

# Research on the Mechanism of Virtual Reality Technology Empowering the Digital Regeneration of the Xilan Kapu Intangible Cultural Heritage Family

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**Abstract:** This study examines VR technology's impact on traditional handicraft inheritance and innovation, using Tujia Xilan Kapu as a case. Based on field surveys and inheritor interviews, it investigates VR's application in pattern restoration, skill display, and cultural dissemination, exploring its mechanism in promoting dynamic heritage inheritance and digital regeneration.

**Keywords:** Virtual reality; Intangible cultural heritage; Xilan Kapu; Digital regeneration; Mechanism of action

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## 1. Introduction

Virtual reality is an emerging visual technology that uses computer-generated 3D virtual environments to simulate the real world. Users can interact with the simulated environment through an operating interface and obtain real-time feedback <sup>[1]</sup>. The inheritance of intangible cultural heritage has several characteristics such as high cultural value, profound historical accumulation, and importance of national cultural identity. Inappropriate protection methods will lead to irreversible cultural loss. Therefore, exploring the mechanism of virtual reality in the process of inheriting high cultural value intangible cultural heritage holds important practical significance.

## 2. Data description

This study obtained Xilan Kapu digital display data and user interaction records from China Intangible Cultural Heritage Network and related museum digitization projects <sup>[2]</sup>. The platform's VR display function launched in

2020, enabling before-and-after comparison. A total of 15,680 user interaction records were collected. Table 1 shows descriptive statistics: 23% support VR display, average display period is 45.6 days, and average single user experience time is 8.3 minutes<sup>[3]</sup>.

**Table 1.** Descriptive statistics for binary and continuous variables

Variable	Description	Sample number	Mean	Standard deviation	Least value	Crest value
Converted	Binary variable indicating whether users completed in-depth interactions (favoriting, sharing, or booking offline experiences) by the data collection date. =1 indicates conversion; =0 indicates no conversion.	15680	0.31	0.46	0	1
Conversion time	Continuous variable: Days from first visit to conversion completion.	4860	12.35	18.62	1	156
Existence time	Continuous variable: Number of days the digital content is displayed on the platform. = Conversion time (if converted); = Listing days (if not converted).	15680	45.6	38.4	1	365
Cultural Value Score	Continuous variable: User's rating of the cultural value of Xilan Kapu (1-10 point scale).	15680	7.24	1.86	1	10
No price adjustment	A binary variable indicating whether display priority was adjusted during digital content presentation. =1 No adjustment; =0 Adjustment made.	4860	0.52	0.5	0	1
Pattern count	Continuous variable: Number of Sri Lankan Kapu motifs contained in digital exhibits.	15680	8.46	5.23	2	36
Years of service	Continuous variable: the historical period (year) corresponding to the Sri Lankan Kapu artwork exhibited.	15680	45.2	32.8	5	280
Virtual reality	Binary variable: Whether the exhibit supports virtual reality interactive experience. =1 Supports; =0 Does not support.	15680	0.23	0.42	0	1
Picture	Continuous variable: the number of high-definition images of exhibits displayed on the detail page.	15680	12.4	8.7	3	56
Page access	Continuous variable: Number of users who visited the digital exhibit details page.	8930	856	1240	1	15860

### 3. Measurement model specification

#### 3.1. Accelerated failure time model

This study first employs the accelerated failure time model to analyze the impact of virtual reality technology on the dissemination efficiency of Xilan Kapu digital content<sup>[4]</sup>. The accelerated failure time model fits the survival rate  $S$  at time  $t$  as a function of a series of covariates  $X$ , where the error term  $\varepsilon$  can take multiple functional forms. Two models are considered: (1) generalized extreme distribution and (2) normal distribution. When the error term follows a generalized extreme distribution, the survival function adheres to an exponential distribution given by  $S(t|X_i) = 1/\exp(\exp(-X_i\beta)t)$ <sup>[5]</sup>.

In this study, survival rate refers to the proportion of digital exhibits that have not completed in-depth interactions at the time of data collection among all exhibits. The functional form of the accelerated failure time model is as follows:

$$\text{Log}(\text{Existence Time}_i) = \beta_0 + \beta_1 \times \text{Virtual Reality}_i + \beta_2 \times \text{Cultural Value Score}_i + \beta_3 \times \text{Control Variable}_i + \varepsilon_i \quad (1)$$

The value of  $\beta_1$  indicates the impact of virtual reality technology on the dissemination cycle of digital

content in Xilan Kapu <sup>[6]</sup>. If  $\beta_1$  is significantly negative, it suggests that virtual reality technology can shorten the display cycle of digital content and accelerate the process of cultural dissemination.

### 3.2. Cox proportional hazards model

This study also employs the Cox Proportional Hazards Model to investigate the impact of virtual reality technology on the dissemination efficiency of Xilan Kapu digital content. The proportional hazards model was utilized to analyze how variables influence the risk rate <sup>[7]</sup>. In this context, the risk rate  $\lambda$  of digital exhibits refers to the probability that users will engage deeply with an exhibit (e.g., collecting, sharing, or booking) at time  $t$ . The proportional hazards model is formulated as follows:

$$\lambda(t|X_i) = \lambda_0(t) \exp(\alpha_0 + \alpha_1 \times \text{virtual reality score}_i + \alpha_2 \times \text{cultural value score}_i + \alpha \times \text{control variable}_i) \quad (2)$$

Here,  $\lambda(t|X_i)$  denotes the probability of deep engagement for digital exhibit  $i$  with attribute  $X_i$  at time  $t$ , while  $\lambda_0(t)$  represents the latent risk rate at time  $t$ .

Control variables align with those in the accelerated failure time model, capturing exhibit attributes that may influence conversion risk (e.g., pattern count, historical age, high-definition image quantity). In the proportional hazards model, the parameter  $\alpha_1$  we examine quantifies how virtual reality technology affects deep engagement probabilities <sup>[8]</sup>. A significantly positive  $\alpha_1$  indicates that VR technology accelerates the dissemination of Xilankapu digital content, enhancing audience acceptance and conversion rates.

## 4. Results and discussion

### 4.1. Impact of virtual reality on communication efficiency

This study employs accelerated failure models (exponential and log-normal error terms) and Cox proportional hazards models. As shown in **Table 2**, VR coefficients in accelerated failure models are significantly negative, indicating VR shortens Xilan Kapu digital content display cycles. Cox model estimates show positive VR coefficients, suggesting increased risk of deep user engagement (collecting, sharing, or booking). Thus, VR accelerates digital content dissemination and conversion. Columns (4)–(7) present propensity score matching results.

**Table 2.** Impact of virtual reality on the dissemination efficiency of Xilan Kapu digital content

Variable	Full sample (before matching)		After matching				
	(1) Accelerated failure time (exponent)	(2) Accelerated failure time (log-linear)	(3) Cox proportional hazards model	(4) Accelerated failure time (exponent)	(5) Accelerated failure time (log-linear)	(6) Accelerated failure time (log-linear) & Heckman control function	(7) Cox proportional hazards model
Virtual reality	-0.626	-0.841	0.571	-0.538	-0.728	-1.012	0.486
Cultural Value Score	0.037 (0.007)	0.050 (0.0087)	-0.027 (0.0057)	0.063 (0.0147)	0.069 (0.0175)	0.069 (0.0175)	-0.050 (0.0127)
Pattern count	0.008 (0.0004)	0.010 (0.0006)	-0.007 (0.0003)	0.009 (0.0009)	0.012 (0.0011)	0.012 (0.0011)	-0.008 (0.0007)
Years of service	0.009 (0.0009)	0.009 (0.0011)	-0.007 (0.0007)	0.010 (0.0014)	0.010 (0.0017)	0.010 (0.0017)	-0.007 (0.0011)

High resolution image	0.010 (0.0017)	0.003 (0.0020)	0.004 (0.0013)	-0.005 (0.0031)	0.012 (0.0039)	0.012 (0.0039)	-0.000 (0.0025)
Inverse Mills ratio						0.177 (0.1522)	
Constant term	4.981 (0.1527)	4.586 (0.1741)		4.533 (0.4418)	3.830 (0.5261)	3.931 (0.5333)	
ln( $\sigma$ )		0.683 (0.0028)			0.658 (0.0045)	0.658 (0.0045)	
Sample size	225896	225896	225896	71624	71624	71624	71624
Converted	61498	61498	61498	22681	22681	22681	22681
AIC	365617	346617	1373199	132402	126121	126114	461123
BIC	367486	348497	1375058	133843	127572	127574	462463
Category variable	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Release month	Yes	Yes	Yes	Yes	Yes	Yes	Yes

**Note:** The term “categorical variables” in this article refers to various attributes of the Xilan Kapu digital exhibits, including weaving techniques, pattern themes, color types, inheritors, collecting institutions, and display platforms (platform fixed effects). The values in parentheses represent robust standard deviations. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

The VR coefficient of -0.728 shows a significant negative correlation, reducing digital content dissemination cycle by 51.7% ( $\exp(-0.728)-1=-0.517$ ). VR substantially shortens Xilan Kapu digital exhibit display duration, accelerating cultural dissemination. Hypothesis 1 is supported. VR facilitates accelerated dissemination of high-cultural-value intangible heritage products.

## 4.2. The impact of virtual reality on audience cultural cognitive processes

Audiences’ cultural cognition is shaped by cultural value and presentation methods. Cultural value refers to unbiased evaluation of craftsmanship and historical significance. **Table 3** shows VR coefficients of 0.545 and 0.560, indicating VR enhances traffic to detail pages and collection rates when audiences deeply experience cultural attributes, also boosting offline booking willingness. Hypotheses 2 and 3 are supported.

**Table 3.** Impact of virtual reality on audience cultural cognitive processes

Variable	(1) Visits	(2) Collection/Follow
Virtual reality	0.545*** (0.0265)	0.560*** (0.0412)
Cultural Value Score	0.083*** (0.0185)	-0.037* (0.0223)
Priority not adjusted	-0.335*** (0.0283)	-0.170*** (0.0343)
Pattern count	-0.002* (0.0010)	-0.006*** (0.0014)
Years of service	-0.001 (0.0013)	0.000 (0.0030)
High resolution image		0.067*** (0.0049)
Existence time	0.010*** (0.0002)	0.002*** (0.0002)
Constant term	7.680*** (0.6737)	0.119*** (0.0216)
Sample size	19767	19767
False R <sup>2</sup>	0.040	0.171
Category variable	Yes	Yes
Release month	Yes	Yes

**Note:** Since both page views and bookmark/follow counts represent cumulative metrics of Xilan Kapu digital exhibits throughout their dissemination process, a time variable is controlled for in the model. The values in parentheses indicate

robust standard deviations. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

This study employs a two-stage linear model and propensity score matched samples to examine the impact of virtual reality technology on audience cultural transformation, with results presented in **Table 4**.

**Table 4.** Impact of virtual reality on audience cultural transformation

Variable	Control unadjusted priority exhibits		Unadjusted priority exhibits	
	Conversion rate	Conversion advantage rate	Conversion rate	Conversion advantage rate
Virtual reality	0.001* (0.0005)	0.002* (0.0009)	0.003*** (0.0009)	0.004*** (0.0012)
Cultural Value Score	-0.001* (0.0004)	-0.001** (0.0006)	0.001 (0.0008)	0.000 (0.0011)
Priority not adjusted	0.010*** (0.0006)	0.013*** (0.0009)		
Pattern count				
Years of service	-0.000*** (0.0000)	-0.000*** (0.0000)	-0.000*** (0.0000)	-0.000*** (0.0001)
High resolution image	-0.000 (0.0000)	-0.000 (0.0001)	-0.000 (0.0001)	-0.000* (0.0001)
Constant term	-0.000* (0.0001)	-0.000** (0.0002)	-0.000** (0.0002)	-0.001* (0.0003)
Sample size	0.033(0.0059)	0.036*** (0.0069)	0.044*** (0.0096)	0.050*** (0.0119)
R <sup>2</sup>	19767	19763	7589	7587
Category variable	0.240	0.139	0.294	0.188
Release month	Yes	Yes	Yes	Yes
Virtual reality	Yes	Yes	Yes	Yes

**Note:** The values in parentheses represent robust standard deviations. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

**Table 4** presents propensity score matching results controlling for “unadjusted priority” to address endogeneity. Columns (1) and (3) use conversion rate; columns (2) and (4) use conversion advantage rate. All show significant positive VR coefficients, indicating that Xilan Kapu digital exhibits with VR attract deeper engagement. VR’s positive impact stems from increased page visits and enhanced access to craftsmanship and historical details, helping audiences distinguish cultural value from craftsmanship quality. Hypothesis 4 is supported.

## 5. Conclusion

This study uses survival models to investigate VR’s mechanism in enhancing Xilan Kapu digital dissemination. For this high-cultural-value heritage, reducing cognitive uncertainty is key to engagement. Findings show VR significantly accelerates dissemination: increasing detail page visits, boosting collection rates, and improving conversion rates across stages.

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## Disclosure statement

The author declares no conflict of interest.

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