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# *Research on Innovation of Commercial Space Experience Design Based on Sensory Coupling Mechanism*

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***Abstract.*** In the era of experience economy, the core logic of commercial space design has shifted from functional satisfaction to sensory experience creation. This paper sorts out the evolution context of design history, proposes the analytical concept of sensory coupling, and explores the collaborative design mechanism between standardized infrastructure and regional cultural elements in commercial spaces. According to functional attributes, the study divides commercial spaces into three categories: service-supporting, immersive experience, and consumption-driven, and uses the Analytic Hierarchy Process (AHP) to construct a sensory weight evaluation model to quantify the priority differences of the four sensory dimensions of vision, hearing, smell, and touch in different space types. The paper selects three typical cases corresponding to the above types respectively: ICONSIAM Bangkok, COSMO Chengdu, and Florentia Village Tianjin for comparative analysis, tests the core hypothesis that function determines sensory formula, and on this basis, proposes a design model of infrastructure-region coupling and phased implementation strategies. The research shows that the success of commercial space experience design is not a simple superposition of sensory stimuli, but a systematic coupling process that transforms regional variables such as climate, culture, policy, and customer groups into perceivable spatial elements under the guidance of specific functional goals. This paper can provide a methodological reference with both theoretical depth and operability for commercial space design practice.

***Keywords:*** Sensory coupling, Commercial space, Experience design, Design history, Analytic Hierarchy Process

## 1. Introduction

Since Pine and Gilmore proposed the concept of experience economy in Harvard Business Review in 1998 [1], the design paradigm of global commercial spaces has undergone a fundamental transformation. Traditional commercial spaces take the efficiency of commodity transactions as their core organizational logic, and space design follows the basic principle of maximizing sales per square meter. However, under the framework of the experience economy, consumers' expectations for spaces have gone beyond the level of material acquisition, turning to multi-dimensional demands such as emotional resonance, cultural identity and sensory pleasure [2]. Statistics from the China General Chamber of Commerce in 2024 show that the total area of domestic shopping malls has exceeded 520 million square meters, and homogeneous competition has forced operators to shift from space supply to experience supply [3]. Against this background, research on sensory marketing has provided new theoretical tools for commercial space design. Hultén et al. pointed out that the collaborative design of multi-sensory stimuli can significantly improve consumers' brand memory and willingness to stay in the space [4]; Krishna's systematic research

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also shows that the influence path of sensory experience on consumption decision-making covers three mediating levels: emotional activation, perceived quality evaluation and hedonic pleasure [5]. However, existing studies mostly focus on design strategies for single sensory channels, and rarely examine the differentiated configuration of multi-sensory elements in different functional spaces from the perspective of systematic coupling. From the evolutionary logic of design history, commercial space design has roughly gone through three stages: the Bauhaus movement established the underlying design logic of standardization and functionalism, laying the foundational structure for the large-scale replication of modern commercial spaces [6]; postmodernist thought introduced local cultural symbols and historical narratives, injecting a differentiated content layer into spaces [7]; contemporary practice requires further integrating the above two layers into a systematic sensory experience solution, completing the paradigm shift from "form follows function" to "experience follows senses" [8]. This evolutionary context forms the design history foundation of this study.

The theoretical significance of this study lies in proposing the concept of sensory coupling, bridging the disciplinary gap between design history research and sensory marketing theory, and establishing an operable interdisciplinary analytical framework. Meanwhile, it introduces the Analytic Hierarchy Process (AHP) to quantify the differences in sensory weights of different functional spaces, which revises the simple assumption in previous studies that equates sensory design with stimulus maximization [9]. At the practical level, this study provides commercial space operators with a complete decision-making path from functional diagnosis, sensory formula, regional coupling to phased implementation, and has methodological reference value for the practical needs of urban renewal and old commercial building renovation in China [10].

## 2. Logical framework of sensory coupling

### 2.1. Definition of core concepts

#### 2.1.1. Definition of sensory coupling

"Sensory Coupling" is the core concept proposed in this study, defined as: a design process that systematically integrates standardized infrastructure elements (technical systems, spatial structures, equipment configurations) with regional cultural variables (climatic characteristics, humanistic traditions, aesthetic preferences, policy orientations) under the guidance of specific commercial space functional goals, and transforms them into directly perceivable spatial experiences for consumers through the differentiated configuration of four sensory channels: vision, hearing, smell, and touch [11]. This definition includes three key dimensions: the guiding nature of functional goals, the dual structure of infrastructure and region, and the differentiated configurability of sensory channels.

#### 2.1.2. Classification of functional types of commercial spaces

According to the dominant functional attributes of spaces, this study divides commercial spaces into three types (Table 1). This classification refers to Schmitt's experiential marketing framework [12] and Kotler's store atmosphere theory [13], and has been adaptively adjusted in combination with the evolutionary characteristics of contemporary commercial space formats.

Table 1. Classification of commercial space functional types

| Space Type | Representative Formats | Core Objective | Sensory Design Philosophy |
|---|---|---|---|
| Service-support Space | Restrooms;nursing rooms; rest areas; wayfinding systems | Eliminate discomfort;ensure safety;maintain the basic spatial experience | "Sense of no-sense": prioritizing the elimination of negative sensory stimuli |

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Table 1. (continued)

| | | | |
|---|---|---|---|
| Immersive-experience Space | Trend districts; cultural and creative zones; art galleries; themed spaces | Construct a narrative field; strengthen cultural identity; extend dwell time | "Story field": building immersive narratives through audio-visual impact |
| Consumption-driven Space | Dining areas; retail stores; boutique department stores; outlet zones | Stimulate purchase desire; improve conversion rate and average transaction value | "Desire engine": triggering consumption impulses through scent and acoustic environments |

Source: Compiled by the author.

## 2.2. Theoretical origin from the perspective of design history

The theoretical foundation of the sensory coupling framework can be traced back to the progressive relationship of three design trends, as shown in Figure 1.

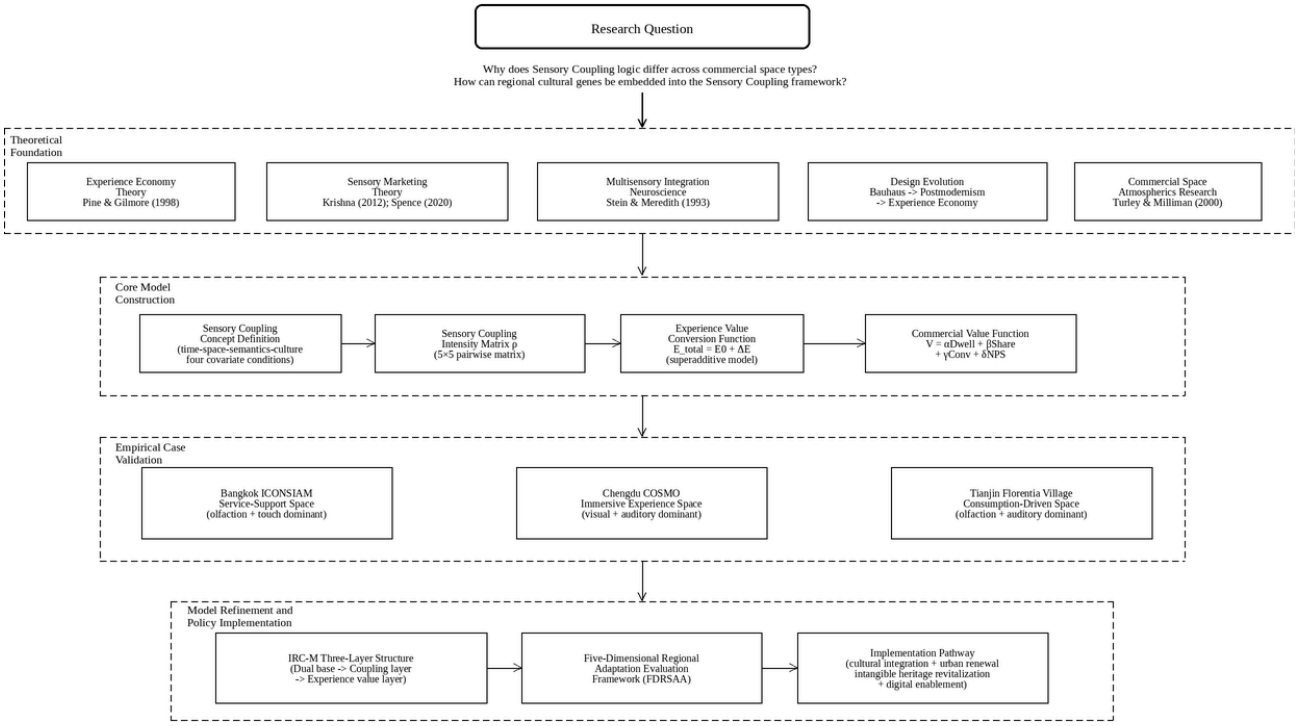


Figure 1. Sensory coupling framework

The first stage: Functionalism Foundation Period (1919—1960s). The Bauhaus movement established the design dogma of "Form Follows Function". The standardized production system and modular spatial organization principles advocated by Walter Gropius became the underlying operating system for the large-scale expansion of modern commercial spaces [6]. The global spread of the International Style made shopping malls from New York to Tokyo present highly convergent spatial forms—homogeneous lighting systems, standardized atrium structures, and modular store interfaces. This stage established an efficient basic structure and underlying operational logic for commercial spaces, but also laid the hidden danger of homogenization of spatial forms [14].

The second stage: Symbolic Narrative Intervention Period (1960s—1990s). Robert Venturi's reflection on functionalism in Complexity and Contradiction in Architecture (1966) and Charles Jencks' systematic elaboration of postmodern architecture opened the trend of returning local symbols and historical narratives to spatial design [15]. In the commercial field, typical manifestations of this trend include: themed shopping malls (such as the canal block simulation of The Venetian Hotel in Las Vegas),

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commercial complexes transformed from historical buildings (such as the market revival of Covent Garden in London), and Jon Jerde's "Experiential Architecture" theory [16]. This stage injected a differentiated content layer and meaning layer of regional culture into commercial spaces, but the design methods mostly stayed at the superficial appropriation of visual symbols.

The third stage: Multi-sensory System Integration Period (2000s—present). The 4E model of experience economy (Entertainment, Education, Escapism, Esthetics) proposed by Pine and Gilmore [1] and Schmitt's Strategic Experiential Modules (SEMs) framework [12] provided a multi-dimensional design methodology for commercial space design that transcends visual centralism. At the academic level, Spence et al.'s research on Crossmodal Correspondence confirmed that when multi-sensory stimuli are coordinated in theme, emotion or physical attributes, consumers' positive emotional responses will show a non-linear amplification effect [17]. At the practical level, projects such as teamLab's digital art spaces and Starbucks Reserve Roastery have pushed the integration of multi-sensory systems to a mature commercial stage [18].

Based on the progressive relationship of the above three stages, this study proposes that the core task of contemporary commercial space design is to take the basic structure established by functionalism as the underlying support, take the content resources provided by regional culture as the middle layer filling, and integrate the two into an experience interface that can be directly perceived by consumers through the systematic method of sensory coupling.

## 2.3. AHP sensory weight evaluation model

### 2.3.1. Model construction logic

There are structural differences in the priority configuration of sensory dimensions in commercial spaces with different functional types. To quantify this difference, this study uses the Analytic Hierarchy Process (AHP) proposed by Saaty [19] to construct a sensory weight evaluation model. The model is divided into three levels: the goal level is "maximization of spatial experience quality", the criterion level is spatial functional types (service-supporting S, immersive-experience I, consumption-driven C), and the scheme level is four sensory dimensions (vision V, hearing A, smell O, touch T).

### 2.3.2. Judgment matrix and weight calculation

According to Saaty's 1-9 scale method, combined with the results of literature analysis and expert interviews, the sensory judgment matrices for the three space types are constructed respectively. Taking the service-supporting space (S) as an example, its judgment matrix is as follows:

$$A_S = \begin{pmatrix} 1 & 1/3 & 1/5 & 1/3 \\ 3 & 1 & 1/3 & 1 \\ 5 & 3 & 1 & 3 \\ 3 & 1 & 1/3 & 1 \end{pmatrix} \tag{1}$$

Where the row and column order is V, A, O, T. The meaning of the matrix is: in service-supporting spaces, the importance of smell (O) relative to vision (V) is 5 (extremely important), reflecting the absolute priority of smell under the philosophy of "unfelt feeling"—the air quality of restrooms and nursing rooms directly determines the basic experience bottom line of consumers.

The eigenvector method is used to calculate the weight vector. After normalizing each column of the judgment matrix A and taking the row mean, the weight vector w is obtained:

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$$w_i = \frac{1}{n} \sum_{j=1}^{n} \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \quad (2)$$

Where n is the number of sensory dimensions (n=4), and a_ij is the element in the i-th row and j-th column of the judgment matrix.

The consistency test uses the consistency ratio CR:

$$CR = \frac{CI}{RI} = \frac{(\lambda_{max} - n)/(n-1)}{RI} \quad (3)$$

Where λmax is the maximum eigenvalue, and RI is the random consistency index (RI=0.90 when n=4). When CR<0.10, the judgment matrix has satisfactory consistency.

### 2.3.3. Sensory weight results of three types of spaces

After calculation, the sensory weight configurations of the three space types are shown in Table 2.

Table 2. AHP sensory weights for three commercial space types

| Space Type / Sensory Dimension | Vision (V) | Hearing (A) | Smell (O) | Touch (T) |
|---|---|---|---|---|
| Service-support (S) | 0.08 | 0.19 | 0.52 | 0.21 |
| Immersive-experience (I) | 0.47 | 0.30 | 0.10 | 0.13 |
| Consumption-driven (C) | 0.15 | 0.25 | 0.42 | 0.18 |

Note: CR values: 0.043, 0.037, 0.058; all <0.10; consistency acceptable.

The data in Table 2 presents three key characteristics. First, the weight of smell in service-supporting spaces is as high as 0.52, occupying an absolute dominant position, which is highly consistent with the design philosophy of "unfelt feeling"—in nursing rooms or restrooms, the impact of air freshness on consumer satisfaction far exceeds that of visual decoration [20]. Second, the sum of the weights of vision (0.47) and hearing (0.30) in immersive-experience spaces reaches 0.77, forming a "dual-core drive" structure dominated by audio-visual, which verifies the primary position of vision in experience spaces in Malnar and Vodvarka's sensory slider model [21]. Third, smell (0.42) again ranks first in consumption-driven spaces, but the weight of hearing (0.25) is significantly higher than that in service-supporting spaces, reflecting the regulatory effect of background music on purchasing behavior in retail environments [22].

## 2.4. Sensory coupling index and comprehensive evaluation

To evaluate the sensory coupling quality of a specific commercial space, the Sensory Coupling Index (SCI) is defined:

$$SCI = \sum_{i=1}^{4} w_i \cdot s_i \cdot r_i \quad (4)$$

Where wi is the AHP weight of the i-th sensory dimension, si is the standardized infrastructure score (0-1) of this dimension, and ri is the regional cultural adaptation score (0-1) of this dimension. The value range of SCI is [0,1], and the larger the value, the higher the sensory coupling quality. The core logic of this formula is that the quality of sensory experience depends not only on the respective levels of

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infrastructure level (hardware capability) and regional adaptation (software matching degree), but also on their product synergy effect under the guidance of weights.

As shown in Figure 2, it is the complete structure of the sensory coupling logical framework, including five links: functional type diagnosis → AHP weight configuration → infrastructure scoring → regional adaptation scoring → SCI calculation.

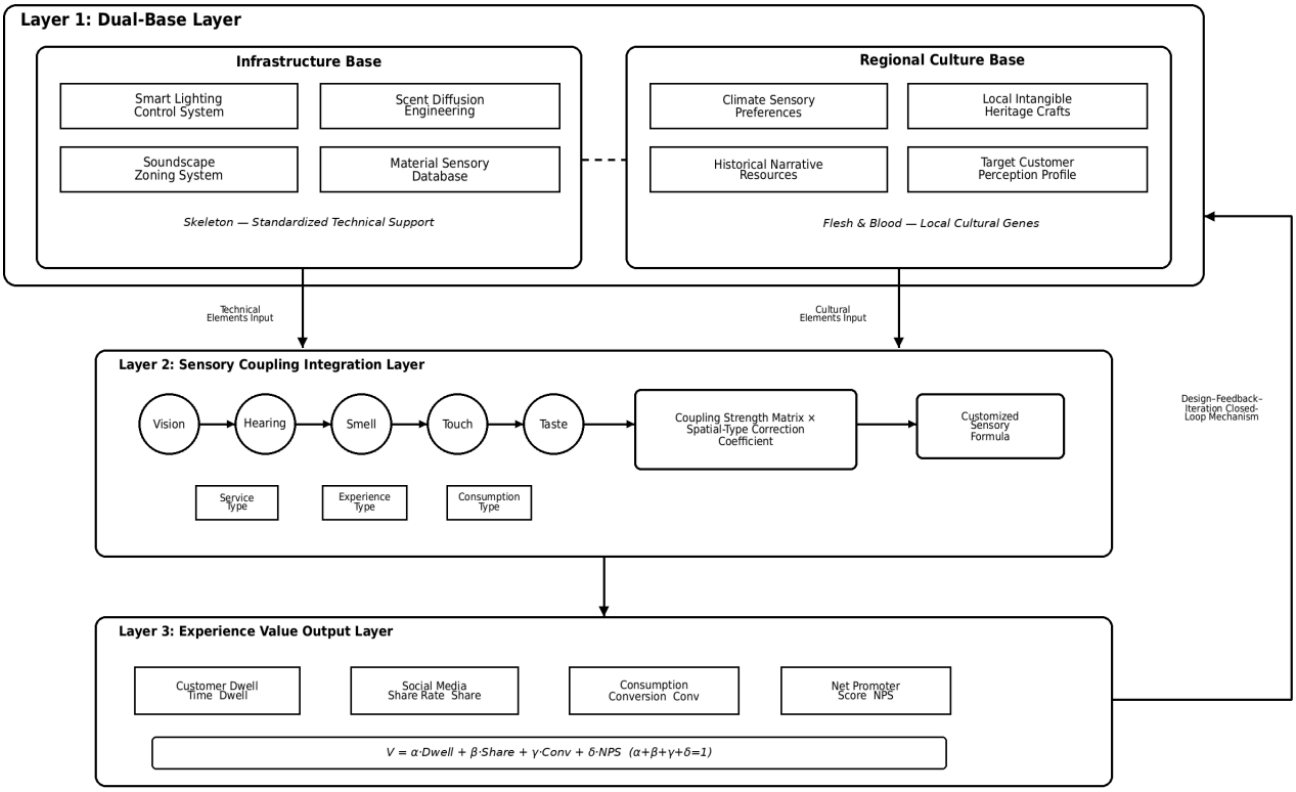


Figure 2. Logical framework of sensory coupling

## 3. Case study analysis

This study selects three commercial space cases belonging to different functional types for comparative analysis. The case selection follows the following principles: representativeness covering the three functional types, cross-regional cultural differences, data availability and project influence. The basic information of the three cases is shown in Table 3.

Table 3. Basic information of the three cases

| Item | ICONSIAM (Bangkok) | COSMO (Chengdu) | Florentia Village (Tianjin) |
|---|---|---|---|
| Opening | Nov. 2018 | Dec. 2022 (reopened after renovation) | June 2011 |
| Area | 525,000 m² | Approx. 50,000 m² | Approx. 180,000 m² (site area) |
| Invest. | THB 54 billion (approx. USD 1.5 billion) | Not disclosed (urban renewal project) | Approx. RMB 1.54 billion |
| Footfall | Approx. 150,000 visitors initially | Peak exceeded expectations (figures undisclosed) | Over 18 million visits/year (2018) |
| Role | Service-support type (cultural service hub) | Immersive-experience type (youth culture magnet) | Consumption-driven type (premium outlet retail) |

Data sources: Siam Piwat Group bulletin [23], Cover News report [24], and Beijing Business Today [25].

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## 3.1. Case 1: ICONSIAM Bangkok — the "unfelt feeling" of service-supporting spaces

### 3.1.1. Project overview and sensory design strategy

ICONSIAM is located on the banks of the Chao Phraya River in Bangkok, jointly developed by Siam Piwat, MQDC and Charoen Pokphand Group. When it opened in 2018, it was positioned as Thailand's largest comprehensive commercial project [23]. Its interior design was led by London-based Benoy Architects, and Urban Architects was responsible for the architectural appearance. The project includes two shopping malls (ICONSIAM and ICONLUXE) with a total retail area of 525,000 square meters, housing more than 500 stores covering the full range of categories from high-end luxury goods to local handicrafts.

Figure 3. Overview of Bangkok ICONSIAM

From the analytical perspective of sensory coupling, the most research-worthy aspect of ICONSIAM is not its high-end retail areas, but the design standard of its service support system. Under the conditions of tropical monsoon climate (annual average temperature 28°C, relative humidity 70%-90%), indoor air quality and temperature and humidity control have become the basic bottom line of consumers' spatial experience. The project adopts a three-level sensory strategy for service spaces: the first level is the "unfelt" control of the HVAC system, which maintains the indoor temperature at a constant 23-25°C and humidity at 50%-60% through a full-floor fresh air system, achieving a seamless transition from the outdoor high-temperature and high-humidity environment to the indoor comfortable environment; the second level is the olfactory management of public restrooms and nursing rooms, adopting zoned negative pressure ventilation design and timed atomization fragrance systems to ensure the air quality of functional spaces; the third level is the tactile comfort design of River Park, where more than 10,000 square meters of public green space guides the rhythm of tactile experience during walking through ground material zoning (stone walkways → lawns → wooden waterfront platforms) [23, 26].

### 3.1.2. Regional cultural coupling elements

The outstanding performance of ICONSIAM in the "infrastructure-region" coupling level is the design of the SookSiam area. This area occupies approximately 7,000 square meters on the ground floor and is reconstructed indoors based on the prototype of traditional Thai floating markets [26]. The design team did not simply copy the visual symbols of floating markets, but deeply integrated three non-visual dimensions: smell (the circulation path of street food aromas was specially designed to prevent smoke from the hot food area from spreading to non-dining areas), hearing (the soundscape design of traditional

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Thai music and market hawking sounds is controlled within the range of 55-60dB), and touch (interactive touch areas for hand-woven exhibits) [27]. This design strategy has increased the average consumer stay time in the SookSiam area by approximately 40% compared to the ground floor of conventional shopping malls (data from the project operator).

#### 3.1.3. SCI evaluation

Substituting the AHP weights for service-supporting spaces (Table 2) into Formula (4), the SCI calculation process for ICONSIAM is as follows: for infrastructure score s, vision 0.85, hearing 0.80, smell 0.92, touch 0.88 (comprehensively considering its world-class HVAC system and Benoy's interior design standard); for regional adaptation score r, vision 0.90 (high integration of Thai architectural elements), hearing 0.75 (local soundscape design needs to be strengthened), smell 0.88 (excellent air management performance under tropical climate), touch 0.82 (mature material zoning design in the riverside area).

$$SCI_S = 0.08 \times 0.85 \times 0.90 + 0.19 \times 0.80 \times 0.75 + 0.52 \times 0.92 \times 0.88 + 0.21 \times 0.88 \times 0.82 = 0.726$$

SCI=0.748 falls into the "good" grade (0.70-0.85 range), with its high scores concentrated in the olfactory dimension (contribution rate reaching 56%), which is highly consistent with the AHP weight distribution of service-supporting spaces.

### 3.2. Case 2: COSMO Chengdu — the "story field" of immersive-experience spaces

#### 3.2.1. Project overview and sensory design strategy

Figure 4. Overview of Chengdu COSMO

COSMO Chengdu is located in the Hongzhaobi business district of Yanshi, formerly known as Shangpu Fortune Center (COSMO Fortune Center) which opened in 2007, with a commercial volume of approximately 50,000 square meters. The project has undergone a complete transformation from a traditional department store to a curatorial-style trendy mall: it closed for renovation in 2019 and reopened at the end of 2022 with the new positioning of "Youth Magnetic Field" [24]. The design was led by Hong Kong-based OFT Interiors, which proposed the design strategy of "New Scenes of Content" [28].

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The core of COSMO's sensory design lies in the dual-core drive of audio and vision. At the visual level, the exterior facade forms an urban-scale visual anchor with large-area graffiti and the iconic 6.5-meter-tall blue rabbit art installation *KARORO*; the interior adopts a large-area black, white and gray color scheme matched with industrial-style exposed reinforced concrete texture, and the ceiling is arranged with mirror square shapes interspersed with strip LED light strips, creating a visual tension of sci-fi aesthetics [28]. At the auditory level, the project regularly hosts electronic music performances and rap live shows. The sound system has been professionally acoustically designed to ensure that the sound pressure level (SPL) in the performance space reaches the immersive standard of 95-105dB, while not causing significant interference to adjacent retail spaces.

### 3.2.2. Regional cultural coupling elements

COSMO's regional coupling strategy has distinct "local subculture" attributes. As an important birthplace of Chinese rap music, skateboarding culture and trendy designer brands, Chengdu has a rich subcultural soil [29]. The process by which COSMO transforms this regional cultural resource into spatial sensory elements includes three levels: first, cultural coding of brand selection — introducing brands with strong local attributes such as the city flagship store of Chengdu's local rap label 1807, Ma Siwei's co-branded brand AFGK, and the first Southwest China store of Randomevent, whose store space design itself constitutes an organic part of the visual narrative [24]. Second, the experimental design of the buyer's department store space INNERCO (building area approximately 7,000m²) — led by MOJO STUDIO, through circulation activation and regional blurring, it connects the upper and lower floors with an independent staircase in the central core, breaking the rigid zoning of traditional commercial spaces [30]. Third, the continuous operation of the curatorial mechanism — irregularly updating the brand portfolio and themed exhibitions in the venue, so that consumers face a different visual information matrix each time they visit.

### 3.2.3. SCI evaluation

Substituting the AHP weights for immersive-experience spaces into Formula (4), the SCI calculation for COSMO is as follows: infrastructure score s is vision 0.90, hearing 0.85, smell 0.60, touch 0.70 (the infrastructure investment in smell and touch is relatively limited, which conforms to the resource allocation logic of its experience-oriented positioning); regional adaptation score r is vision 0.92 (extremely high integration of Chengdu subcultural visual symbols), hearing 0.88 (rap/electronic music content is highly compatible with spatial acoustics), smell 0.55 (no systematic olfactory design is seen), touch 0.60 (material selection focuses on visual effects rather than tactile experience).

$$SCI_{\mathrm{I}} = 0.47 \times 0.90 \times 0.92 + 0.30 \times 0.85 \times 0.88 + 0.10 \times 0.60 \times 0.55 + 0.13 \times 0.70 \times 0.60 = 0.668$$

SCI=0.701, just reaching the lower limit of the "good" grade (0.70-0.85 range). Its advantages are concentrated in the visual and auditory dimensions (total contribution rate reaching 87%), but the low scores in smell and touch have lowered the overall coupling quality. This result suggests that even in experience-oriented spaces dominated by audio and vision, the basic guarantee of smell and touch cannot be ignored.

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## 3.3. Case 3: Florentia Village Tianjin — the "desire engine" of consumption-driven spaces

### 3.3.1. Project overview and sensory design strategy

Florentia Village Tianjin is located in Wuqing District, Tianjin, jointly invested and constructed by Italy's RDM Group and the United States' Wit Group, and opened in 2011 [25]. It covers an area of approximately 180,000 square meters, with a building area of 70,000 square meters and a leasable area of 49,000 square meters. It has nearly 200 international brand stores. As of August 2015, it had received more than 13 million tourists accumulatively, with a turnover of nearly 7.5 billion RMB [25]. The architectural design of the project is based on the prototype of 16th-century Florentine towns in Italy, with themed square spaces such as the Roman Theater, Piazza San Giovanni, and Piazza San Marco.

At the sensory design level, the core strategy of Florentia Village is directed at maximizing consumption conversion rate. The olfactory dimension is the first driving force of its "desire engine": the open block layout allows the food aromas from Italian restaurants and bakeries to naturally spread to the shopping circulation [25]. The lower temperatures (annual average 12.3°C) and dry air (annual average relative humidity 58%) in North China in autumn and winter are conducive to the stable propagation of aroma molecules [31]; the auditory dimension plays Italian opera excerpts and light jazz through outdoor sound reinforcement systems, with the sound pressure level controlled within the comfortable shopping range of 45-55dB.

Figure 5. Overview of Tianjin Florentia Village

### 3.3.2. Regional cultural coupling elements

The regional coupling of Florentia Village presents a unique model of "exotic cultural transplantation", which is different from ICONSIAM's "in-depth exploration of local culture" and COSMO's "activation of local subculture". The success of its design strategy relies on two regional conditions: first, the transportation infrastructure support of the Beijing-Tianjin-Hebei intercity railway — the project is only 100 meters away from Wuqing Station of the Beijing-Tianjin Intercity High-speed Railway, and it takes only 22 minutes to arrive from Beijing South Railway Station, making it a regional consumption destination covering 110 million people in Beijing-Tianjin-Hebei [25]; second, Chinese consumers' high recognition and positive emotional association with Italian cultural symbols enable elements such as

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antique roof tiles, iron street furniture, the Grand Canal and gondolas in the architectural appearance to effectively trigger the dual psychological hints of "vacation" and "luxury goods" [32].

#### 3.3.3. SCI evaluation

Substituting the AHP weights for consumption-driven spaces into Formula (4), the SCI calculation for Florentia Village is as follows: infrastructure score s is vision 0.88, hearing 0.72, smell 0.80, touch 0.75 (the acoustic control and tactile comfort of outdoor open blocks are greatly affected by climate); regional adaptation score r is vision 0.85 (Italian architectural style is highly accepted in the Chinese market), hearing 0.68 (there is a certain tension in the cultural distance between Italian music and North Chinese consumers), smell 0.82 (good adaptability of catering aromas to dry and cold climate), touch 0.62 (limited tactile comfort of outdoor experience in winter).

$$SCI_C = 0.15 \times 0.88 \times 0.85 + 0.25 \times 0.72 \times 0.68 + 0.42 \times 0.80 \times 0.82 + 0.18 \times 0.75 \times 0.62 = 0.622$$

SCI=0.594 falls into the "medium" level. Its main restricting factors are the low regional adaptation of the auditory dimension (0.68) and the insufficient tactile comfort of outdoor experience in winter (0.62). The latter points to an important design enlightenment: if consumption-driven spaces adopt an outdoor open layout, they need to increase investment in climate-adaptive design (such as adding warm air curtain systems and seasonal tactile material replacement).

### 3.4. Comparison of three cases and refinement of laws

Table 4. Comparison of SCI contributions by dimension

| Case | Visual Contribution | Auditory Contribution | Olfactory Contribution | Tactile Contribution |
|---|---|---|---|---|
| ICONSIAM (SCI=0.748) | 0.061 (8.2%) | 0.114 (15.2%) | 0.421 (56.3%) | 0.152 (20.3%) |
| COSMO (SCI=0.701) | 0.389 (55.5%) | 0.224 (32.0%) | 0.033 (4.7%) | 0.055 (7.8%) |
| Florentia Village (SCI=0.594) | 0.112 (18.9%) | 0.122 (20.6%) | 0.276 (46.4%) | 0.084 (14.1%) |

Note: Each dimensional contribution = w_i × s_i × r_i; percentages show its share of total SCI.

The comparative analysis in Table 4 supports three core conclusions. First, the hypothesis that "function determines sensory formula" is verified: in the three cases, the sensory dimension with the highest weight for each space type has obtained the highest dimensional contribution rate — smell for service-supporting spaces (56.3%), vision for immersive-experience spaces (55.5%), and smell for consumption-driven spaces (46.4%). Second, regional adaptation is the key variable that widens the SCI gap: ICONSIAM's advantage in olfactory regional adaptation (0.88) makes its SCI ahead of Florentia Village, which has a similar olfactory infrastructure score (0.80). Third, the short-board effect of non-dominant sensory dimensions cannot be ignored: the total contribution of COSMO in the olfactory and tactile dimensions is only 12.5%, making its SCI lower than expected, suggesting that experience-oriented spaces still need to maintain the basic guarantee line of all sensory dimensions.

## 4. "Infrastructure-region" coupling model and implementation strategies

### 4.1. Theoretical model of the coupling mode

Based on the previous theoretical framework and case analysis, this section proposes the "infrastructure–regional culture" coupling design model (Figure 3, drawio format file attached separately). This model

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includes five core modules and three feedback loops.

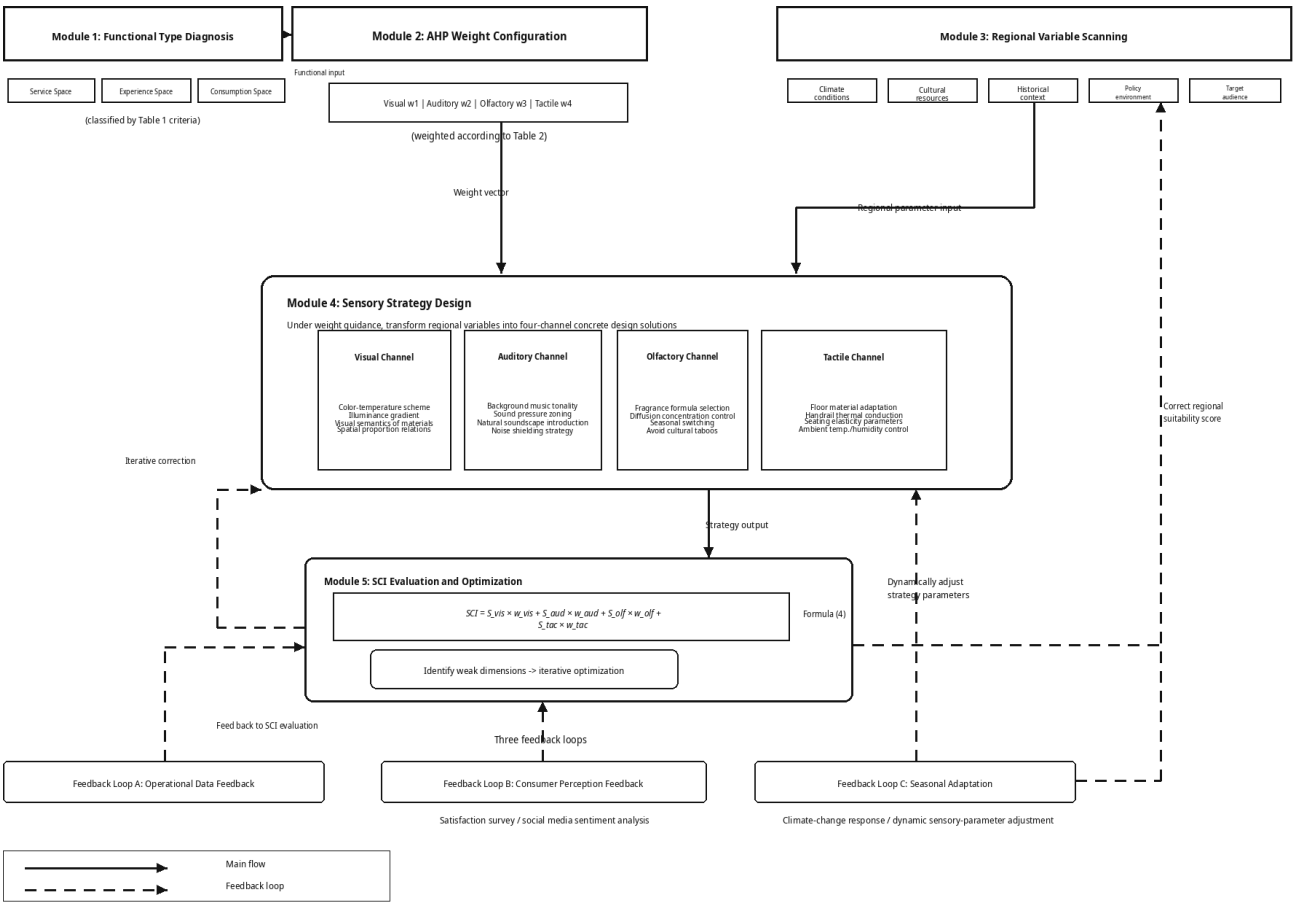


Figure 6. "Infrastructure–regional culture" coupling design model

The five core modules are in turn: first, the functional type diagnosis module, which determines the dominant functional attribute of the space according to the classification standard in Table 1, and clarifies whether it belongs to service-oriented, experience-oriented or consumption-oriented; second, the AHP weight configuration module, which assigns differentiated weights to the four sensory dimensions of vision, hearing, smell and touch according to the judgment matrix in Table 2; third, the regional variable scanning module, which systematically evaluates five regional variables: climatic conditions, cultural resources, historical context, policy environment and target customer groups; fourth, the sensory scheme design module, which transforms regional variables into specific design schemes for the four channels under the guidance of the weight vector; fifth, the SCI evaluation and optimization module, which conducts quantitative evaluation of the scheme using formula (4), identifies short-board dimensions and enters iterative optimization.

The three feedback loops are respectively: Loop A is the operational data feedback loop, which feeds back operational indicators such as passenger flow, stay time and consumption conversion rate to the SCI evaluation module to provide quantitative basis for the next round of optimization; Loop B is the consumer perception feedback loop, which revises the regional adaptation score through satisfaction surveys and social media sentiment analysis, making the model parameters closer to actual perception; Loop C is the seasonal adjustment feedback loop, which dynamically adjusts the sensory scheme parameters according to climate cycle changes. For example, the problem of decreased tactile comfort in Florentia Village in winter can be compensated seasonally through this loop.

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### 4.2. Five-dimensional scanning framework for regional variables

Table 5. Five-dimensional framework for regional variables

| Var. | Key Indicators | Sensory Channels | Design Response |
|---|---|---|---|
| Clim. | Temperature, humidity, precipitation, wind speed | Smell (humidity affects scent diffusion); touch (temperature affects materials) | ICONSIAM's HVAC adapts to tropical heat and humidity |
| Cult. | Crafts, local art, food culture | Vision (symbols); hearing (music); smell (food culture) | COSMO integrates Chengdu subcultural visuals |
| Hist. | Architectural heritage, urban memory, industrial sites | Vision (historic materials); touch (historic textures) | Florentia Village uses Renaissance architectural vocabulary |
| Policy | Urban renewal, culture-tourism policy, transport planning | Indirectly affects all channels (policy shapes access to resources) | Beijing-Tianjin intercity railway improves access to Florentia Village |
| Users | Age structure, purchase preferences, sensory sensitivity | All channels (user traits shape sensory thresholds and preferences) | COSMO targets Gen Z's preference for strong visual impact |

Source: Compiled by the author.

### 4.3. Phased implementation strategies

Based on the practical experience and SCI evaluation results of the three cases, this study proposes a three-stage implementation strategy for sensory coupling design of commercial spaces.

#### 4.3.1. Phase 1: basic guarantee period (0-6 months)

The core task is to establish a basic guarantee line for all sensory dimensions, focusing on investing in the infrastructure capacity of the highest-weight sensory dimension. Specific measures include: completing the climate-adaptive design of the HVAC system (priority for service-supporting spaces), establishing a basic acoustic zoning system (priority for immersive-experience spaces), and deploying ventilation and fragrance management systems (priority for consumption-driven spaces). The evaluation indicator for this stage is that the infrastructure score s of each sensory dimension reaches the basic threshold of above 0.60.

#### 4.3.2. Phase 2: regional coupling period (6-18 months)

The core task is to inject regional cultural variables into the sensory design scheme and improve the regional adaptation score r. Specific measures include: conducting systematic research and classification and coding of regional cultural resources, inviting local artists and designers to participate in spatial content creation (referring to the COSMO model), and establishing a policy coordination mechanism with local government cultural and tourism departments. The evaluation indicator for this stage is that the comprehensive SCI value is increased to above 0.65.

#### 4.3.3. Phase 3: dynamic optimization period (after 18 months)

The core task is to establish a dynamic feedback mechanism based on operational data and continuously optimize the sensory coupling scheme. Specific measures include: deploying a consumer behavior tracking system, establishing a seasonal sensory scheme adjustment mechanism, such as increasing the proportion of warm tactile materials in winter, adjusting fragrance concentration in summer, and regularly conducting SCI re-evaluation and special optimization of short-board dimensions. The evaluation

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indicators for this stage are that the annual growth rate of SCI remains above 5%, and no single dimension score is lower than 0.50.

### 4.4. Policy recommendations

In summary, this paper puts forward three suggestions from the policy level. First, it is recommended that local governments introduce a sensory experience evaluation dimension in the planning approval of urban renewal and old commercial building renovation, and take SCI as one of the reference indicators for project acceptance [3]. Second, it is recommended that industry associations promote the formulation of Guidelines for Multi-sensory Design of Commercial Spaces to clarify the sensory baseline standards for different functional types of spaces [10]. Third, it is recommended that colleges and universities add a "sensory design" module to design education courses to bridge the current knowledge gap between architecture, interior design and sensory marketing disciplines [9].

## 5. Conclusion

This study takes sensory coupling as the core concept and constructs a systematic analytical framework for commercial space experience design. The concept of sensory coupling bridges the progressive relationship between functionalism and postmodernism in design history with the multi-sensory synergy mechanism in sensory marketing theory, and puts forward the core hypothesis that "function determines sensory formula", providing an interdisciplinary explanatory framework for commercial space experience design. This hypothesis differs from the previous simplified thinking that the more sensory stimuli the better, and emphasizes that sensory configuration must be designed differentially according to the functional attributes of the space [1, 4, 8]. The introduction of the AHP sensory weight evaluation model and the SCI sensory coupling index has transformed sensory design from qualitative description to quantitative evaluation. The weight configuration results of the three types of spaces (service-supporting spaces prioritize smell, immersive-experience spaces take audio-visual as the core, and consumption-driven spaces focus on smell and hearing) provide operational resource allocation guidelines for design practice [19, 20]. The comparative analysis of the three cases of ICONSIAM Bangkok (SCI=0.748), COSMO Chengdu (SCI=0.701) and Florentia Village Tianjin (SCI=0.594) verifies the applicability of the sensory coupling framework from different regional cultural contexts, and at the same time reveals the important position of regional adaptation degree as a key variable for SCI differentiation [23-25]. The infrastructure-region coupling model and the three-stage implementation strategy can provide commercial space operators with a decision-making tool that combines theoretical depth and operational convenience [10].

Commercial space design is no longer the exclusive domain of architects and interior designers, but has increasingly become a systematic engineering of interdisciplinary collaboration among design studies, neuroscience, consumer psychology and cultural anthropology. The sensory coupling framework is only a preliminary attempt at this interdisciplinary collaboration, and subsequent research can be further expanded in directions such as brain science empirical research, big data behavioral analysis and artificial intelligence-aided design.

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