

Article

Green Concert Hall Design Perception and Residents' Well-Being: The Roles of Perceived Nature Connectedness and Perceived Restorativeness—Evidence from Chengdu City Concert Hall

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Abstract

As green building concepts continue to expand into public cultural spaces, green concert halls not only serve functions of cultural communication and artistic services, but also play an important role in shaping urban residents' psychological experiences and well-being. However, existing studies on green buildings have mainly focused on energy performance and technical indicators, while limited attention has been paid to how green cultural buildings are associated with residents' well-being through environmental perception. In the Chinese context, research specifically examining green concert halls remains scarce. Based on environmental psychology and restorative environment theory, this study takes the Chengdu City Concert Hall, which has received China's Three-Star Green Building certification, as the research object. A conceptual model of "green concert hall design perception–perceived nature connectedness–perceived restorativeness–residents' well-being" was constructed to explore the underlying mechanisms linking green concert hall design perception and residents' well-being. Green concert hall design perception was conceptualized as a second-order construct consisting of four dimensions: green design legibility, eco-environmental comfort, green aesthetic integration, and green cultural symbolism. Perceived nature connectedness and perceived restorativeness were introduced as mediating variables. A survey was conducted among 879 Chengdu residents with concert-hall attendance experience, and structural equation modeling (SEM) was employed for empirical analysis. The results indicate that (1) green concert hall design perception is significantly and positively associated with residents' well-being; and (2) perceived nature connectedness and perceived restorativeness both play significant mediating roles in the relationship between green concert hall design perception and residents' well-being, while also forming a significant sequential mediating effect. The findings suggest that green concert halls are associated with more positive environmental experiences through ecological and aesthetic characteristics, and that residents' well-being may be further linked to strengthened nature connectedness and restorative perceptions. This study extends research on green public cultural buildings from the perspective of residents' psychological perception, and provides theoretical support and practical implications for human-centered green concert hall design and the development of urban green cultural spaces.

Keywords: green concert hall; green building; residents' well-being; perceived nature connectedness; perceived restorativeness; structural equation modeling



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1. Introduction

Against the backdrop of global climate governance, low-carbon urban development, and the enhancement of public cultural services, the greening of urban public buildings has become a key issue in contemporary architectural development [1]. Public cultural buildings serve functions such as promoting the arts, showcasing culture, and organizing community activities; their spatial quality is closely linked to residents' public cultural life [2,3]. As the concept of green building has expanded to cultural spaces such as concert halls, theaters, and art museums, the scope of evaluation for green public cultural buildings has gradually shifted from energy conservation, emissions reduction, material performance, and environmental control to users' spatial perceptions and experiential feedback [4–6]. For buildings of this type, the value of green design must be tested in real-world conditions.

This study takes the Chengdu City Concert Hall in Chengdu, China, as its subject of study to examine the relationship between green concert hall design perception and residents' well-being. As a public cultural building that has earned China's three-star green building certification, the Chengdu City Concert Hall possesses distinct green building characteristics and serves as a typical venue for performances, making it an ideal setting for observing how residents perceive the spatial features of a green concert hall [7]. In recent years, Chengdu has continued to expand its public cultural infrastructure, and residents' demand for high-quality cultural spaces has been growing steadily. This urban context provides a practical foundation for research on the users of the Green Concert Hall [8].

The Chengdu City Concert Hall was selected as the research case because it is a public cultural building with China's Three-Star Green Building certification and provides residents with a direct and immersive experience of green architectural design during cultural participation. This case is a specific building case in Chengdu rather than a statistically representative sample of concert halls nationwide. Therefore, the findings should not be directly generalized to all concert halls or public buildings in China. Instead, this case provides context-specific evidence and practical implications for the future planning and design of newly built green concert halls under similar urban and cultural conditions. Existing studies have not sufficiently integrated green building attributes, public cultural space experience, and residents' psychological pathways. Accordingly, this study introduces Green Concert Hall Design Perception as a context-specific construct to examine how green design in a public cultural building may be associated with residents' well-being through perceived nature connectedness and perceived restorativeness.

Concert halls are a type of public cultural space that offers a particularly immersive experience [9]. The length of time audiences spend in the concert hall remains relatively consistent, and the architectural environment continues to influence the performance experience [10]. Whether the spatial layout is clear, the viewing environment is comfortable, and the green design harmonizes with the concert hall's artistic atmosphere—all of these factors influence residents' assessment of the venue's quality [11]. Research on green concert halls must therefore go beyond a mere description of architectural techniques; it must also examine how audiences perceive green design, how they evaluate their spatial experience, and how these perceptions influence their assessment of their own quality of life.

Existing research on green buildings has established relatively mature evaluation frameworks in areas such as energy efficiency, indoor environmental quality, material performance, and green certification, providing a crucial basis for assessing building energy efficiency and environmental performance [12–15]. In contrast, there has been insufficient discussion of the psychological mechanisms at play among users of green public cultural buildings. Concert halls are highly aesthetic and immersive environments, and residents' evaluations of these spaces are typically formed during the entire performance

experience [16]. Without an analysis of design perception and cognitive pathways, the relationship between green design and residents' well-being is likely to remain at a conceptual level, making it difficult to establish a verifiable explanatory framework.

Drawing on environmental psychology and restorative environment theory, this study further examines the mediating roles of perceived nature connectedness and perceived restorativeness in the relationship between green concert hall design perception and residents' well-being. Perceived nature connectedness is used to explain whether residents develop a psychological closeness to nature and ecological identity as a result of green concert hall design [17]; Perceived restorativeness is used to explain whether concertgoers experience renewed focus, mental relaxation, and a sense of immersion in a concert hall setting [18]. By examining these two mediating variables, this study seeks to uncover the specific psychological pathways through which green concert hall design perception influences residents' well-being, thereby avoiding the limitation of reducing the positive effects of green design to mere generalizations.

Therefore, based on cross-sectional data from 879 permanent residents of Chengdu who have attended performances at the Chengdu City Concert Hall, this study employs structural equation modeling to analyze the relationships among green concert hall design perception, perceived nature connectedness, perceived restorativeness, and residents' well-being. The study aims to answer three questions: Is there a positive association between green concert hall design perception and residents' well-being? Do perceived nature connectedness and perceived restorativeness play a mediating role in this relationship? Can the case of the Chengdu City Concert Hall provide empirical evidence for the human-centered design evaluation of green public cultural buildings? Through this research, the study aims to provide a clearer explanation of the psychological mechanisms underlying green concert hall design perception and offer theoretical support for the development of urban green public cultural spaces.

2. Literature Review and Research Hypotheses

2.1. Green Concert Hall Design Perception and Residents' Well-Being

The concept of "green concert hall design perception" is a contextualized concept developed based on research into user perception in green buildings, architectural environmental psychology, and the experience of public cultural buildings. Drawing on Bitner's theory of service spaces, the physical environment within architectural spaces influences users' cognition, emotions, and evaluations [19]. Wakefield and Blodgett further note that spatial layout, environmental ambiance, and aesthetic elements in recreational service settings influence perceptions of place quality [20]. Related research on green buildings also indicates that users' evaluations of buildings depend on green certifications, but are also influenced by factors such as environmental quality, spatial experience, and psychological perceptions [21,22]. Drawing on theories of biophilic design, post-occupancy evaluation studies, and prior research on public cultural buildings, this study conceptualizes Green Concert Hall Design Perception as a second-order construct comprising four first-order dimensions: green design legibility, eco-environmental comfort, green aesthetic integration, and green cultural symbolism. The selection of these four dimensions is based on the specific characteristics of green concert halls as both green buildings and public cultural spaces. Green design legibility captures whether users can recognize and understand visible green design cues; eco-environmental comfort reflects users' perceived comfort in relation to environmental conditions such as light, acoustics, ventilation, and air quality; green aesthetic integration emphasizes the harmony between ecological elements and the artistic atmosphere of the concert hall; and green cultural symbolism reflects whether the building conveys broader meanings related to sustainability, urban culture, and ecological

values. Other possible aspects of green buildings, such as energy consumption, construction technology, operational management, and material life-cycle performance, were not included as dimensions of this construct because they are mainly technical indicators and are not always directly perceived by ordinary residents during a concert-going experience. Therefore, the four selected dimensions are intended to capture the perceptible, experiential, aesthetic, and cultural aspects of green concert hall design from the user's perspective. Green design legibility refers to residents' recognition and understanding of design cues such as natural lighting, green materials, and ecological landscapes; its theoretical foundation is derived from research on architectural legibility [23]. Environmental comfort encompasses the physical and psychological well-being derived from environmental conditions such as noise, light, temperature, and air quality; relevant studies indicate that indoor environmental quality is a key factor influencing the comfort and satisfaction of building occupants [24]. The integration of green aesthetics reflects the harmony between natural elements, eco-friendly materials, and the artistic atmosphere of the concert hall, embodying the fusion of natural expression and spatial aesthetics in biophilic design [25]. The symbolic aspect of green culture refers to the extent to which a concert hall conveys urban culture, public values, and a sense of local identity through its architectural form, ecological imagery, and spatial expression [26]. Therefore, the green concert hall design perception can be understood as the comprehensive subjective evaluation formed by residents regarding the spatial environment of the concert hall; its connotations encompass the recognizability of green design, environmental comfort, and aesthetic harmony, as well as the perception of cultural significance. This construct also responds to a gap in the existing literature. Previous studies on green buildings have mainly focused on technical performance, certification standards, indoor environmental quality, and post-occupancy satisfaction, while studies on public cultural spaces have more often emphasized cultural participation, service experience, and spatial use. However, limited research has integrated the green attributes, cultural functions, public nature, and user psychological pathways of public cultural buildings into a unified explanatory framework. In this sense, Green Concert Hall Design Perception is not simply a direct extension of existing green building evaluation indicators. Rather, it is a context-specific construct that shifts attention from technical evaluation to residents' perceptual and psychological experience in a green public cultural setting.

Residents' well-being generally refers to residents' overall assessment of their living conditions, emotional experiences, and psychological functioning [27]. Diener defines subjective well-being as an individual's overall assessment of life satisfaction, positive emotions, and negative emotions, emphasizing that well-being has a distinctly subjective evaluative nature [28]. Ryff further noted that well-being is not merely a matter of happiness and life satisfaction, but also encompasses psychological states such as a sense of control over one's environment, positive relationships, life goals, and personal growth [29]. Therefore, residents' well-being is defined in this study as the overall assessment of life, positive emotional experiences, and perceptions of psychological functioning that residents form through their daily lives and experiences in public spaces. Existing research indicates that residents' well-being is closely linked to the urban environment and public spaces in which they live. Keyes proposed that individual well-being also encompasses social dimensions such as social integration, social acceptance, and social participation, suggesting that experiences of interaction and participation in public spaces influence residents' well-being [30]. Urban environmental studies have also found that green spaces and high-quality public spaces can enhance residents' well-being by providing opportunities for recreation, social interaction, and mental recovery [31]. In the field of cultural spaces, Fancourt and Finn note that engagement with art and culture helps promote health and

well-being [32]. These studies suggest that, as a public space that combines ecological and cultural functions, the Green Concert Hall may contribute to residents' well-being through both the spatial environment and cultural engagement, as well as by fostering positive emotions.

Research on the built environment indicates that spatial design features can influence residents' well-being through their perception of the environment. Mouratidis notes that the urban built environment can affect residents' subjective well-being through channels such as leisure activities and social relationships, suggesting that spatial design features can become part of residents' daily life experiences and further influence their assessment of well-being [33]. In their research on public spaces, Cattell et al. found that urban public spaces designed for lingering, observing, and socializing not only support individual relaxation and social interaction but also serve as important environmental resources for promoting residents' well-being [34]. Furthermore, Cuypers et al. found that participation in cultural activities is significantly associated with well-being indicators such as life satisfaction [35]. Taken together, these studies indicate that a concert hall combining the attributes of green architecture, public space, and cultural services may enhance residents' well-being by improving the spatial experience, promoting emotional recovery, and fostering a sense of cultural engagement—provided that the design features of the concert hall are perceived by residents as clear, comfortable, aesthetically pleasing, and culturally meaningful. Based on this, the following hypothesis is proposed:

H1. *Green concert hall design perception has a positive impact on residents' well-being.*

2.2. Mediating Mechanisms and Research Hypotheses

The following hypotheses are developed within a unified mediation framework rather than as separate and unrelated assumptions. H1 examines the direct association between Green Concert Hall Design Perception and residents' well-being. H2 and H3 further explain two psychological mechanisms through which this relationship may occur, namely perceived nature connectedness and perceived restorativeness. H4 extends these two mechanisms by proposing a sequential pathway in which green design perception first enhances residents' perceived nature connectedness, which then strengthens perceived restorativeness and ultimately relates to residents' well-being. In this way, the hypotheses are theoretically connected and collectively explain how green concert hall design may be linked to residents' well-being through both direct and indirect psychological pathways.

The concept of "perceived nature connectedness" stems from research on connection to nature and typically refers to an individual's subjective sense of connection, closeness, and belonging to the natural world. Mayer and Frantz developed the Nature Connection Scale to measure individuals' emotional connection to the natural world, illustrating that this concept emphasizes the subjective experience of the relationship between humans and nature [36]. In subsequent research, Schultz further explained the connection with nature from the perspective of "self-nature inclusion," arguing that the relationship between humans and nature encompasses cognitive connection, emotional care, and behavioral commitment [37]. Capaldi's research further demonstrates that there is a consistent positive relationship between connection with nature and well-being, suggesting that people's subjective experiences of their relationship with nature can translate into positive psychological outcomes [38]. Based on the above research, perceived nature connectedness is defined in this study as the subjective sense of closeness to nature that residents experience when interacting with a green concert hall, arising from design cues such as green landscapes, eco-friendly materials, and the ambient atmosphere. This variable emphasizes how green concert halls stimulate residents' psychological experience of a relationship with nature through perceptible natural elements.

Design elements such as natural light and natural materials in the built environment can foster a psychological connection between people and nature. Richardson and Butler note that the core of biophilic design lies in promoting the connection between people and nature through the built environment [39]. From this perspective, if residents can clearly perceive the green design features of the Green Concert Hall, it may enhance their sense of closeness to and connection with nature. Furthermore, experimental research by Mayer et al. found that exposure to nature can enhance individuals' sense of connection to nature, positive emotions, and reflective capacity, and that this sense of connection to nature partially mediates the relationship between exposure to nature and positive psychological outcomes [40]. A study by Liu et al. based on residents of Guangzhou, China, confirmed that connection with nature is a stronger predictor of psychological well-being than exposure to nature alone, and plays a role in the relationship between exposure to nature and mental health [41]. In the context of a green concert hall, residents' positive perceptions of green design, the ecological environment, and natural imagery first strengthen their perceived nature connectedness, thereby enhancing their positive emotions, sense of life's meaning, and overall well-being. Based on this, the following hypothesis is proposed:

H2. *Perceived nature connectedness serves as a bridge between the green concert hall design perception and residents' well-being.*

Perceived restorativeness stems from research on restorative environments and the theory of attentional recovery; it generally refers to the extent to which an individual subjectively perceives that a particular environment can alleviate mental fatigue, restore attentional resources, and regulate emotions [42,43]. The Attention Restoration Theory posits that certain environments have restorative effects because they reduce the cognitive load associated with sustained directed attention and promote attention restoration through environmental characteristics such as flexible attraction, distance from daily stressors, spatial extent, and alignment with individual needs. It should be noted that "Being Away," "Fascination," "Extent," and "Compatibility" are restorative environmental characteristics derived from the Attention Restoration Theory, and subsequent scales for perceived restorativeness and empirical studies have largely operationalized these concepts based on this framework. Recent studies indicate that natural environments play a supportive role in attentional recovery, but their effectiveness is influenced by exposure methods, measurement indicators, and specific attentional processes; therefore, perceived restorativeness must be understood in the context of specific environmental situations [44,45]. Further research on urban public spaces has found that factors such as spatial design and sensory elements—which contribute to the perceived quality of the environment—can influence users' evaluations of a space's perceived restorativeness [46]; Research on urban public spaces also suggests that restorative experiences in urban environments with a high degree of naturalness can similarly be perceived by residents as places of restorative power [47]. In addition, research on green office spaces has found that factors such as the proportion of indoor greenery and color complexity can predict perceived restorativeness, suggesting that green design and the visual environment within a building can also enhance the restorative experience [48]. Based on the above research, perceived restorativeness is defined in this study as the comprehensive subjective experience of psychological resource recovery, mental relaxation, and emotional regulation that residents experience when interacting with a green concert hall, resulting from natural lighting, ecological landscapes, green materials, a comfortable acoustic, lighting, and thermal environment, and the overall spatial ambiance.

Green concert hall design perception primarily reflects residents' evaluations of green elements, ecological quality, aesthetic harmony, and cultural significance within the ar-

chitectural space. In a study of university campuses, Hipp et al. found that a partial mediating relationship exists between students' perceptions of campus greenery and their assessments of quality of life, indicating that green environment perception and evaluations of well-being involve users' subjective experiences of perceived restorativeness [49]. Akpınar's study on the perceptual dimensions of urban green spaces further illustrates that when environmental features are perceived by individuals, they often result in experiences such as relaxation, stress relief, and psychological recovery [50]. In their study on green spaces on campus, Malekinezhad et al. further analyzed the perceived restorativeness by positioning it between the perceived environmental quality and the restorative experience, pointing out that there is a continuous relationship among spatial perception characteristics, restorative evaluations, and psychological restorative experiences [51]. Extending this to the context of a green concert hall, if residents perceive the hall's green concert hall design as clear, comfortable, harmonious, and culturally meaningful, this spatial evaluation may further manifest as restorative experiences such as relief from daily stress, relaxation of attention, and emotional soothing; these restorative experiences, in turn, are linked to residents' positive evaluations of their own well-being. Therefore, perceived restorativeness can be understood as a crucial psychological component in the relationship between the green concert hall design perception and residents' well-being. Based on this, the following hypothesis is proposed:

H3. *Perceived restorativeness mediates the relationship between green concert hall design perception and residents' well-being.*

The concept of "green concert hall design perception" refers to residents' overall perception of natural lighting, ecological landscapes, and sustainable materials. As residents experience the clarity, harmony, and comfort of these elements, they are likely to develop a subjective sense that "nature is present within the architectural space" and that "they are closer to nature." Relevant research indicates that biophilic design and the experience of proximity to nature are both associated with individuals' sense of perceived nature connectedness and residents' well-being, suggesting that natural elements in the built environment can translate into psychological experiences that enhance the relationship between humans and nature [52]. Building on this, a sense of connection with nature encompasses cognitive identification with nature, as well as a sense of closeness, belonging, and emotional engagement. When residents experience this connection with nature in the Green Concert Hall, the space may also be perceived as an environment that offers relaxation, comfort, and psychological support. Research by Samus et al. has found that the naturalness and wildness of urban green spaces are associated with perceived nature connectedness and positive emotional experiences, suggesting that this sense of connection can further transform the natural features of the environment into positive psychological experiences [53]. Furthermore, restorative experiences emphasize the individual's subjective sense of being free from stress, experiencing mental relaxation, and emotional relief within a given environment. Research on indoor natural environments has shown that there is a correlation between the sense of connection to nature and perceived restorativeness across indoor settings with varying levels of natural density, suggesting that the experience of connecting with nature can further correspond to the perception of an environment's restorative potential [54]. Extending this to the context of green concert halls, residents' positive perceptions of green design features may initially manifest as an enhanced sense of closeness to and belonging with nature, subsequently leading to an increased sense of spatial restoration, and ultimately linking to their assessment of residents' well-being. Based on this, the following hypothesis is proposed (The proposed model is shown in Figure 1):

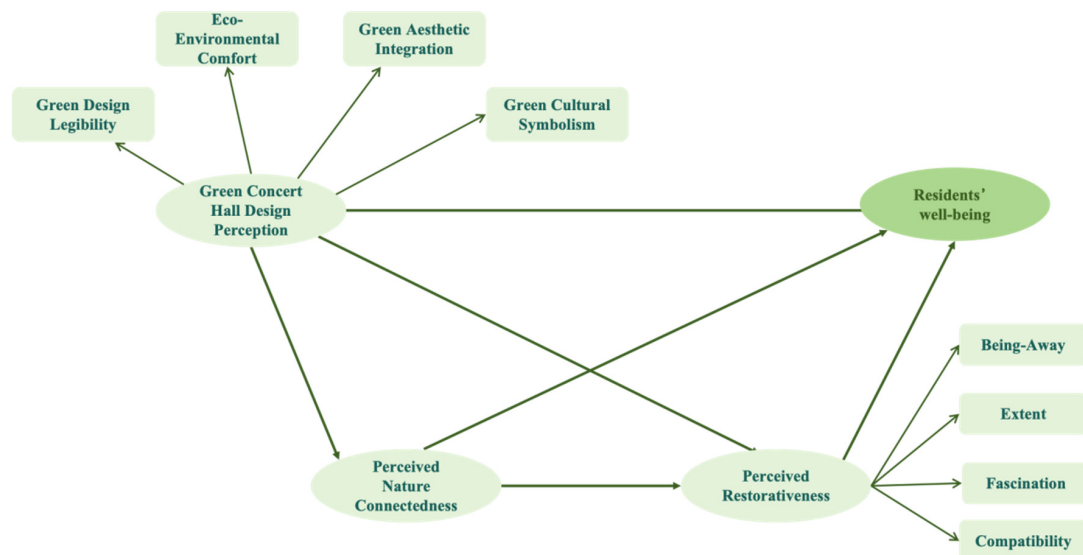
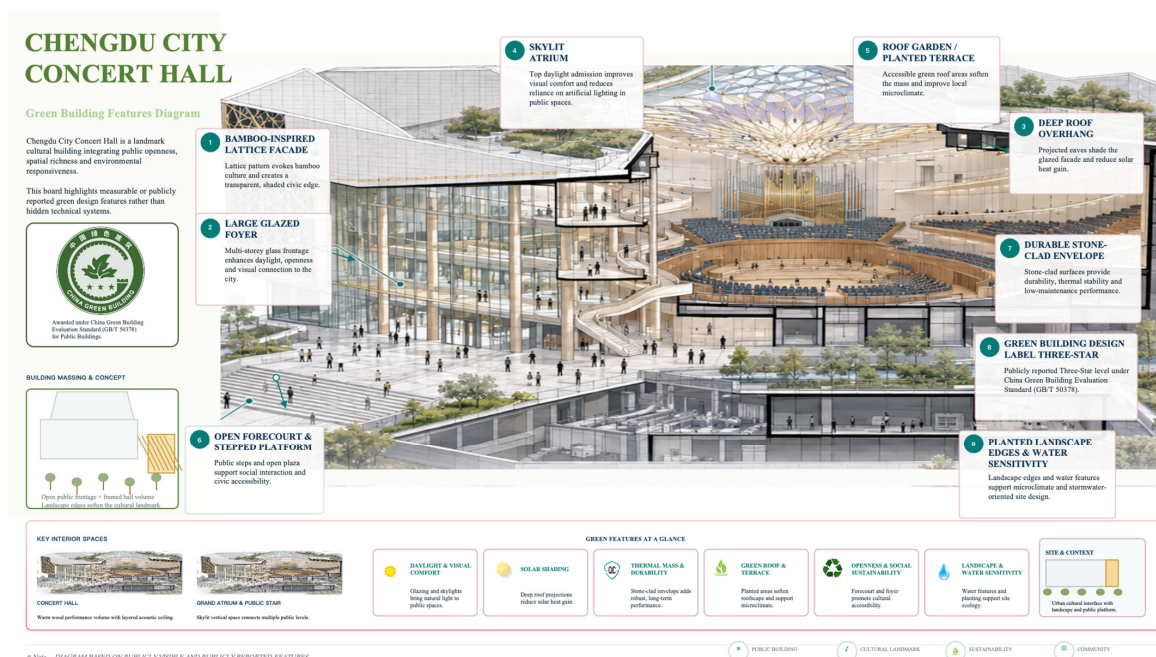


Figure 1. Proposed Conceptual Model.

H4. Green concert hall design perception is positively associated with residents' well-being through the chain mediation of perceived nature connectedness and perceived restorativeness.

To provide a more concrete visualization of the green design features of the Chengdu City Concert Hall, Figure 2 summarizes its representative green strategies across building massing, key interior spaces, roofscape, and site context, including daylight admission, green roof, deep overhang shading, planted landscape edges, and open forecourt. This diagram helps ground the measurement of green concert hall design perception in the actual architectural evidence. For the visual presentation in Figure 2, we employed ChatGPT (GPT-5.5, OpenAI) as a rendering assistant. The author crafted all textual prompts, determined the compositional structure, and rigorously reviewed the final output for scientific accuracy. All intellectual content and narrative interpretations remain the sole responsibility of the author.



3. Research Design

3.1. Participants

This study surveyed long-term Chengdu residents who had attended a performance at Chengdu City Concert Hall. The survey was conducted from October 2025 to January 2026. The offline survey was conducted in accordance with the opening hours and performance schedule of Chengdu City Concert Hall. As performances were more frequently scheduled on Fridays and weekends, most questionnaires were distributed during these periods. Participants were required to meet all of the following criteria: (1) they had Chengdu household registration, held a formal job in Chengdu, or belonged to a long-term resident group such as local university students studying and living in Chengdu; (2) they had lived in Chengdu continuously for at least two years; (3) they were 18 years old or above; (4) they had visited Chengdu City Concert Hall and completed at least one full performance-viewing experience within the past 12 months; and (5) they participated voluntarily and were able to complete the questionnaire independently.

This study followed the principles of anonymity, voluntary participation, and informed consent. No personally identifiable information was collected. A total of 950 questionnaires were distributed, and 928 were returned, giving a response rate of 97.7%. After data cleaning, 879 valid questionnaires were retained, with a valid response rate of 94.7%. The demographic characteristics of the sample are shown in Table 1. Overall, the sample mainly consisted of young and middle-aged respondents with relatively high educational attainment and middle-income backgrounds. These characteristics are broadly consistent with the core audience profile of the concert hall and can reasonably reflect the perceptions of residents who actually attended performances at Chengdu City Concert Hall.

Table 1. Descriptive analysis of basic information.

Variable	Category	n	%
Gender	Male	427	48.6
	Female	452	51.4
Age	18–30 years	281	32.0
	31–45 years	379	43.1
	46–60 years	167	19.0
	Over 60 years	52	5.9
Educational Background	High school and below	126	14.3
	Associate/Bachelor’s degree	598	68.0
	Master’s degree and above	155	17.7
Monthly Income	Below 5000 RMB	214	24.3
	5000–10,000 RMB	412	46.9
	Above 10,000 RMB	253	28.8
Occupation	Enterprise/Institution employee	370	42.1
	Student	163	18.6
	Freelancer	143	16.3
	Other	203	23.1
Continuous residence in Chengdu	2–5 years	243	27.6
	6–10 years	315	35.8
	Above 10 years	321	36.6
Household Registration/Employment Status	Has Chengdu household registration	539	61.3
	No household registration but has formal employment in Chengdu	309	35.2
	Other (local university students, etc.)	31	3.5

The age-group classifications in Table 1 were used for descriptive analysis rather than derived from a single universally accepted age-classification standard. Respondents were

divided into four groups: 18–30 years, 31–45 years, 46–60 years, and over 60 years. This grouping was informed by research on adult developmental stages and was designed to distinguish younger adults, earlier middle-aged adults, later middle-aged adults, and older adults while maintaining interpretable subgroup sizes [55]. The first category broadly captures the transition from emerging adulthood to young adulthood, which previous research has situated primarily from the late teens through the twenties. The threshold of over 60 years is consistent with Article 2 of the Law of the People’s Republic of China on the Protection of the Rights and Interests of the Elderly, which defines older persons as citizens aged 60 years or above [56]. The two intermediate categories were operationally divided into 15-year intervals to facilitate descriptive comparison across adult age groups.

3.2. Questionnaire Distribution Process

This study adopted a fully offline questionnaire distribution method, with survey points set up at the main audience exits and rest areas of the Chengdu City Concert Hall. The distribution took place within 30 min after each performance and during intermissions to best capture respondents’ immediate environmental perception after viewing. To avoid selection bias that may arise from “random interception” (e.g., intercepting only slower-moving, less time-constrained, or more outgoing audience members), this study employed systematic sampling: surveyors invited one out of every five audience members based on their order of exit. If the selected audience member refused or did not meet the inclusion criteria, the next person in line was invited. All surveyors received standardized training and passed a consistency test (Kappa coefficient > 0.85) before the formal survey.

Before formally completing the questionnaire, surveyors first explained the purpose of the study, the principle of anonymity, the fact that data would be used solely for academic research, and that respondents had the right to withdraw at any time. Respondents were also informed of and asked to sign a written informed consent form. The questionnaire was administered in paper form and took approximately 8–12 min to complete. To identify and eliminate invalid responses, an open-ended attention check item was embedded after all scale items and before the collection of demographic information. The item read: “Please briefly describe: Did you notice any design elements or details related to ‘green,’ ‘ecology,’ ‘nature,’ or ‘environmental protection’ in the Chengdu City Concert Hall? If yes, please list 1–2 examples (e.g., green plants, natural lighting, energy-saving facilities, eco-friendly materials, ventilation design, etc.). If not, please write ‘none.’” This open-ended item was designed to verify whether respondents had actually visited the concert hall and whether they remained attentive while completing the questionnaire. This item was used solely for verification of actual visit and attentive completion; failure to identify green elements was not a criterion for exclusion. Two researchers independently coded the open-ended responses. Questionnaires with patterned answers, more than 30% missing data, or clear contradictions were also excluded. After cleaning using the above criteria, a total of 49 invalid questionnaires were excluded from the 928 collected (31 for failing the open-ended attention check, 12 for patterned answers, 4 for excessive missing data, and 2 for contradictions), resulting in 879 valid questionnaires.

3.3. Variable Measurement

All scale items were measured using a five-point Likert scale, where 1 indicates “strongly disagree” and 5 indicates “strongly agree.” To ensure the accuracy and comprehensibility of the scales in a Chinese context, this study conducted a standardized translation-back translation procedure for all original English items. Two researchers with professional backgrounds in both Chinese and English independently performed the translation and back translation, respectively, and subsequently conducted semantic

comparisons and revisions of the translated text. The measurement instruments used in this study were either developed or adapted according to the characteristics of each construct. As no established scale specifically measures Green Concert Hall Design Perception, this scale was developed by the authors based on relevant theories and previous studies and was further contextualized for the concert-hall setting. The scales for Perceived Nature Connectedness and Perceived Restorativeness were adapted from established scales in previous studies. The measurement of Residents' Well-being was adapted and integrated from existing well-being scales and related studies. The specific theoretical foundations and adaptation procedures for each scale are described below.

Measurement of Green Concert Hall Design Perception: In this study, Green Concert Hall Design Perception is defined as a second-order construct comprising four first-order dimensions: Green Design Legibility, Eco-Environmental Comfort, Green Aesthetic Integration, and Green Cultural Symbolism. Given the lack of established scales specifically targeting green concert hall design perception in existing research, this study adopted a procedure of “theoretical review—item contextualization—expert review—small-scale pilot testing—formal sample validation” during the scale development process. First, based on relevant theories and established scales regarding architectural legibility, indoor environmental quality, environmental aesthetics, biophilic design, the cultural significance of the built environment, and ecological values, the study initially formed an item pool comprising four dimensions: Green Design Legibility (GDL), Eco-Environmental Comfort (EEC), Green Aesthetic Integration (GAI), and Green Cultural Symbolism (GCS). Second, all items were semantically adapted to the performance-viewing context of the Chengdu City Concert Hall to ensure they accurately reflect residents' actual perceptions of the green concert hall's spatial environment. Subsequently, three experts, including two specialists in architectural design and one specialist in art psychology, were invited to review the item content. The expert review focused on content validity, consistency with the construct definitions, clarity of expression, and contextual appropriateness. The experts mainly recommended replacing generic expressions related to “green design” with wording more closely aligned with the concert-hall setting and the performance-viewing experience. Prior to the formal survey, a small-scale pilot test was conducted with 52 respondents to assess the comprehensibility of the questionnaire items, completion time, and potential semantic ambiguities. Based on the pilot feedback, minor wording refinements were made to improve contextual clarity. For example, the item “In this concert hall, the indoor environment made me feel comfortable” was revised to “In this concert hall, the indoor environment made me feel comfortable during the performance.” The respondents also demonstrated a consistent understanding of the items under the Green Cultural Symbolism dimension. No items were deleted, and all items were retained for the formal survey.

In measuring Green Design Legibility, this study primarily draws on Lynch's classic research on environmental legibility and spatial recognition, and, by incorporating subsequent research on spatial orientation and the perception of green buildings, revises the original measurement logic—which focused on “whether a space is easy to recognize and understand”—to “whether green design elements are easy to recognize and understand [57].” This dimension focuses on whether audiences can clearly identify the concert hall's eco-friendly facilities, energy-efficient designs, and ecological spatial features. Typical items include: “I can clearly identify the green design elements in this concert hall” and “This concert hall clearly conveys its green, energy-efficient, or sustainable design intentions.” In measuring Eco-Environmental Comfort, this study primarily draws on research related to Indoor Environmental Quality (IEQ), Post-Occupancy Evaluation (POE), user environmental satisfaction, and biophilic design. Traditional IEQ scales typically focus on thermal comfort, air quality, daylighting, ventilation, acoustic environment, and material

health [58]. This study adapts the framework to the context of concert hall performances, refining it to assess audience perceptions of environmental comfort, acoustic comfort, and health and safety during performances. Typical items include: “The indoor environment of this concert hall made me feel comfortable during the performance” and “The acoustic environment of this concert hall made me feel natural, clear, and comfortable.” In measuring Green Aesthetic Integration, this study primarily draws on Nasar’s research on environmental aesthetic evaluation, the Kaplans’ theories on environmental preferences and natural aesthetics, as well as relevant perspectives from biophilic design regarding natural materials, natural forms, and spatial aesthetics [59–61]. This dimension focuses on assessing whether green elements are harmoniously integrated with the concert hall’s architectural style, spatial form, color palette, materials, and artistic atmosphere. Typical items include: “The green elements of this concert hall are consistent with the overall architectural style” and “The green design of this concert hall enhances the overall artistic atmosphere.” In measuring Green Cultural Symbolism, this study primarily draws on Rapoport’s research on the cultural significance of the built environment [62], as well as the New Ecological Paradigm ecological values scale proposed by Dunlap et al. [63]. This dimension focuses on whether the green design of a concert hall conveys symbolic meanings such as respect for nature, sustainable development, local culture, and ecological civilization. Typical items include: “The green design of this concert hall conveys the cultural significance of respecting nature” and “The green design of this concert hall embodies the values of sustainable development.” The Cronbach’s α coefficients for this variable are 0.834, 0.844, 0.840, and 0.843.

Regarding the measurement of the mediating variable perceived nature connectedness (PNC), this study drew upon the Connectedness to Nature Scale (CNS) developed by Mayer and Frantz and its simplified Chinese revision, and adapted it to the context of the Green Concert Hall [36]. This scale is designed to assess individuals’ psychological identification with and emotional connection to nature in specific environments, reflecting the subjective experience of human–nature interaction. Given the unique nature of concert hall settings, this study has made appropriate adjustments to the scale’s wording to ensure it can measure participants’ overall experience of attention to natural elements, psychological connection, and a sense of immersion within the concert hall. Typical items include “In this concert hall space, I feel closely connected to nature” and “The concert hall environment makes me pay more attention to and cherish nature.” The scale has been validated for reliability and validity in a Chinese sample and can effectively measure individuals’ perception of connection to nature in indoor or specific environments [64,65]. The Cronbach’s alpha coefficient for this variable is 0.857.

Regarding the measurement of the mediating variable, Perceived Restorativeness, this study adopted a well-established scale from previous research and adapted it to the concert hall context. The Chinese version of the Perceived Restorativeness Scale, revised by Li et al., was employed. The scale comprises four dimensions: Being-Away (distancing from the everyday environment), Extent (the breadth and coherence of the environment), Fascination (features that capture attention), and Compatibility (the alignment of the environment with personal needs) [66]. In the Being-Away dimension, items include “In the concert hall, I can temporarily escape the hassles of daily life”; in the Extent dimension, items include “The space here makes me feel a sense of overall harmony and coherence”; in the Fascination dimension, items include “In the concert hall, I notice many interesting details”; in the Compatibility dimension, the original scale contained only two items, and this study added one new item: “The layout and atmosphere of the concert hall allow me to easily immerse myself in the music,” to enhance measurement completeness. This scale has been validated in a local Chinese sample and is effective in measuring users’ restorative experiences

in concert halls. The Cronbach's α coefficients for this variable are 0.834, 0.807, 0.811, and 0.847.

To measure the dependent variable, residents' well-being (RW), this study drew on the Satisfaction With Life Scale (SWLS) developed by Diener et al. [67]. The scale consists of five items, such as "Overall, my life is close to my ideal state" and "I am satisfied with my life." Additionally, this study drew upon the positive emotion dimensions related to architectural experiences from Bradburn's Emotional Balance Scale and the Positive and Negative Affect Schedule (PANAS) developed by Watson et al., and combined these with Deng et al.'s measurement methods regarding the built environment and residents' well-being, ultimately resulting in a scale comprising eight items [68,69]. An example item is "I am satisfied with my current life situation." The Cronbach's α coefficient for this variable is 0.923.

3.4. Variable Abbreviations

To facilitate model specification, data analysis, and presentation of the results, the main variables and their dimensions are abbreviated as follows. Green Concert Hall Design Perception is abbreviated as GCHDP. It is treated as a second-order construct consisting of four first-order dimensions: Green Design Legibility (GDL), Eco-Environmental Comfort (EEC), Green Aesthetic Integration (GAI), and Green Cultural Symbolism (GCS).

Perceived Nature Connectedness is abbreviated as PNC. Perceived Restorativeness is abbreviated as PR. PR is also treated as a second-order construct consisting of four first-order dimensions: Being Away (BE), Extent (EX), Fascination (FA), and Compatibility (CO). Residents' Well-being is abbreviated as RW. These abbreviations are used consistently in the following analyses.

4. Data Analysis

4.1. Common Method Bias Test

Since all variable data in this study were collected from self-reported questionnaires administered to the same participant group, the relationships among the variables may be subject to common method bias. To assess the potential extent of this bias, this study employed both Harman's single-factor test and a CFA single-factor comparison method for diagnosis [70]. In Harman's single-factor test, all observed variables were entered into an unrotated exploratory factor analysis. The results showed that the first unrotated common factor had an eigenvalue of 11.687, explaining 28.504% of the total variance, which is significantly below the conventional empirical threshold of 40%, indicating the absence of typical common method bias characterized by a single factor accounting for the majority of variance. For further validation, this study constructed a single-factor confirmatory model in which all measurement items were loaded onto one common factor, and compared its fit with that of the hypothesized multi-factor measurement model. The specific fit indices are presented in Table 2. The comparison results showed that the single-factor model exhibited a poor fit ($\chi^2/df = 12.368$, RMSEA = 0.114, CFI = 0.500, TLI = 0.473, SRMR = 0.104), with all indices failing to meet acceptable fit standards. In contrast, the hypothesized multi-factor measurement model demonstrated a good fit ($\chi^2/df = 1.382$, RMSEA = 0.021, CFI = 0.984, TLI = 0.982, SRMR = 0.024). Based on the results of both methods, it can be concluded that common method bias does not pose a significant systematic threat to the relationships among the variables in this study, and the subsequent structural equation modeling analyses are built on an acceptable level of reliability.

Table 2. Common Method Bias Test: Comparison of Fit Between Single-Factor Model and Measurement Model.

Fit Index	Single-Factor Model	Measurement Model
χ^2	9634.428	1010.736
χ^2/df	12.368	1.382
RMSEA	0.114	0.021
GFI	0.539	0.947
SRMR	0.104	0.024
NFI	0.480	0.945
TLI	0.473	0.982
CFI	0.500	0.984

4.2. Confirmatory Factor Analysis

This study used confirmatory factor analysis (CFA) to examine the measurement model for the ten latent variables included in the questionnaire: GDL, EEC, GAI, GCS, PNC, BE, EX, FA, CO, and RW. This analysis was conducted to assess the convergent and discriminant validity of the scales and to provide a reliable basis for the subsequent structural equation modeling analysis.

As shown in Table 3, the standardized factor loadings of all measurement items ranged from 0.704 to 0.865, meeting the commonly accepted threshold of 0.70. This indicates that all items were closely associated with their corresponding latent variables and had good explanatory power and representativeness. The composite reliability (CR) values for GDL, EEC, GAI, GCS, PNC, BE, EX, FA, CO, and RW were 0.834, 0.846, 0.840, 0.843, 0.857, 0.840, 0.817, 0.818, 0.856, and 0.923, respectively. All CR values were above 0.80, suggesting strong internal consistency among the items within each latent variable. The average variance extracted (AVE) values were 0.557, 0.578, 0.568, 0.574, 0.546, 0.637, 0.599, 0.600, 0.665, and 0.599, respectively, all exceeding the commonly used threshold of 0.50. This shows that each latent variable explained more than half of the variance in its corresponding measurement items, indicating good convergent validity.

Since Green Concert Hall Design Perception (GCHDP) was specified as a second-order construct represented by Green Design Legibility, Eco-Environmental Comfort, Green Aesthetic Integration, and Green Cultural Symbolism, its second-order measurement quality was also examined. The results showed that the standardized second-order loadings of GCHDP on GDL, EEC, GAI, and GCS were 0.693, 0.673, 0.689, and 0.761, respectively, all above 0.60. This suggests that the four first-order dimensions adequately reflected the higher-order construct of green concert hall design perception. The composite reliability of GCHDP was 0.797, close to 0.80, indicating acceptable internal consistency for the second-order construct. Taken together, these results support the use of GCHDP as a second-order latent variable in the subsequent structural equation model.

To further assess discriminant validity among the latent variables, this study used both the Fornell-Larcker criterion and the HTMT ratio matrix. As shown in Table 4, the bold values on the diagonal are the square roots of the Average Variance Extracted, while the off-diagonal values are the correlations between latent variables. According to the Fornell-Larcker criterion, discriminant validity is established when the square root of the AVE for each construct is greater than its correlations with all other constructs [71]. The results show that this condition was satisfied for all latent variables, indicating that the constructs can be clearly distinguished from one another and that there was no serious conceptual overlap. Specifically, the square roots of AVE for RW, CO, FA, EX, BE, PNC, GCS, GAI, EEC, and GDL were 0.774, 0.815, 0.775, 0.774, 0.798, 0.739, 0.758, 0.754, 0.760, and 0.746, respectively. All of these values were higher than the corresponding inter-construct

correlations. Therefore, the measurement model showed good discriminant validity and provided a reliable basis for the subsequent structural model analysis.

Table 3. Results of Confirmatory Factor Analysis.

Latent Variable	Item	Standardized Loading	CR	AVE
GDL	GDL1	0.742	0.834	0.557
	GDL2	0.736		
	GDL3	0.747		
	GDL4	0.759		
EEC	EEC1	0.707	0.846	0.578
	EEC2	0.786		
	EEC3	0.778		
	EEC4	0.768		
GAI	GAI1	0.743	0.840	0.568
	GAI2	0.736		
	GAI3	0.752		
	GAI4	0.784		
GCS	GCS1	0.771	0.843	0.574
	GCS2	0.722		
	GCS3	0.785		
	GCS4	0.751		
PNC	PNC1	0.704	0.857	0.546
	PNC2	0.764		
	PNC3	0.714		
	PNC4	0.758		
	PNC5	0.752		
BE	BE1	0.795	0.840	0.637
	BE2	0.811		
	BE3	0.788		
EX	EX1	0.746	0.817	0.599
	EX2	0.777		
	EX3	0.798		
FA	FA1	0.756	0.818	0.600
	FA2	0.788		
	FA3	0.779		
CO	CO1	0.865	0.856	0.665
	CO2	0.805		
	CO3	0.774		
RW	RW1	0.778	0.923	0.599
	RW2	0.761		
	RW3	0.793		
	RW4	0.780		
	RW5	0.746		
	RW6	0.787		
	RW7	0.769		
	RW8	0.778		

As shown in Table 5, the HTMT ratio was employed as a rigorous indicator for assessing discriminant validity. The results indicate that all HTMT ratio values between any two latent variables in this study are below the recommended conservative threshold of 0.85 [72]. This further rigorously verifies that there is no serious multicollinearity issue among the latent variables, and that the measurement dimensions of different variables are mutually

independent with clear boundaries. Based on the comprehensive evaluation of various fit indicators, it is evident that the overall reliability and validity of the measurement scale used in this study are excellent, and the measurement model achieves an ideal level of fit. Each item accurately, stably, and effectively measures its corresponding latent variable, and the measurement dimensions of different variables possess significant distinctiveness and independence. These results provide data support and a model foundation for subsequent empirical research, including path analysis and hypothesis testing among variables.

Table 4. Discriminant validity based on the Fornell-Larcker criterion: correlations among latent variables and square roots of AVE.

	RW	CO	FA	EX	BE	PNC	GCS	GAI	EEC	GDL
RW	0.774									
CO	0.344	0.815								
FA	0.365	0.423	0.775							
EX	0.427	0.589	0.474	0.774						
BE	0.369	0.425	0.55	0.47	0.798					
PNC	0.491	0.367	0.354	0.398	0.381	0.739				
GCS	0.384	0.312	0.359	0.336	0.34	0.383	0.758			
GAI	0.392	0.317	0.327	0.32	0.381	0.410	0.516	0.754		
EEC	0.437	0.301	0.328	0.301	0.301	0.459	0.521	0.464	0.760	
GDL	0.370	0.339	0.366	0.337	0.27	0.382	0.527	0.488	0.454	0.746

Note: The bold values on the diagonal represent the square roots of the Average Variance Extracted (AVE) for each latent variable; the off-diagonal values are the correlation coefficients between constructs.

Table 5. Discriminant Validity Test: HTMT Ratio Matrix.

	BE	CO	EEC	EX	FA	GAI	GCS	GDL	PNC	RW
BE	1									
CO	0.432	1								
EEC	0.300	0.298	1							
EX	0.475	0.596	0.303	1						
FA	0.551	0.427	0.322	0.473	1					
GAI	0.385	0.326	0.466	0.320	0.328	1				
GCS	0.339	0.314	0.523	0.338	0.360	0.518	1			
GDL	0.27	0.349	0.453	0.337	0.367	0.489	0.526	1		
PNC	0.384	0.372	0.463	0.402	0.357	0.412	0.386	0.381	1	
RW	0.371	0.338	0.434	0.426	0.364	0.390	0.384	0.370	0.491	1

4.3. Correlation Analysis

As shown in Table 6, the correlation analysis results indicate that all core variables are significantly positively correlated with each other. The correlation coefficients between GCHDP and its four first-order dimensions, namely GDL, EEC, GAI, and GCS, are 0.744, 0.735, 0.749, and 0.772, respectively, suggesting that these four dimensions adequately reflect the higher-order construct of Green Concert Hall Design Perception. PNC is significantly positively correlated with GCHDP, PR, and RB, with correlation coefficients of 0.464, 0.427, and 0.436, respectively, indicating that perceived nature connectedness has stable associations with green design perception, restorative experience, and residents' well-being. The correlation coefficients between PR and its four dimensions, namely BE, EX, FA, and CO, are 0.748, 0.751, 0.744, and 0.734, respectively, demonstrating a high degree of consistency between the four restorative dimensions and the overall construct of perceived restorativeness. Furthermore, RB is significantly positively correlated with GCHDP, PNC, and PR, with correlation coefficients of 0.463, 0.436, and 0.438 respectively.

These results provide preliminary support for the subsequent structural equation modeling and mediation effect tests.

Table 6. Pearson Correlation Analysis.

	GDL	EEC	GAI	GCS	BE	EX	FA	CO	GCHDP	PNC	PR	RW
GDL	1											
EEC	0.380	1										
GAI	0.409	0.392	1									
GCS	0.441	0.442	0.436	1								
BE	0.225	0.251	0.322	0.284	1							
EX	0.277	0.250	0.263	0.280	0.390	1						
FA	0.301	0.265	0.271	0.297	0.453	0.384	1					
CO	0.292	0.252	0.275	0.265	0.363	0.493	0.353	1				
GCHDP	0.744	0.735	0.749	0.772	0.361	0.357	0.378	0.361	1			
PNC	0.322	0.394	0.349	0.328	0.325	0.335	0.297	0.317	0.464	1		
PR	0.367	0.342	0.381	0.379	0.748	0.751	0.744	0.734	0.490	0.427	1	
RW	0.324	0.383	0.344	0.339	0.325	0.368	0.315	0.298	0.463	0.436	0.438	1

Note: All correlation coefficients are significant at $p < 0.01$.

4.4. Structural Equation Model

This study assessed the fit of the structural equation model using a range of commonly reported fit indices. As shown in Table 7, the results indicate that the proposed model fit the data well. The chi-square to degrees of freedom ratio (χ^2/df) was 1.418, which is below the recommended threshold of 3, suggesting an acceptable overall model fit. The RMSEA value was 0.022, indicating a low level of model error. The GFI and AGFI values were 0.943 and 0.936, respectively, both exceeding the recommended threshold of 0.90. In addition, the CFI, NFI, RFI, TLI, and IFI values were 0.982, 0.941, 0.937, 0.981, and 0.982, respectively, all above 0.90. Taken together, these results show that the structural model had a good fit and was suitable for further path and mediation analyses.

Table 7. Model fit indices for the structural equation model.

Fit Index	Recommended Criterion	Value
χ^2	-	1085.050
df	-	765
χ^2/df	<3	1.418
GFI	>0.9	0.943
RMSEA	<0.10	0.022
CFI	>0.9	0.982
NFI	>0.9	0.941
RFI	>0.9	0.937
TLI	>0.9	0.981
AGFI	>0.9	0.936
IFI	>0.9	0.982

As shown in Table 8 and Figure 3, the path coefficient results include both structural paths and second-order measurement paths. For the structural paths, GCHDP was significantly and positively associated with PNC, PR, and RW, with standardized path coefficients of 0.579, 0.528, and 0.286, respectively. PNC was also significantly and positively associated with PR and RW, with standardized path coefficients of 0.231 and 0.193, respectively. PR was significantly and positively associated with RW, with a standardized path coefficient of 0.247. These results suggest that green concert hall design perception was directly as-

sociated with residents' well-being and may also be indirectly associated with it through perceived nature connectedness and perceived restorativeness [73–78].

Table 8. Path coefficients of the structural equation model.

Path			Unstandardized Coefficient	S.E.	C.R.	<i>p</i>	Standardized Coefficient
GCHDP	→	PNC	0.757	0.070	10.815	***	0.579
PNC	→	PR	0.180	0.040	4.476	***	0.231
GCHDP	→	PR	0.537	0.067	7.963	***	0.528
GCHDP	→	GDL	1.000				0.688
GCHDP	→	EEC	0.947	0.078	12.093	***	0.698
GCHDP	→	GAI	1.002	0.081	12.296	***	0.698
GCHDP	→	GCS	1.049	0.082	12.770	***	0.732
PR	→	BE	1.000				0.683
PR	→	EX	0.970	0.078	12.495	***	0.744
PR	→	FA	0.971	0.080	12.096	***	0.687
PR	→	CO	1.010	0.079	12.806	***	0.681
PR	→	RW	0.356	0.083	4.284	***	0.247
PNC	→	RW	0.217	0.050	4.312	***	0.193
GCHDP	→	RW	0.421	0.089	4.727	***	0.286

Note: *** $p < 0.001$.

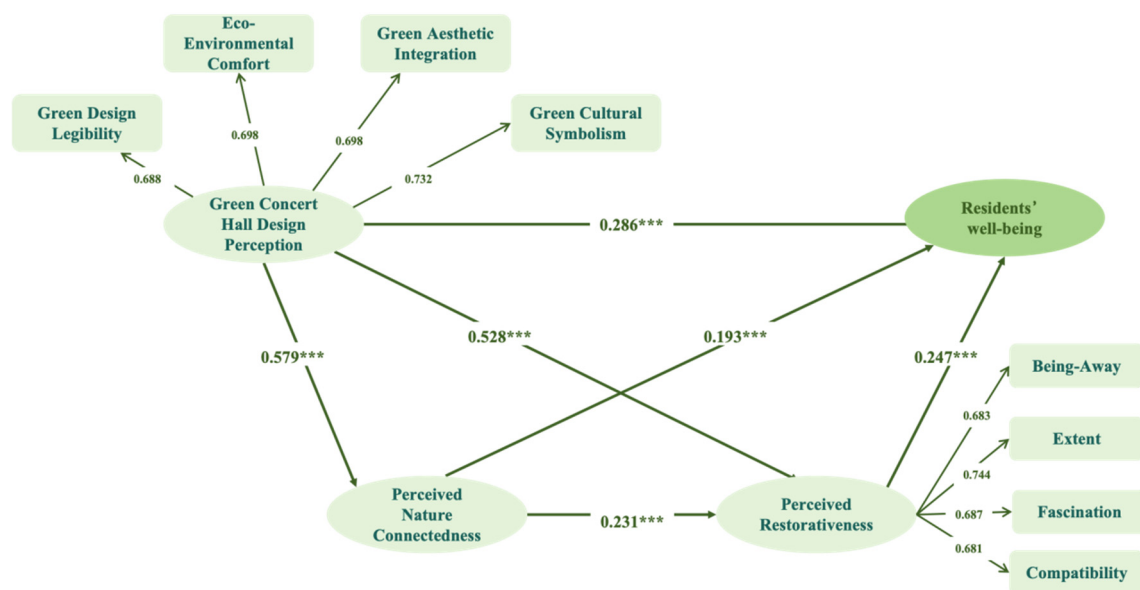


Figure 3. Results of the Modified Structural Equation Model. *** $p < 0.001$.

For the second-order measurement paths, the standardized loadings of GCHDP on GDL, EEC, GAI, and GCS were 0.688, 0.698, 0.698, and 0.732, respectively, and all were statistically significant. This indicates that green design legibility, eco-environmental comfort, green aesthetic integration, and green cultural symbolism adequately reflected the second-order construct of green concert hall design perception. The standardized loadings of PR on BE, EX, FA, and CO were 0.683, 0.744, 0.687, and 0.681, respectively, and all were statistically significant. This indicates that being away, extent, fascination, and compatibility adequately reflected the second-order construct of perceived restorativeness.

4.5. Mediation Analysis

The significance of indirect effects was tested using the bootstrap method with 5000 re-samples, and bias-corrected confidence intervals were used to determine significance [79,80].

As shown in Table 9, the total association between GCHDP and RW was 0.561. Its 95% confidence interval did not include zero, and the p -value was below 0.01. Together with the significant direct association, this result suggests that GCHDP was associated with RW through both direct and indirect paths.

Table 9. Results of mediation analysis.

Parameter	Estimate	SE	Lower	Upper	p
GCHDP $\rightarrow$ PNC $\rightarrow$ PR $\rightarrow$ RW chain-mediated indirect effect	0.033	0.015	0.01	0.072	0.003
GCHDP $\rightarrow$ PNC $\rightarrow$ RW indirect effect	0.112	0.036	0.041	0.184	0.004
GCHDP $\rightarrow$ PR $\rightarrow$ RW indirect effect	0.13	0.045	0.054	0.241	0.003
GCHDP $\rightarrow$ RW direct effect	0.286	0.074	0.138	0.431	0.001
GCHDP $\rightarrow$ RW total effect	0.561	0.044	0.471	0.642	0.001

Several indirect paths in the model were statistically significant. The sequential indirect association from GCHDP to RW through PNC and PR was 0.033, with a confidence interval ranging from 0.010 to 0.072. Since the confidence interval did not include zero and the p -value was significant, this sequential mediation path was statistically supported. For the single-mediator paths, the indirect association between GCHDP and RW through PNC was 0.112, while the indirect association through PR was 0.130. The confidence intervals for both paths did not include zero, and both paths were statistically significant. In comparison, the indirect association through PR was slightly stronger than that through PNC. Overall, the total association between GCHDP and RW consisted of both a direct association and several indirect associations. The parallel mediation paths and the sequential mediation path together show a more complex association structure between the core variables and RW, and further clarify the mediating roles of PNC and PR in the proposed model.

5. Discussion

5.1. Direct Effects

The research findings demonstrate a significant positive correlation between the green concert hall design perception and residents' well-being. The core significance of this finding lies in the fact that the value of a green concert hall is reflected in whether residents can derive a clear, comfortable, harmonious, and culturally meaningful subjective experience from the architectural space. From the perspective of the research context, green concert halls differ from both typical green buildings and ordinary public cultural facilities. Their uniqueness lies in the fact that they simultaneously possess ecological and environmental attributes, artistic and aesthetic attributes, and public cultural attributes. Residents' positive evaluations of green concert halls stem from a comprehensive perception of environmental quality, spatial comfort, artistic ambiance, and urban cultural symbolism. Therefore, the relationship between green concert hall design perception and residents' well-being reflects residents' holistic response to the environmental quality of public cultural architecture. This finding also indicates that the well-being value of green public cultural buildings cannot be understood solely from the perspective of architectural technical indicators or the provision of cultural services. For residents, whether a green concert hall is "meaningful," "comfortable," or "representative of the city" are equally integral to their assessment of residents' well-being. Particularly in urban public life, the concert hall may also serve as a vital spatial medium through which residents perceive urban quality, develop a sense of place, and gain positive emotional experiences. From this perspective, the construction of green concert halls must avoid reducing green design to mere technical specifications or decorative elements. More importantly, green design should be made recognizable, experiential, and culturally expressive, enabling residents to understand its

ecological value and appreciate its spatial quality through direct interaction or perception, and to incorporate these aspects into their positive assessment of the city's quality of life.

5.2. Chain Mediation

The research findings reveal a continuous psychological pathway linking green concert hall design perception to residents' well-being, which is jointly constituted by perceived nature connectedness and perceived restorativeness. Compared to a direct relationship based on spatial evaluation, this finding emphasizes that residents' green concert hall design perceptions extend further into their relationship with nature and their experience of psychological restoration. Specifically, natural lighting, ecological landscapes, green materials, and a comfortable spatial atmosphere within the green concert hall first provide residents with perceptual cues to identify natural attributes. When these cues are perceived by residents as clear, harmonious, and aesthetically pleasing, residents are more likely to form the subjective feelings that "nature exists within the architectural space" and that "they are closer to nature." This indicates that green design in the concert hall context holds significance in terms of both environmental quality and perceived nature connectedness. Once perceived nature connectedness is established, residents' experience of the space shifts further toward the restorative dimension. The perception of perceived nature connectedness emphasizes a sense of closeness, belonging, and emotional engagement between humans and nature, while the perception of perceived restorativeness reflects an individual's subjective experience of escaping daily stress, relaxing their attention, and soothing their emotions within the space. It is evident that there is a strong psychological continuity between the perceived nature connectedness and restorative experiences: the former reflects the establishment of a relationship between residents and nature, while the latter reflects the extension of this relationship to the levels of psychological relaxation and emotional regulation. Therefore, the relationship between green concert hall design perception and residents' well-being comprises a progressive structure encompassing "green concert hall design perception—experiences of nature connectedness—restorative experiences—well-being evaluations." Residents' positive evaluations of the green concert hall's design features first manifest as an enhanced sense of closeness to and belonging with nature, subsequently as an improved sense of spatial restorative experience, and ultimately align with their comprehensive assessment of quality of life, positive emotions, and psychological functioning. This outcome demonstrates that the well-being significance of the green concert hall stems not only from its service function as a public cultural facility but also from the experiences of connection with nature and psychological restoration stimulated by its green design.

5.3. Comparative Analysis

In recent years, research on green and healthy buildings has largely focused on certification systems and indoor environmental quality. For example, Kent et al. compared user satisfaction in WELL- and LEED-certified buildings and found that WELL-certified buildings received higher ratings for overall building satisfaction and most indoor environmental quality indicators [81]. Such studies emphasize issues of health, comfort, and satisfaction in green building assessments, which aligns with the present study's focus on residents' well-being; however, their research subjects are primarily actual users of office buildings, and their evaluations concentrate on certification systems and differences in indoor environmental quality. In contrast, the present study does not center on green certification or a single environmental performance metric; rather, it integrates the design legibility, eco-environmental comfort, aesthetic integration, and cultural symbolism of green concert halls into a unified perceptual framework, further emphasizing the question of "how green

design is understood and experienced by residents” in public cultural buildings. In research more closely related to public cultural buildings, Asojo and Hazazi used the Bell Museum as a case study to examine the relationship between biophilic design strategies and indoor environmental quality, user satisfaction, health, and work performance [82]. This study also focuses on biophilic design elements in public buildings, such as natural light, natural materials, and spatial organization, indicating that green design in cultural public buildings has begun to be incorporated into frameworks for evaluating health and user experience. However, that study was primarily based on post-occupancy evaluations by museum staff, focusing on indoor environmental quality and work experience; the present study, in contrast, expands the research scope to include urban residents and incorporates the cultural service attributes, artistic atmosphere, and urban symbolic significance of concert halls into the analysis, thereby highlighting the social and contextual nature of green public cultural buildings in assessments of residents’ well-being. The study most closely related to the present study is the research by Zhang et al. on waterfront concert halls in China. That study found that design features such as water visibility, accessibility, and integration are correlated with user satisfaction and influence building experience evaluations through psychological pathways such as biophilia and the sense of nature’s presence [83]. This is similar to the line of thinking in the present study regarding “how the green concert hall design perception contributes to the experience of a connection with nature.” However, there are still notable differences between the two: that study focuses on “water” as a specific natural element and on user satisfaction, whereas the present study focuses on the overall green concert hall design perception and extends the outcome variable from satisfaction to residents’ well-being; at the same time, the present study further distinguishes between perceived nature connectedness and perceived restorativeness, presenting a continuous psychological process ranging from experiences of closeness to nature to psychological restoration and ultimately to assessments of well-being. From the perspective of urban green space research, Hung’s study on urban parks found a close relationship between perceived biophilic design, perceived restorativeness, perceived naturalness, and subjective vitality [84]; A comparative study by Molari et al. on green walls in Turin and Lisbon also noted that the plant diversity, repetition, and spatial integration of green walls are associated with perceived restorativeness and comfort [85]. Together with the present study, these studies demonstrate that nature-inspired design in urban environments is not merely about landscape beautification; it also influences users’ psychological evaluations of their experiences. The key difference lies in the fact that existing research has largely focused on open green spaces—such as parks and green walls—or single natural elements, whereas the present study extends the discussion to the green concert hall, a multifunctional public cultural building. It emphasizes that green design, artistic experiences, and cultural symbolism collectively form the contextual foundation for residents’ well-being assessments.

Overall, recent studies have examined the relationship between natural elements, spatial experiences, and well-being assessments in various contexts, including healthy buildings, biophilic design in public buildings, waterfront concert halls, urban parks, and green walls. The present study shares a common focus with these studies in that it emphasizes users’ subjective perceptions of green design and natural elements; However, the present study differs in that it integrates the attributes of green buildings, public cultural facilities, and residents’ well-being assessments into the specific context of a green concert hall, and further explores the continuous psychological pathway formed by perceived nature connectedness and perceived restorativeness. Therefore, the present study does not merely verify the general effects of green spaces or biophilic design, but rather provides a contextualized expansion of the relationship between green concert hall

design perception, psychological experiences, and residents' well-being within the context of public cultural architecture.

5.4. Theoretical Contributions and Practical Contributions

The theoretical and practical contributions of this study should be understood within the specific context of the Chengdu City Concert Hall. This study is not merely an application of environmental psychology and restorative environment theory to a sustainable concert hall. Rather, it extends these perspectives by treating the green concert hall as a public cultural building in which green design, artistic experience, cultural symbolism, and residents' well-being are intertwined. Specifically, this study constructs Green Concert Hall Design Perception as a second-order construct consisting of green design legibility, eco-environmental comfort, green aesthetic integration, and green cultural symbolism. This construct shifts the evaluation of green public cultural buildings from technical performance alone to residents' perceptual and psychological experience. In addition, by examining the pathway of "green design perception–perceived nature connectedness–perceived restorativeness–residents' well-being," this study provides a human-centered explanatory framework for understanding how green public cultural buildings may contribute to residents' well-being.

At the same time, because this study is based on one specific building case in Chengdu, the findings should not be directly generalized to all concert halls or public buildings nationwide. Instead, they provide context-specific evidence and design references for the future planning, design, and operation of newly built green concert halls under similar urban and cultural conditions. The findings suggest that future green concert hall design should not focus solely on green technologies, energy-saving indicators, or visual displays; rather, it should also consider whether residents can recognize, understand, and experience the spatial value of green design. Natural lighting, ecological landscaping, green materials, acoustic, lighting, and thermal environments, and low-carbon technologies should be integrated into entrance areas, waiting areas, rest areas, performance spaces, and external public spaces in a more intuitive and harmonious manner, creating a continuous green experience that enhances residents' connection with nature, spatial comfort, and psychological relaxation. At the same time, green concert halls should transcend the functional limitations of a single performance venue. Through green building tours, ecological art activities, public exhibitions, community cultural exchanges, and open recreational spaces, they should increase opportunities for residents to engage during non-performance hours. In terms of operations and management, the post-evaluation system should incorporate the visibility of green design, environmental comfort, connection to nature, restorative experiences, and cultural identity. This will continuously optimize residents' spatial experiences, transforming the green concert hall into an urban public cultural space that embodies ecological quality, artistic experiences, cultural identity, and psychological support.

6. Conclusions

This study takes the Chengdu City Concert Hall as its research subject and constructs a theoretical model linking green concert hall design perception, perceived nature connectedness, perceived restorativeness, and residents' well-being. The study defines green concert hall design perception as a second-order construct comprising the legibility of green design, ecological and environmental comfort, the integration of green aesthetics, and the symbolic significance of green culture. It emphasizes that residents' evaluations of green concert halls involve not only green building technologies and environmental performance but also aesthetic experiences, cultural significance, and perceptions of public value. The results indicate a significant positive relationship between green concert hall design perception

and residents' well-being. Residents' positive perceptions of natural lighting, ecological landscapes, green materials, spatial comfort, artistic atmosphere, and cultural symbolism are closely associated with their quality of life, positive emotions, and psychological functioning. This suggests that the value of a green concert hall lies not only in its performance services and architectural performance but also in the comprehensive experience it offers as a high-quality public cultural space. Furthermore, perceived nature connectedness and perceived restorativeness mediate the relationship between green concert hall design perception and residents' well-being, forming a continuous psychological pathway. Residents' positive perceptions of green design features first manifest as enhanced feelings of closeness to and belonging in nature, subsequently transforming into a sense of spatial restorativeness, and ultimately linking to their evaluations of well-being. It is evident, therefore, that the well-being significance of green concert halls does not stem from a single design element but is jointly constituted by green concert hall design perception, perceived nature connectedness, and experiences of psychological restoration. Future construction of green concert halls and similar public cultural buildings should place greater emphasis on the perceptibility of green design, the comfort of spatial experiences, the integration of natural elements with artistic ambiance, and the cultural symbolic value embodied by the architecture.

7. Limitations and Future Directions

This study has several limitations. First, as the analysis is based on cross-sectional survey data, the findings should be interpreted primarily as statistical associations rather than definitive causal relationships. Although the hypothesized paths were developed from established theories and the structural equation model demonstrated a good fit, the temporal sequence among green concert hall design perception, perceived nature connectedness, perceived restorativeness, and residents' well-being cannot be fully determined. In addition, some unmeasured factors, such as residents' pre-existing environmental attitudes, frequency of arts participation, familiarity with the concert hall, and baseline well-being, may simultaneously influence their perceptions of the building environment and their psychological responses. Future studies could employ longitudinal tracking, experimental designs, or quasi-experimental methods and include relevant control variables to provide stronger evidence regarding the proposed relationships. Second, the main variables in this study were measured through a single self-reported questionnaire administered at the same point in time. Although subjective perceptions are important for understanding users' experiences, it remains difficult to fully distinguish perceptions of the architectural environment from stable individual preferences or temporary emotional states. Furthermore, the questionnaires were distributed during intermissions or shortly after performances. Participants' responses may therefore have been influenced to some extent by the emotional atmosphere or enjoyment associated with the cultural event itself. The specific types of performances attended by respondents were not recorded or controlled in this study, which also limits the ability to examine whether different performance contexts affected their responses. Future research could record performance types, incorporate event-related emotional responses and visit frequency as control variables, and compare participants' perceptions before and after performances or during non-performance visits. Objective environmental measurements, behavioral observations, interviews, and post-occupancy evaluation methods could also be combined with questionnaire data to improve the comprehensiveness of the findings. Third, this study focuses on Chengdu City Concert Hall as a single case. While this provides a context-specific understanding of residents' perceptions, the generalizability of the findings remains limited. Future studies could conduct comparative analyses of concert halls in different cities, with different architectural characteristics

and varying levels of green certification. In addition, factors such as cultural participation, local identity, aesthetic experience, social interaction, and a sense of belonging to the city may also contribute to the well-being value of green public cultural buildings. These variables could be further examined to develop a more comprehensive explanatory framework. These limitations will be addressed in future studies.

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Institutional Review Board Statement: This study conducted a questionnaire survey with no clinical trials on humans or experiments on animals involved, and strictly adheres to the principles of voluntariness and anonymity. Meanwhile, this study posed no risks to participants, as it employed non-invasive methods (e.g., anonymous surveys) and adhered to the right of withdrawal. In accordance with [National Health Commission Order No. 11, 2016], ethical approval was not required. The authors take full responsibility for the ethical integrity of this work. Therefore, further approval from an ethics committee was not required due to the minimal-risk and anonymous nature of the survey.

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