

Article

Efficiency Assessment Method for Evoking Cultural Empathy in Symbolic Cultural and Creative Products Based on Fuzzy-FMEA

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Abstract: To address the issue of user empathy throughout the emotional experience process, this study presents a method to evaluate the efficacy of cultural empathy evoked based on fuzzy-FMEA. The method focuses on symbolic culture and creative products, constructing an evaluation index system and decision-making framework in terms of cultural empathic evoking. It utilizes thematic analysis to discover and categorize the factors that influence cultural empathy, as well as an evaluation index system to improve the Failure Mode and Effects Analysis framework. It effectively solves the limitations of traditional FMEA, such as single weighting and uncertainty. According to the assessment report, cognitive association failure and scenario restoration failure are significant risk factors for cultural empathy-evoking failure. This study's findings provide designers with realistic proposals for thematic symbolic imagery and serialized design forms, as well as scientific assessment tools and decision-making resources for cultural industries and policymakers.

Keywords: symbolic cultural and creative products; the evaluation index system; cultural empathy evoking; fuzzy-FMEA; emotional experience



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1. Introduction

With the promotion of the cultural creativity industry, consumers are more concerned than ever about their own perceptual needs in terms of consumption. Symbolic Cultural and Creative Products (CCPs) link culturally with people through culture, symbols, and color, aiming to transmit information and emotions [1,2]. These products are more likely to provoke emotional responses than ones that emphasize beauty or functionality. Currently, product design focuses primarily on scenario reconstruction analysis and symbol extraction from cultural themes [3]. Product assessment is also extensively utilized as an effective way to reduce risk and increase product relevance [4,5]. By assessing and addressing this issue, it is possible to streamline production processes and increase their system efficiency while reducing costs [6]. After reviewing related research, the precise interpretation of symbols may assist customers in better understanding culture, leading to emotional connections. Thus, symbolic CCPs as objects may be evaluated for their cultural empathy-evoking efficacy in order to motivate design optimization, stimulate psychological emotions, and awaken cultural empathy.

As cultural features become increasingly important, an increasing number of symbolic CCPs decode cultural implications into symbolic connections [7]. However, poor design

responses to cognitive information, such as semantic interpretation, symbol association, and aesthetic impression [8], tend to cause negative emotions in users and even affect the experience because the initiator is the product in the service process. From the perspective of emotional experience [9–12], this research focuses on evaluating the empathy-evoked efficiency of symbolic CCPs in the process of symbol cognition and cultural interpretation. In recent years, Failure Mode and Effects Analysis (FMEA) has been widely utilized to analyze the impact of failure models on product service performance. To overcome uncertainty and cognitive aberrations, several scholars have developed traditional FMEA improvement methods such as “risk ranking”, “extended FMEA”, “gray theory”, and “fuzzy inference” [13]. Although some achievements have been made in the design and evaluation of symbolic CCPs, some serious issues have been ignored. First of all, the existing index system mainly focuses on functional or aesthetic assessments. However, it ignores the critical aspect of evoking cultural empathy. Second, it is still a challenge to identify the ambiguous linguistic evaluation of users and the differences in experience brought about by different cultural backgrounds in the service process. At present, there is a lack of systematic assessment methods and optimization strategies that clarify the goal of symbol design and product development and improve the empathic efficacy of symbolic CCPs for users. As a result, this study aims to present new perspectives and methods for evaluating and designing cultural empathy-evoking in symbolic CCPs.

Therefore, two challenges need to be solved in order to evaluate the efficiency of cultural empathy evoked towards symbolic CCPs. One challenge is to construct a methodical way to rate the emotional impact of symbolic CCPs, as well as to figure out what each part of the user’s emotional journey needs by quantitative analysis and cluster analysis [14]. Another challenge is to enhance index transformation and the fuzzy-FMEA method. The improved cultural empathy evoking effectiveness evaluation method effectively addresses individual cognitive variations as well as the ambiguity of users’ fuzzy perceptions by transforming indicators using a two-layer assessment model and identifying and evaluating key touchpoints. This study aims to give evaluation standards and decision-making references for judging how well symbolic CCPs evoke cultural empathy, based on the ideas of systematization, comprehensiveness, and usability.

The subsequent sections of this paper are structured as follows: The related works are shown in Section 2. In Section 3, the research scenario and procedure are briefly described. In Section 4, the research method and design process are mainly discussed, including establishing an evaluation system, transforming new risk assessment factors by evaluation standards, finding key assessment contents by evaluation indicators, identifying failure risk of key touchpoints by FMEA, and clarifying the priority of touchpoints with high risk. A case study of design practice is provided in Section 5. Finally, Section 6 contains a discussion of future work and the conclusion.

2. Literature Review

To identify research-worthy priorities from complex service processes, the three research methods, cultural empathy in product design, evaluation methods in CCPs, and fuzzy-FMEA, presented in the relevant literature are highly informative.

2.1. Cultural Empathy in Product Design

Empathy study focuses on defining the notion, discussing its qualities, and analyzing its structure [15,16]. Empathy is an individual’s ability to sense or envision the emotional state of others, comprehend and experience those emotions, and then react accordingly. It is the process of feeling other people’s emotions, emphasizing the ability to empathize with others [17]. Many scholars believe that empathy possesses objectivity, heterogene-

ity, and variability, and they analyze it through the lenses of emotional empathy and cognitive empathy.

Cultural empathy is a process of recognizing and connecting with a product's cultural meanings and historical roots, based on its cultural qualities and implicit conceptual knowledge. Product design may affect customers' choices, purchases, and comprehension of information, generating a distinct evaluation of the product, improving understanding, and eliciting emotional responses [18]. Cultural empathy in product design may be described as a cognitive and emotional response to visual information or cultural elements during the product experience [19]. Cultural empathy is crucial for product design and significantly influences consumer choices [20]. Product effectiveness is another important aspect that influences customer decisions. Some studies indicate that products must possess functional efficacy [21], social efficacy [22], and emotional efficacy. Symbolic CCPs propagate culture by symbol elements, and their effectiveness is assessed not just by functionality and visual appeal. More importantly, they should be able to attract customers [23], satisfy their needs, help users understand cultural connotation and historical scenarios [24], and achieve emotional resonance. As a consequence, in addition to their visual appeal, utility, and cultural cognition, symbolic CCPs should elicit cultural empathy.

Related studies analyzed product efficiency from several viewpoints, including emotional efficacy and cultural empathy, offering essential insights for comprehending the design of CCPs. Nevertheless, research methodologies have predominantly depended on case studies and theoretical insights, without a formal assessment framework, which constrains comprehensive examination and optimization of cultural empathy during the early phases of product design. This study attempts to assess product effectiveness using the efficacy of cultural empathy-evoking and employing a simulated experience design to accurately capture consumers' positive feelings and influential factors during the experience.

2.2. Evaluation Methods in CCPs

Product efficacy or market attributes are often employed as indicators to evaluate CCPs and provide optimization solutions. Symbolic CCPs disseminate cultural value with symbol elements, and studies have been conducted to explore the evaluation standards from a variety of fields. Hu (2023) constructed the perceptual evaluation of local cultural situation display from the two dimensions of display elements and display forms [25]. Wang (2024) constructed an evaluation index system for the discourse power of intangible cultural discourse from the standpoint of the foundation, communication, and creativity of intangible cultural heritage [26]. Ren (2024) established a structural equation model of local evaluation, including three dimensions: physical landscape, human action, and local significance [27]. It is necessary to enrich the system with different theories or methods. One case used the comprehensive index method to construct an evaluation index system of aesthetic culture and functional evaluation on colored leaf forests [28]. Zhang (2023) evaluated the application of a generated pop art style image on cultural and creative products from the perspectives of cultural factors: innovation factor, experience factor, and design expression factor [29].

Despite scholars having completed a detailed and varied investigation from several perspectives, these studies mostly focus on certain fields or cases, lacking a comprehensive index system for evaluating cultural empathy evoked by symbolic CCPs. Furthermore, assessment methods frequently rely on surveys and expert ratings, which may be affected by individual factors. Although current research provides valuable references and insights, further integration and refinement of assessment methods are necessary to provide a more objective and comprehensive evaluation system.

2.3. Fuzzy-Failure Mode and Effects Analysis (Fuzzy-FMEA)

Failure Mode and Effects Analysis (FMEA) is a proactive risk assessment approach that identifies, prioritizes, and takes action on known or potential system failure modes before they occur. It is widely utilized in a variety of industries to ensure security and dependability. In recent years, academics at home and abroad have integrated traditional FMEA into the Product Service System (PSS). Yousaf et al. (2023) employed the risk priority number of FMEA to completely assess and identify five key failure modes in the design and production process of automobile rear axle housing, therefore improving product and service quality [30]. He et al. (2020) offered a two-stage Failure Mode and Effects Analysis (FMEA) approach to optimize crucial components and systems in offshore wind turbines [31]. The proposed method was given along with its application in assessing the risk of an intelligent household appliance servicing system [32]. Song (2024) proposed a structural design decision model that combines FMEA and TRIZ to create product designs that meet user demands [33].

However, there are some drawbacks to using the traditional FMEA analysis method in practice, such as oversimplification due to the same weight of failure risk elements, difficulty accurately evaluating the three failure risk factors, and difficulty reflecting the fuzzy uncertainty evaluation method. Experts at home and abroad proposed the fuzzy-Failure Mode and Effects Analysis (fuzzy-FMEA) approach, which uses fuzzy logic to improve the risk assessment process [34]. Goksu and Arslan (2023) employed a rule-based fuzzy failure mode and impact analysis approach to assess possible hazards that might arise during propagation operations [35]. Ribas (2021) used fuzzy-Failure Mode and Effects Analysis to continuously monitor and enhance the structural components of hydropower facilities [36]. To deal with experts' doubts and vague ideas, Kushwaha (2022) suggested a combined system using IF-FMEA and IF-TOPSIS to sort the listed failure causes in order of how similar they are to the ideal solution [37]. Zhao et al. (2023) used image fuzzy set theory to improve the three basic processes, making expert assessment more efficient and accurate [38].

Although the fuzzy-FMEA method efficiently resolves ambiguity, it has several limitations when dealing with varied cultural emotional experiences, such as ignoring user cognitive biases resulting from various cultural backgrounds and failing to classify user demands on multiple levels. Some studies tried to combine fuzzy-FMEA with other methods to solve issues [39], which gave us insights. We should integrate the index system with fuzzy-FMEA, using a staged approach to addressing various concerns.

3. Research Scenario and Methodology

3.1. Participant Selection

The choice of sample size has long been a contentious issue in qualitative research. Mason (2010) noted that the average sample size in action research, case studies, grounded theory research, life history research, and phenomenology research is 23, 36, 32, 23, and 25, respectively [40]. Many scholars have emphasized the principle of "multiples of 6". The sample size of this study was set at 31, and 7 of them were chosen to form the FMEA expert group. This sample size meets the theoretical saturation test in the data analysis in Section 4 and is thus considered reliable and universal.

We selected 31 people for a test group that would engage in the experiment and gather pertinent data. Almost all of them were university students aged 21 to 42 (19 women), with an average age of 27.22. The participants were in good enough health to finish the experiment and volunteered to participate in the investigation. Among them were 9 senior users who frequently purchased CCPs, 8 potential users who were interested in CCPs, 14 professional users with professional skills and knowledge, 7 designers of products, and

7 culture-related volunteers. Potential users have little cognition and expertise with the service process for CCPs. Thus, their data may represent the true impact of the touchpoint design. Senior users and professional users are acquainted with the product's servicing process and have specific inspection and associated professional expertise, and their data might suggest higher criteria for touchpoint design, assisting people to identify more unobvious points.

Due to the fact that multiple responsible parties for FMEA implementation have different backgrounds, knowledge levels, and opinions [41], these factors influence the adaptation of volunteers to product services. A new expert assessment group was formed from the test group by selecting two experienced users, one potential user, two designers, and two cultural practitioners. The benefit is that the connections between FMEA participants can be strengthened, and a collective solution with a high degree of acceptability to the FMEA problem can be yielded.

3.2. Simulation Scenario and Procedure

In addition to meeting functional demands, CCPs emphasize the unique emotional experience that the product provides to the consumer in terms of beauty and sensitivity [42]. Because the effect of cultural empathy between people and products cannot be evaluated through direct language descriptions [43], experimental data should be collected through simulated situations and experiences.

Design simulation scenarios and experience processes first identify the beginning and end points of the user experience, and then grind the logical sequence of events in the process of cultural empathy arousal to determine the experience process. Unlike basic utilitarian items, symbolic CCPs often make contact with the consumer throughout the stage of capturing attention. The purpose of this article is to evaluate if CCPs can correctly transmit culture and elicit empathy through symbols. As a result, the team designed a simulated scenario in which the product attracted user attention at the beginning, the user interpreted culture in detail, and the user elicited pleasant emotions at the end.

To ensure that volunteers experience each scene as comprehensively as possible, as shown in Figure 1, volunteers were asked to perform an immersive experience in a simulated environment, including attraction, symbol recognition, product understanding, cultural interpretation, emotional linkage, and identity. The experience lasted around 8 to 12 min. The experimental process was documented using a camera, images, and audio. User experience data in a simulated scenario may assist the team in analyzing the underlying reasons that impact user cultural empathy.

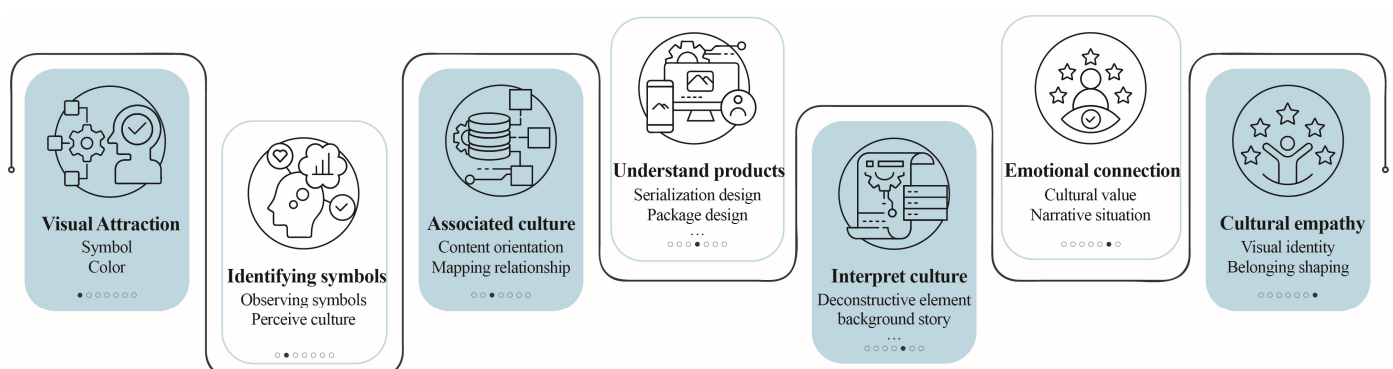


Figure 1. Experience process of symbolic CCPs.

4. Research Method

To solve some failures in the cultural empathy arousal process of symbolic CCPs, a systematic method is necessary to identify potential failure modes and lead to design optimization, ultimately enhancing the service process. We tested how well symbolic CCPs work at evoking cultural empathy in this study by adding an evaluation index system to the fuzzy-FMEA assessment framework. The method is divided into three stages: the first is the construction of an evaluation index system for evaluating the cultural empathy of symbolic CCPs; the second is the indicators transformation and failure analysis; and the third is the assessment of cultural empathy and arousal efficiency.

4.1. Development of an Evaluation Index System for Cultural Empathy-Evoking

Current research usually produces evaluation indicators at three levels: cultural ontology elements, functional experience needs, and emotional changes, working from the outside in [44]. This article expands on prior concepts to explain and improve evaluation indicators from the perspectives of various user groups, with the objective of avoiding cognitive disparities among them.

4.1.1. Data Collection and Coding

A strict semi-structured interview guide enhances the objectivity and reliability of the results. Consequently, we developed an interview guide informed by prior knowledge, focusing on the topic “Emotional Awakening and Its Causes During the Experience of Symbolic CCPs”. Field-testing and expert review methods were utilized to rectify any residual flaws or limitations in the interview guide. The interview guide comprises four questions: Have you lately engaged in any activity related to CCPs? Refer to the experience nodes in Figure 1 to recall your feelings and emotional responses during the experiential activities. In the prior simulated scenario, which stages do you consider most likely to evoke positive or negative emotions? What do you believe may be the cause of these emotions?

Interviews were semi-structured one-on-one, with times ranging from 11 to 15 min. The interviews occurred in a professional interview room, with an experienced designer as the presenter and an assistant as the onsite recorder to record critical information. Participants were told to view a set of photos prior to the beginning of the interview, simulating the experience stages shown in Figure 1.

We thematically coded the interview data obtained through the Thematic Analysis method. To eliminate analytical errors produced by the coders’ personal subjectivity and enhance the theory’s sensitivity, the FMEA group was required to modify and proofread the coding process simultaneously. We conducted a concentrated discussion on any ambiguous or contentious coding classification statements until all classification work was universally agreed upon by all individuals.

Initially, relevant original sentences about the research topic were selected from the interview data. Then, we formulated the original sentences and obtained initial codes that had substantial meaning. This article followed the core idea of staying as open to all viable hypotheses as feasible, deleting nodes with reference points fewer than three. Table 1 shows that 247 substantively significant initial codes were derived from 31 interview materials. The initial codes with similar attributes were then grouped together to form larger themes or groups. Finally, the data were classified into three major themes, each of which was well-defined and represented the data’s main point (Table 2).

Table 1. Typical example of initial coding process in the interview data for cultural empathy-evoking research.

Interview Materials	Initial Codes
I am more interested in cultural features that are symbolic or typical, whether they represent the style of a certain era or location.	Unique cultural content
I am curious about unfamiliar cultures' symbols, colors, suitable events, design combinations, and messages.	Detailed background story
Seeing some other people's remarks makes me want to talk to them even more.	Community building

Table 2. Evaluation index system of cultural empathy-evoking on symbolic CCPs.

Secondary Indicators (Initial Codes)	Primary Indicators (Category)	Evaluation Criterion (Key Themes)
Unique cultural content High recognition objects Easy to trigger group perception	Cultural subject	Cultural correlation
Knowledge bearing and dissemination Aesthetic and design Readability Cognitive relevance	Cultural symbol	
Clear deconstructive elements Clear symbol imagery Suitability adjustment	Symbol element	Scenario restoration
Series design presentation Detailed background story Cultural image followed Narrative situation synchronization	Design presentation	
interestingness novelty interactivity	Application approach	
Visual identity Community building Belonging shaping Fashion sense communication	Value transmission	Emotional identification
Desire for reuse pleasure	Emotional link	

Additionally, we utilized sampling to perform saturation testing on the interview data. Upon comparing the sampled data with the initial codes, the absence of novel concepts or categories signified theoretical saturation. Following the encoding of 25 interviews, we used the remaining 6 interviews for saturation testing and identified no new node names. The saturation test was deemed successful.

4.1.2. Development of an Evaluation Index System

We might find logical patterns of how users' empathy is aroused in cultural emotional experience activities by categorizing and coding the factors that affect emotions aroused in multiple target groups from the original interview data. As a consequence, using major

themes as evaluation standards, categories as primary indicators, and initial coding within unique categories as secondary indicators, we built an evaluation index system of cultural empathy-evoking on symbolic cultural and creative products. Table 2 shows that the evaluation system's goal level is evoking cultural empathy, and the evaluation standards' levels are cultural connection, scenario restoration, and emotional identification.

Cultural correlations include both cultural subjects and cultural symbols, and their major purpose is to identify the mapping relationship between culture and symbols. It should determine if users can connect abstract cultural subjects to concrete symbolic images. The scenario restoration includes symbol element, design presentation, and application approaches, with the main purpose of assessing the user's ability to comprehend and sense culture via symbolic interpretation and cultural experience activities. Emotional identification has two aspects: value transmission and emotional link. It mostly impacts whether individuals identify with the product's visual image and cultural values during the interaction, as well as if it produces positive emotions.

4.2. Indicators Transformation and Failure Analysis Process Based on Fuzzy-FMEA

4.2.1. Indicators Transformation and Touchpoint Identification

This part primarily focuses on the transformation of indicators and the identification of touchpoints. This constitutes a fundamental step for the subsequent analysis based on the fuzzy-FMEA. By translating the evaluation criteria within the indicator system into new risk assessment factors, it further provides a basis for clarifying the touchpoints and other related aspects.

The traditional fuzzy-FMEA assesses the risk of failure using the severity of failure (S), probability of occurrence (O), and failure detection (D), while accounting for mechanical failure. However, it disregards slight emotional changes. In this article, three evaluation standards from the index system are translated into new risk assessment factors: correlation (C), restoration (R), and identity (I), which enhance the directional and scientific validity of the evaluation. Among them, correlation refers to the degree of correlation between various symbol elements and cultural subjects as determined by users throughout the simulation experience. The term "restoration" refers to the scenario restoration of a specific image combined with the presentation of material and design. Identity is the ability to elicit pleasant feelings in the present or future.

The simulated experience process is utilized to define the user behavior timeline based on the symbolic CCPs' set starting and ending points. The secondary indicators in the evaluation index system clarify the evaluation content of each link, effectively evaluate the cultural empathy arousal efficiency of symbolic CCPs, clarify the focus of symbol design and product development, and promote cultural empathy among audiences.

4.2.2. Failure Analysis Process Based on Fuzzy-FMEA

The assessment models and procedures are outlined below.

(1) Build a fuzzy term set.

The evaluation indicators used to assess the subject's performance are generally ambiguous. Fuzzy linguistic evaluation utilizes evaluation values and linguistic variables to quantify the performance of indicators, such as "should", "seem", "very prominent", "small", and so on. These may be represented using fuzzy mathematics, which completely expresses the fuzziness of people's ideas and expressions, making assessment more objective. A consistent evaluation standard, namely the fuzzy term set, has been built for the new risk assessment factors, as shown in Table 3.

Table 3. The fuzzy term set.

Fuzzy Terminology	Severity (S)	Occurrence (O)	Detection (D)	Fuzzy Numbers
Very high (VH)	Significant impact	Very high	Very high	(L, M, U)
High (H)	Moderate impact	High	High	(L, M, U)
Medium (M)	Medium impact	Medium	General	(L, M, U)
Low (L)	Slight impact	Low	Low	(L, M, U)
Very low (R)	Minimal impact	Very low	scarcely	(L, M, U)

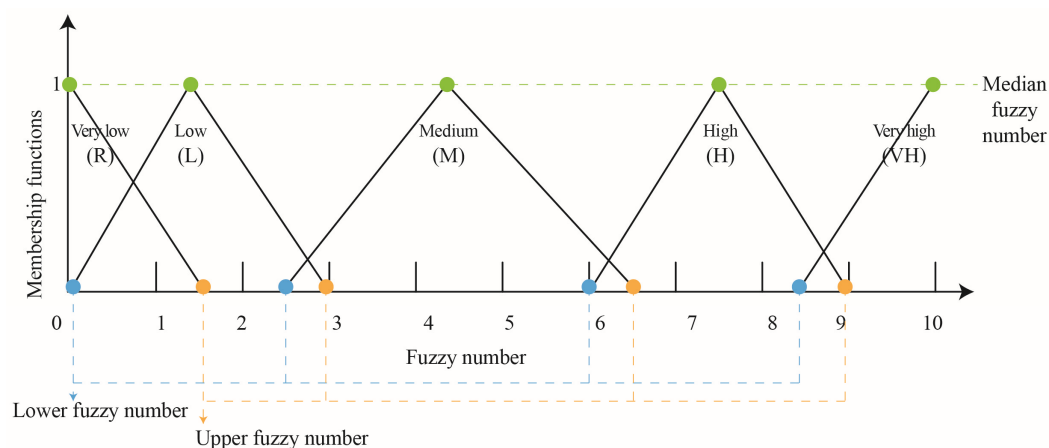
(2) Determine the fuzzy number of fuzzy terms.

Triangular fuzzy numbers serve as a method for transforming ambiguous and uncertain linguistic variables into precise numerical values [45]. This method helps solve the issues in which an object's performance cannot be precisely quantified but can only be fuzzily evaluated using linguistic terms. Triangular fuzzy numbers are often used to quantify the fuzzy term set in Table 1. Formula (1) illustrates the use of the triangular fuzzy number $\tilde{A} = (L, M, U)$, and the membership function for quantification. And M is the median fuzzy number, whereas L and U denote the lower and upper bounds of the fuzzy number, respectively.

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-L}{M-L}, & (L \leq x \leq M) \\ \frac{U-x}{U-M}, & (M \leq x \leq U) \\ 0, & (x < L \text{ or } x > U) \end{cases} \quad (1)$$

In Formula (1), $\mu_{\tilde{A}}(x)$ represents the score x subordinate to a certain fuzzy term set. This function's value ranges from 0 to 1, with increasing subordination bringing the number closer to 1.

The membership function curves determined in accordance with Formula (1) are shown in Figure 2. The horizontal axis represents numerical values, whereas the vertical axis represents membership degree. The membership function is 0 at L and U, reaching a maximum value of 1 at M, thereby forming a triangular shape. This membership function enables triangular fuzzy numbers to represent uncertainty flexibly and underpins subsequent defuzzification processes.

**Figure 2.** Membership function curves of fuzzy terms.

Assume there are m experts, the j th expert's experience value is a_j ($j = 1, 2, \dots, m$), and the expert's judgment of a variable in a failure mode is A_j . The triangular fuzzy number

is then represented as $\tilde{A}_j = (L_j, M_j, U_j)$, and Formula (2) is used to determine the fuzzy numbers for different terms. In Formula (2), $\sum_{j=1}^m a_j = 1$, $a_j \in (0, 1)$.

$$\begin{cases} L = \sum_{j=1}^m a_j L_j \\ M = \sum_{j=1}^m a_j M_j \\ U = \sum_{j=1}^m a_j U_j \end{cases} \quad (2)$$

(3) Defuzzification.

Defuzzification is a critical stage in the fuzzy-MCDM process for evaluating service performance. There are several methods for defuzzification, the most prevalent of which is the center-of-gravity method. This method uses the center-of-gravity of the area measured by the ROC curve and abscissa as the final fuzzy inference output value [46].

$$x(\tilde{A}) = \frac{\int_L^U x \mu_{\tilde{A}}(x) dx}{\int_L^U \mu_{\tilde{A}}(x) dx} \quad (3)$$

Formula (3) calculates the defuzzification value, or failure risk priority value of the secondary indication.

4.3. Service Effectiveness Evaluation Based on Fuzzy-FMEA

According to the aforesaid study background and literature review, we found that the fuzzy-FMEA method should be employed in a phased manner to handle various issues in complex cultural emotional experience activities, taking into consideration both individual differences and multilevel experiential needs. We put the index system into the fuzzy-FMEA framework, transforming the evaluation standards into new risk assessment factors, which is useful for satisfying user demands at various levels. Secondary indicators are used as identification criteria for touchpoints and failure modes, and then derived from multiple target group interview data can successfully decrease user cognitive biases due to individual variations. Fuzzy language is utilized to analyze each risk mode's correlation (C), restoration (R), and identity (I), and touchpoint failure risk is prioritized. Improved approaches may successfully reduce subjective errors while increasing assessment objectivity. Figure 3 illustrates the assessment processes for the methods provided in this study.

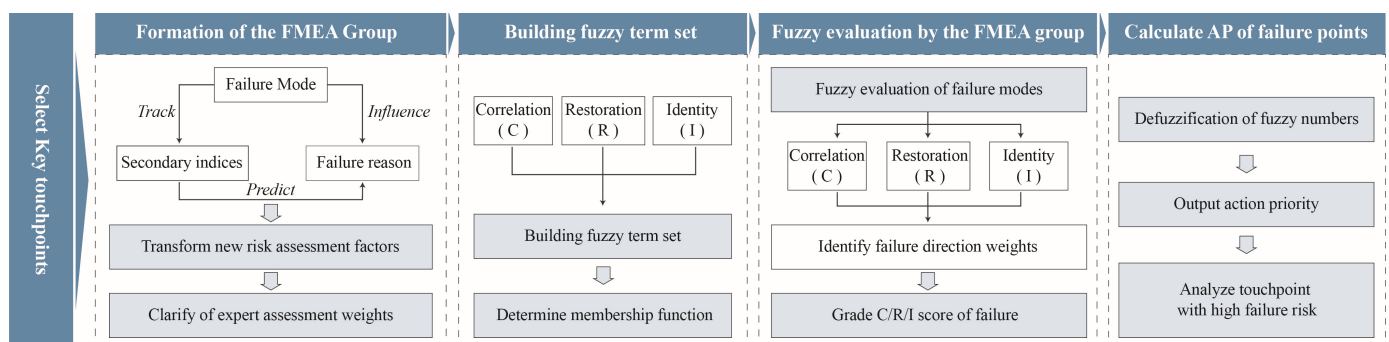


Figure 3. Efficiency assessment processes of symbolic CCPs based on fuzzy-FMEA.

(1) Build an experts group.

Risk assessment is a process involving expert judgment, and it is critical to reduce expert uncertainty and cognitive bias. To achieve this goal, stakeholders in the CCPs service process are brought together, and expert evaluation teams are formed. Using their extensive historical knowledge and skills, they analyze the touchpoints and failure modes that occur

throughout the judging process, determine the risk level, and design assessment programs in collaboration.

Experts' knowledge and abilities vary significantly. Assuming there are m experts, $j = 1, 2, \dots, m$, a_{Cj} , a_{Rj} , and a_{Ij} are the evaluated weighting values of the correlation, restoration, and identity from j th experts for failure modes.

(2) Build a fuzzy term set and determine the degree of membership function.

The article defines a fuzzy term set using the new risk assessment factors correlation (C), restoration (R), and identity (I). Each factor is an integer between 1 and 10, and Table 4 shows the meanings of the associated fuzzy terminology.

Table 4. The fuzzy term set of touchpoint failure.

Fuzzy Terminology	Correlation (C)	Restoration (R)	Identity (I)	Fuzzy Numbers
Very high (VH)	Very high correlation	Very strong (persistent evoking of positive emotions)	Very high	(8.5, 10, 10)
High (H)	High correlation	Strong (often evoking positive emotions)	High	(6, 7.5, 9)
Medium (M)	General correlation	Medium (occasional evoking of positive emotions)	General	(2.5, 4.5, 6.5)
Low (L)	Low correlation	Weak (relatively difficult to evoke positive emotions)	Low	(0, 1.5, 3)
Very low (R)	Unable to relate	Extremely weak (unlikely to evoke positive emotions)	scarcely	(0, 0, 1)

In this study, triangular fuzzy numbers are employed to define terminology sets, with $\tilde{A} = (L, M, U)$ indicating a matching triangular fuzzy number for each fuzzy terminology. The membership function measures the risk factor's degree of dependency, and its value range is (0, 1), with closer to 1 indicating a larger degree of mapping. The membership function curves refer to Figure 2 in the preceding text.

(3) The expert group assesses three failure risk factors.

During this step, each expert is asked to assess the failure model's three risk factors. Assume there are n touchpoints (T_i , $i = 1, 2, \dots, n$). C_{ij} , R_{ij} , and I_{ij} are the ratings of the j th experts on the correlation, extension, and identity of the i th touchpoint. C_i , R_i , and I_i are values describing the fuzzy numbers of correlation, extension, and identity for the i th failure touchpoint, whose calculation is based on Formulas (4)–(6).

$$C_i = \sum_{j=1}^m a_{Cj} C_{ij} = \left(\sum_{j=1}^m a_{Cj} C_{ijL}, \sum_{j=1}^m a_{Cj} C_{ijM}, \sum_{j=1}^m a_{Cj} C_{ijU} \right) \quad (4)$$

$$R_i = \sum_{j=1}^m a_{Rj} R_{ij} = \left(\sum_{j=1}^m a_{Rj} R_{ijL}, \sum_{j=1}^m a_{Rj} R_{ijM}, \sum_{j=1}^m a_{Rj} R_{ijU} \right) \quad (5)$$

$$I_i = \sum_{j=1}^m a_{Ij} I_{ij} = \left(\sum_{j=1}^m a_{Ij} I_{ijL}, \sum_{j=1}^m a_{Ij} I_{ijM}, \sum_{j=1}^m a_{Ij} I_{ijU} \right) \quad (6)$$

In the formula, each fuzzy level has three fuzzy numbers, which are the minimal fuzzy number of the j th experts on the correlation, extension, and identity of the i th touchpoint. Similarly, M represents the middle fuzzy number, and U represents the maximum fuzzy number.

(4) Defuzzification of failure risk values.

In order to quantitatively evaluate the failure risk of different touchpoints, the above evaluation results are defuzzified using Formula (3). C_i , R_i , and I_i defuzzification processes may be reformulated using Formulas (7)–(9).

$$DC_i = \frac{1}{3}[(C_{iU} - C_{iL}) + (C_{iM} - C_{iL})] + C_{iL} \quad (7)$$

$$DR_i = \frac{1}{3}[(R_{iU} - R_{iL}) + (R_{iM} - R_{iL})] + R_{iL} \quad (8)$$

$$DI_i = \frac{1}{3}[(I_{iU} - I_{iL}) + (I_{iM} - I_{iL})] + I_{iL} \quad (9)$$

In these formulas, DC_i , DR_i , and DI_i are values after defuzzifying correlation, extension, and identity for the i th failure mode. C_{iL} represents the minimal fuzzy number from the correlation for the i th failure mode. Similarly, C_{iM} and C_{iU} are the middle fuzzy number and the maximum fuzzy number from correlation for the i th failure mode.

(5) Output action priority.

To improve design efficiency and direct limited resources to the most valuable components, the action priority (AP) table is used for ranking. To prioritize risk mitigation requirements, AP values combine different DC_i , DR_i , and DI_i values.

5. A Case Study of Design Practice

“Huangniu Split the Gorge” is a Yiling District-specific mythological narrative that depicts the present human spirit and has a strong regional identification. However, the previous design would have transmitted culture using a simple symbol (Figure 4), which lacked visual appeal and made it impossible for users to establish a positive emotional experience with products and cultures.



Figure 4. Existing cultural and creative products of Huangniu Split the Gorge.

5.1. Touchpoint Identification and Failure Analysis

The experience process was stated to begin with attracting customers’ attention with symbol images and finish with understanding culture and arousing pleasant feelings through products. This paper collected data for user behavior analysis utilizing qualitative research methods such as non-participant observation, interviews, and questionnaires. Furthermore, the secondary indicators in the index system serve as identification for contact touchpoints.

The experiment collected 320 pictures, about 224 min of audio, and 25 interview records. The team summarized and coded all types of data. The pictures were sorted and classified, and the audio was translated to text. Based on the secondary indicators in Table 2, 23 touchpoints in the service process of symbolic CCPs have been identified, with an analysis of the probable failure modes and their underlying causes, as shown

in Table 5. This section of the work simplified the research process by closely linking evaluation indicators and touchpoints, as well as analyzing touchpoint failure modes using particular indicators to make the assessment more focused.

Table 5. Touchpoint identification and failure analysis of Huangniu Split the Gorge.

Touchpoints	Failure Modes	Failure Reasons	Code
Visual effects attract	Insufficient arousal of cultural attraction	Poor aesthetic or design	T_1
Identifying symbols	Cultural values are not sufficiently refined	Overly abstract symbol design	T_2
Perceive culture	Cultural perception difficulties	Insufficient cultural ambience	T_3
Reading symbols	The symbol image carries a lack of content	Insufficient symbol components	T_4
Observing products	Product lacks aesthetic	Design ideas lack depth.	T_5
Interpreting culture	Low symbolic readability	Overly abstract symbol design	T_6
Related cultures and symbols	Lack of connection between symbol and culture	Insufficient symbol components	T_7
Know the source of symbols	Symbol element information is unknown	Missing symbol information	T_8
Comparing symbol elements and cultural information	Insufficient perception of cultural value	Information retrieval issues	T_9
Search symbolic development	Single symbol design form	Symbols not combined	T_{10}
Viewing series designs	Lack of product theme	Single design form	T_{11}
Clear story background	Product backstory missing	Missing symbol information	T_{12}
Identifying cultural images	Low correlation of cultural image	Overly abstract symbol design	T_{13}
Perceiving cultural value	Insufficient cultural atmosphere	Single experience form	T_{14}
Viewing products	Simple or complex packaged	Lack of interest	T_{15}
Quick viewing information	Single form of experience	Lack of personalized experience	T_{16}
Assembly using products	Poor user experience	Missing specification	T_{17}
Admire product shapes	Unattractive design scheme	Poor color of graphic design	T_{18}
Photograph and share	Social sharing is of low value	Lack of theme, bad display	T_{19}
Build emotional connections	Low emotional correlation	Insufficient symbol–culture link	T_{20}
Share comments online	Lack of current focus	Poor trending topics	T_{21}
Multi-scenes applied	The usage scenario is not clear	Single product function	T_{22}
Emotional output	Failure of positive emotion-evoking	lack of story or interestingness	T_{23}

5.2. Formation of an FMEA Group

Upon the completion of touchpoint identification and failure analysis, it is necessary to form an FMEA group for further in-depth research, as the participation of different experts is of great significance for a more comprehensive and accurate assessment.

Because the knowledge and skills of various experts differ, each expert was given a varied weight when analyzing correlation, restoration, and identity. Firstly, the seven experts in the FMEA group were asked to describe their individual abilities and knowledge. This step promotes understanding among experts, establishing the basis for further weight distribution. They were asked to assess one another and provide preliminary weight judgments. It addresses the differences and synergies between experts, resulting in a more comprehensive and unbiased evaluation. Following that, a consensus conference encourages additional discussion of the peer review results, a consensus decision is formed, and each expert is given the appropriate evaluation weight. After the processes of self-introduction, mutual assessment, discussion, and consensus formation, the seven experts arrived at a common viewpoint. Table 6 shows the weights assigned to the correlation (C), restoration (R), and identity (I) by seven experts.

Table 6. Expert weights for three failure risk factors.

Expert	Roles	Correlation (a_C)	Restoration (a_R)	Identity (a_I)
Expert 1	Designer	0.16	0.11	0.18
Expert 2	Designer	0.16	0.11	0.18
Expert 3	Culture practitioner	0.09	0.15	0.10
Expert 4	Culture practitioner	0.09	0.16	0.10
Expert 5	Senior user	0.21	0.15	0.15
Expert 6	Senior user	0.21	0.15	0.15
Expert 7	Potential user	0.08	0.16	0.14

5.3. Failure Assessment and Result Analysis of Touchpoints

The FMEA group looked at Table 4 and Figure 2, and the evaluated the risk factor levels of correlation, restoration, and identity for each failure mode. Combined with the expert weights in Table 6, the three risk factors in each failure mode were fuzzy-treated using Formula (2). The fuzzy numbers of correlation, restoration, and identity were calculated based on Formulas (4)–(6).

The fuzzy number of risk factors from each touchpoint was defuzzified based on Formulas (7)–(9), as shown in Table 7, columns 5, 6, and 7.

Table 7. The values describing the failure touchpoint of Huangniu Split the Gorge.

Code	C_i	R_i	I_i	DC_i	DR_i	DI_i
T_1	(5.72, 7.26, 8.8)	(4.245, 6.035, 7.66)	(4.39, 6.12, 7.85)	7.26	5.98	6.12
T_2	(3.745, 5.49, 7.235)	(3.21, 4.98, 6.75)	(2.75, 4.35, 6.05)	5.49	4.98	4.38
T_3	(6.19, 7.77, 8.9)	(3.345, 5.13, 6.915)	(2.05, 3.78, 5.51)	7.62	5.13	3.78
T_4	(4.705, 6.39, 8.075)	(3.97, 5.76, 7.55)	(2.25, 4.2, 6.15)	6.39	5.76	4.2
T_5	(4.425, 6.15, 7.875)	(3.035, 4.83, 6.625)	(5.605, 7.315, 8.38)	6.15	4.83	7.1
T_6	(6.925, 8.425, 9.37)	(6.4, 7.9, 9.16)	(2.225, 4.05, 5.875)	8.24	7.82	4.05
T_7	(7.35, 8.85, 9.54)	(6.775, 8.275, 9.31)	(1.5, 3.075, 4.8)	8.58	8.12	3.125
T_8	(3.865, 5.67, 7.475)	(3.585, 5.43, 7.725)	(2.88, 4.74, 6.6)	5.67	5.43	4.74
T_9	(5.595, 7.285, 8.42)	(3.46, 5.38, 7.06)	(2.125, 4.05, 5.975)	7.1	5.3	4.05
T_{10}	(4.635, 6.405, 7.86)	(2.5, 4.5, 6.5)	(2.755, 4.59, 6.425)	6.3	4.5	4.59
T_{11}	(3.13, 5.04, 6.95)	(4.53, 6.24, 7.95)	(4.18, 5.94, 7.7)	5.04	6.24	5.94
T_{12}	(4.53, 6.24, 7.95)	(4.79, 6.52, 8.01)	(2.6, 4.35, 6.2)	6.24	6.44	4.383
T_{13}	(4.075, 5.925, 7.46)	(2.785, 4.65, 6.515)	(2.68, 4.17, 5.76)	5.82	4.65	4.203
T_{14}	(5.77, 7.435, 8.545)	(3.445, 5.31, 7.175)	(3.13, 5.04, 6.95)	7.25	5.31	5.04
T_{15}	(3.55, 5.295, 6.725)	(2.1, 4.02, 5.94)	(3.48, 5.34, 7.2)	5.19	4.02	5.34
T_{16}	(2.5, 4.5, 6.5)	(2.25, 3.795, 5.49)	(3.93, 5.64, 7.35)	4.5	3.845	5.64
T_{17}	(1.975, 3.87, 5.765)	(3.585, 5.43, 7.275)	(1.8, 3.66, 5.52)	3.87	5.43	3.66
T_{18}	(6.05, 7.675, 8.745)	(5.205, 6.915, 8.22)	(2.98, 5.14, 6.43)	7.49	6.78	4.85
T_{19}	(2.975, 4.77, 6.565)	(2.485, 4.11, 5.895)	(3.235, 4.86, 6.215)	4.77	4.163	4.77
T_{20}	(2.1, 4.02, 5.94)	(3.025, 4.95, 6.875)	(4.71, 6.43, 8)	4.02	4.95	6.38
T_{21}	(3.88, 5.715, 7.415)	(3.21, 4.98, 6.75)	(0.45, 1.665, 3.13)	5.67	4.98	1.748
T_{22}	(2.53, 4.08, 5.79)	(3.83, 5.64, 7.45)	(2.4, 4.26, 6.12)	4.13	5.64	4.26
T_{23}	(2.815, 4.77, 6.725)	(3.06, 4.98, 6.9)	(3.405, 5.19, 6.975)	4.77	4.98	5.19

According to the action priority table, the touchpoint's AP level was determined by a combination of several new risk factor values (Table 8).

Table 8. AP level of touchpoints. (a) Action priority table. (b) The AP level of touchpoints. Different background colors in the table represent a certain risk level respectively. Blue stands for the low risk level; yellow represents the medium risk level, which implies a warning; and red indicates the high risk level, meaning that immediate measures must be taken.

Correlation	Restoration	Identity				Touchpoints	Action Priority
		I = 1	I = 2~4	I = 5~6	I = 7~10	T_1 T_2 T_3 T_4 T_5 T_6 T_7 T_8 T_9 T_{10} T_{11} T_{12} T_{13} T_{14} T_{15} T_{16} T_{17} T_{18} T_{19} T_{20} T_{21} T_{22} T_{23}	H L M L M H H L M L M M L M L L L L L L L L L
C = 1	R = 1~10	L	L	L	L		
	R = 1	L	L	L	L		
C = 2~3	R = 2~3	L	L	L	L		
	R = 4~5	L	L	L	L		
	R = 6~7	L	L	L	L		
	R = 8~10	L	L	M	M		
	R = 1	L	L	L	L		
C = 4~6	R = 2~3	L	L	L	L		
	R = 4~5	L	L	L	M		
	R = 6~7	L	M	M	M		
	R = 8~10	M	M	H	H		
	R = 1	L	L	L	L		
C = 7~8	R = 2~3	L	L	M	M		
	R = 4~5	M	M	M	H		
	R = 6~7	M	H	H	H		
	R = 8~10	H	H	H	H		
	R = 1	L	L	L	L		
C = 9~10	R = 2~3	L	L	M	H		
	R = 4~5	M	H	H	H		
	R = 6~7	H	H	H	H		
	R = 8~10	H	H	H	H		
	R = 1	L	L	L	L		

(a)

(b)

According to the failure risk grades in Table 8, prioritize the measures for each touchpoint. The red areas concerning T_1 , T_6 , T_7 , and T_{18} provide a high risk, and measures must be taken to solve their failure issues. There are six M-level touchpoints: T_3 , T_5 , T_9 , T_{11} , T_{12} , and T_{14} , with yellow areas indicating medium risk. It is suggested to take measures to compensate for service failures. The remaining L grades are blue, indicating a low risk of failure and a low priority for design improvements.

5.4. Touchpoint Optimization Design

Because secondary indicators are used to identify touchpoints, the FMEA team believes that classifying the evaluation indicators that are not satisfied for each failed touchpoint would help them find the reasons for cultural empathy-evoking failure. Figure 5 illustrates that the failure points that do not correspond to the evaluation indicators that are mostly in the cultural correlation and scenario restoration categories. As a consequence, we contend the failure of symbolic CCPs to elicit cultural empathy is related to failure with correlate association and scenario restoration.

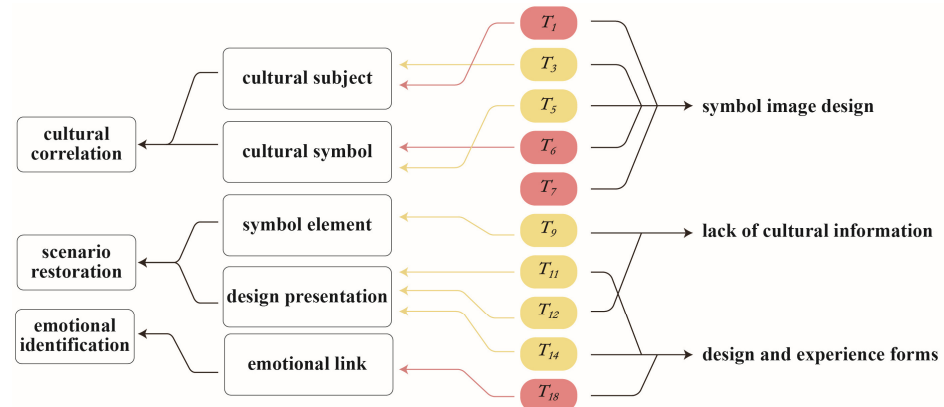


Figure 5. Analysis of failure causes and touchpoint optimization strategies.

The FMEA team will review its findings, combining user research data with the failure reasons for touchpoints in Table 5, to provide optimization design ideas, and summarize the reasons for touchpoint failure. Figure 5 shows that, on the one hand, it is because the symbols do not have enough or the right kind of meaning (T_1 , T_3 , T_5 , T_6 , and T_7), which, when combined with incomplete cultural information (T_9 and T_{12}), makes cognitive correlation fail. On the other hand, scenario restoration fails due to its single design form (T_{18}) or lack of cultural context (T_{11} , T_{12} , and T_{14}). As a result, design ideas are classified into three types: symbol design, cultural information presentations, and design and experience forms.

In terms of symbol image, the key failure reasons for T_1 are that symbol image lacks formal beauty, and it is difficult to engage the target user through the product's visual effects. The fundamental cause of T_7 failure is that the symbol image does not adequately describe the cultural content, making it difficult for the user to associate with the culture. Current studies on the extraction and creation of cultural symbols often involve collecting essential cultural-imagery words from the cultural background and picking corresponding pictures to assist in symbol design [47]. Symbolic designing and coding those pictures was completed with Adobe Illustrator 2023 and Procreate 5.3.10, and 18 symbol elements were obtained (Table 9). This step provided a clearer understanding of the origin of symbolic elements.

Table 9. Symbol element extraction and design reconstruction analysis of Huangniu Split the Gorge.

Words	Huangniu	Huangling Temple	Huangniu cliff	Theurgy	Benefit society	Towering cliffs	Impetuous torrent	Flood myth	Bachu Cultural								
Pictures																	
	SF ₁	SF ₂	SF ₃	SF ₄	SF ₅	SF ₆	SF ₇	SF ₈	SF ₉								
Symbol elements																	
	SF ₁₁	SF ₂₁	SF ₃₁	SF ₄₁	SF ₄₂	SF ₄₃	SF ₄₄	SF ₄₅	SF ₄₆	SF ₅₁	SF ₅₂	SF ₅₃	SF ₅₄	SF ₆₁	SF ₆₂	SF ₇₁	SF ₈₁

T_3 , T_5 , and T_6 failures are mostly caused by the abstract symbol and prototype symbol being too distinct, making it hard to match the corresponding cultural elements and therefore preventing value identification with the user. Therefore, a scenario symbol with various elements should be designed from the perspective of the user's cultural perception, and it should be adaptable to changing demands and themes utilizing alternative symbol

combinations. The author simplified the design of the scenario symbol, added the regional symbol elements SF_{61} and SF_{91} , and generated the abstract symbol. At the same time, scenario symbols can radiate outward, creating a new design with more content, which used more symbol elements to create strong visual effects and help users interpret culture. This thematic and serialized design form can effectively help users connect symbols with culture and elicit their emotions. The refactoring design is shown in Figure 6.

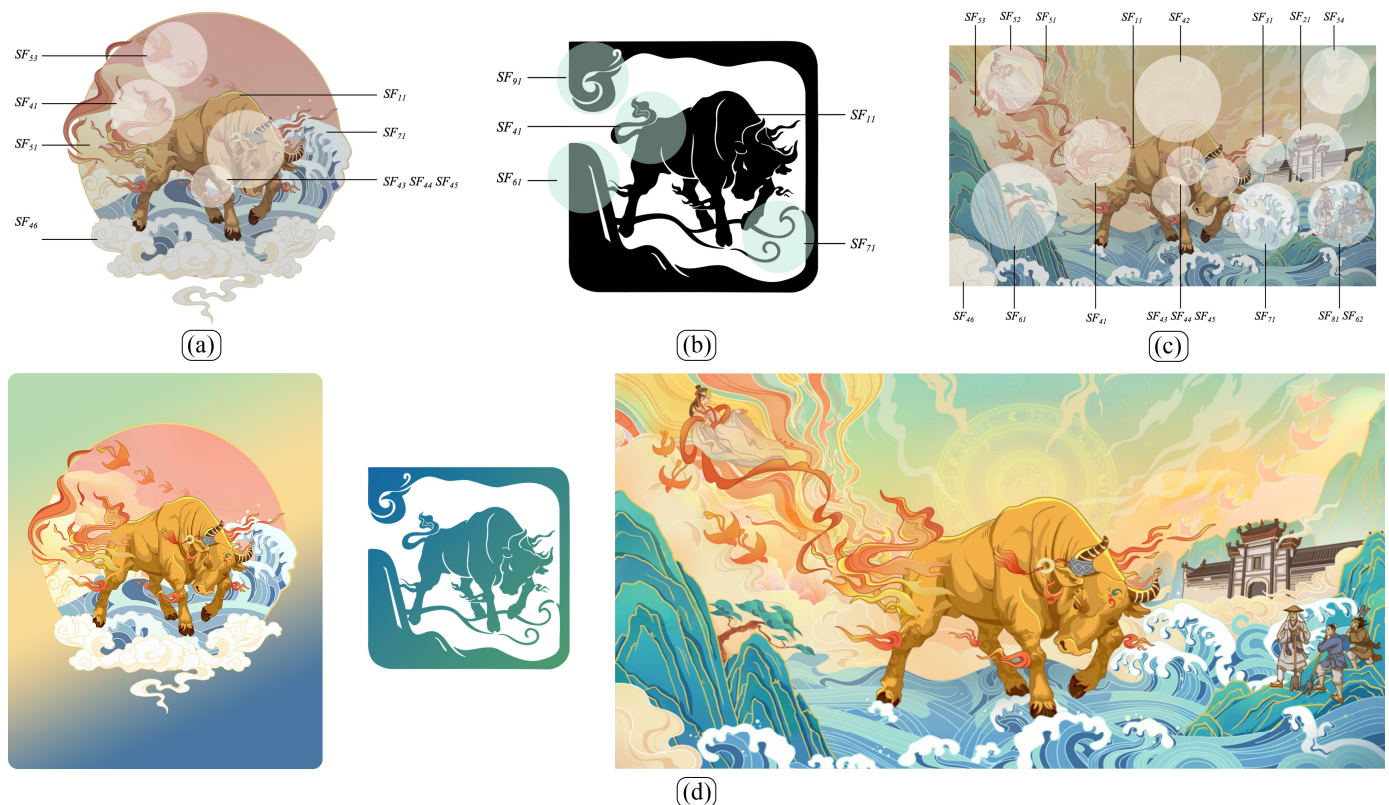


Figure 6. The refactoring design and patterns of Huangniu Split the Gorge: (a) Scenario symbol. (b) Abstract symbol. (c) Refactoring design of symbol elements. (d) Reconstructed design drawing.

Figure 6d shows the drawings after the refactoring design. The shape and color in the overall floor plans have coordination and unity. The colors are mainly blue and green. Blue is the water in the gorge, and green refers to the lush trees on the gorge formed by regional and climatic reasons. Although there were three design forms, they were all centered on the Huangniu, and the original symbol elements such as gorge, water, theurgy, and flood myth were designed to show the cultural implications of towering cliffs, impetuous torrents, and benefiting one side.

In terms of cultural information presentation, T_9 and T_{12} failed due to a lack of symbol evolution process and product background information. Some studies have shown that visual layout and simple aesthetic composition can assist individuals in understanding a region's culture [48]. The design process of symbol elements enables users to completely feel the charm of regional culture, which improves people's depth of experience. These findings indicate that giving detailed background information and offering different ways to query information are necessary. Thus, the cultural information was displayed according to the logical sequence of the extraction of cultural-imagery words, the generation of symbolic elements, and the reconstruction design process. As shown in Figure 7b, we provided convenient information retrieval methods through the use of digital technology, to help users quickly and comprehensively view relevant information.

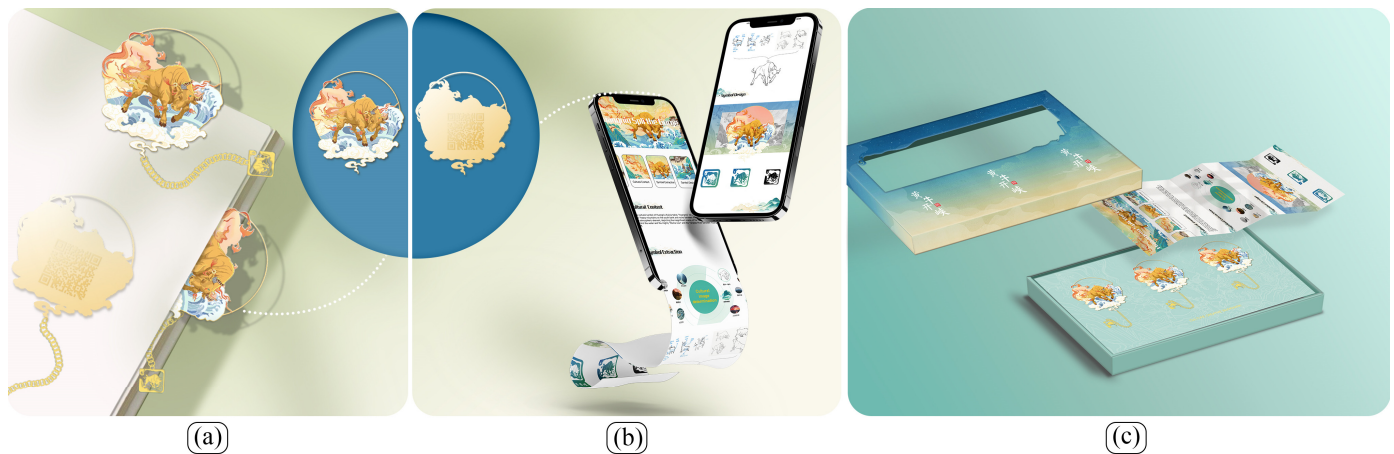


Figure 7. The optimized design scheme of Huangniu Split the Gorge: (a) Derivative design. (b) Convenient information retrieval method. (c) Package design.

In terms of design experience forms, the T_{18} fails due to a lack of design aesthetics, selecting the appropriate product carrier based on the drawings in Figure 6d, and guided by cultural interpretation. Then, a metal bookmark with good visual effect, small size, and easy to carry was the preferred product carrier. As shown in Figure 7a, the scenario symbol was taken as the design object, the metal material was used to enhance the product texture, the hollow upper space enhanced the design sense, and the chain combined with the abstract symbol design provided convenience for searching. T_{11} and T_{14} failed because of single design forms, a lack of thematic features, and narrative situation inconsistencies, all of which reduce user experience pleasure. Currently, CCPs rely on series design schemes and interesting packages to recreate cultural scenarios. In Figure 7c, gradient and Huangniu Split the Gorge were used, and symbol elements SF_{61} and SF_{91} were used to design local visual windows to improve users' sense of experience of the product service process and wake up positive emotions.

5.5. Evaluation and Verification of the Optimization Scheme

Participants were asked to reevaluate the optimized design scheme based on their first reactions to the given questions. To measure their responses, we utilized questions focusing on symbolic cognition, cultural interpretation, and evoking positive emotions, collecting data through the application of a Likert scale. Questionnaires completed in less than two minutes were excluded, resulting in the recovery of 21 valid responses.

Statistical software was employed to process the collected data, calculating the mean score and standard deviation for each question to evaluate the design's performance across various areas of focus. According to the data analysis results in Figure 8, the optimized design scheme achieved significant outcomes in terms of symbolic cognition, cultural interpretation, and evoking positive emotions, with average scores of 4.19, 4.00, and 4.24, respectively (on a scale of 5). Notably, the relatively small standard deviations indicate a concentrated data distribution. Therefore, this study concludes that the optimized design scheme exhibits excellent performance in multiple aspects, validating the effectiveness of the adopted method.

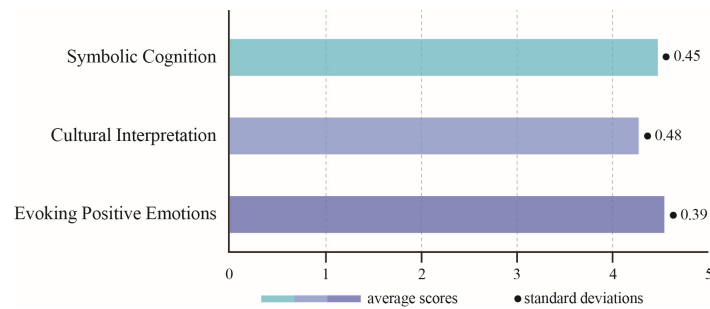


Figure 8. The evaluation results of the optimization scheme.

6. Discussion and Conclusions

6.1. Discussion

The purpose of this study was to evaluate the primary design features of symbolic CCPs in terms of evoking cultural empathy and then return to guide the symbol–culture mapping in the design process. The evaluation index system of CCPs was built using the comprehensive index method and system theory, which implies that the problem of finding the important evaluation contents in cultural empathy-evoking has been solved. The index system was incorporated into the fuzzy-FMEA assessment framework, and the findings show high directivity in the analysis of symbol image empathy-evoking efficacy. It indicated that the problem of identifying the key design features that elicit emotional responses in users has been addressed.

Assessment discovered that cognitive association failures and scenario restoration failures caused cultural empathy-evoked failures in symbolic CCPs. Cognitive association failures are caused by inadequate or overly abstract symbol images, along with an unsatisfactory presentation of cultural information. Scenario restoration failures are caused by narrative situation inconsistencies and single design forms. In general, abstract symbol images and single design forms make it difficult for users to recognize and understand symbol elements and background stories, resulting in a failure to link personal emotional experiences, which leads to a lack of cultural empathy.

In principle, culture-based product design is the symbolic extraction and reconstruction of theme culture, followed by the integration of diverse carrier forms to design and manufacture, completing the “need-experience-value” product service cycle. Thus, it would be feasible to try and generalize the above argument to other similar CCPs. Decision-making resources and realistic proposals are provided to the cultural industries, policymakers, and designers.

For cultural industries, this study offers a set of scientific evaluation tools and optimization strategies for boosting CCPs’ cultural and market competitiveness. Simultaneously, in terms of sustainability, this has the potential to dramatically enhance industrial efficiency while reducing energy usage.

For policymakers, this study pointed out crucial design features that are consistent with market trends and consumer’s emotional demands. It provides a useful decision-making guideline for formulating more accurate and effective policies to support cultural industries.

For designers, the research findings yielded useful design solutions. These provide designers with a realistic decision-making framework to drive product design, which has proven incredibly effective in reducing the product testing and optimization cycle and enhancing work productivity. The proposals are as follows:

- From the perspective of user interpretation culture, a scenario symbol should be completed before designing abstract symbols.

- The design elements of scenario symbols and abstract symbols should be combined and used to assist users in recognizing culture.
- Serialized design application forms should be utilized to create a cultural atmosphere and elicit empathy.

In general, thematic symbol images and series designs may improve the cultural empathy-evoking effect of symbolic CCPs.

6.2. Conclusions

This study gives a scientific evaluation approach and decision-making framework for evaluating the efficacy of cultural empathy-evoking in symbolic CCPs. To establish a systematic evaluation index system, we consider the correlation between symbols and cultural themes, as well as the connection between product experience forms and emotional response. This enables designers to comprehend the key features of cultural empathy throughout the design process. Additionally, we include this method within the framework of FMEA, offering a new viewpoint and method to assess the cultural empathy effectiveness of CCPs. Ultimately, we discover that cognitive association failure and scenario restoration failure are significant risk factors for cultural empathy-evoking failure. This provides significant theoretical and practical guidelines for the future design of symbolic CCPs.

The research has yielded certain results; however, limitations persist. Although the participant group is diverse and representative, additional individuals should be recruited to expand the sample size, and to enhance the universality and precision of the study results. Digital technologies, including artificial intelligence and intelligent design, have facilitated the diversification of product application scenarios. The capture and feedback of real-time data are essential for enhancing users' emotional experiences. So, future studies should concentrate on the effects of symbol design on user cognition in real-time interactive scenarios, as well as utilizing physiological equipment to assess the impact of symbol cognition level on user emotions.

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