

# Statistical Modeling of Tourists' Protection Behavior under Cultural Heritage Knowledge Sharing: Evidence from Shandong Province, China

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**Article History:**

**Received:** 12-01-2025

**Revised:** 15-02-2025

**Accepted:** 01-03-2025

**Abstract:**

Cultural heritage preservation increasingly relies on tourists' active participation, particularly through knowledge-based interactions. This study develops and tests a structural equation model (SEM) to quantitatively analyze the nonlinear relationships between four dimensions of cultural heritage knowledge sharing—informational, social, experiential, and technological—and tourists' protection behavior. Data were collected from 368 domestic tourists at three major heritage sites in Shandong Province, China, using purposive sampling. A bootstrapped SEM approach was employed to estimate path coefficients and assess model fit. The analysis reveals that all four knowledge sharing dimensions significantly and positively impact protection behavior, with technological knowledge sharing exerting the strongest influence. The results underscore the importance of multidimensional knowledge dissemination in shaping behavioral outcomes. Methodologically, this study applies mathematical modeling and latent variable analysis to capture complex behavioral patterns in heritage tourism, providing a foundation for future quantitative frameworks in cultural heritage research.

**Keywords:** Cultural heritage tourism; Knowledge sharing; Tourist behavior; Heritage protection; mathematical model; Sustainable tourism; Structural equation modeling (SEM), statistic analysis

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## 1. Introduction

The preservation of cultural heritage has become a critical global concern, especially in the context of expanding heritage tourism. As cultural heritage sites increasingly serve as important economic and cultural assets, they are simultaneously exposed to mounting risks, including environmental degradation, commodification, and the erosion of authenticity (Tuyen, 2023). In China, Shandong Province is renowned for its profound cultural resources and historical significance, including landmarks such as Mount Taishan, the Confucius Temple, and Baotu Spring (Xin et al., 2023). These heritage sites attract millions of domestic and international tourists annually and are emblematic of China's ancient civilization and cultural continuity.

While much of the existing literature on cultural heritage protection has explored behavioral antecedents such as cultural identity, perceived value, and intention, the role of knowledge sharing in shaping protective behavior among tourists has received relatively limited scholarly attention (Xie et al., 2024; Zhao et al., 2025). However, knowledge sharing—through formal and informal channels such as guided tours, digital storytelling, peer communication, and social media—plays a vital role in enhancing public awareness, appreciation, and responsibility toward heritage conservation (Etim et al., 2024; Li, 2024).

This study aims to empirically investigate the direct impact of cultural heritage knowledge sharing on tourists' cultural heritage protection behavior. It draws on the context of heritage tourism in Shandong Province, examining how tourists' participation in knowledge exchange activities influences their behavioral commitment to protecting cultural assets. By focusing exclusively on the predictive relationship between knowledge sharing and protective action, this research contributes to the understanding of how communication and information dissemination mechanisms can foster more responsible tourism practices. Ultimately, this study seeks to provide practical implications for heritage site managers and cultural policymakers by emphasizing the strategic role of knowledge dissemination in sustaining cultural heritage for future generations.

## 2. Literature review

### 2.1 Definition and Dimensions of Cultural Heritage Knowledge Sharing

Cultural heritage knowledge sharing refers to the dynamic and multidirectional process through which stakeholders—such as tourists, local communities, heritage site managers, and tour guides—exchange, interpret, and co-create knowledge related to tangible and intangible cultural heritage (Reynolds et al., 2022). Unlike one-way communication models, knowledge sharing in heritage tourism emphasizes interactive participation, mutual learning, and cultural transmission (Wang et al., 2024). Scholars argue that such practices contribute to cultivating a “shared sense of stewardship” among tourists, thereby reinforcing a collective responsibility toward heritage conservation (Mazzocchi, 2022). Knowledge sharing can occur in both formal contexts—such as

guided tours and museum exhibitions—and informal settings, including peer interactions, local storytelling, and digital discourse (Grammatikopoulou & Grammalidis, 2023). As such, it represents a crucial communicative mechanism linking heritage experience to behavioral outcomes .

Recent studies have identified multiple dimensions of cultural heritage knowledge sharing that differ in modality, actor involvement, and emotional engagement. First, informational knowledge sharing refers to the transfer of factual and interpretive content through structured narratives, signage, brochures, or docent-led tours. This form emphasizes historical accuracy and educational depth, helping tourists build cognitive understanding of a heritage site. Second, social knowledge sharing focuses on interpersonal and peer-generated knowledge, including conversations between visitors, community-hosted interactions, and reviews shared on social media. This dimension plays a crucial role in social learning and norm formation, especially when it comes to behavioral cues regarding respectful conduct (Fu et al., 2024; González-Valiente et al., 2021; Wang et al., 2024).

Third, experiential knowledge sharing entails the immersive and participatory forms of learning that occur through rituals, festivals, performances, and hands-on activities. These practices allow tourists to internalize cultural values and meaning by “doing,” rather than just “knowing,” which enhances emotional connection and personal investment (Yang & Kirillova, 2023). Lastly, technological or digital knowledge sharing involves the use of ICT tools—such as augmented reality apps, virtual tours, digital archives, and online storytelling platforms—that extend the accessibility and interactivity of cultural content. Studies have shown that digital platforms not only expand the reach of heritage information but also encourage pre-visit engagement and post-visit reflection, thereby strengthening the retention of protective values (Abbasi, 2022; Massari et al., 2024)

These four dimensions—informational, social, experiential, and technological—are not mutually exclusive but often interwoven in real-world heritage tourism settings. Their combined influence reflects the evolving nature of heritage interpretation in the digital age and underscores the need for heritage managers to design multi-channel knowledge strategies. By conceptualizing knowledge sharing as a multidimensional construct, this study aims to systematically examine how each dimension differentially contributes to shaping tourists' protection-oriented behaviors. Understanding these distinctions can enhance the precision of both academic inquiry and practical intervention in cultural heritage management.

## **2.2 Theoretical Link Between Knowledge Sharing and Tourist Behavior**

The relationship between cultural heritage knowledge sharing and tourist behavior can be understood through multiple theoretical lenses, most notably the Theory of Planned Behavior (TPB) and Social Cognitive Theory (Ajzen, 1991; Bandura, 1986). These models emphasize how knowledge, when effectively internalized, shapes individuals' attitudes, perceived behavioral control, and social norms, all of which are critical determinants of actual behavior. In the context of heritage

tourism, knowledge sharing serves as both an educational and motivational mechanism, helping tourists develop informed perspectives and behavioral intentions toward heritage preservation (Wang et al., 2023).

Under the TPB framework, informational knowledge sharing enhances the cognitive component of attitude formation by providing historical, cultural, and environmental facts that frame heritage sites as valuable and vulnerable (Menatizadeh et al., 2024). This framing influences tourists' evaluative judgments and fosters protective behavioral responses. For instance, structured interpretive content has been shown to positively impact pro-environmental behaviors at heritage sites (He et al., 2023). Similarly, social sharing processes—such as peer discourse and community-hosted conversations—reinforce subjective norms. According to Xie et al. (2023), tourists are more likely to comply with conservation norms when such expectations are modeled and shared within their social network, either online or on-site.

Experiential and affective engagement through experiential knowledge sharing further activates emotional and moral dimensions of behavior. Immersive experiences, such as participation in rituals or storytelling with local hosts, often evoke feelings of empathy, respect, and moral responsibility. Wang et al. (2025) argue that when tourists feel emotionally connected to a cultural tradition, they are more inclined to take actions aligned with its preservation. In contrast to passive reception of facts, embodied knowledge tends to create longer-lasting behavioral change.

In addition, digital knowledge sharing platforms play a growing role in shaping tourists' protective behaviors before, during, and after travel. As noted by Martí-Testón et al. (2021), AR-based museum guides and mobile apps not only increase heritage knowledge acquisition but also allow tourists to make more conscious and respectful decisions throughout their visit. From a Social Learning Theory perspective (Bandura, 1986), these digital tools act as behavioral models and feedback mechanisms that reinforce preservation-supportive conduct.

Overall, these theoretical linkages suggest that the diverse dimensions of knowledge sharing are central to shaping tourists' protection behavior—not through direct instruction, but through a combination of information framing, social modeling, emotional resonance, and digital reinforcement. By enhancing tourists' awareness, empathy, and perceived responsibility, knowledge sharing becomes a powerful behavioral driver in heritage conservation contexts.

### **2.3 Hypothesis development**

Based on the theoretical foundations and multidimensional nature of cultural heritage knowledge sharing, this section develops four hypotheses linking each dimension of knowledge sharing to tourists' cultural heritage protection behavior.

### **2.3.1 Informational Knowledge Sharing and Protection Behavior**

Informational knowledge sharing refers to the dissemination of factual, historical, and interpretative information related to cultural heritage (Martins et al., 2023). When tourists are provided with accurate and meaningful information—whether through guided tours, signage, brochures, or official websites—they are more likely to develop cognitive appreciation and protective attitudes toward the site (Zhan et al., 2024). From the perspective of the Theory of Planned Behavior (Ajzen, 1991), such information enhances the attitudinal component, thereby influencing the likelihood of protective behavior. Additionally, Lucchi et al. (2024) highlight that awareness campaigns grounded in historical and conservation information reduce exploitative tourist behavior at vulnerable heritage sites. Based on this evidence, we propose:

H1: Informational knowledge sharing is positively associated with tourists' cultural heritage protection behavior.

### **2.3.2 Social Knowledge Sharing and Protection Behavior**

Social knowledge sharing occurs through interpersonal communication and peer-based information exchange. This includes dialogue among tourists, online reviews, social media sharing, and interactions with local residents (Carvalho & Alves, 2023; Ye et al., 2024). According to Social Cognitive Theory (Bandura, 1986), such interactions foster observational learning and shape perceived social norms, which are central predictors of behavior. Research by Nieto-García et al. (2024) indicates that tourists who engage in conversations about cultural values and sustainable conduct are more likely to mirror these behaviors themselves. Moreover, when tourists perceive that others in their social environment value heritage preservation, they are more likely to conform to these behavioral norms. Therefore, we propose:

H2: Social knowledge sharing is positively associated with tourists' cultural heritage protection behavior.

### **2.3.3 Experiential Knowledge Sharing and Protection Behavior**

Experiential knowledge sharing emphasizes learning through direct participation—such as engaging in cultural rituals, traditional crafts, or storytelling with local hosts. This dimension aligns with experiential learning theory (Kolb, 1984), which asserts that knowledge gained through active, embodied experience is more likely to lead to behavioral transformation. Lucifora et al. (2023) demonstrate that immersive heritage experiences not only improve understanding but also evoke emotional connection, empathy, and a sense of ethical responsibility among tourists. Such affective engagement often results in a stronger inclination toward protective behavior. Hence, we hypothesize:

H3: Experiential knowledge sharing is positively associated with tourists' cultural heritage

protection behavior.

### 2.3.4 Technological Knowledge Sharing and Protection Behavior

Technological or digital knowledge sharing involves the use of ICT tools—such as mobile apps, virtual museums, QR-coded heritage markers, and AR/VR applications—to distribute heritage-related knowledge. These tools facilitate convenient and personalized access to cultural content, enabling deeper pre-visit learning and post-visit reflection. Research by Nag and Mishra (2024) suggests that tourists who use heritage-focused digital platforms are more informed and display higher sensitivity to preservation guidelines. From the standpoint of the Technology Acceptance Model (TAM) (Davis, 1989), when users perceive such technologies as useful and engaging, they are more likely to internalize the knowledge and adjust their behavior accordingly. Consequently, we propose:

H4: Technological knowledge sharing is positively associated with tourists' cultural heritage protection behavior.

Together, these four hypotheses build a multidimensional framework for analyzing how different forms of knowledge dissemination influence tourists' engagement in protective behavior. This framework contributes to a more nuanced understanding of heritage education, communication strategies, and sustainable tourism management. Figure 1. portrays the conceptual framework.

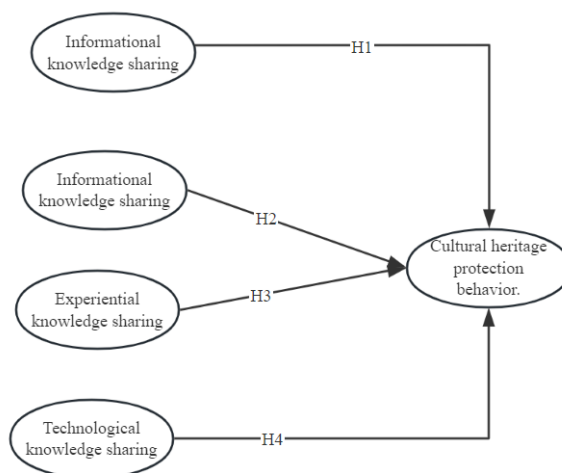


Figure 1. Conceptual framework.

## 3. Research method

### 3.1 Data collection

This study employs a quantitative research design using a structured questionnaire to investigate

the effect of cultural heritage knowledge sharing on tourists' protection behavior. The target population comprises domestic tourists visiting major cultural heritage tourism sites in Shandong Province, China—including Mount Tai, the Confucius Temple in Qufu, and Baotu Spring in Jinan—selected for their rich historical significance, high tourist volume, and relevance to heritage preservation. A non-probability purposive sampling method was employed to ensure that respondents had prior exposure to cultural heritage environments and could meaningfully evaluate knowledge-sharing experiences and protective intentions. Inclusion criteria required participants to be at least 18 years old, to have visited a cultural heritage site within the past six months, and to voluntarily consent to participate in the survey. Based on Hair et al. (2019), a minimum sample size of 200 was set to support structural equation modeling (SEM), with a sample-to-parameter ratio of 10:1. A total of 400 questionnaires were distributed across the selected sites, yielding 368 valid responses after the removal of incomplete or inconsistent entries, resulting in a valid response rate of 92%. Data collection was conducted on-site using self-administered surveys distributed by trained research assistants positioned at major exit points and exhibition areas. The survey process followed ethical standards, ensuring anonymity, voluntary participation, and informed consent.

### **3.2 Instrument**

The research instrument was a structured questionnaire consisting of two main sections: demographic information and latent variable measurement. All constructs were measured using a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The primary independent variable, Cultural Heritage Knowledge Sharing (CHKS), was conceptualized as a second-order construct comprising four reflective dimensions: Informational Knowledge Sharing, measured by 4 items adapted from Khater (2025) and McKercher and Du Cros (2002), focused on factual content provided by heritage sites; Social Knowledge Sharing, also with 4 items adapted from Wang et al. (2012) and Bandura (1986), captured interpersonal communication and peer learning; Experiential Knowledge Sharing, with 4 items based on (2014) and Naranjo et al. (2024), reflected participatory learning through cultural immersion; and Technological Knowledge Sharing, measured using 4 items adapted from Davis (1989) and Aun (2024), assessed the use of digital tools for heritage learning. The dependent variable, Cultural Heritage Protection Behavior (CHPB), was measured with 4 items adapted from Kim et al. (2020) and Prebensen and Xie (2017), reflecting tourists' proactive behavioral efforts to protect heritage resources. In total, 20 measurement items were developed and pre-tested to ensure linguistic clarity, cultural relevance, and content validity.

### **3.3 Data analysis**

Data analysis was conducted in multiple stages using software for structural equation modeling (SEM). Initially, a pilot test with 30 respondents was conducted to assess the clarity and reliability of the measurement items, resulting in minor revisions for improved comprehension. Descriptive

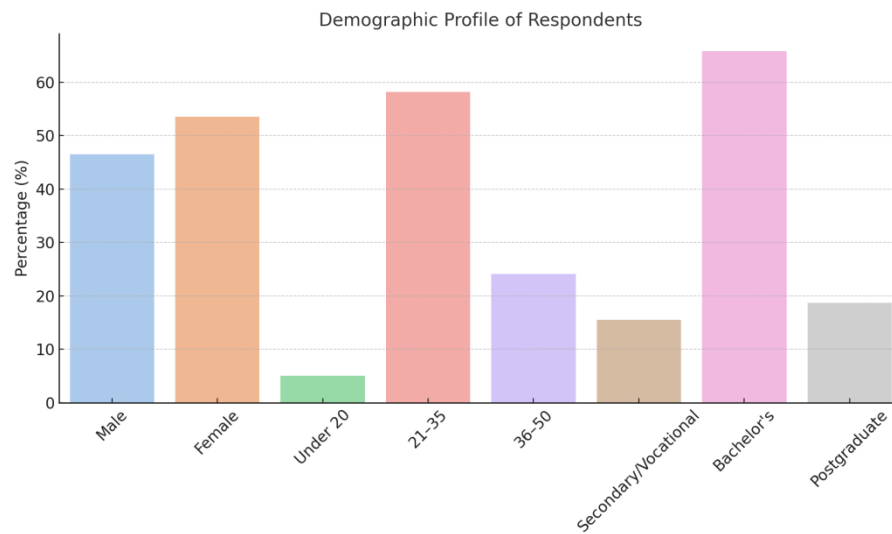
statistics and normality checks were performed on the full dataset, followed by a reliability analysis using Cronbach's alpha and Composite Reliability (CR) to assess internal consistency. Convergent validity was evaluated through factor loadings ( $>0.7$ ) and Average Variance Extracted ( $AVE > 0.5$ ), while discriminant validity was assessed using the Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) ratio. SEM was employed to examine the structural relationships among the constructs through a two-step approach: the measurement model was first validated to confirm construct reliability and validity, and then the structural model was tested to evaluate the proposed hypotheses. Path coefficients, t-values, and p-values were derived using bootstrapping with 5,000 resamples, and model fit indices such as the Standardized Root Mean Square Residual (SRMR) and  $R^2$  values were used to assess the overall model adequacy.

## **4. Results**

### **4.1 Descriptive Statistics Analysis**

Descriptive statistics were used to summarize the demographic characteristics of the respondents and to provide an overview of their responses to the main constructs. Among the 368 valid respondents, 53.5% were female and 46.5% male. The majority of participants (58.2%) were between 21 and 35 years old, followed by 24.1% between 36 and 50, while the remaining were either under 20 or above 50. In terms of education, 65.8% held a bachelor's degree, 18.7% had postgraduate qualifications, and 15.5% had completed secondary or vocational education. Approximately 71.4% of respondents reported having visited a cultural heritage site within the past three months, indicating high relevance to the study context.

For the key research variables, means and standard deviations were computed. The overall mean score for Cultural Heritage Knowledge Sharing (CHKS) was 4.12 ( $SD = 0.51$ ), suggesting that respondents generally perceived knowledge sharing practices at heritage sites as effective. Among the four dimensions, Informational Knowledge Sharing had the highest mean ( $M = 4.28$ ,  $SD = 0.49$ ), followed by Technological ( $M = 4.15$ ), Experiential ( $M = 4.07$ ), and Social Knowledge Sharing ( $M = 3.98$ ). The dependent variable, Cultural Heritage Protection Behavior (CHPB), had a mean score of 4.21 ( $SD = 0.55$ ), indicating a strong self-reported tendency among respondents to engage in protective behaviors when visiting heritage sites. These results suggest that the sample population was generally well-informed, educated, and actively engaged with cultural heritage tourism. The high mean scores across variables also imply favorable conditions for further structural modeling. As shown in figure 2.



**Figure 2. Demographic Profile Of Respondents**

#### 4.2 Reliability and Validity Analysis

To ensure the quality and internal consistency of the measurement model, both reliability and validity analyses were conducted in accordance with guidelines proposed by Hair et al. (2019).

Table 1 shows the internal consistency reliability. The reliability of each construct was evaluated using Cronbach's alpha ( $\alpha$ ) and Composite Reliability (CR). As shown in Table 4.2, all constructs exceeded the recommended threshold of 0.70 for both  $\alpha$  and CR, indicating acceptable internal consistency. Specifically, CHPB had the highest reliability ( $\alpha = 0.89$ , CR = 0.91), followed by Informational Knowledge Sharing ( $\alpha = 0.88$ ), and the other dimensions also ranged between 0.85–0.89.

Table 2 illustrates the convergent validity. Convergent validity was assessed by examining the Average Variance Extracted (AVE) and standardized factor loadings of each item. All items demonstrated factor loadings above 0.70, and the AVE values for all constructs exceeded the 0.50 benchmark, confirming adequate convergence of indicators toward their respective latent constructs. For instance, the AVE for Experiential Knowledge Sharing was 0.64, while that for Technological Knowledge Sharing reached 0.69.

**Discriminant Validity.** Discriminant validity was tested using the Fornell–Larcker criterion and the Heterotrait-Monotrait (HTMT) ratio. According to the Fornell–Larcker criterion, the square root of the AVE for each construct was greater than its correlation with other constructs, satisfying the required condition. Additionally, all HTMT values were below the conservative threshold of 0.85, further supporting discriminant validity. These results confirm that each construct captures distinct

aspects of the conceptual framework and is empirically distinguishable from the others.

$$\sqrt{AVE_i} > \text{Corr}(i, j) \quad \text{for all } j \neq i$$

Where:

- $\sqrt{AVE_i}$ : Square root of the AVE for construct  $i$
- $\text{Corr}(i, j)$ : Correlation between constructs  $i$  and  $j$

$$HTMT_{ij} = \frac{\mathbb{E}(|r_{ij}^{\text{heterotrait}}|)}{\sqrt{\mathbb{E}(r_{ii}^{\text{monotrait}}) \cdot \mathbb{E}(r_{jj}^{\text{monotrait}})}}$$

Where:

- $r_{ij}^{\text{heterotrait}}$ : Correlations between items of different constructs
- $r_{ii}^{\text{monotrait}}$ : Correlations between items of the same construct
- $\mathbb{E}$ : Expectation (mean)

**Table 1. Reliability & Convergent Validity ( $\alpha$ , CR, AVE)**

Construct		Cronbach's Alpha	Composite Reliability (CR)	Average Extracted (AVE)	Variance
Informational Sharing	Knowledge	0.88	0.9	0.66	
Social Knowledge Sharing		0.86	0.89	0.63	
Experiential Sharing	Knowledge	0.85	0.88	0.64	
Technological Sharing	Knowledge	0.87	0.9	0.69	
Cultural Heritage Protection Behavior		0.89	0.91	0.72	

**Table 2. Convergent validity**

	Informational	Social	Experiential	Technological	Protection
Informational	<b>0.81</b>				
Social	0.62	<b>0.79</b>			

Experiential	0.58	0.55	<b>0.8</b>		
Technological	0.6	0.59	0.57	<b>0.83</b>	<b>0.68</b>
Protection	0.66	0.64	0.63	0.68	0.85

### 4.3 Structural Model Analysis and Hypothesis Testing

Following the confirmation of measurement model reliability and validity, structural equation modeling (SEM) was performed using SmartPLS 4.0 to examine the hypothesized relationships between the four dimensions of cultural heritage knowledge sharing and tourists’ protection behavior.

#### 4.3.1 Model Fit and Predictive Power

The model’s overall fit was assessed using the Standardized Root Mean Square Residual (SRMR), which was found to be 0.052—below the commonly accepted threshold of 0.08—indicating a good model fit (Hair et al., 2019). The coefficient of determination ( $R^2$ ) for the dependent variable, Cultural Heritage Protection Behavior, was 0.62, suggesting that approximately 62% of the variance in protection behavior can be explained by the four dimensions of knowledge sharing. This indicates substantial explanatory power.

#### 4.3.2 Path Coefficients and Hypothesis Testing

The significance of each structural path was tested using a bootstrapping procedure with 5,000 resamples. The results are summarized in Table 4.5. All four hypotheses were supported (Table 3):

- H1: Informational Knowledge Sharing → Protection Behavior ( $\beta = 0.24, t = 4.28, p < 0.001$ )
- H2: Social Knowledge Sharing → Protection Behavior ( $\beta = 0.18, t = 3.67, p < 0.001$ )
- H3: Experiential Knowledge Sharing → Protection Behavior ( $\beta = 0.22, t = 4.01, p < 0.001$ )
- H4: Technological Knowledge Sharing → Protection Behavior ( $\beta = 0.30, t = 5.02, p < 0.001$ )

$$PB = \beta_1 \cdot IKS + \beta_2 \cdot SKS + \beta_3 \cdot EKS + \beta_4 \cdot TKS + \varepsilon$$

Where:

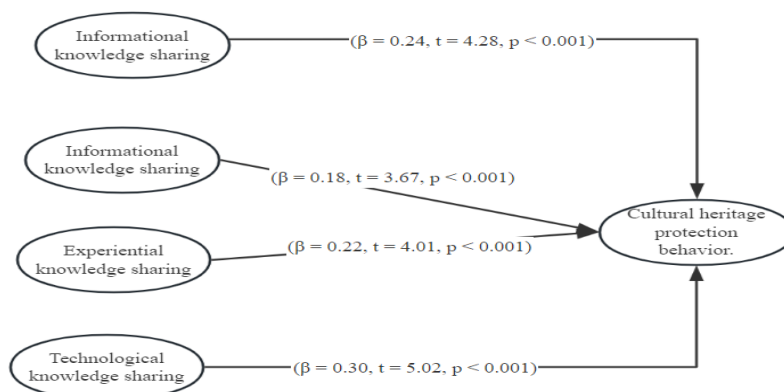
- PB: Cultural Heritage Protection Behavior
- IKS: Informational Knowledge Sharing
- SKS: Social Knowledge Sharing
- EKS: Experiential Knowledge Sharing
- TKS: Technological Knowledge Sharing
- $\beta_1, \beta_2, \beta_3, \beta_4$ : Standardized path coefficients
- $\varepsilon$ : Error term

**Table 3. Hypothesis test**

Hypothesis	Path	Standardized Coefficient ( $\beta$ )	t-value	p-value	Results
H1	Informational → Protection Behavior	0.24	4.28	< 0.001	Supported
H2	Social → Protection Behavior	0.18	3.67	< 0.001	Supported
H3	Experiential → Protection Behavior	0.22	4.01	< 0.001	Supported
H4	Technological → Protection Behavior	0.3	5.02	< 0.001	Supported

Among the four, technological knowledge sharing had the strongest impact on tourists' protection behavior, highlighting the importance of digital tools in promoting heritage awareness and responsible action.

Figure 3 provide robust empirical support for the proposed theoretical model. Each knowledge sharing dimension significantly and positively contributes to tourists' protective behaviors, validating the conceptualization of knowledge sharing as a multidimensional construct. The findings suggest that heritage site managers and policymakers should consider investing in diverse forms of knowledge dissemination, particularly in digital technologies and experiential programming, to foster sustainable visitor engagement.



**Figure 3. Structural model to understand the path of knowledge sharing affecting cultural heritage protection behavior.**

## **5. Discussion and Implications**

### **5.1 Summary of Key Findings**

This study explored the influence of cultural heritage knowledge sharing on tourists' protection behavior by examining four distinct dimensions: informational, social, experiential, and technological knowledge sharing. The results from structural equation modeling revealed that all four dimensions significantly and positively influenced protection behavior, with technological knowledge sharing exerting the strongest effect ( $\beta = 0.30$ ), followed by informational ( $\beta = 0.24$ ), experiential ( $\beta = 0.22$ ), and social ( $\beta = 0.18$ ). These findings confirm the multidimensional nature of knowledge sharing and its effectiveness in promoting sustainable visitor conduct at cultural heritage sites.

### **5.2 Theoretical Implications**

The findings contribute to the existing literature on cultural heritage tourism and tourist behavior in several important ways. First, by conceptualizing knowledge sharing as a multidimensional construct, this study advances our understanding of how different knowledge-sharing modalities contribute to behavioral outcomes. Prior studies have often examined information provision in isolation (Kurki et al., 2023); this research integrates informational, social, experiential, and technological dimensions into a holistic model. Second, the study supports the use of behavioral theories—particularly the Theory of Planned Behavior (Ajzen, 1991) and Social Cognitive Theory (Bandura, 1986)—to explain how knowledge transfer mechanisms shape tourists' attitudes and actions toward heritage protection. Third, the identification of technological knowledge sharing as the most impactful predictor aligns with emerging discussions on digital heritage engagement, underscoring the growing role of ICTs in shaping heritage experiences.

### **5.3 Practical Implications**

From a managerial and policy-making perspective, this study offers several actionable recommendations for enhancing cultural heritage protection through knowledge strategies. Heritage site managers should invest in developing digital engagement tools such as mobile applications, QR-based interpretive content, and interactive AR/VR experiences, as these were found to have the strongest influence on protective behavior. Furthermore, staff training for guides and interpreters should emphasize the role of accurate and compelling storytelling to boost informational knowledge sharing. Local communities and volunteers should be empowered to participate in experiential learning programs—such as workshops, cultural demonstrations, and rituals—that allow visitors to emotionally connect with heritage values. Lastly, social media platforms should be used strategically to facilitate peer-to-peer knowledge exchange and social reinforcement of conservation norms. A blended approach that integrates all four dimensions will likely yield the most effective and sustainable results.

#### 5.4 Limitations and Future Research

Despite its valuable contributions, this study is subject to several limitations that provide directions for future research. First, the study was geographically confined to selected heritage sites in Shandong Province, which may limit the generalizability of findings to other cultural or regional contexts. Cultural norms, management practices, and visitor profiles may vary across different provinces or countries, and thus future studies should consider cross-regional or cross-cultural comparisons to validate and extend the current model.

Second, while this study focused on the direct influence of knowledge sharing on protection behavior, it did not incorporate potential mediating or moderating variables such as cultural identity, environmental attitudes, or personal values. Future research could adopt a more complex model structure to explore how these psychological or contextual factors interact with knowledge-sharing practices to influence behavior more holistically.

Third, all data were collected via self-reported questionnaires, which may be subject to common method bias and social desirability effects. Although anonymity was assured, respondents might have overreported protective behaviors or favorable perceptions of knowledge sharing. Future studies are encouraged to combine qualitative methods (e.g., interviews, observation) or behavioral tracking data to triangulate findings and deepen interpretive insights.

Lastly, the study treated each dimension of knowledge sharing as equally weighted; however, their actual salience may vary depending on tourist demographics, motivations, or site type. Future research may adopt multi-group analysis (MGA) or latent class segmentation to examine how different tourist groups perceive and respond to knowledge-sharing strategies.

In summary, while this study presents a robust model grounded in empirical evidence, it also opens up new avenues for nuanced inquiry into how knowledge transmission, technology, and cultural values intersect to influence sustainable heritage tourism behavior.

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