

Research on the Cross-cultural Adaptation of the Signage System in Macao's Historical Districts to Multiple Groups

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Abstract

The historical district wayfinding system in Macau, as a carrier of the integration of Chinese and Portuguese cultures, faces perceptual differences and functional demand conflicts among three groups: residents, tourists and students. The study, based on 231 mixed questionnaires (including open-ended questions) and field research, focused on the front of the Legislative Assembly (the core tourist area), the Red Market and the Sa Lai Tou district (the residential area), quantitatively analyzed the visual sensitivity, emotional acceptance and functional requirements of the three groups towards Portuguese elements. The study found that the frequency of cultural exposure drove the three groups to show stratified characteristics of "identity-oriented - experience-oriented - cognition-oriented". Based on the integrated data, an optimized strategy of symbolic function adaptation, emotional stratified response, and cultural progressive interpretation was proposed, and scenario-based solutions were designed for the two typical blocks to provide theoretical references for the design of wayfinding systems in multicultural cities.

Keywords: historic districts of macao, wayfinding system, cross-cultural perception, residents, visitors, student

1. Introduction

1.1 Research Background

1.1.1 Adaptation Challenges for Multicultural City Wayfinding Systems

The historic Centre of Macao, as the core carrier of the fusion of Chinese and Portuguese cultures, has a wayfinding system that not only serves the basic function of spatial guidance, but is also an important medium for cultural identity and cross-cultural communication [1]. The Cultural Heritage Protection Regulations of 2023 put forward normative requirements for the wayfinding system in Macao's historic districts, emphasizing its dual responsibilities in cultural interpretation and functional adaptation. However, the existing system faces a significant conflict of diverse needs: 231 questionnaires showed that 45% of residents reported "missing community functions" (conflict between living needs and tourism), 48% of tourists reported "insufficient additional information" (multilingual imbalance), and 60% of students suggested "historical annotations and AR navigation" (unmet knowledge needs); The "efficiency conflict" was prominent in the front of the council Pavilion (tourist area), and the "identity conflict" was significant in the Hong Market and Sha Lai Tou (residential area).

1.1.2 The Exploratory Value of the Issue of Openness

Traditional quantitative studies struggle to explain the "why" and "how" of the differences in demand. Open question analysis shows that residents focus on preserving the local living atmosphere, tourists focus on "wayfinding efficiency", and students value "knowledge exploration". These qualitative data suggest that wayfinding systems need to be adapted to multiple contexts to provide a basis for the "function-emotion-cognitive" three-dimensional optimization framework.

1.2 Objectives and Implications of the Study

1.2.1 Research objectives

Through quantitative statistics and qualitative coding, identify differences in visual sensitivity, emotional acceptance, and functional requirements among residents, visitors, and students to reveal the impact of cultural engagement (high-frequency immersion, low-frequency experience, medium-frequency education) on the stratification of needs, and propose precise optimization strategies based on real needs to form replicable stratification optimization strategies for wayfinding systems.

1.2.2 Practical Implications

It can provide a "function-emotion-cognitive" hierarchical optimization paradigm for the design of wayfinding systems in multicultural cities. By analyzing the differentiated needs of residents, visitors and students, targeted strategies can be proposed to address the conflicts between cultural display and life function, symbolic aesthetics and information efficiency, basic orientation and knowledge dissemination in existing systems, and to enhance the multi-adaptability of wayfinding systems.

2. Theoretical basis

2.1 Berry's Cultural Adaptation Theory

The theory points out that the frequency of an individual's contact with a heterogeneous culture directly affects cognitive depth and emotional attitude, and involves two levels: group (social structure, cultural customs) and individual (identity, values). Berry emphasizes the process of change in cultural adaptation. Cultural adaptation is the cultural and psychological changes that occur in the direct and continuous contact between two or more groups with different cultures and their members. It may be that only one group and its members change, or it may be that both sides of the contact change. In addition, Berry notes that cultural adaptation involves both the group level and the individual level. Cultural adaptation at the group level involves changes in social structure, economic base, political organization and cultural customs; Cultural adaptation at the individual level includes changes in identity, values, attitudes and behavioral capabilities, that is, psychological changes experienced by individuals and eventual adaptation to the new environment [4]. In the context of Macao, residents view Portuguese elements as a natural component of the local culture because of their "frequent immersion" in the mixed environment of Chinese and Portuguese. Tourists' "low-frequency experiences" have led to fragmented perceptions, with a greater focus on the visual novelty of Portuguese elements; Students' "mid-frequency exposure + educational background" form a structured understanding and tend to view Portuguese elements as decodable historical symbols - this difference in exposure frequency constitutes the underlying logic of demand stratification.

2.2 Semiotic Theory

Semiotics, which divides symbols into "signifier" (form) and "signified" (meaning), is a discipline that studies symbols. Ernst Cassirer constructed the semiotics of human culture, stating in his book on Man: "Man is the Animal Symbolicum." That is, man is the animal that uses symbols to create culture, and all human cultural forms are symbolic forms, such as painting, music, dance, design, etc., all are the products of man's symbolic activities. Susan Langer established the theory of artistic symbols based on Cassirer's theory of humanized symbols. She holds that symbolic activity is the most fundamental mental activity of human beings, and art is the creation of symbolic forms of human emotions. Therefore, in semiotics, symbols are regarded as a cultural and social phenomenon. Studying the meaning of symbols and how they are used in spatial design can reveal how people perceive and understand space in different cultural and social contexts [6]. In the wayfinding system, there are significant group differences in the "signal-to-signified" interpretation of Portuguese elements: Manuel arches are seen as "historical continuation" by residents (68%), "European architecture" by visitors (72%), and "colonial evidence" by students (55%). This disparity leads to complex functional adaptation: residents can tolerate symbolic redundancy, while visitors are affected by the high complexity of symbols (with a "pattern interference" score of 4.8 ± 1.5 , significantly higher than residents' 2.1 ± 0.8), which affects information reading efficiency.

2.3 Environmental Behavior

In recent years, environmental behavior has received extensive attention and development internationally, and many scholars have begun to apply its theories to the design of public commercial Spaces. In particular, it has rich research and practical experience in humanization, diversification, spirituality, technology, psychology and behaviorization of commercial Spaces [9], emphasizing the influence of space design on user behavior, and has been widely applied in public space design since the 21st century. In the study, the rate of visitors getting lost (18%) was positively correlated with symbolic complexity ($r=0.62$), verifying the direct impact of visual design on information efficiency; 48 percent of visitors complained that Chinese characters were too small, and 35 percent needed practical information such as "bus stops, parking lots" to reflect the logic of functionality first; Residents' demands for de-commercialization reflect the behavioral need for wayfinding to adapt to the community environment.

3. Research Design and Methods

3.1 Questionnaire Design and Dimension Correspondence

A mixed approach was used to design the questionnaire, which included quantitative scales and open-ended questions, focusing on the perceived differences of Macao's historical and cultural district wayfinding system

among three groups: residents, tourists, and students. The questionnaire consists of 33 questions (32 quantitative questions, 1 open-ended question) and is divided into four major modules (Table 1) corresponding to basic information, cultural exposure and familiarity with the block, perception and evaluation of the wayfinding system, and improvement needs and suggestions. The specific design is as follows:

Table 1. Questionnaire Module Division Table

Modules	Question Type	Core Measurement Content	Data Uses
1. Basic Information	Single-choice questions (4 questions)	Identity (resident/visitor/student), gender, age, educational attainment.	Sample stratification basis differentiates the frequency of cultural exposure.
2. Cultural exposure and neighborhood familiarity	Likert 7-point Scale (5 questions)	Frequency of daily exposure to Portuguese culture/Familiarity with historic districts in Macau and access to information/the importance of Portuguese cultural elements to impressions of Macau.	Analyze the correlation between cultural exposure frequency and demand stratification, and identify differences in group cultural cognition
3. Perception and Evaluation of Wayfinding Systems	Likert 7-point Scale (12 questions)	Functional Experience: Signage dependency, visibility, layout density, material fit. Symbol recognition: Harmony of Chinese and Portuguese elements. Group sentiment: Cultural identity, experience uniqueness.	Analyze the differences in the "signifier - signified" of Portuguese elements. Evaluate the impact of symbolic complexity on information processing
4. Requirements and Suggestions for Improvement	Likert 7-point scale (6 questions), open-ended questions (1 question)	Quantitative requirements: Simplify patterns, add historical annotations, introduce AR navigation, etc Open questions: Specific opinions on functionality and culture.	Align with the "function-emotion-cognitive" three-tier requirements

Source: Collation of this study.

The scale used a 7-point Likert scale, with a gradient selection from "completely inconsistent" to "completely consistent" from 1 to 7 to ensure data statisticability. Open-ended questions (Question 33) were coded in three levels using NVivo 12, with a principal category reliability test Kappa coefficient of 0.82 (>0.8) to ensure the rigor of qualitative analysis.

3.2 Sample Allocation and Data Collection

The sample covers different functional areas, with a particular focus on the area around the front floor of the Legislative Assembly (the visitor core area). Two typical blocks, Red Market and Sa Lai Tau Block (residential area), to enhance the depth of analysis Table 2:

Table 2. Sample Allocation

Population	Sampling method	Data Sources	Valid samples	Recycling cycle
Residents	Community stratified sampling	Shalitou Block + Online Questionnaire	62	2025.4.1-5.1
Visitors	Scenic area port interception	Scan the code to fill in at Senado Pavilion Front + Wan Chai/Tsing Mau Port	85	2025.4.10-5.1
Students	Macau university students + mainland exchange students	On-campus distribution + online questionnaires	84	2025.4.5-5.1

Source: Collation of this study.

Among them, 41 samples (66%) were from the Red Market and Sa Lai Tou blocks for the resident population, 62 samples (73%) were from the Legislative Assembly Front area for the tourist population, and 39 samples were from the student population covering both types of blocks.

4. Analysis of the Cultural Dimension Status and Group Cognitive Differences of the Wayfinding System in Historic Districts of Macao

4.1 Cultural Cognitive Stratification Characteristics of Three Groups

4.1.1 Residents

Residents who have long been immersed in Macao's mixed Chinese-Portuguese environment (Portuguese cultural exposure frequency score 5.9 ± 1.1) have regarded the Portuguese elements in the wayfinding as a natural part of the local culture. Forty-five percent of residents called for the completion of community life information, essentially a need for the continuation of the cultural scene, and thirty-two percent called for "de-commercialization", at the core of resisting wayfinding from being reduced to tourism cultural advertising and avoiding weakening the cultural sense of belonging to the community.

4.1.2 Visitors

On average, tourists stay for 2.3 days. Their exposure to Portuguese culture is mostly fragmented and visual (62% agree that "Portuguese elements are the main impression of Macao"). Forty-five percent complained about the small size of the Chinese font, and thirty-five percent demanded the addition of practical information. On the surface, efficiency is the priority, but in reality, it reflects the logic of short-term cross-cultural contact: a sense of spatial security through clear guidance is needed before cultural information can be focused on; Its "perception of cultural uniqueness" score is 5.2 ± 1.3 , but satisfaction points are focused on visual novelty (such as the shield-shaped coat of coat decoration) rather than understanding of historical significance, creating an experience gap of knowing what but not why.

4.1.3 Students

Students with both "mid-frequency cultural exposure" (4.6 ± 1.0) and "educational background support" tend to view Portuguese elements as decodable historical texts. Sixty percent demanded "added historical annotations," and 45 percent expected "AR Tours to restore historical scenes," with the core being the systematic need for cultural context: existing wayfinding only marked the names of symbols and did not explain "architectural cultural significance in colonial history." 28 percent suggested "optimizing the nighttime function," essentially hoping that the wayfinding would become an informal cultural learning interface to support the need for deepening cultural understanding during field trips.

4.2 Core Manifestations of Cultural Imbalance in Wayfinding Systems

The current demand conflict of the wayfinding system is essentially a mismatch between the function of the cultural carrier and the cultural demands of the group, which is manifested in three aspects:

Cultural identity and communication gap: Although residents recognize the integration of Chinese and Portuguese cultures (harmony level 5.7 ± 0.9), 32% are dissatisfied with "excessive tourism", and scenic spot advertisements in the wayfinding dilute the cultural memory of the community; Only 12% of tourists can understand the historical background of Portuguese road names, and the symbols have a break between "signatory" and "signatory", losing their cross-cultural communication function.

Cultural and functional carrier role conflict: The rate of tourists getting lost (18%) is positively correlated with the complexity of Portuguese symbols ($r=0.62$), while excessive accumulation of symbols reinforces "visual culture" but interferes with information reading; 45 percent of residents need to "complete life information", creating an imbalance between tourism culture and community culture.

Mismatch between cultural interpretation and cognitive level: Students' demand for "historical annotations" (6.2 ± 0.8) is much higher than that of residents (3.8 ± 1.4) and tourists (3.5 ± 1.3), but most of the existing wayfinding annotations are marked with symbolic names, and most do not explain the historical context, resulting in the lack of inheritance of the middle layer of Macao's historical culture.

5. Optimization Strategies for the Historical District Wayfinding system in Macao based on Cultural Adaptation

5.1 Cultural Adaptation Stratification Strategy for Three Groups

5.1.1 Residential communities

The need of residents for wayfinding is essentially a confirmation of the cultural identity of the community, so wayfinding should be a link between "Sino-Portuguese fusion culture" and "daily life dynamics", rather than an isolated spatial sign. Specifically, in residential areas such as Hong Street Market and Sa Lai Tou, life service information should be transformed into cultural scene narratives. For example, in the signboards of residential areas (Figure 4), community service information (vegetable market, bus stop, etc.) should be presented in the form of illustrations + brief text (such as "Hong Street Market Morning Market: "6:00-12:00"), through context reconstruction, strengthen residents' sense of cultural belonging to the community.

5.1.2 Tourist Core Area

The short-term cultural contact characteristics of visitors determine that their wayfinding needs should follow the communication logic of efficiency first, meaning second, establishing spatial security through clear guidance first, and then achieving shallow transmission of cultural symbols. In core tourist areas such as the Praca do Senado and the Ruins of St. Paul's, the handling of Portuguese symbols should take into account both visual recognizability and meaning simplification: avoid symbol overload to interfere with information reading, and attach micro-cultural annotations to each symbol (such as "shield-shaped emblem: Portuguese noble cultural symbols, which have evolved into the signatory of historic buildings in Macau "), achieve quick association of "signifier - signified". The presentation of information should serve the "understandability" of cross-cultural communication: follow the layout logic of "top guide (cultural node) - middle service (practical information) - bottom decoration (symbol)" to ensure that visitors can obtain spatial guidance and capture core cultural information within 30 seconds, meeting the needs of low-frequency contact groups for cultural simplification.

5.1.3 Student Path Area

The medium-frequency contact and educational background of the student body make the need for wayfinding go beyond basic guidance, and wayfinding needs to be an extended interface for informal cultural learning. Metal explanatory boards should be added at the bottom of the vertical wayfinding signs along the high-incidence routes (such as the A-MA Temple - Port Authority building - Church of SAN Lorenzo, etc.) (Figure 1-4) to explain the historical context of Portuguese elements in both Chinese and English (such as "Manuel Arch: Originating from the Portuguese Age of Discovery and becoming an architectural witness to the 'fusion of Chinese and Western trade cultures' in Macau ", the symbol is transformed from visual decoration to historical text. At the same time, it needs to be adapted to the scene requirements of students' in-depth cognition: by linking the "Macao Cultural Heritage Database" with the AR navigation system through QR codes, functions such as the restoration of historical street scenes and dynamic interpretation of symbols are realized, meeting their cognitive advancement from concrete symbols to abstract history, and meeting the needs of the medium-frequency education group for cultural systemicity.



Figure 1. Small wayfinding signboard



Figure 2. Corner signage



Figure 3. Historical building Introduction signs



Figure 4. Notice board along the pedestrian street

Source: Field research collation of this study.

5.2 Culture-Oriented Strategy Implementation Pathways

5.2.1 Small-Scale pilot: Qualitative Assessment and Iteration of Cultural Effects

The core of the pilot is not the application of technology, but the validation of the impact of wayfinding optimization on cultural perception. Five signboards were selected at the front of the Legislative Assembly (tourist

area) and five at the Red Street (residential area) respectively, and symbolic optimization and cultural scene implantation were implemented. After the transformation, feedback was collected through a combination of "qualitative + quantitative" methods: In addition to the conventional quantitative indicators such as symbol comprehension and information acquisition efficiency, more attention should be paid to the descriptive feedback of residents on "community cultural belonging" ("whether the wayfinding makes you more identify with the Chinese and Portuguese cultural characteristics of the block") and the subjective evaluation of tourists on "depth of understanding of Macao culture" ("whether they understand the historical significance of Portuguese symbols through the wayfinding") Use this qualitative information to determine whether the wayfinding has truly fulfilled its function as a cultural carrier rather than a mere functional upgrade, and accordingly iterate the details of the strategy.

5.2.2 Multi-Party Collaboration: Building and Maintaining Multicultural Consensus

The cultural adaptation of the wayfinding system should avoid the dominance of a single subject and instead build a multi-party collaborative mechanism of "community, scholars, students, tourists". Through simulated cultural needs hearings, the core elements of residents' transmission of community cultural memory, the academic accuracy of cultural scholars' symbolic interpretation, the details of students' cognitive decoding requirements, and the clarity of tourists' feedback such as multilingual annotations are formed in a multi-party dialogue to ensure that the optimization of wayfinding does not deviate from the essence of Macao's multiculturalism. Follow-up maintenance requires an annual update of annotations based on the latest historical research findings and new community cultural scenarios (such as new local cultural activity venues), collection of cultural perception feedback through social media every quarter, and regular inviting of scholars to assess the accuracy of symbolic interpretation to avoid cultural misinterpretation and keep the wayfinding system in sync with the cultural development context of Macao Continue to play a role in cultural dissemination and identity building.

6. Conclusions and Prospects

6.1 Research Conclusions

6.1.1 The Essence of Demand Stratification Revealed

The open question reveals that residents' demands are essentially spatial identity construction, tourists are efficiency-first experience consumption, and students are knowledge-driven meaning production. These three constitute the "function-emotion-cognitive" three-tier demand model. The frequency of cultural contact is the core factor in the stratification of needs: residents with high-frequency contact focus on emotional identification and life functions, visitors with low-frequency contact rely on foundation-oriented efficiency, and students with a medium-frequency educational background pursue cognitive depth. The tourist core area needs "efficiency first + shallow cultural communication", and the residential area needs "life services + deep community identity" to provide a micro template for the "regional wayfinding design" of cross-cultural cities.

6.1.2 The Cultural Value of Qualitative Data: Uncovering Deep-Seated Needs and Balancing Conflicts

Open question qualitative data makes up for the lack of quantitative research: on the one hand, decoding deep cultural needs, such as residents' insistence on native materials is to preserve the memory of the coexistence of Chinese and Portuguese material cultures, and students' anticipation of AR Tours is to extend digital cultural learning scenarios; On the other hand, it provides a path to balance cultural conflicts by using practical cultural symbols and adding community information to achieve the symbiosis of tourism culture and community culture and avoid the imbalance of cultural trade-offs in design.

6.2 Future Prospects and Limitations

In the future, long-term block tracking studies will be conducted through Part 5 Optimization strategies to observe the ongoing impact of wayfinding optimization on cultural cognition and behavioral patterns of different groups (such as changes in residents' sense of community belonging, increased revisit rates of tourists, and changes in the way students acquire knowledge), providing a basis for the long-term design of cross-cultural urban wayfinding systems; The cross-cultural perspective and stratified demand analysis of the study can be transferred to multicultural cities such as Hong Kong and Shanghai to provide ideas and practical cases for the design of their wayfinding systems

Due to time constraints, no in-depth interviews were set up. The open question analysis focused on Chinese texts and did not cover multilingual suggestions from the Portuguese residents, which may lead to the neglect of the needs of Macao's multicultural groups (such as the Macanese Portuguese).

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