Exploration of a Digital Platform for Public Participation in Urban Design for Urban Renewal: A Case Study of the Yuejiang Tower Area in Nanjing

Yang Junyan, Zhang Zhonghu, Shi Yi

Abstract: Guided by human-centric values, public participation has become increasingly significant in urban renewal design. However, challenges remain in understanding the interactions between diverse stakeholders and urban spaces, accurately diagnosing existing issues and diverse demands, and deepening public involvement. The development of digital technology offers new formats and approaches for public participation in urban design. This paper identifies the bottlenecks in public participation during the stages of investigation, analysis, design, and outcome perception. It explores the construction of a digital platform for public participation in urban design tailored to urban renewal. Leveraging digital technologies, the platform facilitates real-time public data collection, integrated analysis, and simulation-based visualization, thereby enhancing the collection, transmission, translation, and perception of public opinions. Using the Yuejiang Tower project in Nanjing as a case study, this paper outlines the architecture, functionality, and practical feedback of the public participation digital platform.

Keywords: Public Participation; Digital Platform; Urban Renewal; Urban Design

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Urban renewal is one of the key tasks as China transitions into a quality-focused urbanization phase. From the perspective of urban development strategies under the "new normal," pursuing sustainable urban renewal is both necessary and significant [1]. As the primary users of urban spaces, the level and depth of public participation in the urban renewal process play a critical role in addressing the social conflicts accumulated from a long-standing emphasis on economic development and efficiency-first policies, as well as in enhancing the quality of urban spaces [2]. Urban renewal aims to serve the public's aspiration for a better life. In recent years, practices such as workshops, community gardens, and resident-led renovation committees have enriched the forms of public participation [3-7], providing multiple pathways for urban renewal. However,

in the context of urban design, which is a critical component of urban renewal, public participation typically occurs during pre-design surveys and interviews or post-design feedback collection. This "two-stage participation" process neglects public involvement during the design phase itself. As demands for deeper and more meaningful public engagement continue to grow, the existing design processes in urban renewal remain predominantly expert-led, lacking more effective forms of public participation. Consequently, how to establish a new approach for full-process public engagement in urban design for urban renewal has become a key issue [8].

Compared to existing design processes, urban design for urban renewal should pay more attention to public needs and intentions, focusing on a shift toward bottom-up, populist urban design approaches.This transformation requires overcoming four major pain points in full-process public participation.First, there is the challenge of identifying real public needs and spatial issues. Traditional research methods, such as field visits and workshops, involve lengthy processes where many issues must be addressed on a case-by-case basis [9-10]. These methods are hindered by high costs of public participation, small sample sizes, and insufficient engagement depth.Second, there is the issue of accurately diagnosing spatial problems, such as identifying spatial issues in the complex built urban environment.Additionally, urban design for renewal often focuses on specific public spaces. Traditional research methods struggle to map public feedback to fine-grained spatial details, limiting their ability to support the design process effectively.Third, there is the challenge of accurately transmitting and translating design intentions throughout the urban renewal process. This includes structuring and translating the diverse and complex opinions of multiple public stakeholders regarding the current urban context, as well as clearly presenting and conveying public demands and design intentions.Finally, there is the issue of interactive public presentation in the context of information technology development. Traditional design processes rely on professionals to create regulatory drawings to express design intentions, making it difficult for the public to participate. Moreover, public perception of design outcomes is often limited to "god's-eye" views, such as renderings or master plans, which lack realistic, human-centered experiences.These challenges in public participation lead to low public satisfaction, ineffective presentation of outcomes, and difficulty in gaining residents' approval for implementation [9, 11].

In 2023, the Central Committee of the Communist Party of China and the State Council released the Overall Layout Plan for the Construction of Digital China, aiming to leverage the innovative and leading role of new-generation digital technologies. The development of digital technologies has had a transformative impact on the identification and evaluation [12], as well as the analysis [13], of urban issues. Technologies such as Virtual Reality (VR) and AI offer new possibilities for human-centered perception of urban design outcomes [14]. Relevant technologies and methods have achieved some results in planning practices [15], but existing studies primarily focus on localized approaches [16] and lack exploration of specific technical methods and pathways for full-process public participation.In response, this paper seeks to construct a digital platform for public participation in urban design tailored to urban renewal. The platform aims to achieve precise perception of existing issues and public needs during the research phase, enable more accurate evaluation during the design analysis phase, and enhance the depth of public participation and the realism of outcome perception during the design phase.

1 Public Participation Workflow and Digital Platform for Urban Design in Urban Renewal

1.1 Urban Design and Public Participation in the Urban Renewal Process

Urban renewal emphasizes the alignment of various stakeholders' demands and the coordination of diverse interests [17], as well as the institutionalization and legalization of public participation [18].In specific practices, researchers such as Zhou Jian et al. [19], Zhao Guanning et al. [20], Han Yanan et al. [21], and Tan Xiaohong et al. [22] have summarized and studied urban renewal systems and processes in regions and countries like Shanghai, Shenzhen, Beijing, and Germany. Wu Zhiqiang et al. [23] and Mei Yaolin et al. [24] proposed that urban renewal processes for old residential communities include preliminary organization, project generation, urban renewal design, implementation, and long-term safeguards.Urban design not only enhances the quality of urban spaces through morphological controls such as architectural forms and skylines but also serves as a tool to address human needs and public interests. It effectively bridges the gap between urban renewal and project implementation [25].

In urban design for urban renewal, public participation primarily involves three stages: preliminary research, current situation analysis, and design (Figure 1).During the preliminary research stage, public opinions on existing issues are collected through methods such as surveys, field visits, and online consultations to gather input from various stakeholders.In the current situation analysis stage, integrated opinions are evaluated to ensure the locality and relevance of the proposed solutions [26].In the design stage, the focus is on demand-oriented public co-creation. The urban renewal plan is established based on the integration of diverse stakeholder opinions, assisting public participation in decision-making. Some studies suggest that methods such as public hearings with resident representatives and public disclosure of renewal plans can improve the level of public engagement [27].Overall, existing forms of public participation are primarily active and result-oriented, requiring the public to actively engage throughout the process and provide feedback on outcomes. This approach establishes mechanisms for citizen rights expression, adoption, and feedback. However, it also has limitations, such as low feasibility and lengthy implementation processes [28].By integrating relevant methods and technologies, digital tools can be introduced into the research, analysis, and design processes, enabling more passive participation forms. This includes collecting and analyzing data such as location information and usage preferences, thereby enhancing the depth of public participation.

1.2 Framework for Public Participation in Urban Design Enabled by Digital Platforms

In urban development, the involvement and support of digital platforms have already played significant roles in fields such as territorial spatial planning, social governance, intelligent transportation, housing construction, environmental monitoring, and emergency management. These platforms facilitate multi-departmental coordinated control and process-oriented multi-stakeholder participation [29], positively impacting public participation.The essence of a digital platform for public participation in urban design for urban renewal lies in enhancing the level and depth of public involvement throughout the entire process with the support of digital technology. Its core objective is to leverage digital technology to better understand the interaction between the public and urban spaces, diagnose existing issues, assist the public in directly participating in the design process, and enhance their ability to perceive design outcomes. See Figure 2.

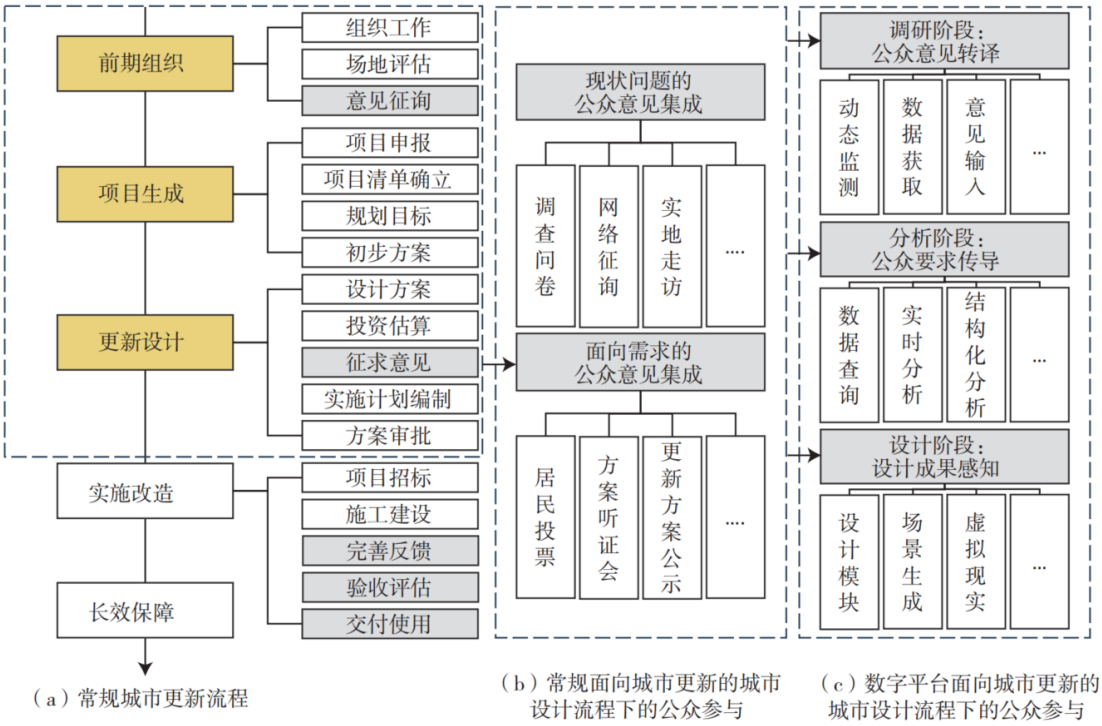

Fig.1 Comparison of public engagement between the conventional approach and the digital platform approach in urban design processes

During the preliminary research stage, the focus should be on public usage perspectives, addressing two main aspects of public participation:Public behavior and activities in urban spaces, such as space and facility usage, duration of stays, and movement trajectories.Public demands for space renewal, including landscape optimization and facility improvements.Digital technology enables the perception of these aspects from multiple dimensions through multi-source data collection. By combining active and passive public research methods, the current state can be effectively assessed.

During the multi-source data analysis stage, emphasis should be placed on the integration and analysis of multi-source data derived from public participation. This involves two key aspects:Integrating and spatially mapping different types of data, such as activity data and demand text data.Structuring and analyzing complex data, such as textual information.

During the public participation design and perception stage, efforts should focus on enhancing public decision-making and perception of outcomes, encompassing three key aspects:Simple facility layout and landscape configuration systems: The development of virtual games offers new approaches to design, such as sandbox placement games for real-world spaces, allowing users to complete facility layout and landscape configurations through simple placement operations.Immediate and direct perception of design outcomes: Digital technologies like Augmented Reality (AR) and Mixed Reality (MR) enable immersive perception of design results through simulation, calculation, and visual presentation, allowing the public to experience the outcomes firsthand.Multi-scheme decision support methods: Rational calculations of post-renewal outcomes, such as facility accessibility and environmental quality, can be provided to support comparison and evaluation of multiple design options.

By integrating the above functions into a digital platform, it provides an integrated system for

multi-channel data collection, low-threshold design, direct perception, and multi-scheme decision support, thereby enhancing public participation across all stages of urban renewal. After the design phase, the platform can also assist in urban operations and management through real-time monitoring capabilities.

2 Constructing a Digital Platform for Public Participation

2.1 Data and Architecture of the Digital Platform

The architecture of the digital platform needs to consider the practicality of project implementation. Therefore, a remote workstation architecture is adopted, with local connections and internet access facilitated through HTML interfaces. This approach offers advantages such as low cost, multi-interface integration, and cross-platform compatibility. Low costs enable rapid and efficient platform development, while multi-interface integration supports the collection of multi-source data and connections with various devices. Cross-platform functionality allows access via mobile or web, improving the convenience of public participation.The digital platform incorporates multiple functional modules, including spatial data, algorithmic analysis, human-computer interaction, and outcome presentation. These modules provide a range of tools for urban design processes, such as spatial foundations, analysis capabilities, interactive design, and more, to support research, analysis, and design phases. See Figure 3.

The spatial data module includes foundational spatial data and real-time collected data.Foundational spatial data refers to immutable base data such as public spaces, roads, buildings, mountains, and waterways obtained through oblique photography, as well as relatively stable data over a certain period, such as POI (Points of Interest) and street views. This data provides a foundational spatial base for integrating and expressing diverse opinions before the design phase and supports subsequent spatial base analysis.On top of this spatial foundation, fixed equipment access ports are installed by relevant departments to collect data such as public opinions and activity levels.By combining foundational and real-time data, the spatial data layer leverages the digital platform to achieve higher granularity in data integration, enhancing the precision and coverage of spatial data. This facilitates the optimized management and utilization of vast amounts of data.

The algorithm analysis module includes subsystems such as text clustering analysis based on public opinions, modular placement data analysis, and accessibility analysis.Compared to traditional data analysis in the early stages of urban design, the data analysis layer utilizes the digital platform's powerful multi-source data integration and cross-analysis capabilities to achieve integrated computation of analytical data.Given the complexity of diverse public stakeholders in urban renewal, the data analysis module incorporates semantic analysis for text-based integrated analysis. This allows for the structured translation of unstructured public opinions, assisting designers in understanding the current situation.

The human-computer interaction module includes three-dimensional presentation of the design and human-computer interaction. It utilizes an intelligent sandbox and virtual reality (VR) interactive platform, where data input systems and program designs establish a solution sandbox and modular scene elements within the update unit. Interaction devices, 3D holographic projections, and VR headsets are used for data output and virtual reality interaction, facilitating public participation in modular placement adjustments.Through rich display and interaction

methods, the human-computer interaction layer optimizes traditional design presentation methods, such as regulatory drawings. This enhances the public’s perception, interaction, and involvement in the design results.

The outcome presentation module includes multi-scheme comparison, model selection, and further interactive iteration processes. Experts and the public can compare and select from multiple schemes on the digital platform. The final comparison and selection results are exported as regulatory drawings, and key implementation projects are output as implementation drawings. The outcome presentation module facilitates the display of urban design outcomes for urban renewal and extends them to implementation, transitioning planning and management toward a three-dimensional model.

2.2 Public Participation Digital Platform Process and Functions

In the urban design process for urban renewal, the digital platform's involvement in the public participation process includes the following application pathways:Preliminary Survey Stage: The digital platform features dynamic monitoring and real-time data acquisition functions, helping to collect and integrate opinions from various public stakeholders.Current Situation Analysis Stage: The digital platform offers intelligent real-time analysis and structuring functions, assisting planners and the public in understanding planning information. It simplifies the data analysis process, provides in-depth analysis of survey results and public opinions, and transmits these insights into the design process. The advantages of the analysis function lie in optimizing data collection and integration methods, enabling high-precision, high-granularity data analysis, and multi-source data integration. It also links public perception to specific spaces, aiding in the collection of public opinions.Design Stage: The digital platform has modular and self-adaptive scene generation capabilities, as well as virtual reality functions. Through the construction of spatial sandboxes and design outcome displays, the platform enriches the presentation of design results, providing a three-dimensional interactive platform that enhances the public's deep perception of the design outcomes and facilitates efficient feedback from residents. See Table 1.

3. Public Data Real-Time Survey Collection and Dynamic Display on the Digital Platform

3.1 Public Demand Data and Digital Platform Spatial Association Technology

Public demand data refers to the textual data collected on the public's awareness of current issues and renovation needs within a given space. These data are typically gathered through surveys, interviews, and other methods, and can also be collected through cooperation with local neighborhood committees, property management, and community service stations, as well as through platforms like WeChat groups and official accounts.As the scale requirements for urban renewal become more refined, public demands need to be more precisely located. Using digital platform spatial association technology, specific spaces are selected, and demand feedback is inputted, completing the collection of public demand data.

The Nanjing Yejing Tower project focuses on the utilization of public spaces in old residential areas. First, the Yejing Tower district is divided into 151 courtyard spaces, public spaces, street and alley spaces, and travel spaces (Figure 4), allowing residents to voice their demands for specific courtyard areas.Public demand data is collected through three methods: community resident activities, field research interviews, and online questionnaire surveys via mini-programs.

The collected data covers multiple aspects, including transportation facilities, public service facilities, community environment, and community services, with over 3,500 pieces of feedback gathered. For example, by organizing 23 specific pieces of feedback from Courtyard No. 2, it was found that this space has issues such as disorganized parking of motor and non-motor vehicles, and a lack of greenery and resting areas, which could be targeted for updates in the future.The collected data is numbered and integrated into the digital platform, forming a public demand dataset.

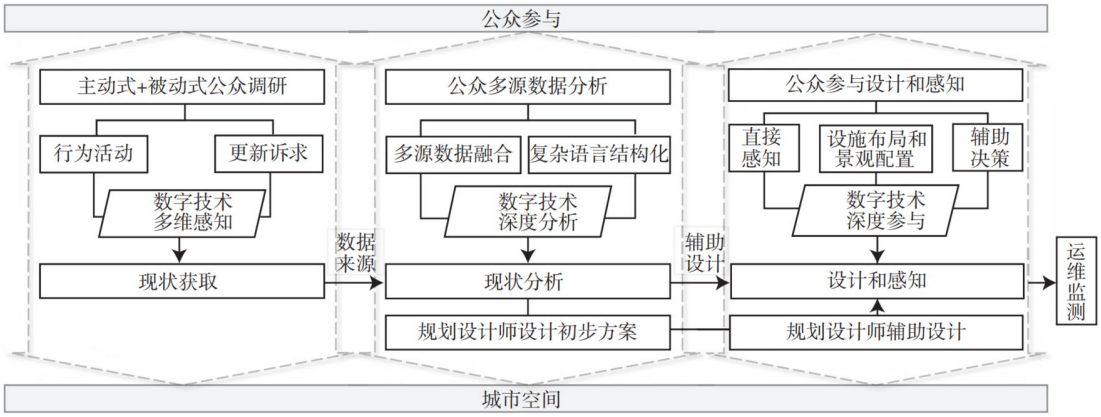

Figure 2 Framework for Public Participation in Urban Design Enabled by Digital Platforms

Figure 3 Digital Platform Foundation for Public Participation

Table 1 Process and Functions of the Public Participation Digital Platform

流程	功能	工具
调研阶段	动态监测和实时数据获取	动态监测居民活力数据；居民输入优化意见，实现居民意见偏好 分析
分析阶段	智慧化实时分析和结构化	建筑物、道路、地形等相关数据查询，建成环境分析、功能业态分析、人群动态分析、街道品质与可达性分析、地形分析、

		空间视域分析、建筑物日照分析等
设计阶段	模块化和自适应生成场景、 虚拟现实功能	三维城市模型建立，方案建成效果对比；电子地图空间定位，空间沙盘与虚拟现实设备规划空间体验，游览方式与场景修改， 反馈意见记录；结合建模实时修改的方案设计构思

Figure 4 Spatial Division and Feedback Collection in the Yejing Tower District

3.2 Public Activity Data and Digital Platform Dynamic Monitoring Technology

Public activity data refers to information about the distribution of people across different times and spaces. In existing studies, public activity data serves various purposes, including measuring urban spatial vitality, analyzing spatiotemporal travel characteristics, and exploring the relationship between human activities and built environment elements. In urban renewal, this data can be used to evaluate the utilization of public spaces and is typically represented through anonymized, location-based services (LBS) data.

In the Nanjing Yejing Tower project, LBS data was imported into the algorithm analysis module. By analyzing user distributions during residential and work-specific time periods over multiple days, local resident data and tourist data were identified. Further analysis of the local resident data allowed for the creation of digital profiles, identifying and monitoring the spatiotemporal patterns of three types of activities: work, consumption, and recreation.The study found that 61% of the working population in the Nanjing Yejing Tower area are employed within a 2 km radius of their residence, indicating local employment and short commuting distances. See Figure 5.

4 Public Data Integration and Structured Processing on the Digital Platform

4.1 Spatial Diagnosis of Demand Conflicts Based on Public Demand Data

Public demand data exhibits characteristics of textual complexity and unstructured formats. Although spatial association technology links these demands to specific spaces, further structured processing is necessary. By integrating and analyzing public demand data, the primary demands and conflicts within different spaces can be diagnosed.To achieve the structured translation of unstructured public opinions, the digital platform employs the following approach:

A text semantic library is constructed to classify and integrate the textual data.Semantic recognition and analysis technology is applied to extract and segment the collected data into multiple key phrases or sentences.Using a text similarity algorithm, the data is categorized into various demand types.By identifying the greatest commonalities among extensive public feedback, a spatial problem matrix is generated. This matrix diagnoses the core demands of residents and the conflicts present in the space, providing guidance for subsequent design processes.

For over 3,500 demand data points, the Nanjing Yejing Tower project analyzed feature word frequency and co-occurrence patterns to categorize residents' core demands, important demands, and general demands for different spaces, forming a spatial demand matrix. Field research was conducted to further validate the identified issues.For example, among 29 pieces of feedback regarding Courtyard No. 150, issues such as disorganized parking, mixed traffic of pedestrians and vehicles, and insufficient public fitness facilities were identified (Figure 6). By recognizing conflicting spaces, residents' core demands were reflected in multiple design schemes, achieving efficient collection, analysis, feedback, and implementation of resident opinions.

4.2 Diagnosis of Low-Activity Spaces Based on Public Activity Data

Public activity data, with its spatiotemporal characteristics, effectively describes the relationship between people and time-space. By collecting 24-hour public activity data and analyzing space usage, the digital platform can automatically calculate space utilization efficiency and intelligently diagnose low-activity spaces.First, public activity analysis is conducted using LBS data and activity chain recognition technology. Space usage analysis is then performed based on business data, street view data, and land use information. Finally, by integrating public activity data with space usage information, a public space utilization efficiency map is generated, allowing for the diagnosis of low-activity spaces.

The Nanjing Yejing Tower project conducted a grid-based analysis of public activity data, identifying key factors influencing population distribution, such as the distribution of public service facilities, green coverage rate, and open space area.By analyzing specific space usage and patterns of human activity, it was found that parks and scenic areas have high activity levels, while courtyard spaces within the community exhibit low activity levels. Additionally, weak connections between the community and parks, as well as a lack of commercial service facilities in the southeastern part of the community, were identified. These issues suggest opportunities to enhance the quality of courtyard spaces and improve park accessibility in future updates.Based on this coupled analysis, spatial problems were diagnosed (Figure 7), revealing potential spatial demands.

5 Public Participation in the Design Process and Scenario Simulation Perception

5.1 Public Participation in Sandbox Design and Digital Platform Module Setup

The public participation digital sandbox game is a human-computer interaction game based on the digital platform, where facility modules can be placed. Similar to early games like SimCity and Cities: Skylines, it combines entertainment with public operability. Supported by digital platform technology, the digital sandbox game offers a new approach to enhance the degree of public participation in the design process.During the design process, the digital sandbox game effectively lowers the design threshold, allowing the public to complete design proposals by placing modules. On the digital platform, the current site conditions are imported to create a digital sandbox base. A series of public facility modules are constructed, enabling users to zoom in and select specific spaces within the site and further place various modules, completing the spatial layout of public facilities.

step 1. 停留点识别	$C = \sum_1^n (E_1(v,d) \& E_2(t) \& M(p))$，其中，C为基于ST_DBSCAN算法得到的簇，$E_1$为相邻两点的空间邻域，v为两点之间的速度，d为两点距离，E_2为时间邻域，M为聚类点的最少点个数，基于速度（v）和时间（t）的约束条件识别出停留点
step 2. 公众活力计算	$S_i = \sum_0^{23} E_{it}/24$， $\sigma_i^2 = \sum_0^{23}(E_{it}-\bar{E})^2/24$， 其中，$S_i$为栅格i公众活力集聚程度，$E_{it}$为栅格i在t时段中出现的人口数量，$\sigma_i^2$为栅格i公众活力稳定程度，$\bar{E}$为0至23个时段中出现的平均人口数量，$t \in [0, 23]$
step 3. 公众活力地图	$A_i = a*S_i + b*\sigma_i^2$ 其中，A_i为栅格活力值，a和b为权重值

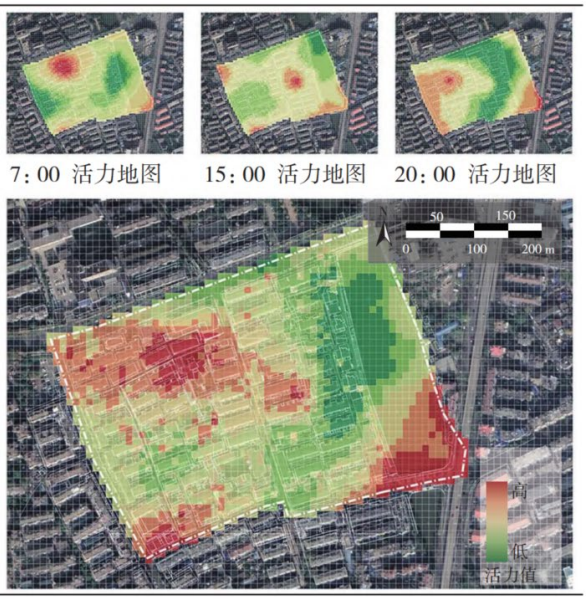

Fig.5 Calculation process and results of public vitality

step 1. 文本特征词分割	基于Jieba词库数据，增加阅江楼片区地名关键词，对诉求文本数据进行关键词切分
step 2. 特征词共现提取	$P_{ab} = \sum_{j=1} F_{aj} * F_{bj}$，其中，$P_{ab}$是基于全部诉求数据表示的特征词a与特征词b的基本连接关系量，F_{aj}为第j条诉求中特征词a频数，F_{bj}为第j条诉求中特征词b频数
step 3. 分类整理	通过人工进一步校核分类共现特征词，根据词频和共现关系整理城市空间诉求矩阵

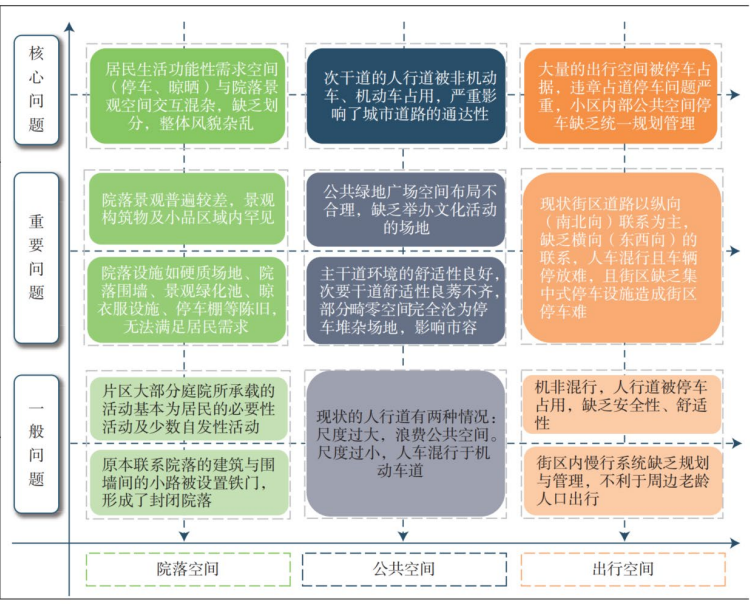

Fig.6 Structured analysis and results of public comments

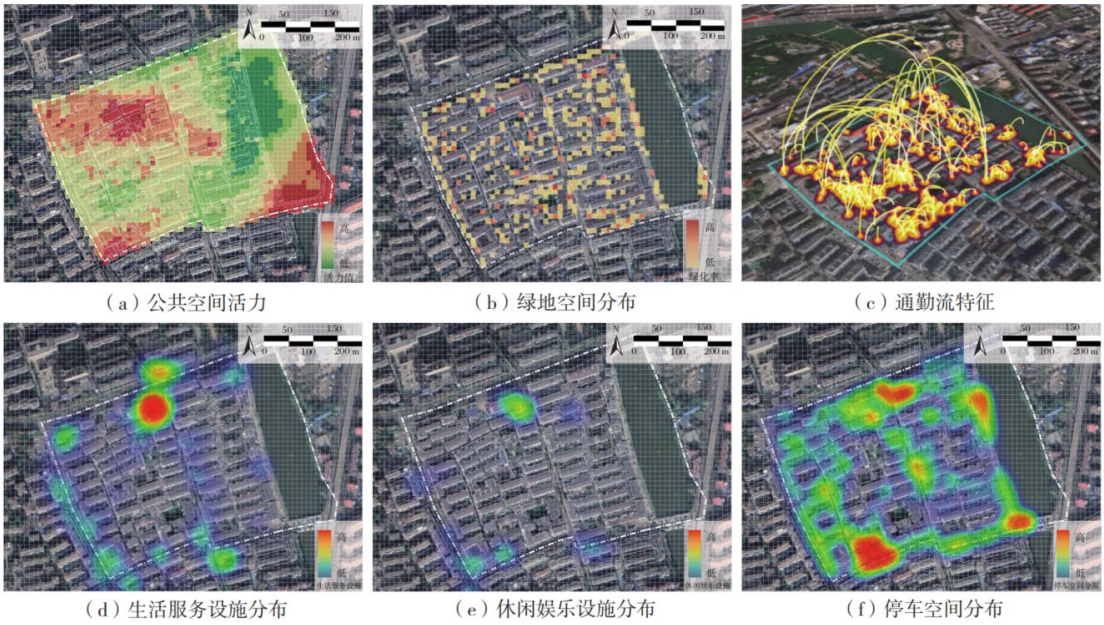

Fig.7 Related analysis of public vitality based on multi-source data

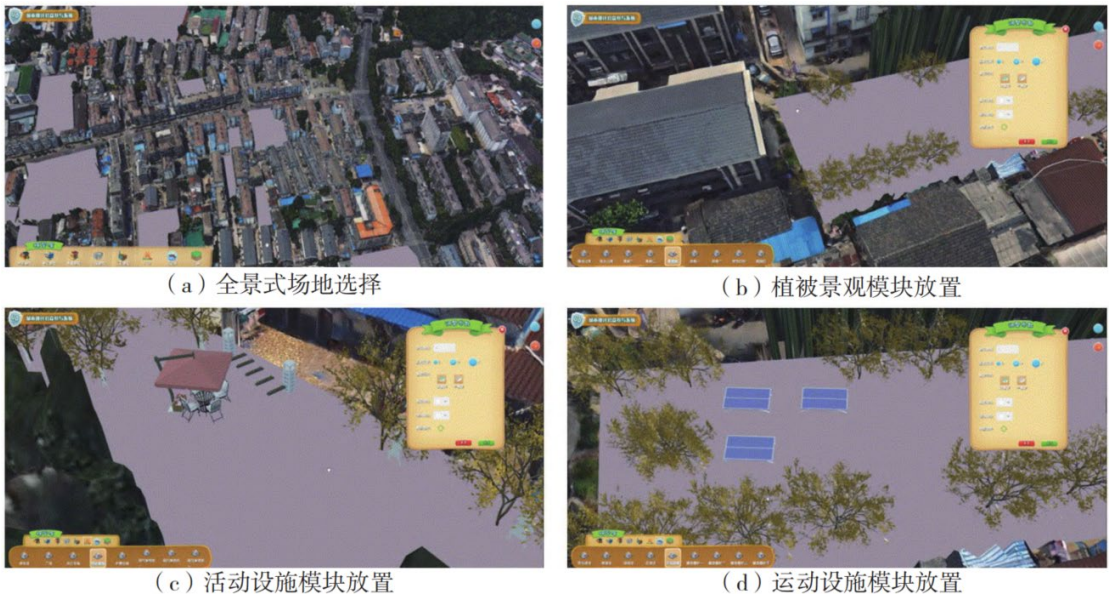

Fig.8 Sandbox game process

The Nanjing Yejing Tower project established a 3D urban model to create an interactive design panel where residents can engage in online sandbox design. Based on the priorities of urban renewal, the interactive panel includes a game process consisting of panoramic site selection, vegetation landscape module placement, activity facility module placement, and sports ground module placement, enabling residents to design autonomously (Figure 8).The project organized community activities to involve residents in the game, collecting over 70 localized design proposals. For instance, a resident, Mr. Li, suggested removing the garbage station on the north side of the riverside walkway and adding greenery along the river. By selecting specific vegetation

landscape modules in the sandbox game and placing them in the riverside space, the design could be completed directly.By merging and optimizing multiple proposals, these localized design ideas were incorporated into the overall design plan, resulting in several alternative solutions for different areas.

5.2 Public Perception in Virtual Reality and Digital Platform Scenario Simulation

In recent years, advancements in technology have rapidly driven virtual reality (VR) toward more compact and cost-effective implementations. The rapid development of VR and mixed reality (MR) technologies has significantly enhanced people's ability to perceive virtual scenes.Previous studies have employed virtual reality technology to enable public three-dimensional perception of bicycle-oriented street design proposals and collect feedback [30]. In urban renewal, virtual scenes of proposed updates can assist the public in experiencing spatial scales and qualities, providing immediate feedback on design shortcomings.

The Nanjing Yejing Tower project utilized a digital platform to simulate and generate three-dimensional design scenarios. Users could wear VR devices to engage in immersive, first-person perspective exploration, adjusting the placement of elements in the scene through selection and movement operations. This enabled them to perceive various outcomes of the design, such as facility accessibility and landscape aesthetics.During multiple design proposal exhibitions, virtual reality displays of the scenarios were presented. Residents on-site could explore the virtual scenes, experience them firsthand, and vote for their preferred designs. The implementation plan was finalized based on public feedback. See Figure 9.

5.3 Multi-Scheme Public Comparison and Digital Platform Decision Support

The spatial diagnostic results from the digital platform not only provide planners with a basis for urban design but also offer the public a quantified understanding of the current spatial conditions. For multi-scheme comparisons, the public often lacks sufficient understanding of traditional paper-based outcomes. Quantified results can help the public comprehend the proposals and further assist in decision-making.On the digital platform, a radar-based quantitative evaluation matrix is first constructed to evaluate indicators of public concern, such as transportation accessibility, facility richness, street safety, spatial attractiveness, green coverage ratio, and parking availability. These evaluations generate radar chart results. Subsequently, comparisons between the current state and proposed schemes, as well as comparisons among multiple schemes, are visualized using radar charts.

The Nanjing Yejing Tower project used the digital platform to generate multiple preliminary proposals. By analyzing and comparing these proposals with radar matrix evaluations of the site before and after updates, the platform supported the selection of a design scheme. Evaluations focused on aspects such as transportation accessibility, facility richness, and spatial attractiveness (Figure 10).The digital platform facilitated public decision-making through quantitative methods. The final design scheme for the Yejing Tower community renewal was determined, incorporating multiple rounds of public input. The update focuses on courtyard spaces and key entrances, with renovations planned based on public feedback.

6 Conclusion and Outlook

6.1 The Role of Digital Technology in Enhancing Public Participation in Urban Design for Urban Renewal

In the context of the new era, the public's demand for a better life presents greater challenges for urban space renewal. Addressing the complex human-space relationship requires deeper analysis of the current situation and broader participation in the design process from multiple stakeholder perspectives.The development of digital technology offers new possibilities for advancing public participation in urban design. Its core aim is to utilize multi-source big data to understand the interaction and conflicts between the public and urban spaces from more multidimensional perspectives, while directly assisting the public in participating in the design process and perceiving design outcomes.

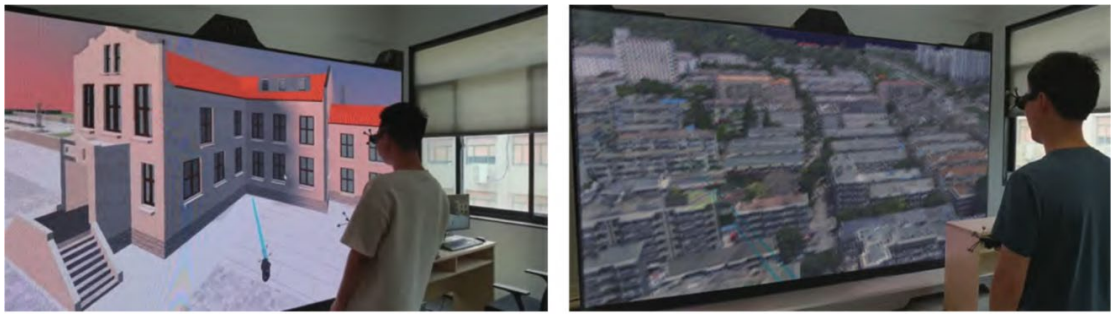

Fig.9 Scenario simulation and perception

Fig.10 Multi-scenario presentation and comparison

Based on this, this paper explores the construction of a digital platform for public participation in urban design tailored to urban renewal. It proposes a full-process public participation framework encompassing current situation data acquisition, analysis, design, and perception. Through real-time public data collection and dynamic display on the digital platform, public data

integration and structured processing, as well as sandbox design and scenario simulation on the platform, the framework enables comprehensive public participation across multiple stages of research, analysis, and design. The goal is to expand the types and channels of data collection, integrate multiple stakeholder demands, and achieve multi-source data integration, ultimately enhancing the level and depth of public participation throughout the entire urban design process.

6.2 Limitations of Digital Technology Application Research

Although public participation based on the digital platform was effective in the Yejing Tower project, its further application has encountered challenges such as willingness and residents' capabilities due to the lack of institutional arrangements. This study still has the following limitations.Firstly, the project itself requires substantial time and financial investment. The construction of the digital platform needs to integrate multi-source data and multiple interfaces, and involve multiple rounds of communication and collaboration with platform development companies. The smooth execution of the project must account for these costs.Secondly, it was observed during the project that active public participation is difficult. Multiple activities are required to collect sufficient data. Future update processes should further consider the possibility of passive public participation, while also addressing concerns about user privacy.Finally, citizens' awareness of participation is relatively low, and there are still certain barriers to using the digital platform. Residents may find it too difficult to learn how to use the platform or participate in the project, and may not perceive it as worth the effort. In the future, attention should be given to how to motivate residents to invest time and effort in the decision-making process.

6.3 Prospects for the Development of the Human-Community-City Symbiosis Paradigm Promoted by Data Technology

As digital technology's influence on urban planning and design continues to deepen, it is important to approach its role with caution and rationality, advocating for the correct value orientation. Digital technology has enhanced the ability to gain insights into the dynamics and real needs of the public, while also increasing the risks of personal privacy and security breaches. The future development of digital technology and human-centered values should not be seen as opposing forces. Therefore, during the use of data technology, it is crucial to first avoid these risks and guide the technology's role in promoting the development of the right values, while preventing the negative impacts of digital technology. Furthermore, as a technological tool, digital technology should not deviate from serving human-centered values, and should be guided by the core demands and interests of the public, addressing the complex needs of multiple stakeholders.

Digital technology is evolving at an unprecedented speed, enhancing the ability to perceive complex urban spaces and public groups. It enables high-precision insights across urban, community, and human-centered scales, improving people's perception of community and urban-scale spaces from a human-centered perspective. It serves as a crucial link in building the human-community-city symbiosis research paradigm.In the future of urban renewal, urban design should continuously strengthen the application of digital technologies, such as GPT, AI, AR, MR, and game engine developments. On one hand, these technologies can quickly structure and address the complex needs of multiple stakeholders through human-computer interaction. On

the other hand, by combining virtual and real environments, they can significantly enhance people's perception of future spaces from a human-centered scale.For public participation in urban design for urban renewal, the integration and application of various digital technologies will benefit sustainable urban development. Digital technology will become an increasingly important and indispensable part of the process.

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