Grounded Theory-Derived Quality Assessment of Indoor Badminton Venues Based on Online Reviews: From Functional Experience to Acoustic Perception

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Article

Grounded Theory-Derived Quality Assessment of Indoor Badminton Venues Based on Online Reviews: From Functional Experience to Acoustic Perception

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Abstract

Indoor badminton venues are common mass-fitness spaces in China, but their acoustic environment remains underexamined relative to lighting, thermal comfort, and functional facilities. This study uses grounded theory to examine how users perceive acoustic conditions within the broader experience of indoor badminton venues. A total of 4,721 raw online reviews for seven purposively selected venues in five Chinese cities were collected, and 3,937 valid reviews remained after preprocessing. A hybrid text-processing procedure combining DeepSeek-V3-assisted term pre-screening and Python jieba segmentation identified 74 core high-frequency terms; all grounded-theory coding was conducted manually in NVivo 15. Open, axial, and selective coding generated 32 initial categories, 6 main categories, and an Indoor Badminton Venue User Experience Perception Model. Acoustic-related categories were then extracted to construct an Acoustic Environment Perception Mechanism sub-model. The results show that noise level was directly mentioned in only 45 reviews but was indirectly embedded in sport atmosphere, time-based flow, and user experience, indicating a latent perceptual role. Moderate sound may be interpreted as a vibrant sport atmosphere, whereas crowd overload and reverberant spatial conditions may shift perception toward chaotic noise. The findings provide qualitative evidence for integrating user-centered acoustic considerations into the design and operation of mass-leisure sports venues.

Keywords: indoor badminton venue; acoustic environment perception; grounded theory; user experience; online reviews

1. Introduction

Indoor sports facilities have become essential infrastructure in modern urban environments, supporting the growing global emphasis on physical activity and public health [1]. As a key provider of mass fitness, the environmental quality of indoor sports venues directly affects users' exercise experiences and health benefits. Badminton, one of the most popular sports in China, benefits from being weather-independent, having flexible exercise intensity, and a low participation threshold; consequently, indoor badminton venues have become core sports facilities in urban communities and commercial complexes. However, while venue construction has flourished, issues with the acoustic environment have long been overlooked. Indoor badminton venues, owing to their large space volumes and numerous reflective surfaces, are highly prone to acoustic problems such as excessive reverberation and noise accumulation [2,3], severely impairing users' communication and exercise experiences [4].

Studies have shown that the acoustic environmental quality of sports buildings varies significantly with venue type, spatial enclosure, and user density. Yoo [2] found that the Ulsan Sports Hall in Korea suffers from severe acoustic issues (e.g., excessive reverberation, echoes, and sound focusing) due to

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its large volume and abundant hard reflective interior surfaces. Al-Arja et al. [3] conducted in-situ acoustic measurements in 20 indoor fitness halls in Amman, Jordan, finding reverberation times as high as 1.09–5.38 s and equivalent sound pressure levels of 80–110 dB(A) during activity, with 90% of the personal daily noise exposure measurements exceeding the occupational exposure limit of 85 dB(A); most venues lacked any acoustic treatment. Conetta et al. [4] examined 9 indoor sports halls and gymnasiums in the UK and found that mid-frequency reverberation times in most venues far exceeded standards, with noise levels significantly elevated during physical education classes due to high student density. Del Brenna [5] surveyed 18 sports halls across 14 venues in Helsinki, with fewer than half meeting current acoustic specifications. Ansari [6] pointed out that indoor swimming pools represent one of the most acoustically challenging types of sports buildings, where the enormous space and humid environment lead to particularly prominent reverberation problems. Deng [7] surveyed the acoustic environment of 10 sports training halls and identified excessive reverberation time as the core acoustic deficiency. Chen and Ma [8] studied 8 large-space buildings in Tianjin, including sports buildings, and found that background noise was generally high in many large-space settings; overall, more than 90% of surveyed users reported that the acoustic environment affected their mood, attention, thinking, or behavior. Similar acoustic challenges have been confirmed in other large-span public spaces such as airport departure lounges [9] and hospital outpatient halls [10].

Existing research on the acoustic environment of sports buildings has mostly focused on large comprehensive venues or professional competition venues [2,4–7], while studies on mass-oriented badminton venues, primarily used for fitness and social activities, are relatively scarce. Sjödin [11] used the 2017 BWF World Badminton Championships as the experimental setting and found that equivalent noise and impulsive sound levels exceeded limits during prolonged work by technical officials, posing a risk of hearing damage; however, that study focused on professional events rather than mass leisure venues. Furthermore, existing studies and standards generally emphasize the measurement and analysis of objective acoustic parameters [12,13], while the systematic exploration of users' subjective perceptual experiences remains insufficient, leading to a disconnect between objective measurement and subjective perception [8]. A recent study by Huang et al. [14] conducted an empirical study in six high-traffic badminton venues to examine the relationship between acoustic and emotional factors in badminton hall environments and users' evaluations of acoustic comfort. The findings indicated that noise levels in indoor badminton venues exhibit pronounced temporal fluctuations, and fewer than half of the respondents reported satisfaction with the acoustic conditions. In addition, users' intrinsic interest in and enthusiasm for badminton significantly influenced their subjective perception of acoustic comfort. Concurrent with this, the contribution of acoustic comfort to overall environmental comfort was found to surpass that of thermal comfort.

While the above studies, particularly the recent findings by Huang et al. [14], have offered initial empirical evidence on users' subjective perceptions of the acoustic environment in indoor badminton venues, these insights remain largely descriptive and derived from structured surveys. Such approaches may not fully capture the complexity, contextual richness, and latent dimensions of user experience as it unfolds in real-world settings. A more in-depth, inductive inquiry is therefore needed to systematically explore how users perceive, interpret, and respond to the acoustic conditions within the holistic context of badminton hall use. To address this gap, the present study adopts grounded theory—a qualitative methodology that enables theoretical constructs to emerge directly from empirical data.

Grounded Theory was proposed by Glaser and Strauss [15] in 1967 as a bottom-up inductive qualitative research method. Its core lies in deriving theory grounded in practice through the collection, coding, and analysis of real-world data. Through inductive reasoning and data analysis, theoretical saturation is reached—i.e., when newly added data no longer generate new conceptual categories, theory construction is complete. The research process is non-linear and can be iteratively refined [15–17]. Its core operational logic is to identify core concepts and their internal connections and to construct

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a theoretical system bottom-up [18,19], through three levels of analysis: open coding, axial coding, and selective coding [16,20].

Grounded theory has been widely applied in urban open spaces [21], urban parks [22], landscape architecture [23], and soundscape studies [24–26]. In the field of environmental perception, Glover [27] used narrative interviews and grounded theory to extract the operational patterns of social capital in community gardens. Related soundscape-emotion research has also provided useful measurement references: Zhang et al. [28] conducted a laboratory audio-visual experiment using 16 urban open-space soundscape excerpts from Harbin and a Chinese questionnaire, developed semantic differential scales from 92 candidate emotional-descriptive terms, and identified 5 categories of felt emotions and 7 categories of perceived emotions through factor analysis. Hussein et al. [29] adopted constructivist grounded theory and proposed a practical pathway for incorporating cultural memory protection into historic urban landscape management. Li et al. [24] used grounded theory to construct a five-dimensional integration model of traditional Chinese garden elements in modern urban landscape design. Moshona et al. [25] derived an eight-dimensional taxonomy of soundscape interventions based on 43 real-world soundscape intervention cases worldwide, while Ercakmak Osma and Dokmeci Yorukoglu [30] further proposed Indoor Soundscape Intervention (ISI) criteria for architectural practice through a systematic review with grounded theory analysis.

In soundscape research, Liu and Kang [31] used grounded theory to reveal five core categories of subjective understanding of urban soundscapes: soundscape definition, soundscape memory, soundscape emotion, soundscape expectation, and soundscape esthetics. Cao and Kang [21] used grounded theory to construct a perceptual structure of soundscapes in urban public spaces, identifying four perceptual dimensions: sound classification, sound features, psychological responses, and soundscape preferences. Orhan and Yilmazer [32] adopted grounded theory to investigate the indoor soundscape perception framework of neonatal intensive care units. These studies indicate that grounded theory, as the qualitative research method recommended by the International Organization for Standardization (ISO) 12913-3 [33], is particularly suitable for exploring emerging interdisciplinary fields lacking mature theoretical support.

For the methodological combination of "online reviews + grounded theory," several recent representative studies are also available: Tao and Duan [34] used Qianmen Street in Beijing as a case study and constructed a historic street renewal evaluation system containing 4 first-level and 15 second-level indicators based on online reviews and grounded theory; a study on age-friendly rural public spaces [35] further integrated grounded theory with FKANO and DEMATEL to identify priority levels of user needs; grounded theory analysis driven by online review data has also been successfully extended to shared bicycle winter travel [36] and Airbnb user experience [37], among other domains. Meanwhile, large language model–based mining of Dianping reviews has been validated in consumer perception research—e.g., applying the Qwen3-32B model to perform Function-Experience-Symbolism (F-E-S) framework semantic mapping on reviews of Beijing time-honored restaurants [38]. These studies provide direct methodological references for the present research design. Additionally, Lyu [22] collected review texts of urban parks from Dianping and other platforms and used grounded theory to construct a tourist satisfaction evaluation system; Chen [39] applied three-level grounded coding to build a post-occupancy evaluation model for archeological site parks; Liu [40] combined grounded theory to identify localized sound sources in She ethnic villages and comparatively analyzed perceptual differences between hosts and guests regarding sound sources and soundscapes.

Based on the above background, this study employs grounded theory to qualitatively analyze the acoustic environment of indoor badminton venues. In terms of research strategy, this paper deliberately adopts a two-stage path of "first constructing an overall experience model, then extracting the acoustic sub-model" rather than coding only acoustic-related reviews in isolation. The specific objectives include: (1) using authentic online reviews from Dianping as the raw data to bottom-up construct an indoor badminton venue user experience perception model; (2) within this model framework, isolating and focusing on the acoustic dimension to refine an acoustic environment

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perception mechanism sub-model; (3) clarifying the latent role of the acoustic environment in overall experience, its core influencing factors, and users' latent acoustic needs, thereby providing theoretical support for subsequent quantitative evaluation and optimized design of the acoustic environment. This strategy is adopted because acoustic requirements in badminton venues do not exist as isolated technical parameters; rather, they are embedded in multi-dimensional interactions among physical space, crowd-flow operation, and users' psychological expectations. Locating the acoustic dimension within the overall experience framework, therefore, helps reveal the latent characteristics of acoustic needs more accurately.

2. Materials and Methods

The overall research procedure is summarized in Figure 1.

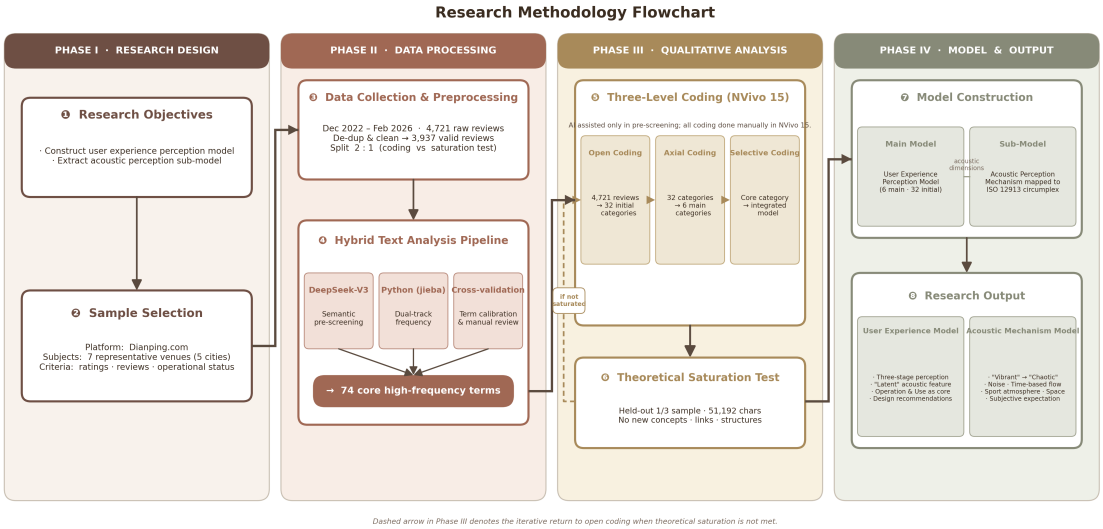

Figure 1. Research methodology flowchart. The workflow includes research design, data collection and preprocessing, grounded-theory coding, theoretical saturation testing, and model construction.

2.1. Selection of Study Venues

To deeply explore the multi-dimensional perceptual characteristics and evaluative demands of users regarding the acoustic environment of badminton venues in real exercise scenarios, this study constructed a theoretical model of acoustic experience and evaluation for such specific sports venues bottom-up by scraping authentic online review data from the Dianping platform.

Grounded theory emphasizes building theory bottom-up from raw data, requiring authentic, natural texts close to users' on-site experiences. As textual carriers of users' spontaneous evaluations, online reviews offer stronger immediacy and authenticity than questionnaire surveys and structured interviews [41,42]. This "online reviews + grounded theory" research paradigm has recently been exemplarily validated in the field of built environment evaluation [34], and the present research design directly draws on these prior works.

Dianping (Dianping.com) is a major Chinese local lifestyle service rating platform, with functions and a business model similar to those of Yelp and TripAdvisor internationally [38]. The platform aggregates a large volume of spontaneous feedback from consumers after authentic on-site experiences; reviews actively posted by users after actual consumption are less affected by researcher-imposed preset questions and can therefore more authentically present subjective feelings [41,43,44]. In recent years, text mining methods based on such online reviews have been widely applied in tourism experience [43], restaurant services [44], brand image research [38], and public space perception [34], among other fields. Grounded theory analysis based on online reviews has also recently extended to digital platform studies such as Airbnb user experience [37], further supporting the methodological feasibility of using online reviews as the corpus in this study. Although the samples in this study

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are all drawn from Chinese cities, mass-oriented indoor badminton venues exhibit globally common spatial configurations (large span, high clearance, hard reflective surfaces) and usage patterns (high density, leisure socializing); thus, the findings provide reference value for the acoustic design of similar indoor leisure sports venues internationally.

In terms of sample selection, to ensure the richness of the raw text database and to enable the data to reach the saturation required by grounded theory, this study comprehensively considered factors such as urban distribution, venue popularity, and audience reach. Ultimately, 7 differentiated badminton venues located in 5 cities—Beijing, Shanghai, Guangzhou, Wuhan, and Nanning—were selected as research samples. Venue selection was based on a comprehensive evaluation of indicators such as user star ratings, the number of valid reviews, operational status, and information completeness on Dianping; the selection covered a differentiated gradient of star ratings from 3.3 to 4.8 and prices from 35 to 114 CNY/hour, in order to maximize the richness of perceptual features. Distribution information of the 7 sampled venues is shown in Table 1, and their geographic distribution is shown in Figure 2.

Table 1. Basic information of the 7 sampled badminton venues.

Venue Name	City	Valid Reviews	Star Rating (out of 5)	Average Price (CNY/court)
SUPERBOX Super Show	Beijing	1625	4.8	114
Binjiangge	Wuhan	810	4.8	80
Youth Palace Badminton Center	Wuhan	681	4.3	65
588 Badminton Gym	Shanghai	322	4.2	46
104 Badminton Gym	Guangzhou	159	3.6	107
New Elite Badminton Gym	Guangzhou	242	3.4	65
Xiuxiang Aoguan Gym	Nanning	98	3.3	35

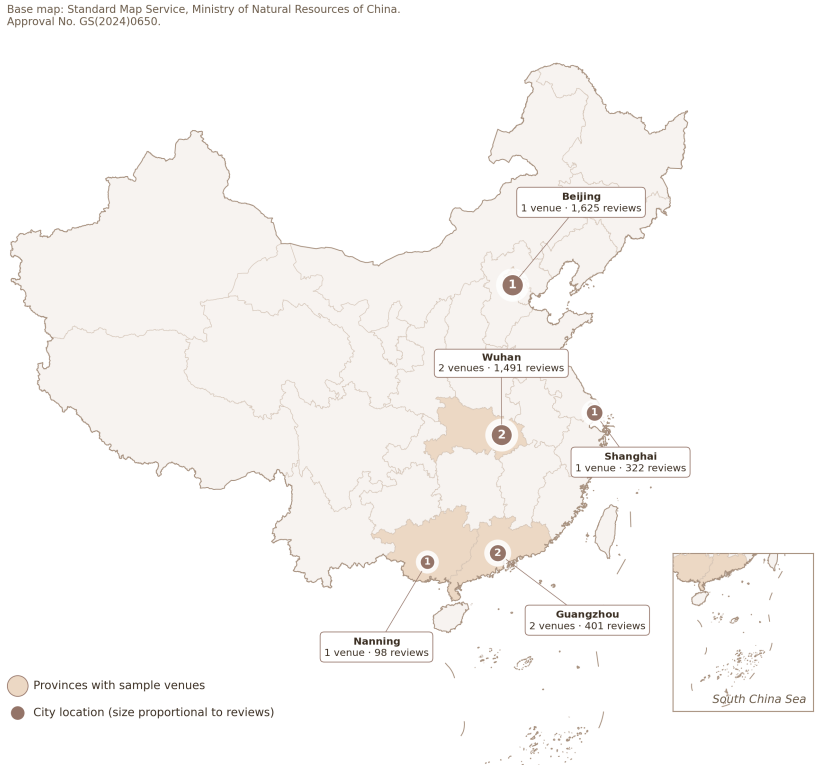

Figure 2. Geographic diribution of the seven sampled badminton venues. The map shows the city-level distribution of the sampled venues and review counts.

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2.2. Data Collection and Preprocessing

This study used a Python plug-in to collect review data from the Dianping platform, selecting user reviews of the 7 above-mentioned badminton venues from December 2022 to February 2026, yielding a total of 4,721 raw reviews. Each review primarily contained the user name, review time, star rating, and review text. Before text analysis, usernames and other personal identifiers were removed or anonymized.

After acquiring the raw review data, the textual material was preprocessed to enhance the quality of subsequent coding analysis: duplicate posts, meaningless spam, reviews containing only simple emoticons, and reviews with no substantive information were removed; special characters, garbled text, and ineffective content with low relevance to the research topic were deleted; after format unification, 3,937 valid records remained. The valid review texts were then divided in a 2:1 ratio into two groups: two-thirds (with 123,234 characters after preprocessing) served as the core sample for three-level coding, while the remaining one-third (with 51,192 characters after preprocessing) was reserved for subsequent theoretical saturation testing. All valid texts were finally imported into NVivo 15 for coding analysis.

In qualitative research using online reviews as material, conducting word frequency analysis first allows researchers to quickly grasp core issues and refine sensitive concepts before initiating open coding, which improves the targeted nature of concept extraction and category induction.

2.3. Hybrid Text Analysis Method

In preliminary attempts at text preprocessing and word frequency mining, this study found that the traditional text mining tool ROST CM-6 has clear limitations in Chinese segmentation accuracy. Because such software relies primarily on built-in traditional dictionaries, its ability to recognize domain-specific terminology (e.g., sports venues, exercise experience) and out-of-vocabulary words common in online reviews is weak. Relying solely on manually supplemented custom dictionaries is not only labor-intensive but also highly susceptible to omissions and errors caused by the researcher's subjective oversight.

Accordingly, to ensure the reliability and validity of text analysis, this study constructed a hybrid text processing pipeline coordinating "large language model (LLM)-based semantic assistance + Python natural language processing." Semantic mining of Dianping reviews based on large language models has recently been validated in consumer perception research [38], and the methodological reasoning of this study aligns with that line of work. The specific steps are as follows:

(1) *AI-assisted high-frequency term pre-screening.* A front-end processing framework (Cherry Studio) connected to the DeepSeek API was introduced for preliminary text denoising and semantic recognition. The specific model used was DeepSeek-V3 (released in December 2024). Compared with the mechanical segmentation of traditional software, large language models have stronger contextual understanding capabilities. By inputting the full review text (with user nicknames removed) into the model, the top 100 high-frequency core conceptual terms most relevant to "user experience" and "environmental perception" were automatically extracted within the overall semantic context. An example input prompt was: "Please extract from the following badminton gym user review text the top 100 high-frequency core conceptual terms most relevant to 'user exercise experience' and 'venue environmental perception,' ranked by frequency from high to low; output only the terms and estimated frequencies, with no further explanation." It is important to emphasize that AI was involved only in the preliminary screening of high-frequency terms and did not participate in any grounded-theory coding process. All three-level coding (open coding, axial coding, selective coding) was performed manually by the researchers in NVivo 15.

(2) *Python dual-dimensional word frequency statistics.* The Python jieba segmentation library was introduced for dual quantitative validation: on the one hand, the 100 core terms preliminarily extracted by AI were used as a target list, and a Python script was used to perform absolute matching and term-by-term tracing in the original corpus, accurately counting actual occurrence frequencies; on

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the other hand, the jieba algorithm was directly applied to the raw corpus to perform independent text segmentation and term frequency–inverse document frequency (TF–IDF) statistics, generating an independent top-100 high-frequency word list natively from the algorithm.

(3) *Cross-validation and calibration of results.* The two sets of results were compared and calibrated: in cases of statistical inconsistency, custom domain segmentations consistent with the actual usage scenario of badminton venues were preferred; meaningless function words were removed; and synonymous terms were merged with normalized expressions. Through manual verification, approximately 15% of the AI-screened terms had biased frequency estimates and were corrected through Python's precise statistics; about 8% of the terms were judged by the researchers to be of low relevance to the research topic and were removed. Finally, 74 core high-frequency terms closely related to the research topic were obtained.

2.4. Grounded Theory Coding Procedure

Regarding text-processing tools, NVivo, as one of the most widely used qualitative analysis software packages [45–47], supports systematic grounded-theory coding analysis through its powerful coding management and visualization functions, enabling fine-grained organization of massive raw data [48].

This study performed coding analysis of the initial textual material based on grounded theory to derive a user experience perception model for indoor badminton venues. This method enables exploration of the position and weight of the acoustic environment within other perceptual categories and evaluation systems in indoor badminton venues. Systematic coding analysis based on grounded theory comprises three core steps:

(1) *Open Coding*. Using the raw text as the analytical basis, the material is decomposed sentence by sentence, and the textual content is conceptualized; an initial label is assigned to each evaluation. Through continuous comparison, merging, and reduction, initial categories that authentically reflect users' perceptions and evaluations within badminton venues are refined, accurately capturing respondents' auditory experiences and core pain points in actual usage scenarios.

(2) *Axial Coding*. Building on the fragmented initial categories produced by open coding, the internal logical relationships among categories—including causal relations, conditional relations, contextual associations, mechanisms, and coping strategies—are further organized to identify the affiliations, associations, and hierarchical structures among categories. Categories that are semantically similar or logically related are grouped and integrated to form main categories with higher generality and explanatory power.

(3) *Selective Coding*. From the multiple main categories formed, a single core category with the strongest commanding and explanatory power is further refined, and the logical associations between the other main categories and the core category are systematically organized to establish the overall theoretical model.

After coding is completed, theoretical saturation testing is conducted; if saturation is not achieved, the analysis returns to the coding stage for iterative refinement until saturation is reached. To reduce pre-coding bias, the high-frequency term list was used only as a sensitizing reference for identifying potentially relevant semantic fields, rather than as a fixed coding framework. Ambiguous coding results were repeatedly compared against the original review texts and resolved through discussion among the research team before category consolidation.

3. Results

3.1. High-Frequency Term Analysis

Based on the hybrid text-processing pipeline, this study ultimately extracted 74 core high-frequency terms; their frequency statistics are partially shown in Table 2.

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Table 2. Statistical results of the top 74 high-frequency terms in online review texts (partial display).

No.	Term	Frequency	No.	Term	Frequency
1	Court (*changdi*)	2571	38	Booking (*yuyue*)	165
2	Very good (*henhao*)	901	39	Compound (*yuanqu*)	158
3	Nice (*bucuo*)	882	40	Bright (*mingliang*)	151
4	Service (*fuwu*)	712	41	Nearby (*fujin*)	149
5	Environment (*huanjing*)	667	42	Tidy (*zhengjie*)	140
6	Badminton (*yumaoqiu*)	620	43	Comfortable (*shushi*)	137
7	Playing (*daqiu*)	599	44	Hygiene (*weisheng*)	137
8	Parking (*tingche*)	576	45	Worthwhile (*zhide*)	134
9	Clean (*ganjing*)	510	46	Staff (*gongzuorenyuan*)	126
10	Price (*jiage*)	493	47	Suitable (*shihe*)	122
11	Convenient (*fangbian*)	467	48	Court mat (*dijiao*)	116
12	Facilities (*sheshi*)	463	49	First time (*diyici*)	113
13	Air conditioning (*kongtiao*)	454	50	Rest (*xiuxi*)	111
14	Spacious (*henda*)	395	51	Evening (*wanshang*)	109
15	Lighting (*dengguang*)	367	52	Atmosphere (*fenwei*)	108

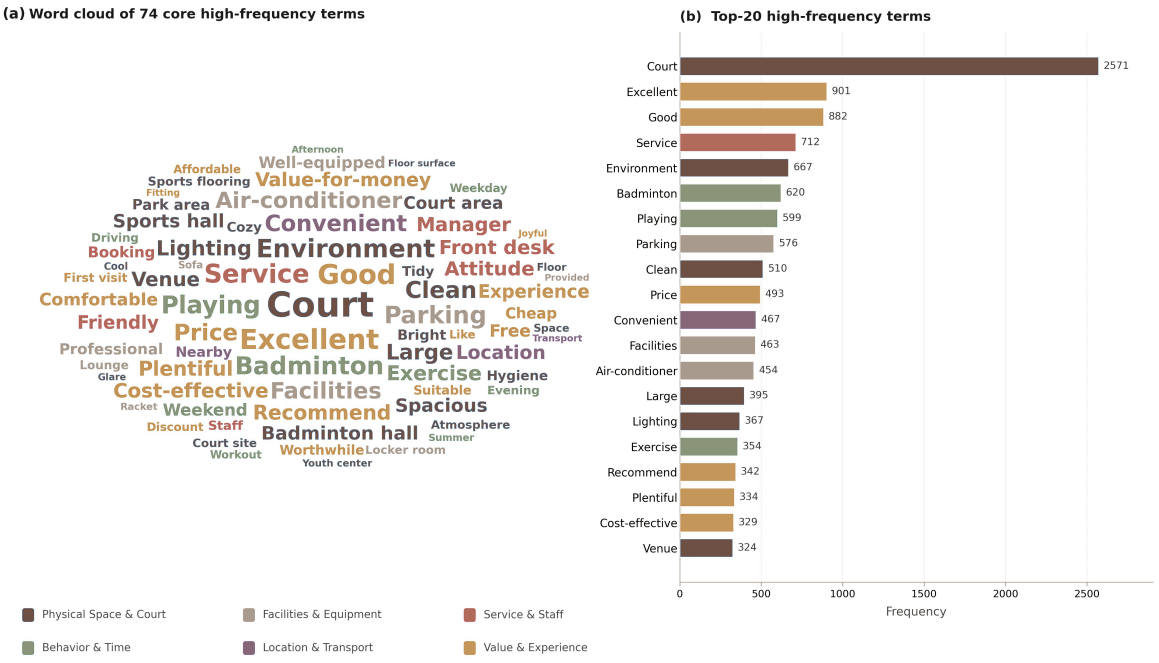

Figure 3. Word cloud and Top-20 bar chart of 74 core high-frequency terms. The visualization highlights the dominant position of court-related, service-related, environmental, and value-related terms in user reviews.

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As visualized in Figure 3, the high-frequency terms cover multiple dimensions, including venue hardware, service experience, price/value, environmental atmosphere, and travel convenience. Among them, "court" appears 2,571 times, far exceeding other terms, indicating that court conditions are the core anchor of user evaluation. Positive sentiment terms such as "very good" and "nice" rank near the top, reflecting that the overall sample evaluation is dominated by positive feedback.

Further classifying the high-frequency terms (Table 3), they can be grouped into eight categories. The category "courts and spatial environment" contains the most high-frequency terms, fully indicating that, as a sport with extremely high requirements for hardware conditions such as space height and floor non-slip properties, the physical environmental quality of the venue directly determines users' core exercise experience. Notably, "atmosphere" (108 occurrences), as a term closely related to the acoustic environment, ranks 52nd among the high-frequency terms; its meaning in the original texts carries both positive ("the playing atmosphere is great") and negative ("too noisy, the atmosphere is chaotic") connotations, providing important clues for the construction of the subsequent acoustic environment sub-model. Considering that this dual semantic orientation points specifically to the acoustic–social dimension, this study lists it as an independent category rather than grouping it under the pure spatial environment category.

Table 3. Classification of high-frequency terms for badminton venue user experience and scene perception (revised version).

No.	Category	High-Frequency Terms
1	Courts and spatial environment	Court, compound, spacious, large, space, ground, floor, court mat, court area, venue, badminton gym, gymnasium, ground area
2	Physical environmental conditions (light, thermal, visual)	Lighting, bright, glaring, air conditioning, cool, tidy, comfortable, hygienic, clean
3	Facilities and equipment	Facilities, complete, rest, locker room, sofa, parking, free, racket, provide, professional
4	Service management and staff evaluation	Service, staff, front desk, owner, attitude, enthusiastic, booking
5	Activity behavior and time	Playing, exercise, workout, badminton, weekend, weekday, evening, afternoon, first time, driving
6	Acoustic and social atmosphere	Atmosphere (with both positive and negative connotations)
7	Location and transportation	Location, nearby, traffic, convenient
8	Price and experience evaluation	Price, cost-effective, cheap, affordable, value-for-money, discount, worthwhile, suitable, appropriate, like, comfortable, experience, very good, nice, recommend, happy

3.2. Open Coding Results

In the open coding stage, the raw reviews were decomposed sentence by sentence and conceptualized, ultimately yielding 32 initial categories. The following example illustrates the concept extraction process using an original review:

> Original review: "The courts are quite spacious, with about 16 badminton courts—more than enough. Court 12 is a bit small for singles, so be careful when booking. The service is okay, the group-buy voucher worked smoothly. The lighting in this gym is quite bright, and the good thing is it's not glaring. The courts and the toilets are clean."

The extracted concepts include: spacious court, sufficient court quantity (reflecting positive evaluation of spatial scale and satisfaction with court supply); singles court too small, booking caution required (reflecting negative feedback on court specifications and the influence of court differentiation on booking decisions); decent service, smooth booking, bright lighting, lighting not causing eye

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discomfort, clean ancillary facilities (highly summarizing the comprehensive evaluation of soft service and hard environment).

To avoid inflating the popularity of a category due to multiple concepts being repeatedly counted within a single review, this study adopted "number of comments involved" for the frequency statistics of initial categories—i.e., counting the number of independent reviews mentioning that category—in order to better reflect the prevalence of each issue among the user population.

It should be noted that, since a single review often involves multiple dimensions (e.g., a single review may simultaneously mention court conditions, lighting, and noise level), the same review may be counted once in each related category. Consequently, the cumulative "number of comments involved" across the 32 initial categories totals 3,575, which is greater than the number of independent reviews used in coding (2,625)—this cumulative value reflects the breadth of coverage of each issue across user reviews rather than the actual number of sample reviews. This statistical approach follows the basic principle of "concept–category coverage" in grounded theory, more accurately reflecting the prevalence of issues among the user population rather than emphasizing repeated mentions by individual users. The 32 initial categories and their numbers of comments involved are shown in Table 4.

Table 4. Open coding results: 32 initial categories with comment frequencies. Full version with concept-extraction examples and quoted reviews is provided in Table A1 (Appendix A).

No.	Initial Category	Comments	No.	Initial Category	Comments
1	Court size	427	17	Sport atmosphere	139
2	Court height	55	18	User experience	194
3	Spatial division	45	19	Overall rating	47
4	Floor quality	146	20	Social interaction	52
5	Noise level	45	21	Use frequency	81
6	Thermal perception	155	22	Repurchase intention	52
7	Lighting condition	195	23	Transport access	121
8	Air humidity	2	24	Geographic location	106
9	Ventilation	89	25	Parking service	55
10	Visual presentation	33	26	Surroundings	17
11	Environmental odor	10	27	Price & fees	334
12	Court quality	159	28	Facility completeness	268
13	Court quantity	91	29	Facility hygiene	71
14	Capacity constraint	34	30	Management standards	12
15	Booking system	109	31	Service attitude	272
16	Time-based flow	134	32	Coaching service	25

After coding was completed, the high-frequency term list was used to retrospectively verify the online review texts and check whether any initial categories had been omitted. After verification, the extracted concepts and initial categories were confirmed to broadly cover the various aspects of badminton venue user experience and scene perception, encompassing both core perceptual elements at the physical level (e.g., venue facilities, environmental conditions) and subjective experience dimensions (e.g., exercise experience, service interaction); thus, the analysis could proceed to subsequent axial coding and theoretical model construction.

Although the "noise level" category accounts for only a small share of the total comments, the acoustic issues it reflects (excessive reverberation, peak-period noise compounding, adjacent-zone interference) correspond to typical acoustic deficiencies identified in sports building research [3,4,7]. The latent role of these acoustic concerns within the broader experience model is further examined in Section 4.3.

3.3. Axial Coding Results

Through axial coding, this study consolidated the 32 initial categories into 6 main categories (Table 5). The hierarchical structure is shown in Figure 4, and the axial-coding flow is presented in Figure 5.

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Table 5. Axial coding results: 6 main categories aggregated from 32 initial categories. Full version with the initial-category breakdown is provided in Table A2 (Appendix A).

No.	Main Category	Comments Involved	Share (%)
1	Physical Space & Court Conditions	923	25.80
2	Environmental Comfort & Perception	529	14.79
3	Facilities & Service Support	648	18.13
4	Operation & Use Experience	610	17.06
5	Value & Behavioral Intent	566	15.83
6	Location & Accessibility	299	8.36
	Total	**3,575**	**100.00**

Note: percentages are calculated based on the total "comments involved" of the 32 initial categories (3,575), not on the 4,721 raw reviews; the same review may involve multiple categories.

Figure 4. Hierarchical distribution of perception categories. The sunburst diagram shows the relationship between the 6 main categories and the 32 initial categories.

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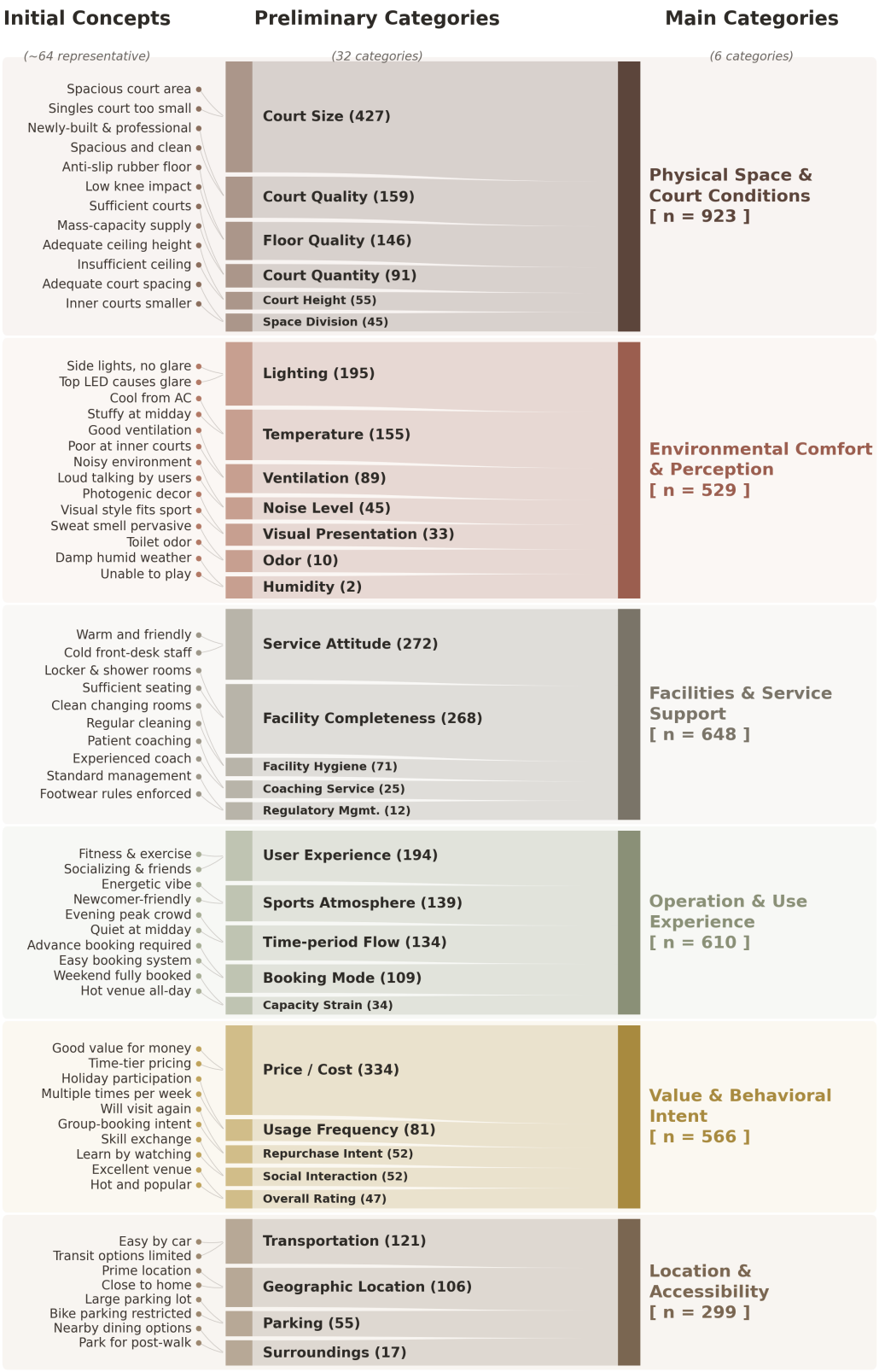

Figure 5. Sankey diagram of the axial-coding flow from 32 initial categories to 6 main categories, showing how open-coding categories were consolidated during axial coding.

3.4. Selective Coding and Model Construction

Building on the results of open coding and axial coding, and through continued comparison and in-depth analysis of the user review text data and the main categories, this study constructed

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the "Indoor Badminton Venue User Experience Perception Model." The model reveals that the user perception path follows a progressive logic from "comprehensive cost evaluation" to "on-site core perception" and finally to "comprehensive value judgment and behavior" (Figure 6).

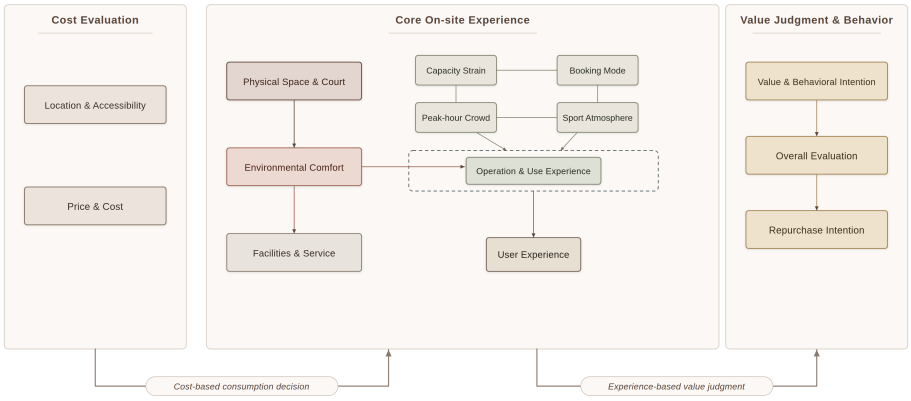

Figure 6. User experience perception model for indoor badminton venues. The model shows a three-stage pathway from cost evaluation to core on-site experience and value-based behavioral intention.

3.5. Theoretical Saturation Test

To examine the completeness and generality of the model, this study used the reserved one-third of valid review texts (51,192 characters in total) for the theoretical saturation test. After importing the reserved texts into NVivo 15, the analysis strictly followed the three-level coding procedure. The results showed: no new initial concepts or sub-categories were extracted during coding; no new dimensional supplements emerged within the internal features of the existing main categories; and the logical relationships among categories were all encompassed by the existing theoretical framework, with no new structural relationships emerging.

The following examples illustrate the saturation test process: in the reserved sample, comments such as "when there are many people in the gym, the sound just hums" could be directly classified under the existing "noise level" category; "on weekday afternoons the courts are empty, very comfortable to play" could be classified at the intersection of "time-based flow" and "user experience"; "after the sound-absorbing cotton was installed, it became much quieter than before" could be classified under "noise level." None of these new comments exceeded the explanatory boundaries of the existing category system. Accordingly, the model constructed in this study is judged to have achieved theoretical saturation.

4. Discussion

4.1. Interpretation of the User Experience Perception Model

The constructed "Indoor Badminton Venue User Experience Perception Model" indicates that the formation of user evaluation is not a simple superposition of various elements, but a dynamic process centered on "Operation & Use Experience" as the core main category and serving as a key transformation link. Comprehensive user perception evaluation frameworks have been widely adopted in public space research [49], and the six-main-category model in this study is consistent with this line of thinking.

Comprehensive cost evaluation stage. Users' venue selection and evaluation begin with comprehensive cost evaluation. Before making a consumption decision, users need to weigh two dimensions simultaneously: the time and convenience cost constituted by "Location & Accessibility" (geographic location, transport access, parking service), and the direct monetary cost of "Price & fees." Together, these constitute the gating filter for users entering the venue.

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On-site core perception stage. Once inside the venue, users are situated within the foundational environment constructed by "Physical Space & Court Conditions" and "Facilities & Service Support." The physical space of the courts (court size, court height, floor quality, etc.) is the most direct hardware interface, ensuring not only the basic conduct of exercise but also significantly influencing comfort across the visual, tactile, and somatic dimensions, thereby directly constituting "Environmental Comfort & Perception." At this stage, the latent yet critical position of the acoustic environment within overall environmental perception must be specially noted. Environmental comfort encompasses not only manifest physical conditions such as temperature and lighting, but also the auditory dimension—the acoustic environment—as a core indicator of spatial quality. Existing research has confirmed via structural equation modeling (SEM) that the influence of indoor fitness environments on activity intensity is mainly mediated by perceived variables such as comfort and convenience [50]; although acoustic comfort has not been explicitly incorporated into prior models, the present study suggests, through grounded theory, that it may also play a comparable mediating role. On this basis, the venue's inherent resource constraints (capacity constraint), through management mechanisms (booking system, time-based flow), interact with the core activity to jointly shape the "Operation & Use Experience."

Comprehensive value judgment stage. Based on the comprehensive comparison between prior cost evaluation and on-site core experience, users complete value judgment and behavioral intent output, determining repurchase intention and use frequency, and achieving the transition from one-off consumption to long-term retention.

4.2. Interpretation of the Acoustic Environment Perception Mechanism Sub-Model

Building on the user experience perception model, this study further extracts categories such as "noise level," "time-based flow," "sport atmosphere," and "physical space" to construct the "Indoor Badminton Venue Acoustic Environment Perception Mechanism" sub-model (Figure 7). The core mechanisms of this sub-model are as follows:

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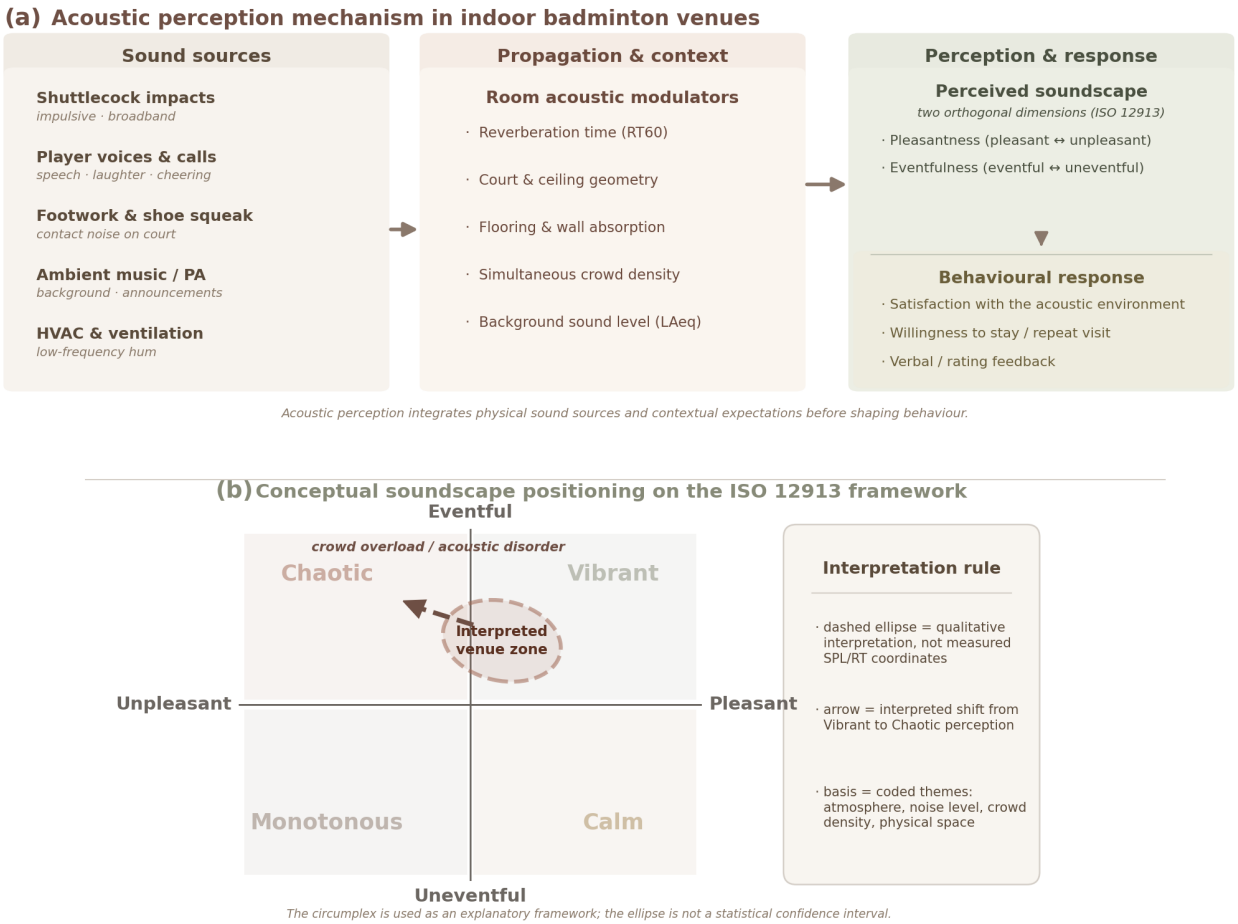

Figure 7. Acoustic perception sub-model with the ISO 12913 two-dimensional soundscape circumplex. The figure interprets the shift from positive sport atmosphere to negative noise perception through the Pleasantness–Eventfulness framework.

(1) *Objective determinative role of physical space.* The physical space of the venue (court size, ceiling height, presence of sound-absorbing materials) constitutes an important physical condition of the acoustic environment and may influence reverberation characteristics. Existing BIM-based research [51] indicates that reverberation time is a key parameter related to building acoustic comfort and can be optimized through the placement of sound-absorbing materials.

(2) *Dynamic regulatory role of time-based flow.* Variations in time-based flow constitute the dynamic regulatory factor of the acoustic environment. During peak periods, capacity constraints cause activity density between courts to surge sharply, with shuttle-impact sounds, shouting, and friction sounds compounding at high frequency. If the physical space lacks adequate sound-absorbing and noise-reducing design, users' descriptions suggest that high crowd density may interact with reverberant spatial conditions, potentially producing a perceived high-noise environment.

(3) *Duality of sport atmosphere and noise level—interpretation based on the ISO 12913 soundscape evaluation framework.* In the text mining, users frequently mentioned "great atmosphere" and "lively" alongside "too noisy" and "chaotic," revealing a unique attribute of the acoustic environment of indoor leisure badminton venues: the acoustic environment and sport atmosphere are "two sides of the same coin." This finding can be theoretically interpreted via the two-dimensional soundscape evaluation circumplex proposed by Axelsson et al. [52] in ISO 12913-1 [53]. In this model, soundscape perception is distributed along two orthogonal dimensions—Pleasantness and Eventfulness—forming four quadrants: Vibrant, Chaotic, Calm, and Monotonous [54,55]. Moderate shuttle-impact sounds and conversational sounds fall within the "Vibrant" quadrant—pleasant and eventful—being decoded as a positive sport atmosphere that can elicit excitement; under such conditions, an increase in SPL does

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not necessarily lead to acoustic discomfort. Evidence from public open-space soundscape research suggests that activity-oriented zones may tolerate or even benefit from higher sound-event levels than restoration-oriented zones [56]. However, when crowd overload is perceived to intensify sound energy and acoustic disorder, soundscape perception crosses from the "Vibrant" quadrant into the "Chaotic" quadrant—unpleasant and eventful—and sport atmosphere is instantly transformed into negative noise-level perception, undermining concentration and overall comfort. This critical transition from positive to negative is a core feature distinguishing the acoustic environment of mass leisure badminton venues from that of professional competition venues. This finding aligns with the coexistence of "high SPL–high preference" phenomena in the field of leisure noise [57,58].

(4) *Regulatory role of users' subjective expectations.* Faced with the same objective acoustic conditions and crowd density, the final value evaluation varies among individuals. Some users have higher tolerance for the acoustic environment and tend to interpret high SPL as a manifestation of a vibrant exercise atmosphere; others are extremely sensitive to shouting and mechanical noise and feel significant noise pressure within the venue. This individual variation further confirms the principle of "context-dependency" of soundscape perception emphasized by the ISO 12913 standard [53].

4.3. Latent Characteristic of Acoustic Environment Perception

An important finding of this study is that acoustic environment perception exhibits a pronounced "latent" characteristic. Although users seldom directly use professional acoustic terminology in everyday evaluations, and may even subjectively neglect the independent existence of the acoustic environment, this does not signify the absence of acoustic demands. As an indispensable dimension under the "Environmental Comfort & Perception" main category, "noise level" subtly yet profoundly influences exercise concentration and psychological comfort. A poor acoustic environment is directly translated into negative perceptions such as "noisy" and "loud disturbance," breaking exercise concentration and even masking the venue's strengths in other hardware aspects such as court size and floor quality. However, current mass-oriented badminton venues generally lack sufficient attention to acoustic environment design. This finding not only highlights the importance of meeting latent acoustic demands for elevating overall venue experience, but also validates the research significance of conducting quantitative evaluation of the acoustic environment in such building spaces, which are highly prone to dense activity noise.

Figure 8 further illustrates the distribution of the 32 initial categories. Among these categories, the "noise level" category, which directly points to acoustics, involves only 45 reviews (approximately 1.3%), and its data weight is relatively limited. This study demonstrates the latent influence of the acoustic environment through cross-category associations such as "sport atmosphere" and "time-based flow"; nevertheless, this proportion also objectively reflects that the acoustic environment indeed occupies a "latent" rather than "manifest" position in users' spontaneous evaluations. This phenomenon itself constitutes an important methodological finding of the present study: as spontaneous feedback, online reviews can still reveal the critical role of the acoustic environment through cross-category semantic associations even when users do not actively use acoustic terminology—and this is precisely the unique value of the "bottom-up" grounded theory approach relative to structured questionnaires.

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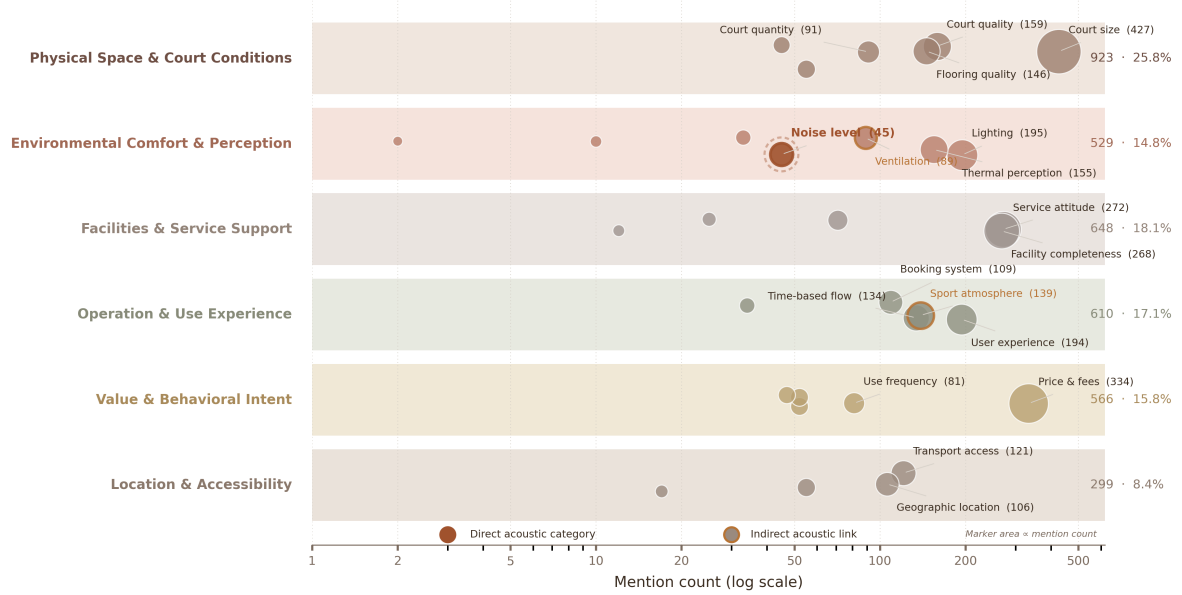

Figure 8. Distribution of 32 initial categories across six main categories. The figure supports the interpretation that acoustic perception appears as a low-frequency but cross-category issue in spontaneous reviews.

4.4. Architectural Design and Operation Optimization Recommendations

Based on the above findings, this study proposes the following potential practical recommendations for the optimization of the acoustic environment of indoor badminton venues, addressed to architects and venue operators. A systematic review of Indoor Soundscape Intervention (ISI) criteria for architectural practice has already been formed [30], providing a theoretical basis for the recommendations below.

(1) *Low-cost sound absorption measures.* Economical sound-absorbing materials (e.g., sound-absorbing curtains, perforated metal panel composite sound-absorbing structures, or polyester fiber sound-absorbing panels) can be installed on the venue's side walls to reduce mid- and high-frequency reverberation time. Such acoustic retrofits can be conducted in conjunction with energy-efficiency renovation projects, improving overall indoor environmental quality (IEQ) performance [59]. As shown in users' positive feedback such as "with sound-absorbing walls all around, noise is very low while playing," such measures may enhance user experience. Acoustic-deficiency studies of large-volume public buildings of a similar type (e.g., hospital outpatient halls) likewise confirm that parallel walls and hard finishes can reduce speech transmission index (STI) performance and produce flutter echoes [10]; these findings provide a useful reference for badminton venues, although venue-specific acoustic measurements are still needed before detailed design.

(2) *Crowd density regulation.* By optimizing the time-slot management of the booking system, the number of simultaneously used courts during peak periods can be controlled to avoid spiraling SPL increases caused by excessive activity density (the Lombard effect / "café effect": as background noise rises, speakers instinctively raise their volume, forming a positive feedback loop in multi-person environments). Especially during evening and weekend peak periods, appropriately lowering the court booking ceiling may be considered, provided that operational feasibility and user demand are also evaluated.

(3) *Spatial acoustic zoning.* In venue planning, acoustic zoning of courts may be considered through methods such as partition curtains and half-height walls, reducing acoustic crosstalk between adjacent courts and improving users' exercise concentration and verbal communication quality with companions. Because ceiling heights of ≥ 12 m can better accommodate sports such as volleyball and badminton [60], zoning design should not compromise safety, visibility, ventilation, or sport clearance, and should optimize the sound-absorbing performance of interface materials while ensuring sufficient clearance.

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4.5. Limitations

This study has the following limitations, which should be considered when interpreting the conclusions:

(1) *Bias in data sources.* Online reviews are subject to survivor bias, i.e., users at the extremes of satisfaction or dissatisfaction are more inclined to post reviews, while the voices of moderate users may be underrepresented. Additionally, the user demographic on Dianping may skew younger, neglecting the acoustic perception characteristics of middle-aged and older exercisers. Subsequent research could draw on the mixed-method approach of disability-friendly design research [61], expanding the sample to cover the acoustic needs of special groups such as the elderly and people with disabilities.

(2) *Lack of corresponding objective acoustic measurement data.* This study is purely qualitative and did not obtain objective acoustic parameters (e.g., reverberation time T_{30}, background noise SPL, STI) or detailed building physical-spatial parameters (e.g., venue volume, composition of major surface materials) for the 7 sampled venues; thus, cross-validation between the subjective perceptions extracted from text (e.g., "loud echoes," "too noisy") and objective acoustic data could not be performed. Subsequent research should supplement on-site acoustic measurements to fill this gap, and could also incorporate machine learning methods to prioritize categories identified by grounded theory [36].

(3) *Cultural and regional limitations.* All samples were drawn from the Dianping platform in Chinese cities; generalization of the conclusions to other cultures and regions should be approached with caution. Although the spatial configuration of badminton venues is globally common, users' sensitivity to speech intelligibility under different linguistic backgrounds may differ [62], and tolerance and preferences for the acoustic environment may also vary across cultural backgrounds.

5. Conclusions

Using grounded theory, this study collected 4,721 raw Dianping reviews of seven purposively selected indoor badminton venues across five Chinese cities; after preprocessing, 3,937 valid reviews were retained for analysis. The main conclusions are as follows:

(1) The study constructed an indoor badminton venue user experience perception model that follows a progressive pathway from cost evaluation to core on-site experience and then to value-based behavioral intention. This model shows that acoustic perception is embedded within a broader experience system rather than operating as an isolated environmental factor.

(2) The acoustic environment occupies a latent but structurally important position in spontaneous user reviews. Although "noise level" was directly mentioned in only 45 reviews, acoustic-related meanings were indirectly connected with categories such as "sport atmosphere," "time-based flow," and "user experience," indicating that users may perceive acoustic problems without necessarily expressing them in professional acoustic terms.

(3) The acoustic perception mechanism of indoor badminton venues is characterized by the dual relationship between sport atmosphere and noise perception. Moderate activity sounds may be interpreted as a vibrant sport atmosphere, whereas excessive crowd density and acoustically reflective spatial conditions may shift perception toward chaotic noise within the ISO 12913 soundscape framework.

(4) The findings suggest that acoustic optimization in mass-leisure badminton venues should combine physical design and operational management. Potential strategies include low-cost sound absorption, time-slot-based crowd-density regulation, and spatial acoustic zoning, but these qualitative findings should be further validated through objective acoustic measurements and subjective evaluation in future research.

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Institutional Review Board Statement: Ethics review and approval were waived for this study because it used only publicly available online review data scraped from the Dianping platform, with all personal identifiers (e.g., user nicknames) removed prior to analysis. No human participants were directly recruited, contacted, or interviewed.

Informed Consent Statement: Not applicable. This study analyzed only publicly accessible online reviews voluntarily posted by users on the Dianping platform; no direct interaction with human participants occurred.

Data Availability Statement: Restrictions apply to the availability of these data. The data were collected from Dianping, and the raw review texts are not publicly shared due to platform terms and user privacy considerations. Anonymized coding results and aggregated frequency statistics are available from the corresponding author upon reasonable request.

Acknowledgments: During the preparation of this study, the authors used DeepSeek-V3 via Cherry Studio only for preliminary high-frequency term pre-screening. The authors reviewed and verified all AI-assisted outputs, and all grounded-theory coding was manually conducted by the researchers. The authors take full responsibility for the content of this publication.

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

Appendix A Full open and axial coding tables

This appendix presents the full versions of Tables 4 and 5 from the main text. Table A1 provides the full open-coding output, including representative concept extractions and quoted user reviews for each of the 32 initial categories. Table A2 provides the full axial-coding aggregation showing how each of the 32 initial categories was assigned to one of the 6 main categories.

Table A1. Full open coding results: 32 initial categories with concept-extraction examples and quoted user reviews.

No.	Initial Category	Concept Extraction (Examples)	Original Review (Examples)	Comments Involved
1	Court size	Large court area, strong sense of openness, smaller singles court size	a. The courts are quite large; b. Overall feels very spacious; c. The singles court is indeed a bit small	427
2	Court height	Suitable ceiling height, clear lobs touching the ceiling	a. High ceiling, very convenient to play; b. Clear lobs almost always touch the ceiling	55
3	Spatial division	Sufficient spacing between courts, no mutual interference	a. The distance between courts is large enough, no interference	45
4	Floor quality	Good court mat, floor, and joists, comfortable underfoot feel	a. The court mat, floor, and joists are OK; b. Floor and court mat have good slip resistance	146

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Table A1. Continued from previous page.

No.	Initial Category	Concept Extraction (Examples)	Original Review (Examples)	Comments Involved
5	Noise level	Perceived noise level, loud user shouting, noisy environment, sound-absorbing wall effect, echo interference	a. With sound-absorbing walls all around, noise is very low while playing; b. Some people shout loudly, really noisy; c. Echoes are too loud, can't hear when shouting	45
6	Thermal perception	Perceived temperature level, good air conditioning cooling	a. The court is stuffy at noon; b. AC works well, very cool	155
7	Lighting condition	Side-mounted lighting not glaring, top LED lights obstructing sight	a. Lights are arranged on the sides, not glaring while playing; b. Top LED lights make it impossible to see the shuttle	195
8	Air humidity	Plum rain season, damp feel	a. During plum rain season it's just unplayable	2
9	Ventilation	Inner courts ventilation moderate, central AC configured	a. Ventilation in inner courts is mediocre; b. With central AC, ventilation is good	89
10	Visual presentation	Court layout exquisite, dark green wall surfaces	a. Layout is very exquisite; b. Dark green walls, visually very suitable	33
11	Environmental odor	Sweat smell pervading the court, restroom odor	a. The whole court smells of sweat	10
12	Court quality	Excellent environmental performance, relatively new gym	a. The environment is impeccable, spacious and clean, fairly professional	159
13	Court quantity	Large scale, sufficient number of courts	a. The courts are very large, visually at least 20+ courts	91
14	Capacity constraint	Fully booked on weekends, very popular	a. Almost fully booked on weekends, extremely popular	34
15	Booking system	Advance booking, convenient booking system	a. Booked two or three days in advance, this gym is quite popular	109
16	Time-based flow	Time-based traffic differences, large evening crowd	a. Few people in the afternoon, but lots in the evening	134

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Table A1. Continued from previous page.

No.	Initial Category	Concept Extraction (Examples)	Original Review (Examples)	Comments Involved
17	Sport atmosphere	Good playing atmosphere, friendly to beginners, lively but orderly, crowded and noisy	a. The playing atmosphere is great, as a beginner I had a lot of fun; b. Too many people on weekends, can't communicate due to noise	139
18	User experience	Excellent first-time experience, exercising the body, social interaction	a. Excellent first-time experience, both exercise and meeting friends	194
19	Overall rating	Excellent venue rating	a. A really great badminton gym	47
20	Social interaction	Watching others to improve skills, exchanges among players	a. You learn a lot watching others play	52
21	Use frequency	Exercise during holidays, high weekly frequency	a. Come three or four times a week	81
22	Repurchase intention	Intent to book courts with team, repeated repurchase	a. Will come again with friends if there's a chance	52
23	Transport access	Convenient self-driving, deficiencies in some transport modes	a. Driving is very convenient; b. Taxi is more convenient	121
24	Geographic location	Excellent location, close to home	a. Excellent location, close to home	106
25	Parking service	Large parking lot, sufficient spaces	a. Large parking lot at the entrance, plenty of spaces	55
26	Surroundings	Surrounding dining options, post-exercise stroll	a. There are restaurants nearby, after playing we go for a meal	17
27	Price & fees	Mid-to-high price, value-for-money advantage	a. With advance booking discounts, more cost-effective than many gyms	334
28	Facility completeness	Equipped with locker rooms and showers, sufficient seating	a. The gym has locker rooms and showers, very convenient and modern	268
29	Facility hygiene	Locker room clean and tidy, regular cleaning	a. The locker room is fairly clean	71
30	Management standards	Standardized court management, hard-soled shoes prohibited	a. The courts are managed in a fairly standardized way	12
31	Service attitude	Warm service attitude, negative front-desk attitude	a. The staff are friendly and enthusiastic; b. The front-desk lady has a poor attitude and ignores court squatting	272

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Table A1. Continued from previous page.

No.	Initial Category	Concept Extraction (Examples)	Original Review (Examples)	Comments Involved
32	Coaching service	Patient coaching, experienced coaches	a. The coaches are particularly patient in providing guidance	25

Table A2. Full axial coding results: aggregation of 32 initial categories into 6 main categories, with comment counts and shares.

No.	Main Category	Initial Category	Comments	Share (%)	Main Category Total
1	Physical Space & Court Conditions	Court size	427	11.94	923 (25.80%)
		Court height	55	1.54	
		Spatial division	45	1.26	
		Court quality	159	4.45	
		Court quantity	91	2.55	
		Floor quality	146	4.08	
2	Environmental Comfort & Perception	Noise level	45	1.26	529 (14.79%)
		Thermal perception	155	4.34	
		Lighting condition	195	5.45	
		Air humidity	2	0.06	
		Ventilation	89	2.49	
		Visual presentation	33	0.92	
		Environmental odor	10	0.28	
3	Facilities & Service Support	Facility completeness	268	7.49	648 (18.13%)
		Facility hygiene	71	1.99	
		Management standards	12	0.34	
		Service attitude	272	7.61	
		Coaching service	25	0.70	
4	Operation & Use Experience	Capacity constraint	34	0.95	610 (17.06%)
		Booking system	109	3.05	
		Time-based flow	134	3.75	
		Sport atmosphere	139	3.89	
		User experience	194	5.42	
5	Value & Behavioral Intent	Price & fees	334	9.34	566 (15.83%)
		Repurchase intention	52	1.45	
		Overall rating	47	1.31	
		Social interaction	52	1.45	
		Use frequency	81	2.27	
6	Location & Accessibility	Transport access	121	3.38	299 (8.36%)
		Geographic location	106	2.96	
		Parking service	55	1.54	
		Surroundings	17	0.48	

Note: percentages are calculated based on the total "comments involved" of the 32 initial categories (3,575), not on the 4,721 raw reviews; the same review may involve multiple categories.

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