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A User-Centered Decision-Support Model for Sustainable Heritage-Based Design Innovation: An RTPB-ELM Approach

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Abstract

This study develops a user-centered decision-support model to facilitate sustainable futures for heritage-based design innovation using Minnan natural incense culture as an empirical case. Minnan natural incense culture faces significant challenges in sustainable transmission due to industrial substitutes, changing lifestyles, and declining engagement among younger generations. Although cultural tourism and creative industries offer revitalization opportunities, existing research lacks a systematic, user-centered framework that translates cognitive mechanisms into actionable design strategies. By integrating the revised theory of planned behavior (RTPB) and the elaboration likelihood model (ELM), a hybrid RTPB–ELM framework is proposed to examine how user cognition, behavioral intention, and contextual design variables influence cultural recognition and decision-making outcomes in sustainability transitions. Based on 179 valid questionnaire responses and structural equation modeling (SmartPLS 3.0), results indicate that both internal perceived behavioral control ($\beta = 0.196$, $p = 0.019$) and external perceived behavioral control ($\beta = 0.195$, $p = 0.013$) significantly affect cultural recognition, with approximately 79–80% of the total effects of incense-related design variables (types, utensils, and usage scenarios) mediated through these control factors. Two distinct user groups—central-route and peripheral-route users—were identified, highlighting differentiated cognitive processing pathways. The findings validate a transferable RTPB–ELM model that links micro-level user cognition to macro-level cultural resilience and heritage innovation. This framework offers practical guidance for adaptive design strategies and supports evidence-based sustainability transitions in intangible cultural heritage contexts.

Keywords: sustainable heritage-based design; user-centered decision-making; RTPB–ELM model; cultural recognition; sustainability transitions

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1. Introduction

According to the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage [1], intangible cultural heritage (ICH) encompasses knowledge, skills, and practices associated with social customs, rituals, festive events, and traditional craftsmanship. The Convention emphasizes safeguarding cultural practices that communities, groups, and individuals recognize as part of their cultural identity, ensuring their continuity, adaptability, and capacity for reinvention over time [2]. In recent years, ICH has increasingly been recognized not only as a cultural asset, but also as a critical resource for shaping sustainable cultural futures, fostering community participation, and enhancing meaningful user experiences. The Minnan region, located in southern Fujian Province of China and

encompassing the cities of Quanzhou, Xiamen (Amoy), and Zhangzhou, is the birthplace and core area of Minnan culture, as well as the primary region where the Minnan dialect (Hokkien) is spoken. Integrating Central Plains traditions, maritime culture, and overseas influences, Minnan culture has profoundly shaped Taiwanese society and the cultural identity of overseas Chinese communities in Southeast Asia.

Minnan natural incense culture represents a distinctive form of intangible cultural heritage rooted in everyday rituals, spiritual practices, and aesthetic traditions. Representative practices include Quanzhou Yongchun incense—predominantly handmade stick incense used in religious ceremonies—and Xiamen natural blended incense, traditionally appreciated by scholars and literati for self-cultivation and sensory refinement. Between 2017 and 2021, these practices were inscribed on China's national and provincial intangible cultural heritage lists [3], reflecting their historical significance and cultural value.

However, Minnan natural incense culture faces significant challenges under contemporary social transformations. Industrial substitutes, changing lifestyles, and declining engagement among younger generations have weakened traditional transmission pathways. Meanwhile, cultural tourism and creative heritage industries have created new opportunities for revitalization. In this context, design-driven approaches that integrate user experience, multisensory perception, and participatory engagement have emerged as promising strategies. These approaches enable the sustainable transmission and future-oriented transformation of incense-related heritage practices.

Although research on intangible cultural heritage and tourism has expanded in recent years, empirical investigations into user-centered cultural recognition mechanisms of specific heritage practices—such as incense culture—remain limited. Existing studies in heritage tourism emphasize cultural identity, authenticity, and visitor motivation [4], yet few have quantitatively examined how users cognitively recognize and evaluate intangible heritage practices through designed products and experiences [5]. More importantly, current research rarely translates users' cultural recognition mechanisms into actionable design strategies that support sustainable heritage-based design innovation. This gap limits the capacity of heritage design and tourism development to move beyond symbolic representation toward evidence-based, future-oriented decision-making frameworks.

To address these limitations, this study draws on behavioral design theory and consumer information-processing perspectives to construct a user-centered analytical framework for sustainable heritage innovation [6]. The revised theory of planned behavior (RTPB) is adopted to identify the antecedents of users' cultural recognition by quantitatively explaining how attitudes, subjective norms, and perceived behavioral control influence cultural recognition outcomes. Meanwhile, the elaboration likelihood model (ELM) complements this approach by distinguishing users' cognitive processing routes, clarifying how central-route users and peripheral-route users differ in their engagement with intangible cultural heritage.

By integrating RTPB and ELM, this study proposes a hybrid decision-support framework that bridges behavioral intention, cognitive processing, and design variables. This integration overcomes the limitations of single-model applications and enables the segmentation of user groups, the interpretation of cultural recognition pathways, and the formulation of adaptive design strategies. Such an approach is particularly valuable for guiding sustainable design practices and future-oriented innovation in intangible cultural heritage contexts. Based on the integrated RTPB–ELM framework, this study conducts an empirical analysis of Minnan natural incense culture and validates design strategies through applied design practice, ultimately constructing a cultural recognition-driven design framework for intangible cultural heritage (see Figure 1). Specifically, this research addresses the following questions:

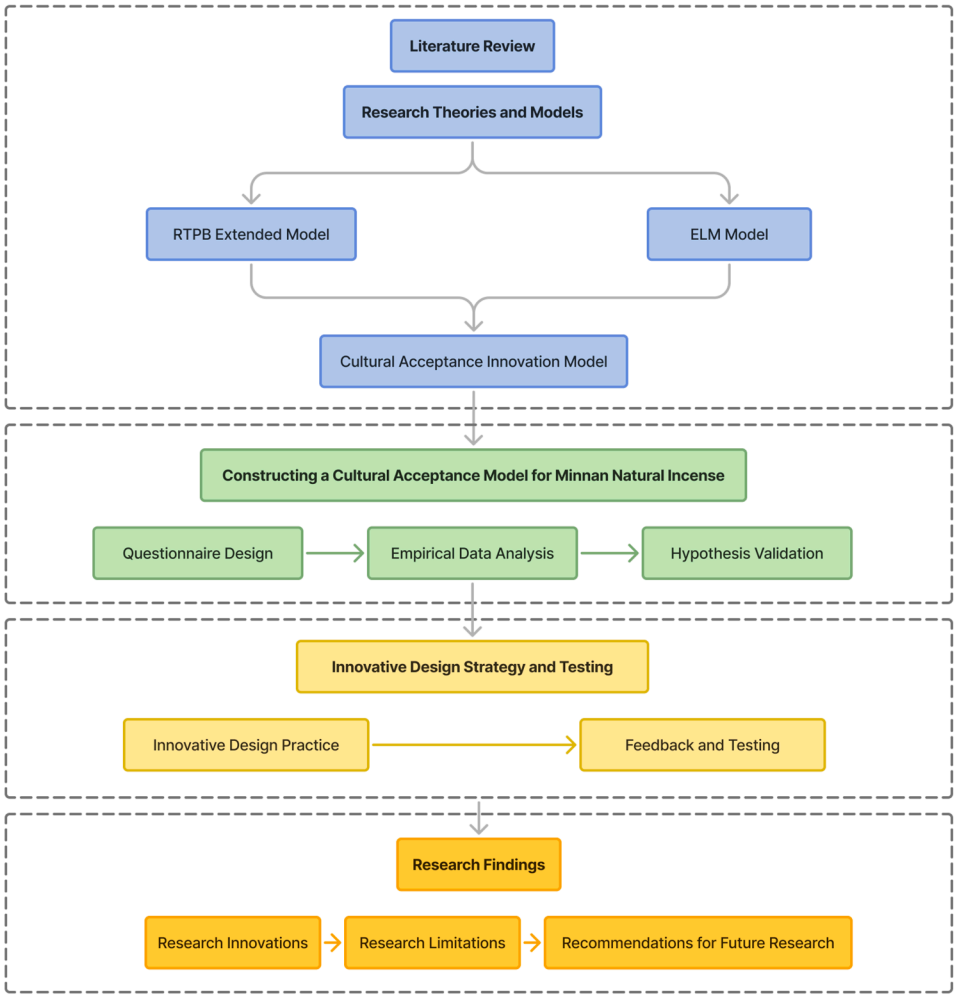


Figure 1. A cultural recognition-driven design framework (authors' own work).

How can behavioral design theory be applied to transform users' behavioral intentions into cultural recognition, thereby supporting evidence-based decision-making in sustainable ICH-based design innovation?

How can consumer information-processing theory be integrated with behavioral design models to segment user groups, generate differentiated user profiles, and guide future-oriented design strategies for the sustainable transmission of Minnan natural incense culture?

2. Literature Review

2.1. Heritage Protection and Incense Culture Research

Incense culture, as an important component of traditional Chinese culture, has a long history and rich cultural connotations. In southern Fujian Province, China, incense culture exhibits unique regional characteristics, particularly represented by the intangible cultural heritage of Minnan natural incense culture. Yongchun incense, primarily handmade stick incense, is mostly used for religious rituals, while Xiamen incense, characterized by blended natural incense, is valued for cultivating self-cultivation and aesthetic refinement among the literati.

Existing studies on incense culture have predominantly adopted qualitative approaches. For example, Sun and Zhang (2018) [7] conducted a comprehensive literature review and categorized relevant research into three main areas: material culture research based on incense materials, cultural practice research centered on incense, and olfactory

cultural research extended from sensory experience. Pan (2020) [8] employed historical textual analysis of ancient documents to explore the origins and evolution of incense culture, emphasizing the significance of incense types, product selection, and burning methods in daily life and cultural practices. More recently, Wang and Du (2024) [9] applied bibliometric analysis to identify the core elements of incense culture research—primarily incense, herbal incense, and associated practices—yet explicitly noted that academic studies in this field still lack systematicity and interdisciplinary theoretical frameworks [10]. Although these studies provide valuable descriptive insights into the historical, material, and cultural dimensions of incense culture, they are largely qualitative, rely heavily on secondary sources or literature synthesis, and offer limited empirical investigation into users' cognitive processing routes, behavioral mechanisms, or quantitative validation of cultural recognition. Consequently, there remains a critical gap in developing an integrated theoretical model that can quantitatively examine user-centered cognitive differences and translate them into sustainable heritage design innovation. To address these methodological and theoretical limitations, the present study integrates the revised theory of planned behavior (RTPB) with the elaboration likelihood model (ELM) to construct a hybrid decision-support framework, thereby providing a more systematic and user-centered approach to incense culture research.

2.2. Theory of Planned Behavior (TPB) and Revised TPB (RTPB)

In the field of social psychology, the theory of planned behavior (TPB), proposed by [11], is an important model for explaining individual behavioral intentions. The theory emphasizes that individual behavior is determined by behavioral intention, which in turn is influenced by three factors: attitude toward the behavior, subjective norm, and perceived behavioral control. Specifically, attitude refers to the individual's positive or negative evaluation of the behavior; subjective norm reflects the social pressures perceived by the individual; and perceived behavioral control involves both self-efficacy and external environmental factors in executing the behavior [12,13].

TPB has been widely applied in various fields, including health [14], environmental science [15], tourism management [16], education [17], and cultural heritage protection [18]. Furthermore, Conner and Armitage (1998) divided perceived behavioral control into two constructs: "internal control", referring to self-efficacy, and "external control", referring to external situational factors beyond the individual's full control [19]. Based on this refinement, the revised theory of planned behavior (RTPB) provides a more nuanced mechanism to explain the transformation between cultural cognition and behavioral intention, offering a quantitative tool to study users' cultural recognition of intangible cultural heritage (see Figure 2).

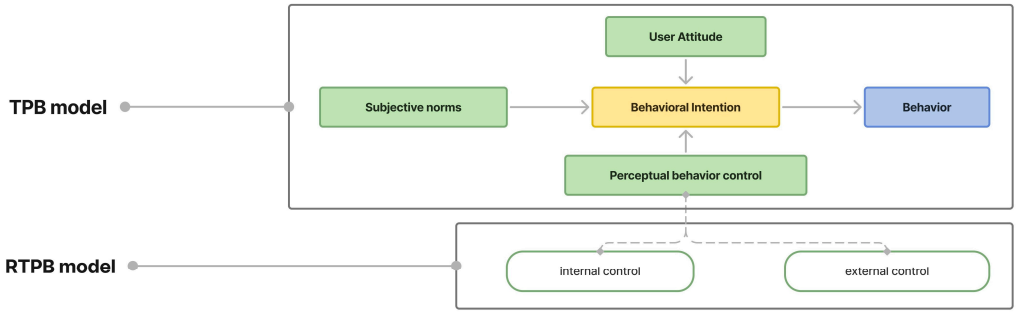


Figure 2. TPB model and RTPB model (authors' own work).

2.3. The Elaboration Likelihood Model (ELM)

The elaboration likelihood model (ELM), as shown in Figure 3, was proposed by Petty and Cacioppo (1986) [20] and is a classic theory in the field of consumer information processing. The model argues that individuals process information through two distinct routes: the central route and the peripheral route. The central route depends on high levels of motivation and cognitive ability, emphasizing the quality and logic of the argument itself. In contrast, the peripheral route functions when individuals lack sufficient motivation or ability, relying more on external cues and sensory experiences [21].

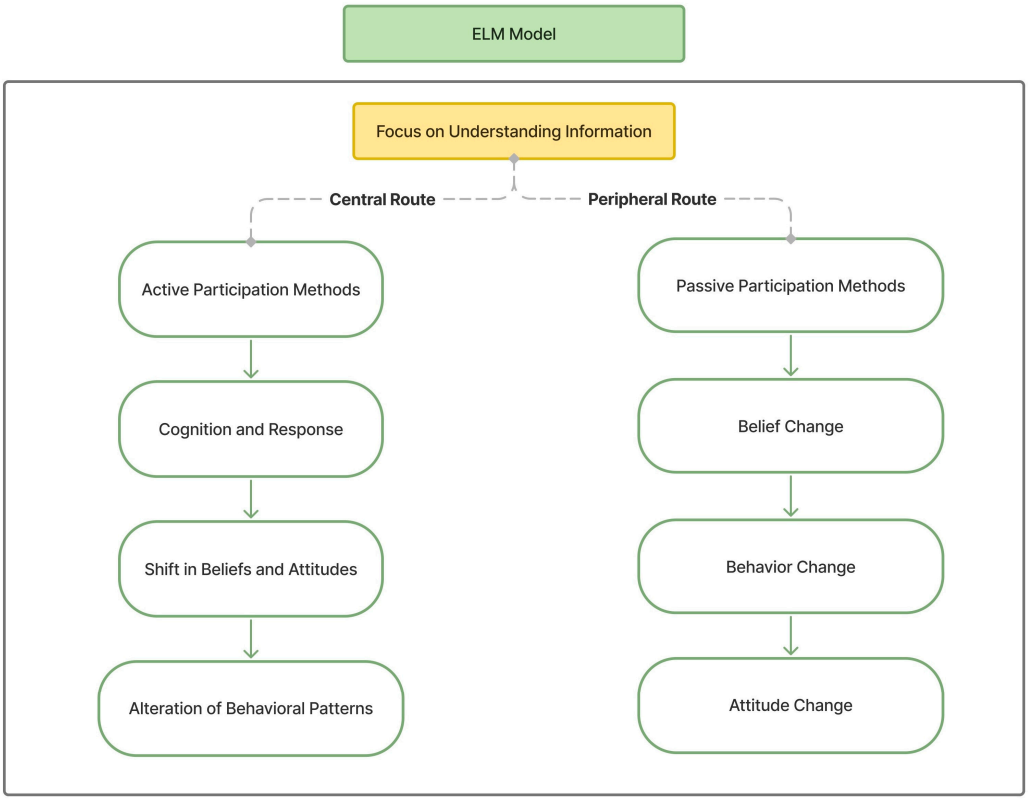
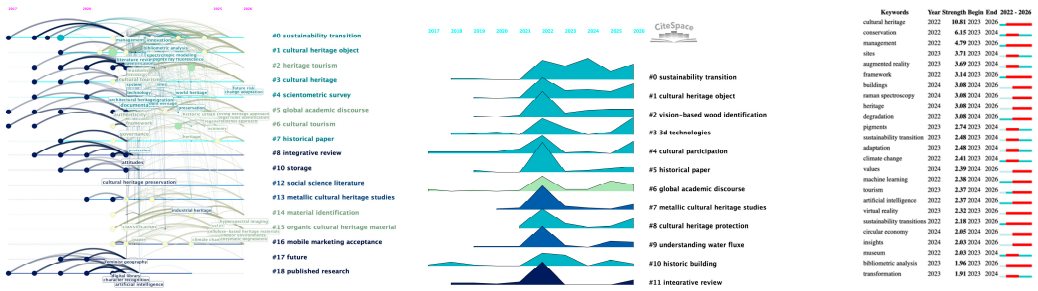


Figure 3. ELM model (authors' own work).

Existing research has applied ELM widely in advertising [22], consumer behavior, healthcare, and media studies, demonstrating its effectiveness in explaining differences in users' information processing. Within heritage tourism studies, ELM provides strong theoretical support for understanding cognitive differences when tourists encounter intangible cultural heritage. Users who adopt the central route tend to focus more on cultural logic and historical connotations, while those who adopt the peripheral route rely more on sensory and atmospheric experiences. Thus, the ELM model provides a useful basis for designing heritage tourism products and segmenting target audiences.

To further identify the research gaps in a systematic and visual manner, this study conducted a bibliometric analysis using CiteSpace 6.4.1 on TPB- and ELM-related literature in the WoS Core Collection from 2021 to 2026 (top 50% nodes per slice). As illustrated in Figure 4, the keyword co-occurrence timeline (a) shows that existing studies are primarily concentrated in traditional domains such as cultural heritage, heritage tourism, and sustainability transitions, with most research relying on qualitative descriptions or single-theory applications. The thematic landscape view (b) reveals the growth trends of these clusters over the past five years, yet the intersection between user-centered design, heritage design innovation, and the RTPB–ELM framework remains notably sparse. The citation burst analysis (c) indicates that keywords such as "sustainability transition", "cul-

tural heritage", and "heritage innovation" have exhibited strong bursts during 2022–2026, suggesting that the field is in a rapid development phase.



(**a**) (**b**) (**c**)

Figure 4. CiteSpace visualization of the TPB/ELM-related literature (WoS Core Collection, 2021–2026, top 50% nodes). (**a**) Keyword co-occurrence timeline; (**b**) thematic landscape view; (**c**) top 25 keywords with the strongest citation bursts.

A synthesis of key studies reveals consistent patterns and limitations. Recent TPB applications in heritage contexts have examined digital cultural heritage learning (Ning & Zhang, 2026) [23], extended TPB with cultural identity and scarcity to predict the purchase intention of intangible cultural heritage products (Zhang et al., 2026) [24], and integrated pro-environmental factors to understand tourist adoption of autonomous vehicles (Zhang et al., 2024) [25]. These studies demonstrate TPB's utility in explaining downstream behavioral outcomes such as sustainable practices, purchasing, and technology acceptance. However, they remain largely single-theory extensions focused on post-experience behaviors and lack integration with dual-route cognitive processing models such as ELM. Similarly, research on incense culture and intangible heritage has been predominantly qualitative and descriptive (Sun & Zhang, 2018; Pan, 2020; Wang & Du, 2024) [7–9], offering valuable historical and material insights but limited empirical examination of user cognitive mechanisms or translation into design strategies.

In summary, the present study addresses these gaps by systematically integrating RTPB (which supplies behavioral intention antecedents) with ELM (which distinguishes central and peripheral cognitive routes). By introducing cultural recognition as a distinct mediator—defined as a composite cognitive outcome of emotional identification, value judgment, and sustainable participation willingness (distinct from attitude, identity, or perceived value)—and grounding it in an empirical case of Minnan natural incense culture, this research provides a novel hybrid decision-support framework. It not only advances the theoretical understanding of user-centered heritage innovation but also translates findings into differentiated, evidence-based design strategies, thereby bridging the gap between behavioral theory and sustainable heritage practice.

3. Materials and Methods

3.1. Research Model and Hypotheses

As an integral part of traditional Chinese incense culture, Minnan natural incense culture contains complex and highly specialized cultural information. Ordinary users, lacking sufficient cultural knowledge, often find it difficult to fully understand its cultural connotations. Because cultural recognition of incense culture is inherently subjective, users' cognition and judgments are influenced by multiple factors. When lacking adequate knowledge or experience, users tend to rely on others' experiences or external environmental cues to make evaluations [26]. This cultural recognition process can be understood as a sustainability-related cognitive outcome within heritage tourism contexts, providing a the-

oretical entry point for examining how users form cultural recognition of Minnan natural incense culture in support of sustainable heritage transmission.

To address this, the present study adopts the elaboration likelihood model (ELM) to explain the differentiation of information processing routes caused by differences in users' motivation and cognitive ability. It then integrates variables from the revised theory of planned behavior (RTPB) to construct an evidence-based, decision-support research model that better captures the mechanisms of cultural recognition [23]. The research model is shown in Figure 5.

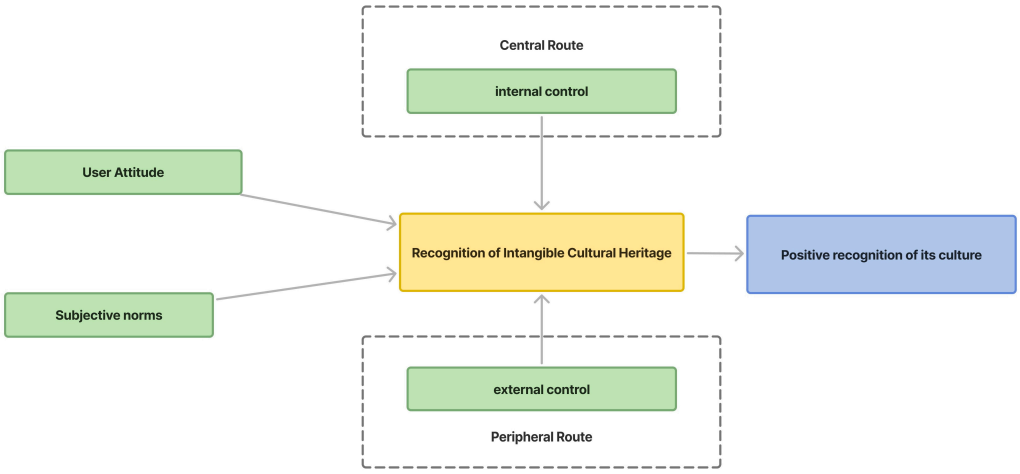


Figure 5. RTPB–ELM decision-support model for sustainable cultural recognition (authors' own work).

In this model, perceived internal control and external control are regarded as direct drivers of users' intentions and behaviors related to sustainable engagement with heritage culture. Specifically, when users possess higher internal control (i.e., confidence in their ability to understand and evaluate incense culture) as well as higher external control (i.e., perception of supportive contexts, resources, and environments), their cultural recognition of Minnan natural incense culture is enhanced [27]. Such cultural recognition further supports users' willingness to participate in sustainable heritage-related practices. Based on this reasoning, the following hypotheses shown in Figure 6 are proposed:

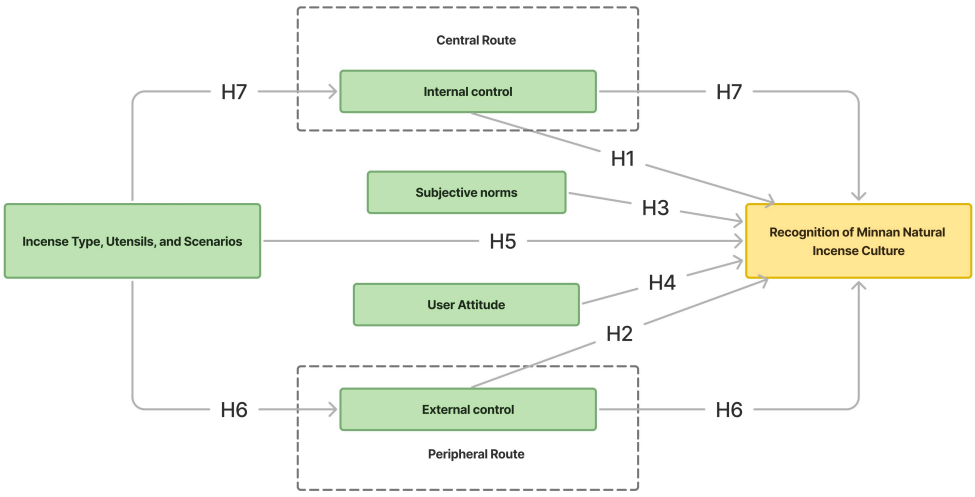


Figure 6. Influence model of users' cultural recognition of Minnan natural incense culture (authors' own work).

H1. *Among users adopting the central route, perceived internal control positively influences cultural recognition of Minnan natural incense culture.*

H2. *Among users adopting the peripheral route, perceived external control positively influences cultural recognition of Minnan natural incense culture.*

Building on this, the study incorporates variables of incense type, utensils, and usage scenarios, together with users' subjective norms and attitudes, to further propose:

H3. *Users' subjective norms positively influence cultural recognition of Minnan natural incense culture.*

H4. *Users' attitudes positively influence cultural recognition of Minnan natural incense culture.*

H5. *Incense type, utensils, and scenarios positively influence cultural recognition of Minnan natural incense culture.*

H6. *Incense type, utensils, and scenarios indirectly influence cultural recognition of Minnan natural incense culture through the mediating effect of perceived external control.*

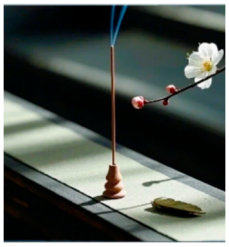
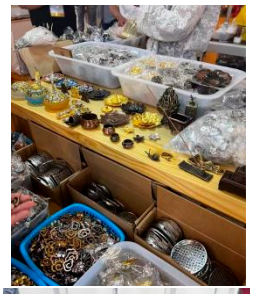
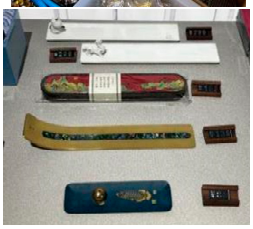
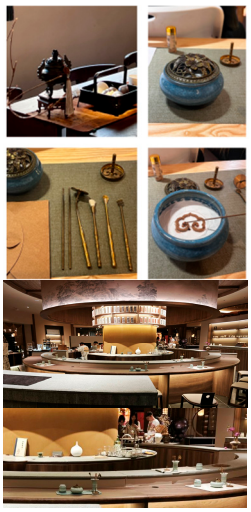
H7. *Incense type, utensils, and scenarios indirectly influence cultural recognition of Minnan natural incense culture through the mediating effect of perceived internal control.*

3.2. Scale Design

To ensure the validity and reliability of the measurement scales, this study drew on established scales from previous research and modified certain items according to the specific characteristics of Minnan natural incense culture. A structured survey instrument was developed to support sustainability-oriented, decision-based analysis. Semi-structured interviews were conducted with local residents and incense merchants near temples in Xiamen and Quanzhou, as well as with shop owners in large shopping malls in these cities. First-hand data were collected to systematically identify incense-related design variables, including incense types, utensils, and usage scenarios (treated as design-mediated variables influencing sustainable cultural recognition, see Table 1).

In southern Fujian, incense types mainly include stick incense, coil incense, and seal incense. Stick incense can be categorized into two subtypes: signed incense (with bamboo sticks) and unsigned incense (without sticks). Historically, incense products were also divided into "yin incense" (sandalwood-based) and "yang incense" (agarwood-based). At present, signed incense (also called rooted incense) is often associated with ancestral worship and religious practices in Quanzhou Yongchun, reflecting the Minnan cultural tradition of "preserving the root" in family rituals. In contrast, unsigned incense (rootless incense) is primarily used in daily life, tea appreciation, and leisure contexts. The primary raw material consists of agarwood from Hainan or Southeast Asian origins, often blended with other medicinal herbs to create incense. In northern China, particularly in Hebei, incense-making favors the addition of borneol (龙脑) to achieve invigorating and mind-awakening effects. Coil incense is also a form of unsigned incense, while seal incense requires higher cultural knowledge and remains limited to smaller groups of enthusiasts and experts.

Table 1. Research summary of Minnan natural incense.

Incense types: stick incense (signed and unsigned), coil incense, seal incense	Signed Stick Incense 	Unsigned Stick Incense 	Seal Incense Tools and Settings 
Utensils: public temple incense burners; private traditional and modern utensils	Incense burner located in front of the Quanzhou Guan Yue Temple  	Incense accessories  	Incense burner located in front of Quanzhou Patron Saint Statue  
Scenarios: religious rituals, official cultural promotion, lifestyle and leisure practices	Quanzhou Intangible Cultural Heritage Museum: Yongchun Incense-Making Craft Process 	Minnan Family Incense Burner The Blessing Ceremony 	Tea Ceremony and Seal Incense Experience Space 

Incense utensils in Minnan are classified into public and private use. Public utensils include large incense burners used in temples such as Quanzhou Tianhou Temple,

Quanzhou Guan Yue Temple, Xiamen Baosheng Dadi Temple, and Xiamen Nanputuo Temple. Private utensils are more diverse and can be further divided into traditional and modern types: traditional incense burners are mainly used for home altars and family rituals, while modern utensils include small incense holders, incense clip burners, seal incense sets, and even electronic heating devices.

The use of Minnan natural incense spans three main contexts: (1) religious rituals, such as ancestral worship during the Spring Festival and the "Song Wang Chuan" ritual, where large quantities of incense are burned collectively; (2) official cultural promotion, such as heritage museum exhibitions and public cultural events; and (3) lifestyle and leisure, where incense is integrated into tea culture, home atmospheres, and commercial settings. Examples of these contexts are shown in Table 1.

To refine the questionnaire, several rounds of expert consultation and pilot testing were conducted. After collecting 58 preliminary responses, reliability and validity tests were performed using Cronbach's α and exploratory factor analysis (EFA) in IBM SPSS Statistics version 27. Items that did not meet the criteria were deleted. The final instrument included 6 constructs and 22 measurement items (see Table 2). The questionnaire consisted of four parts.

Table 2. Questionnaire design (excerpt).

Variable	Definition	Measurement Items
Attitude	The positive or negative evaluation of a specific behavior by the user	A1. I strongly agree that Minnan natural incense culture is an important part of Minnan culture. A2. I strongly agree that Minnan natural incense culture is an important part of traditional Chinese culture [11]. (1 = strongly disagree, 5 = strongly agree)
Subjective Norm	The perceived social pressure experienced by individuals when engaging in a particular behavior	SN1. People around me (e.g., teachers, classmates, family members) believe that Minnan natural incense culture is worth inheriting [28]. SN2. The positive attitudes of people around me toward Minnan natural incense culture influence my cultural recognition of it. SN3. Celebrity endorsements or recommendations regarding Minnan natural incense culture affect my cultural recognition of it. SN4. Publicity through social media (e.g., short video platforms) makes me value incense culture more. (1 = strongly disagree, 5 = strongly agree)
Perceived Internal Control	The confidence of users in their ability to understand incense culture	I1. I carefully analyze the deeper meaning of Minnan natural incense culture (e.g., historical origins, ritual connotations). I2. When experiencing incense culture or purchasing related products, I pay attention to craftsmanship and symbolic meaning. I3. I believe that the transmission of incense culture requires systematic knowledge learning and logical reasoning. I4. I believe I have the ability to understand the core value of Minnan natural incense culture. I5. I believe I am capable of participating in the transmission of incense culture (e.g., making incense, participating in rituals) ([19,21,29]). (1 = strongly disagree, 5 = strongly agree)

Table 2. *Cont.*

Variable	Definition	Measurement Items
Perceived External Control	Users' perception of scene, resource support, and surrounding environment	E1. I rely more on intuitive situational atmospheres (e.g., fragrance comfort, ritual settings) to experience incense culture [30]. E2. I mainly experience the charm of incense culture through participation in activities (e.g., worship, exhibitions). E3. Traditional ritual scenes (e.g., clan worship) make it easier for me to accept Minnan natural incense culture. E4. Innovative experiential settings (e.g., cultural exhibition activities) enhance my incense culture experience (Conner & Armitage,1998) [19]. (1 = strongly disagree, 5 = strongly agree)
Incense Types, Utensils, and Scenarios		T: Incense types, including stick incense, coil incense, seal incense.  U: Incense utensils, including traditional censers, sachets, innovative products.  S: Incense scenarios, including museums, Minnan-specific ritual ceremonies, and home/office use. 

Table 2. *Cont.*

Variable	Definition	Measurement Items
Cultural Recognition of Minnan Natural Incense Culture	The degree of acceptance of the cultural value and inheritance of incense culture	R1. I have a strong sense of cultural identity with Minnan natural incense culture. R2. I am willing to actively participate in promotional and experiential activities related to Minnan natural incense culture. R3. I am willing to purchase related products to experience Minnan natural incense culture (within an acceptable price range). R4. I will recommend Minnan natural incense culture experiences to others. (1 = strongly disagree, 5 = strongly agree)

Basic information: Demographic data including age, gender, religious practice experience, and birthplace (Minnan/Taiwan or other regions).

User attitudes, subjective norms, and perceived control variables: Adapted from TPB/RTPB-related scales to reflect sustainable heritage-related behavioral cognition.

Incense types, utensils, and scenarios: Measured according to empirical observations.

Dependent variable: Cultural recognition of Minnan natural incense culture as a sustainability-related cognitive outcome. In addition, semi-structured open-ended questions were included to support the development of innovative design strategies.

These constructs jointly describe users' cognitive and contextual mechanisms underlying sustainable engagement with intangible cultural heritage [27].

Attitude: Users' positive or negative evaluations of Minnan natural incense culture. Subjective norm: Perceived social pressure from peers, family, or media regarding incense culture. Perceived internal control: Users' confidence in their knowledge and ability to understand incense culture. Perceived external control: Users' reliance on environmental cues and situational support. Incense types, utensils, and scenarios: Different categories of incense, tools, and application contexts. Cultural recognition of Minnan natural incense culture: Emotional identification, willingness to purchase, participate, and recommend.

4. Results

4.1. Data Collection and Sample Description

The questionnaire survey was distributed through an Internet platform using a combination of self-distribution, commissioned survey company distribution, dissemination via university departments, social media platforms, and on-site surveys in surrounding districts of Xiamen. Data collection was completed in May 2025.

A total of 208 questionnaires were returned. To ensure data quality and response validity, invalid responses were systematically screened and excluded according to the following pre-established inclusion and exclusion criteria: (1) extremely short completion time, indicating insufficient attention and a lack of thoughtful consideration (thus rendering the data unreliable); (2) patterned or straight-lining responses, such as selecting the same extreme value (e.g., predominantly 1 or 5 on the Likert scale) across a large number of items, which compromises the scientific rigor and validity of the responses; and (3) responses from ineligible participants. After applying these criteria, 179 valid questionnaires remained, yielding an effective response rate of 86.1%.

As shown in Table 3, the age distribution of the respondents was mainly concentrated in the 18–25 age group, accounting for 70% of the total sample, with other age groups also represented. The gender distribution was relatively balanced (male 46.15%, female

53.85%). Respondents from the Minnan and Taiwan region accounted for 63.46%, while 36.54% were from other regions. Nearly half of the respondents reported being familiar with religious incense practices or had participated in incense burning rituals. This indicates that the sample distribution is relatively balanced across different demographic segments, ensuring the representativeness and credibility of the findings.

Table 3. Descriptive statistics of the sample.

Survey Variable	Description	Sample Size	Percentage (%)
Age	Under 18	19	9.13%
	18–25	70	33.65%
	26–35	38	18.27%
	36–45	42	20.19%
	Above 46	39	18.75%
Gender	Male	96	46.15%
	Female	112	53.85%
Place of Origin	Minnan/Taiwan	132	63.46%
	Other regions	76	36.54%
Familiarity with Religious Incense Practices	Yes	86	41.35%
	No	122	58.65%
Participation in Religious Incense Rituals	Yes	90	43.27%
	No	118	56.73%

This study adopted partial least squares structural equation modeling (PLS-SEM) rather than covariance-based structural equation modeling (CB-SEM) for the following reasons. First, the sample size of this study (N = 179) is relatively small-to-moderate. PLS-SEM requires a smaller sample size and provides greater statistical power compared with CB-SEM [31]. Second, the present research is exploratory in nature, with the primary focus on prediction and theory extension rather than on strict parameter estimation and confirmatory testing. Third, the proposed model incorporates multiple mediation effects and higher-order constructs; PLS-SEM is more robust in handling complex models and non-normally distributed data. Although CB-SEM offers stricter model fit indices, its advantages are not evident in small-to-moderate sample sizes or prediction-oriented studies. Therefore, PLS-SEM was considered the more appropriate analytical approach for this study.

For data analysis, this study applied partial least squares structural equation modeling (PLS-SEM) [32], which is particularly suitable for handling complex path models in exploratory research involving sociocultural and psychological factors [33]. Due to its robustness and reliability with relatively small sample sizes, Smart PLS 3.0 was [33] employed to test the research model (see Figure 7).

4.2. Measurement Model Analysis

4.2.1. Reliability and Validity Analysis

All constructs were measured using scales. Cronbach's alpha was used to test internal consistency [34]. Values between 0.6–0.7 indicate acceptable reliability, 0.7–0.8 good reliability, and above 0.8 very good reliability. In this study, Cronbach's alpha values of the six constructs ranged from 0.6–0.8, indicating generally good reliability.

Convergent validity was assessed through average variance extracted (AVE) and composite reliability (CR). Following Fornell et al., CR values greater than 0.7 and AVE [35] values above 0.5 indicate adequate convergent validity. As shown in Table 4, the lowest AVE value was 0.504, confirming convergent validity. Discriminant validity was tested using

the Fornell–Larcker criterion, which compares the square root of AVE with inter-construct correlations. As shown in Table 5, the square roots of AVE exceeded the corresponding correlations, confirming discriminant validity [36].

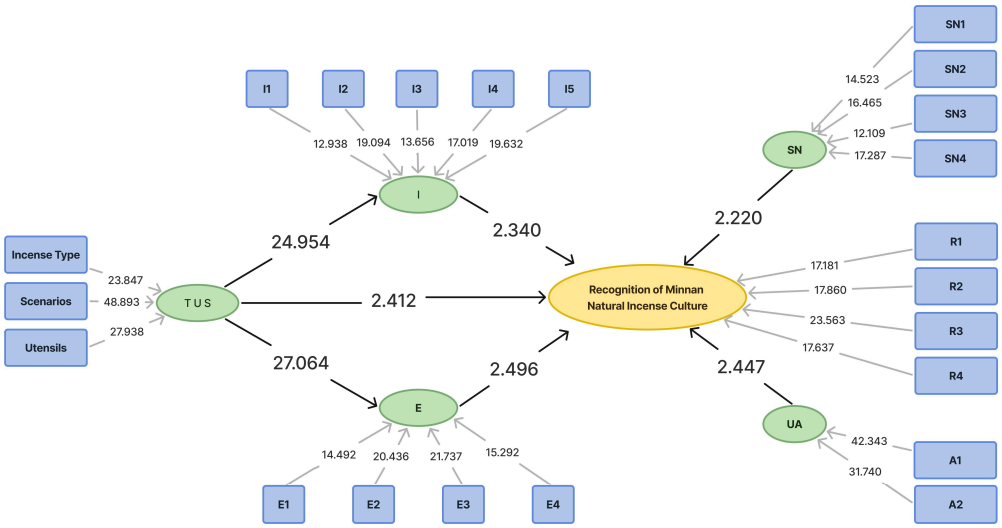


Figure 7. Structural equation testing of the research model (authors' own work).

Table 4. Reliability and validity results for the measurement constructs.

Construct	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)
Perceived Internal Control (I)	0.753	0.835	0.504
Perceived External Control (E)	0.734	0.834	0.557
Incense Types, Utensils, and Scenarios (T U S)	0.728	0.847	0.649
User Attitude (A)	0.679	0.861	0.757
Subjective Norm (SN)	0.698	0.816	0.526
Cultural Recognition of Minnan Natural Incense (R)	0.744	0.839	0.565

Table 5. Discriminant validity.

Constructs	I	E	U C S	A	SN	R
Perceived Internal Control (I)	0.710					
Perceived External Control (E)	0.731	0.746				
Incense Types, Utensils, and Scenarios (T U S)	0.761	0.777	0.806			
User Attitude (A)	0.627	0.542	0.639	0.870		
Subjective Norm (SN)	0.721	0.729	0.754	0.622	0.725	
Cultural Recognition of Minnan Natural Incense (R)	0.718	0.707	0.731	0.623	0.712	0.752

4.2.2. Structural Model Analysis

The explanatory power of endogenous variables was evaluated using R^2 values, with thresholds above 0.2 considered acceptable [37]. As shown in Table 6, the model demonstrated strong explanatory power. Bootstrapping with 5000 resamples was applied to test the significance of path coefficients. Results are summarized in Tables 7 and 8.

Table 6. Explanatory power of the model.

Construct	R^2	Adjusted R^2
Perceived Internal Control (I)	0.580	0.578
Perceived External Control (E)	0.603	0.601
Cultural Recognition of Minnan Natural Incense (R)	0.649	0.639

Table 7. Hypothesis testing results.

Hypothesis	Path	Coefficient	Std. Dev.	T-Value	*p*-Value	Result
H1	I → R	0.196	0.084	2.340	0.019	Supported
H2	E → R	0.195	0.078	2.496	0.013	Supported
H7	T U S → I	0.762	0.031	24.954	0.000	Supported
H6	T U S → E	0.777	0.029	27.064	0.000	Supported
H5	T U S → R	0.189	0.078	2.412	0.016	Supported
H4	A → R	0.158	0.065	2.447	0.014	Supported
H3	SN → R	0.188	0.085	2.220	0.026	Supported

Table 8. Mediation effect analysis.

Hypothesis	Mediation Path	Coefficient	Std. Dev.	T-Value	*p*-Value
H7	T U S → I → R	0.149	0.064	2.330	0.020
H6	T U S → E → R	0.151	0.061	2.481	0.013

All seven hypotheses (H1–H7) were supported ($p < 0.05$). Specifically:

H1 (I → R): Perceived internal control had a significant positive effect on cultural recognition of Minnan natural incense. H2 (E → R): Perceived external control also exerted a significant positive effect. H5 (T U S → R): Incense types, utensils, and scenarios had a moderately positive direct effect. H3 and H4: Subjective norms and user attitudes positively influenced cultural recognition, though with weaker effects. Furthermore, the mediation effects were significant: T U S → I → R (path coefficient = 0.149, $p = 0.020$), with indirect contribution accounting for 78.8% of the direct effect. T U S → E → R (path coefficient = 0.151, $p = 0.013$), contributing 79.9%. These findings suggest that incense types, utensils, and scenarios influence cultural recognition primarily through enhancing perceived internal and external control, with indirect effects outweighing direct effects, thereby validating H6 and H7.

4.3. Minnan Natural Incense Innovative Design Strategies

4.3.1. The Proposal of Design Strategies

This study utilized the standardized latent variable scores generated by SmartPLS 3.0 to classify the 179 respondents. Taking the mean value (≈0) of the perceived internal control construct score as the threshold, respondents scoring higher than 0 on perceived internal control were classified as central-route users ($n = 102$, 57.0%), while those scoring 0 or below were classified as peripheral-route users ($n = 77$, 43.0%). As shown in Table 9 (descriptive statistics of latent variables), both perceived internal control and perceived external control exhibited substantial individual differences (standard deviation ≈ 1.000), providing a solid empirical basis for this classification. This approach is highly consistent with the ELM theory's premise that differences in cognitive motivation lead to divergent processing routes, and its validity is further supported by the subsequent path analysis results (both H1 and H2 were significant).

Table 9. Descriptive statistics of latent variables.

Latent Variable	Mean	Median	Min	Max	SD	Excess Kurtosis	Skewness	N
Perceived Internal Control	0.000	0.237	−2.488	1.861	1.000	−0.267	−0.741	179.000
Perceived External Control	0.000	0.279	−2.580	1.453	1.000	0.028	−0.920	179.000

As shown in Table 10, effect size analysis further revealed that incense type, utensils, and scenarios exerted large effects on perceived external control and perceived internal control, with f^2 values reaching 1.383 and 1.519, respectively (large effects), while their direct effects on cultural recognition were only 0.028 (small effect). This result clearly explains the dominance of indirect effects (79–80%): design variables primarily influence cultural recognition indirectly by enhancing users' perceived behavioral control, rather than exerting a direct effect.

Table 10. Effect size analysis (f^2) among latent variables.

Predictor (Independent Variable)	PIC [1]	PEC [2]	CR [3]
Incense types, utensils, and scenarios	1.383	1.519	0.028
PIC	—	—	0.036
PEC	—	—	0.035
User attitude	—	—	0.037
User's subjective norm	—	—	0.034

[1] PIC = Perceived Internal Control. [2] PEC = Perceived External Control. [3] CR = Cultural Recognition of Minnan Natural Incense. f^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively [37]. The large f^2 values (1.383 and 1.519) of design variables on PIC and PEC, together with their small direct effect (0.028) on CR, clearly demonstrate the dominance of indirect effects (79–80%) in the model.

Based on the seven hypotheses validated through the structural equation modeling [38], the RTPB–ELM model confirms hypotheses H1–H4 as the antecedent factors influencing users' cultural recognition of Minnan natural incense culture, while hypotheses H5–H7 further verify that incense types, utensils, and scenarios directly and indirectly affect users' cultural recognition. In practical design, following the information-processing paths defined by the ELM model, users can be segmented into two groups: those adopting the central route and those adopting the peripheral route. Central-route users rely more on rational analysis (perceived internal control), focusing on cultural connotations and logical reasoning, and tend to prefer in-depth cultural experiences [39] during travel. Peripheral-route users, in contrast, depend more on sensory impressions (perceived external control), emphasizing direct product experience and contextual atmosphere, and in potential consumption scenarios, they pay greater attention to practicality [40] and aesthetic appeal when purchasing cultural and creative souvenirs. Accordingly, innovative design strategies for Minnan natural incense are proposed, as summarized in Table 11.

4.3.2. Design Practice and Verification

To further validate the feasibility and practical applicability of the RTPB–ELM decision-support model, targeted design practices were conducted using the differentiated strategies derived from Table 11. The design process explicitly followed the keyword extraction from the perceived internal control (I1–I5) and perceived external control (E1–E4) items, ensuring every prototype was grounded in the SEM results and scale measurements rather than speculation.

Table 11. Design strategies.

User Classification Criteria	Empirical Basis	Design of Keyword Extraction	Design Strategies	Product (System) Design
Central-route users (n = 102, 57%)	H7: T U S → I → R β = 0.149 H1: I → R β = 0.196	I1: Historical origins, ritual connotations → Types: signed stick incense I2: craftsmanship, symbolic meaning → Utensils: private traditional I3: Systematic knowledge, logical reasoning → Scenarios: official cultural promotion I4: Core value of Minnan natural incense → All three variables I5: Making incense, participating in rituals → Scenarios: religious rituals	1. Develop the "Decoding Minnan Natural Incense Cultural Genes" product series: integrate historical narratives of incense-making and usage into experiential products	Handcrafted artisanal incense, high-end customized incense
			2. Establish Minnan incense pop-up stores with short lectures and experiential workshops (paid) to enable central-route tourists to deeply learn and understand Minnan natural incense	Minnan incense culture pop-up store brand service design system: Premium workshop, quality incense products
Peripheral-route users (n = 77, 43%)	H6: T U S → E → R β = 0.151 H2: E → R β = 0.195	E1: Intuitive situational experience → Types: coil & seal incense E2: Participation in activities (worship, exhibitions) → Utensils: public temple burners E3: Traditional Minnan elements → Scenarios: religious rituals & lifestyle leisure E4: Innovative experiential settings → Scenarios: lifestyle & leisure practices.	1. Develop creative products for household use 2. Minnan incense-themed fragrance gift boxes 3. Pop-up interest checkpoints in tourism settings: quick, experiential formats to promote incense products.	1. Intelligent electronic incense devices 2. Travel souvenirs (design for promoting Minnan natural incense culture)
			4. Leverage media channels for promotion	1. Brand official short videos showcase the incense-making process, creatively popularizing knowledge of Minnan's natural incense culture 2. Celebrity and influencer KOLs experience and recommend

For central-route users (high perceived internal control), the design prioritized historical origins, ritual connotations, craftsmanship, and systematic knowledge (I1–I5). All design prototypes in this section were generated with the assistance of AIGC tools (Gemini 2.5 Flash Image (Nano Banana) and Jimeng AI 3.0). The authors subsequently reviewed, edited, and refined all AI-generated content to ensure cultural authenticity, alignment with the RTPB–ELM empirical results, and compliance with academic standards.

Through AIGC co-creation, a flagship store brand for Minnan incense cultural handicrafts was developed, primarily offering paid craft experiences and premium incense product sales (Figure 8). The store layout integrates traditional temple-style incense burners with modern interactive ritual spaces, directly responding to I5 (making incense, participating in rituals) and I3 (systematic knowledge learning).

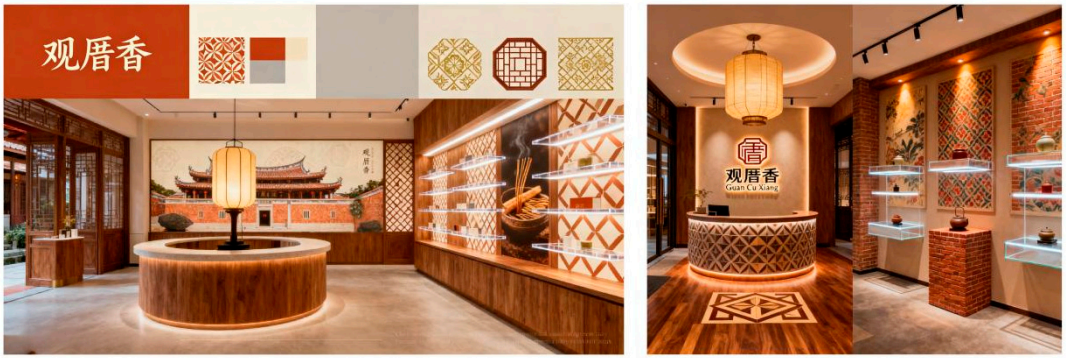


Figure 8. AIGC-generated flagship store for Minnan incense cultural handicrafts designed for central-route users. The layout integrates historical ritual elements (I1, I5) with interactive craft workshops, directly derived from perceived internal control keywords and H1/H5 paths.

For peripheral-route users (high perceived external control), the design emphasized intuitive situational experience, participation in activities, and innovative experiential settings (E1–E4). An innovative household intelligent Minnan-style incense lamp was designed (Figures 9–11). This product retains core traditional Minnan stylistic features (E3) while transforming conventional incense burning into a modern, electronically controlled heating system with app-based scent diffusion and ambient lighting, aligning with E1 (intuitive situational experience) and E4 (innovative experiential settings). A cloud-based cultural community platform was also integrated (Figure 9) to facilitate brand sharing and low-effort cultural exchange (E2).

Verification was performed through a targeted expert review involving three domain specialists (two professors in cultural heritage design and sustainable tourism with over 10 years of ICH experience, and one senior designer from a national intangible cultural heritage protection center). Experts evaluated the prototypes against the SEM paths (H1–H7), mediation effects (78–80% indirect), and the keyword mappings in Table 9. Consensus feedback confirmed:

> *"The central-route flagship store and craft experiences directly operationalize the strong internal control paths, providing users with logical, knowledge-driven engagement."*
>
> *"The intelligent incense lamp and community platform effectively address peripheral-route needs through sensory and effortless experiential cues, matching."*
>
> *"AIGC-assisted generation ensured rapid iteration while maintaining cultural authenticity; the keyword-to-design mapping demonstrates rigorous theoretical grounding."*

Figure 9. Exterior and product details of the household intelligent Minnan-style incense lamp. Traditional Minnan motifs (E3) are combined with modern electronic heating and ambient lighting (E4).

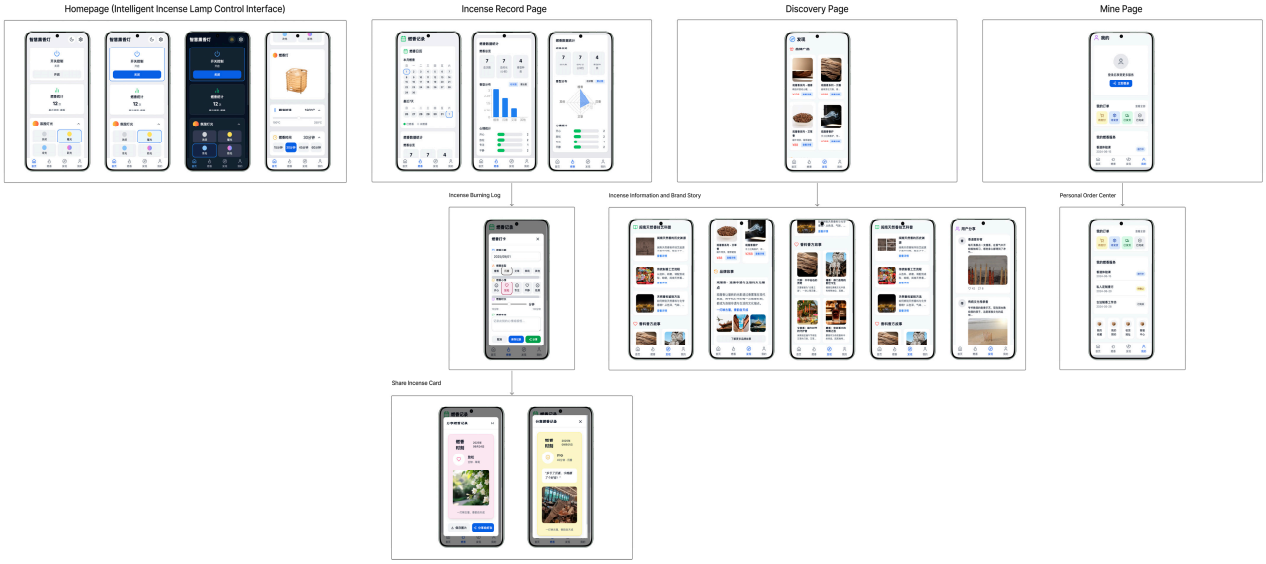


Figure 10. Cloud-based cultural community platform and intelligent incense lamp interface. The platform supports low-effort sharing (E2), while the lamp provides an intuitive situational experience (E1) for peripheral-route users.

Figure 11. Usage scenarios of the intelligent incense lamp in lifestyle and leisure contexts, demonstrating the transformation from traditional burning to innovative experiential settings.

These expert validations, combined with the explicit linkage between scale items, SEM results, and design keywords (Table 9), confirm the rationality and real-world applicability of the proposed practices. The RTPB–ELM model thus proves to be a robust decision-support tool for sustainable heritage-based design innovation.

Additionally, a series of creative daily-use products featuring natural fragrances from Southern Fujian—such as an incense tablet and incense chip bookmark—was developed (Figure 12). These items blend traditional seal and coil incense forms with contemporary aesthetics, targeting lifestyle and leisure scenarios while preserving symbolic meaning.

Figure 12. Series of creative daily-use products (incense tablets, pouches, and pendants) developed using seal and coil incense forms. Designs blend traditional craftsmanship (I2) with contemporary aesthetics to serve both user routes.

5. Conclusions and Discussion

This study demonstrates that cultural recognition functions not merely as an outcome of user cognition but as a dynamic mechanism that shapes sustainability transitions within heritage-based systems. By empirically validating the RTPB–ELM framework, the findings reveal how behavioral intention, cognitive processing routes, and contextual design variables interact to influence cultural recognition pathways. Rather than viewing heritage preservation as a static act of safeguarding craftsmanship, this research conceptualizes it as an adaptive socio-cultural system in which user cognition mediates long-term transformation and continuity. In this sense, the proposed model contributes to sustainability transition research by identifying micro-level behavioral drivers that collectively influence macro-level cultural resilience and future-oriented innovation trajectories.

The results demonstrate how behavioral design theory can be operationalized to transform behavioral intention into cultural recognition. By quantifying psychological drivers such as attitudes, subjective norms, and perceived behavioral control, the RTPB framework provides a scientific tool for predicting users' acceptance of ICH-related products and experiences. This contributes to sustainability-oriented design decision-making by enabling designers to identify behavioral motivations, detect barriers to cultural recognition, and strategically guide product and service interventions at an early design stage.

The integration of consumer information processing theory with behavioral design theory enables effective user segmentation. The combined RTPB–ELM framework distinguishes two types of user cognition—central-route users and peripheral-route users—revealing differentiated cultural recognition mechanisms. Central-route users rely primarily on rational cultural interpretation and internal perceived control, whereas peripheral-route users are more influenced by sensory experience, situational atmosphere, and external environmental cues. This differentiation supports the construction of precise user profiles and facilitates the development of adaptive design strategies for sustainable heritage engagement, including tailored incense experiences, branding narratives, and multisensory cultural interactions.

Beyond its theoretical and design implications, this study offers insights for intangible cultural heritage protection and management policies [41]. The findings suggest that cultural recognition should be regarded as a key supporting indicator within sustainability-oriented heritage governance, rather than focusing solely on the preservation of craftsmanship itself. Compared with a singular emphasis on technical transmission, users' cultural recognition more directly influences participation, purchasing, and dissemination intentions.

Accordingly, it is recommended that cultural management authorities incorporate a cultural recognition assessment mechanism into the monitoring and evaluation systems of ICH projects. Such an approach would enable the optimization of protection strategies and scenario design based on user experience. The results further indicate that perceived external control—such as ritual atmosphere and immersive experiential settings—significantly enhances cultural recognition. Therefore, local governments are encouraged to collaborate with museums, cultural institutions, and creative industries to develop more interactive and participatory incense culture experience scenarios. These measures can strengthen public engagement and contribute to the sustainable revitalization of intangible cultural heritage.

6. Core Contributions

Theoretical Contribution

By integrating the extended theory of planned behavior with the elaboration likelihood model, this study proposes the RTPB–ELM integrated framework, offering a novel

interdisciplinary approach for explaining cultural recognition mechanisms in intangible heritage contexts.

Methodological Contribution

This study pioneers the application of the ELM model to incense culture research and develops a 22-item cultural recognition scale specifically for Minnan natural incense culture. Empirical results confirm the roles of user attitudes, subjective norms, perceived internal and external control, as well as incense-related variables (types, utensils, and scenarios), thereby clarifying how cultural recognition mediates between user cognition and heritage-related behavior.

Practical Contribution

By proposing differentiated design strategies for distinct user cognition routes and validating them through design practice, this research demonstrates the feasibility of applying the RTPB–ELM framework in real-world heritage-based innovation. The findings provide actionable guidance for designers, cultural practitioners, and heritage managers engaged in sustainable cultural transmission.

It is important to note that in practical design processes, central-route and peripheral-route users cannot be strictly separated. The proposed framework functions as a preliminary decision-support tool for designers, guiding strategy formulation based on dominant user tendencies rather than rigid classification. Users' cognitive routes may shift over time, and interactions between the two routes can jointly influence decision-making. Consequently, design solutions addressing both routes are not contradictory but complementary. When strategically integrated, they can support more comprehensive brand positioning and enhance the adaptability of heritage-based products, thereby attracting broader user groups and supporting sustainable cultural revitalization.

7. Limitations and Future Research

Despite its contributions to sustainable heritage-based design innovation through the RTPB–ELM framework, this study has several limitations. First, the sample was predominantly composed of younger participants (70% aged 18–25) from the Minnan and Taiwan regions. Although this demographic focus directly addresses the generational gap in intangible cultural heritage (ICH) transmission highlighted in the introduction—where industrial substitutes, changing lifestyles, and declining engagement among younger generations have weakened traditional pathways—it may limit the generalizability of the findings to older age groups and non-regional users. Second, data collection relied primarily on online questionnaires, which may introduce self-selection bias. Third, while expert review and AIGC prototyping provided strong preliminary validation within the project timeframe, the differentiated effects of incense-related design variables (types, utensils, and scenarios) across user groups were not fully quantified through large-scale field testing.

To enhance the reproducibility of this research work, the study provided detailed descriptions in the Section 3 of the questionnaire design process, scale sources, SmartPLS 3.0 analysis parameters, and user classification method (perceived internal control score > 0). Other researchers can therefore fully replicate the statistical results and classification process using the same analytical workflow.

Future research could expand the sample structure to include more diverse age groups and geographic regions and incorporate real-market feedback to further refine the design strategies. By integrating user segmentation based on cultural recognition levels, subsequent studies may construct labelled user models to guide differentiated brand innovation and sustainable product–service system design for intangible cultural heritage.

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data curation, writing—original draft preparation, writing—review and editing, visualization, supervision, project administration, and funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Xiamen Academy of Arts and Design, Fuzhou University (Project identification code: REA250601-01) on 1 June 2025.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Due to the anonymous nature of the online questionnaire survey, written informed consent was not required.

Data Availability Statement: The data supporting the findings of this study are openly available in Zenodo at https://zenodo.org/records/18783986 (accessed on 26 February 2026), reference number https://doi.org/10.5281/zenodo.18783986.

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

Abbreviations

The following abbreviations are used in this manuscript:

RTPB	Revised Theory of Planned Behavior
ELM	Elaboration Likelihood Model
ICH	Intangible Cultural Heritage
PLS-SEM	Partial Least Squares Structural Equation Modeling
AIGC	Artificial Intelligence Generated Content

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