

A Study on the Influencing Factors of the Cultural Image Perception in Subway Station Space: Taking the Subway Stations in the Historic Districts of Beijing as Examples

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ABSTRACT: In the new round of urbanization, subway construction has increasingly become the main axis of coordinated urban underground space development. As the engineering and technical problems are better solved, the construction and transformation of underground space turns to pay more attention to creating spatial “images” that satisfy psychological experiences, and to strengthen the “thematic” relationship between the above-ground and underground spaces. Based on the application of the theory of image creation in underground space and the coordination of urban public cultural construction, many cities have engaged in spatial practices using subways as cultural media carriers, prompting the gradual interpretation of the subway station space as a symbol for inheriting regional culture and displaying urban images. In the process of transforming the essence of subway station space design from “function” to “human-centricity”, the expression of cultural images such as the city’s regional characteristics, historical heritage, and place spirit has become the core issue in related practice and research. Although existing studies have conducted a certain degree of normative research on the environmental elements and design strategies that enhance the expression of cultural images in subway stations, they have ignored the empirical analysis of cultural image influencing factors measured from the perspective of the user’s subjective perception. Therefore, this study draws upon a literature review and analysis to extract variable evaluation indicators that characterize the cultural image of subway station space and environmental design factors, aiming to investigate in depth how the environmental design of subway station space can effectively strengthen the cultural image perception of the surrounding area.

The study takes the typical historical and cultural subway stations adjacent to historical districts-Nanluoguxiang Station, Shichahai Station, Yonghegong Station, and Zhangzizhong Road Station as the research objects, while defining both the above-ground and underground parts of the subway station as the spatial research scope. It obtained the data of the users’ perception and evaluation data of cultural images and related environmental elements, through 252 Likert scale questionnaires, and combined SPSS and AMOS software to systematically and quantitatively analyze the environmental design factors that affect the perception of cultural images in the subway station space and their degree of correlation, with a view to providing reasonable optimization strategies and development suggestions for relevant cultural practices on subway stations. The evaluation indicators of the questionnaire include two parts. One is the perception result of the cultural image of subway station space, including the cultural atmosphere, historical background, image taste, and regional characteristics as the evaluation indicators. Secondly, the environmental design factors affecting the perception of the cultural image of the subway station are classified into above-ground and underground spaces. The above-ground part involves 7 evaluation indicators, including spatial scale and outline, feature and style, detail elements, accessibility to tourist attractions, open space

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connection, landscape features, and entrance signage. Underground space involves 8 evaluation indicators, including the visual interface of subway station hall, platform area, auxiliary facilities, public art, signage system, thematic atmosphere, and spatial experience.

In order to determine the environmental design influencing factors of the cultural image perception of subway station space, and to find the internal structural relationship between the variables, the research first uses exploratory factor analysis (EFA) to divide the initial 15 environmental design indicators into reasonable dimensions, and then the structural validity test was carried out by confirmatory factor analysis (CFA), and the relationship model between the common factors of environmental design and the corresponding heading items was revised. Finally, in order to establish and verify the structural model of the perception of spatial cultural images in subway stations, the research employs structural equation model analysis (SEM), taking the result of perception of spatial cultural images in subway stations as the dependent variable and the common factor of the space environment design as the latent variable to verify the variables, including the influence relationships, the degrees of association and the regression path coefficients among them.

The research results show that: (1) In the evaluation of cultural image perception, the item expressing the historical heritage of the location has the highest score. In the horizontal comparison of the comprehensive evaluation of the cultural image of the 4 sample subway stations (Yonghegong Station > Nanluoguxiang Station > Shichahai Station > Zhangzizhong Road Station), the evaluation results are basically consistent with the current environmental status of the built spaces of each subway station; (2) based on the exploratory factor analysis results, the main dimensions of the space environmental design of the subway station are determined to be three aspects: Feature coordination, interface decoration, and service facilities. Based on the confirmatory factor analysis to optimize the measurement model and structural model, the correlation between environmental design factors and cultural image perception was analyzed. The three latent variables all have a significant positive impact on cultural image creation and have different degrees of influence. The degree of correlation is F1 feature coordination > F2 interface decoration > F3 service facilities, and the environmental design factors are significantly positively correlated. Therefore, if the overall design between the three can be coordinated, the cultural image expression of the subway station space can be effectively strengthened; (3) the demographic variable difference test shows that factors such as gender, age, education level, and occupational background have no obvious influence on the perception and evaluation of cultural images and environmental design factors of the interviewees, which proves that actively creating cultural images of subway station space universally applicable to all demographic groups; (4) based on the structural equation model verifying the causal relationship between environmental design factors affecting cultural image perception, the model fitting results are effective and credible. The regression path coefficients of the three latent variables of feature coordination, interface decoration, and service facilities are 0.40, 0.37, and 0.23, respectively. The correlation coefficients of the three latent variables have increased, indicating that the respondents' perception of the cultural image of the subway station space comes primarily from the recognition and judgment of the coordination of the characteristics of the historical district station area, followed by the decoration of the spatial interface in the subway station. Information transmission is affected to a certain extent by the quality characteristics of the spatial service facilities inside and outside the subway station. The more obvious the design intention of the subway station's spatial environment, the stronger the cultural image perception.

Finally, based on the results of quantitative analysis, the study puts forward the strategic suggestions and a design process for systematically shaping the cultural image of subway station space from five aspects: Creating an integrated human-centric space environment, coordinating the surrounding features of subway stations, strengthening the construction of underground space scenes, improving the human-centric service facilities in the station area, and cooperating to build the overall cultural image of the city.

KEY WORDS: subway station space; cultural image; perception; environmental design; influencing factors

Introduction

With the ongoing process of urbanization, subway systems have become a major driver of coordinated underground urban development. The extension and expansion of subway station space plays a key role in the construction of the urban above-ground and underground public space system. It is not only crucial for improving land use and traffic conditions in old urban areas [1], but also plays a positive role in preserving regional cultural heritage and inheriting urban culture. Although engineering and techni-

cal problems have been largely solved, environmental psychological issues, such as how to eliminate the public's negative perceptions regarding the use of space and enhance their willingness to participate in activities, still constrain the optimal development of underground space [2]. In response, many studies have proposed using Lynch's theory of urban image as a strategy to improve the image of the underground space environment. According to Lynch, urban environments possess legibility, and their environmental image is a product of an individual's direct perception of the external environment and past ex-

perience memory [3]. Underground space also constitutes environmental order through a series of recognizable elements such as edges (interfaces), paths, landmarks, and districts, presenting its own place characteristics and emotional connotations [4,5]. It is this perceptible place attribute that highlights the “value and significance” of underground space and enhances the public’s sense of identity [6]. Therefore, the new round of construction and renovation of underground space pays more attention to creating imageable spaces that satisfy psychological experiences and strengthening the “thematic” connection between above-ground and underground spaces [7].

Subway stations are not only nodes in the transportation network, but also places rooted in the urban area [8]. Based on the application of the theory of creating underground space images and the coordination of urban public culture construction, many cities have launched spatial practices using the subway as a cultural medium. Subway station space has gradually evolved into a symbolic gateway and iconic place for inheriting urban culture. As the design principles of subway station space shift from “function” to “human-centricity,” the expression of cultural images such as urban regional characteristics, historical heritage, and the sense of place has become a core issue in related practices and research. The design of subway station space should not only meet functional requirements, but also enhance the identity of the place, highlight the regional image characteristics, and improve the cultural experience [9]. The cultural representation of subway station space should explore the historical and cultural elements around the station, echo the landmark buildings, translate above-ground geographic and cultural information into symbolic underground spatial elements in the form of symbols, create landmark references and memory points [10], and integrate underground and above-ground cultural resources by strengthening the spiritual connection between subway stations and ground information nodes, and helping users form a coherent understanding of the city [11]. The spatial cultural image of subway stations is generated in the process of users’ overall perception of the subway station and its surrounding environment. The cultural image of subway station spaces is generated

through users’ overall perception of both the station and its surrounding environment. It conveys and expresses urban cultural meanings by extracting and abstracting characteristic environmental elements and by using the physical space of the subway station as an information carrier.

Existing literature has conducted some normative research on environmental factors and design strategies for enhancing the expression of cultural image in subway station space. Peng Di proposed that the physical structure of subway stations is the basis for generating the sense of place. The sense of identity and belonging of the station should be strengthened from the aspects of human-centric design, diversified experience, landscape integration, and cultural context assimilation [12]. Li Chongrui proposed that the creation of the cultural image of subway stations should take the cultural characteristics of the station area as the guiding thread. The interior space should use cultural elements to decorate the interface, strengthen the integrated design of auxiliary facilities, and the outdoor space should continue the regional cultural context and integrate the pedestrian sightseeing routes [13]. Based on the premise that the subway station area serves as a carrier of the urban landscape, Xu Xiaoxu extracted the elements of regional cultural expression from the three levels of urban area, station area transition, and underground space, and used the Analytic Hierarchy Process (AHP) method to summarize and analyze the element weights and propose design strategies [14]. However, existing research neglects empirical analysis of the influencing factors of cultural image measured from the user’s subjective perception perspective, and is predominantly qualitative, lacking quantitative research. Therefore, this paper aims to conduct an in-depth study on how the environmental design of subway station space can effectively enhance the perception of the cultural image of the area. Four typical subway stations in the historical districts of Beijing are selected as research objects. By designing a questionnaire survey on cultural image and environmental elements, user perception evaluation data are collected. Combined with SPSS and AMOS software, a systematic quantitative analysis of environmental design factors that affect the cultural image perception of subway station space and their correlation is conducted, in order to provide reasonable optimization strategies and de-

velopment suggestions for related cultural practices in subway station areas.

1 Overview of the research sample

1.1 Classification of Beijing subway stations

Based on the dominant functions of land use around subway stations, subway stations in Beijing can be divided into four categories: Transportation hub type, public center type, residential type, and historical and cultural type [15]. The station area of historical and cultural stations mainly consists of historical districts, scenic spots, heritage conservation units, museums, exhibition halls, and other cultural facilities, and mainly serves tourism and leisure experiences. The study takes typical historical and cultural subway stations adjacent to historical districts as the research object.

1.2 Sample station selection

The old city area in the center of Beijing, shaped like the Chinese character “凸” (convex), has the most concentrated cultural resources and is also a hotspot for the perception of regional cultural images. Beijing’s relevant

plans have successively designated 33 historical and cultural conservation areas in the old city area. Based on this, the Beijing Urban Master Plan (2016 – 2035) has identified 13 key areas with outstanding historical and cultural value as cultural essence zones. The study selected four subway stations—Nanluoguxiang, Shichahai, Yonghegong, and Zhangzizhong Road—as samples. These stations are concentrated in the cultural essence areas of Shichahai-Nanluoguxiang, Yonghegong-Guoqizian, Zhangzizhong Road North-Xintaicang, and Zhangzizhong Road South-Dongs Third to Eighth Streets in the northeast corner of the old city (Table 1 and Figure 1). Given that the area is a gateway space for tourism, the Beijing Municipal Commission of Planning and Natural Resources has carried out planning and renovation of key stations based on human-centric concepts since 2010. At present, the design practices of the four sample subway stations in terms of entrance and exit environment, station building, integrated interior decoration, and public art have received a lot of positive feedback (Figure 2).

Table 1 Location information of sample stations

Stations	Category	Line	Main adjacent historical districts	Main types of adjacent cultural facilities
1. Nanluoguxiang Station	Transfer station	Lines 6 and 8	Nanluoguxiang	Former residences of historical figures and religious temples
2. Shichahai Station	Ordinary station	Line 8	Shichahai	Scenic spots, former residences of historical figures, religious temples
3. Yonghegong Station	Transfer station	Lines 2 and 5	Yonghe Temple-Guoqizian	Scenic spots, religious temples
4. Zhangzizhong Road Station	Ordinary station	Line 5	Zhangzizhong Road South, Zhangzizhong Road North	Former residences of historical figures

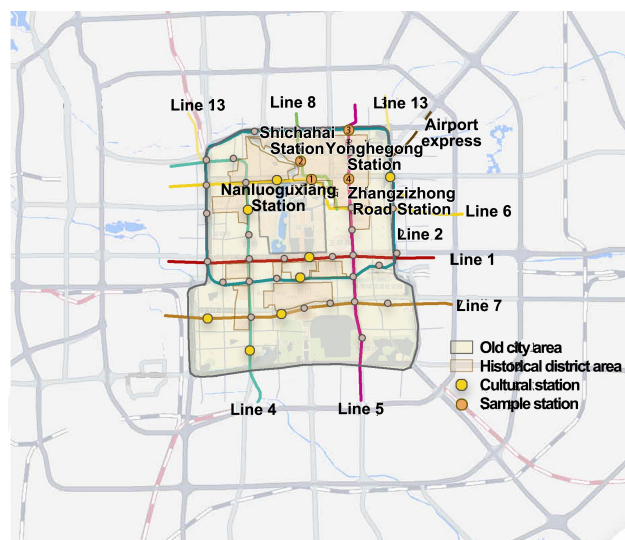


Figure 1 Location map of the sampled stations

1.3 Spatial scope

The research space includes both above-ground and underground areas. The above-ground portion refers to the area within a 100 m radius of station entrances and exits. During the construction and renovation of the subway station, this area can participate to a large extent in the environmental design of the public space around the station, including the coordinated renovation of buildings and streets, and the configuration of landscape facilities. The underground portion refers to the independent functional areas within the subway station. The focus of environmental design is on the main passenger gathering and distribution spaces, such as concourses, platforms, and transfer passages.

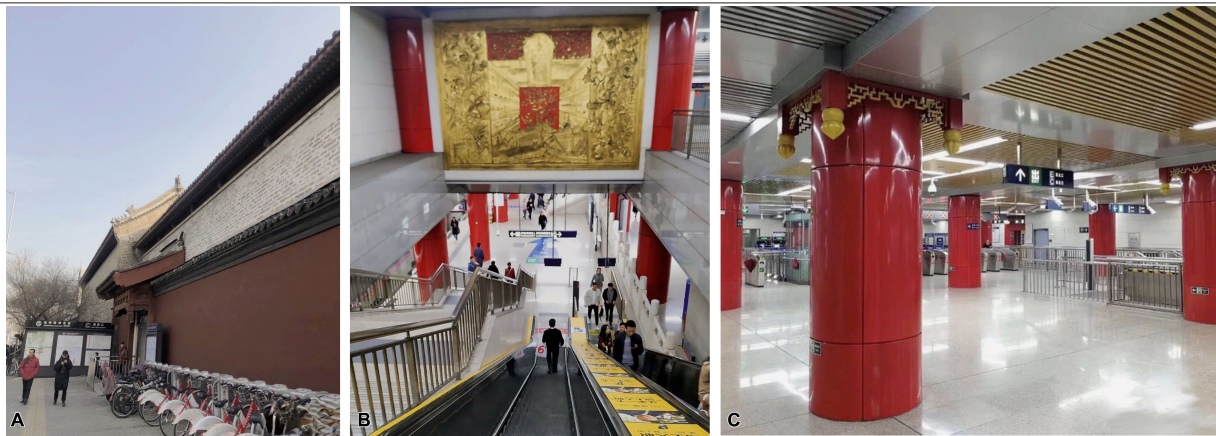


Figure 2 A, B, C: Current status of the indoor and outdoor environmental design at Yonghegong Subway Station

2 Research design

2.1 Indicator extraction and construction

In contrast to environmental implications, Lynch defined the material environment as an independent variable. The spatial cultural image of a subway station is a collection of comprehensive perceptions and experiences, and its creation and expression are subject to the allocation and control of the material elements of the subway station's spatial environment. Material elements are independent variables, while the cultural image perception is the dependent variable. After setting keywords on domestic and international academic platforms such as CNKI, the study retrieved and screened 50 relevant articles (2006 – 2019), and extracted evaluation indicators for characterizing variables based on literature review and analysis. The cultural image of subway station space is inherently abstract and difficult to observe directly. To balance the perception levels of cultural image in multiple dimensions, evaluation indicators are extracted from four aspects: Cultural atmosphere, historical background, image taste, and regional characteristics [10, 13, 14, 16, 17] for description (Table 2). The environmental design factors affecting the cultural image perception of subway stations are classified into unknown dimensions. Therefore, based on the physical structure of the subway station, it is classified into two parts: Above-ground (outdoor) space and underground (indoor) space. The above-ground space is directly related to the external environment (historical district), involving seven evaluation indicators: The scale and outline of connecting spaces, style, detail elements, accessibility to tourist attractions, open space connection, landscape features, and entrance signage [13, 14, 18, 19]. The underground space involves eight evaluation indicators: The

visual interface of the subway station hall and platform area, auxiliary facilities, public art, signage system, scene theme, and spatial experience [10, 13, 14, 20 – 22] (Table 3).

Table 2 Evaluation indicators for cultural image perception

Evaluation objectives	Evaluation indicators	Document frequency
Overall perception	C1 Enhancing the cultural atmosphere	19
	C2 Showcasing historical heritage	35
	C3 Shaping image and taste	35
	C4 Reflecting regional characteristics	41

Table 3 Environmental design evaluation indicators related to the creation of cultural image

Evaluation objectives	Evaluation indicators	Document frequency
Above-ground space	S1 Scale and outline suitability	12
	S2 Style suitability	15
	S3 Detail elements suitability	13
	S4 Accessibility to tourist attractions	12
	S5 Open space connectivity	8
	S6 Landscape feature suitability	10
	S7 Entrance signage suitability	11
Underground space	S8 Public art suitability	11
	S9 Wall and column surface aesthetics	19
	S10 Ceiling surface aesthetics	16
	S11 Paving and enclosure aesthetics	15
	S12 Wayfinding system suitability	24
	S13 Seating, lighting, and other auxiliary facilities suitability	17
	S14 Thematic atmosphere fit	32
	S15 Cultural experience diversity	6

2.2 Questionnaire design and distribution

The questionnaire is divided into three parts. The first part is demographic statistics, including four questions: Gender, age, education level, and occupation. The second part is the evaluation of the overall perception of the cultural image of the subway station space, which includes 4 items, corresponding to the evaluation indicators in Table 2. The third part is the evaluation of the environmental design elements of the subway station's above-ground and underground spaces, which includes 15 items, corresponding to the evaluation indicators in Table 3. The second and third parts consist of scale items, using a 5-point Likert scale to differentiate the perceived level of the evaluation items. The perceived values correspond to 5—very good, 4—good, 3—average, 2—poor, and 1—very poor, respectively. To ensure the relevance and effectiveness of the data collection, all questionnaires were printed and distributed on-site at multiple entrances and exits of sample subway stations from December 12 to 15, 2019. A total of 70 questionnaires were collected at each station, and the number of valid questionnaires was as follows: 65 At Nanluoguxiang Station, 61 at Shichahai Station, 62 at Yonghegong Station, and 64 at Zhangzizhong Road Station, yielding a total of 252.

2.3 Research methods

This paper investigates the environmental design influencing factors of the cultural image perception in subway station space, explores the inherent structural relationships among variables, and establishes and validates a measurement model for the cultural image perception in subway station space. Although a spatial cultural image exists objectively, its abstract nature makes it impossible to observe directly. Using structural equation modeling allows us to describe the characteristics and relationships of latent variables through some observable variables. Before applying structural equation modeling, the selected latent variables, i.e., the factors influencing environmental design, must first be categorized. Here, exploratory factor analysis and confirmatory factor analysis are used.

2.3.1 Exploratory factor analysis (EFA)

Exploratory factor analysis is used to find structural

relationships between multivariate observed variables to reduce data dimensionality. It identifies the potential structure of a scale by calculating the covariance matrix and estimating factor loadings. By using exploratory factor analysis on the initial 15 environmental design indicators, several closely related items can be condensed into a few core factors ($F_1, F_2, \dots, F_N$).

2.3.2 Confirmatory factor analysis (CFA)

Confirmatory factor analysis is used to test whether the relationships between factors and measurement items conform to the hypothesized structure. After establishing a measurement model using exploratory factor analysis, the structural validity of the existing model is verified using AMOS software, which can further refine the relationship model between environmental design common factors and indicator items.

2.3.3 Structural equation modeling (SEM)

Structural equation modeling is used to process, evaluate, and adjust multivariate models, thereby confirming or falsifying research hypotheses[23]. Using the perception of cultural image in subway station space as the dependent variable and common factors of spatial environment design ($F_1, F_2, \dots, F_N$) as latent variables, a structural equation model is established. This model can verify whether the spatial environment design of subway stations has a positive impact on the cultural image perception, and can also analyze the degree of correlation and regression path coefficients among the variables.

3 Results analysis

SPSS software was used to analyze the valid questionnaire results. The sample of this survey was balanced in gender, wide in age distribution, covered various occupational fields, and most of the respondents had received higher education, so it was highly representative (Figure 3). In the reliability test, the overall Cronbach's α value for the 252 questionnaires was 0.907, and the Cronbach's α values for the Cultural Image and Environmental Factors Evaluation Scale were 0.876 and 0.837, respectively. In addition, the Cronbach's α values for the questionnaires collected from the four sample subway stations ranged from 0.867 to 0.911. In summary, the reliability test results for each part

were all greater than 0.7, indicating that the collected questionnaire data had good internal consistency and

could be further analyzed. Furthermore, it was reasonable to treat the four stations as a whole for the study.

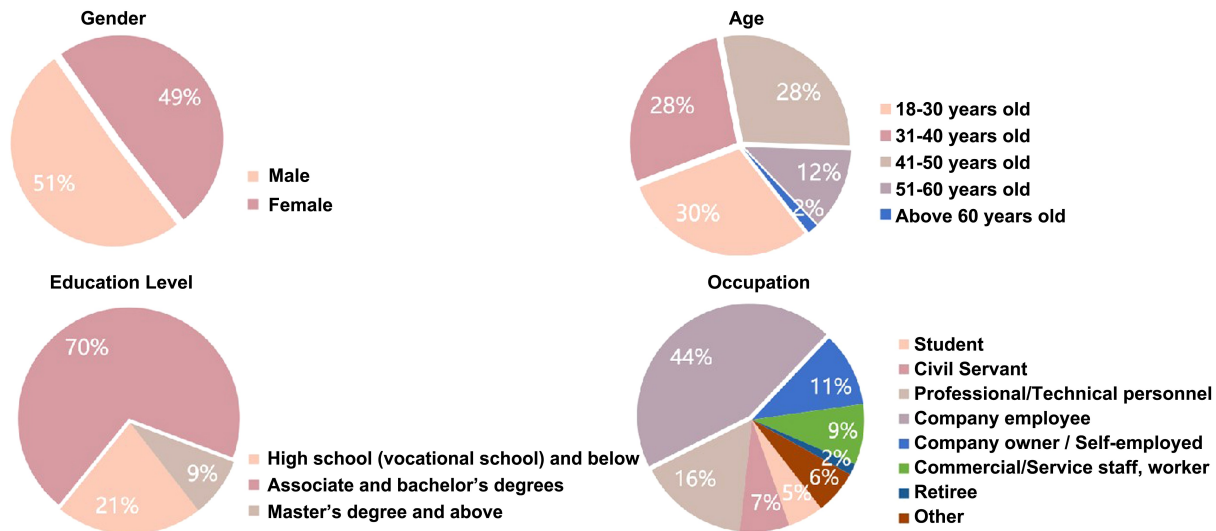


Figure 3 Demographic characteristics analysis of respondents

3.1 Analysis of the results of cultural image perception

The average score of the evaluation index for the perception of cultural image in subway stations was statistically analyzed, and the comprehensive score was 3.847, which proves that the sample subway station space is close to a good level in terms of cultural image creation. Among the four evaluation indicators, the item expressing the historical heritage of the area scored the highest, exceeding 4 points, while the other three

items scored close to 4 points (Figure 4). In the horizontal comparison of the comprehensive evaluation of the cultural image of the four stations, Yonghegong Station > Nanluoguxiang Station > Shichahai Station > Zhangzizhong Road Station, with evaluation scores of 4.209, 4.069, 3.774, and 3.379, respectively. The evaluation results are basically consistent with the current environmental status of the existing spaces of each subway station.

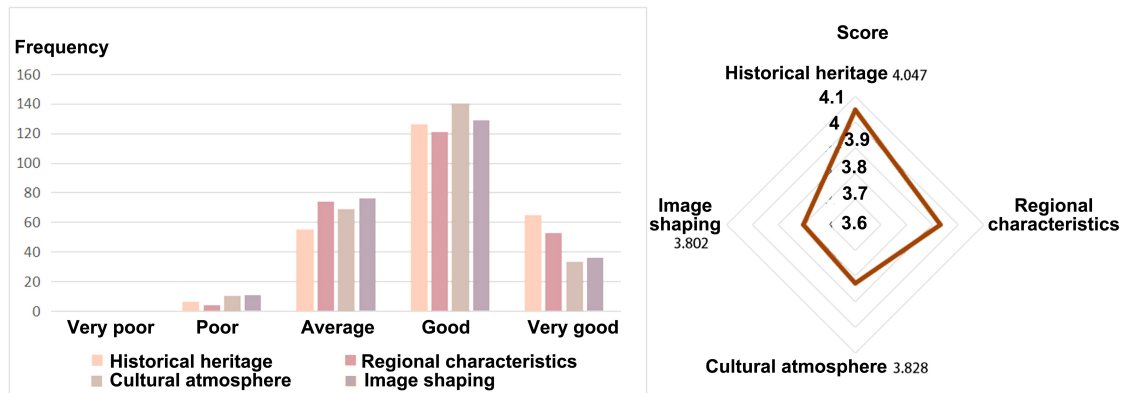


Figure 4 Evaluation results of cultural image perception

3.2 Exploratory factor analysis of environmental design evaluation elements

First, we examined whether the environmental design evaluation factor scale was suitable for factor analysis. The results showed that the KMO value was 0.871 (> 0.6); the significance-value of Bartlett's test of sphericity was

0.000 (< 0.01), indicating that the 15 items initially selected were suitable for establishing a factor model. Common factors were extracted using principal component analysis and varimax rotation. A factor loading value greater than 0.5 was set as the extraction criterion. The results showed that only the loading value of evaluation item S15 (cultur-

al experience) did not meet the criterion, so it was deleted. The component matrix of the remaining 14 evaluation items after rotation showed 3 principal component factors, with a cumulative variance contribution rate of 63.900% (> 60%), which explained most of the information of the

initial variables. Based on the content of the items involved in the three principal component factors, they are named as follows: Feature coordination common factor, interface decoration common factor, and service facility common factor (Table 4).

Table 4 Exploratory factor analysis of environmental design evaluation elements

	Common factor F ₁ : Feature coordination	Common factor F ₂ : Interface decoration	Common factor F ₃ : Service facilities
Cumulative contribution rate of variance	25.554%	45.104%	63.900%
Eigenvalues	3.833	2.933	2.819
Variance explained	25.554%	19.550%	18.796%
Cronbach's α value	0.888	0.855	0.844
Observed variables (Factor loading)	S2 style 0.873	S8 Public art 0.812	S13 Auxiliary facilities 0.771
	S1 Scale profile 0.854	S9 Wall and column surface 0.811	S6 Landscape feature 0.767
	S14 Theme atmosphere 0.853	S10 Ceiling surface 0.784	S12 Wayfinding system 0.738
	S3 Detail elements 0.829	S11 Paving and enclosure surface 0.780	S7 Entrance signage 0.684
	S4 Accessibility to tourist attractions 0.672	—	S5 Open space 0.550
Average rating	4.064	3.904	3.394

The common factor of feature coordination explains 25.554% of the total variance. The order of variance contribution rate is as follows: Style suitability > scale and outline suitability > (underground) thematic atmosphere fit > detail element suitability > accessibility to tourist attractions. The content mainly refers to the coordination and integration of subway station space and historical district features.

The common factor of interface decoration explains 19.550% of the total variance. The order of variance contribution rate is as follows: Public art suitability > wall and column surface aesthetics > ceiling surface aesthetics > paving and maintenance surface aesthetics. The content mainly refers to the visual interface of the subway station's underground space and the decorative and aesthetic aspects of public art.

The common factor of service facilities explained 18.796% of the total variance. The order of variance contribution rate was as follows: Suitability of auxiliary facilities such as seats and lighting > suitability of landscape features > suitability of (underground) signage system > suitability of (above ground) entrance signage > connectivity of open space. The content mainly refers to the auxiliary improvement and human-centric design of service facilities in the above-ground and underground spaces of

subway stations.

Based on the dimensional division of evaluation elements for subway station spatial environment design, the average values of the evaluation results of the items covered by each common factor were calculated. The factor for feature coordination was 4.064, the factor for interface decoration was 3.904, and the factor for auxiliary facilities was 3.394.

3.3 Confirmatory factor analysis of environmental design evaluation elements

Confirmatory factor analysis was conducted using Amos software to analyze the dimensional composition of environmental design evaluation elements. The measurement model constructed by the observed variables and their corresponding latent variables shows that there is a moderate positive correlation among the three latent variables: Feature coordination, interface decoration, and service facilities. Except for factor S5 (open space), whose loading is less than 0.5, the loadings of the other factors are between 0.51 and 0.93, which are within the acceptable and ideal range. After items that did not meet the criteria were removed and the model was optimized, the composite reliability of each dimension was greater than 0.8 (Table 5), indicating that the model had good structural validity and that all fitting coefficients reached acceptable and ideal levels.

Table 5 Confirmatory factor analysis of environmental design evaluation elements

Path	Factor loading	Averag evariance extracted (AVE)	Composite reliability (CR)
S3← F ₁	0.846	0.704	0.921
S4← F ₁	0.591		
S14← F ₁	0.861		
S2← F ₁	0.931		
S1←F ₁	0.920		
S10← F ₂	0.707	0.673	0.911
S11←F ₂	0.706		
S9← F ₂	0.869		
S8←F ₂	0.875		
S7←F ₃	0.511	0.508	0.800
S12←F ₃	0.679		
S13←F ₃	0.817		
S6←F ₃	0.802		

3.4 Tests for differences in demographic variables

Independent samples t-tests were used to compare the

Table 6 Results of tests for differences in demographic variables

	Gender		Age		Education level		Occupation	
	t-value	p-value	F-value	p-value	F-value	p-value	F-value	p-value
F ₁ Feature coordination	0.015	0.988	1.198	0.311	0.592	0.554	0.375	0.916
F ₂ Interface decoration	0.426	0.670	0.199	0.963	1.984	0.140	1.144	0.336
F ₃ Service facilities	1.776	0.077	0.421	0.834	0.850	0.429	0.524	0.816
Cultural image	0.402	0.688	0.742	0.593	1.833	0.162	0.837	0.557

3.5 Correlation analysis of environmental design factors and cultural image perception

SPSS correlation analysis results (Table 7) show that all three principal component factors in the spatial environment design dimension of the subway station are significantly positively correlated with cultural image perception ($P < 0.01$), with the correlation degree as follows: F₁ feature coordination > F₂ interface decoration > F₃ serv-

differences in evaluations of the overall perception of cultural image and the 3 dimensions of environmental design among respondents of different genders. The p-values of all test variables were greater than 0.05 (Table 6), indicating that there were no significant differences in perception evaluations between men and women. One-way ANOVA was used to compare the differences in the evaluations of respondents of different ages, education levels, and occupations in the three dimensions of overall perception of cultural image and environmental design. The p-values of each part were all greater than 0.05 (Table 6), which was not statistically significant. This indicates that different ages, education, and occupational backgrounds have no significant impact on the perceived evaluation of cultural image and environmental design factors. This demonstrates that creating a cultural image through subway station spatial environment design has universal applicability to various groups of people.

ice facilities, proving that environmental design factors have a positive impact on cultural image perception. Meanwhile, all environmental design factors are significantly positively correlated, indicating that the latent variables are not independent or exclusive material factors, but have a certain degree of interdependence and promotion, which also shows that spatial environmental perception is systematic.

Table 7 Correlation analysis of environmental design factors and cultural image perception

	F ₁ Feature coordination	F ₂ Interface decoration	F ₃ Service facilities	Cultural image
F ₁ Feature coordination	1	—	—	—
F ₂ Interface decoration	0.488**	1	—	—
F ₃ Service facilities	0.489**	0.337**	1	—
Cultural image	0.642**	0.593**	0.460**	1

** $P < 0.01$

3.6 Regression analysis of factors influencing cultural image perception

The causal relationship between the spatial environment design factors of subway stations and the cultural image perception was verified and analyzed using Amos structural equation modeling. The overall goodness-of-fit index was used to test the fit between the hypothetical model

and the sample data. The model fit results (Table 8) show that the absolute goodness-of-fit indices GFI, AGFI (> 0.8), and RMSEA (< 0.1) meet the acceptable standards, CMIN/DF and SRMR meet the ideal standards, and the relative goodness-of-fit index also meets the standards, ensuring the validity and credibility of the research results.

Table 8 Fit coefficients and discrimination criteria for structural equation modeling

	CMIN/DF	GFI	AGFI	CFI	NFI	RMSEA	SRMR
Observed values	2.932	0.860	0.811	0.920	0.884	0.088	0.0523
Judgment criteria	< 3 Ideal	> 0.8 Acceptable	> 0.8 Acceptable	> 0.9 Ideal	> 0.9 Ideal	< 0.1 Acceptable	< 0.08 Ideal

The model results show (Figure 5): (1) The three latent variables, namely, feature coordination, interface decoration, and service facilities, which are the main dimensions of subway station space environment design, all have a significant positive impact on the creation of cultural image. Their regression path coefficients are 0.40, 0.37, and 0.23, respectively. Among them, feature coordination and interface decoration are significant at the 0.01 level, and service facilities are significant at the 0.05 level. This indicates that the respondents' perception of the cultural image of subway station space is based on the recognition and judgment of the coordination of the features of the historical district station area, followed by the information transmission of the interface decoration in the subway station space, and is also affected to a certain extent by the quality characteristics of the service facilities inside and outside the subway station space. The more obvious the intention of the environmental design, the stronger the perception of the cultural image of the subway station space; (2) in the structural equation model, the correlation coefficients of the three latent variables of feature coordination, interface decoration and service facilities have increased, and the observed variables reflecting the theme fit of the space (S14 thematic atmosphere fit, S8 public art suitability) have a high load, indicating that the various environmental design elements complement each other at the level of image perception, and should be integrated comprehensive through material media; (3) in the cultural image evaluation, the respondents have a clear and positive perception of historical heritage and regional culture,

which indirectly confirms the correctness and necessity of using the subway station space as a gateway to the city for regional image marketing.

4 Strategy recommendations

Based on the results of quantitative analysis, the study proposes strategies and design processes for systematically creating the spatial cultural image of subway stations (Figure 6).

4.1 Creating an integrated human-centric spatial environment

The study concluded that environmental design factors influencing the cultural image perception in subway stations can be categorized into three aspects: Feature coordination, interface decoration, and service facilities. Coordinating these three aspects will have a multiplier effect. However, preliminary research revealed that while subway culture practices have become widespread in many Chinese cities, they largely remain at the level of interior decoration design, exhibiting problems of similarity in form and limited dimensionality. Therefore, it is recommended that subway stations in key urban areas actively expand the construction dimensions of cultural image, taking into account both the subway station area space and underground space, shifting from two-dimensional to three-dimensional and from planar to stereoscopic. Furthermore, they should carry out integrated environmental design from three aspects: Feature coordination, scene creation, and human-centric facilities. This involves mobilizing multiple disciplines such as urban design, architectural design, and landscape design to participate in relevant prac-

tices, and coordinating various environmental elements to carry out a three-dimensional and comprehensive overall

expression, so as to comprehensively enhance the cultural narrative effectiveness of subway station media spaces.

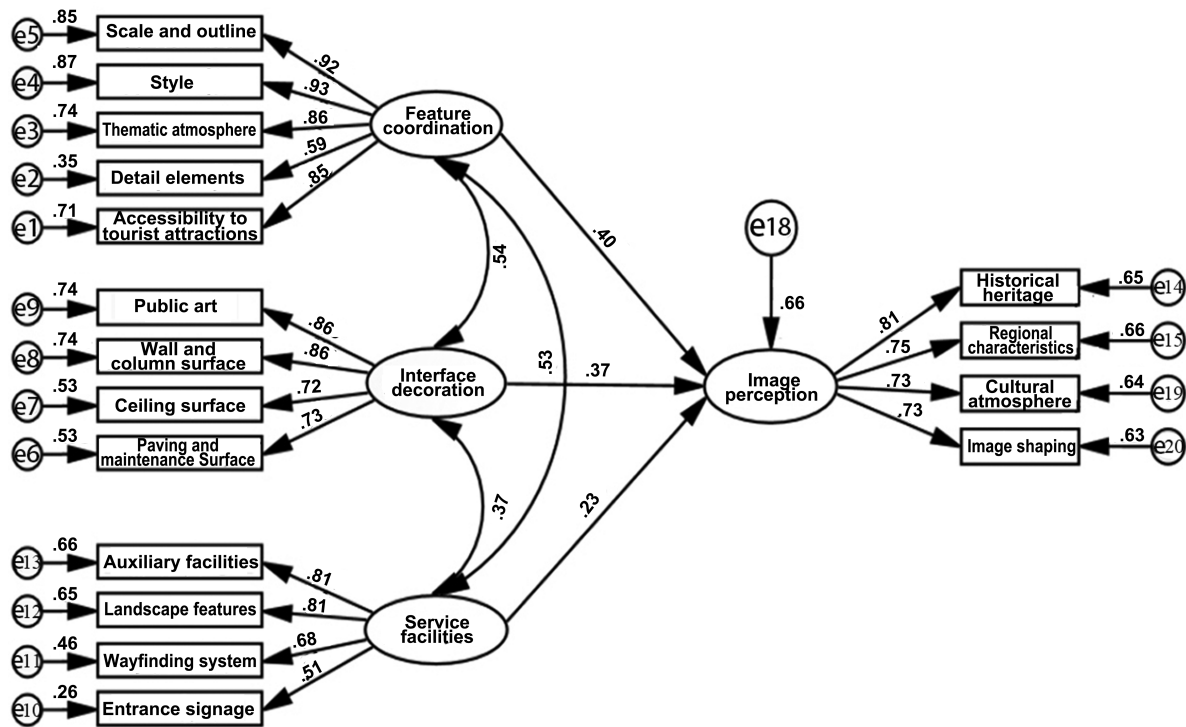


Figure 5 Structural Equation Model of the relationship between Subway Station Spatial Environment Design and Cultural Image Perception

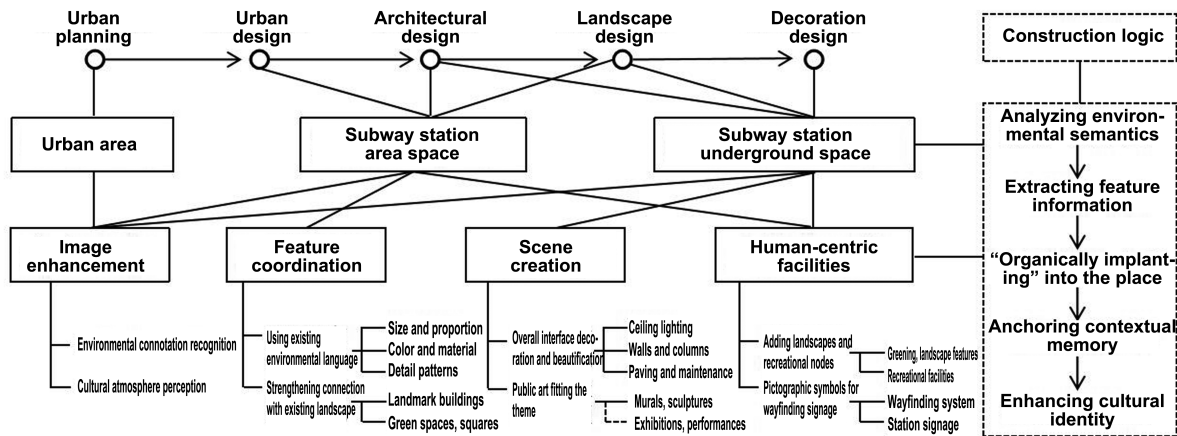


Figure 6 Design process for creating cultural images in subway station space

4.2 Coordinate the landscape features around the subway station

Feature coordination is the primary influencing factor in controlling the expression of cultural images in subway station space. The public's perception of the cultural image of subway station space is also related to their overall interpretation of the existing environment. Therefore, the design of subway station space should follow the semantic background of the surrounding environment, organically

integrate into the existing site through the mining, refinement, and reorganization of characteristic information, and maintain and coordinate the authenticity and integrity of the station area's features. First, in the urban design and architectural design of the subway station entrance and exit areas, the conservation principle of "restoring the old as it was" can be appropriately adopted. The "old" historical environment can be used as the design script, and attention should be paid to the control of elements such as color and

material, height and proportion, and decorative patterns. This will ensure that the style, scale, outline, and detailed decoration maintain visual continuity with the surrounding blocks of the station area and organically continue the existing environmental context. For example, the design of Nanluoguxiang Station of the subway adopted a scheme based on the concept of “darning” (urban weaving). In the architectural and street design of the subway station entrances and exits, the traditional architectural language of the historical district was abstracted and integrated at a macro spatial scale. The sense of invasion of traffic nodes was eliminated through the isomorphic integration of environmental elements, and the historical spatial texture of

the old city was restored to a certain extent (Figure 7). Secondly, the design should appropriately strengthen the connection and transition between the subway station entrances and exits and the historical districts, buildings, and other landmark landscapes. The place characteristics of the subway station are further enhanced through the “bundled” design of the two. For example, Yonghegong Subway Station has set up multiple entrances and exits that smoothly connect to the Yonghegong temple buildings, Yonghegong-Guoqizhuan Creative Park, and the ring park, which not only improves the accessibility of the surrounding cultural space but also enhances people’s perception of the station area.



Figure 7 A, B, and C: Entrance/Exit and interior space design of Nanluoguxiang Subway Station

4.3 Enhance the creation of underground space scenes

In addition to fulfilling functional requirements, the underground space of a station should also effectively connect the above-ground and underground environments, and maintain the spatiotemporal unity of the sense of place by depicting and continuing the characteristics of the above-ground place. The creation of scenes in underground spaces includes two parts: Public art and surface decoration. The former focuses on establishing the theme and conveying the “meaning” by introducing public artworks such as murals and sculptures that echo the historical districts, landmarks, and station names of the subway station areas, directly narrating the “theme” of the above-ground place. For example, there is a mural depicting the Shichahai scene in Shichahai Station and a sculpture of Zhangzizhong at Zhangzizhong Road Station. The latter focuses on expressing the “meaning” through imagery by extracting visual symbols that reflect the surrounding environment to decorate the continuous spatial interface and re-

produce the above-ground scene. For example, Shichahai and Nanluoguxiang Subway Stations extract traditional architectural vocabulary such as sloping roofs, gray brick walls, and wooden rafters to decorate the ceilings, beams, columns, and walls of the stations, echoing the formal characteristics of the historical districts (Figures 7C and 8). Yonghegong Station uses golden murals, red columns, and white marble steps as elements for overall decoration to highlight the theme of religious sites (Figures 2B and 2C). The combination of public art and spatial interfaces that fit the theme of the site creates “anchor points” for the memory of the site through “scenes,” which helps to strengthen people’s positioning of the ground environment and form a clear spatial cognition. However, the current art practices in China’s subway stations are one-dimensional and generally lack interactive cultural projects with public participation. It is hoped that temporary art activities such as exhibitions and performances can be introduced in the future to further enrich the cultural experience of subway spaces.

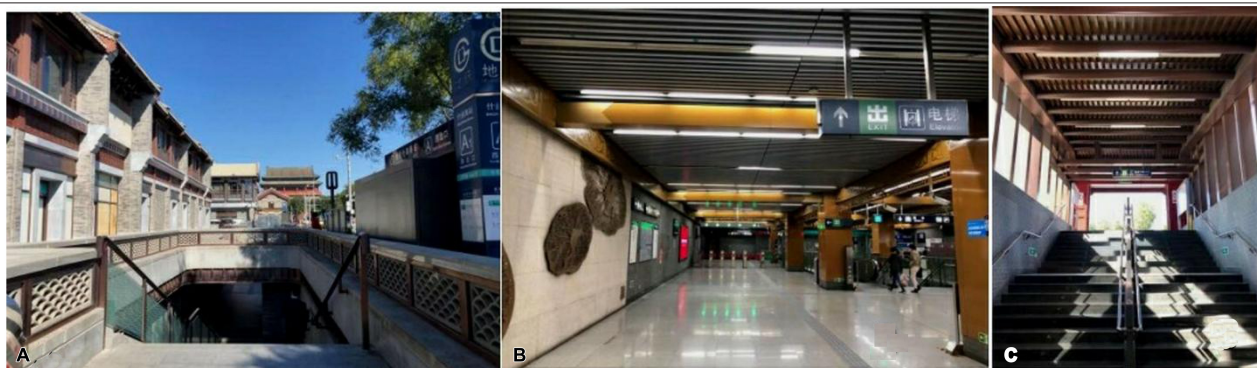


Figure 8 A, B, C: Entrance and exit design and internal space of Shichahai Subway Station

4.4 Improve the station's human-centric service facilities

Service facilities play a subtle guiding role in the gathering and movement of people, and are an invisible clue that organically connects above-ground and underground spaces. Improving the human-centric design of service facilities can further enhance the cultural image of subway station space. For landscape and recreational facilities, the leisure landscape can be transformed by adding green vegetation, sculptures, seats, and other facilities, providing places for people to stay and interact, and optimizing the recreational experience of urban nodes. At the same time, innovative design language can be used to transform the traditional form of service facilities and integrate them into the station's integrated design. For example, the Beijing Forest Park Station embeds the lighting system into the "tree branch" grid of the roof to create a continuous and unified "forest" image (Figure 9). For signage and wayfinding facilities, symbolic design can be used to represent the cultural connotation of the station area. Important buildings, landscapes, or historical events that are coupled with the subway station space can be used as pictographic objects to reconstruct the abstract cultural identity of the subway station. For example, the Xi'an Metro uses the "Xi'an City Wall" as a symbolic element for the overall identity. The identity of each station also provides a symbolic interpretation of the cultural landmarks adjacent to the station area. For example, Houweizhai station uses the ancient village gate and soldiers' armor as symbols, and Yuxiangmen uses the ancient city traffic channels and auspicious clouds as design elements (Figure 10).



Figure 9 Lighting facilities at Forest Park subway station



Figure 10 Signage design for the Xi'an subway system and some stations

4.5 Shaping the overall cultural image of the city

The creation of a pleasant environment in subway stations can effectively enhance people's perception of regional cultural images and has a universal cultural media

function for all types of people in the city. If a cultural network can be woven around subway lines, it will comprehensively enhance the city's image, activate urban memory, highlight urban characteristics, increase local identity, and innovate the development path of the "last mile" of public cultural services. Therefore, future urban development and construction should consider strengthening the integration of rail transit planning and cultural space planning in the top-level design stage, so that more subway stations and geographical and cultural nodes can achieve a mutual feedback relationship, and realize the cultural catalyst effect of the city on a large scale by means of the "point-axis" linkage mechanism of the subway network [24].

Conclusion

In the new round of urban expansion and construction, the competition for comprehensive urban strength is increasingly focused on the contest of cultural soft power. Cultural construction using subways as a medium has opened up a new direction for urban cultural development. Subway station space, which is coupled with geographical and cultural nodes, has evolved into a "second space" for inheriting and showcasing regional culture. The popularization of the "human-centric turn" in subway station space design has prompted related research to focus on how to effectively create and express the essence of profound regional culture. Based on a literature review, this study selected 15 evaluation indicators for subway station spatial environment design related to the creation of cultural image, and 4 evaluation indicators for cultural image perception. Taking four typical historical and cultural subway stations adjacent to historical districts in Beijing as research objects, and using the results of 252 questionnaires as data, the study explored and analyzed the environmental design factors and dimensions that influence users' perception of the cultural image of subway station space, as well as the influence relationships between variables. Furthermore, it proposed countermeasures and suggestions for improving subway station environmental design, aiming to provide a basis and reference for the optimized development of subway cultural practices. However, the evaluation system and methods proposed in this study also have certain limitations. Further research plans should improve

these shortcomings to make the research conclusions more objective and reasonable.

Sources of Figures and Tables

Figures 1 – 9: Photographs and drawings by the author;
Figure 10: Compiled from online sources: <https://www.logone-ws.cn/xian-metrostation-sign.html>; <http://www.logozhan.com/3870.html>;

Tables 1-8: Drawn by the author.

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