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Article

Participatory Renewal of Historic Districts Based on Bayesian Network

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Abstract: Public participation is a requirement for contemporary urban governance in China, especially in the protection planning of historic districts. In the rapid development stage, many historic districts have lost their functional positioning in cities and are gradually disappearing due to outdated facilities and services. Previous studies have pointed out that protecting historic and cultural districts requires the joint efforts of multiple stakeholders. Integrating multiple stakeholders' interests and needs is a complex problem in related research fields and planning practices. The traditional forms of public participation, such as questionnaire surveys, interviews, and symposiums, have the problem of high time costs for collection and analysis. At the same time, the information has been translated multiple times, making it challenging to avoid misunderstandings and errors. Therefore, there is an urgent need for an alternative platform for public participation in the renewal of China's historic districts. Taking Houzaimen Street in Jinan City as an example, this paper uses the Bayesian network to establish a spatial evaluation model of historic districts. Our aims are to translate natural semantics into the design semantics of the architectural field, accurately locate the spatial problems of the historic district, and provide targeted improvement measures. In this paper, a public feedback channel for Houzaimen Street is established to provide a reference for the renewal of the historic district and the advancement of public participation.

Keywords: historic districts; participatory renewal; Bayesian network

Citation: Yang, Y.; Xia, Y.; Zhao, J.; Liu, C. Participatory Renewal of Historic Districts Based on Bayesian Network. *Information* **2024**, *15*, 628. https://doi.org/10.3390/info15100628

Academic Editors: Maria Carmen Carnero and Heming Jia

Received: 28 July 2024
Revised: 7 October 2024
Accepted: 10 October 2024
Published: 11 October 2024

1. Introduction

The renewal and preservation of historic districts are significant in realizing sustainable urban development. Previous studies have shown that the renewal of historic districts synthesizes professional technology and public participation dimensions [1]. It requires professional participatory renewal and the provision of public will [2]. However, the government, experts, and professionals still dominate the participatory renewal of historic districts in China. The lack of extensive public participation affects the smooth implementation of preservation. Public participation is significant in cultural conservation, innovative development, sustainable development, and enhancement of visitor satisfaction in historic districts [3]. Only through the extensive collection and analysis of public evaluations can public satisfaction be enhanced in all aspects, providing vital support and reference for the development of historic districts [4]. However, there are areas for improvement in the existing methods and techniques of public participation in historic districts. Previous studies have pointed out that protecting historic and cultural districts requires the joint efforts of multiple stakeholders [5]. Due to the large number of stakeholders associated with historic districts, it takes effort to efficiently and accurately translate the will of the public into the design basis for urban construction. Integrating the interests and needs of multiple stakeholders is a complex problem in related research fields and planning practices [6,7]. Therefore, only through broad and deep public participation can the interests of all parties be balanced and the public's wishes met.

In the renewal of China's historic districts, traditional public participation methods include public interviews during the planning and design stages and publicizing the results of the design plans after they are completed [8]. The traditional forms of public participation, such as questionnaire surveys, interviews, and symposiums, pose the problem of high time costs for collection and analysis. At the same time, the information is translated multiple times, making it challenging to avoid misunderstandings and errors. Some scholars have analyzed the current situation of public participation in Beijing's historic and cultural preservation zones and concluded that there needs to be more efficient public participation mechanisms in the renewal process [9]. With the arrival of the network era, self-media technology has brought new possibilities for traditional public participation. The Internet's instantaneous nature can improve inefficiency and single channels in traditional participation methods. Some scholars have proposed a framework for analyzing the value of historic districts through the analysis of self-media data, which leads to the evaluation patterns of the public and tourists [10]. The Internet has made obtaining public evaluations on a large scale easier. According to this characteristic, some scholars have collected the performance evaluation of many renewed historic districts and constructed an evaluation system based on goal achievement and residents' satisfaction [11]. While the Internet has made access to public evaluations easy, there is still a lack of an efficient and accurate translation tool to process these public evaluations [12]. Some scholars believe that in public participation, the invited public would generally have problems describing their needs accurately and in enough detail, which makes it difficult for design organizations to fully grasp the public's needs and apply them to the overall planning and design [13]. Therefore, a mature participation-feedback-processing design system is still needed to ensure public participation is expressed, collected, and translated.

2. Participatory Renewal

2.1. The Concept and Need for Participatory Renewal

Participatory renewal refers to all stakeholders cooperating with designers and developers to express their reasonable interests in the various stages of participatory renewal, such as pre-preparation, assessment, decision making, and implementation [14]. Public opinion is incorporated into decision making to realize public interests and satisfy public wishes. Applying participatory updating, the entire design process will be public-centered, in which designers understand user behaviors and processes and more accurately capture the potential needs of the public. A public participation platform for participatory regeneration needs to consider the demands of all stakeholders involved in construction activities. The main participants include relevant government departments, indigenous residents, external visitors, development companies, and designers. The above subjects are highly related to construction behavior and interact with each other in complex ways. They must work together and cooperate, constituting a multi-subject participation system based on demand relationships. Applying the participatory renewal model, the functional positioning and participation forms of each stakeholder are as follows (Table 1).

Table 1. Analysis of the subjects of participatory renewal in historic districts.

Participating Stakeholders	Stakeholder Definition	Functional Positioning	Participation Forms
Government Administration	The governmental administration refers to the grass-roots government that has the closest relationship with renovating and constructing historic districts and the relevant functional departments of the government.	Managers, decision-makers	1. Improving laws and regulations, relevant construction technical specifications, capital investment, infrastructure construction, organizing and managing the planning of historic districts, and selecting planning preparation units; 2. Managing and guiding residents to participate in construction; 3. Binding and supervising the behavior of enterprises.

Table 1. *Cont.*

Participating Stakeholders	Stakeholder Definition	Functional Positioning	Participation Forms
Residents	Residents are the audience of the historic district's style enhancement construction, and they are the core participants. They are the primary force that promotes the construction of historic districts.	Users, creators	1. Participating in the industrial operation of historic districts; 2. Maintaining the sustainable and healthy development of historic district industries; 3. Cooperating with the government and the design teams.
Developer	Enterprises are the investors in the historic district style and become the active executors of the long-term interests.	Investors, managers	1. Investing funds to promote the development of the historic district style; 2. Promoting the healthy operation of the historic district industry and being able to undertake the critical responsibility of balancing economic development and resource protection.
Visitors	Tourists are the intuitive experiencers who perceive the style of the historic district.	Users, consumers	Based on tourism demand, providing feedback for planning.
Design Team	Planners and architects represent the relevant professional teams	Core organizer, coordinator	1. Designing the construction of historic district landscapes through the preparation of historic district planning and construction, and architectural and landscape scheme design; 2. Providing professional knowledge, technical skills, professional pursuits, and social responsibility.
Others	Including potential visitors and NGOs who are interested in the historic district	Innovator, intellectual participant	Provide innovative points for the creation as well as the renewal of the industry in the historic districts.

The composition of subjects with multiple interests is complex, and the reasons for their behavior varies. Improving the ways and means of expression is necessary to realize participatory renewal. In previous studies, participatory renewal has achieved good application in promoting public participation in construction projects. Some scholars have proposed a method of categorizing voice rights, which guarantees the balance and breadth of public participation by estimating the voice rights of different public groups in site selection, construction, and operation [15]. Some scholars have established a performance evaluation system for the protection and renewal of historic districts, which enriches the evaluation system of public participation by evaluating the performance of the renewal of historic districts through BSC technology [16]. Regarding passive participation, some scholars use VEP technology to collect the public's spatial mobile behavior and stopover perception in historic districts, generating indicators of preference satisfaction to assist decision making more comprehensively [17]. The examples of participatory regeneration mostly stay at the micro-implementation level and still need a perfect systematic analysis and participation system. Therefore, more complete technical and institutional support is required to realize the efficient and effective transformation of the public's wishes into programmatic decisions.

2.2. The Realistic Dilemma of the Participatory Renewal Model

The participatory renewal theory has laid a theoretical foundation for the protection and renovation of historical districts. However, the traditional participatory updating model mainly involves interviews and questionnaire surveys, which require a lot of analysis and summarization work, introducing time and manpower costs to the design practice. The process of designing questionnaires and interviews may still result in omissions. Regarding representation, participatory renewal makes it challenging to ensure that all voices are heard, especially by the public, who possess a low knowledge level. Mobilizing the public to participate fully in decision making requires skills training to equip the public with knowledge, which is often difficult to achieve. Moreover, participation in the renewal of historic districts requires a deeper understanding of the relevant professional fields' theoretical connotations and design methodology. This professional-level barrier is difficult

for the public to understand. Therefore, a public-will translation tool that can accurately convert natural semantics into design semantics is needed to reduce the resistance to public participation.

Analyzing and extracting public semantics is necessary to establish a public semantic translation tool. While ensuring the maintenance of public intent, the tool should be as concise and easily recognizable as possible. In addition, it is essential to construct a corresponding relationship in natural semantics to ensure that the translation tool can accurately and quickly translate public semantics. This paper built a spatial quality evaluation model for historic districts based on a Bayesian network and established a core conversion system of "natural semantics–design semantics". In this paper, we used the participatory renewal of Jinan Houzaimen Street as a historic district as an example. The public opinion data in the representative space points are substituted into the evaluation model to complete the logic of natural and design semantics deduction. Thus, the evaluation of urban spatial quality and the diagnosis of participatory renewal problems are realized. A unified framework is used to evaluate and understand the weights and impacts of various information to provide decision support for participatory renewal.

3. Bayesian Network

3.1. The Concept and Current Application of Bayesian Network

The Bayesian Network (BN) is often applied to predict system risks or analyze the causes of accidents. It is based on the principle of probabilistic analysis, which is based on the observed evidence of unknown events [18]. It can identify causes and diagnose problems in terms of dynamic probability distributions. Based on the BN model, composed of nodal probabilities and the BN structure, the BN model displays good visibility of the probability of occurrence and cause inference for each event. Therefore, the BN has been widely used in several disciplines. The BN is often applied to fault diagnosis methods for equipment and risk prediction for major engineering systems. In transportation, the Peter-Clerk algorithm is often used to learn the structure of the BN model. Then, the model parameters are learned through questionnaires and the maximum expectation algorithm to realize the analysis of the causal mechanisms of traffic accidents. Evaluation experts use the assignment method, combining BN and entropy weight methods, to determine the weights of indicators and achieve the evaluation and prediction of system risk. The BN was introduced into the modeling of risk adaptation in the traditional village industry, analyzed the key driving factors of risk adaptation, and predicted the system risk of the traditional village industry [19,20]. These methods are good at predicting potential risks or analyzing unknown failures. However, their models' accuracy depends on the sample size, and the better the data, the more accurate the effect. Some scholars applied expert judgment to determine the conditional probabilities between BN nodes and established a prediction model for diagnosing and predicting the risk of major engineering systems [21]. Some scholars have used BN iterations in architectural design to generate optimized architectural design solutions that satisfy the given topological relationships based on BNs trained using real-world data. Based on the ease of operation of nodes and structures, the BN is well established in public participation analysis and public will feedback. In evaluating public service quality, establishing a comprehensive evaluation model based on the BN can be used to understand the service quality of urban rail transit based on the evaluation and realize targeted improvement [22]. In the existing research, there are various urban renewal decision-making models based on public participation. In this paper, four representative methods are selected to compare the methods' advantages, defects, and other aspects (Table 2). The comparison shows that the BN has good variability and flexibility. In decision making, it can be flexible to make dynamic corrections to the results based on continuously added data. It can help decision-makers make timely adjustments based on new predictions and develop more reliable and sustainable decision-making programs.

Table 2. Urban renewal decision-making models based on public participation.

Methodologies	Introduction	Sustainable Redevelopment	Cost Analysis	Revenue Analysis
LUCRS Model (Land Use Change and Resource Suitability Model)	A model for simulating and predicting public perceptions of urban land use change.	High capacity for sustainable redevelopment. Specializes in land use change and resource suitability analysis.	High: data acquisition and modeling costs	Significant long-term benefits. Long-term resource optimization, avoiding environmental restoration costs
Traffic Volume Decision Model	Adoption of multi-party collaborative platforms such as online voting, questionnaires, collective decision-making systems.	Average sustainability. Optimization of transport systems to reduce emissions and energy consumption.	Moderate: data and infrastructure costs	Significant medium- and long-term benefits. Direct economic and environmental benefits from traffic optimization
Crowdsourcing Model	Extensive collection of public views based on the Internet and mobile technology platforms.	Poor sustainability. Promoting sustainable development through original means public input.	Low: relies on public data, platform costs	Low cost to gather large amounts of data. Reduces social conflicts, optimizes plans, lowers hidden costs.
Public Survey Model	Traditional research questionnaires, online surveys, telephone interviews, etc., combined with GIS or online mapping tools.	Average sustainability. Systematized collection of public demand for sustainable development.	High: high costs for survey design and data collection	High cost, especially for large-scale surveys. Suitable for high-impact projects
BN-based decision modeling for urban planning	Relying on the dynamic probabilistic analysis of BN, public evaluations are used as BN nodes to diagnose spatial problems.	High capacity for sustainable redevelopment. The evaluation model developed can be replicated in different regions.	Moderate: Evaluation model construction and design	Accurately gathers public opinions, reduces social risks. More efficient and economical decision-making for urban renewal

In summary, the dynamics and visibility that the BN can demonstrate in complex public events with a lack of samples ensure the heavenly advantage of BN modeling introduced into the field of public participation. Therefore, applying the BN in participatory updating allows public sample data to be systematically processed through iterative machine learning. It can also establish dynamic probability distributions to measure public willingness accurately.

3.2. Bayesian Network Modeling

In the BN, the nodes pointed by arrows are child nodes, and the nodes at the end of the arrow are parent nodes. A probability function exists for each node event to occur or not, and a conditional probability table represents this function. The following steps are usually required to construct a Bayesian network model. First, the variables and their dependencies are identified. The factors that influence the spatial quality of the historic neighborhoods are taken as the variables of the Bayesian network. Then, the influence factors are correlated to the natural semantics when spatial problems occur in the historic street to determine the dependency relationship. Second, the network structure is determined. Based on the identified dependencies, the historic street spatial evaluation model can then create a directed acyclic graph to represent the structure of the Bayesian network model. The influencing factors are nodes, and the arrows indicate their dependencies. The model can be quickly completed in this step using the Bayesian network modeling tool GeNIe 4.0. The GeNle platform was explicitly developed for Bayesian network analysis, allowing interactive model building and learning. Online in 1998, it gained widespread use in visualizing probability distributions. After establishing the network structure, conditional probability distributions need to be defined for each node, and this step needs to consider the dependency relationship between the influencing factors and the distribution of the related data. The a priori probability of the model is obtained through the statistical data and logical reasoning, and the dynamic probability distribution is realized by calculating the posterior probability X as an example.

Let $G = (I, E)$ denote a directed acyclic graph, where I denotes all variable nodes in this graph and E denotes all directed edges. $U = \{X_1, X_2, \ldots X_n\}, n \geq 1, X = (X_i), i \in I$

denotes a random variable, and bn is the topology of the network on this set of variables U. It contains U and the set of probability tables B_p.

$$B_p = \{ p(x_i|pa(x_i), x_i \in U)\}$$

where $pa(x_i)$ denotes the "cause" of variable X. The joint probability of node X is denoted by

$$p(U) = \prod_{i \in U} p(x_i|pa(x_i))$$

3.3. BN Spatial Evaluation Model

This paper applies BN technology to public participation in participatory renewal. This section focuses on model construction, and a case study is applied to display the model practice in Section 4. Based on the prediction and diagnosis ability of the BN for unknown factors. Taking the public's natural semantics for spatial evaluation as the computational basis, we extract and analyze the spatial type of occurrence and word frequency probability statistics of public semantic keywords. The correspondence between public spatial evaluation and urban spatial problems is realized. Based on this correspondence, the participatory renewal spatial evaluation model is constructed. We take the design semantics of the architectural field corresponding to the urban spatial problem as the root node. Moreover, we take public semantic keywords as sub-nodes. In this way, the BN structure is established as a causal chain. Through the participatory renewal spatial evaluation model, the public's natural semantics are transformed into the design semantics of the architectural domain. It can also realize the precise positioning of urban spatial problems through probability calculation.

Determining variables and their dependence mainly depends on determining influencing factors for the spatial evaluation of historic districts. Its structure should be established to comprehensively and genuinely reflect the spatial service content of the historic district. It should also consider the public's subjective perception and utilization needs. Based on five representative theoretical works and domestic and international studies on the influence factors of urban spatial quality, this paper selects the first- and second-level influence factors (Table 3). The table shows the impact factors with significant spatial qualities obtained by searching for representative-related studies at home and abroad.

Table 3. Influence factor extraction based on the literature review.

References	First-Level Influence Factors	Rank	Second-Level Influence Factors
[23–25]	A Infrastructure	A1	Public Space
		A2	Entertainment Facilities
		A3	Road Accessibility
		A4	Functional Service
[26–29]	B Environment	B1	Air Quality
		B2	Material Selection
		B3	Green Coverage
		B4	building Sites
[24,25,30]	C Architectural exterior	C1	Building Form
		C2	Facade Design
		C3	Window Design
		C4	Color and Texture
[30–32]	D Spatial morphology	D1	Spatial Openness
		D2	Spatial Layout
		D3	Height and Levels
		D4	Functional Circulation

The root node of the BN model represents the relic influence factor, and the sub-nodes represent the public natural semantics. Self-media data were captured using a Python 3.13.0 web crawler. We utilized public interviews and questionnaires regarding the actual space to obtain specific space evaluation data. Then we used both as the original data text of the model. We utilized linear discriminant analysis (LDA) to identify natural public semantics

theme information and obtained the multilayer probability distribution of natural semantics using statistical word frequency to get the a priori probability. A specific space with a significant performance of the influence factor was selected, the frequency of occurrence of different natural semantics in the space was counted, and the natural semantics with a high frequency of occurrence could correlate with the influence factor, as shown in Table 4. Public natural semantics are derived from the research of 60 actual real spaces. Evaluations from the public in different actual real spaces were collected using online open data and questionnaires. The average number of public comments collected per real space was about 420. The probability distribution of public semantics in each real space was counted using LDA. We associated the spatial features of the actual real spaces with the natural semantics that frequently occur, and produced the correspondence between the spatial features and the natural semantics. Relying on the GeNle platform, first-level influence factors, second-level influence factors, and public natural semantics are created at three different levels of nodes. The input a priori probability completes the BN iterative machine learning to realize the construction of the historical street spatial evaluation model, as shown in Figure 1. Figure 1 shows the network structure created by substituting the impact factors and public semantics into the GeNle platform. The BN model can be completed by inputting the probability distribution. Once the historical street spatial evaluation model is established, it can be practiced on different historical streets. This method is a universal method based on extensive research. With the historical street spatial evaluation model, spatial problems can be diagnosed only using the public semantics of the historical streets.

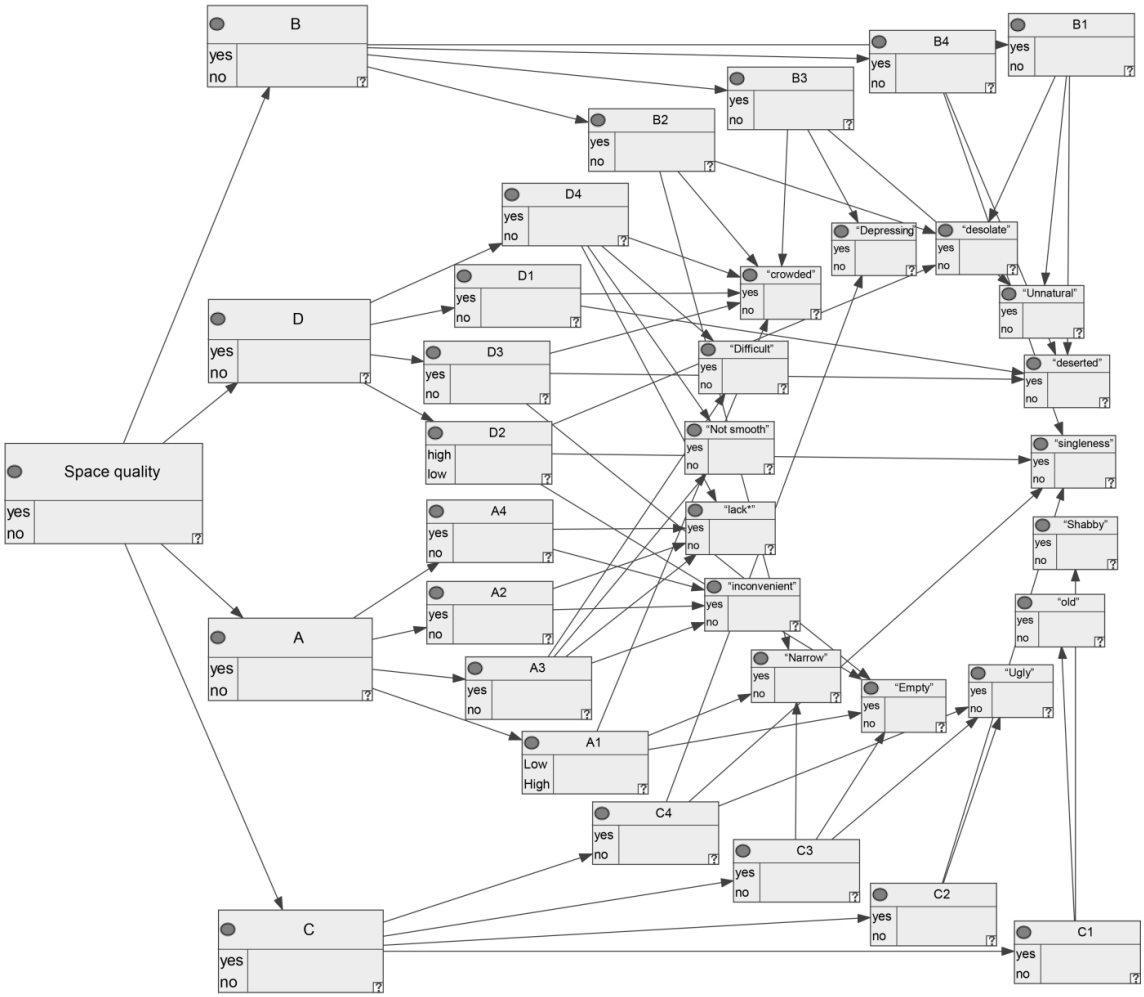

Figure 1. Spatial evaluation model for historic districts.

Table 4. The prior probability and the corresponding public natural semantics.

Second-Level Influence Factors	Prior Probability	Public Natural Semantics (By Word Frequency)
A1	0.05	Crowded, Spacious, Narrow...
A2	0.02	Boredom, Monotony, Lack *...
A3	0.23	Poor, Inconvenient...
A4	0.15	Lacking *, Inconvenient, Unfriendly...
B1	0.05	Smelly, Oppressive, Crowded...
B2	0.06	Deserted, Single, Unnatural...
B3	0.22	Unnatural, Desolate, Empty...
B4	0.17	Desolate, Narrow, Crowded...
C1	0.03	Dilapidated, Deserted, Old...
C2	0.14	Poor, Inconvenient...
C3	0.22	Huge, Empty, Narrow, Ugly...
C4	0.13	Single, Ugly...
D1	0.11	Empty, Crowded, Deserted...
D2	0.16	Narrow, Empty, Crowded...
D3	0.02	Monolithic, Crowded...
D4	0.06	Repressive, Singular...

Note: * stands for lack of environmental amenities, restrooms, stores, etc.

4. Case Study of Houzaimen Street

Houzaimen Street, located in the Lixia District of Jinan City, China, is a historic neighborhood that has existed for more than 500 years, as shown in Figure 2. The location is self-drawn, and the pictures were acquired via shooting. Historically, Houzaimen Street was built with over 280 guild halls and stores. It became an essential space for public life because of its well-developed commerce, carrying the public's traditional memories of the city and perpetuating its historical heritage. With the development of modern business models, Houzaimen Street has gradually lost its commercial status and service functions, and the area's vitality continues to decline. This paper takes Houzaimen Street as a practice area, diagnoses the spatial problems according to the established spatial evaluation model of the historic district, and generates targeted improvement programs based on the functional forms and environmental characteristics.

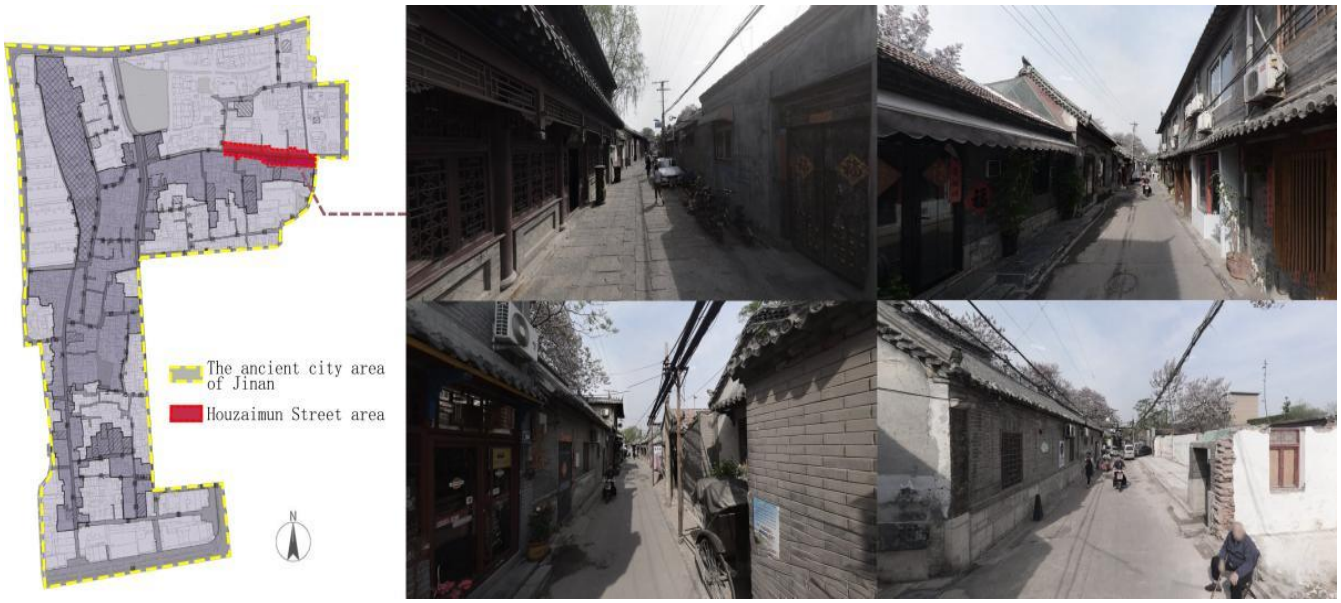

Figure 2. The location and pictures of Houzaimun Street.

4.1. Access to Research Data

Data were collected through field research with questionnaires and open data online as follows:

- Data obtained from field research

The questionnaire distribution and interview data period was from December 2023 to January 2024, and the distribution location was selected as the public activity area with high public flow on Houzaimen Street. The primary respondents were the neighborhood residents and the traveling public, and random sampling and subjective judgment were used to select the sample. A total of 800 questionnaires were distributed, with 734 valid responses received, resulting in an effective response rate of 91.75%.

- Online open data

Self-media websites include Baidu Search, Weibo, Xiaohongshu, eLong, Mafengwo, and Baidu Travel. Baidu Search, China's largest search engine with the highest market share; Weibo, a Twitter-like social media platform with the highest market share among China's social media; Xiaohongshu, a platform for sharing shopping tips and life experiences, especially popular among young women; eLong, an essential player in China's online travel market; Baidu Travel, provides travel information, tips and online booking services with a high market share; Mafengwo, a comprehensive travel service platform focusing on travel tips, community sharing, and online booking.

The keyword "Houzaimen Street" was typed into the search field of these websites. A Python web crawler was utilized to capture the evaluation content as the research data source and a total of 19,805 valid public natural semantics were captured. Statistical data was extracted from the public comments related to the quality of spatial services. We used ROSTCM6 to analyze the sentimental trends in the public comments with the keyword "Houzaimen Street" and obtain the frequency table of the public's natural semantics (as shown in Figure 3). Figure 3 shows the obtained public semantics analyzed after substituting them into ROSTCM6, visualized by counting word frequencies.

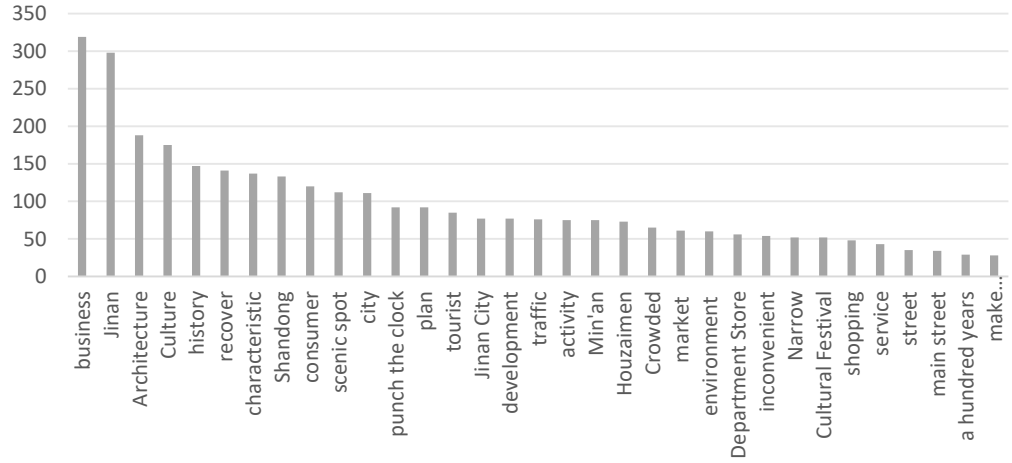

Figure 3. Public semantic frequency.

4.2. Diagnosis of Spatial Problems in Houzaimen Street

According to the research data results, the public evaluation keywords of Houzaimen Street are extracted and input into the spatial evaluation model of the historic neighborhood. The evaluation results are outputted to locate the influencing factors of the urban spatial problems, and the influencing factors with high correlation are selected for the causal analysis of the problems to finally diagnose the urban spatial problems. To strengthen the guidance of the method described in this paper for participatory renewal and better illustrate the principle of diagnostic reasoning, the public evaluation of Houzaimen Street is taken as an example. The spatial problem diagnosis is carried out according to the

probability of each influencing factor node after the node change, and the diagnostic results are shown in Figure 4. Figure 4 shows the probabilistic results of operating the model with the emergent public semantics set to "yes".

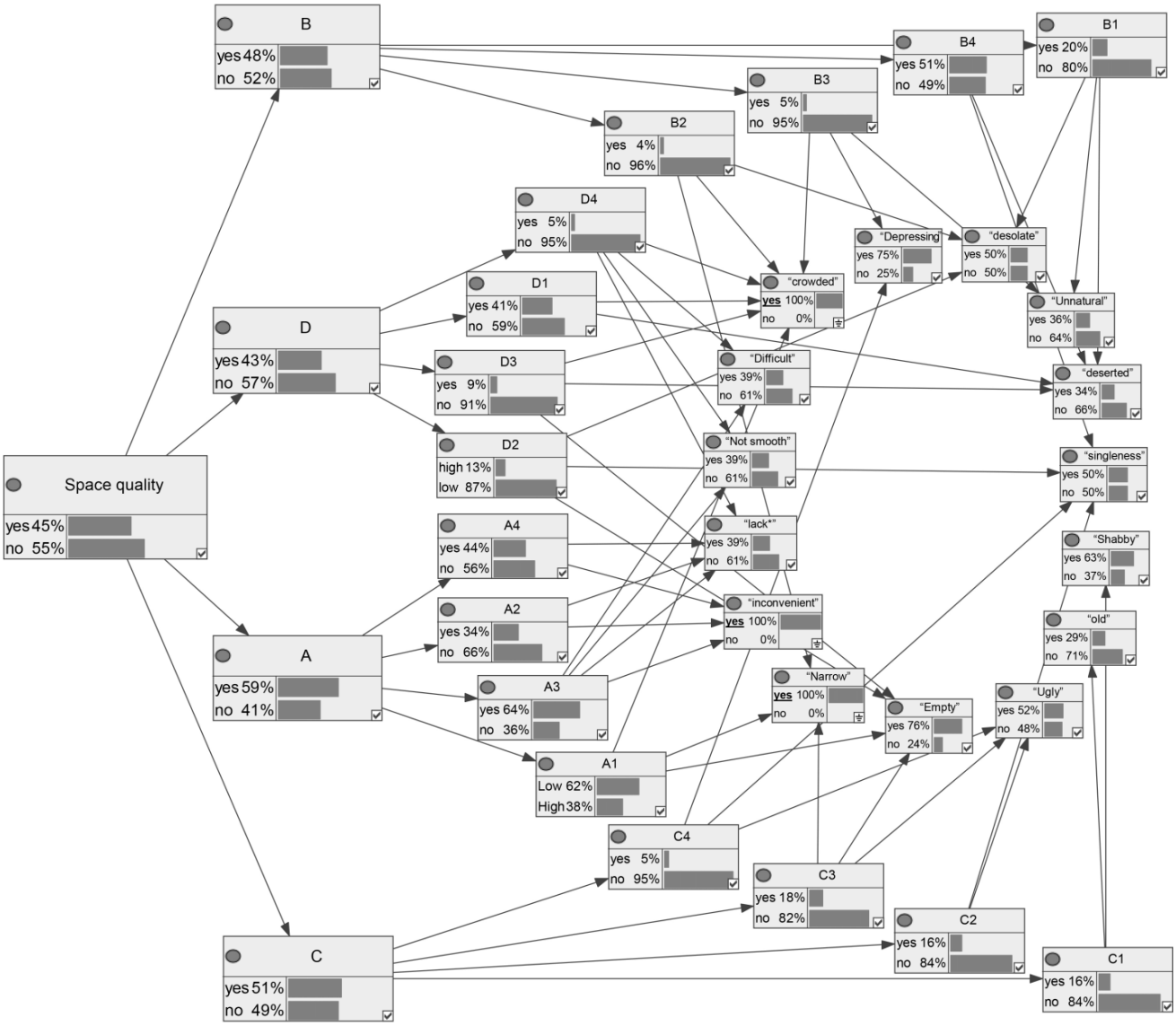

Figure 4. Applying the spatial evaluation model for historic districts in Houzaimen Street.

According to Figure 4, by bringing "Crowded", "Inconvenient", and "Narrow" into the model and setting the probability as "Yes", a diagnostic result can be obtained for Houzaimen Street. The most severe problems are revealed to be about infrastructure, including the low proportion of public space, low road accessibility, and the lack of functional services and recreational facilities. According to the diagnostic analysis, it is indicated that Houzaimen Street's accessibility and insufficient public space have the most severe impact on the public, ranking as high as 64% and 62%, respectively, which suggests that road transportation and public space do not support the public's daily use. Given the tourism functions of Houzaimen Street, the infrastructure must be complete. Functional service facilities can improve the experience of tourists, and recreational facilities can improve the interest and richness of the scenic spot, which can be optimized by taking measures such as building additional public service facilities and expanding the visitors' sitting area and the public activity platform. In addition to infrastructure aspects, the issues of low spatial openness and low floor area ratio have also received greater public attention, indicating

cramped street space and the low utilization of buildings, thus leading to negative public comments. This calls for a renewal that focuses on the psychological feeling that space and streets bring to people, utilizes unused building space, and re-assigns functions and utilizes them through a systematic planning approach.

5. Renewal Strategy

Participatory renewal is an urban development strategy aiming to improve the urban environment and quality of life. Houzaimen Street, as an essential part of Jinan's old city center, has a crucial impact on Jinan's urban image and public quality of life. Therefore, the following section will focus on spatial issues, select specific spaces as the primary target of participatory renewal, and propose a targeted transformation strategy.

5.1. Strategies for Public Space

The most significant problems in the Houzaimen Street diagnostic analysis are insufficient roadway accessibility and the under-representation of public space found within the neighborhood streets. The reason for this is the over-representation of residential functions and the chronic encroachment of residents on the corners and streets of the neighborhood. This leads to inadequate public space and reduced travel efficiency. Public nodes often meet multiple essential public service functions. However, there are too few functional nodes, resulting in a portion of public activity being functional failure and the inhibition of commercial vitality. We recommend to coordinate the abandoned and unused public spaces scattered in Houzaimen Street and to utilize the consolidated vacant spaces for public resource allocation. Moreover, building public rest areas and improving transportation facilities, will make Houzaimen Street attractive to the public, allowing them to gather spontaneously and interact with each other, realizing a diversified combination of public spaces and stimulating the vitality of public spaces in Houzaimen Street.

5.2. Strategies for Service Facilities

Houzaimen Street needs more functional services and recreational facilities. This problem can be addressed by redesigning, repairing, and upgrading facilities. In terms of functional facilities, we recommend an increase in fitness and exercise facilities. Specific measures include installing shade or sun-shading facilities at activity venues, installing barrier-free facilities and rest platforms in buildings, and improving the functionality of public service facilities. Additional recreational facilities, such as book corners and recreational areas, can be installed at the setbacks of buildings and corners of streets and alleys. To appease to the diversity and complexity of the public, some small entertainment stores can be installed to enhance their public and compound functions. This will improve the convenience and comfort of Houzaimen Street and enhance the service quality and use value of its service facilities.

5.3. Strategies for Traditional Features

The public is more concerned about the spatial comfort of the area, so participatory renewal should focus on improving the quality of the built environment. This includes the visual enhancement of the buildings, the improvement of the openness of the view, and so on. An abandoned building on Houzaimen Street was selected to be used for the traditional architectural interface design. The dilapidated area was utilized for the visual landscape transformation. In practice, the design solution preserves the weathering traces of the building's original walls. It redesigns both its original gallery space and the space for the specific functional needs arising from people's daily lives. The line of sight, the street, and the landscape are linked together to form a picturesque landscape scroll full of poetic Jinan historical streets (as shown in Figure 5).

Figure 5. Before and after façade renovation.

6. Conclusions

Historic districts are an essential foundation for enhancing the vitality of a city and perpetuating its cultural heritage. The renewal of historic districts is closely related to the life of the public. A deep-level participatory renewal is needed to realize successful decision making in the renewal of historic districts. This paper analyzes the existing participatory renewal system with semantic transformation as the research object and spatial quality improvement as the core. Based on BN technology, it establishes a spatial evaluation model for historical neighborhoods and, at the same time, focuses on the conversion system between natural semantics and design semantics. The method aims to quickly and efficiently realize the positioning of urban spatial problems and provide an auxiliary tool for the participatory renewal of historic districts. Taking Houzaimen Street as a practical case, the method analyzes the fundamental factors affecting public use. It proposes a spatial renovation strategy for historic districts based on the perspective of public use. An open and efficient platform for public participation is created, providing ideas for the participatory renewal of historic districts.

There are some limitations to the application of the method. Public attention is focused on spatial form and perception, with insufficient consideration given to comments on site performance. Therefore, the methodology must be combined with macro and traditional planning tools. In addition, the public has an insufficient understanding of the cyclical nature of planning and insufficient awareness of the time and economic elements of the planning practice. Therefore, the blueprint vision made based on the BN still needs the involvement of planners to clarify the implementation path. Moreover, this method is limited by different language habits, and it is easy to make errors when using it across regions, so it depends heavily on the richness of the corpus. In future research, this method can be combined with VR technology to enrich the public's participation channels through online experiences and optimize strategies in real time. In decision making, this method can be integrated with various decision-making models, such as the LUCRS Model, to determine land use performance. This provides a more comprehensive basis for decision making.

Author Contributions: Conceptualization, J.Z.; methodology, C.L.; formal analysis, J.Z.; writing—original draft, Y.Y.; writing—review and editing, C.L., Y.X. and J.Z.; funding acquisition, Y.X. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study due to the use of anonymous surveys and the absence of sensitive information or personal identifiers.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to confidentiality agreements with participants/subjects.

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

References

1. Foroughi, M.; de Andrade, B.; Roders, A.P.; Wang, T. Public participation and consensus-building in urban planning from the lens of heritage planning: A systematic literature review. *Cities* **2023**, *135*, 104235. [CrossRef]
2. Xie, H.; He, Y.; Wu, X.; Lu, Y. Interplay between auditory and visual environments in historic districts: A big data approach based on social media. *Environ. Plan. B Urban Anal. City Sci.* **2022**, *49*, 1245–1265. [CrossRef]
3. Jokar, S.; Shojaei, P.; Askarifar, K.; Haqbin, A. Investigating social risks of construction projects in historic tourism sites in urban districts of developing countries: Social network analysis approach. *Int. J. Contemp. Hosp. Manag.* **2024**, *36*, 358–378. [CrossRef]
4. Zeayter, H.; Mansour, A.M.H. Heritage conservation ideologies analysis—Historic urban Landscape approach for a Mediterranean historic city case study. *HBRC J.* **2018**, *14*, 345–356. [CrossRef]
5. Ghadiri, M.; Sarrafi, M. Integrating support groups, an effective approach to regenerate historic neighborhoods of Iran Case study: Oudlajan Neighborhood, Tehran. *Land Use Policy* **2021**, *112*, 105820. [CrossRef]
6. Tarakci, S.; Turk, S.S. Public value capturing in urban renewal: The fikirtepe case (Istanbul, Turkey). *J. Hous. Built Environ.* **2022**, *37*, 125–155. [CrossRef]
7. Zhu, R.; Hu, X.; Liu, C. Structural analysis of inter-industrial linkages: An application to the Australian construction industry. *Constr. Manag. Econ.* **2020**, *38*, 934–946. [CrossRef]
8. Zhang, X.; Pan, D.; Wong, K.; Zhang, Y. A New Top-Down Governance Approach to Community Gardens: A Case Study of the 'We Garden' Community Experiment in Shenzhen, China. *Urban Sci.* **2022**, *6*, 41. [CrossRef]
9. Ren, X.; Ren, H.; Hao, W.; Zhao, Y. Comparative Study on the Vitality of Typical Historical Districts in Beijing from the Perspective of Scene Theory. *Acad. J. Archit. Geotech. Eng.* **2024**, *6*, 1–7.
10. Ginzarly, M.; Roders, A.P.; Teller, J. Mapping historic urban landscape values through social media. *J. Cult. Herit.* **2018**, *36*, 1–11. [CrossRef]
11. Kovacs, J.F.; Galvin, K.J.; Shipley, R. Assessing the success of Heritage Conservation Districts: Insights from Ontario, Canada. *Cities* **2015**, *45*, 123–132. [CrossRef]
12. Li, J.; Wang, Y.; Liu, C. Spatial effect of market sentiment on housing price: Evidence from social media data in china. *Int. J. Strat. Prop. Manag.* **2022**, *26*, 72–85. [CrossRef]
13. Chan, K.S.; Siu, Y.F.P. Urban governance and social sustainability. *Asian Educ. Dev. Stud.* **2015**, *4*, 330–342. [CrossRef]
14. Li, X.; Li, B.; Jiang, W. State-led versus market-led: How institutional arrangements impact collaborative governance in participatory urban regeneration in China. *Habitat Int.* **2024**, *150*, 103134. [CrossRef]
15. Zhang, X.; Xu, J.; Ju, Y. Public participation in NIMBY risk mitigation: A discourse zoning approach in the Chinese context. *Land Use Policy* **2018**, *77*, 559–575. [CrossRef]
16. Wang, Q.; Zhang, H.; Wu, X. Research on Landscape Renewal of Historic District Based on VEP Method—Taking Jinjiang Wudian City Block as an Example. *Sichuan Archit.* **2021**, *41*, 27–30.
17. Lv, Z.; Zhou, Y.; Shi, J. Research On the Performance EvaIuation of the Protection And RenewaI of Shantang Historic District Based on BSC. *Mod. Urban Res.* **2022**, *6*, 61–66.
18. Chebil, W.; Wedyan, M.; Alazab, M.; Alturki, R.; Elshaweesh, O. Improving semantic information retrieval using multinomial naive Bayes classifier and Bayesian networks. *Information* **2023**, *14*, 272. [CrossRef]
19. Yang, Y.; Zhou, Z.; Wang, X. A Preliminary Study on the Construction Method of Small town Planning Analysis. *J. Hum. Settl. West China* **2022**, *37*, 94–101.
20. Pavlova, M.B.; Mikhaylova, V.V. Influence of the Industry on Traditional Economy: In the Context of Social and Economic Development of Rural Territories (on the Example of the Village of Iyengra of Neryungrinsky District of the Republic of Sakha (Yakutia)). In *IOP Conference Series: Earth and Environmental Science*; IOP Publishing: Bristol, UK, 2020; Volume 459.
21. Moradi, R.; Cofre-Martel, S.; Droguett, E.L.; Modarres, M.; Groth, K.M. Integration of deep learning and Bayesian networks for condition and operation risk monitoring of complex engineering systems. *Reliab. Eng. Syst. Saf.* **2022**, *222*, 108433. [CrossRef]
22. Zhao, J.; Hao, X.; Yang, Y. Research on Urban Sustainability Indicators Based on Urban Grain: A Case Study in Jinan, China. *Sustainability* **2023**, *15*, 13320. [CrossRef]
23. Sharaf, F.M.; Çinar, H.S.; Irmeili, G.A. Quality Evaluation of Public Pedestrian Spaces: The Case of Abdali Development in Amman City, Jordan. *Civ. Eng. Arch.* **2023**, *11*, 2321–2335. [CrossRef]
24. Tajaddini, S.; Mahmoudabadi, A.; Khalilzadeh, M.; Čerba, O.; Martolos, J. Pedestrianization in historic districts in terms of traffic, urban development, and economic perspective of sustainable city. *Trans. Transp. Sci.* **2023**, *14*, 43–53. [CrossRef]
25. Qi, Y.; Chodron Drolma, S.; Zhang, X.; Liang, J.; Jiang, H.; Xu, J.; Ni, T. An investigation of the visual features of urban street vitality using a convolutional neural network. *Geo-Spat. Inf. Sci.* **2020**, *23*, 341–351. [CrossRef]
26. Yue, W.; Chen, Y.; Zhang, Q.; Liu, Y. Spatial Explicit Assessment of Urban Vitality Using Multi-Source Data: A Case of Shanghai, China. *Sustainability* **2019**, *11*, 638. [CrossRef]
27. Liu, C.; Li, Y. GIS-based dynamic modelling and analysis of flash floods considering land-use planning. *Int. J. Geogr. Inf. Sci.* **2017**, *31*, 481–498. [CrossRef]
28. Zarghamfard, M.; Bahadori, B.; Hoseinzadeh, R.; Safaralizadeh, E. Analysis of the spatial inequality in residential quality indicators: The 22 urban regions of Tehran Metropolis. *Bull. Geogr. Socio-Econ. Ser.* **2023**, *59*, 7–23. [CrossRef]

29. Yang, Y.; Liu, C.; Li, B.; Zhao, J. Modelling and forecast of future growth for Shandong's small industrial towns: A scenario-based interactive approach. *Sustainability* **2022**, *14*, 16823. [CrossRef]
30. Peren, S.; Gökce, D. Conservation-led urban spatial quality assessment in historical commercial streets: The case of 'sakarya uzun çarşi'. In *Change-Transformation And Critique of Urban Spaces Urban Spaces: Policies and Identity*; Livre de Lyon: Lyon, France, 2023; p. 97.
31. Mela, A.; Tousi, E.; Melas, E.; Varelidis, G. Spatial Distribution and Quality of Urban Public Spaces in the Attica Region (Greece) during the COVID-19 Pandemic: A Survey-Based Analysis. *Urban Sci.* **2023**, *8*, 2. [CrossRef]
32. Riazi, H.; Haghighatnaeini, G.; Dadashpour, H. Spatial-Functional Structure in Connection with the Quality of Sustainable Urban Accessibility (Case Study: Enghelab Islami Square Area in The Tehran Metropolitan). *Geogr. Res.* **2023**, *38*, 191–201.