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Evaluation of Public Perception of Commercial Pedestrian Streets Based on UGC Data: A Case Study of Chongqing, China

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Abstract

Against the backdrop of high-density Asian cities shifting from production- to consumption-oriented spaces, commercial pedestrian streets are key to urban public life and vitality. This study selects six major commercial pedestrian streets in Chongqing and employs natural language processing (NLP) and importance–performance analysis (IPA) methods to construct a four-dimensional evaluation framework (spatial, commercial, cultural, location/facility). It analyzes public perception and experience based on user-generated content (UGC). Findings show that: (1) Significant differences across dimensions form three development types: cultural identity, functional hub, and distinctive growth, reflecting structural bottlenecks in transitioning from single- to multi-functional spaces. (2) IPA identifies "business formats," "cultural activities," and "consumption experience" as priorities for improvement, while "commercial atmosphere" and "transportation conditions" are current strengths to maintain. (3) Sentiment analysis reveals that negative perceptions focus on basic functions and sense of place, whereas positive sentiments relate to cultural expression and spatial esthetics, highlighting the role of cultural soft power and visual design in street appeal. This study reveals public perception patterns via big data analysis, offering empirical support for the refined renewal, cultural preservation, and sustainable management of commercial pedestrian streets in high-density Asian cities.

Keywords: commercial pedestrian street; user generated content (UGC); natural language processing (NLP); importance–performance analysis (IPA); public perception

1. Introduction

In the context of the global shift of cities from production-oriented spaces to consumption-oriented spaces, the functional restructuring of consumption spaces has become an international issue [1,2]. The core trend is the evolution from single commercial carriers to composite urban nodes that integrate economic, cultural, and social functions [3–5]. This transformation is deeply aligned with the rise of the "experience economy" and the "people-oriented" urban renewal concept [6–8]. In China, policies have recently been implemented to respond to this global trend. These initiatives foster new consumption growth points and build international consumption center cities. They explicitly aim to create high-quality commercial pedestrian streets characterized by 'commercial prosperity, a strong cultural atmosphere, and distinctive features'." This implies that the planning and construction of these streets need to transcend the traditional shopping function paradigm and achieve a fundamental shift in their core value from having a "functional superposition" to being

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"perception-driven" through cultural implantation, format innovation, and the creation of social scenes [9,10].

Within the context of Asian cities, this transformation is particularly urgent and complex. High-density Asian cities commonly face challenges such as limited land resources, a high development intensity [11,12], and intense interweaving of historical contexts and modern commerce [13,14]. As vital stages for urban public life, the renewal of commercial pedestrian streets involves not only commercial vitality but also deeper issues such as cultural identity, social integration, and spatial justice [15–17]. However, the current renewal efforts in many Asian cities remain trapped within "form-priority" path dependency, which emphasizes the physical environment over experiential content and leads to problems such as street homogenization, superficial cultural representation, and the loss of a sense of place [13,15,18]. Therefore, understanding the public's multidimensional spatial perception of these streets and using that perception as the core basis for optimization is not only a specific requirement in the Chinese policy context but also a key pathway for enhancing the quality of urban public spaces and strengthening their place appeal in Asian cities.

At the international level, research on urban streets and public spaces has gradually moved beyond the assessment of physical form to emphasize multisensory experiences, social interaction, and users' subjective responses [4,19]. Recent studies have also begun to employ user-generated content (UGC), including social media texts and images, to capture these perceptions at a broader scale [20,21]. This shift provides an important basis for understanding commercial pedestrian streets as experiential public spaces rather than solely as commercial facilities.

However, traditional research methods, such as questionnaires and interviews, remain limited in their ability to comprehensively and dynamically capture the public's complex and evolving spatial demands and experiential feedback. Consequently, the utilization of big data resources, particularly unstructured UGC from social media and online review platforms, has become a methodological imperative for deeply understanding the public's authentic and spontaneous evaluation of urban spaces. This data-driven analysis paradigm transcends the instantaneity and scale limitations of traditional methods, providing key technical support for revealing implicit, large-scale public perception patterns.

This paradigm is a core link in the transition from "experience-driven" planning to the refined governance of "evidence-oriented" and "human-perception-oriented" approaches.

To date, however, few studies have operationalized this UGC-based paradigm to evaluate commercial pedestrian streets in high-density mountainous cities, where the three-dimensional topography and clustered spatial configuration may generate distinct perception patterns not found in flatland contexts. In particular, the simultaneous comparison of multiple streets with different functional orientations—ranging from historical landmarks to modern commercial hubs and emerging university-town nodes—remains underexplored. Chongqing was therefore selected as the case study because it combines mountainous topography with high-density urban development, resulting in a distinctive three-dimensional spatial structure, while its major commercial pedestrian streets vary in spatial hierarchy, functional orientation, and development stage. Such a comparative gap limits our understanding of whether perception issues are shared across streets or are unique to specific development types, a distinction critical for differentiated planning strategies.

To address this gap, this study formulates three research questions:

RQ1: What are the structural characteristics of public perception toward the six major commercial pedestrian streets in Chongqing across the four dimensions of environment, commerce, culture, and location/facilities?

RQ2: How do perception structures differ among pedestrian streets with varying functional orientations and development stages?

RQ3: Which perception dimensions constitute critical shortcomings requiring priority intervention, and which represent existing strengths to be maintained?

Correspondingly, the objectives of this study are threefold: (1) to quantify and map public perception across the four-dimensional framework using UGC data combined with NLP and IPA; (2) to diagnose the importance–performance gaps across perception dimensions and classify streets into development types based on their distinct perceptual structures; and (3) to propose both general and street-specific optimization strategies grounded in empirical evidence, providing actionable insights for the planning and management of commercial pedestrian streets in high-density urban contexts.

By answering these questions, this study contributes to the emerging body of data-driven urban perception research in three ways. First, it extends the application of UGC-based analysis from individual public spaces to a multi-street comparative framework. Second, it operationalizes the four-dimensional perception model in the specific context of commercial pedestrian streets in a high-density mountainous city. Third, it translates perceptual diagnosis into actionable planning strategies, bridging the gap between big-data analytics and practical urban planning and management.

2. Literature Review

The literature reviewed in this study was identified through searches of Web of Science, Scopus, and China National Knowledge Infrastructure (CNKI), covering publications from 2000 to 2025. The search keywords included combinations of "commercial pedestrian street," "urban public space perception," "user-generated content (UGC)," "natural language processing (NLP)," and "importance–performance analysis (IPA)." The search prioritized peer-reviewed journal articles, with supplementary references drawn from seminal books and authoritative institutional reports. This selection was guided by relevance to the study's focus on public perception of commercial pedestrian streets.

2.1. Theoretical Evolution: The Shift from Physical Space to Experiential Perception in Urban Consumption Space Research

Research on commercial pedestrian streets profoundly reflects a paradigm shift in our understanding of commercial space within the fields of urban geography and urban planning. This shift generally manifests as an evolutionary path from the objective depiction of physical space to the subjective exploration of spatial perception and experience.

The first thematic shift concerns the transition from physical-space description to experiential-perception research. Early studies focused on objective dimensions such as spatial layout, business format composition, and transportation accessibility, and employed methods such as space syntax, field surveying, and functional analysis [22,23]. Wang Peng's systematic examination of circulation design and spatial organization established foundational knowledge of the physical configuration of commercial pedestrian streets [22]. Building on this, Guo Xiangmin and Wang Jincan applied space syntax to interpret the characteristics of public spaces under both static and dynamic activities to identify underlying problems and propose renewal strategies [23]. While this foundational research aimed to optimize commercial performance through physical environment improvements, it often struggled to explain why streets with similar physical conditions exhibited significant differences in vitality and appeal largely because of its failure to consider users' complex feelings and behavioral logic. With the rise in experience economy theory, research attention shifted toward the public's lived experience within commercial pedestrian streets. Chen Suyin integrated the characteristics of Lingnan water village settlements into commercial

pedestrian street design and applied inherited traits such as water affinity and climate adaptation to create a consumer experience with regional characteristics [24]. Drawing on experience economy theory, Tan Lingchong explored pathways for optimizing scenic urban commercial streets in terms of theme positioning, functional structure, circulation organization, and spatial carrier design, aiming to strengthen responses to tourist consumption demands and enrich leisure and entertainment experiences [25].

A second shift involves the diversification of perceptual dimensions. Beyond general experience, researchers began to examine specific perceptual modalities and user groups. Visual perception emerged as a central concern. Ding Hua, Xiong Lian, and Chen Qi analyzed the spatial visual perception of commercial pedestrian streets under different conditions from three perspectives—subjective influencing factors, objective influencing factors, and visual composition elements—and proposed evaluation methods and optimization strategies based on visual perception [26]. Yang Minggang and Li Xiaomei, from a user perspective, identified service touchpoints that could be optimized and innovated in shopping environments and proposed service design ideas to enhance consumer satisfaction and promote the modernized management of commercial pedestrian street environments [27]. Gao Tangxuan explored the perception mechanism and creation strategies for night-time street scenes from the consumer perspective and revealed that night-time perception operates through distinct sensory and atmospheric logics [28]. Zhang Fan and Lu Qi, adopting a female perspective and combining virtual design with experimental methods, studied the factors influencing visual perception preferences in commercial pedestrian spaces and constructed a spatial element evaluation model and a visual comfort scale to provide a scientific basis for improving spatial quality [29]. Together, these studies demonstrate that street perception is not a monolithic construct but rather a multidimensional phenomenon shaped by diverse sensory inputs and user characteristics.

A third shift is methodological: from traditional surveys toward data-driven, digitally enabled approaches. While questionnaire-based satisfaction studies [30] and analytic hierarchy process (AHP) evaluations [31] have provided valuable insights into commercial street quality, their reliance on predefined indicators and limited sample sizes constrains their capacity to capture dynamic, large-scale public perception patterns. In response, emerging research has adopted eye-tracking and physiological sensing technologies to measure subconscious perceptual responses to street environments. Guo Jinnan and Li Yuan used eye-tracking and physiological sensing data to assess the spatial characteristics of historical streets and tourists' psychological perceptions and then summarized the mechanisms underlying the effect of historical streetscapes on tourist perception [32]. Zhang Lu, Li Chenyang, Wang Jinpeng, and others studied the visual perception of authenticity in traditional commercial pedestrian streets from the tourist perspective and quantified how four types of street interfaces influence perceived authenticity [33]. More recently, natural language processing (NLP) has enabled systematic analysis of unstructured UGC. Li Lin and Wang Lu evaluated public sentiment perception toward urban public streets in Shanghai and identified key built-environment elements and street types that affect satisfaction [34]. These methodological innovations collectively point toward a more comprehensive, data-driven framework for understanding perceptions of commercial pedestrian streets.

Although the research focus has shifted to perceptual experience, the limitations of traditional research methods have become increasingly apparent when dealing with dynamic, large-scale public perception data. Inherent bottlenecks such as limited sample sizes, high costs, and low spatiotemporal coverage make it difficult to capture the complex and volatile emotional responses and behavioral trajectories of massive crowds in street areas continuously and in real time. Despite these advancements, the full potential of

digital technology for perception research on commercial pedestrian streets has yet to be systematically realized.

2.2. Methodological Innovation: The Use of UGC Data as a New Paradigm for Gaining Insight into Urban Spatial Perception

The proliferation of the mobile internet has led to massive amounts of UGC. The text, images, and videos that are spontaneously shared by the public on social networks, travel websites, and other platforms provide an unprecedented, large-scale, and unstructured data source for urban spatial perception research [35]. Building upon this, gaining insights into public perception through data mining and text analysis has become a research hotspot in academia. Compared with traditional methods, the use of UGC data introduces a revolutionary paradigm shift with three levels of specific advantages: first, the "spontaneity" of data generation ensures the authenticity and originality of the content, and this feedback, which is based on real experiences, can more genuinely reflect users' subtle inner feelings; second, the "vastness" of the data scale allows researchers to overcome traditional sample limitations, thereby enabling the aggregation of macrolevel public sentiment and spatial perception patterns from microlevel individual evaluations; and finally, the "richness" of the data connotation transcends traditional functional evaluation; its unstructured texts record deep experiences across multiple dimensions, such as spatial atmosphere, emotional resonance, and cultural identity.

International research has increasingly adopted data-driven and multidimensional approaches to investigate perceptions of and experiences within urban public spaces. Guerrero et al. used geotagged Instagram images to identify patterns of use and perceived cultural ecosystem services in urban green infrastructure [20]. More recently, Zhang et al. integrated crowdsourced activity data, street-view imagery, and points-of-interest data to examine how visual and built-environment characteristics shape the recreational use of blue spaces in Rotterdam [21]. Complementing these data-driven approaches, Rezvanipour et al. demonstrated that street perception is jointly shaped by multisensory, social, and physical attributes [36]. Together, these studies highlight the potential of digital traces and multidimensional perception frameworks in large-scale experiential assessment.

Related applications in China have also focused primarily on urban parks and other public spaces. For example, at the micro-perception level, Dang Hui used topic models to analyze social media comments on the urban parks in Xi'an and categorized cultural services into five types, namely, esthetics, cultural heritage, education, recreation, and healing, thereby revealing the public's multidimensional perception of cultural ecosystem services. The intensity of service perception is closely related to park size and characteristics, providing spatially informed decision-making references for optimizing the cultural functions of parks [37]. Zhao trained text classification models to accurately identify public comments on park accessibility, usability, and attractiveness from social media data texts and used sentiment analysis to convert these texts into quantified perception scores, thereby systematically evaluating the spatial quality of urban parks and achieving a comprehensive interpretation of public spatial perception ranging from "what is perceived" to "how it is felt" [38]. Su Chang quantified the public perception preferences for plants in the parks of Wuhan by constructing a plant perception dictionary and conducting sentiment analysis. The results of that study revealed that public perception was focused on plant species, seasonal appearance, and overall impressions and that the perception of plant species was negatively correlated with emotional scores. On this basis, suggestions for optimizing plant landscapes were proposed from four aspects: compensating for seasonal aspects, regulating viewing periods, innovating species, and strengthening the popularization of science [39].

This approach is also applicable to more macroscopic urban perception research. For instance, Xu Xiaobo collected user review data from Ctrip and constructed an evaluation

system containing 24 indicators to evaluate tourism cities. In that study, researchers used the relative value of word frequency and the relative value of sentiment scores to quantify the perception degree (importance) and performance (satisfaction) of each indicator and subsequently conducted a comparative importance–performance analysis of 49 urban evaluation indicators [40]. This study follows this approach to examine the degree of public perception and approval of commercial pedestrian streets. Furthermore, Lu Ningjing, using Tianjin Xiaohongshu notes as a case study, profoundly revealed the comprehensive potential of UGC data for the study of urban image space. Through spatial analysis, sentiment analysis, and text mining, researchers systematically analyzed the positive correlation between the "core-subcenter" spatial structure of Tianjin's urban image, emotional perception, and regional popularity and extracted the differentiated action mechanisms of UGC in three types of areas—"traditional humanistic," "emerging internet-famous," and "niche suburban"—which are characterized by a "historical inheritance—real-time interaction—forward-looking" layout. This case fully demonstrates that UGC data can not only be used to effectively identify macro spatial patterns but also to deeply interpret micro perceptual motivations, thereby providing precise practical paths for urban spatial optimization [41].

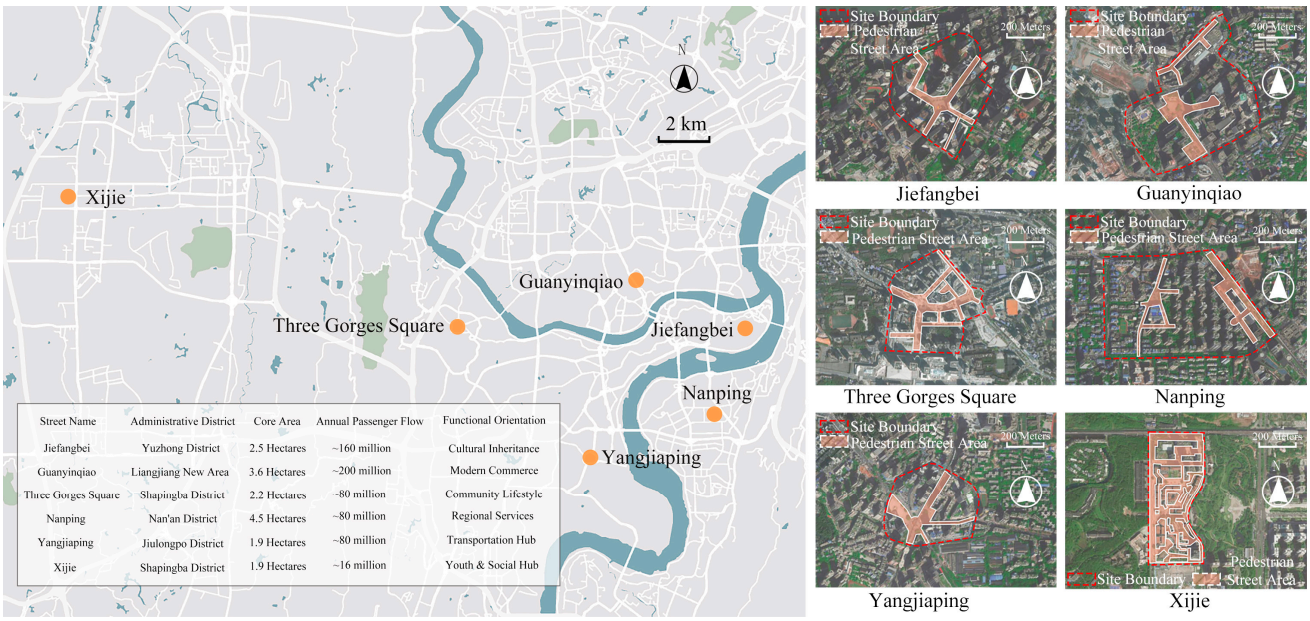
In summary, this study draws on the aforementioned research paradigms, particularly the importance–performance analysis framework constructed by Xu Xiaobo et al., and applies it to the specific urban consumption space of commercial pedestrian streets [40]. The aim is to systematically investigate the degree of the public's multidimensional perception and emotional approval of these streets to reveal their image characteristics and optimization directions. Regarding the ethics of using UGC for research purposes, we acknowledge several key considerations. The data used in this study consist of publicly available user reviews from the Dianping platform, from which we collected only non-personally identifiable information, with no direct contact with users. Our data collection complied with the platform's terms of service. We recognize that ethical standards for UGC research continue to evolve, particularly concerning data ownership, user privacy, and the question of whether publicly accessible social media content requires informed consent. To address these concerns, all the data in this study were aggregated and analyzed at the street level, and no individual user's review is quoted in isolation. This approach ensures that our analysis does not cause harm to individuals or communities and aligns with the principle of minimizing privacy risks while drawing on the richness of UGC data for urban perception research.

3. Research Design and Methodology

3.1. Case Selection and Data Sources

3.1.1. Sample Street Selection

Chongqing, as a typical mountainous city in southwestern China, has commercial pedestrian streets that are shaped by the joint influence of the natural "Two Rivers and Four Banks" topographic pattern and its high-density, intensive urban development model. This has resulted in distinctive three-dimensional spatial forms and a functional positioning of clustered distribution. Within the current commercial spatial structure of Chongqing's main urban area, six representative commercial pedestrian streets have developed: Jiefangbei Street, Guanyinqiao Street, Three Gorges Square Street, Nanping Street, Yangjiaping Street and Xijie Street. These streets constitute the core components of the urban consumption network (Figure 1). In this study, these six streets were selected as research samples, primarily on the basis of their typicality and coverage in terms of spatial hierarchy, functional type, and development stage.



Street Name	Administrative District	Core Area	Annual Passenger Flow	Functional Orientation
Jiefangbei	Yuzhong District	2.5 Hectares	~160 million	Cultural Inheritance
Guanyinqiao	Liangjiang New Area	3.6 Hectares	~200 million	Modern Commerce
Three Gorges Square	Shapingba District	2.2 Hectares	~80 million	Community Lifestyle
Nanping	Nan'an District	4.5 Hectares	~80 million	Regional Services
Yangjiaping	Jiulongpo District	1.9 Hectares	~80 million	Transportation Hub
Xijie	Shapingba District	1.9 Hectares	~16 million	Youth & Social Hub

Figure 1. Distribution of and basic information about the six major commercial pedestrian streets in Chongqing, China.

Spatially, the research samples cover a multi-scalar geographical range from traditional urban cores to emerging functional expansion areas, including both municipal-level commercial centers with annual passenger flows in excess of hundreds of millions and secondary commercial nodes that serve specific regions. In terms of functional attributes and development paths, these six streets reflect diverse orientations, including cultural heritage, modern commerce, community lifestyles, regional services, transportation hubs, and youth and social hubs, which largely cover the main development models of commercial pedestrian streets in high-density mountainous cities. This typological representation in both space and function lays a solid empirical foundation for the systematic analysis of the structural differences and common patterns in public perception.

3.1.2. Data Source

In this study, Dianping (https://account.dianping.com), a leading domestic life service and local consumption platform, was selected as the data acquisition source. This platform aggregates massive, multidimensional, and timely user reviews and has become a key data source for urban spatial perception research, as it combines both large-scale data and academic credibility [42,43]. Using the Python programming language (version 3.11.1), the six major commercial pedestrian streets in Chongqing were sampled to crawl user review data from the Dianping platform covering the period of 1 January 2019, to 31 December 2024.

3.1.3. Data Preprocessing

Through data cleaning (the removal of duplicates, advertisements, and invalid texts) and structured processing (the extraction of key information such as street names, review times, and full review texts), a total of 12,043 valid review data entries were obtained (Table 1). The detailed processing modes and operational criteria used for data cleaning are presented in Table 2.

Table 1. Research subjects and data.

No.	Case	Data Volume	Example Review
1	Jiefangbei	3288	Jiefangbei is a symbol of history. It looks magnificent when lit up at night. . . worth a trip to check in and take photos.
2	Guanyinqiao	4511	Guanyinqiao Commercial Pedestrian Street is large in scale, with wide and clean streets. . . The night view is beautiful and full of atmosphere.
3	Three Gorges Square	1787	It must be said that Three Gorges Square Commercial Pedestrian Street is always packed with people, the renovations. . . many people come here to hang out.
4	Nanping	251	The newly completed 3D walkway in Nanping Commercial Pedestrian Street is truly beautiful, great for taking the kids for a stroll. . . it gives a strong 3D feel.
5	Yangjiaping	1015	The ginkgo trees along Yangjiaping Commercial Pedestrian Street are a brilliant golden color. . . the falling leaves are so beautiful!
6	Xijie	1191	Xijie Commercial Pedestrian Street has strong university vibes, the murals on the walls are also very distinctive. . . riding a bike here feels very relaxing.
	Total	12,043	

Table 2. Review data-cleaning steps and operational criteria.

Step	Targeted Content	Processing Mode	Operational Criteria
1. Empty-review removal	Empty or content-free reviews	Automated	Reviews with empty content or containing only spaces or line breaks were removed.
2. Garbled-text removal	Garbled text/ invalid characters	Automated	Reviews containing unparseable Unicode characters (e.g., garbled text) were removed.
3. Deduplication	Duplicate reviews	Automated	Duplicate entries with exactly identical textual content were removed, with only one record retained for each duplicate.
4. Advertisement/ spam filtering	Advertisements and spam	Automated screening with manual verification	Automated screening: Regular expressions were used to flag reviews containing explicit promotional expressions, such as “add VX,” “add me on WeChat,” “click to claim,” or “coupon link.” Manual verification: Two researchers independently examined the flagged reviews, and a review was removed only when both researchers classified it as advertising or spam.
5. Text normalization	Punctuation marks	Automated	Chinese and English punctuation marks were removed, while Chinese characters, Latin letters, and numerals were retained.
6. Text normalization	Emoji symbols	Automated	All emoji symbols were removed because they are difficult to process directly in conventional NLP analysis.
7. Text normalization	Redundant spaces	Automated	Leading and trailing spaces were removed, and consecutive spaces were merged into a single standard space.
8. Text normalization	Synonym standardization	Automated (using a customized dictionary)	Common variant expressions referring to the same entity, such as “Line 1” and “Metro Line 1,” were standardized as a single term to prevent the same entity from being treated as different entries during word segmentation.

Note: “VX” is a colloquial abbreviation commonly used on Chinese online platforms to refer to WeChat.

In addition, multiple reviews from the same user were retained rather than aggregated. This decision was made for two reasons: first, a user may visit the same street at different times and have genuinely different experiences, and second, a user may comment on different spatial aspects (e.g., shopping experiences, nightscape, and cultural atmosphere) across separate reviews. Retaining all reviews preserves both temporal variation and multidimensional richness. However, duplicate reviews—defined as identical or near-identical text from the same user—were removed to eliminate redundant content.

3.2. Research Framework

This study follows a logical research sequence consisting of three main phases: (1) the construction of an evaluation system and data processing, (2) data quantification and analysis, and (3) the proposal of optimization strategies. This framework is adopted to systematically analyze the public perception of the six sampled commercial pedestrian streets in Chongqing. The specific research framework and technical pathway are illustrated in Figure 2.

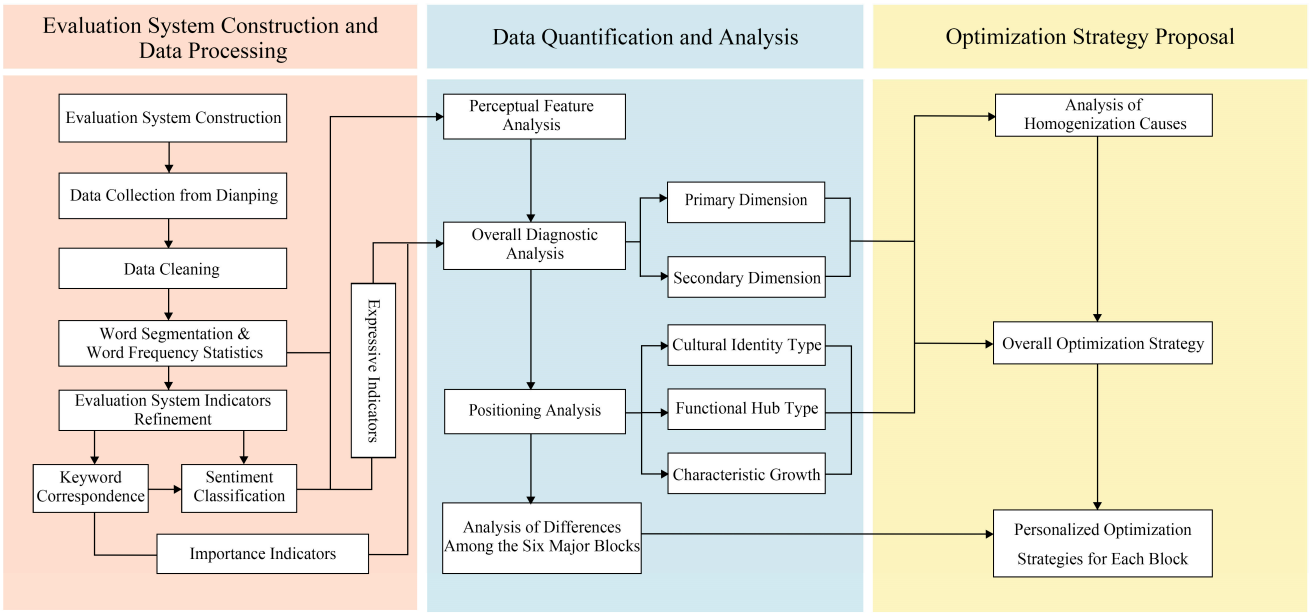


Figure 2. Research methodology.

In the first phase—evaluation system construction and data processing—a theoretical framework for assessing the public perception of commercial pedestrian streets was developed based on a literature review. This framework covers four primary dimensions: environmental perception, commercial perception, cultural perception, and location and facility perception. Public review texts were subsequently collected from the Dianping platform as the UGC data source. After data cleaning and filtering, a structured dataset was formed, and specific indicators of the evaluation system were refined to support the subsequent quantitative analysis.

In the second phase—data quantification and analysis—NLP and importance–performance analysis (IPA) were comprehensively applied to conduct an in-depth exploration of the review data. Through word frequency statistics and sentiment analysis, the degree of public attention (as an importance indicator) and degree of public approval (as a performance indicator) for each perception dimension were quantified. Building on this, an overall IPA of the six streets was first conducted to identify the general structure and common characteristics of public perception. Individual comparative analyses were subsequently conducted for each street to reveal the heterogeneity in their perception struc-

tures and to classify them accordingly. Finally, by examining the secondary dimensions, the different characteristics of each street were revealed in terms of their specific spatial element configurations.

In the third and final phase—optimization strategy generation—planning recommendations are proposed from a dual perspective of common optimization and targeted measures. This study is aimed at providing empirical evidence and decision-making support for the refined planning and sustainable operational management of commercial pedestrian streets in the future.

3.3. Analytical Methods

3.3.1. NLP Analysis

NLP, as a key branch of artificial intelligence, enables information extraction and a deep understanding of human language through computational techniques [44,45], thereby providing a methodological basis for mining the public's genuine and subtle perceptions of urban space from massive unstructured texts [46,47]. In the field of urban research, NLP has developed in a core analytical tool. Its typical technical paths include word frequency statistics, sentiment analysis, and text classification, which can be used to systematically reveal the focus of public cognition and emotional tendencies, effectively overcoming the scale and timeliness limitations of traditional research methods.

In this study, NLP technology is primarily used for the dual task of quantifying public perception. On the one hand, it is used to identify high-frequency spatial element keywords that appear in reviews through word frequency statistics, which serves as the quantitative basis for assessing the degree of public "attention" to measure its importance in subsequent analysis. On the other hand, sentiment judgment and score calculations are conducted on review texts through sentiment analysis to transform subjective experiences into quantified approval indicators to serve as a measure of the performance of the public's street experiences. Together, these two outputs provide direct data input for the subsequent methods.

To implement the sentiment analysis described above, we employed a publicly available pretrained language model specifically designed for Chinese consumer review classification.

Sentiment analysis was performed using the uer/roberta-base-finetuned-jd-binary-chinese model, a pretrained RoBERTa-base model fine-tuned on the JD Binary dataset for binary sentiment classification (positive vs. negative). The model was developed and released by the UER (Universal Encoder Representation) research group and is publicly available through the Hugging Face model hub under the model ID uer/roberta-base-finetuned-jd-binary-chinese.

The base model, chinese_roberta_L-12_H-768, is a 12-layer Transformer encoder with a hidden size of 768 and is pretrained on a large-scale Chinese corpus. It adopts the RoBERTa (Robustly Optimized BERT Approach) architecture [48], which improves upon BERT through dynamic masking, larger batch sizes, and longer training durations, resulting in enhanced robustness and contextual representation for Chinese text understanding. The fine-tuning process was conducted on the JD Binary dataset, which consists of JD.com user reviews annotated with sentiment polarity labels (positive vs. negative). The model was fine-tuned for three epochs with a sequence length of 512, a learning rate of 3×10^{-5}, and a batch size of 32, following the optimal hyperparameter configuration reported by the model developers. At the end of each epoch, the model checkpoint that achieved the best performance on the development set was retained.

This model was selected for the present study for three reasons. First, its fine-tuning domain—JD.com consumer reviews—closely matches the nature of our dataset (Dianping consumer reviews of commercial spaces), ensuring domain relevance for the sentiment

classification task. Second, the model is publicly available as a pretrained checkpoint with a standardized inference pipeline, enabling direct application without additional fine-tuning and ensuring full reproducibility of our analysis. Third, the model architecture (RoBERTa-base) has demonstrated strong performance across various Chinese NLP benchmarks, making it a reliable choice for text classification tasks.

Although the model developers have not publicly released the specific accuracy metrics for this checkpoint on a standard test set, the model's reliability is supported by three indicators. First, the fine-tuning procedure followed a rigorous validation protocol: the model was fine-tuned for three epochs on the JD Binary training set, and the checkpoint that achieved the best performance on the development set was retained at the end of each epoch, ensuring that the final model is not overfitted to the training data. Second, the model has been widely adopted by the NLP community, with over 15,000 monthly downloads and usage in more than 28 public Hugging Face Spaces at the time of writing, indicating its practical reliability across diverse Chinese text classification tasks. Third, the model architecture (RoBERTa-base) is among the most extensively benchmarked architectures for Chinese language understanding, with well-documented strong performance across multiple NLP benchmarks [48]. For the purposes of this study—where the goal is to produce a reliable directional classification (positive vs. negative) of consumer reviews rather than a high-stakes fine-grained sentiment distinction—this pretrained model provides a methodologically sound and reproducible solution.

3.3.2. Importance–Performance Analysis (IPA)

Importance–performance analysis (IPA) is a classic decision support and diagnostic tool proposed by Martilla and James in 1977. Its core lies in the construction of a two-dimensional matrix that uses "importance" as the horizontal axis and "performance" as the vertical axis. By projecting the evaluation values of various attributes into the matrix quadrants, strengths, improvement priorities, and the sequence for resource optimization can be intuitively identified [49]. With the rise in big data research, the data source for IPA has expanded from traditional questionnaires to UGC to indirectly measure importance and performance through NLP techniques. This method combines the advantages of large-scale data and reflections of real behavior, thereby providing an effective path for the dynamic perception evaluation of urban spaces [50,51].

In this study, importance is conceptually consistent with the degree of perception, and performance corresponds to the degree of approval, which reflects the public's sense of identity with the commercial pedestrian street. On this basis, a diagnosis is conducted according to the quadrant distribution of the elements in the matrix (Figure 3): those elements falling into Quadrant I (the Core Advantages Zone) show excellent performance, constitute the core strengths of the street, and must be consolidated and maintained; the elements in Quadrant II (the Hidden Advantages Zone) show good performance but lack sufficient public perception, which constitutes the street's potential competitiveness, and their value transformation should be promoted; the elements in Quadrant III (the Hidden Shortcomings Zone) have low degrees of public perception and approval, represent weak links in street perception, and can maintain the status quo under limited resources, whereas the elements in Quadrant IV (the Critical Shortcomings Zone) have a high degree of perception but a low degree of approval from the public's perspective and require optimization interventions.

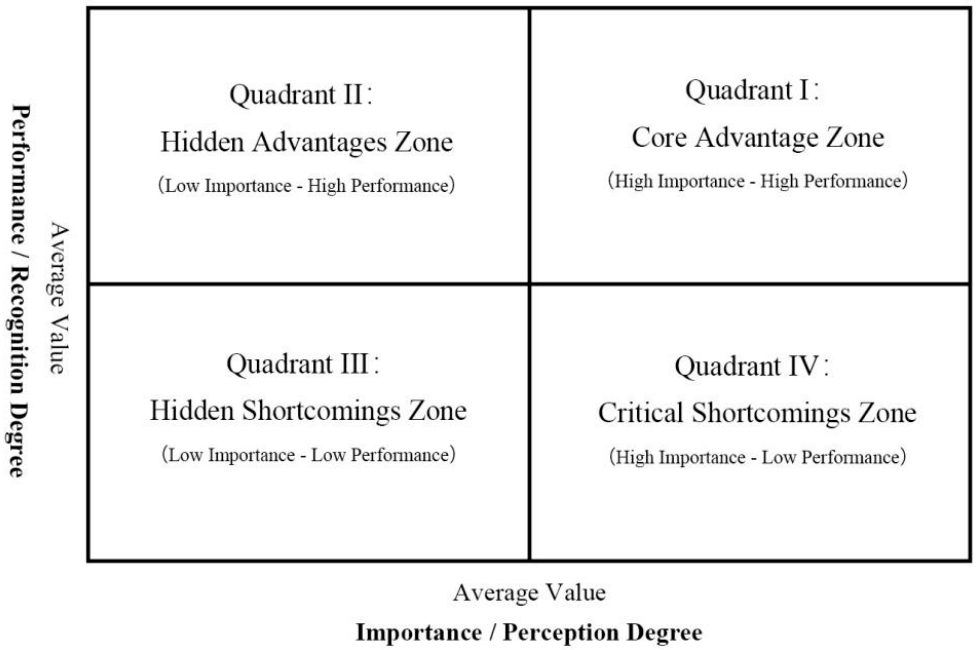


Figure 3. Importance–performance (IPA) quadrant distribution chart.

In this study, the importance of each perception dimension was operationalized as the relative frequency of keywords belonging to that dimension within the entire review corpus. This operationalization follows the established practice in UGC-based perception research [40], where word frequency is interpreted as a proxy for public attention—the more frequently a spatial element is mentioned, the more salient it is in the public's perception. The underlying assumption is that users spontaneously mention what they consider noteworthy, and the aggregate mention frequency across a large sample reflects the collective importance of that element.

The performance of each dimension was operationalized as the average sentiment score of reviews containing keywords from that dimension. This follows the same logic: sentiment scores reflect the public's approval or satisfaction with the specific aspect they commented on. When users express positive sentiment about a dimension, it indicates that the street is performing well in that regard; negative sentiment indicates a performance gap. This dual operationalization—word frequency as importance and sentiment as performance—enables a direct mapping of UGC data onto the IPA framework without imposing researcher-defined survey questions or predetermined weights.

Regarding the uneven number of reviews across streets, we adopted the following analytical strategies. First, all importance and performance scores were calculated as relative values (percentage-based) rather than absolute counts. Importance was measured as the proportion of keyword mentions within each street's total review corpus, rather than raw frequencies; performance was measured as the average sentiment score, which is independent of sample size. This ensures that streets with fewer reviews are not systematically disadvantaged.

Second, we conducted a sensitivity check by randomly resampling the larger datasets (Guanyinqiao and Jiefangbei) to match the sample size of the smaller streets and reran the IPA. The quadrant distribution remained stable, with no dimension shifting across quadrant boundaries except for marginal movements within the same quadrant. This finding indicates that the uneven sample size does not materially affect the overall diagnostic conclusions.

Nevertheless, we acknowledge that the smaller sample from Nanping (n = 251) warrants more cautious interpretation. Where relevant, we note this limitation in the discussion of individual street results.

3.4. Construction of a Four-Dimensional Perception Evaluation System

3.4.1. Construction of First-Level Dimension Indicators

On the basis of a systematic review of the relevant literature (Table 3), this study reveals that although different scholars have taken varying analytical foci in public perception research on commercial pedestrian streets because of their diverse research backgrounds and technical routes, the core elements of their studies can be categorized into the following four dimensions: the physical environment, functional formats, cultural spirit, and support systems. The comparison presented in Table 3 provides the methodological basis for constructing the four-dimensional perception evaluation system adopted in this study.

On this basis, a four-dimensional evaluation system comprising environmental perception (A), commercial perception (B), cultural perception (C), and location and facility perception (D) is proposed in this study to comprehensively analyze the spatial perception characteristics of the public toward commercial pedestrian streets from multiple dimensions and perspectives.

3.4.2. Construction of Second-Level Dimension Indicators

In this study, the Jieba (version 0.42.1, https://github.com/fxsjy/jieba, accessed on 11 June 2026) word segmentation tool was used to process the cleaned texts, keywords were extracted, and 200 high-frequency keywords were selected as the basic word set for the perceptual elements. On this basis, multiple members of the research team independently classified these keywords and analyzed their semantic connotations according to the theoretical definitions of the first-level dimension indicators. In the initial independent classification stage, the majority of keywords (approximately four-fifths) received unanimous agreement from all members, while approximately one-tenth received agreement from the majority of members, indicating an overall high initial agreement rate. Subsequently, disagreements on the remaining keywords were resolved through collective discussion on a case-by-case basis. For keywords that remained unresolved after discussion, two external experts (specializing in urban geography and commercial planning, respectively) were invited to conduct independent arbitration. Through the above process, full consensus was achieved on the final classification of all keywords, with no keywords left unassigned. Based on these validation results, a perception evaluation system encompassing 18 secondary indicators was constructed, with each secondary dimension containing at least three semantically consistent keywords. This system effectively accomplishes the transformation from raw text to a structured evaluation framework, ensuring both scientific validity and consistency (Table 4).

Table 3. Review of Relevant Literature Supporting the Construction of the Four-Dimensional Perception Evaluation System.

Author(s) (Year of Publication)	Research Methodology	Research Content	Dimensions Involved
Ding et al. 2014 [26]	Theoretical analysis, field survey, and questionnaire survey	An in-depth analysis of the spatial visual perception of commercial pedestrian streets under various conditions from three perspectives: the subjective influencing factors, objective influencing factors, and visual composition elements.	Environmental
Wu et al. 2015 [52]	Netnography and content analysis	Identification of 98 clues affecting the perception of attractiveness in urban central commercial pedestrian streets and analysis of their positive and negative effects.	Environmental, Commercial, Location and Facility
Ye et al. 2019 [30]	Questionnaire survey and IPA	Exploration of the composition of the satisfaction evaluation system for modern recreational commercial pedestrian streets and a comparative analysis of the main factors influencing tourists' and residents' satisfaction evaluations.	Environmental, Commercial, Cultural, Location and Facility
Qin et al. 2022 [53]	SD (semantic differential) method	Evaluation of the perceptions of spatial nodes from the aspects of space, architecture, landscape, service facilities, and human activities and summary of the factors influencing street space perception.	Environmental, Cultural, Location and Facilities
Li et al. 2024 [31]	Questionnaire survey and AHP (analytic hierarchy process)	Construction of an evaluation system for the spatial quality of traditional commercial pedestrian streets from a new consumption perspective and empirical analysis.	Environmental, Commercial, Cultural, Location and Facility
Guo et al. 2025 [32]	Eye-tracking	Assessment of the spatial characteristics of historical streets, tourists' eye-tracking and physiological sensing data, and psychological perceptions and a summary of the mechanisms underlying the effect of historical streetscapes on tourist perception.	Environmental
Zhang et al. 2025 [33]	Eye-tracking	Study of the visual perception of four types of interfaces in commercial pedestrian streets from the tourist's perspective.	Environmental
Li et al. 2025 [34]	NLP analysis and linear regression analysis	Evaluation of public sentiment perception toward urban public streets in Shanghai and identification of key built environment elements and street types that affect satisfaction.	Environmental, Commercial, Cultural, Location and Facility

Table 4. Four-dimensional evaluation system for the public perception of commercial pedestrian streets.

Primary Dimension	Secondary Dimension	Description	Representative Keywords
A Environmental Perception	1. Spatial Scale	The public's intuitive perception of spatial relationships such as street width and building height.	street, spacious...
	2. Architectural Style	The overall style, appearance, and era characteristics reflected by the buildings.	building, glass...
	3. Landscape and Greenery	The arrangement and visual appeal of natural elements (e.g., greenery, plants, flowers) and landscape installations within the street.	sculpture, greenery...
	4. Nightscape and Lighting	The overall atmosphere and visual attraction created by lighting at night.	night view, neon lights...
	5. Signage and Nodes	Wayfinding signage and spatial nodes (e.g., plazas) that encourage people to linger.	square, monument...
	6. Environmental Cleanliness and Order	The cleanliness, sanitation, and sense of order in the environment.	clean, tidy...
B Commercial Perception	7. Business Formats	The diversity and completeness of commercial types such as shops, dining, and entertainment venues.	snack, cuisine...
	8. Brand Appeal	The popularity, uniqueness, and drawing power of the brands present.	brand, Starbucks...
	9. Commercial Atmosphere	The sense of liveliness created collectively by pedestrian flow, shopfront decorations, etc.	bustling, prosperous...
	10. Commercial Activities	Temporary commercial promotion events such as sales, markets, and exhibitions.	concert, market...
	11. Consumption Experience	The service quality and satisfaction level perceived during shopping and consumption.	delicious, affordable, fun...
C Cultural Perception	12. Crowd Characteristics	The intuitive impression of the types of people, their behaviors, and the overall ambiance in the street.	merchants, customers, tourists...
	13. Cultural and Historical Ambiance	The distinctive cultural atmosphere created by historical sites, cultural symbols, etc.	art, history...
	14. Sense of Place	The unique sense of identity, belonging, and memorable points associated with the street.	Mountain City, Fog City...
	15. Cultural Activities	Noncommercial public cultural and social activities such as street performances and festivals.	check-in, photo taking...
D Location and Facility Perception	16. Transportation Conditions	The convenience of access and departure via public transport, walking, etc.	Line 3, Line 1...
	17. Surrounding Resources	The synergy and complementarity with the surrounding environment and its attractions.	Hongya Cave, Chongqing University...
	18. Service Facilities	The availability and condition of public facilities such as rest seating, restrooms, and parking lots.	facilities, parking lot...

4. Analysis and Results

4.1. Perception Characteristics: High-Frequency Words and Sentiment Analysis

4.1.1. Analysis of High-Frequency Word Characteristics by Street

High-frequency words provide an intuitive mapping of the public's cognitive structure and can effectively reveal their core focus regarding spatial images. On the basis of the UGC data obtained from the Dianping platform, the public perception characteristics of six commercial pedestrian streets were analyzed through word-frequency statistics and word cloud visualization (Figure 4) to intuitively reveal the core image of each street from the perspective of public perception. The word cloud analysis results reveal that public perceptions of the six commercial pedestrian streets in Chongqing exhibit significant functional differentiation and thematic foci.



Figure 4. Word cloud with high-frequency words for the six commercial pedestrian streets sampled in Chongqing.

The word cloud for Jiefangbei is centered on words such as "check-in," "landmark," "history," "Hongya Cave," and "monument," which indicate its prominent status as an urban cultural symbol and tourist destination. Public cognition is highly concentrated on its historical identity and spatial symbolism, while the appearance of high-frequency words such as "delicacy" and "tasty" shows that its catering function also receives widespread attention, thus forming a compound perception structure of "cultural experience and food consumption".

The word cloud for Guanyinqiao features terms such as "business street," "shopping mall," "shopping," "entertainment," and "bustling," which have the highest density, thus highlighting its distinct positioning as a modern commercial agglomeration area. Furthermore, the frequent appearance of words such as "delicious," "cuisine," and "snacks" further reinforces the prominence of the catering sector within its commercial functions. Overall, it presents the characteristics of a high-intensity, diversified, consumption-oriented modern commercial hub.

The word cloud for Three Gorges Square is dominated by functional vocabulary such as "square," "business street," "transportation," and "convenience," and descriptive terms such as "bustling" and "shopping" are also relatively common. Overall, this street presents a cognitive profile of a traditional civic activity center and daily service

hub, but with relatively weaker perceptions of its distinct commercial characteristics and experiential depth.

The word cloud for Nanping exhibits a spatial cognitive clustering phenomenon that centers on "Wanda Plaza," with basic functional words such as "business street," "shopping," and "mall" constituting its main image dimensions. Compared with other streets, it has a lower total vocabulary volume and diversity, and its public perception is relatively concentrated, reflecting its functional positioning as a regional commercial center. Its cross-regional appeal and image uniqueness show potential for improvement.

The word cloud for Yangjiaping is strongly associated with the urban transportation system, with "light rail" and "Line 2" emerging as its main cognitive elements. Vocabulary related to commercial facilities, such as "business streets" and "square," collectively shapes its image as a community commercial center that is reliant on rail transit. Public perception of this street closely revolves around transportation convenience and daily service functions.

The word cloud for Xijie features youth-oriented and scene-based characteristics. High-frequency words such as "university town," "youth," "atmosphere," "activities," and "food, drink, and fun" clearly demonstrate its positioning as a youth leisure and social space that leverages university resources. Public cognition is highly focused on youthful vitality, campus culture, and interactive experiences, demonstrating its unique customer base targeting and ambiance.

Integrating the word cloud analyses of the six streets reveals a clear functional differentiation and cognitive hierarchy regarding public perception of Chongqing's commercial pedestrian streets: the historical and cultural landmark status of Jiefangbei, the modern commercial agglomeration of Guanyinqiao, the community life reliance of Three Gorges Square, the regional service function of Nanping, the transportation interchange hub role of Yangjiaping, and the youth vitality scene of Xijie, which collectively construct a multi-layered, differentiated cognitive map of the urban commercial space. This provides an important semantic foundation for the subsequent in-depth analysis of the structure of public perception.

4.1.2. Overall Sentiment Distribution and Interstreet Variation Analysis

(1) Overall Sentiment Distribution

On the basis of the UGC data sentiment analysis results for each street (Figure 5), from an overall perspective, the distribution of public perception sentiment for the six commercial pedestrian streets in Chongqing shows a significant characteristic of an overall high-level equilibrium with subtle internal differentiation. Specific data show that the percentage of positive sentiment for all six streets is above 90%, with Xijie leading at 96.56% and Nanping lagging at 92.83%, which results in a range of only 3.73 percentage points. This highly concentrated positive sentiment indicates that the core commercial pedestrian streets in Chongqing have established relatively stable public trust in terms of their basic environmental quality, service functions, and spatial order, and that the overall spatial experience has gained general approval.

(2) Interstreet Differences

However, under the overall pattern of high-level equilibrium, the sentiment scores for each street still reveal meaningful subtle differences. On this basis, they can be categorized into two tiers.

The first tier is the high-approval stability zone, which includes Xijie, Three Gorges Square, Yangjiaping, and Jiefangbei, all of which have a positive sentiment proportion in excess of 95%. The feature that these streets have in common is the high level of alignment between their functional positioning and public expectations. Relying on its university town setting, Xijie satisfies the leisure and social needs of youth groups. Moreover, Three

Gorges Square, Yangjiaping, and Jiefangbei, which serve as regional service centers, effectively cater to their citizens' daily commercial and public service needs. Their clear role definitions and stable functional supplies contribute to their positive performance in public sentiment feedback.

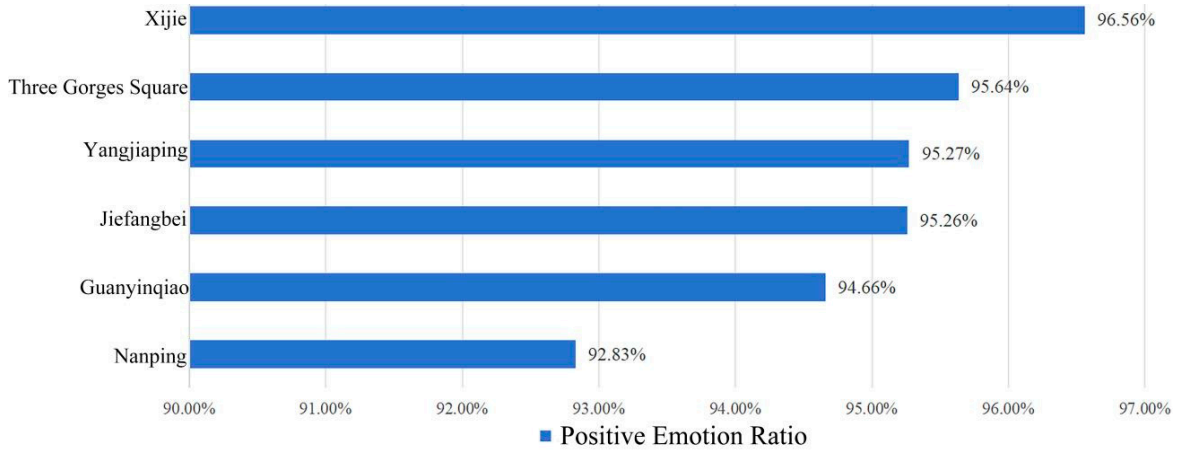


Figure 5. Distribution of Positive Sentiment for Six Major Commercial Pedestrian Streets in Chongqing.

The second tier is the relative fluctuation in approval zone, which includes Nanping and Guanyinqiao. Represented by Nanping, although its positive sentiment proportion remains relatively high (92.83%), its comparatively lower score may indicate that, as a traditional street undergoing transformation, it still faces challenges in shaping distinctive characteristics and enhancing attractiveness. There could be a slight misalignment between its spatial offerings and the public's expectations for deeper experiences, particularly those of non-local tourists.

4.2. Overall Diagnosis: IPA Quadrant Analysis of Perception Dimensions

Through the compilation of the overall dimension indicator data for the six streets, the following results were obtained (Table 5).

Table 5. Statistical table of importance and satisfaction scores for each perception dimension of the six commercial pedestrian streets in Chongqing.

Primary Dimension	Importance/ Perception (%)	Performance/ Satisfaction (%)	Secondary Dimension	Importance/ Perception (%)	Performance/ Satisfaction (%)
A Environmental Perception	13.93	98.11	1. Spatial Scale	2.15	98.17
			2. Architectural Style	1.98	97.87
			3. Landscape and Greenery	1.36	97.97
			4. Nightscape and Lighting	1.36	98.84
			5. Signage and Nodes	6.46	98.25
			6. Environmental Cleanliness and Order	0.28	97.18
B Commercial Perception	42.55	97.41	7. Business Formats	17.77	97.17
			8. Brand Appeal	2.40	97.97
			9. Commercial Atmosphere	12.95	97.83
			10. Commercial Activities	0.82	97.28
			11. Consumption Experience	8.40	97.11
			12. Crowd Characteristics	3.73	97.67
C Cultural Perception	25.15	97.74	13. Cultural and Historical Ambiance	4.34	98.76
			14. Sense of Place	3.72	96.69
			15. Cultural Activities	13.33	97.65
D Location & Facility Perception	18.35	97.80	16. Transportation Conditions	8.74	97.91
			17. Surrounding Resources	9.21	97.70
			18. Service Facilities	1.00	95.92
Average	25.00	97.77	Average	5.56	97.66

4.2.1. The IPA Quadrant Distribution Characteristics of the First-Level Dimensions

On the basis of the IPA results for the first-level dimensions of the six streets (Figure 6), the four core perception dimensions for Chongqing's six major commercial pedestrian streets show systematic spatial differentiation characteristics, which reflect the structural relationship between the street space supply and public experience demand.

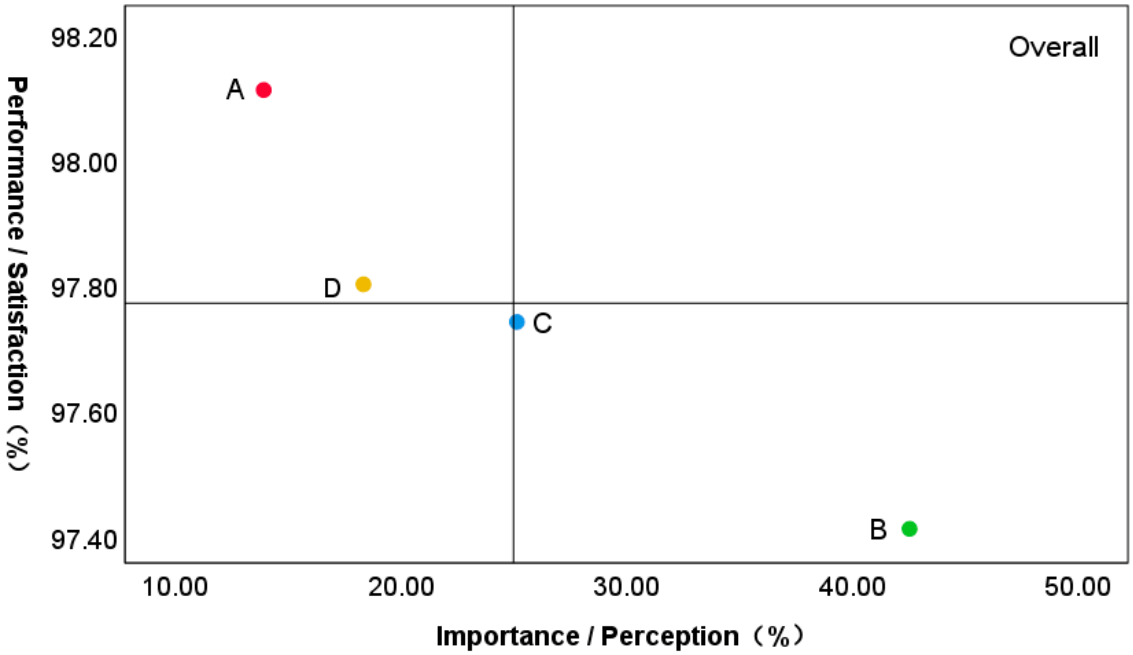


Figure 6. IPA Matrix of the primary perception dimensions for the six commercial pedestrian street in Chongqing (Overall). Note: A. Environmental Perception; B. Commercial Perception; C. Cultural Perception; D. Location and Facility Perception.

Both environmental perception (A) and location and Facility perception (D) fall into Quadrant II (the Hidden Advantages Zone), which is characterized by "low importance–high performance". This finding indicates that the material spatial quality of the streets (e.g., architectural style, landscaping, etc.) and the basic support conditions (e.g., transportation accessibility, service facilities, etc.) have received relatively high public evaluations, thus constituting the "static foundation" for the stable operation of street functions. However, their relatively low perceived importance also suggests that these elements, which serve as basic guarantees, have not yet been fully transformed into significant perceptual advantages for driving the unique charm and core competitiveness of the streets.

In sharp contrast, both commercial perception (B) and cultural perception (C) are concentrated in Quadrant IV (the Critical Shortcomings Zone), and they are manifested as "high importance–low performance". This distribution pattern indicates that the public holds high expectations regarding the richness of commercial formats, the quality of the consumption experience, and the uniqueness of the cultural atmosphere in these streets. However, the actual supply shows significant deficiencies in content characteristics, experiential depth, and cultural expression which prevents these high expectations from being effectively met. Together, these two dimensions constitute the key bottleneck constraining the current high-quality development of these streets.

This quadrant distribution structure reveals a core contradiction: current street planning and construction have achieved remarkable results at the "form" level (environment and facilities) but are severely lagging in terms of supply quality and characteristic shaping at the "content" level (e.g., commerce and culture). This imbalanced state, which is char-

acterized by "overly strong basic hardware but relatively soft core software," is the main structural obstacle restricting deep and satisfactory experiences on the part of the public.

4.2.2. The IPA Quadrant Distribution Characteristics of the Second-Level Dimensions

At the more operational level of second-level perception dimensions, the IPA further reveals the optimization priority of specific spatial elements (Figure 7).

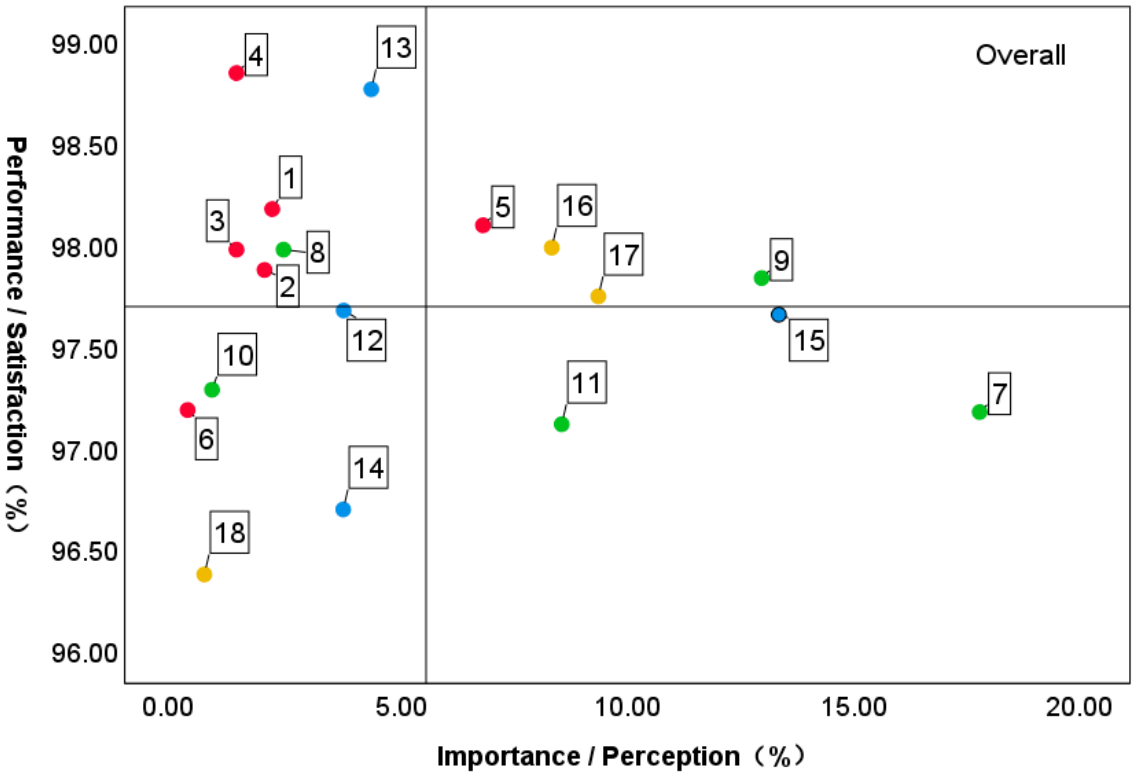


Figure 7. IPA Matrix secondary perception dimensions for the six commercial pedestrian streets in Chongqing (Overall). Note: 1. Spatial Scale; 2. Architectural Style; 3. Landscape and Greenery; 4. Nightscape and Lighting; 5. Signage and Nodes; 6. Environmental Cleanliness and Order; 7. Business Formats; 8. Brand Appeal; 9. Commercial Atmosphere; 10. Commercial Activities; 11. Consumption Experience; 12. Crowd Characteristics; 13. Cultural and Historical Ambiance; 14. Sense of Place; 15. Cultural Activities; 16. Transportation Conditions; 17. Surrounding Resources; and 18. Service Facilities.

(1) The Core Advantages Zone (Quadrant I)

This zone includes landmarks and nodes (A5), commercial atmosphere (B9), transportation conditions (D16), and surrounding resources (D17). These elements constitute the structural advantages for street development, which are often closely related to the city's macro location, transportation network, and landmark system, and serve as the fundamental engine for stimulating street vitality. Planning and design should focus on consolidating and strengthening these advantages through refined design, such as the optimization of transportation interchange systems and the enhancement of the recognizability and artistry of signage systems.

(2) Hidden Advantages Zone (Quadrant II)

This zone includes spatial scale (A1), architectural style (A2), landscape and greening (A3), nightscape lighting (A4), brand appeal (B8), and cultural and historical atmosphere (C13). This quadrant contains the existing spatial resources of the streets. Their high performance reflects the potential value of the existing spatial fabric and cultural heritage, while

their low importance indicates that they have not yet been fully transformed into perceptible and participatory experiential content. Event planning, narrative spatial connections, and functional mixing should be used to promote the activation and value regeneration of static resources.

(3) The Hidden Shortcomings Zone (Quadrant III)

This zone includes environmental cleanliness (A6), commercial activities (B10), crowd characteristics (C12), a sense of place (C14), and service facilities (D18). These elements are related to the daily operation and micro-characteristics of these streets. Their dual-low characteristic indicates that, under resource constraints, these aspects are not core contradictions that urgently need resolution. However, vigilance is needed with regard to "environmental cleanliness", which serves as a basic guarantee of spatial quality and should be maintained through regular management.

(4) The Critical Shortcomings Zone (Quadrant IV)

This zone includes commercial formats (B7), consumption experience (B11), and cultural activities (C15). This quadrant is directly related to the functional complexity, cultural vitality, and spatial use efficiency of the streets. Its low performance reveals a significant disconnect between functional planning and spatial design. Systematic interventions such as business format guidance policies, flexible public space design, and the implementation of deep cultural content are urgently needed to enhance the overall experiential quality of these streets.

4.3. Positioning Analysis: Differences in Perception Characteristics Among the Sampled Streets

4.3.1. Overall Street Characteristics

On the basis of the IPA quadrant distribution results of the first-level dimensions for each street, the public perception structure of Chongqing's six major commercial pedestrian streets shows significantly differentiated characteristics (Figure 8).

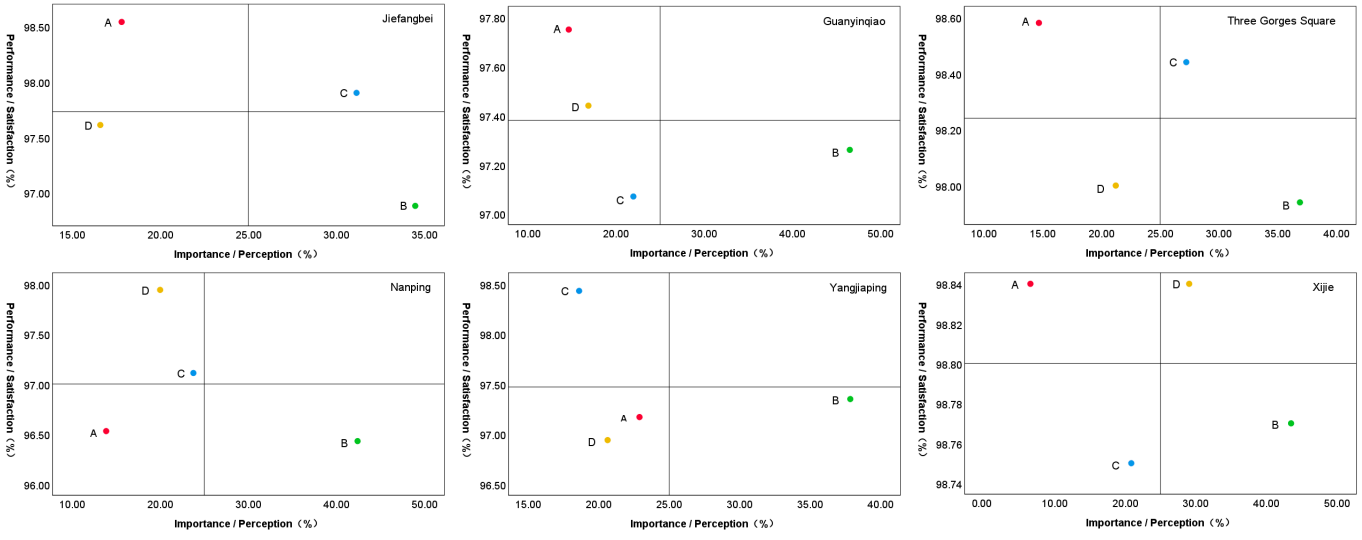


Figure 8. IPA Matrix of the primary perception dimensions for the six commercial pedestrian streets in Chongqing (Individual). Note: A. Environmental Perception; B. Commercial Perception; C. Cultural Perception; and D. Location and Facility Perception.

In terms of commonality, the commercial perception dimension of all of these streets, without exception, falls into Quadrant IV (the critical shortcomings zone). This phenomenon reveals the structural contradiction faced by Chongqing's commercial pedestrian streets: the public holds high expectations for the commercial functions of these streets,

but in reality, the commercial supply of each street (including commercial formats, brand appeal, consumption experience, etc.) fails to effectively meet these expectations. This finding indicates that format homogenization, insufficient commercial innovation, and superficial consumption experiences are systemic, chronic problems that transcend the individual positioning of these six Chongqing pedestrian streets.

4.3.2. Differentiated Street Types

Under these common challenges, the combination of the strengths and weaknesses of each street clearly reflects its different development positions and resource endowments (Table 6).

Table 6. Distribution of the primary perception dimensions across IPA quadrants for the six commercial pedestrian streets in Chongqing.

Street Name	Quadrant I: High Importance-High Performance	Quadrant II: Low Importance-High Performance	Quadrant III: Low Importance-Low Performance	Quadrant IV: High Importance-Low Performance	Street Type
Jiefangbei	Cultural	Environmental	Location and Facility	Commercial	Cultural Identity Type
Guanyinqiao		Environmental, Location and Facility	Cultural	Commercial	Functional Hub Type
Three Gorges Square	Cultural	Environmental	Location and Facility	Commercial	Cultural Identity Type
Nanping		Location and Facility, Cultural	Environmental	Commercial	Functional Hub Type
Yangjiaping		Cultural	Environmental, Location and Facility	Commercial	Distinctive Growth Type
Xijie	Locational and Facilities	Environmental	Cultural	Commercial	Distinctive Growth Type

(1) Cultural Identity Type Streets: Jiefangbei and Three Gorges Square

As the commercial pedestrian streets with the most profound historical and cultural accumulation in Chongqing, both Jiefangbei and Three Gorges Square Streets have their cultural perception (C) dimension firmly located in Quadrant I, demonstrating strong cultural identity and place-based charm. This constitutes their core competitiveness and has garnered widespread public recognition. The environmental perception (A) of Jiefangbei is located in Quadrant II, indicating favorable spatial form and visual quality. In contrast, the location and facility perception (D) of Three Gorges Square falls into Quadrant III, suggesting potential shortcomings in aspects such as transportation connectivity and service facilities.

The commercial perceptions (B) of both streets are situated in Quadrant IV. Their commercial development largely remains in the mode of traditional retail or tourist souvenir shops, which do not create high-value-added immersive consumption scenarios commensurate with their cultural stature. There is a clear "disconnection" between cultural assets and commercial value transformation, which traps these streets in the dilemma of "possessing cultural depth but lacking commercial appeal".

(2) Functional Hub Type: Guanyinqiao and Nanping

The perception structures of Guanyinqiao and Nanping exhibit distinct function-oriented characteristics. Both the environmental perception (A) and the location and facility perception (D) of Guanyinqiao are located in Quadrant II, highlighting the quadrant's advantages in terms of spatial foundation and transportation convenience, which provide them with stable functional support. The location and facility perception (D) and cultural perception (C) of Nanping are both located in Quadrant II, indicating its satisfactory

performance as a subregional center and its degree of cultural affinity. This reflects that both streets, as urban regional hubs, possess relatively good provisions in terms of accessibility, infrastructure, and overall environment.

However, the cultural perception (C) of Guanyinqiao falls into Quadrant III, indicating an insufficient shaping of cultural characteristics and a sense of place, as well as a tendency to overly prioritize commercial functions. The environmental perception (A) of Nanping is also located in Quadrant III, reflecting issues with the refinement of its spatial quality. As products of modern rapid urban construction, the commercial perception (B) of both major streets are concentrated in Quadrant IV. While they have achieved relatively high standards in terms of spatial functionality and infrastructure, their planning may overemphasize efficiency and scale, leading to convergent streetscape appearances, a lack of distinctive historical context, and innovative business offerings. Consequently, they are trapped in a homogenized competitive situation of "having commercial scale but lacking distinctive character".

(3) Distinctive Growth Type Streets: Yangjiaping and Xijie

As later-developing streets, Yangjiaping and Xijie show a marked "coexistence of strengths and weaknesses" in their perception structures. The cultural perception (C) of Yangjiaping is located in Quadrant II, indicating that it possesses a certain cultural heritage and affinity. However, its environmental perception (A) and location and facility perception (D) both fall into Quadrant III, illustrating obvious shortcomings in terms of basic spatial quality and service facilities and severely limiting the improvement of the overall street experience.

The perception structure of Xijie is the most unique, with its location and facility perception (D) shifting to Quadrant I, which fully reflects its locational advantage of leveraging the university town setting and its positive interaction with the young customer base. However, its cultural perception (C) unexpectedly falls into Quadrant III. This presents a strong contrast, indicating that the current cultural expression might be superficial (e.g., murals, art installations) and fail to form truly attractive, immersive cultural activities and atmosphere. As a result, its cultural potential is not fully realized or perceived.

This type of street generally possesses innate advantages in certain aspects (e.g., Yangjiaping's local culture and Xijie's customer base), but its overall planning and operation have failed to achieve systematic synergy. For Yangjiaping, deficiencies in its foundational system (environment, facilities, etc.) restrict the utilization of its cultural advantages. For Xijie, a weak content system (cultural depth) prevents it from fully leveraging its superior location and customer base conditions.

4.4. Differential Analysis: Individual Characteristics of Street Perception Structures

In the second-level perception dimensions, the six commercial pedestrian streets exhibit more refined structural characteristics, which reflect significant differences in element configuration under different development models (Figure 9).

Jiefangbei is characterized by "prominent cultural representation—a weak commercial function." Its cultural dimensions, which include landmarks and nodes (A5) and the cultural and historical atmosphere (C13), are firmly located in the Core Advantages Zone. In contrast, its commercial function dimensions, including business formats (B7), commercial atmosphere (B9), and consumption experience (B11), are concentrated in the Critical Shortcomings Zone, which implies systematic obstacles in the commercialization of its cultural resources.

Guanyinqiao displays an element imbalance pattern of "sound basic functions—a lack of distinctive content." It is basic dimensions such as landmarks and nodes (A5), commercial atmosphere (B9), transportation conditions (D16), and surrounding resources

(D17) perform excellently (Core Advantages Zone). However, business formats (B7), consumption experience (B11), and cultural activities (C15) are severely lacking (critical shortcomings zone) for Guanyinqiao, revealing the crowding-out effect of large-scale development on personalized content.

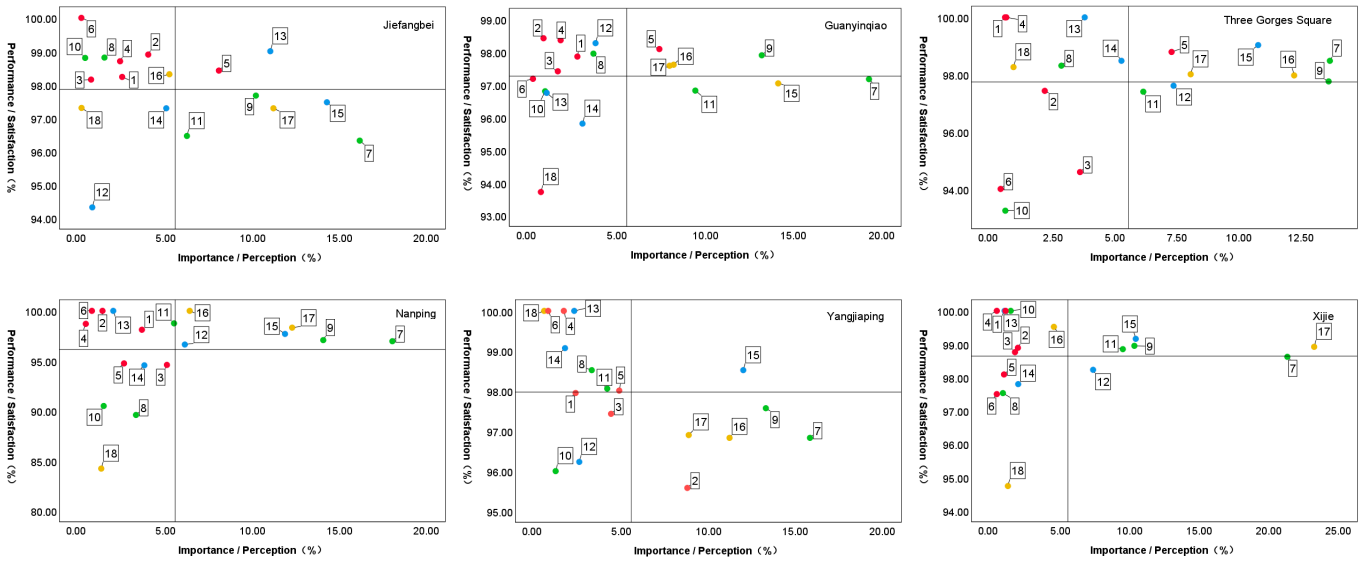


Figure 9. IPA Matrix of Secondary perception dimensions for the six commercial pedestrian streets in Chongqing (Individual). Note: 1. Spatial Scale; 2. Architectural Style; 3. Landscape and Greenery; 4. Nightscape and Lighting; 5. Signage and Nodes; 6. Environmental Cleanliness and Order; 7. Business Formats; 8. Brand Appeal; 9. Commercial Atmosphere; 10. Commercial Activities; 11. Consumption Experience; 12. Crowd Characteristics; 13. Cultural and Historical Ambiance; 14. Sense of Place; 15. Cultural Activities; 16. Transportation conditions; 17. Surrounding Resources; and 18. Service Facilities.

Three Gorges Square shows a combined characteristic of "complete service functions–insufficient experiential quality." Its basic functional dimensions such as landmarks and nodes (A5), transportation conditions (D16), and surrounding resources (D17) are firmly located in the Core Advantages Zone, and business formats (B7), commercial atmosphere (B9), and cultural activities (C15) also receive relatively high evaluations. However, its consumption experience (B11) is located in the critical shortcomings zone, reflecting the need for improvement in service quality and experiential value.

Nanping embodies a configuration model of "balanced functional development–ambiguous distinctive identity." It has multiple dimensions that are distributed in the Core Advantages Zone, with no dimensions falling into the Critical Shortcomings Zone, which demonstrates its stable functional provision as a regional commercial center. However, dimensions such as landscape and greenery (A3), nightscape and lighting (A4), and brand appeal (B8) are located in the Hidden Advantages Zone, which suggests room for improvement in image recognition.

Yangjiaping shows a development trend of "outstanding cultural affinity–weak systemic support." Its cultural activities (C15) perform excellently (Core Advantages Zone). However, multiple basic and commercial dimensions, including architectural style (A2), business formats (B7), commercial atmosphere (B9), transportation conditions (D16), and surrounding resources (D17), simultaneously fall into the critical shortcomings zone, thereby forming a development situation of "single-point prominence, systemic weakness." This reflects the underlying problem of insufficient synergy among the various systems within the street.

Xijie demonstrates an element configuration of "prominent youth vitality–superficial cultural connotation." Its vitality dimensions such as the commercial atmosphere (B9), consumption experience (B11), and cultural activities (C15) are located in the Core Advantages Zone, thus confirming the success of its youth-oriented positioning. However, both business formats (B7) and crowd characteristics (C12) are in the Critical Shortcomings Zone, which suggests a gap between the supply of commercial content and the diversified demands of its young customer base.

In summary, the differences in the distribution of the secondary dimensions across these streets not only confirm the analysis of perception characteristics and the diagnostic results from the primary dimensions but also further reveal the internal logic and structural characteristics of street element configurations under different development models. This provides a more refined analytical perspective for understanding the differentiated development paths of commercial pedestrian streets.

5. Discussion

5.1. Analysis of the Causes of Common Challenges Faced by Commercial Pedestrian Streets

The common challenges for Chongqing's six major commercial pedestrian streets revealed by this study—namely, the widespread placement of commercial perception and cultural perception in Quadrant IV ("High Importance—Low Performance")—can be systematically analyzed from four aspects: planning and design, commercial operation, governance mechanisms, and cultural expression.

5.1.1. Planning and Design Level: Prioritization and Disconnection from Functional Content

There is a widespread path dependency in the current planning and construction of commercial pedestrian streets, in which form is prioritized over content. This logic focuses on the visual order improvement of physical space and infrastructure enhancement in an attempt to build attractiveness through grand landmarks, tidy streets, and convenient transportation. This planning path can quickly improve the hardware environment. However, it generally neglects the street's cultural core and distinctive commercial formats. Consequently, structural misalignment emerges between high-quality spatial carriers and mediocre place content. This misalignment ultimately undermines the streets' core competitiveness.

5.1.2. Commercial Operation Level: The Conflict Between Standardized Supply and Personalized Demand

At the commercial operation level, capital-driven, large-scale, fast-turnover development models tend to introduce low-risk, replicable chain brands, which results in severe homogenization in business format composition. Moreover, short-term lease policies and high rent thresholds squeeze the living space of small and micro creative businesses. These conditions make it difficult to sustainably develop commercial content with local characteristics and cultural connotations. This creates a sharp contradiction with the public's growing demand for uniqueness, experientiality, and cultural relevance in the current consumption upgrade context and directly leads to a low approval rating in the commercial perception dimension.

5.1.3. Governance Mechanism Level: The Imbalance Between Static Control and Dynamic Operation

Existing street governance mechanisms exhibit distinct "static" characteristics. Planning and construction are often oriented toward an ultimate blueprint and lack flexible adjustment mechanisms for responding to market changes and achieving continuous

operational thinking. There is insufficient connection among cultural activity planning, commercial format guidance, and daily space management. This disconnect causes streets to fall into functional solidification after completion. This governance model, which lacks dynamic content updates and refined operations, makes it difficult for these streets to maintain sustained vitality, which ultimately leads to the mediocrization of public experience and emotional detachment.

5.1.4. Cultural Expression Level: The Disconnect Between Symbolic Presentation and Experiential Integration

In the process of cultural value transformation, there is a widespread disconnect between "symbolic" expression and "experiential" integration. Most streets' cultural resource utilization, such as the renovation of historical building facades and the application of cultural patterns, remains at the superficial level of symbol extraction and visual presentation and lacks an effective means of transforming cultural connotations into participatory, immersive contemporary life practices. The failure to organically integrate cultural expression with commercial consumption and daily activities prevents the profound cultural heritage of some streets from being transformed into sustained place attractiveness, ultimately causing high expectations but low approval ratings in cultural perception. Collectively, these empirical findings test and refine the prevailing 'form-priority' paradigm, suggesting a refinement toward a more integrated 'form-content synergy' model in which spatial quality and experiential content are mutually reinforcing rather than hierarchically ordered.

5.2. Overall Street Optimization Strategies Based on Four-Dimensional Perception

The following optimization strategies are directly derived from the IPA quadrant results, in which importance is represented by relative keyword frequency and performance is measured by the average sentiment score of the reviews associated with each perception dimension. Accordingly, the proposed interventions focus on addressing Critical Shortcomings, activating Hidden Advantages, and consolidating Core Advantages.

5.2.1. Environmental Perception Dimension: The Promotion of the Transformation from a Static Base to a Situational Carrier

The environmental perception dimension is located in the Hidden Advantages Zone of Quadrant II and is characterized by relatively high levels of public approval but insufficient relative attention. The core optimization for this dimension lies in realizing the value transformation from a "static base" to a "situational carrier"—that is, transforming highly approved static spatial resources into perceptible, narratable experiential carriers.

Optimization strategies in the environmental dimension should focus on two key aspects. First, nightscape lighting and spatial nodes should be strategically integrated. The street's cultural IP—such as mountain city lanes and dock stories—should be embedded into thematic light art installations and narrative routes. This integration can transform functional squares and monuments into visual focal points that combine check-in appeal with cultural storytelling. Second, spatial microrenewal should be promoted for spatial scale, landscape, and architectural style. Targeted interventions should focus on micrspaces, including street corners, building boundaries, and idle gaps. Design methods—such as characteristic paving, modular greening, vertical green walls, and facade activation—can translate large-scale spatial features into tangible detail experiences, ultimately enhancing the public's perception of spatial quality.

Furthermore, in the aforementioned value transformation process, priority must be given to ensuring "environmental cleanliness", which is located in the Hidden Shortcomings Zone. As a foundational element of spatial quality, environmental cleanliness is the basic prerequisite for the realization of all the other optimization strategies. Without this

basic guarantee, even the most creative light-and-shadow narratives and spatial micro-renewal strategies will have their overall experiential effects severely weakened. Therefore, maintaining high standards of environmental cleanliness should be treated as a fundamental task throughout the entire process to provide solid support for the transformation of hidden advantage elements into core competitive advantages.

5.2.2. Commercial Perception Dimension: Implementing Reconstruction from Homogenized Supply to Characteristic Scenarios

The commercial perception dimension is located in the Critical Shortcomings Zone of Quadrant IV, and it is characterized by high public attention but significantly insufficient approval. The core of optimization for this dimension lies in implementing a strategic reconstruction from "homogenized supply" to "characteristic scenarios" to enhance the uniqueness and experiential value of commercial content through systematic interventions. Accordingly, creative markets and brand-oriented activities are proposed to address the Critical Shortcomings in Business Formats and Consumption Experience, activate Commercial Activities and Brand Appeal, and build on the existing Core Advantage of Commercial Atmosphere.

Optimization strategies include the following: first, for "commercial formats" and "consumption experience," which are both located in the Critical Shortcomings Zone, business format guidance policies that match the street's cultural positioning should be formulated. By setting differentiated access conditions, providing rent incentives and incubation support, focusing on the cultivation of slow consumption formats with local characteristics, such as local cultural and creative industries, and providing characteristic catering and experience workshops, the street's unique commercial gene can be developed and the public's consumption experience can be improved. Second, for both "brand appeal," which is in the Hidden Advantages Zone, and "commercial activities," which is in the Hidden Shortcomings Zone, through the introduction of well-known brands to open theme-limited stores, the conducting of co-branding collaborations, and the full utilization of public spaces for regular thematic activities such as design markets and brand pop-up exhibitions, commercial activities themselves can be transformed into continuously updated consumption attractions, thereby enhancing the dynamic effectiveness of brand value.

5.2.3. Cultural Perception Dimension: Deepening the Transition from Cultural Symbols to Participatory Narratives

The cultural perception dimension is located in the Critical Shortcomings Zone of Quadrant IV and characterized by strong public expectations but insufficient approval of the actual experience. The core of the optimization strategy for this dimension lies in deepening of content creation from that of "cultural symbols" to that of "participatory narratives" to transform abstract cultural connotations into perceptible, interactive real-world experiences. Accordingly, cultural events and narrative routes are proposed to address the Critical Shortcoming in Cultural Activities and the relatively weak Sense of Place, while activating the existing Cultural and Historical Ambiance.

Optimization strategies include the following: first, for "cultural activities," which are situated in the Critical Shortcomings Zone, combined with the "cultural and historical atmosphere," which is located in the Hidden Advantages Zone, it is recommended to systematically plan an annual, thematic calendar of public cultural activities, such as street theater festivals, intangible cultural heritage handicraft workshops, and urban sound collections, to transform the static historical and cultural atmosphere into dynamic, participatory contemporary life practices is recommended. Second, for the "sense of place," which is positioned in the Hidden Shortcomings Zone, the integration of elements such as local

dialects, old photographs, and traditional materials into store designs, public art, and wayfinding systems should be encouraged, and immersive narrative tour routes around "Chongqing Flavor" or the "Mountain City Code" should be developed to strengthen the public's cognition of the streets' uniqueness and emotional attachment.

5.2.4. Location and Facility Perception Dimension: Upgrading Basic Guarantees to Seamless Service

The location and facility perception dimension as a whole is located in the Hidden Advantages Zone of Quadrant II, and it is characterized by relatively high levels of public approval but insufficient relative attention. The core of the optimization strategy for this dimension lies in enhancing the intelligence and user-friendliness of services while maintaining high performance.

Optimization strategies include leveraging "transportation convenience" in the Core Advantages Zone and "service facilities" in the Hidden Shortcomings Zone, as well as the optimization of the last-kilometer connection between the street and public transportation hubs (e.g., subway stations) to provide clear pedestrian navigation and shared micromobility options. Simultaneously, digital management of basic service facilities such as restrooms, seating, and Wi-Fi coverage should be implemented to achieve high-quality service that is "invisible" yet "not unfelt". Furthermore, for "surrounding resources" in the Core Advantages Zone, "regional linkage theme routes" should be designed to systematically connect the street with its surrounding resource points such as parks, art galleries, museums, and cultural and creative streets, and themed tours such as "Art Walk Routes" or "Gourmet Exploration Routes" should be created to transform the locational advantage of the street into a broader consumption ecosystem advantage and make it a core strength of the street. The implementation of these strategies would involve collaboration among municipal planning authorities, commercial operators, and community organizations, with expected outcomes including enhanced visitor satisfaction, increased dwell time, and strengthened commercial vitality.

5.3. Targeted Optimization Strategies for Individual Streets

Based on the individual secondary-dimension IPA results presented in Figure 9, the following street-specific strategies are intended to address each street's Critical Shortcomings while maintaining and leveraging its Core Advantages.

On the basis of the specific differences in each street in the four-dimensional perception IPA, targeted differentiated optimization paths are further proposed to guide each street in precisely addressing its structural shortcomings while maintaining its existing advantages to achieve synergistic improvement in function and quality.

5.3.1. Cultural Identity Type Streets: Strengthening the Commercialization Capacity of Cultural Resources

(1) Jiefangbei

Focus should be placed on promoting the scenario-based transformation of cultural resources and the integration of formats, such as the introduction of experiential formats, including immersive theaters, intangible cultural heritage workshops, and themed cultural and creative collective stores, to develop culture–consumption linkage scenarios. Simultaneously, a tiered brand introduction mechanism should be established to restrict homogeneous commercial expansion, and cultural and creative retail formats with local characteristics should be actively cultivated to enhance consumption stickiness and brand recognition.

(2) Three Gorges Square

This street should focus on promoting refined improvements in service quality and spatial experiences. By implementing merchant service standardization, optimizing public space rest facilities, and adding cultural guide interactive installations, public approval and lingering intentions can be enhanced. Simultaneously, the internal and external transportation transfer systems should be optimized to increase both street accessibility and stay comfort, thereby creating a user-friendly consumption environment.

5.3.2. Functional Hub Type Streets: Promoting the Transformation from Functional Carriers to Content Platforms

(1) Guanyinqiao

Strengthening the implementation of characteristic content and cultural expression while maintaining the advantage of a commercial scale is recommended. A "Creative Format Incubation Zone" can be established to guide niche designer brands and cross-border experience stores and to establish the systematic planning of thematic commercial activities, such as design weeks and pop-up markets, for enhancing the dynamic attractiveness of the commercial space. Simultaneously, the visual identity and narrative capability of cultural nodes can be enhanced through carriers such as art installations and street galleries.

(2) Nanping

The focus for this street should be placed on enhancing image recognizability and brand appeal, prioritizing the optimization of the nightscape lighting system, renovating commercial outdoor seating areas, and planning thematic marketing activities to shape a memorable street brand image. In terms of the format mix, the proportion of chain brands should be moderately controlled, and the development of regional characteristic brands should be increased to stimulate commercial vitality through differentiated content.

5.3.3. Distinctive Growth Type Streets: Addressing the Systemic Shortcomings and Deepening the Cultural Connotation

(1) Xijie

Going beyond the superficial expression of visual symbols and deepening the content production and community cultivation of youth culture is recommended. By establishing a youth creative alliance, hosting branded art festivals, and implementing campus co-creation programs, the street can be upgraded from a "youth gathering place" to a "source of youth culture", resulting in the capacity for continuous content updating and dissemination.

(2) Yangjiaping

The current priority for Yangjiaping is addressing its systemic shortcomings in infrastructure and spatial quality, including optimizing the transportation transfer system, improving the quality of street furniture and greening, and optimizing public service facilities. On this basis, its cultural resources should be fully utilized to create characteristic activities such as community art festivals and local cultural markets, and the organic synergy between "cultural resources" and "commercial functions" should be promoted.

6. Conclusions and Implications

6.1. Main Conclusions

On the basis of UGC data, word-frequency analysis, sentiment analysis, and IPA are integrated into this study to systematically dissect the public perception characteristics, structural issues, and their underlying causes within the six major commercial pedestrian streets of Chongqing. The main conclusions are as follows:

6.1.1. Public Perception Exhibits the Structural Tension of an "Importance–Performance" Imbalance

The results of this study reveal that the overall public emotional evaluation of the six commercial pedestrian streets in Chongqing shows a high-level equilibrium trend, with the proportion of positive sentiments all in excess of 92%, which reflects the fact that these streets have established widespread public trust at the basic environment and service guarantee levels. High-frequency-word analysis reveals significant differences in cognitive functions, with each street being perceived as having different roles to play, such as those of cultural landmarks, commercial hubs, and regional centers.

However, the IPA reveals the structural contradiction behind the overall positive impression: the cultural perception and commercial perception dimensions, which represent the core competitiveness of the streets, generally fall into the Critical Shortcomings Zone of "High Importance–Low Performance," whereas the basic dimensions such as environment and location and facilities are located in the Hidden Advantages Zone of "Low Importance–High Performance". This contrast suggests that the public's overall emotional preference may be based on access convenience and initial spatial impressions, while there is widespread disappointment regarding the deep experience of the streets' cultural connotation and commercial quality, resulting in the formation of a cognitive separation between the evaluations of emotion and those of specific functional dimensions.

6.1.2. Common Street Challenges Reveal the Systemic Limitations of the "Form-Priority" Planning Approach

In this study, the common core problems faced by all streets are identified as the homogenization of commercial formats and the superficiality of cultural expression. Their causes are rooted in urban renewal's current dependence on the "form-priority" planning path. This path overemphasizes physical space renovation and visual order creation. Although it improves hardware levels in the short term, it leads to a systemic imbalance across the four levels of planning and design, commercial operation, governance mechanisms, and cultural expression.

Specific manifestations include the disconnection between form and function in planning and design, the suppression of personalized cultivation by standardized supply in commercial operations, the lack of dynamic operational thinking in governance mechanisms, and the symbolic presentation that constrains deep experiences in cultural expression. Ultimately, this prevents the effective transformation of high-quality static spatial capital into dynamic place content with sustained attractiveness, thus constituting a fundamental bottleneck that restricts the high-quality development of these streets.

6.1.3. Street Development Type Differentiation Requires a Governance Logic of "Precise Diagnosis—Differentiated Intervention"

Under common challenges and on the basis of the differences in perception structure, the streets can be divided into three differentiated types: first, the cultural identity type, whose core competitiveness is clear but contains challenges in the conversion of cultural resources into commercial value, being trapped in the dilemma of "having cultural connotations but lacking commercial connotations"; second, functional hub-type streets, which have solid basic functional support but insufficient cultural characteristics and face the risk of over-commercialization and appearance homogenization; and third, the distinctive growth type, whose development situation presents coexisting "strengths and weaknesses" and is either constrained by basic system shortcomings or stuck with superficial cultural connotations. This typological difference requires planning management to transcend universal strategies. Instead, differentiated interventions should be adopted based on precise diagnoses.

6.1.4. Optimization Paths Require a Systemic Shift from "Space Shaping" to "Content Operation"

In response to the conclusions detailed above, the optimization strategy framework for this study emphasizes a fundamental paradigm shift. At the overall level, promoting the transformation of environmental perception from a static base to a situational carrier, reconstructing commercial perception from homogenized supply to characteristic scenarios, deepening cultural perception from cultural symbols to participatory narratives, and improving the location and facility perception from that of a basic guarantee to that of a seamless service is necessary. At the individual street level, personalized strategies should be implemented: the development of cultural landmark-type streets should focus on the innovative commercial transformation of cultural value; that of functional hub-type streets should be focused on the cultivation and implantation of characteristic content; and that of distinctive growth-type streets should address systemic shortcomings or deepen cultural connotations to achieve effective resource integration and value release.

6.2. Research Contributions

6.2.1. Methodological Contribution: Analytical Path in Which NLP and IPA Are Integrated

In this study, NLP technology is integrated with the IPA method to address the data scale and timeliness limitations of traditional questionnaires. By systematically mining unstructured UGC data, dynamic and refined measurements of public perception preferences and approval are achieved, which provides methodological support for the quality evaluation of commercial pedestrian streets.

6.2.2. Theoretical Framework Contribution: A Four-Dimensional (Environmental, Commercial, Cultural, Locational and Facilities) Perception Model

In this study, a multidimensional evaluation framework covering physical space, commercial functions, cultural connotations, and support systems was constructed, and the internal structure of public perception of commercial pedestrian streets was systematically analyzed. This framework not only reveals the heterogeneous development patterns of different streets across perception dimensions but also provides an analytical basis for understanding the constituent elements of street competitiveness in high-density urban environments.

6.2.3. Practical Application Contribution: Shifting Decision Support from Data Insight to Precise Objectives

Through sentiment analysis and IPA quadrant positioning, the factors associated with public approval and priority improvement zones were identified, and the "Core Advantages Zone" and "Critical Shortcomings Zone" were clarified. This provides empirical evidence for planning managers aiming to implement differentiated renewal strategies and optimize resource allocation, potentially facilitating the governance transition of commercial pedestrian streets from "scale expansion" to "quality improvement".

6.3. Research Limitations and Prospects

6.3.1. Limitations and Extensions at the Data and Methodological Levels

This study relies on public UGC data, which can involve sample self-selection bias, namely, the differences in perception between active online users and the general population. Future research should combine multi-source data such as questionnaires and field observations for cross-validation to enhance the universality and robustness of the research conclusions.

In addition, the uneven sample size across the six streets may affect the stability of the perception estimates for streets with fewer reviews, particularly Nanping (n = 251).

While our sensitivity check confirmed the robustness of the main IPA patterns, we acknowledge that statistical inferences from smaller samples are less stable. Future studies with more balanced data collection—or through the integration of additional data sources—would strengthen the reliability of comparative analyses across streets with large sample-size disparities.

The sentiment analysis relied on a publicly available pretrained model without additional fine-tuning or independent validation on the present Dianping review dataset. Although its consumer-review training domain is relevant to this study, the model may not fully capture context-dependent expressions, mixed sentiments, irony, or local linguistic features. Future research should validate the model using manually annotated samples and report classification metrics such as accuracy, precision, recall, and F1-score.

Furthermore, because the IPA quadrant classification is based on mean-value crosshairs, indicators close to quadrant boundaries may shift with small changes in keyword frequency, sentiment scores, or threshold settings. Accordingly, the quadrant results should be interpreted as a relative diagnostic structure rather than as fixed categorical divisions. Future studies could compare alternative threshold settings and conduct additional robustness tests.

Another limitation concerns the lack of user-group differentiation in the current analysis. The UGC data used in this study do not contain explicit user identity information, making it impossible to distinguish whether reviewers are residents, tourists, commuting workers, or students. These groups may hold divergent expectations and perceptions of commercial pedestrian streets: tourists may prioritize iconic landmarks and visual esthetics, whereas residents may value daily convenience and service accessibility. This limitation is compounded by the uneven distribution of user types across the six streets. For instance, Xijie is situated within a university town, and its reviews are likely dominated by students and young visitors, while Jiefangbei attracts a higher proportion of tourists. The aggregation of perception data across all users inevitably masks these group-specific variations. Future research should incorporate user-profiling techniques, such as analyzing review language patterns, check-in frequencies, or stated travel purposes, to enable more targeted and inclusive street design.

6.3.2. Room for Expansion in Cases and Scale

This study focuses on six commercial pedestrian streets in Chongqing. Its conclusions have certain reference value for similar high-density cities, but different cultural backgrounds and distinct development stages can lead to differences in perception structures. Future research should conduct cross-city and cross-cultural comparative studies to explore the common and individual patterns of quality perception in commercial pedestrian streets.

6.3.3. Dynamic Evolution and Long-Term Tracking Research

The quality perception of commercial streets is a dynamic, evolutionary process. This study is based on a cross-sectional analysis and cannot reflect the long-term development trends of these streets. Future research should conduct longitudinal tracking studies in conjunction with street renewal policies and major events to reveal the temporal evolution patterns of public perception and its influencing factors.

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