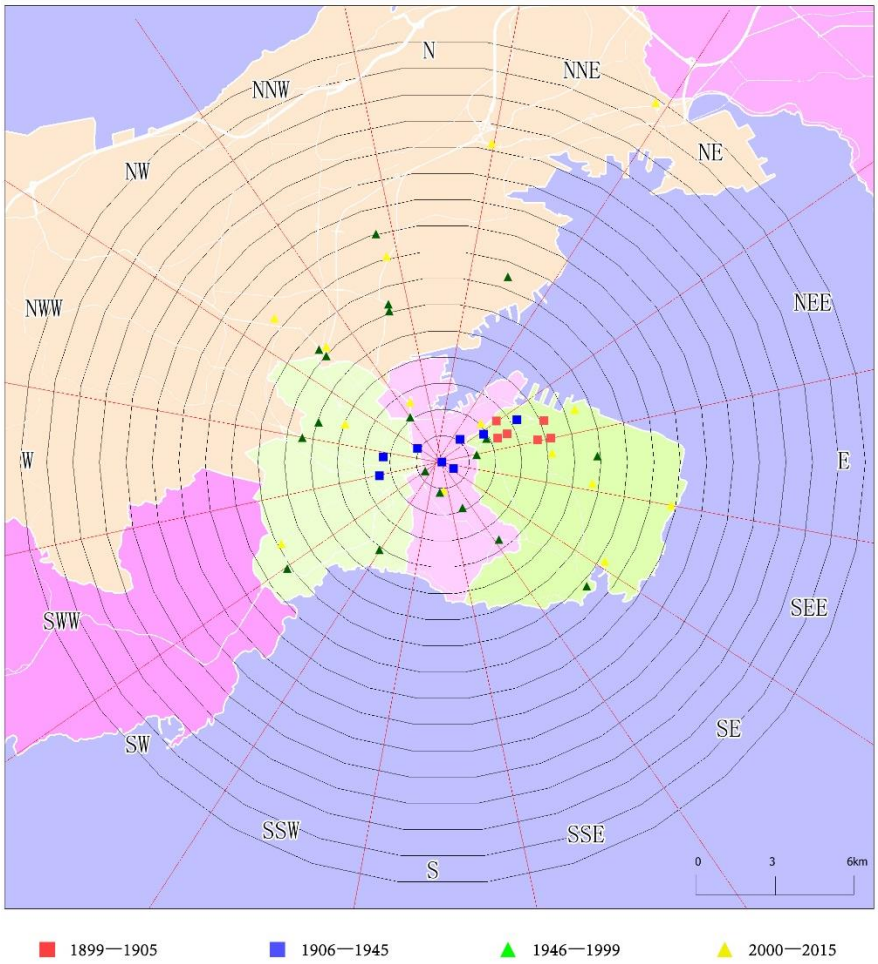

Figure 3. Differences in the spatial distributions of city squares.

3.2.2. Service Scope of City Squares

Voronoi spatial segmentation and adjacent query principle are used to analyze the distribution service scope of each square in Dalian. Meanwhile, ArcGIS software is used to create a Voronoi analysis diagram of Dalian squares to obtain the distribution service scope of these squares. The following can be seen from Figure 4: (1) in 1999, Dalian city squares were more concentrated in the central city area, and their service area was relatively small; meanwhile in 2016, squares in the central city were also concentrated compared to 1999, and the service area was also reduced. However, due to their high popularity, squares such as People's Square and Zhongshan Square have a wider influence in the central city. (2) In 1999, the number of squares located in the northeast of the city was relatively small. Therefore, they were relatively scattered and their service scope was relatively wide. In 2016, the number of these squares increased, but they were still relatively scattered. The reason for this is because the area is large, and these squares are far away from the central urban area. Consequently, the popularity of them is relatively low, and their influence is mainly concentrated in their service areas.

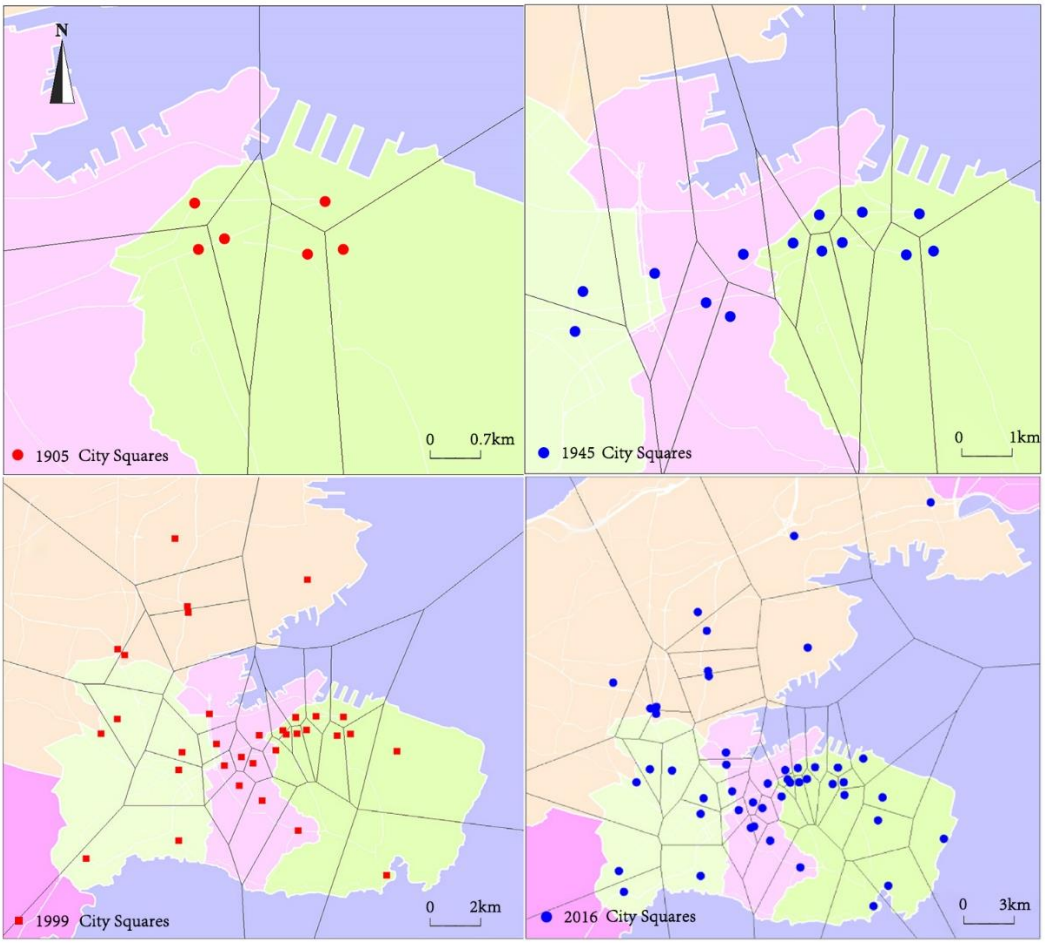

Figure 4. Voronoi diagram of city squares.

3.3. Factors Influencing the Evolution of the Spatio-Temporal Pattern of City Squares

3.3.1. Natural Factors

Natural factors such as topography and slope are important factors affecting the spatial pattern of city squares. Dalian is surrounded by more mountains and hills, with fewer plains and lowlands. The highest altitude of the third type of city square is 38.80 m, followed by the second, the fourth type and the first type of the squares. The average altitude of the four types of squares is between 22 m and 48 m, enjoying low altitude.

Only a few squares (i.e., Huale Square, Garden Square, Qixing Square, Shanluan Square, Qiuzhi Square, Shidao Street Square, Fumin Square and Xuri Square) are above 48 m. This indicates that city squares are basically located in the living areas of residents' homes, business services, tourism and leisure and transportation arteries. These areas are relatively flat, and a few squares are in low hilly areas.

3.3.2. Economic Factors

Urban planning is important for each city. The rational formulation of the development function of each region in urban planning is naturally inseparable from the financial support of the government. Tsarist Russia began the planning and construction of Dalian Port in 1898, and then planned and constructed the "Dalini City" with the benefits and funds obtained during the invasion of China by the Eight-Power Allied forces. The initial planning and construction of the squares were gradually carried out. During the period of Japanese colonial rule, the scale of the city continued to expand and the economy and other aspects also developed. Financial support was also given to urban infrastructure. From the early stage of New China to the reform and opening up, the quantity and quality of Dalian city squares were relatively backward. After the reform and opening up, Dalian was listed as one of the first batch of coastal economic open cities in China. Therefore, its economy developed rapidly, and its number of squares has increased as well. Since the beginning of the new century, with rapid economic development the city image gradually became valued by the government departments of each city. A sound economy will contribute greatly to city squares.

3.3.3. Social Factors

As an economically developed city in Northeast China, Dalian has developed only for more than 100 years, but the urban expansion and population growth in the past 100 years are the most important guarantees for its economy. Since the founding of New China, Dalian city squares have gradually spread with the expansion of the city's scale and its increase in population. Construction of city squares also affects the population distribution. For example, the populations around Digital Square and Xueyuan Square were small in 2000, but gradually increased by 2010. In addition, there are more squares in areas with higher urban population densities. On the one hand, the construction of city squares provides convenient conditions for urban development. On the other hand, urban construction and population are important for promoting city squares.

3.3.4. Political Factors

Since the construction of Dalian city squares, each period features different urban planning. They inevitably show a certain political color. In addition, the demand for urban construction and development in each period is different, affecting the construction of city squares by various policies. During the lease period of Tsarist Russia, rulers mainly used European urban planning ideas for "Dalini City", and also adopted the star-shaped radial system. They laid the foundation for square planning and construction of Dalian for the next 100 years. During the period of Japanese colonial rule, as the focus of the city gradually shifted to the west; consequently, the construction of city squares also shifted to reflect western urban areas. The number of city squares doubled compared with that during Tsarist Russia, with traffic diversion being the main function of squares. In the new century, Dalian has been affected by this policy. Only two city squares have been built in Dalian since 2004, and the scale of them is also small. The special Donggang Music Fountain Square is larger since it was built on land reclaimed from the sea and does not belong to the original land resources of the city.

4. Discussion

Most of the evaluation objects of human settlements are countries, cities and communities [5,38]. Li takes the Shahekou residential community in Dalian as the study object.

He uses five systems to explore the types of urban human settlements, and divides the spatial pattern into six main factors of human settlements [39]. Similar to Li's research, this paper constructs the evaluation index system from five major systems of human settlements and comprehensively considers the influencing factors under spatio-temporal differentiation. However, there are few studies concerning public space at home and abroad, and this classification of city squares is a new attempt in analyzing public space and human settlements.

4.1. Selection of Evaluation Indicators and Influencing Factors

The evaluation of city squares at home and abroad mostly arises from a single evaluation index or research perspective. For example, Xu tests and compares three kinds of perceived green space and three kinds of residents' health, among which the green space of public squares is positively correlated with social health [40]. Guedoudj uses direct observation and questionnaires to evaluate the environment of city squares through the accessibility and comfort of their residents. In addition, the users' age and gender also have a direct impact on the use of, in addition to the preference and attractiveness of the squares [41]. Acar uses GIS to analyze the distribution of squares. He believes that the diversity of square activities is very important for the quality and feasibility of livable urban spaces [42]. Shao is more targeted; based on the physiological, psychological and behavioral characteristics of the elderly, relying on the advanced theoretical basis at home and abroad and the selection results of existing evaluation factors, he uses clustering analysis and correlation analysis to screen the space quality of the squares; from these, he constructs the space evaluation system of elderly friendly city squares. The study results provide an important theoretical basis for the planning and design of city squares [43]. Faye discusses the square as a complex space, whose various characteristics have a variety of effects on the residents [44]. Turgut believes that in addition to bus stations and railway stations, today's squares have become places with a constant stream of people and heavy traffic. With such changes, the needs of residents have also changed. However, city squares are still the neglected urban space, and efforts should be made to build their surrounding transportation network [45].

Many studies at home and abroad involve evaluation factors such as residents' composition, natural environment, urban transportation and psychological index. This paper connects the selection basis of city square evaluation factors with sciences of human settlements. It not only brings the above factors into the evaluation system, but also adds indicators closely related to residents, such as education and culture, commercial health care, safety and security. These are creatively summarized as five systems of human settlements. On this basis, four types of squares are obtained: comprehensive square, recreational square, commercial service square and traffic square.

In research on the influencing factors of city squares at home and abroad, scholars believe that the design of any urban space needs to better understand its historical development context [46]. Atik studies the influencing factors of city squares in Turkey by assessing socio-economic and cultural changes, and provides suggestions for urban managers on sustainable development and future city square improvement [47]. Li takes improving the spatial quality of city squares as the starting point. Beginning from the perspective of users, he preliminarily constructs the comprehensive evaluation index system for city squares, and summarizes the factors affecting them [48]. Mehan considers the impact of city squares on the quality of social life, and studies and improves attention on influencing factors such as the city's own conditions, culture, society and residents' psychological needs [49]. Jiang reveals that the transformation of the public performance of Chinese city squares is closely related to the country's changing political background and social and cultural factors [50]. In addition to natural, economic and social factors, due to the different historical and cultural background of Dalian in each of its time periods, city squares inevitably reflect a certain political color. In addition, due to the different needs of residents for urban construction and development in each period, city squares are affected

by various policies. Therefore, this paper selects the political influence mechanism of the city square distribution pattern, and analyzes three different historical evolution time series: the leasing of Tsarist Russia, Japanese rule and the construction of New China.

4.2. Limitations

This study takes into consideration human settlements as the main factor, and only studies representative city squares. The lack of feedback information in some questionnaires affects the accuracy of various indicators. In addition, there is no internationally recognized scientific evaluation standard for the evaluation of human settlements in city squares. Moreover, the data of city squares in different regions in China vary greatly. Whether the study conclusion can achieve the expected vision for the improvement of different urban regions, in addition to the scope and intensity of the impact of squares, needs to be continuously investigated.

5. Conclusions

Scholars mostly use spatial analyses to investigate the relationships between physical characteristics of city squares and human activities through the needs of their users. Based on a human settlements perspective analysis, the following conclusions are:

Scholars at home and abroad analyze city squares mostly focusing on design. They change the shape, environment and function in order to adapt to urban development and residents' activities. From the perspective of human settlements, this paper establishes 28 evaluation indicators for city squares, including natural system, human system, social system, residential system and support system. The PCA is used to comprehensively evaluate the indicators; finally, four principal component factors are extracted. On the basis of PCA, 48 squares are classified by a systematic clustering method, with the majority being comprehensive squares, followed by traffic squares, recreational squares and commercial service squares.

As for the spatial distribution of city squares, cities show different characteristics in scale, quantity and type. The spatial agglomeration trend of squares in Dalian is obvious. Regardless of core density or point density, Zhongshan District, Xigang District, Shahekou District and the junction area between Shahekou District and Ganjingzi District are the absolute agglomeration areas. Meanwhile, the correlation between squares is also gradually increasing. The spatial distribution pattern develops from "semicircle" to "strip", and finally presents as a "Y-shape". The spatial pattern of the squares has evolved from the initial "triangle" to the later "trapezoid", and then to the current "butterfly".

Domestic and foreign research involves a relatively single field, including the factors affecting the livability of the squares, the factors affecting the determination of the natural comfort range, and an overview of the influencing conditions of spatial structure and land use properties on the spatial differentiation. This paper summarizes six influencing factors of spatio-temporal differentiation for squares in Dalian, and comes to the conclusion that natural factors affect the overall pattern of city square distribution. Economic, social and political factors have an important impact on the number, scale and shape of squares. Ecological and technological factors determine the image of city squares and the diversification of their functions.

In future research, we should make up for the defects of data, integrate other factors such as society, and further enrich and expand the city square evaluation index system, in order to improve the scientificity and objectivity of the evaluation results. In addition, it will be necessary to deepen time explorations and expand spatial scales. In different periods of city squares, the forms, landscapes and types of different squares are studied such that the city squares in different times and space have matching evaluation systems. The attraction of city squares to people has an important impact on the sustainable construction of developing cities. Therefore, in order to make human settlements service functions of city squares, researchers and planners must coordinate and promote the further optimization

and upgrading of urban spatial structures; corresponding suggestions should be put forward for city squares and for urban planning in the future.

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

Funding: This research was funded by the Scientific Study Project for Institutes of Higher Learning, Ministry of Education, Liaoning Province (Grant number J202154); Natural Science Foundation of Guizhou Province (Grant number [2019]1150).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Hwang, J. Representing Spatiotemporal Context of Public Space for Urban Design. In Proceedings of the 2013 Fourth International Conference on Computing for Geospatial Research and Application, San Jose, CA, USA, 22–24 July 2013; p. 153.
2. Jin, Y.; Jin, H.; Kang, J. Combined effects of the thermal-acoustic environment on subjective evaluations in urban squares. *Build. Environ.* **2020**, *168*, 106517. [CrossRef]
3. Wang, M.; Zhang, X.; Luan, W. Structure and Spatial Analysis of Evaluation of Residential Environment in Dalian City. *Sci. Geogr. Sin.* **2003**, *23*, 87–94. (In Chinese) [CrossRef]
4. Cai, Y. *Urban Square*; Southeast University Press: Nanjing, China, 2006. (In Chinese)
5. Li, X.; Zhang, J.; Yang, J.; Zhang, L. Analysis of the attraction field of urban human settlements: A case study of Dalian. *Geogr. Res.* **2012**, *31*, 1199–1208. (In Chinese) [CrossRef]
6. Agryzkov, T.; Martí, P.; Nolasco-Cirugeda, A.; Serrano-Estrada, L.; Tortosa, L.; Vicent, J.F. Analysing successful public spaces in an urban street network using data from the social networks Foursquare and Twitter. *Appl. Netw. Sci.* **2016**, *1*, 1–15. [CrossRef]
7. Wang, Y.; Chen, J. Does the rise of pseudo-public spaces lead to the 'end of public space' in large Chinese cities? Evidence from Shanghai and Chongqing. *Urban Des. Int.* **2018**, *23*, 215–235. [CrossRef]
8. Wang, Y.; Yamaguchi, K.; Kawasaki, M. Urban revitalization in highly localized squares: A case study of the Historic Centre of Macao. *Urban Des. Int.* **2016**, *23*, 34–53. [CrossRef]
9. Kassabaum, M.C. Early Platforms, Early Plazas: Exploring the Precursors to Mississippian Mound-and-Plaza Centers. *J. Archaeol. Res.* **2018**, *27*, 187–247. [CrossRef]
10. Yang, J.; Yang, Y.; Sun, D.; Jin, C.; Xiao, X. Influence of urban morphological characteristics on thermal environment. *Sustain. Cities Soc.* **2021**, *72*, 103045. [CrossRef]
11. Van Deusen Jr, R. Public space design as class warfare: Urban design, the 'right to the city' and the production of Clinton Square, Syracuse, NY. *GeoJournal* **2002**, *58*, 149–158. [CrossRef]
12. Zalewski, A. Transportation Aspects of Shaping the Public Spaces of Urban Squares in Warsaw (Poland). *IOP Conf. Ser. Mater. Sci. Eng.* **2019**, *603*, 42092. [CrossRef]
13. Xue, J. *Open Space & Square Design*; Phoenix Science Press: Nanjing, China, 2004. (In Chinese)
14. You, W.; Ding, W. Effects of urban square entry layouts on spatial ventilation under different surrounding building conditions. *Build. Simul.-China* **2020**, *14*, 377–390. [CrossRef]
15. Yang, J.; Wang, Y.; Xiu, C.; Xiao, X.; Xia, J.; Jin, C. Optimizing local climate zones to mitigate urban heat island effect in human settlements. *J. Clean. Prod.* **2020**, *275*, 123767. [CrossRef]
16. Stocco, S.; Cantón, M.A.; Correa, E.N. Design of urban green square in dry areas: Thermal performance and comfort. *Urban For. Urban Gree.* **2015**, *14*, 323–335. [CrossRef]
17. Kariminia, S.; Shamshirband, S.; Hashim, R.; Saberi, A.; Petković, D.; Roy, C.; Motamedi, S. A simulation model for visitors' thermal comfort at urban public squares using non-probabilistic binary-linear classifier through soft-computing methodologies. *Energy* **2016**, *101*, 568–580. [CrossRef]
18. Fayoumi, M.A.E. Street Vendors' Roles in Main Squares Utilization as a Type of Tactical Urbanism Application in G.C.R. "A Criticism Review on Ramses Square". *Procedia Environ. Sci.* **2017**, *37*, 153–163. [CrossRef]
19. Pang, R.; Hou, C.; Man, W.; Song, Y.; Zhao, Z. Study on Spatial Structure and Accessibility of Urban Squares in Changchun. *Econ. Geogr.* **2015**, *35*, 88–93. (In Chinese) [CrossRef]

20. Qixiang, H.; Hanchuan, P. Study on People Square's Mass Passenger Flow Management System Launched in Shanghai Urban Rail Transit. *Procedia Soc. Behav. Sci.* **2013**, *96*, 751–765. [CrossRef]
21. Spyrou, E.; Korakakis, M.; Charalampidis, V.; Psallas, A.; Mylonas, P. A Geo-Clustering Approach for the Detection of Areas-of-Interest and Their Underlying Semantics. *Algorithms* **2017**, *10*, 35. [CrossRef]
22. Xiao, J.; Hilton, A. An Investigation of Soundscape Factors Influencing Perceptions of Square Dancing in Urban Streets: A Case Study in a County Level City in China. *Int. J. Environ. Res. Public Health* **2019**, *16*, 840. [CrossRef]
23. Meng, Q.; Zhao, T.; Kang, J. Influence of Music on the Behaviors of Crowd in Urban Open Public Spaces. *Front. Psychol.* **2018**, *9*, 596. [CrossRef]
24. Pugh, T.W. From the Streets: Public and Private Space in an Early Maya City. *J. Archaeol. Method Theory* **2018**, *26*, 967–997. [CrossRef]
25. Hajmirsadeghi, R.S.; Shamsuddin, S.; Foroughi, A. The Relationship between Behavioral & Psychological Aspects of Design Factors and Social Interaction in Public Squares. *Procedia Soc. Behav. Sci.* **2014**, *140*, 98–102. [CrossRef]
26. Zhang, L. People's behavior psychology and the design of urban square. *Urban Probl.* **2008**, *8*, 65–67. (In Chinese)
27. Lenzholzer, S. Engrained experience—A comparison of microclimate perception schemata and microclimate measurements in Dutch urban squares. *Int. J. Biometeorol.* **2010**, *54*, 141–150. [CrossRef] [PubMed]
28. Ding, Y.; Li, S. Study on city square image based on public perception: A case of Guangzhou Huacheng Plaza. *World Reg. Stud.* **2018**, *27*, 65–76. (In Chinese) [CrossRef]
29. Yang, B.; Volkman, N.J. From traditional to contemporary: Revelations in Chinese garden and public space design. *Urban Des. Int.* **2010**, *15*, 208–220. [CrossRef]
30. Chen, C.; Zhou, B.; Yang, D.; Deng, W.; Yan, Z.; Qi, F. City square: An issue to be studied. *City Plan. Rev.* **2002**, *26*, 31–45. (In Chinese) [CrossRef]
31. Li, Q.; Peng, K.; Cheng, P. Community-Level Urban Green Space Equity Evaluation Based on Spatial Design Network Analysis (sDNA): A Case Study of Central Wuhan, China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10174. [CrossRef]
32. Yang, J.; Sun, J.; Ge, Q.; Li, X. Assessing the impacts of urbanization-associated green space on urban land surface temperature: A case study of Dalian, China. *Urban For. Urban Gree.* **2017**, *22*, 1–10. [CrossRef]
33. Xu, Y. Discussion on Spiritual Dimension of Square Space: Read on Status Quo of City Plaza in Shanghai. *Huazhong Archit.* **2010**, *28*, 21–24. (In Chinese) [CrossRef]
34. Li, C.; Li, Y. Analysis on the Spatial Form of City Square. *Planners* **2002**, *18*, 45–48. (In Chinese) [CrossRef]
35. Wang, H.; Qiu, J.; Breuste, J.; Ross Friedman, C.; Zhou, W.; Wang, X. Variations of urban greenness across urban structural units in Beijing, China. *Urban For. Urban Gree.* **2013**, *12*, 554–561. [CrossRef]
36. Massaro, A.; Birardi, G.; Manca, F.; Marin, C.; Birardi, V.; Giannone, D.; Galiano, A.M. Innovative DSS for intelligent monitoring and urban square design approaches: A case of study. *Sustain. Cities Soc.* **2021**, *65*, 102653. [CrossRef]
37. Dalian City Construction Archives. *The Squares of Dalian*; Dalian Publishing House: Dalian, China, 2007. (In Chinese)
38. Wu, L. *Introduction to Science of Human Settlement*; China Architecture & Building Press: Beijing, China, 2001. (In Chinese)
39. Li, X.; Zhang, Y.; Gao, J. Spatial Pattern and Classification of Human Settlement:A Case Study of Shahekou in Dalian. *Sci. Geogr. Sin.* **2014**, *34*, 1033–1040. (In Chinese) [CrossRef]
40. Xu, L.; Liu, D.; Liu, Y.; Zhang, N.; Yang, L. Analysis of Plant Composition and Diversity on Urban Square in Mudanjiang City, China. *Bangl. J. Bot.* **2021**, *50*, 277–287. [CrossRef]
41. Guedoudj, W.; Ghenouchi, A.; Toussaint, J. Urban attractiveness in public squares: The mutual influence of the urban environment and the social activities in Batna. *Urbe. Rev. Bras. De Gestão Urbana* **2020**, *12*, e20190162. [CrossRef]
42. Acar, H.; Yavuz, A.; Eroğlu, E.; Acar, C.; Sancar, C.; Değermenci, A.S. Analysis of activity, space and user relations in urban squares. *Indoor Built Environ.* **2021**, *30*, 1466–1485. [CrossRef]
43. Shao, J.; Zhang, H.; Liu, J. Quality Evaluation of Square Space Based on the Aging-friendly City: Central city plaza in Harbin. *Build. Energy Effic.* **2018**, *46*, 78–83. (In Chinese) [CrossRef]
44. Faye, B.; Le Fur, É. Square, Plaza, Piazza, Place: What Do We Know about these Targets of Urban Regeneration Programmes? *Urban Stud.* **2012**, *49*, 3081–3099. [CrossRef]
45. Turgut, D. Case study on holistic assessment of the relationship between city and square. *J. Archit. Urban.* **2020**, *44*, 152–165. [CrossRef]
46. Paiva, P.D.D.O.; Sousa, R.D.B.; Alves, S.F.N.D. Patchwork quilt: A methodology proposed for the study of historic gardens. *Urban For. Urban Gree.* **2021**, *62*, 127169. [CrossRef]
47. Atik, D.; Keleş, E.; Bayrak, G. Unable to Inhale in an Historical Square. *Eur. J. Sustain. Dev.* **2018**, *7*, 274–286. [CrossRef]
48. Li, C. *Comprehensive Evaluation System of Square Based on the Analytic Hierarchy Process*; Hefei University of Technology: Anhui, China, 2012. (In Chinese)
49. Mehan, A. Investigating the Role of Historical Public Squares on Promotion of Citizens' Quality of Life. *Procedia Eng.* **2016**, *161*, 1768–1773. [CrossRef]
50. Jiang, M.; Nakajima, N. Chongqing People's Square after 1997: Situated publicness of municipal squares in reform-era China. *Urban Res. Pract.* **2022**, 1–29, *ahead-of-print*. [CrossRef]