



Screening Dalian Urban Cultural Elements and Core Kansei Words for Metro Interior Design

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Abstract. To improve the correspondence between cultural expression and affective cognition in metro interior design, this study develops a screening procedure for urban cultural elements and Kansei words oriented to Dalian city culture. Public online texts related to Dalian city impressions, regional culture, and representative cultural symbols were collected to construct a thematic corpus for metro interior design research. After text cleaning, Chinese word segmentation, stop-word filtering, and manual verification, two lexical pools were established: an affective adjective pool and a representative cultural noun pool. Word-frequency statistics, semantic consolidation, and expert discussion were then used to generate preliminary candidates. A small-sample five-point Likert questionnaire was further conducted to evaluate the candidates in terms of semantic clarity, design applicability, regional representativeness, recognition clarity, and design transferability. The results show that clean and orderly, coastal, romantic, modern, and elegant can serve as core Kansei words for subsequent metro interior evaluation. Dalian trams, coastal culture, wharfs, locust blossoms, and spotted seals show relatively high suitability for regional recognition and design transformation. The findings provide a semantic basis and cultural-element reference for integrating Dalian regional culture into metro interior design.

Keywords: metro interior design, Dalian urban culture, Kansei words, text mining, semantic screening.

1 Introduction

Metro systems are key components of urban public transport, serving both mobility and cultural representation. Rail vehicles act as visual media for city image, where regional cultural elements can be translated into forms, patterns, and colors to enhance recognition and emotional resonance¹. In metro interiors, components such as hand straps, handrails, and seat partitions thus become important carriers of cultural expression².

However, current cultural design in rail transit largely depends on designers' experience, leading to subjective element selection and unclear affective positioning. Studies suggest that cultural elements should be systematically identified, interpreted, and transformed, and that methods such as shape grammar and semantic evaluation can improve design objectivity³. Therefore, metro interior design needs to clarify both the

affective meaning and transformation suitability of cultural elements before application⁴.

Kansei engineering provides an effective approach by linking design elements with users' emotional responses. It has been applied to explore relationships between product form and perception in rail-transit design⁵, offering methodological support for integrating urban culture into metro interiors⁶.

Based on this, this study focuses on Dalian and addresses two questions: public affective perceptions of the city and representative cultural elements suitable for design transformation. Through online text mining, word-frequency analysis, semantic consolidation, expert discussion, and questionnaire surveys, core Kansei words and cultural elements are identified to support metro interior design.

This study contributes by proposing a dual screening framework combining text mining and questionnaire evaluation, linking public perception with cultural resources to reduce subjectivity; and providing a structured semantic and cultural basis for metro interior design.

2 Research Methods

2.1 Corpus Acquisition and Corpus Construction

With Dalian urban culture as the central research theme, this study set two collection directions: affective descriptions and cultural elements. For affective-description texts, the focus was on public descriptions of Dalian's city image, spatial atmosphere, and emotional impressions. For representative cultural nouns, the focus was on textual content related to Dalian's regional culture, urban memory, and typical cultural symbols.

The corpus was collected from public online platforms. The collected fields included titles, body texts, and source links. After organization, 1,300 raw corpus records containing affective-description texts and cultural-element-related texts were obtained, providing the data basis for subsequent lexical extraction and statistical analysis.

2.2 Text Cleaning and Lexical Pool Construction

After the corpus was collected, Python was used to clean and preprocess the raw text. The jieba toolkit was then used for Chinese word segmentation, and culture-specific proper nouns related to Dalian were added to a custom dictionary to improve segmentation accuracy. During term filtering, a general stop-word list, a topic-de-redundancy list, and a whitelist were combined to remove terms with low semantic relevance while retaining valid terms related to affective descriptions and cultural elements. The processed terms were then organized into two lexical pools: affective adjective entries were grouped into 12 semantic dimensions, and representative cultural nouns were summarized into seven cultural themes. These results provided the basis for subsequent word-frequency analysis and candidate screening.

2.3 Word-Frequency Statistics and Candidate Screening

To improve the efficiency of subsequent screening, word-frequency statistics were used to preliminarily screen affective adjectives and representative cultural nouns. Word frequency was calculated according to the absolute number of occurrences of the target term in the corpus. A higher word-frequency value indicates that the term appears more frequently in the relevant corpus and has relatively stronger representativeness. Let t denote the target term, D denote the corpus text set, and $f(t, D)$ denote the absolute occurrence frequency of t in D . The word frequency $F(t)$ is expressed as follows:

$$F(t) = f(t, D) \quad (1)$$

On the basis of the word-frequency results, the top 30 affective words and the top 30 representative cultural nouns were extracted as preliminary candidate terms for semantic consolidation and questionnaire screening.

2.4 Calculation of Questionnaire Means and Composite Scores

In the small-sample subjective screening questionnaire, a five-point Likert scale was used to score the candidate Kansei words and cultural elements. Let x_{ijk} denote the rating of the k th candidate term in the j th evaluation dimension in the i th valid questionnaire, and let n denote the number of valid questionnaires. The mean score of the candidate term in the corresponding dimension can be expressed as:

$$\bar{x}_{jk} = \frac{1}{n} \sum_{i=1}^n x_{ijk} \quad (2)$$

For Kansei-word screening, the evaluation dimensions included semantic clarity, design applicability, and regional representativeness, denoted by C_k , A_k , and R_k , respectively. The composite mean score S_k of the k th Kansei word was calculated as:

$$S_k = \frac{C_k + A_k + R_k}{3} \quad (3)$$

For cultural-element screening, the evaluation dimensions included recognition clarity, design transferability, and regional representativeness, denoted by I_m , D_m , and L_m , respectively. The composite mean score T_m of the m th cultural element was calculated as:

$$T_m = \frac{I_m + D_m + L_m}{3} \quad (4)$$

Because the questionnaire was intended for candidate pre-screening, all evaluation dimensions were used to judge whether a candidate term should be retained. Therefore, equal weighting was adopted for the calculation of composite mean scores.

2.5 Reliability and Structural Suitability Tests

To examine the stability of the questionnaire data, Cronbach's alpha was used for reliability analysis. Let the scale include k items, σ_i^2 denote the variance of the i th item, and σ_T^2 denote the variance of the total score. Cronbach's alpha can be expressed as:

$$\alpha = \frac{k}{k-1} \left(1 - \frac{\sum_{i=1}^k \sigma_i^2}{\sigma_T^2} \right) \quad (5)$$

To determine whether the questionnaire data were suitable for subsequent statistical analysis, the Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test of sphericity were further used. The KMO value can be expressed as:

$$KMO = \frac{\sum_{i \neq j} r_{ij}^2}{\sum_{i \neq j} r_{ij}^2 + \sum_{i \neq j} p_{ij}^2} \quad (6)$$

Here, r_{ij} denotes the simple correlation coefficient between variables i and j , and p_{ij} denotes the partial correlation coefficient between variables i and j . A higher KMO value indicates a more obvious common-factor structure among variables. When the significance level of Bartlett's test is less than 0.05, the variables are considered correlated and can support subsequent statistical analysis.

3 Screening of Core Kansei Words

3.1 Semantic Consolidation of High-Frequency Kansei Words

After the high-frequency Kansei words were extracted, the 30 high-frequency affective terms were further semantically consolidated. Because high-frequency Kansei words may include similar meanings, repeated expressions, and inconsistent semantic levels, directly including all 30 terms in a subsequent questionnaire would increase overlap among evaluation dimensions and impose a heavier cognitive burden on respondents. Therefore, this study consolidated the Kansei words according to semantic similarity, urban-imagery orientation, and applicability to metro interior design evaluation.

After preliminary classification by the researchers and revision through expert-group discussion, the 30 high-frequency Kansei words were consolidated into 11 preliminary core Kansei candidates: romantic, clean and orderly, healing, elegant, rustic, bright, modern, coastal, historically profound, accessible, and grand.

3.2 Small-Sample Questionnaire Design for Kansei Words

To further determine whether the 11 preliminary Kansei words were suitable for subsequent metro interior design evaluation, a small-sample subjective screening questionnaire was designed. Each Kansei word was evaluated from three dimensions: semantic clarity, design applicability, and regional representativeness. Semantic clarity was used to determine whether the meaning of the word was clear; design applicability was used to determine whether the word was suitable for describing the intended feeling of metro

carriage interior design; and regional representativeness was used to determine whether the word could reflect the cultural temperament of Dalian.

The questionnaire adopted a five-point Likert scale and included 33 rating items. A total of 20 valid questionnaires were collected. The mean score of each Kansei word in the three dimensions was calculated, and an equal-weighted composite mean score was used as the main criterion for core Kansei-word screening.

3.3 Questionnaire Results for Kansei Words

To verify the reliability of the Kansei-word screening questionnaire, reliability, structural suitability, and mean-score analyses were conducted on the 20 valid responses. The Cronbach's alpha coefficients for semantic clarity, design applicability, and regional representativeness were 0.888, 0.914, and 0.882, respectively, and the overall scale coefficient was 0.959. These values indicate good internal consistency, As shown in Table 1. The KMO values for the three dimensions were 0.643, 0.676, and 0.606, respectively, and the significance levels of Bartlett's test of sphericity were all less than 0.001. These results show that the questionnaire data met the needs of statistical analysis at the pre-survey stage, As shown in Table 2. According to the Likert-scale mean results, the terms with composite mean scores above 4.00 were clean and orderly, coastal, romantic, modern, and elegant. These five terms were therefore identified as the core Kansei words for subsequent metro interior affective evaluation, As shown in Table 3.

Table 1. Reliability test results of the core Kansei-word pre-survey questionnaire.

Evaluation dimension	Cronbach's alpha	Interpretation
Semantic clarity	0.888	Good internal consistency
Design applicability	0.914	Good internal consistency
Regional representativeness	0.882	Good internal consistency
Overall scale	0.959	High overall consistency

Table 2. Structural suitability test results of the core Kansei-word pre-survey questionnaire.

Evaluation dimension	KMO value	Bartlett significance	Interpretation
Semantic clarity	0.643	< 0.001	Acceptable for exploratory research
Design applicability	0.676	< 0.001	Acceptable for exploratory research
Regional representativeness	0.606	< 0.001	Acceptable for exploratory research

Table 3. Mean-score statistics of the core Kansei words based on the Likert scale.

Rank	Kansei word	Composite mean score
1	Clean and orderly	4.47
2	Coastal	4.30
3	Romantic	4.12
4	Modern	4.12
5	Elegant	4.02

4 Screening of Representative Cultural Elements

After high-frequency representative cultural nouns were extracted, they were further semantically consolidated according to semantic orientation, regional representativeness, and potential for design transformation. Unlike Kansei words, cultural nouns refer to more concrete cultural objects, regional symbols, and urban cultural carriers. In this process, the consolidation considered not only the frequency of the terms but also whether the corresponding cultural elements could be recognized by the public and transformed into design language for metro interior design.

After semantic consolidation, the high-frequency representative cultural nouns were reduced to 13 cultural-element candidates: spotted seal, tram, locust blossom, wharf, coastal culture, marine production and living culture, historic building clusters, Lvshun, ginkgo, sunset, historic sites, folk crafts, and cormorant.

4.1 Small-Sample Questionnaire Design for Cultural Elements

To further screen cultural elements suitable for the metro interior design transformation stage, a small-sample subjective screening questionnaire was designed based on the previous semantic consolidation results. The questionnaire focused on 13 cultural-element candidates, and each candidate was evaluated from three dimensions: recognition clarity, design transferability, and regional representativeness.

Recognition clarity was used to determine whether the cultural element was easy to understand and recognize. Design transferability was used to determine whether the cultural element could be transformed into form, color, pattern, or cultural semantics in metro interior design. Regional representativeness was used to determine whether the cultural element could reflect Dalian's urban cultural characteristics. The questionnaire adopted a five-point Likert scale, included 39 rating items, and used the composite mean score as the main screening criterion.

4.2 Questionnaire Results for Cultural Elements

The questionnaire results show that the Cronbach's alpha coefficients for recognition clarity, design transferability, and regional representativeness were 0.840, 0.881, and 0.884, respectively, and the overall scale coefficient was 0.954. These values indicate good internal consistency, As shown in Table 4. The KMO values for the three dimensions were 0.520, 0.650, and 0.662, respectively, and the significance levels of Bartlett's test were all less than 0.001. These results indicate that the questionnaire data can be used as a statistical basis at the pre-survey stage, As shown in Table 5.

The mean-score analysis indicates that Dalian trams, coastal culture, wharfs, locust blossoms, and spotted seals obtained relatively high composite mean scores. Among them, Dalian trams ranked first with a score of 4.35, followed by coastal culture with a score of 4.32. These results indicate that the five cultural elements perform well in recognition clarity, design transferability, and cultural representativeness, As shown in Table 6. This finding directly addresses the second research question proposed in the Introduction by identifying Dalian trams, coastal culture, wharfs, locust blossoms, and

spotted seals as cultural elements with relatively strong representativeness, recognizability, and design transferability. Accordingly, they can be treated as key objects for subsequent metro interior design transformation.

Table 4. Reliability test results of the core cultural-element pre-survey questionnaire.

Evaluation dimension	Cronbach's alpha	Interpretation
Recognition clarity	0.840	Good internal consistency
Design transferability	0.881	Good internal consistency
Regional representativeness	0.884	Good internal consistency
Overall scale	0.954	High overall consistency

Table 5. Structural suitability test results of the core cultural-element pre-survey questionnaire.

Evaluation dimension	KMO value	Bartlett significance	Interpretation
Recognition clarity	0.520	< 0.001	Usable as a pre-survey reference
Design transferability	0.650	< 0.001	Acceptable level
Regional representativeness	0.662	< 0.001	Acceptable level

Table 6. Mean-score statistics of the core cultural elements based on the Likert scale.

Rank	Cultural element	Composite mean score
1	Dalian tram	4.35
2	Coastal culture	4.32
3	Wharf	4.03
4	Locust blossom	3.98
5	Spotted seal	3.92

5 Results and Discussion

Through online corpus acquisition, text preprocessing, word-frequency statistics, semantic consolidation, and small-sample questionnaire screening, this study constructed a semantic basis for Dalian urban culture for metro interior design. In response to the first research question, the results indicate that public affective cognition of Dalian is mainly associated with five Kansei descriptors: clean and orderly, coastal, romantic, modern, and elegant. These terms reflect public perceptions of Dalian's spatial temperament and are applicable to affective evaluation in metro interior design.

The selected Kansei words imply different design orientations. "Clean and orderly" is related to visual organization and perceived neatness in metro interior space. "Coastal" reflects Dalian's regional identity and can guide the use of curved forms, lighter color palettes, and marine-related visual elements. "Romantic" and "elegant" express emotional and aesthetic expectations associated with the city image, while "modern" corresponds to the functional and contemporary character of public transportation interiors. Thus, these words can serve not only as perceptual descriptors but also as semantic targets for subsequent design evaluation.

In response to the second research question, Dalian trams, coastal culture, wharfs, locust blossoms, and spotted seals were identified as cultural elements with relatively high recognition clarity, regional representativeness, and design transferability. These elements represent different cultural dimensions of Dalian: trams reflect urban transportation memory and historical identity; coastal culture and wharfs express marine-city imagery and port characteristics; locust blossoms convey plant imagery and a soft romantic temperament; and spotted seals provide ecological and biomorphic references with local recognizability. Taken together, the selected elements offer diverse cultural resources for metro interior design transformation rather than functioning merely as decorative symbols.

Methodologically, this study provides a traceable procedure for transforming dispersed public cultural perceptions into structured design-oriented semantic resources. Compared with cultural-element selection based primarily on designer experience, the integration of corpus analysis, semantic consolidation, expert discussion, and questionnaire evaluation helps reduce subjectivity in the early design research stage. Although this study remains at the preliminary screening stage and does not include design-element coding, affective-evaluation mapping, or design-scheme validation, its procedure can support subsequent research on the coordination of regional cultural expression and affective perception in urban rail-transit interior design.

6 Conclusions

This study constructed a thematic corpus of Dalian urban culture through online text collection and corpus processing, and established an affective adjective lexical pool and a representative cultural noun lexical pool for subsequent semantic analysis.

Based on word-frequency statistics, semantic consolidation, and expert discussion, five core Kansei words—clean and orderly, coastal, romantic, modern, and elegant—were identified for metro interior affective evaluation. These words clarify the main affective perceptions of Dalian in the context of metro interior design.

Through semantic consolidation and questionnaire evaluation from the dimensions of recognition clarity, design transferability, and regional representativeness, Dalian trams, coastal culture, wharfs, locust blossoms, and spotted seals were identified as cultural elements with high suitability for design transformation. These elements represent regional cultural resources with strong recognizability and design transferability.

Overall, the findings provide a semantic and cultural-element basis for integrating Dalian regional culture into metro interior design. The study also offers a preliminary methodological reference for linking public affective cognition, regional cultural resources, and design transformation in urban rail-transit interior design. Future research may further examine the explicit features and implicit meanings of these elements and apply them to specific metro interior components for design evaluation and validation.

References

1. Sun Minghan, Xiang Zerui. Tianfu's Essence: The Exterior Design of a Subway Train Integrating Tianfu Culture [J]. *Design*, 2023,36(14):26–27. DOI: 10.20055/j.cnki.1003-0069.000940.
2. Liu Jie. Research on the exterior design of modern tramways based on perceptual engineering [D]. Southwest Jiaotong University, 2023. DOI: 10.27414/d.cnki.gxnju.2023.003067.
3. Han Xue. CMF design research for RV interiors based on perceptual engineering [D]. Nanjing Forestry University, 2025. DOI: 10.27242/d.cnki.gnjlu.2025.001155.
4. Deng Jing. Research on the exterior design of tourist-specific tramways from a cultural biomimicry perspective [D]. Southwest Jiaotong University, 2023. DOI: 10.27414/d.cnki.gxnju.2023.003070.
5. Rong Xin, Dong Shiyu, Xiao Jianghao. Exterior design of subway vehicles based on shape grammar and regional culture [J]. *Packaging Engineering*, 2020,41(16):230–235. DOI: 10.19554/j.cnki.1001-3563.2020.16.035.
6. Song Wenbo. Front fascia design of the Hongqi H7 based on shape grammar [D]. Yanshan University, 2019.

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