Research on the Design of High-Speed Railway Carriages with the Theme of "Ice and Snow Tourism" Based on the KJ-AHP Method

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Abstract: In response to the problems of fragmented cultural images and single experience dimensions in the carriages of high-speed trains for ice and snow tourism in Northeast China, a theme carriage design scheme integrating regional cultural symbols and functional innovation is proposed to enhance tourists' immersive cultural experience and promote the upgrading of cultural tourism in cold regions. the KJ method system extracts the cultural symbols of Northeast ice and snow. the AHP method is based on the data of 112 user questionnaires. By integrating the KJ method and the AHP analytic hierarchy process, a three-dimensional framework of "passenger - carriage - culture" is constructed. the weights of design elements are quantitatively analyzed, and the spatial optimization design is completed according to the priority of the weights. the ceiling of the first-class seat with a theme of hua jiao is designed to create an ambient lighting system based on the outline of hua jiao. Sound insulation boards are added to the seats to enhance privacy. the foot pads integrate the function of collecting snow water and are decorated with the texture of hua jiao. the second-class seat ceiling with the theme of chili peppers projects cultural light and shadow through the "Chinese window lattice" element. the seats adopt a biomimetic shape of chili peppers and a gradient of red and green colors. Anti-drop sensor light strips are added to the corridor to ensure safety. the scheme realizes the precise transformation of cultural symbols and demand-oriented design through the KJ-AHP model, solves the problem of superficial cultural expression, and provides methodological and practical references for regional cultural tourism transportation design.

Keywords: KJ-AHP Model; Ice and Snow Cultural Symbols; The Three-Dimensional Framework of "Passenger - Carriage - Culture"; Optimization of Carriage Space

1. Introduction

The Northeast region of China, recognized as a core area for ice and snow tourism resources, has seen an increasing demand for high-quality travel experiences. Rail transit is favored due to its green safety features and convenient comfort. On January 9, 2025, the General Office of the State Council issued a notice titled "Several Measures to Further Cultivate New Growth Points and Prosper Cultural and Tourism Consumption, " aimed at implementing the directives from the Central Committee of the Communist Party of China and the State Council regarding expanding service consumption and promoting cultural tourism development. This initiative seeks to leverage cultural empowerment and tourism-driven effects while deepening synergies between "cultural tourism+various industries" and "various industries+cultural tourism. "However, current designs for tourist train carriages often exhibit shortcomings such as superficial application of folk pattern symbols that lack depth in transformation, reliance on visual elements without considering interactive or functional engagement leading to a singular experiential dimension. Consequently, “ice and snow tours” have become mere formal labels. the "Arxan Train" advocates for revitalizing the economy through cultural tourism; although it features themed carriages, its ecological and intangible heritage themes have yet to be deeply integrated with seating functionality or lighting systems. As a result, passengers find it challenging to perceive the cultural essence within these carriages which show limited differentiation from standard trains. In light of this situation, this paper explores constructing a model using KJ (Affinity Diagram) method combined with AHP (Analytic Hierarchy Process) to calculate design element weights. Subsequently, based on these weights, we will output differentiated design positioning for first-class and second-

class seats ultimately generating thematic carriage proposals.

2. Three-Dimensional Framework Of "Passenger - Carriage - Culture" And Extraction of Cultural Elements

2.1 The Three-Dimensional Framework of "Passenger - Carriage - Culture"

The trinity integration and innovation of the "passenger-carriage - culture" high-speed rail carriage system design for ice and snow tourism is based on the synergy of the three elements. Cultural symbols are transformed through design and act on the carriage space, ultimately serving the multi-dimensional experience needs of passengers. the coupling relationship level is as follows, as shown in **Figure 1.**

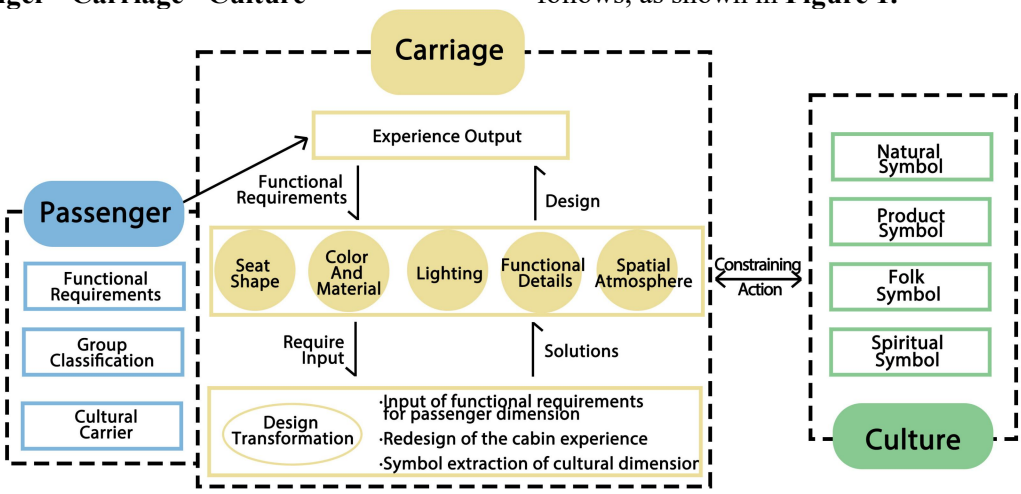

Figure 1. Passenger - Carriage - Culture Model

1) Centered on the passenger dimension: Distribute questionnaires to collect user experience demands and classify different travel groups of passengers;
2) Carriage dimension: Use the affinity diagram method to conduct a detailed analysis of the physical space and design element areas of high-speed rail carriages, studying the shape of seats, color and material, lighting, functional details, spatial atmosphere, etc.
3) Cultural dimension: the core symbols of the "ice and snow tourism" culture in Northeast China can be extracted through nature, products, folk customs and spirit.

2.2 The Application of KJ Method in the "Ice and Snow Tour" Culture

KJ, also known as the Affinity diagram method, is a quality management tool proposed by Japanese cultural anthropologist Jiro Kawakita in 1964, which integrates scattered language information. First, collect the information and record it independently as each card[3] ; Then, based on the cards with similar content, they are grouped in a hierarchical order of "large group - medium group - small group". Finally, each group extracts the theme tags for naming, and then draws a relationship diagram to reveal the overall picture of the problem and the innovative path to form a diagram. In this paper, a questionnaire survey was conducted to collect passengers' demands for high-speed rail carriages. After integrating the demands into cards using the KJ method[4] , the demand information was graphically illustrated, as shown in **Figure 2.**

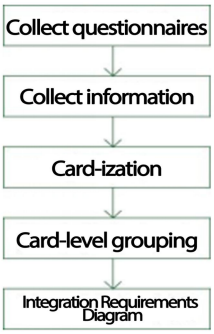

Figure 2. Diagram of the Design Requirements for High-Speed Rail Carriages Obtained by the KJ Method

2.2.1 Questionnaire Data Analysis

To accurately capture the core demands of passengers for the "ice and snow tour" themed high-speed rail carriages, this study adopted the questionnaire survey method to collect 112 valid samples, covering multiple user groups. A total of 112 valid questionnaires were collected in this study, including 49 males and 63 females. the age distribution of the samples is as follows: 29 people aged 18-25, 32 people aged 26-35, 24 people aged 36-45, 17 people aged 46-55, and

10 people aged 56 and above. In terms of travel types, there were 35 people traveling in groups with friends, 33 people traveling with children in families, 21 people traveling alone, and 23 people on business trips. the questionnaire focuses on passengers' expectations for the environment of cultural-themed carriages and initially extracts seven demand keywords: "practical, high-end, warm, lively, artistic, grand and modern". To eliminate semantic redundancy and enhance the reliability and validity of the scale[5], see **Table 1**.

Table 1. Expected Reliability Analysis

	Mean Value of the Scale After Item Deletion	Variance of the Scale After Item Deletion	Corrected Correlation Between Item and Total Score	Cronbach's Alpha After Item Deletion	Overallα
Practical	20.84	23.632	0.507	0.789	
Sophisticated	20.8	25.312	0.485	0.791	
Warm and Inviting	21	23.135	0.608	0.769	
Vibrant	21.02	25.675	0.368	0.813	0.807
Artistic	21.25	22.91	0.658	0.761	
Elegant	20.76	23.41	0.632	0.766	
Contemporary	20.63	24.09	0.555	0.78	

To enhance the reliability and validity of the scale, item analysis and reliability tests were conducted first. As shown in Table 1, after deleting "modern", the Cronbach α coefficient increased from 0.789 to 0.807, indicating that this item has a limited contribution to the overall consistency. However, a further semantic examination reveals that "modern" and "advanced" highly overlap in the respondents' semantic understanding, both pointing to spatial grade and aesthetic quality. Therefore, to avoid duplicate dimensions, ultimately retain "modern" and delete "advanced" words. the overall α coefficient of the revised scale was 0.807, indicating good internal consistency. Among them, the total correlation coefficients of the three correction terms "warm", "artistic" and "grand" were 0.608, 0.658 and 0.632 respectively, showing a significant positive correlation, verifying the aggregation trend of cultural experience demands. the correlation coefficient of "lively" is 0.368, which is relatively independent and reflects the differentiated demands of the youth group. In this way, it can be evenly distributed in the design of high-speed rail carriage space.

2.2.2 Extraction of cultural symbols for "Ice and Snow Tourism" based on the KJ method

After card-organizing the questionnaire text information, multiple rounds of coding and grouping operations were adopted. the research team invited three experts with backgrounds in design and user research to independently complete the initial grouping, and used semantic similarity and the co-occurrence relationship of high-frequency words as the aggregation criteria. Subsequently, through group discussions, the inconsistent items were negotiated and unified, and finally the grouping results that passed the consistency test were formed. Based on the semantic clustering results, it can be specifically divided into three major categories, namely the "big groups", namely the safety and practicality type, the emotional experience type, and the cultural perception type.

1) the safety and practicality type takes the keyword "practical" as its core, integrating functional demands such as seat durability, storage convenience, and safety protection. It has a relatively high weight in families and the middle-aged and elderly groups (accounting for 29.5% and 32.1% respectively).

2) the emotional experience type integrates emotional words such as "warm" and "lively", reflecting the differences in experiences in different scenarios. Family travelers prefer warmth and comfort, business travelers tend to favor privacy and order, while young users favor vitality and interaction.

3) Cultural perception type, covering aesthetic keywords such as "artistic" and "grand", emphasizes spatial atmosphere and cultural narrative, reflecting passengers' overall perception needs for regional cultural images.

After the completion of each group, the category boundary consistency was confirmed by the second round of expert review, and the group stability was verified through coding consistency calculation (Cohen's κ=0.82). Finally, a diagram is formed under the hierarchical structure of "large group - medium group - small group", providing a clear data logic for the subsequent

AHP modeling, as shown in **Figure 3**.

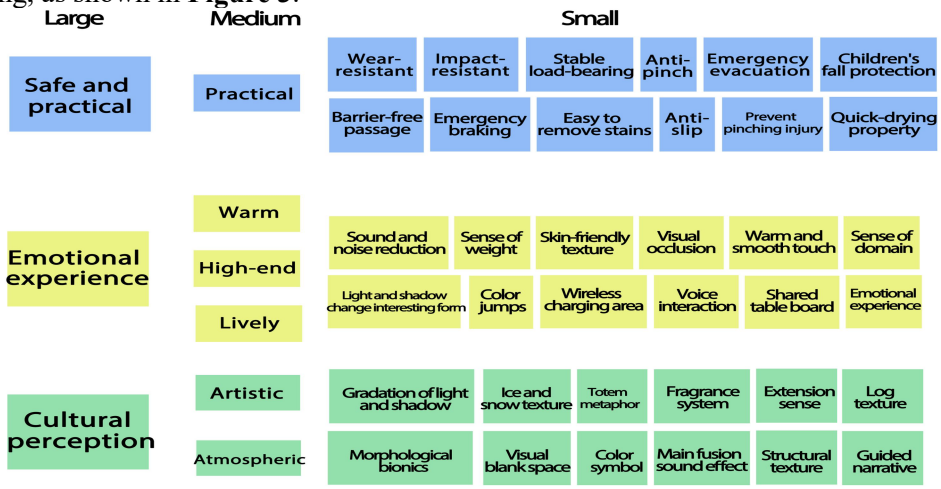

Figure 3. Shows the Initial "Large Group - Medium Group - Small Group" Sorting by the KJ Method

After completing the hierarchical clustering of the requirement statements, the topic tags of the three major requirement groups and their subordinate teams are named and graphically constructed to form the core hub of the "demand-design" transformation path. Firstly, the "Functional Robustness" label of the safety and practicality group, with its sub-group "Dynamic Safety Protection" targeting scenariospecific pain points such as anti-drop, directly drives the integrated design of the anti-drop light strip for the second-class seat. Meanwhile, the "Ease of Cleaning and Maintenance" sub-group focuses on the weather resistance requirements of the material, transforming it into a fast-drying hydrophobic coating process for the snow water collection foot pads of the first-class seat. Secondly, the Emotional Experience group takes "Scenario-based emotional resonance" as its graphic theme. Among them, the "Private Space Creation" group responds to the high demand of family and business customers for a sense of domain and has derived first-class seat sound insulation boards. the "Dynamic Atmosphere Interaction" group precisely captured the sensitivity of the youth group to color and light and shadow, and produced a dynamic lighting solution featuring a red and green gradient fabric for a second-class chili seat and a Chinese-style window lattice. Finally, the Cultural Perception Group defined it as a "symbolic narrative field". Its "Natural Symbol Metaphor" group condensed the spiritual core of the Korean ethnic group's spicy culture into the shape of a chili pepper seat curve, while the "Spatial Aura Construction" group used the vertical lighting sequence on the ceiling to enhance the enthusiasm of the people in Northeast China, using the shape of the hua jiao pepper from Dunhua to narrate the natural symbols bestowed by the black soil. Meet the universal expectations of passengers of all ages for a grand and cultural atmosphere.

This diagram reveals that the essence of demand is a ternary coupling of functional guarantee, emotional trigger, and cultural immersion, and maps it to the differentiated design strategy of the carriage space, as shown in Figure 4. the first-class seats connect the "upgraded material touch" suede seats with the "private space creation" physical partitions by using bionic elements of hua jiao pepper, creating a warm and high-end quiet scene. the second-class seats use the chili symbol as a medium, integrating the vibrant colors of "dynamic atmosphere interaction" and the rotatable table boards of "social scene stimulation", to activate the dynamic experience of friends and companions. By now, the KJ method not only systematically reconstructs chaotic requirements but also outputs 24 executable design orientations through diagrams, providing a structured blueprint for the subsequent AHP weight distribution and scheme deepening. the design process and final presentation results are more scientific and reasonable[6].

Both hua jiao and chili peppers, two regional plants, symbolize both nature and culture. Dunhua pepper originates from the agricultural tradition of the black soil and represents the imagery of harvest and warmth. Yanji peppers are deeply rooted in the dietary and festival culture of the Korean ethnic group, symbolizing passion and vitality. the two are often used side

by side in the folk customs of Northeast China, reflecting the complementarity and layering of regional cultures.

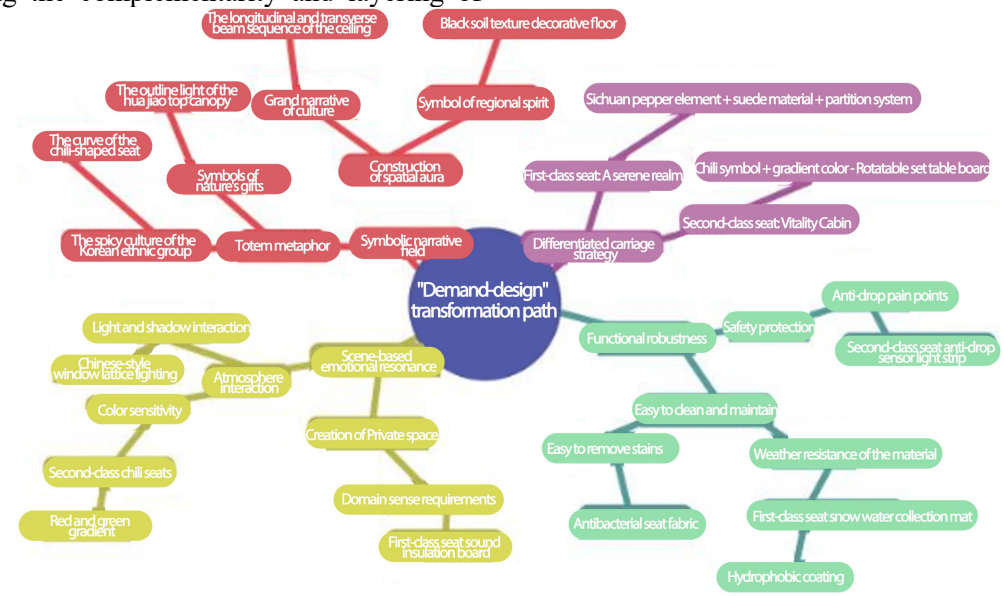

Figure 4. Illustrates the Design Strategy of High-Speed Rail Carriages Using the KJ Method and Weight Analysis

2.3 Construction of AHP Hierarchical Model

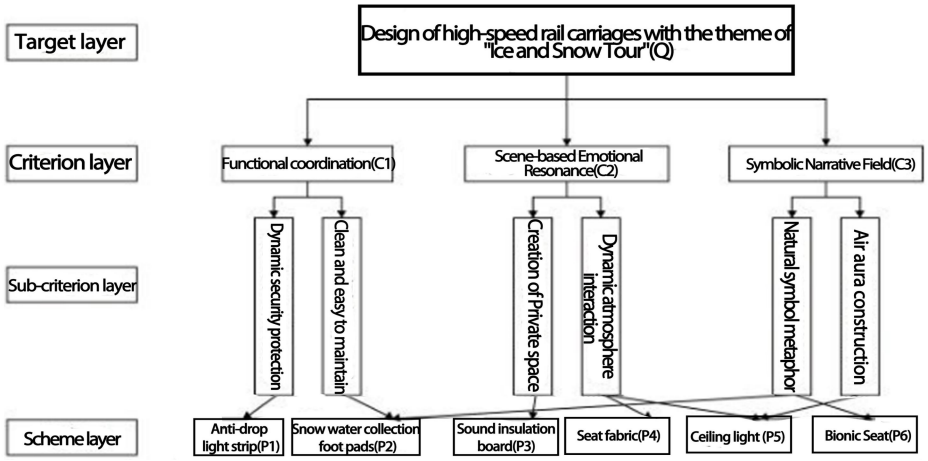

Figure 5. Shows the AHP Hierarchical Structure Model of Passenger Demand in High-Speed Rail Carriages with the Theme of "Ice and Snow Tour"

The main working procedure of AHP involves the following steps: system analysis, element identification, hierarchy construction, pairwise comparison matrix formulation, and weight calculation[7] . First, based on the "demand-design" transformation diagram generated by the KJ method[8] , an AHP hierarchical model is established in this phase to quantify the weights of design elements. This model strictly preserves the demand clustering structure derived from the KJ method, decomposing passenger requirements for the "Ice and Snow Tour" themed high-speed rail carriage design (Q) into a three-level hierarchical framework. the criterion layer consists of three primary theme dimensions: functional robustness (C1), scenario-based emotional resonance (C2), and symbolic narrative field (C3). the sub-criterion layer corresponds to six clustered categories identified through the KJ method, including dynamic safety protection (S1) and natural symbol metaphor (S5). Finally, the solution layer specifies concrete design elements such as anti-drop light strips (P1) and bionic seats (P6), as illustrated as shown in Figure 5.

The second point is that Professor Saaty proposed a pairwise comparison of the importance of elements at the same level concerning target passenger demand, thereby constructing a judgment matrix. From the perspective of the goal layer matrix, comparisons are made regarding the importance

of criteria C1, C2, and C3 relative to the objective Q. In terms of the criterion layer matrix, comparisons are conducted for sub-criteria S1-S6 in relation to their respective criteria. Furthermore, within the scheme layer matrix, comparisons are established for schemes P1-P6 concerning their associated sub-criteria. the 1-9 scale method developed by Saaty is employed to denote levels of importance. Subsequently, weight values are calculated using the eigenvector method:

1) Calculate the geometric mean of each row of the judgment matrix, as in (1):

$$M_i = \left(\prod_{j=1}^{n} a_{ij} \right)^{1/n} \tag{1}$$

In the formula, M_i represents the judgment matrix; a^{ij} is the pairwise comparison value at the i-th row and j-th column (given according to Saaty's 1–9 scale method); n is the order of the matrix; and M_i is the geometric mean of the i-th row.

2) Normalized weight vector, as in (2):

$$W_i = \frac{M_i}{\sum_{k=1}^{n} M_k} \tag{2}$$

In the equation, M_i corresponds to (1): W_i represents the weight components of the judgment matrix, which are obtained through normalization using the characteristic vector method.

Consistency check:

3) Calculation of the Maximum Eigenvalue, as in (3):

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{W_i} \tag{3}$$

In the expression, AW denotes the product of matrix A and weight vector W, where $(AW)_i$ represents its i-th element. the remaining symbols are consistent with those previously defined.

4) Calculation of Consistency Indicators, as in (4):

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{4}$$

The formula includes: λ_{max} as in (3); n represents the order of the matrix; and CI denotes the consistency index.

According to tabulated values, the random index is RI=0.58 when n=3, and RI=0 when n=2.

5) Examination of Consistency Ratio as in (5):

$$CR = \frac{CI}{RI} < 0.1 \tag{5}$$

Original Text: "In the formula: CI is consistent with (4); RI is the Random Consistency Index (obtained from a table based on matrix order); CR represents the Consistency Ratio.

6) Calculation of Comprehensive Weights:The global weight at the scheme level = Criterion Layer Weight × Sub-Criterion Layer Weight × Scheme Level Weight. ", as in (6)

$$W_{p_i}^{global} = W_{C_k} \times W_{S_m} \times W_{P_i} \tag{6}$$

In the formula: W_{Pi}^{global} represents the global weight at the scheme level; W_{Ck} denotes the weights at the criterion level; W_{Sm} indicates the weights at the sub-criterion level; and W_{Pi} refers to the weights at the scheme layer. By calculating this product for all schemes and ranking them accordingly, we can derive the final priority order of schemes.

Please have 20 experts in the field of design evaluate and compare the relevant requirements for the "Ice and Snow Tourism" themed high-speed train carriage design. the results will be used to construct a judgment matrix, which will then undergo normalization to derive the relevant indicators for the "Ice and Snow Tourism" themed high-speed train carriage design. This process will facilitate the calculation of weight values for passenger demands based on the judgment matrix, as in Table 2.

Table 2. Target Layer Q Judgment Matrix and Weight

	C_1	**C_2**	**C_3**	**Weight**
C_1	1	1/3	1/5	0.106
C_2	3	1	1/3	0.26

The next step involves conducting a consistency test, as in Table 3. the CR values for all indicators are below 0.1[11] , indicating that the judgment matrices have passed the consistency test. This suggests that each demand factor possesses a certain level of credibility.

Table 3. Consistency Inspection Data

	Q	C_1	C_2	C_3
λ_{max}	3.104	2.032	2.189	2.056
CR	0.09	0.05	0.02	0.03

Subsequently, the weights of the criterion layer and sub-criterion layer are multiplied to derive a comprehensive weight value, which is then sorted as shown in Table 4. In terms of functional robustness (C1) for the high-speed train carriage design themed around "Ice and Snow Tourism, " it is essential to prioritize the installation of anti-fall lighting strips for passengers to ensure their safety during evening

movements in second-class seating. Regarding scenario-based emotional resonance, creating private spaces is crucial to meet the high demand from family or business travelers for tranquil environments. In relation to symbolic narrative contexts, it is necessary to incorporate natural symbol metaphors that validate the correct extraction of cultural carriers such as "hua jiao pepper" and "chili" identified through KJ method analysis, thereby ensuring the significance of cultural dissemination.

Table 4. "Snow and Ice Tour" Theme High-Speed Rail Car Design Demand Factors Weights and Sorting

Criteria Layer (Weights) Functional Robustness C_1(0.106)	Sub-criteria Layer			Comprehensive Weight	Ranking
	Factors	Detailed Introduction	Weight		
Contextual Emotional Resonance C_2(0.260) Symbolic Narrative Domain C_3(0.634)	Dynamic Safety Protection S_1	Demand for Nighttime Warning Light Strips	0.75	0.08	5
	Convenient and Easy Maintenance S_2	Material Weather Resistance and Extension of Flooring Practical Lifespan	0.25	0.026	6
Criteria Layer (Weights) Functional Robustness C_1(0.106)	Creation of Private Spaces S_3	Visual Privacy Requirements in Various Fields	0.667	0.173	2
	Interactive Dynamic Atmosphere S_4	Vibrant Demand for Color and Light Variation	0.333	0.087	4
Contextual Emotional Resonance C_2(0.260)	Natural Symbolic Metaphors S_5	Cultural Translation of Bionic Forms Inspired by Sichuan Pepper and Chili Peppers	0.8	0.507	1
	Construction of Spatial Aura S_6	Macro Aesthetics of Lighting Sequences and Material Textures	0.2	0.127	3

3 "Design Proposal for High-Speed Train Carriage with A 'Ice and Snow Tourism' Theme"

3.1 Comprehensive Design Philosophy

The design of high-speed train carriages themed around "Ice and Snow Tourism" targets diverse passengers, integrating culture with the train to create a medium for disseminating Northeast cultural elements through the "Passenger-Carriage-Culture" framework. the design should prioritize cultural symbols, utilizing unique natural metaphors from Northeast China as the core of symbol extraction, ensuring that these natural symbols effectively serve as cultural carriers. Incorporating robust functionality alongside emotional contextualization is essential, particularly in response to the harsh winter conditions characterized by heavy snowfall in Northeast China. A snowwater protection system will be added, and considerations must be made regarding floor materials within the carriage to mitigate damage from snowmelt corrosion. This approach aims to extend the lifespan of flooring within high-speed train carriages. While optimizing space by dividing into first-class and second-class compartments, it is crucial that the internal layout maintains both universality and engagement. the multifunctional design should cater to various travel needs of different passengers.

3.2 Design of Space for First-Class Seats in High-Speed Trains

Based on the clustering results of the "Natural Symbol Metaphor" group in the KJ method and the ranking of C3-S5 (weight 0.507) in the AHP model, Jilin Dunhua's specialty "hua jiao" has been identified as a representative regional symbol, embodying both the richness of Northeast China's black soil and its passionate emotions. Therefore, its form and color will be prioritized for visual translation in functional design. The ceiling features an abstract lighting system that mimics the contours of Sichuan pepper, projecting a warm golden glow at night to symbolize the abundance of local resources from black soil. the overall design theme for the carriage incorporates sophisticated shades of gold and red, reflecting both cultural heritage

and technological advancement, as illustrated in Figure. 6.

Figure 6. Design of First-Class Train Carriage with the Theme of 'Ice and Snow Travel

The design of the first-class seating functionality and its robust narrative field is reflected in the demand weight indicators. the implementation of a clean and convenient foot mat system, validated by the KJ method, correctly extracts cultural symbols by utilizing "Sichuan pepper, " a natural plant from the Dunhua region in Northeast China, as a metaphorical carrier for nature. This design should be embodied in a snowmelt foot mat featuring Sichuan pepper, as in Figure 7.

The hydrophobic coating employs micro-nano dual-scale surface structures to achieve high contact angles (>150°), providing waterproof and stain-resistant properties while reducing snowmelt corrosion. However, its durability under prolonged friction, ultraviolet exposure, and high humidity-low temperature conditions still requires validation[13] .

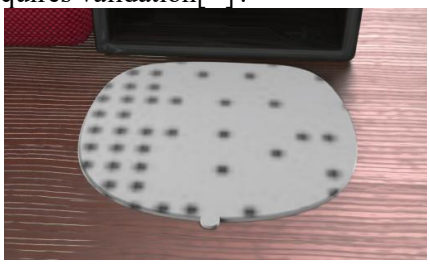

Figure 7. Ice and Snow Tour' Theme First-Class High-Speed Train Carriage Foot Mat

The design of first-class seating incorporates emotional resonance through contextualization, as reflected in the sub-criteria of creating private spaces (S3) and dynamic atmospheric interactions (S4). This approach integrates soundproof panels (P3) with seat materials to ensure that the needs of both family travelers and business passengers are met.

The seat design for first-class accommodations is informed by comprehensive anthropometric data for adults across the nation. the average height for males aged 18–44 is 169.7 cm, while females average 158 cm; additionally, males typically weigh approximately 1.3 times more than females[14] . Taking these differences into account, the angle of the backrest and height of the seat cushion have been designed to accommodate variations in gender and body type through an adjustable structure that supports comfortable postures for different passengers.

The ergonomic parameters for first-class seats are based on national adult size standards and research on comfort during rail travel. Utilizing human-machine data from "Chinese Adult Body Dimensions, " foundational dimensions such as cushion height, seat depth, and armrest height have been established within specific ranges. Furthermore, a review of railway seating comfort has informed relationships between geometric parameters—such as backrest angle and seat distance—and overall comfort levels. An adjustable backrest mechanism has been implemented to cater to diverse body types and sitting preferences[15] .

Figure 8. Dimensions of First-Class Seat Upholstery

3.3 Design of Space in Second-Class Seats on High-Speed Trains

The second-class carriage is arranged in a 2+2 configuration, designed primarily to resonate with the vitality of young passengers and enhance the overall visual effect. the large panoramic windows provide an unobstructed view, while the luggage racks feature prominent patterns that reflect cultural interweaving, making it easier for passengers seated on the inner side to access their small belongings. Additionally, warm ambient lighting is installed inside the luggage compartments to protect passengers' eyes and facilitate nighttime retrieval of their bags.

The ceiling design incorporates Chinese-style lattice window structures with atmospheric

lighting that aligns with contemporary fashion trends appealing to younger individuals. Warning light strips are installed along both sides of the aisle to guide passengers during nighttime movements. The seats are inspired by the shape of Yanji's chili peppers, with headrests designed to resemble the upper part of a chili pepper, adding dynamism and vibrancy to the entire space, as Figure. 9.

Figure 9. Design of the Second-Class Carriage for the 'Ice and Snow Tourism' Theme High-Speed Train

The design of the second-class seating functionality emphasizes robustness: To reduce the risk of falls during nighttime and while in motion, a combination of flush-mounted embedded light-guiding warning strips and under-seat guiding lights is employed based on the AHP priority of dynamic safety protection (S1). the light-guiding strips are installed flush with the ground to indicate path boundaries and high-risk areas; meanwhile, the under-seat guiding lights provide surface illumination to mitigate glare, as in Figure. 10.

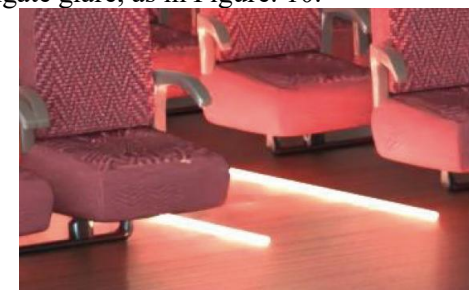

Figure 10. Level Embedded Warning Strip and Guidance Light Under the Seat

The design of emotional resonance in the second-class seating area is reflected in the dynamic atmosphere interaction (S4). the ceiling features a "Chinese lattice window" lighting structure, with lights extending longitudinally to enhance the spatial hierarchy and visual order. the rhythm of light and shadow draws inspiration from the traditional courtyard window lattice characteristics found in Northeast China, creating a warm and inviting ambiance for passengers while evoking a sense of familiarity with regional culture, as in Figure. 11.

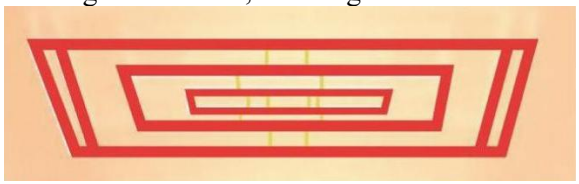

Figure 11. Reading Light for Second-Class Seats

The design of the narrative field for second-class seating reflects a prominent alignment between the "cultural perception types" identified through the KJ method and the "natural symbolic metaphor" factor highlighted in AHP weight analysis. the chili culture in Yanji is symbolized by its spiciness, enthusiasm, and cohesion, which resonates with the vibrant needs of the youth demographic (S4). Consequently, it has been selected as a core design medium.

The biomimetic chair shape inspired by chilies (P6) received the highest resource allocation, resulting in a significant differentiation from the functional demand hierarchy of first-class seating. the "chili" symbol in Yanji interprets Korean ethnic spicy culture and extends its influence across China to various parts of the world. the second-class seats are designed to mimic chili shapes, featuring cushions with a red-green gradient color scheme, as show in Figure. 12(a). Given that space within second-class compartments is limited, an adjustment angle of up to 14° has been implemented (as shown in Figure. 12(b)), allowing passengers to immerse themselves fully in experiencing Northeast China's cultural warmth.

Figure 12. Headrest of the Second-Class Seat in Red and Green Color Scheme (a) and the Angle Adjustment of the Backrest for the Second-Class Seat (b).

4 Conclusion

This study integrates the KJ method with the AHP model to establish a three-dimensional analytical framework of "Passenger-Carriage-Culture. " It positions high-speed train carriages as carriers for immersive cultural dissemination,

allowing for an in-depth analysis of the weighting of travel demands related to ice and snow tourism, thereby providing support for design decision-making. Methodologically, affinity diagramming is employed to cluster symbols of Northeast ice and snow culture, while the AHP is utilized to quantify the prioritization of these demands. This approach constructs a pathway from qualitative insights to quantitative assessments for regional thematic transportation design. In practical application, differentiated carriage designs have emerged: first-class seating integrates Sichuan pepper symbols with hydrophobic features and private experiences; second-class seating enhances interactive vitality through biomimetic forms inspired by chili peppers. This synergy fosters both cultural translation and functional innovation.

The findings from this research provide empirical case studies that contribute to upgrading cold-region cultural tourism industries. Future plans include expanding development efforts to encompass dining cars and business class sections within the entire carriage system, alongside optimizing design criteria through user experience tracking—ultimately facilitating innovations in cultural dissemination models for tourist trains.

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