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Cultural Identity, Trust, and Usage Intention in Regional Culture-Themed Metro Passenger Interfaces: An Extended TPB Study

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Highlights

Please indicate how your work links to systems science via your contributions to systems practice, theory, and/or methodology.

- Applies an extended TPB framework to examine cultural presentation, cultural identity, and trust in metro passenger interfaces.
- Uses a structural model to examine how individual perceptions interact within a public transportation information environment.

What are the main findings and/or the implications of the main findings?

- Trust had the numerically largest direct coefficient for usage intention; perceived cultural identity showed a significant indirect association through trust.
- Regional cultural presentation was positively associated with perceived cultural identity and trust, informing culturally responsive interface design.

Abstract

Passenger information systems help metro passengers access real-time operational information, yet the relationships between regional cultural design in these interfaces and passengers' perceptions and usage intentions remain underexplored. This study extends the theory of planned behavior (TPB) by incorporating regional cultural presentation, perceived cultural identity, and trust to examine passengers' intention to use regional culture-themed passenger interfaces (RCPIs). Survey data from 712 valid respondents, measured using 27 observed variables, were analyzed with partial least squares structural equation modeling. Attitude, subjective norm, perceived behavioral control, and trust directly predicted usage intention, with trust having the largest direct coefficient. Perceived cultural identity did not directly predict intention but acted indirectly through trust. Regional cultural presentation was positively associated with cultural identity and trust. These findings characterize associations among passengers' evaluations of regional cultural presentation, perceived cultural identity, trust, and usage intention in metro passenger interfaces. The study provides context-specific evidence on passengers' responses to regional culture-themed interfaces within an extended TPB framework and offers implications for interface design.

Keywords: regional cultural design; passenger information interfaces; Theory of Planned Behavior; cultural identity; trust

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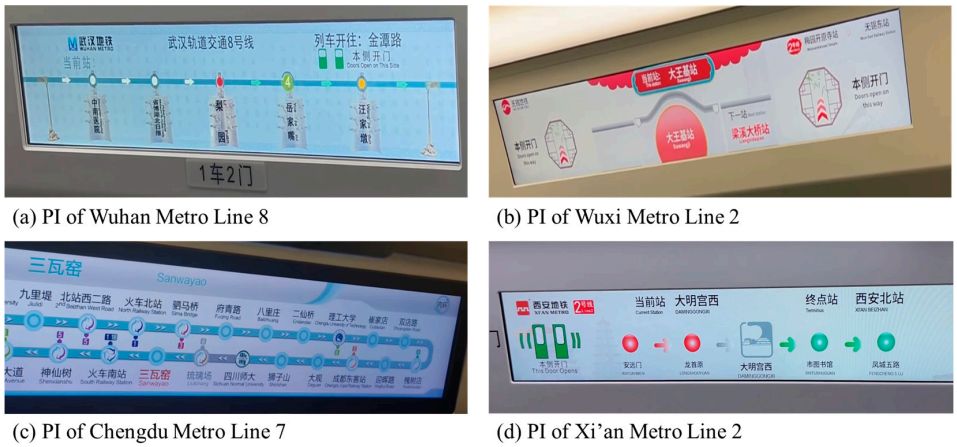
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1. Introduction

According to the China Association of Metros, urban rail transit systems were operating in 58 cities in mainland China by the end of 2024. Underground sections accounted for 69.69% of the total urban rail transit route length in operation [1]. The daily service coverage rate of metro systems has reached 6.5% [2], with a pronounced trend toward long-distance commuting [3]. An increasing number of urban residents choose to commute by metro rather than other public transportation modes. As the scale of the rail network becomes more complete, the previously rapid construction pace has gradually slowed, and the development focus has shifted toward providing high-quality passenger services. This transformation requirement has been incorporated into the national strategic plan, the *Outline for Building China's Strength in Transport*.

Corresponding to the rapid development of subway construction is the technological innovation of rail transit equipment, particularly the comprehensive digitalization of the onboard Passenger Information Display System (PIDS). This system integrates advanced technologies such as cloud computing, big data, and the Internet of Things with passengers' travel tasks and has gradually become a standard configuration in trains manufactured by China Railway Rolling Stock Co., Ltd. (CRRC). The interactive interface design of PIDS is typically led by metro operating companies in each city, which often require differentiated design strategies across different lines (as industrial design projects are usually tendered separately for each line). Consequently, the diversity of passenger information display methods in Chinese metro trains may exceed the combined variety found in samples from other countries. Traditional in-train passenger information interfaces consist of LED indicators and printed films displaying line information. Although this design is simple, it lacks the capacity to present richer content. Currently, widely used LCD screens can flexibly display information such as arrival countdowns, crowding levels, and station layouts through digital interfaces [4–6]. These improvements have been proven to provide tangible benefits for passengers during their journeys. In addition to incorporating functional information, Chinese metro companies are also striving to enhance the aesthetic and cultural attributes of passenger interfaces (PI). Compared with PI in other regions of the world, some designs are highly distinctive and even "avant-garde." In particular, the integration of regional cultural elements into PI is officially regarded as part of establishing a brand image for urban rail transit, aiming to showcase the city's attractiveness and promote cultural dissemination.

Regional culture generally refers to the historical heritage, social customs, and lifestyles that have been accumulated and formed through long-term development within a specific geographical area. It can manifest in material forms such as architecture, landscapes, and clothing, or in intangible forms such as opera, craftsmanship, and dialects [7–11]. Transforming regional culture into design elements and integrating them into metro train PI has become highly popular in China recently. For example, the station name background in the passenger information system of Wuhan Metro Line 8 uses the Zenghouyi bronze chime bells, artifacts unearthed in Hubei Province from the Warring States period (fifth century BC), as design elements (Figure 1a); the Wuxi Metro Line 2 integrates white walls and lattice windows from Hui-style architecture into the PI (Figure 1b); the Chengdu Metro Line 7 features the emblems of three universities along its route as station icons in the interface (Figure 1c); and the Xi'an Metro has even introduced the "One Station, One Symbol" design concept, aiming to create customized visual identities for each station (Figure 1d). However, further evidence is needed on how passengers' evaluations of regional cultural presentation are associated with their intention to use these interfaces.



(a) PI of Wuhan Metro Line 8 (b) PI of Wuxi Metro Line 2

(c) PI of Chengdu Metro Line 7 (d) PI of Xi'an Metro Line 2

Figure 1. Passenger interfaces with regional cultural elements. The Chinese text on the displays provides passenger information, including station names and travel directions. Examples include "当前站" (current station), "终点站" (terminus), and "本侧开门" (doors open on this side).

When running underground, metro trains constitute typical mobile enclosed spaces. Passengers, without access to external information, may experience sympathetic nervous system imbalance due to psychological stress, leading to distortions in spatial and temporal perception [12]. Human spatial awareness is primarily guided by visual information [13]. Personal mobile devices and PIDS are the primary visual information sources available in underground train operations; however, information displayed on large screens can elicit higher levels of multidimensional trust across cognitive, emotional, and behavioral dimensions [14]. The documented benefits of PIDS include reducing travel uncertainty, enhancing the sense of safety, and improving the overall travel experience [15]. From information perception and cognitive processing to decision-making actions, understanding and trust are crucial determinants of situational awareness and the efficiency of action feedback [16]. Whether the inclusion of regional cultural elements in PI exerts positive or negative effects on passengers' understanding and human–computer trust has emerged as a new research question.

The purpose of this study is to investigate the impact of regional cultural elements in PI on users through an extended theory of planned behavior model. The basic structure of this paper includes a literature review in Section 2; an introduction to the research framework and the proposed hypothesis model in Section 3; research methods in Section 4, detailing the questionnaire design, collection and screening procedures, and data analysis and modeling methods; results in Section 5, reporting the survey sample distribution, evaluating model validity, and testing hypothesized influence paths; a discussion of the findings in Section 6; and a summary of conclusions and research outlook in Section 7.

2. Literature Review

2.1. Regional Culture Integration in Urban Rail Transit

As an extension of underground space, metro systems are evolving from mere passenger transport infrastructure into significant carriers of urban public culture, serving functions of city memory and cultural heritage. Many cities have begun exploring ways to integrate regional culture into urban rail transit, even establishing systematic brand symbols from the early stages of planning. For instance, the historically oldest London Underground has its distinctive roundel and Johnston typeface, which have become iconic representations of the city. The map designed by Harry Beck is further regarded as a classic in information design [17]. The Paris Metro is renowned for its Art Nouveau-style station entrances, with stations like the Louvre and Rivoli incorporating art exhibits into the metro

space, creating an "underground city museum" imbued with romantic historical imagery. In China, where metro construction has advanced most rapidly, cities have used artistic stations, train designs, and wayfinding systems as media to embed historical narratives, landscape symbols, folk elements, and contemporary art into passengers' daily commutes, aiming to enhance the travel experience through continuous cultural expression [18,19]. These practices demonstrate that the integration of regional culture represents a comprehensive and continuous form of innovative expression that helps enhance the cultural value of urban rail transit and bring socio-economic benefits to the local area.

Related studies suggest that cultural design in metro trains positively influences passenger experience, urban image, and social identity. At the passenger experience level, the integration of culture and design can alleviate commuting stress and create a comfortable and enjoyable travel environment [20,21].In terms of shaping urban image, rail transit serves as a city's calling card, with its design style and cultural connotations directly reflecting the city's spirit and cultural heritage. For example, urban rail vehicle designs in Reims [22], Marseille, and Angers [23] incorporate locally associated motifs, such as champagne, fishing boats, and flowers, to express the distinctive character of these cities. The design translation of regional culture has become an important means to enhance urban attractiveness. [24]. At the level of social identity, cultural symbols in the metro help strengthen residents' sense of local identity and enhance metro brand recognition [25]. Overall, the intervention of cultural design, as a prevailing trend, has a certain history and scale within urban rail systems.

2.2. Train Passenger Interface Innovation

With the rapid proliferation of intelligent human–machine interaction technologies in urban rail trains, China alone has launched 54 fully automated lines across 23 cities [1]. GoA (Grades of Automation) 4-level trains operate, stop, open and close doors, and handle emergencies entirely under system control, without human intervention [26]. As PIDS increasingly serve as the basis for passenger decision-making, their importance has become more pronounced. PI is gradually evolving from a single-level information dissemination tool into a service system capable of multimodal presentation and real-time line information delivery. The widespread adoption of digital interfaces in carriages has amplified both the richness of information content and the diversity of presentation formats, while simultaneously introducing new human–computer interaction challenges. Especially on trains operating in dark tunnels, the lack of spatial and temporal reference cues makes it difficult for passengers to gauge journey progress using landmarks outside the windows, resulting in distortions in time and space perception. This manifests as difficulties in orientation [27–29], discomfort [5], and perceived time elongation [30]. Passengers experience increased cognitive load while searching for target information [31]. Optimizing the organization of information and design elements in PI facilitates perception, comprehension, and decision-making, thereby helping to prevent errors such as stopping at the wrong station or alighting prematurely [32].

Commonly used design optimization methods currently include highlighting 3D arrival maps [33], magnifying local sections of the route [34], and dynamic line displays [6]. Contextualized information presentation helps improve passengers' search and retrieval efficiency, showing advantages in tasks such as confirming the train's real-time location and passenger density [35]. However, providing information aligned with cognitive and behavioral needs is only a necessary but not sufficient condition for ensuring passengers make decisions and act. The likelihood of behavior following information perception depends on the level of trust in that information [36,37]. Low trust implies that passengers hesitate after receiving information and fail to achieve effective behavioral feedback. A

meta-analysis by Hancock et al. [38] indicates that enhancing interface comprehensibility, providing decision support, and fostering situational awareness are effective means to improve trust levels. There is currently a lack of key evidence supporting whether the presentation of regional cultural elements in PI design facilitates passengers' information perception, guides attention, and enhances comprehensibility.

2.3. Cultural Design and Human–Computer Interaction Trust

Trust in human–computer interaction is a complex and multidimensional psychological construct, commonly defined as users' belief that a system's reliability and predictability in uncertain environments align with their expected behaviors [39–41]. Moreover, numerous studies have demonstrated that the mechanisms of trust formation in various systems, including website features [42], mobile interfaces [43], traffic information [44], and artificial intelligence [40], are closely related to HCI design. Specifically, optimized design methods such as anthropomorphic icon design [45], multimodal information presentation [46], and the combined use of text and symbols [47] have been proven to facilitate information comprehension and enhance trust in transportation environments.

The pioneering study by Vance et al. [48] focused on the influence of culture on trust in IT products, suggesting that culture primarily modulates user trust through visual appeal. To systematically understand the role of culture in human–computer trust, scholars have addressed trust-related issues through theories such as affordance theory [49], visual rhetoric theory [50], and the theory of planned behavior combined with Technology Acceptance Theory [51]. Recently, Guo et al. [52] proposed the human factors "onion model," analyzing from core to surface how cultural design in user interfaces affects preferences, trust, identity, and behavioral dimensions, revealing the interplay of emotions across these layers. Users' deep-seated cultural values can directly or indirectly influence their preferences for interface elements, providing theoretical guidance for cross-cultural design.

The integration of cultural elements in interface design aims to enhance aesthetics and design meaning by reflecting the values, beliefs, traditions, and symbols of specific geographic regions [53]. However, in different cultural contexts, the cognitive processes through which users form trust and the trait indicators they rely on vary. Studies by Morales et al. [54] and Pycha and Zellou [55] have demonstrated that local accents in voice interactions positively influence brand memory and perceived credibility. In train PI, many cities such as Guangzhou (Cantonese), Taipei (Hokkien), and Hohhot (Mongolian) also use local dialects as broadcast languages in addition to Mandarin and English. Therefore, it is hypothesized that culturally aligned design can enhance passengers' trust in PI. Considering the subjectivity and multidimensionality inherent in culture and trust, employing IS models represented by TPB is more effective in revealing passengers' perceptions of regional culture-themed passenger interfaces (RCPIs) and the pathways through which trust is generated.

3. Research Framework and Hypotheses

3.1. Theory of Planned Behavior

The theory of planned behavior (TPB) is a widely applied social-psychological theory for predicting human behavior. Proposed by Ajzen in the 1980s, it extends the theory of reasoned action (TRA) [56]. At its core, TPB posits that behavioral intention is the most direct predictor of behavior. In previous studies, TPB and its extended models have been widely applied to explain and predict the usage behaviors of public transportation and human–computer interaction [57–60]. In the HCI domain, trust is considered a key factor in the adoption of information systems and human–computer interfaces. Trust positively influences user attitudes by reducing perceived risk and enhancing information credibility, and it can also directly drive behavioral intention in uncertain situations [61,62]. Moreover, it

interacts strongly with traditional technology acceptance models (TAM/TPB), significantly improving explanatory power. Studies have found that culturally adapted interfaces significantly outperform non-adapted versions in terms of usability and affective evaluation, and symbolic cultural elements can enhance users' sense of cultural belonging [63]. Consumer behavior research also indicates that when a product aligns with a user's cultural identity, social identification enhances perceived value and behavioral intention [64]. Building on extended TPB research on technology and public transport acceptance, this study focuses on regional culture-themed passenger interfaces in metro systems. It incorporates regional cultural presentation (RCP), perceived cultural identity (PCI), and trust (TR) into the TPB framework to examine their relationships with passengers' behavioral intentions alongside the core TPB constructs. This context-specific application connects cultural interface design with behavioral acceptance research.

TPB posits that behavioral intention (BI) is influenced by three main factors: attitude (AT), subjective norm (SN), and perceived behavioral control (PBC) [56]. AT refers to an individual's positive or negative evaluation of a specific behavior, with positive evaluations directly affecting BI. SN refers to the perceived social pressure an individual feels. If passengers believe that people around them are more willing to accept regional culture-themed passenger interface designs, or that society generally acknowledges that RCPIs enhance the travel experience, they will feel greater social pressure to accept and use such designs. PBC refers to an individual's perceived ease or difficulty in performing a specific behavior, reflecting their assessment of personal ability, required resources, and potential obstacles. If passengers find the PI interface simple to use and information easily accessible, their perceived behavioral control will be higher. PBC influences actual behavior by affecting behavioral intention. Accordingly, the following hypotheses are proposed in this study:

- H1: Attitude toward PI positively influences the behavioral intention to use PI.
- H2: Subjective norm positively influences the behavioral intention to use PI.
- H3: Perceived behavioral control positively influences the behavioral intention to use PI.

3.2. Perceived Cultural Identity

Cultural identity profoundly shapes an individual's values, beliefs, and worldview [65]. When a behavior or object aligns with the values upheld by one's culture, individuals are more likely to form a positive attitude. According to Zhang [66], cultural identification exerts a significant effect on tourists' attitudes, subjective norms, and behavioral intentions related to environmental responsibility. This suggests that cultural identity directly impacts an individual's evaluation of particular behaviors, resulting in favorable or unfavorable attitudes. Similarly, within train passenger interfaces, passengers' cultural identification may directly increase their intention to continue using the system.

When individuals have a strong sense of identification with their own culture, they are generally more willing to comply with the expectations of their cultural group. This strong compliance motivation transforms cultural identity into a powerful subjective norm. Studies have found that cultural tightness can moderate the influence of personal values and social norms on behavior [67].

Trust is regarded as a key factor in HCI research. Culturally congruent designs help enhance predictability, comprehensibility, and emotional resonance, thereby strengthening the perceived credibility of information or systems (i.e., trust). Studies in cross-cultural e-commerce indicate that cultural background influences trust formation mechanisms [68]. At the interface design level, designs that align with users' cultural expectations can increase acceptability and trust. These arguments motivate the following hypotheses:

- H4: Perceived cultural identity positively influences attitude toward PI.
- H5: Perceived cultural identity positively influences subjective norm.

- H6: Perceived cultural identity positively influences behavioral intention.
- H7: Perceived cultural identity positively influences trust.

3.3. Regional Cultural Presentation

Regional cultural presentation refers to the display of local cultural elements in PI through visual, auditory, or other interactive forms. This includes, but is not limited to, local architectural styles, traditional historical patterns, and visual representations of dialects. When passengers encounter culturally distinctive elements, the way these elements are presented may enhance their perception and understanding of the local culture, thereby promoting the formation of cultural identity.

Trust typically functions as a psychological mechanism to reduce perceived risk and enhance judgments of reliability in uncertain situations. Culturally aligned interfaces can decrease cognitive discrepancies and comprehension barriers, increasing the predictability and interpretability of information, thereby reducing uncertainty and fostering trust formation. In technology acceptance research, trust has often been shown to directly influence usage intention and to interact with paths such as attitude [69]. Regional cultural elements may therefore strengthen trust by improving interface comprehensibility and eliciting emotional resonance.

Regional cultural presentation enhances the aesthetic congruence and emotional resonance of an interface, making it easier for users to form positive evaluations. In other words, cultural alignment may increase users' subjective liking and satisfaction in the usage context, thereby positively influencing attitude. Psychology also suggests that the way culture is formed and perceived can affect individuals' attitudes [70].

In HCI-related studies, cultural localization has been shown to enhance perceived usability [71]. Cultural elements may support interface use when they are familiar to passengers and integrated with task-relevant information. However, their benefits may depend on how they are implemented. Dense ornamentation, competing visual cues, or unfamiliar symbols may increase visual clutter and the effort required to locate and interpret operational information. Cultural familiarity and visual complexity may therefore have competing implications for passengers' perceived ease of use. The positive relationships proposed in this study reflect the anticipated benefits of recognizable and functionally integrated cultural cues. The following hypotheses are proposed:

- H8: Regional cultural presentation positively influences perceived cultural identity.
- H9: Regional cultural presentation positively influences trust.
- H10: Regional cultural presentation positively influences attitude.
- H11: Regional cultural presentation positively influences perceived behavioral control.

3.4. Trust

Trust is the user's perception of the reliability, integrity, and benevolence of a party (system, designer, or provider) in uncertain situations [72], which enhances positive evaluations of the target behavior or object by modifying assessments of behavioral beliefs. In other words, when passengers believe that the information provided by the interface is reliable and will not lead to losses, they are more likely to hold a positive attitude toward using the system. Empirical research by Cheung and To [73] using an extended TPB model shows that trust significantly promotes users' positive attitudes toward mobile in-app advertisements.

Previous studies have incorporated trust as an additional extension or mediating variable in models, arguing that trust can enhance users' intention to continue using a product [74]. Ma et al. [75] demonstrated that a trusted system can strengthen users' subjective norms by increasing their perception of "others think I should do this." The

preceding discussion suggests that trust may influence passengers' attitudes, behavioral intentions, and subjective norms. The following hypotheses are proposed:

- H12: Trust positively influences attitude toward PI.
- H13: Trust positively influences behavioral intention to use PI.
- H14: Trust positively influences subjective norms.

3.5. The Influence of Mediating Effects

Studies have found that incorporating cultural elements into design can significantly enhance users' sense of cultural closeness and identification with a product. Song [76] observed that embedding traditional cultural elements in robots increases users' affinity toward the product and evokes cultural identity and pride, thereby improving acceptance. Furthermore, Liu and Zhao [77] found that in products featuring traditional cultural symbols, cultural identity mediates the effect of cultural symbol design on purchase intentions.

Subjective norms, a concept in TPB related to social influence, reflect the consideration of others' opinions and behavioral standards when making decisions. In collectivist cultural contexts (e.g., China, Southeast Asia), subjective norms often exert a stronger influence on behavioral intentions than personal attitudes [78]. This reasoning suggests that trust in a technology or system may contribute to perceived social pressure to use it.

Trust often serves as a key factor directly influencing behavioral intention [79]. It is essential for reducing usage barriers and mitigating perceived risks; when users believe that a system functions properly and safeguards their interests, they are more willing to use it. Ding and Najaf [80] found through mediation analysis that trust mediates the relationships among interoperability, perceived humanization, and behavioral intention. The following mediation hypotheses are proposed:

- H15: Regional cultural presentation indirectly influences behavioral intention through perceived cultural identity.
- H16: Trust indirectly influences behavioral intention through subjective norms.
- H17: Perceived cultural identity indirectly affects behavioral intention through trust.

In summary, based on previous studies, this research establishes an extended TPB framework to explore the influencing factors of passengers' acceptance and use of PI when cultural design elements are incorporated. The framework model illustrating the hypothesized relationships is shown in Figure 2.

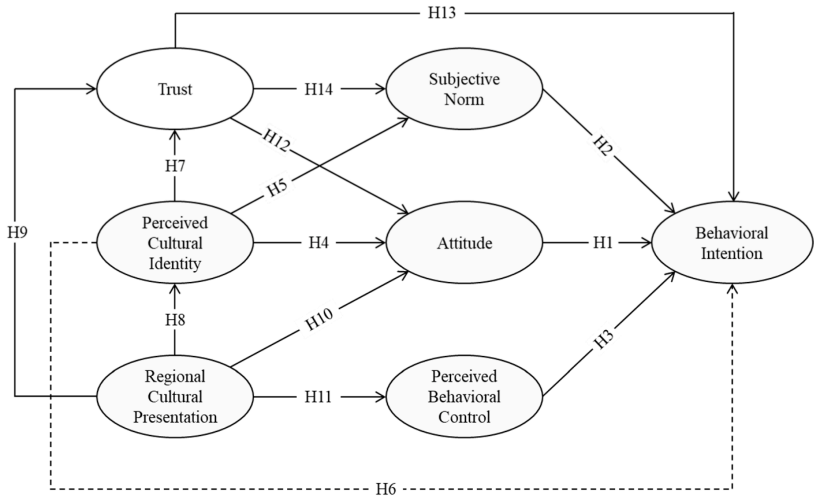


Figure 2. Research model.

4. Research Methods

This study was approved by the Ethics Committee of Xihua University (approval no. XHLL-III-20260033) and conducted in accordance with the principles of the Declaration of Helsinki. The methods described in this section were developed based on applicable international standards and guidelines. All participants in the online survey were required to check a box indicating their informed consent regarding the study's purpose and data usage before responding.

4.1. Questionnaire Design

A questionnaire was designed to examine passengers' perceptions of regional culture-themed passenger interfaces and their usage intentions.

Before completing the measurement items, respondents were shown examples of interfaces from Wuxi Metro Line 2 and Wuhan Metro Line 8 incorporating regional cultural elements, alongside examples from Fuzhou Metro Line 5 and Beijing Subway Line 1 without such elements. These images illustrated the interface category addressed by the questionnaire. Respondents provided an overall evaluation of regional culture-themed passenger interfaces rather than separate ratings of each example.

The questionnaire consisted of two parts. The first part collected respondents' demographic information, including gender, age, education level, commuting frequency, and experience living in their city. Respondents were also asked to report their confidence in understanding regional culture. This information helps assess whether the scale data vary across different demographic groups. The second part comprised measurement items assessed using a five-point Likert scale, where 1 to 5 corresponded to "strongly disagree," "disagree," "neutral," "agree," and "strongly agree," respectively. The questionnaire included 27 observed variables to examine the relationships among seven latent variables: attitude (AT), subjective norms (SN), perceived behavioral control (PBC), behavioral intention (BI), perceived cultural identity (PCI), regional cultural presentation (RCP), and trust (TR). The measurement items for each latent variable were adapted from previous studies. The observed items for AT, PBC, and BI were adapted from the classic scales of Ajzen [56] and Taylor and Todd [81]; SN items were derived from Liu and Zhao [77]; PCI and RCP items were based on Zong et al. [82]; and TR items were adapted from Raj [83]. These scales have been widely recognized and validated in relevant fields, demonstrating strong reliability and validity. In this study, the established scales were appropriately modified to better align with the context and objectives of the current research.

4.2. Data Collection

The survey was conducted from 10 February to 5 May 2026, using the online questionnaire platform Tencent Questionnaire (https://wj.qq.com, accessed on 6 February 2026) for data collection. To ensure data validity, responses completed in less than 60 s were excluded, and each IP address was allowed to submit only once. All participants took part anonymously and voluntarily, and respondents received a reward of 5 RMB upon submission.

Before the formal survey, a pilot test was conducted with 100 respondents to examine the reliability and comprehensiveness of the questions. Based on the feedback, the questionnaire was adjusted and revised to ensure the clarity of items and options. The formal survey was then carried out, strictly following the screening process to exclude responses with logical inconsistencies. A total of 830 questionnaires were distributed, resulting in 712 valid responses. The full questionnaire is provided in Appendix A.

4.3. Analysis Method

Before estimating the structural model, descriptive statistics and univariate normality tests were conducted for the 27 measurement items using SPSS Statistics 27 (see Appendix B for detailed results). The Shapiro–Wilk tests indicated that all items deviated significantly from normality ($W = 0.801$–0.866, all p-values < 0.001). The distributions were generally negatively skewed, indicating a tendency toward higher ratings. These distributional characteristics provided additional support for using partial least squares structural equation modeling (PLS-SEM), which does not require multivariate normality of the observed data. PLS-SEM estimates complex path models involving latent constructs through an iterative procedure that estimates construct scores and model parameters, with an emphasis on explaining variance in endogenous constructs and supporting prediction. The model was estimated using SmartPLS 4. The statistical significance of structural path coefficients and indirect effects was assessed using 10,000 bootstrap resamples, with bias-corrected and accelerated (BCa) 95% confidence intervals and two-tailed tests at the 5% significance level.

Three competing structural specifications were estimated to examine the sensitivity of the findings to alternative model assumptions. M1 replaced the TR→AT path with AT→TR. M2 retained the original path direction and added a direct RCP→BI path. M3 combined both modifications. All other structural paths were retained. The analyses examined changes in the direction, magnitude, and statistical significance of the path estimates. Detailed results are provided in Supplementary Material S2. Separately, a covariate-adjusted model was estimated by adding age, travel frequency, and self-reported understanding of regional culture as predictors of BI to the original model. The same sample, measurement specification, and estimation settings were used for the supplementary analyses. The covariate-adjusted results are provided in Supplementary Material S2.

5. Results

5.1. Descriptive Statistical Analysis

Among the respondents, 45.2% were male and 54.8% were female. The majority of participants were aged between 19 and 30. Most held a bachelor's or associate degree (68.3%), and 62.6% reported taking the subway at least once a week. In addition, 89.6% had long-term living experience in the local area, and 78.6% expressed a certain level of confidence in their understanding of regional culture. Descriptive statistics of the respondents are shown in Table 1.

Table 1. Overview of respondents.

Characteristics	Items	Frequency	Proportion (%)
Gender	Male	322	45.2
	Female	390	54.8
Age	18 or younger	68	9.6
	19–30	496	69.7
	31–40	76	10.7
	41–50	40	5.6
	51 and above	32	4.5
Education level	Junior high school and below	64	9
	High school or technical secondary school	102	14.3
	Bachelor's degree or associate degree	486	68.3
	Master's degree or above	60	8.4

Table 1. *Cont.*

Characteristics	Items	Frequency	Proportion (%)
Frequency of riding	Several times a week (daily commuting)	218	30.6
	1–2 times per week (e.g., weekend outings)	228	32
	A few times a month	266	37.4
Life experiences in the city	native-born	414	58.1
	Long-term settlement of outsiders	224	31.5
	Temporary business trip	74	10.4
The degree of understanding of regional culture	I do not really understand what 'regional culture' is	152	21.3
	I have a basic understanding of what 'regional culture' is	438	61.5
	I have a deep understanding of what 'regional culture' is	122	17.1

5.2. Measurement Model Evaluation

To verify the reliability and validity of the measurement model, this study strictly followed the testing procedures of PLS-SEM. Following the recommendations of Hair et al. [84], Cronbach's alpha and composite reliability (CR) were employed to evaluate the internal consistency of the latent variables. Cronbach's alpha reflects the strength of the correlations among observed variables and is generally expected to exceed the threshold value of 0.7 [85]. As shown in Table 2, all α coefficients of the latent variables in this study were higher than this criterion (0.794–0.871), indicating a high degree of homogeneity among the measurement items for each latent variable. The composite reliability (CR) values ranged from 0.879 to 0.912, exceeding the recommended threshold of CR > 0.7 [84], indicating internal consistency reliability of the measurement model. In addition, the convergent validity of the model was assessed using the average variance extracted (AVE), which reflects the extent to which a latent variable explains the variance of its observed indicators. According to Fornell and Larcker [86], an AVE value greater than 0.5 is required. In this study, the AVE values for all latent constructs ranged between 0.616 and 0.743, all above the stricter threshold of 0.6, demonstrating that each construct effectively explains more than 60% of the variance in its measurement items. Finally, the factor outer loadings were examined to assess the linear relationship between each observed variable and its corresponding latent construct. All outer loadings ranged from 0.738 to 0.878, exceeding the threshold of 0.708 suggested by Hair et al. [84], indicating strong linear associations between the observed variables and their latent constructs.

Discriminant validity was assessed using cross-loadings, the Fornell–Larcker criterion, and bootstrapped HTMT confidence intervals. All indicators loaded more strongly on their assigned constructs than on other constructs, and the square root of each construct's AVE exceeded its correlations with other constructs (Tables 3 and 4). HTMT values ranged from 0.631 to 0.851 and were below 0.90. However, TR–PBC (0.851) slightly exceeded the conservative threshold of 0.85, while SN–PBC (0.839) and SN–AT (0.834) approached it. All two-sided 90% bootstrap confidence intervals excluded 1, but the upper bound was 0.903 for TR–PBC and rounded to 0.900 for SN–AT (Table 5). Thus, cross-loadings and the Fornell–Larcker criterion provided supporting evidence, whereas HTMT indicated borderline discriminant validity for selected construct pairs, particularly TR and PBC. The corresponding structural relationships should be interpreted in light of this measurement limitation. As a supplementary indicator-level diagnostic, outer VIF values ranged from 1.456 to 2.425, below the reference threshold of 3.0. Complete results are provided in Supplementary Material S3.

Table 2. Measurement model assessment.

Constructs	Items (Code)	Outer Loadings	CA	CR	AVE
Attitude	AT1	0.856	0.817	0.879	0.646
	AT2	0.805			
	AT3	0.771			
	AT4	0.779			
Behavioral Intention	BI1	0.838	0.826	0.897	0.743
	BI2	0.870			
	BI3	0.878			
Perceived Behavioral Control	PBC1	0.837	0.794	0.879	0.707
	PBC2	0.867			
	PBC3	0.818			
Perceived Cultural Identity	PCI1	0.851	0.871	0.912	0.722
	PCI2	0.872			
	PCI3	0.850			
	PCI4	0.824			
Regional Cultural Presentation	RCP1	0.738	0.854	0.895	0.632
	RCP2	0.837			
	RCP3	0.842			
	RCP4	0.776			
	RCP5	0.776			
Subjective Norm	SN1	0.843	0.812	0.889	0.727
	SN2	0.855			
	SN3	0.859			
Trust	TR1	0.770	0.843	0.889	0.616
	TR2	0.740			
	TR3	0.799			
	TR4	0.801			
	TR5	0.811			

Note: CA: Cronbach's alpha; CR: composite reliability; AVE: average variance extracted.

Table 3. Cross-loading results.

Items (Code)	SN	TR	RCP	AT	PCI	PBC	BI
AT1	0.543	0.546	0.541	0.856	0.552	0.586	0.526
AT2	0.532	0.495	0.520	0.805	0.484	0.519	0.517
AT3	0.518	0.489	0.385	0.771	0.484	0.473	0.427
AT4	0.588	0.467	0.519	0.779	0.426	0.530	0.535
BI1	0.566	0.497	0.520	0.537	0.499	0.538	0.838
BI2	0.513	0.616	0.467	0.546	0.480	0.592	0.870
BI3	0.564	0.562	0.529	0.537	0.543	0.523	0.878
PBC1	0.567	0.541	0.479	0.553	0.440	0.837	0.492
PBC2	0.548	0.600	0.472	0.518	0.507	0.867	0.543
PBC3	0.587	0.618	0.567	0.584	0.593	0.818	0.571
PCI1	0.531	0.573	0.518	0.495	0.851	0.556	0.534
PCI2	0.490	0.588	0.513	0.488	0.872	0.496	0.526
PCI3	0.536	0.578	0.598	0.583	0.850	0.557	0.460
PCI4	0.495	0.534	0.623	0.489	0.824	0.481	0.478
RCP1	0.447	0.462	0.738	0.482	0.549	0.486	0.540
RCP2	0.514	0.452	0.837	0.522	0.578	0.503	0.520
RCP3	0.493	0.459	0.842	0.571	0.546	0.484	0.459
RCP4	0.501	0.387	0.776	0.411	0.510	0.489	0.427
RCP5	0.452	0.369	0.776	0.448	0.437	0.440	0.364

Table 3. *Cont.*

Items (Code)	SN	TR	RCP	AT	PCI	PBC	BI
SN1	0.843	0.488	0.482	0.570	0.507	0.545	0.533
SN2	0.855	0.566	0.546	0.605	0.512	0.612	0.559
SN3	0.859	0.552	0.519	0.560	0.527	0.571	0.530
TR1	0.496	0.770	0.405	0.510	0.451	0.549	0.532
TR2	0.508	0.740	0.367	0.449	0.512	0.503	0.520
TR3	0.441	0.799	0.409	0.492	0.510	0.535	0.467
TR4	0.464	0.801	0.462	0.456	0.551	0.581	0.480
TR5	0.550	0.811	0.466	0.528	0.594	0.574	0.543

Table 4. Discriminant validity (Fornell-Larcker criterion).

	SN	TR	RCP	AT	PCI	PBC	BI
SN	0.852	—	—	—	—	—	—
TR	0.629	0.785	—	—	—	—	—
RCP	0.606	0.539	0.795	—	—	—	—
AT	0.679	0.622	0.616	0.803	—	—	—
PCI	0.605	0.669	0.663	0.606	0.849	—	—
PBC	0.677	0.700	0.606	0.658	0.616	0.841	—
BI	0.635	0.649	0.586	0.627	0.588	0.640	0.862

Table 5. HTMT Values and 90% bootstrap confidence intervals.

	SN	TR	RCP	AT	PCI	PBC	BI
SN	—	—	—	—	—	—	—
TR	0.756 [0.675, 0.820]	—	—	—	—	—	—
RCP	0.727 [0.640, 0.800]	0.631 [0.547, 0.702]	—	—	—	—	—
AT	0.834 [0.759, 0.900]	0.748 [0.676, 0.809]	0.729 [0.652, 0.789]	—	—	—	—
PCI	0.718 [0.639, 0.782]	0.778 [0.715, 0.830]	0.765 [0.700, 0.820]	0.717 [0.647, 0.776]	—	—	—
PBC	0.839 [0.765, 0.899]	0.851 [0.789, 0.903]	0.730 [0.639, 0.806]	0.812 [0.742, 0.874]	0.733 [0.655, 0.799]	—	—
BI	0.775 [0.713, 0.830]	0.775 [0.719, 0.821]	0.693 [0.623, 0.755]	0.760 [0.697, 0.815]	0.694 [0.617, 0.763]	0.785 [0.731, 0.835]	—

5.3. Common Method Bias Assessment

To further assess common method bias, a full collinearity assessment was conducted to supplement Harman's single-factor test. The latter showed that the first factor accounted for 45.9% of the variance. Given the limitations of this test in diagnosing common method bias, full collinearity variance inflation factors (VIFs) were additionally calculated for the seven constructs using latent variable scores from the PLS-SEM model. As shown in Table 6, the full collinearity VIFs ranged from 2.242 to 2.700, below the reference threshold of 3.3. These results indicate that full collinearity did not exceed this threshold in the present sample (Table 6).

Table 6. Full collinearity assessment results.

Construct	Auxiliary Regression R^2	Full Collinearity VIF
SN	0.602	2.512
TR	0.623	2.652
RCP	0.554	2.242
AT	0.592	2.451
PCI	0.593	2.46
PBC	0.63	2.7
BI	0.561	2.278

5.4. Path Analysis Results

The endogenous constructs had R^2 values ranging from 0.367 to 0.552. The model explained 55.2% of the variance in BI, with an adjusted R^2 of 0.546. Effect sizes ranged from 0.012 to 0.785, with the largest values observed for RCP→PCI ($f^2 = 0.785$) and RCP→PBC ($f^2 = 0.579$). PCI→TR ($f^2 = 0.323$) and TR→SN ($f^2 = 0.168$) showed medium effect sizes, whereas PCI→BI had an effect size below 0.02 ($f^2 = 0.012$). Inner VIF values ranged from 1.000 to 2.588, below the reference threshold of 3.0. Detailed results are provided in Supplementary Material S3.

The modeling results for all research hypotheses are shown in Figure 3. AT, SN, PBC, and TR all have significant effects on BI, with path coefficients (β) of 0.180 ($p = 0.002$), 0.191 ($p = 0.001$), 0.164 ($p = 0.013$), and 0.229 ($p < 0.001$), respectively. Therefore, hypotheses H1, H2, H3, and H13 are supported. RCP, PCI, and TR also have significant effects on AT, with path coefficients $\beta = 0.326$ ($p < 0.001$), 0.165 ($p = 0.009$), and 0.336 ($p < 0.001$), respectively. Therefore, hypotheses H10, H4, and H12 are supported. The path coefficients from PCI and TR to SN are $\beta = 0.333$ ($p < 0.001$) and 0.406 ($p < 0.001$), respectively, indicating that H5 and H14 are also supported. The path coefficients from RCP and PCI to TR are $\beta = 0.170$ ($p = 0.001$) and $\beta = 0.556$ ($p < 0.001$), respectively, supporting H9 and H7. The path coefficient from RCP to PCI is $\beta = 0.663$ ($p < 0.001$); thus, H8 is supported. RCP also has a significant effect on PBC ($\beta = 0.606$, $p < 0.001$), confirming H11. However, the effect of perceived cultural identity on behavioral intention is not significant ($\beta = 0.109$, $p = 0.084$), indicating that H6 is not supported.

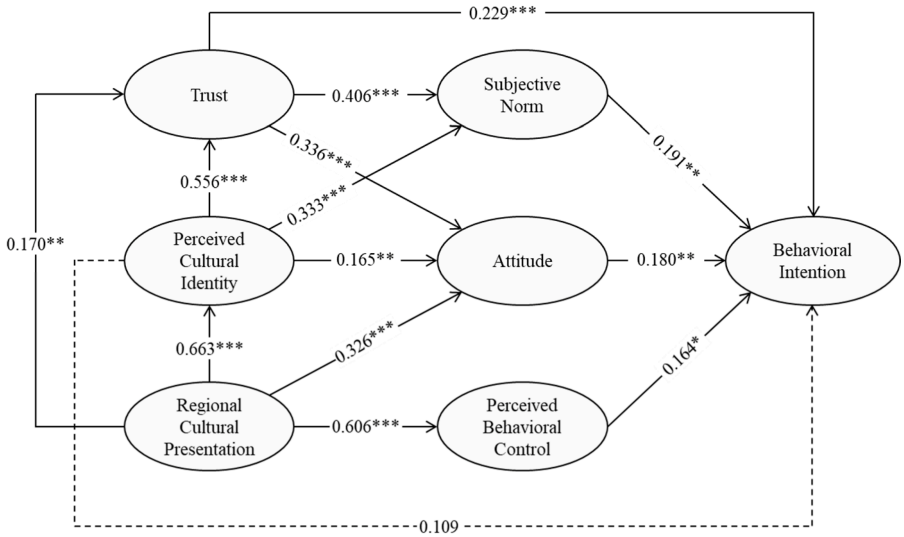


Figure 3. Structural equation model with standardized coefficients. Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Nonsignificant paths are presented by a dashed line.

As a supplementary check, age, travel frequency, and understanding of regional culture were included as covariates predicting BI. After adjustment, AT, SN, PBC, and TR remained positively and significantly associated with BI ($\beta = 0.174$, 0.189, 0.159, and 0.232, respectively; all p-values < 0.05), whereas the direct PCI→BI association remained nonsignificant ($\beta = 0.112$, $p = 0.075$). These results indicate that the direction and significance pattern of the principal paths to BI were maintained after covariate adjustment. Detailed results are provided in Supplementary Material S2 and Figure S4. PLSpredict yielded positive Q^2 prediction values for all 22 endogenous indicators, ranging from 0.130 to 0.378. This indicates a lower squared prediction error than the indicator-average benchmark for these indicators. Detailed prediction results are provided in Supplementary Material S3.

5.5. Mediation Effect Testing

Bootstrap analysis was used to examine the total and specific indirect effects [87]. In the original model, the total effect of regional cultural presentation (RCP) on behavioral intention (BI) was positive and statistically significant ($\beta = 0.490$, $t = 15.130$, $p < 0.001$, 95% bootstrap CI [0.427, 0.553]). Because the original model did not specify a direct RCP→BI path, this total effect represents the sum of all model-implied indirect effects linking RCP to BI. However, the specific indirect effect through perceived cultural identity (RCP→PCI →BI) was not statistically significant ($\beta = 0.072$, $t = 1.698$, $p = 0.090$, 95% bootstrap CI [−0.007, 0.162]). Thus, H15 was not supported. This finding indicates that the specific pathway through PCI directly to BI was not supported, while the combined indirect association between RCP and BI across the specified pathways was significant.

As shown in Table 7, the specific indirect effect of trust (TR) on BI through subjective norm (SN) was statistically significant ($\beta = 0.078$, $p = 0.003$), supporting H16. The direct effect of TR on BI was also positive and significant ($\beta = 0.229$), a pattern consistent with complementary mediation. The total indirect effect and total effect of TR on BI were 0.138 and 0.368, respectively. The specific indirect effect of PCI on BI through TR was also statistically significant ($\beta = 0.128$, $p < 0.001$), supporting H17. In contrast, the direct effect of PCI on BI was not statistically significant ($\beta = 0.109$, $p = 0.084$). The total indirect effect and total effect of PCI on BI were 0.298 and 0.407, respectively. These findings support the mediating role of trust in the relationship between perceived cultural identity and interface-use intention.

Table 7. Mediated effects test.

Path	Total Effect	Direct Effect	Specific Indirect Effect	Total Indirect Effect	Result
H16: TR→SN→BI	0.368	0.229	0.078	0.138	Supported
H17: PCI→TR→BI	0.407	0.109	0.128	0.298	Supported

5.6. Competing Model Analyses

Table 8 summarizes selected path estimates across the three competing models. In M1, AT was positively associated with TR ($\beta = 0.327$, $p < 0.001$). In M2, the added RCP→BI path was positive and significant ($\beta = 0.143$, $p = 0.007$), and this association remained significant in M3 ($\beta = 0.144$, $p = 0.007$). Across all three specifications, PCI→TR and TR→BI remained positive and significant, whereas PCI→BI remained nonsignificant. However, RCP→TR was significant in M2 but not in M1 or M3, indicating sensitivity to the specification of the attitude–trust relationship. These results identify both consistent associations

and specification-dependent relationships. Complete model diagrams are presented in Figures S1–S3.

Table 8. Selected path estimates across competing models.

Structural Path	M1: β (p)	M2: β (p)	M3: β (p)
AT→TR	0.327 (<0.001)	—	0.327 (<0.001)
TR→AT	—	0.336 (<0.001)	—
RCP→BI	—	0.143 (0.007)	0.144 (0.007)
RCP→TR	0.045 (0.403)	0.170 (0.001)	0.046 (0.399)
PCI→TR	0.441 (<0.001)	0.556 (<0.001)	0.441 (<0.001)
TR→BI	0.230 (<0.001)	0.238 (<0.001)	0.239 (<0.001)
PCI→BI	0.108 (0.084)	0.055 (0.405)	0.054 (0.409)

Note: Values are standardized path coefficients, with p-values in parentheses. M1 replaces TR→AT with AT→TR; M2 adds RCP→BI to the original model; M3 combines both modifications. A dash indicates that the path was not specified.

5.7. Multigroup Analysis

To further examine heterogeneity in structural relationships, supplementary multigroup analyses were conducted by gender, age, educational attainment, residential experience, travel frequency, and self-reported understanding of regional culture. MICOM assessments identified compositional non-invariance for some constructs in specific group comparisons; consequently, the interpretation of group differences was qualified by the corresponding measurement invariance results. Detailed MICOM and multigroup results are provided in Supplementary Material S1.

Among the comparisons reported, no statistically significant gender differences in structural paths were detected. At the nominal 0.05 significance level, selected paths differed across the other grouping variables. For example, the TR→BI path coefficient was higher among respondents aged 41–50 than among those aged 19–30 ($\beta = 0.762$ versus 0.130, permutation $p = 0.015$). The TR→AT coefficient was higher among residents who had moved to the city and settled long-term than among locally born residents ($\beta = 0.493$ versus 0.299, $p = 0.042$). In contrast, no significant group differences were detected in the RCP→PBC or RCP→TR paths among the reported comparisons. These supplementary findings indicate that the strength of selected relationships varies across respondent groups and help specify the scope of the pooled-sample findings.

6. Discussion

Given the large-scale and short-term integration of regional cultural design into metro PIs across different cities, there is still a lack of usability studies from the user perspective. This study proposes an extended model based on the theory of planned behavior (TPB) to fill this research gap. The main objective is to investigate how regional cultural elements in metro PIs affect passengers' continuance intention, with a particular focus on the roles of cultural identity and trust in this process. The findings support the core propositions of TPB, showing that passengers' attitudes toward RCPIs (AT), perceived social pressure (SN), and perceived behavioral control (PBC) all significantly influence usage intention, consistent with Ajzen's [56] classical conclusions. When passengers hold a positive attitude toward the incorporation of regional cultural elements in PI design, or when the social environment supports such designs, and they recognize that RCPIs make searching for station names and obtaining and understanding information more convenient, they are more likely to accept and be willing to use RCPIs.

Among the direct paths to usage intention, trust had the numerically largest standardized coefficient ($\beta = 0.229$), followed by subjective norm ($\beta = 0.191$), attitude ($\beta = 0.180$),

and perceived behavioral control ($\beta = 0.164$). In public transport environments, passengers' willingness to use an information system largely depends on their perception of its reliability and credibility [88]. If the system provides accurate, authoritative, and culturally congruent information, passengers are more likely to develop reliance and actively use it.

Additionally, the results indicate that passengers' perceived cultural identity toward RCPIs does not directly influence their usage intention; rather, it operates indirectly through the mediating pathway of trust. First, the incorporation of regional cultural design enhances passengers' perceived behavioral control, as more intuitive and easily understandable representations make information acquisition and usage feel more convenient and manageable. This "capability pathway" indicates that cultural elements not only hold aesthetic value but also enhance the usability of PIDS through interaction optimization [31]. Second, the presentation of regional culture can evoke passengers' affective trust, and the results suggest that trust can be further strengthened through perceived cultural identity, which in turn indirectly influences subjective norms and attitudes, ultimately promoting usage intention. This "identity-trust" pathway underscores the role of cultural design in fostering group belonging and social consensus [89], while also highlighting the pivotal position of trust between values and behavior. However, this interpretation requires caution: although some trust items link cultural elements to credibility or perceived accuracy, these associations do not establish that cultural design improves the factual accuracy of operational information.

The supplementary analyses further clarify these relationships by distinguishing associations that remain consistent across specifications from those that depend on model structure. PCI→TR and TR→BI remained positive and significant across specifications, supporting their relevance to passengers' evaluations and usage intentions. The significant RCP→BI path in M2 and M3 indicates that the association between cultural presentation and usage intention is not fully accounted for by the indirect routes specified in the original model. At the same time, the sensitivity of RCP→TR to the attitude–trust specification suggests that the direct association between cultural presentation and trust should be interpreted in relation to the broader model structure. The alternative models do not establish the temporal ordering of attitude and trust. Separately, adjustment for age, travel frequency, and cultural understanding preserved the principal direct associations with BI, providing additional evidence of their stability under the specified covariate adjustment.

The lack of support for H15 highlights a distinction between cultural identification and interface-use intention. Although regional cultural presentation was positively associated with perceived cultural identity, its specific indirect effect on behavioral intention through perceived cultural identity was not statistically significant. One possible explanation is that passengers may recognize and appreciate the cultural meaning of an interface while forming usage intentions primarily around practical tasks, such as locating and understanding travel information. Cultural identification may thus support appreciation of the design without necessarily translating into an intention to use it. Meanwhile, the significant indirect effect of perceived cultural identity on behavioral intention through trust in H17 suggests that trust-related evaluations may help explain this relationship. Together, these findings provide a basis for distinguishing passengers' identification with cultural content from their willingness to use the interface and for further examining how these evaluations are connected.

From a theoretical perspective, this study builds on extended TPB research linking trust and cultural identity to behavioral intention. Cheung and To [73] incorporated trust into an extended TPB model of mobile in-app advertising, while Ibrahim et al. [90] examined trust in the acceptance of bus-based park-and-ride facilities. The positive relationship between trust and attitude in the present study is consistent with these studies. In cultural heritage tourism, Zhang et al. [91] incorporated cultural identity into TPB and reported

a significant direct relationship with consumption intention. In the present sample, the direct relationship between perceived cultural identity and interface-use intention was not statistically significant, whereas the indirect effect through trust was significant. This pattern adds evidence of a trust-related pathway linking cultural identity to interface-use intention. By jointly examining regional cultural presentation, perceived cultural identity, and trust alongside the core TPB constructs, this study connects these research strands in the context of regional culture-themed metro passenger interfaces.

The supplementary multigroup analysis further contextualizes these findings by identifying variation in the strength of selected relationships across passenger groups. These differences suggest that the practical application of the pooled-sample findings should take passenger characteristics into account, particularly when prioritizing design features for different user groups.

From a practical perspective, the findings suggest several priorities for designing RCPIs. Given the positive association between perceived behavioral control and usage intention, designers should prioritize easy access to station names, travel direction, and transfer information. These elements should occupy stable, prominent positions and retain standardized text and symbols; regional cultural motifs can serve as supplementary cues without replacing essential guidance. The positive association between trust and usage intention also supports attention to information credibility. Practical measures include clearly distinguishing decorative content from operational messages, indicating the update status of dynamic information, and checking consistency across displays. Cultural familiarity should be evaluated separately from factual information accuracy. Although regional cultural presentation was positively associated with perceived cultural identity, the unsupported H15 suggests that cultural appeal alone is an insufficient basis for judging likely interface acceptance. Cultural motifs should therefore be assessed for both local recognizability and compatibility with information-search tasks. These recommendations can be evaluated through comparisons of prototypes with different levels of cultural decoration, using station-identification and transfer-information tasks. Relevant measures include completion time, error rate, perceived mental effort, and trust ratings. Such testing would help determine which design choices preserve cultural expression while supporting efficient information access.

This study has several limitations. First, online recruitment may have favored responses from younger participants, resulting in a sample concentrated in the 19–30 age group. This age distribution may affect the interpretation of the model, and future research could specifically examine its applicability to other age groups. Second, the supplementary competing-model and multigroup analyses help assess sensitivity to model specifications and differences across groups, but do not eliminate these limitations. Regarding measurement, some trust items may blur the distinction between credibility and system reliability, leading respondents to combine cultural aesthetic evaluations with judgments of information reliability. Future research could distinguish these concepts more clearly. Furthermore, this study primarily assessed the anticipated benefits of cultural presentation through users' subjective perceptions, without experimentally measuring their performance in accessing and understanding information. Future controlled experiments could incorporate objective performance measures, such as information retrieval accuracy, alongside measures of cognitive load to further examine the relationship between subjective evaluations and task performance and identify the conditions under which cultural elements are beneficial.

7. Conclusions

With the accelerating digital transformation in public transportation, passengers are confronted with increasingly overwhelming information and interfaces. It is therefore

important to assess whether these interface changes meet passengers' needs and contribute to a positive travel experience. In China, metro system PIDS are experiencing rapid and large-scale integration of regional cultural elements. This study developed an extended TPB model to investigate how regional cultural presentations within PI influence passengers' usage intentions through psychological mechanisms such as cultural identification and trust. The results support several hypothesized associations within the extended TPB framework, providing context-specific evidence on the relationships among regional cultural presentation, perceived cultural identity, trust, and intention to use RCPIs. Overall, the results contribute to cultural dissemination and service optimization in public transport settings.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/systems14111421/s1. **Supplementary Material S1. Measurement Invariance and Multigroup Analysis.** Table S1. MICOM Results Indicating Non-invariance or Inequality. Table S2. Results of Multigroup Analysis (MGA). **Supplementary Material S2. Competing Model and Covariate-Adjusted Analyses.** Figure S1. Competing model M1: Attitude as an antecedent of trust. Figure S2. Competing model M2: Addition of a direct RCP→BI path. Figure S3. Competing model M3: Reversed attitude–trust direction and an additional direct RCP→BI path. Figure S4. Structural model adjusted for age, travel frequency, and understanding of regional culture. **Supplementary Material S3. Additional Model Assessment Results.** Table S3.1. Structural model assessment. Table S3.2. Outer model collinearity statistics. Table S3.3. Q^2 predict values for endogenous indicators.

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Data Availability Statement: The data used to support the findings of this study are available from the corresponding author upon request.

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

Appendix A. Survey Questionnaire (English Translation)

Survey on Regional Cultural Design in Metro Passenger Information Interfaces

Study title: Cultural Identity, Trust, and Usage Intention in Regional Culture-Themed Metro Passenger Interfaces: An Extended TPB Study

Research team: Industrial Design Research Team, School of Art and Design, Xihua University.

This questionnaire asks for your views on incorporating regional cultural design elements into passenger information interfaces displayed on electronic screens in metro trains. It contains 33 questions and takes approximately 10–15 min to complete.

Your responses will be used for academic research. Participation is voluntary, and you may stop before submitting your responses. Please review the following information before deciding whether to participate.

For details of the ethical considerations and privacy protections for this study, please see our Research Ethics and Privacy Information.

Before participating, please read our Participant Information and Informed Consent Form.

Please review the examples below before completing the questionnaire.



Figure A1. Left: Interfaces incorporating regional cultural elements. **Top left**: Wuxi Metro Line 2, featuring decorative window elements from Suzhou gardens. **Bottom left**: Wuhan Metro Line 8, featuring bronze chime bells associated with Chu culture. **Right**: Interfaces without regional cultural elements. **Top right**: Fuzhou Metro Line 5. **Bottom right**: Beijing Subway Line 1.The Chinese text on the metro displays identifies stations and provides travel information, such as the next stop, destination, and side on which the doors open.

Part 1 Basic Information

Please select one option for each question.

1. Gender

☐ Male ☐ Female

2. Age

☐ 18 or younger ☐ 19–30 ☐ 31–40 ☐ 41–50 ☐ 51–60 ☐ Over 60

If you are under 18, please ask your parent or legal guardian to review and electronically sign our Parent or Legal Guardian Informed Consent Form before you continue.

Participants under 18 may proceed only after their parent or legal guardian has completed the handwritten electronic signature. They should also be willing to participate themselves.

3. Education level

☐ Junior high school and below ☐ High school or technical secondary school

☐ Bachelor's degree or associate degree ☐ Master's degree or above

4. Frequency of riding

☐ Several times a week (daily commuting)

☐ 1–2 times per week (e.g., weekend outings)

☐ A few times a month

5. Experience of living in the city

☐ Born and raised locally ☐ Moved to the city and settled there long term

☐ Visiting temporarily for business or travel

6. Confidence in understanding regional culture

☐ I do not really understand what 'regional culture' is

☐ I have a basic understanding of what 'regional culture' is

☐ I have a deep understanding of what 'regional culture' is

Part 2 Usage Intention Survey

For each statement, select one response.

1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

Statement	Response
AT1: I believe that incorporating regional cultural design into passenger information interfaces is a good idea.	☐1 ☐2 ☐3 ☐4 ☐5
AT2: I believe that incorporating regional cultural design into passenger information interfaces can enhance the travel experience.	☐1 ☐2 ☐3 ☐4 ☐5
AT3: I am willing to use passenger information interfaces that incorporate regional cultural design.	☐1 ☐2 ☐3 ☐4 ☐5
AT4: I hold a positive attitude toward the inclusion of regional cultural elements in passenger information interface design.	☐1 ☐2 ☐3 ☐4 ☐5
SN1: My family members and friends generally approve of incorporating regional cultural elements into interface design.	☐1 ☐2 ☐3 ☐4 ☐5
SN2: I find that most people on social media or in public discussions hold a positive attitude toward wayfinding interfaces that incorporate regional cultural elements.	☐1 ☐2 ☐3 ☐4 ☐5
SN3: I believe that the government, metro operators, or manufacturers are encouraging the incorporation of regional cultural design into wayfinding interfaces.	☐1 ☐2 ☐3 ☐4 ☐5
PBC1: I believe that interfaces incorporating regional cultural design are easier to understand and use.	☐1 ☐2 ☐3 ☐4 ☐5
PBC2: The regional cultural elements in the interface do not interfere with my access to travel information.	☐1 ☐2 ☐3 ☐4 ☐5
PBC3: If regional cultural elements are incorporated into the existing interface, I think I can adapt quickly.	☐1 ☐2 ☐3 ☐4 ☐5
BI1: I support the continued use of designs that incorporate regional cultural characteristics in the interface.	☐1 ☐2 ☐3 ☐4 ☐5
BI2: Interfaces with regional cultural characteristics have increased my browsing frequency.	☐1 ☐2 ☐3 ☐4 ☐5
BI3: I hope to see different lines use interfaces with regional cultural characteristics.	☐1 ☐2 ☐3 ☐4 ☐5
TR1: The regional cultural elements in the interface (such as dialect announcements) make it trustworthy.	☐1 ☐2 ☐3 ☐4 ☐5
TR2: When social information conflicts with the information on the screen, I do not doubt the authority of the interface information.	☐1 ☐2 ☐3 ☐4 ☐5
TR3: I believe that the inclusion of regional cultural elements makes the presentation of location information more accurate.	☐1 ☐2 ☐3 ☐4 ☐5
TR4: I believe that the authorities use this design to make it easier for passengers to understand the interface information.	☐1 ☐2 ☐3 ☐4 ☐5
TR5: Regional cultural designs that align with my cultural background make me feel at ease during my journey.	☐1 ☐2 ☐3 ☐4 ☐5
PCI1: Integrating regional cultural design into the interface makes me feel a sense of closeness and familiarity.	☐1 ☐2 ☐3 ☐4 ☐5
PCI2: The interface design featuring regional cultural elements enhances my interest in and sense of belonging to local culture.	☐1 ☐2 ☐3 ☐4 ☐5
PCI3: I believe that the regional cultural elements in the interface reflect the depth of local culture rather than mere superficial decoration.	☐1 ☐2 ☐3 ☐4 ☐5
PCI4: Interfaces incorporating regional cultural design make me more aware of the unique characteristics of this line.	☐1 ☐2 ☐3 ☐4 ☐5
RCP1: The regional cultural elements in the interface are distinctive and can differentiate it from designs of other cities or lines.	☐1 ☐2 ☐3 ☐4 ☐5
RCP2: The landmark buildings in the interface better reflect the characteristics of regional culture.	☐1 ☐2 ☐3 ☐4 ☐5
RCP3: The natural landscapes in the interface better reflect the characteristics of regional culture.	☐1 ☐2 ☐3 ☐4 ☐5
RCP4: The intangible cultural heritage elements in the interface better reflect the characteristics of regional culture.	☐1 ☐2 ☐3 ☐4 ☐5
RCP5: The depiction of local fauna and flora in the interface better reflects regional cultural characteristics.	☐1 ☐2 ☐3 ☐4 ☐5

This is the end of the questionnaire. Thank you for your participation!

Appendix B. Item Descriptive Statistics and Normality Tests

Table A1. Descriptive statistics and Shapiro–Wilk normality tests for the measurement items (N = 712).

Item	Mean	SD	Skew-ness	Excess Kurtosis	Shapiro–Wilk W	*p*-Value
AT1	3.896	0.892	−0.771	0.349	0.839	<0.001
AT2	3.927	0.881	−0.747	0.487	0.846	<0.001
AT3	4.059	0.855	−1.143	2.105	0.801	<0.001
AT4	4.096	0.882	−0.828	0.385	0.827	<0.001
SN1	3.969	0.873	−0.832	0.713	0.836	<0.001
SN2	4.037	0.856	−0.879	0.914	0.828	<0.001
SN3	4.107	0.865	−1.018	1.141	0.811	<0.001
PBC1	3.975	0.892	−0.547	−0.358	0.852	<0.001
PBC2	3.983	0.992	−0.954	0.721	0.832	<0.001
PBC3	3.958	0.919	−0.832	0.592	0.843	<0.001
BI1	4.011	0.845	−0.610	−0.035	0.843	<0.001
BI2	4.031	0.953	−0.884	0.357	0.832	<0.001
BI3	4.006	0.909	−0.731	0.216	0.844	<0.001
TR1	3.862	0.934	−0.533	−0.090	0.866	<0.001
TR2	3.888	0.902	−0.629	0.248	0.859	<0.001
TR3	4.008	0.929	−0.797	0.330	0.841	<0.001
TR4	3.972	0.997	−0.813	0.140	0.843	<0.001
TR5	4.065	0.871	−0.946	1.061	0.822	<0.001
PCI1	4.006	0.949	−0.764	−0.026	0.840	<0.001
PCI2	4.084	0.918	−0.802	0.119	0.828	<0.001
PCI3	4.154	0.879	−1.004	0.797	0.807	<0.001
PCI4	4.084	0.867	−0.682	−0.127	0.833	<0.001
RCP1	4.126	0.911	−1.012	0.745	0.811	<0.001
RCP2	4.051	0.953	−0.902	0.542	0.827	<0.001
RCP3	4.048	0.931	−0.829	0.347	0.833	<0.001
RCP4	4.034	0.858	−0.628	0.273	0.833	<0.001
RCP5	4.093	0.919	−0.862	0.252	0.824	<0.001

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