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Investigating the impact of virtual tourism on travel intention during the post-COVID-19 era: Evidence from China

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Abstract:

This study explores the mechanism that contributes to travel intention in the field of virtual tourism. The overall research method is based on the "Stimulus-Organism-Response" (SOR) theory. In the research model, the effects of content quality, system quality, and interaction quality in virtual tourism on tourism experience and travel intention are explored, as well as the role of virtual attachment and travel intention. A total of 390 respondents were invited to participate in a virtual tourism experience before providing feedback through a questionnaire. SmartPLS 3.3.2 was used to validate the causal model, and most of the study hypotheses were supported. The findings show that virtual tourism significantly promotes travel intention. Specifically, content quality, system quality, and interaction quality positively affect tourists' travel intention through the complementary mediations of tourism experience and virtual attachment; and system quality even directly promotes travel intention. However, tourism experience does not affect virtual attachment. The present study extends prior studies on virtual tourism with SOR as a general model for field tourism experience research, while demonstrating the effectiveness of virtual tourism in promoting tourists' travel intention. The results are useful in assisting governments in developing relevant policies and services, as well as helping tourism companies understand virtual tourism as an enhancement for tourist travel intention, thus contributing to the recovery of the tourism industry in the post-COVID-19 era.

Keywords: Virtual tourism, stimulus-organism-response model, travel intention, PLS-SEM, post-COVID-19, China

Paper type: Long research paper

1. Introduction

The COVID-19 pandemic was the most significant public health emergency with the most rapid spread and broadest infection range since the founding of the People's Republic of China in 1949 (Zhang, 2020). During the outbreak, economic activities in China were basically at a standstill (Qarnain et al., 2020), except for certain industries that still functioned to meet the basic needs of the public. The outbreak significantly disrupted the entire tourism industry due to the allopatric and clustered nature of tourism activities (XIE & SHA, 2012), a series of activities undertaken by tourists who travel from the source to the destination via the tourism corridor. In response to COVID-19, Chinese cities have primarily closed communities, surrounding villages, and towns to restrict the movement of people. As a result of this response, demand for tourism activities was passively reduced to zero. Travel agencies, which were the gateways, were asked to suspend their operations. In contrast, air carriers and railroads, as the gateways, changed their usual "change and

refund" policy and offered refunds to passengers who had already purchased tickets. Accordingly, passenger traffic and revenue in the transportation industry plummeted during the pandemic (Suau-Sanchez et al., 2020). In tourist destinations, tourist attractions were almost completely shut down. Hotels were either shut down, or provided temporary housing for medical staff or used as temporary isolation sites to receive patients (Chen et al., 2020). Arguably, the tourism supply was essentially at zero.

The sudden onslaught of COVID-19 kept people at home (Altena et al., 2020), which was a big blow to the offline tourism industry. Since the pandemic was alleviated in China, the offline tourism industry still faces a significant challenge (Donthu & Gustafsson, 2020). In this course, the tourism industry has also explored new ways of development, i.e., "virtual tourism (Zhang et al., 2022)", "live-streaming tourism (Qiu et al., 2021)", and other new ways of relaunching the tourism industry with the help of the internet and innovative technologies. The segmentation of "smart technology + tourism" is reflected in integrating virtual reality (VR) technology and tourism products (Loureiro et al., 2020). The development of virtual reality technology has broken through past limitations, which could only simulate the natural environment through pictures or videos and provided participants with a better "immersion" experience (Hudson et al., 2019). As the influence of VR technology expands and attracts more attention, relevant academic research also becomes increasingly available. Pioneering research mainly combines virtual reality technology with landscape design, medical education, and disease treatment from the research content. Nevertheless, further literature search revealed that the existing literature on "VR and tourism" is sparse. Scholars have now focused on the marketing value of VR technology (Leung et al., 2020; Lo & Cheng, 2020; Song et al., 2020) and destination image building (Alyahya & McLean, 2021; Chang, 2021; Lin et al., 2020). Although the methods used in these studies are relatively homogeneous and lacking in empirical evidence, they still provide vital tools, methods, and mindsets for studying VR technology and tourism. The theory has guiding significance for practice, and VR technology, as a new communication medium, has an immeasurable impact on the tourism industry's development. Hence, it is imperative to strengthen academic research in virtual tourism.

The decisive intervention of virtual technology has given new connotations, characteristics, and forms to the relationship between people and places (El-Said & Aziz, 2021). The traditional binary space of tourist and physical tourist places shifts into the ternary connections between virtual place, tourist, and real place. The interrelationship of such ternary spatial continuity has become an essential topic in the study of the people and the place in the digital era. At present, scholars have paid attention to constructing the ternary space (Kunz & Seshadri, 2015). However, the study of tourists' behavioral intentions in the ternary space still needs to be advanced. Virtual tourism may affect users' experiences, attitudes, and behaviors (Chung et al., 2015; Jung et al., 2015; Tussyadiah et al., 2018). However, the way virtual tourism affects users' travel experience and emotional attachment, as well as the role of virtual tourism on future travel intention *in the field,* is still unclear. Therefore, starting from the SOR theory, this paper constructs a model of the influencing factors of virtual tourism experience (3D reconstruction of the real tourism place) - the inner psychology of users in the virtual tourism process - the travel intention in the field. We explore how virtual tourism uses digital technology to construct users' attachment to real tourism places and then influence their travel intention in the field.

This study, therefore, starts from the characteristics of virtual tourism, draws on the research theories and experiences of established social media platforms such as live streaming, short video, and online shopping, while introducing two mediating variables of tourism experience and virtual attachment based on the psychological perspective, with the "Stimulus-Organism-Response" theory (referred to as SOR model) as the theoretical framework. We construct a conceptual model of the impact of virtual tourism on tourists' travel intention, and carry out empirical analysis to explore how virtual tourism affects field travel intention through

users' intrinsic state. This study contributes to a comprehensive and in-depth understanding of the new tourism human-ground relationship in the information age. It clarifies the mechanism of human-ground emotional attachment in virtual tourism, as well as the mechanism of virtual tourism influence on users' travel intention in the field, deepening the study of the human-place relationship in the ternary space. The results provide a feasible direction for promoting the integration of tourism locations and people in the information age. Furthermore, this study has important practical implications for the experience design of virtual tourism, tourism destination marketing innovation, and enhancement of tourist loyalty in the post-COVID-19 era. Overall, this paper empirically examines the impact of virtual tourism on tourists' travel intention in the field through the questionnaire method, specifically by addressing the following research questions:

RQ1: Does the virtual tourism experience increase users' travel intention in the field?

RQ2: What factors contribute to tourists' travel intention in the field of virtual tourism?

RQ3: How do important influencing factors of virtual tourism experience (content quality, system quality, interaction quality), tourism experience, virtual attachment, and travel intention interact with each other?

2. Theoretical background and research hypothesis

2.1 Stimulus-Organism-Response (SOR) model

The Stimulus-Organism-Response (SOR) model is a model of human cognitive behavior, first proposed by (Mehrabian & Russell, 1974). It reflects the "stimulus-perception-response" process of human behavior. The SOR theory model suggests that stimuli from the external environment influence individuals' behavioral decisions by affecting their emotions. The term "stimulus" refers to the factors that stimulate and cause individuals to act (Sherman et al., 1997). The term "organism" refers to an individual's interior psychological state (Sherman et al., 1997). The term "response" refers to the individual's numerous behaviors or behavior intentions in response to the stimuli and the organism (Sherman et al., 1997). In the SOR framework, the stimulus is generally used as the independent variable, the organism as the mediating variable, and the response as the dependent variable. SOR began as a cognitive model used in psychology and is now frequently utilized to examine Internet user behavior (Chen & Yao, 2018; Kim et al., 2018; Ul Islam & Rahman, 2017; Zhu et al., 2020).

In tourism research, the SOR model was used to study travel experience (Chen et al., 2021; Min et al., 2019), travel intention (Min et al., 2019; Su et al., 2021; Turulja & Činjarević, 2021), and user engagement (Ali et al., 2021; Tian et al., 2021; Yadav et al., 2021). Researchers have found various factors capable of influencing tourist travel intention, including tourists' internal reasoning and the influence of certain external factors, such as tourists' reference information, personal perceptions, and perceived risks (Mullet & Karson, 2018). Various social, economic, and psychological factors may impact tourists' travel intentions. Among them, both the reference group and the individual's subjective perceptions play a vital role in forming travel intentions. The reference group of tourists and their subjective knowledge psychologically form emotional preferences and inherent impressions of a tourist destination, which affects the willingness and choice of tourists to travel to that destination. SOR theory suggests that the external environment stimulates the individual's perceptions and emotions, which affects the individual's behavior (Song et al., 2021). Therefore, in studies of consumer travel intentions or behaviors, giving subjects “S” (e.g., VR environment) stimuli before measuring “R” (e.g., questionnaire results) tend to reveal more valid findings when travelers use digital technology such as virtual reality (VR), artificial intelligence (AI), and augmented reality (AR) to immerse themselves in a highly immersive virtual tourism experience. The process of content stimulation produces the individual's organism, i.e., psychological state. The content quality, system quality, and

interaction quality of virtual tourism will directly impact the tourists' tourism experience and virtual attachment, which will affect the tourists' travel intention in the field.

2.2 The impact of virtual tourism experience on tourists' intrinsic state

According to previous research findings, content quality, system quality, and interaction quality are essential variables that entice tourists to use digital devices for virtual tourism experiences (Jung et al., 2015; Moon & Han, 2018b; Stylidis et al., 2021). According to the SOR theory, tourists experienced content quality, system quality, and interaction quality of the virtual travel as stimuli in the experience process. The organism, i.e., the internal process that mediates the external stimulus and behavioral response received by the individual, is in this study expressed as the tourist experience and virtual attachment of tourists.

2.3 Virtual tourism and tourism experience

Experience is an objectively existing psychological need. Essentially, the tourism experience is an individualized feeling of an individual responding to certain stimuli (Packer & Ballantyne, 2016). Morrison et al. discovered that physical environmental factors such as music, lighting, and facilities were positively associated with customer mood (Morrison et al., 2011). Lee, park, and Han found that the quality of online content affects user engagement and acceptance. Due to the attractiveness of the web, uploading high-quality images or videos can influence user satisfaction (Lee et al., 2014). Ghose and Huang found that the higher the availability of modern technology, the more companies can promote product quality through personalized services and products. In this way, service quality is improved by increasing satisfaction (Ghose & Huang, 2009). In the context of virtual tourism, its interaction quality mainly refers to the ability to provide personalized information, understand tourists' needs and preferences, and personalized interactions. Chang designed an AR-based cultural heritage tour system. He found through a questionnaire that tourists had a strong experience with this system (Chang et al., 2015). Jung's study found that the content of augmented reality technology, personalized services, and system quality affect tourists' experience and thus their satisfaction (Jung et al., 2015). Based on this, this study proposes the following hypotheses:

H1: The content quality of virtual tourism positively affects the tourism experience;

H2: The system quality of virtual tourism positively affects the tourism experience;

H3: The interaction quality of virtual tourism positively affects the tourism experience.

2.4 Virtual tourism and virtual attachment

The specific and deep connections people make to a place by assigning meaning to it are called "place attachments" (Oleksy & Wnuk, 2017). Attachment refers to "the human tendency to develop strong emotional ties to specific people and objects (Bowlby, 1977)". With the development of technology, an individual's attachment is not necessarily to a real place. However, it can be extended to a broader scope (Rakić & Chambers, 2012). For example, with the rapid development of new media, people with common interests or experiences communicate and interact through computer networks, creating emotional attachments to the virtual communities they form (Chan & Li, 2010). When experiencing social isolation or loneliness, some users develop an emotional attachment to the Internet and social media (Wang et al., 2021).

Moreover, in the context of the current COVID-19 pandemic, virtual tourism rekindles tourists' travel confidence, helps them gain a sense of control and security, and regains their travel rhythm. Attachment arises from experience (Gross & Brown, 2008; Io & Wan, 2017), and the perceived value of different experiences has different effects on attachment production (Frost et al., 1995; Pelled & Hill, 1997). When the virtual world is more realistic, the user's visual senses are more actively involved in aesthetic perception, resulting

in a more memorable experience and encouraging attachment to virtual tourism (Kim et al., 2018). In addition, the dual stimulation of content quality (virtual scenery) and interactive format (virtual experience) allows users to perceive the experience value of entertainment and enjoyment (Oleksy & Wnuk, 2017). When users' own emotional needs are satisfied, they will have a positive emotional evaluation of the virtual scenery, which leads to the enhancement of virtual attachment (Oleksy & Wnuk, 2017). This study contends that while utilizing digital devices for virtual tourism, tourists perceived positive content quality, system quality, and interaction quality would drive their connection to virtual tourism. Therefore, the following hypotheses are proposed in the present study:

H4: The content quality of virtual tourism positively affects virtual attachment;

H5: The system quality of virtual tourism positively affects virtual attachment;

H6: The interaction quality of virtual tourism positively affects virtual attachment.

2.5 The impact of tourists' intrinsic state on travel intention

2.5.1 Tourism experience and travel intention

The organism is an internal cognitive process in response to external stimuli. In this process, the information generated by the organism as a result of the stimulus, such as sensations, perceptions, and emotions, will become the basis for subsequent travel intentions and travel behaviors. The emotions generated by an individual stimulated by the external environment will lead the user to approach or avoid behaviors towards the environment and mediate between environment and behavior (Yüksel, 2007). Ekanayake found that tourists' experiences positively influenced their travel intentions by studying tourists in the eastern province of Sri Lanka (Ekanayake & Gnanapala, 2016). Kim studied tourists of virtual reality tourism based on the diffusion of innovation theory. He found that users' authentic tourism experience positively affects their travel intention (Kim et al., 2020). Kim and Jung studied the effect of tourists' authentic experience on their travel intention based on SOR theory. The study finds that tourists' behavioral intentions are influenced by their sense of authentic virtual reality tourism experiences (Kim et al., 2018). Raouf Ahmad Rather investigated the impact of experiential marketing activities on tourists' behavioral intentions in tourist destinations. It was found that tourists' experiences of marketing activities in tourist destinations affect their travel intention (Rather, 2019). Based on this, this paper proposes the following hypothesis:

H7: Tourism experience positively affects travel intention.

2.5.2 Virtual attachment and travel intention

The prior studies hav efound that with the intervention of network information, the traditional two-dimensional perspective of the human-territory relationship is extended to a three-dimensional space. New human-territory links and interaction forms of (real)person-(virtual)person, (virtual)person-(virtual)place, and (real)place-(virtual)place emerge (Chen & Zhenfang, 2020). The cognition, emotion, and behavior of virtual and real spaces influence each other and intermingle. Users' purchase intentions in the virtual world are consistent with those in the real world (Suh et al., 2011), and Ren et al. demonstrated that attachment to virtual communities affects the frequency with which individuals visit virtual communities (Ren et al., 2012). Kim et al. also found that their attachment to VR influenced VR tourism users' intentions to visit real places (Kim et al., 2018). Therefore, based on the above literature, this study argues that users' awareness and behavior in the virtual world somehow represent real-world awareness and behavior. Virtual attachment enhances tourists' desire for real-world travel destinations. Therefore, the virtual attachment will stimulate the travel intention in the field. Based on this, the following hypothesis is proposed:

H8: Virtual attachment positively affects travel intention.

2.5.3 Virtual attachment and tourism experience

Regarding the relationship between residents' activity participation and local attachment, many empirical studies point out that residents' involvement in local activities positively affects their local attachment (Guest & Lee, 2016; Rollero & De Piccoli, 2010; St. John et al., 1986). Furthermore, through an empirical study, Kyle et al. and Hwang et al. found that tourists' leisure activity participation had a significant positive effect on their place attachment (Hwang et al., 2005; Kyle et al., 2017). In the study on the relationship between the cognitive gap, affective experience, and place attachment, scholars also confirmed that affective experience positively affects place attachment (Hidalgo & HernÁNdez, 2001). The higher the quality of tourists' emotional experience, the higher their level of attachment. It is hypothesized that the higher the positive tourism experience, the greater the likelihood that the tourist will develop a virtual attachment to the destination. Based on this, the following hypothesis was proposed:

H9: Tourism experiences positively influence virtual attachment.

2.5.4 The mediating role of the tourists' intrinsic state

The SOR theory emphasizes the mediating role of the response between the stimulus and the individual's behavior. By comparing the results of prior studies, it was found that tourism experience and virtual attachment play a connecting role between various influencing factors and behavioral intention. Chae, Kuo et al. found that service quality positively impacts customer recommendation and continued usage behavior (Chae et al., 2002; Kuo et al., 2009). Wang and Chen found that the presentation of information systems positively affected consumers' intention to use them(Wang & Chen, 2011). Jung points out that the quality of content affects tourists' attitudes toward AR applications (Jung et al., 2016). N Zhang et al. found that brand attachment exerts a partial mediating effect on the relationship between effective CC and brand commitment (Zhang et al., 2013). Jenny Lee et al. found a mediating effect between place attachment on satisfaction and loyalty (Lee et al., 2012). Based on this, the following hypotheses were formulated:

H10: Tourism experience has a mediating role in influencing travel intention on content quality;

H11: Tourism experience has a mediating role in influencing travel intention on system quality;

H12: Tourism experience has a mediating role in influencing travel intention on interaction quality;

H13: Virtual attachment has a mediating role in influencing travel intention on content quality;

H14: Virtual attachment has a mediating role in influencing travel intention on system quality;

H15: Virtual attachment has a mediating role in influencing travel intention on interaction quality.

3. Methods

3.1 Research model

In summary, this study employs SOR theory as the research framework. Content quality, system quality, and interaction quality of virtual tourism as the antecedent variables of tourism experience, virtual attachment, and tourists' travel intention in the field. The construction of a research model of the factors influencing virtual tourism on tourists' travel intention in the field, as shown in Figure 1.

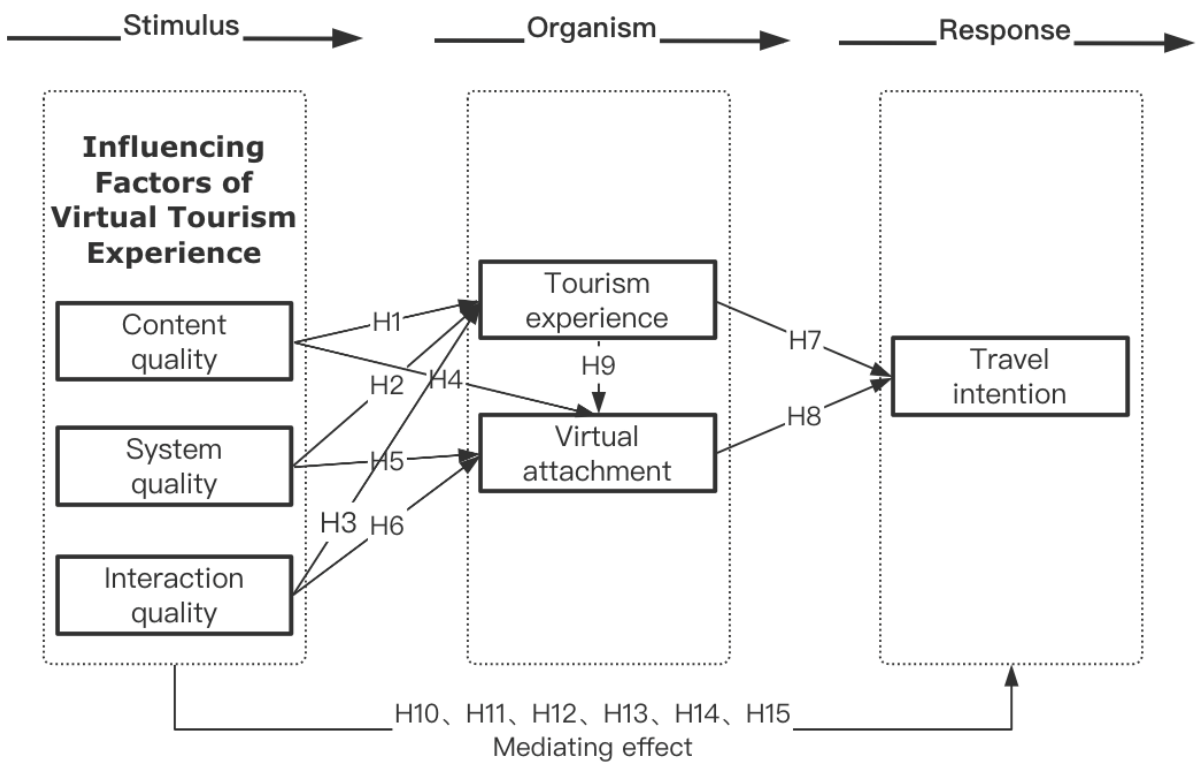

Figure 1. Research model

3.2 Usability test design and data collection

Virtual tourism is a new type of tourism as well as a new industry. Currently, Chinese tourists have less exposure and knowledge about it (Lu et al., 2021; Wu, 2020). With universal access to such new consumer technology, we implemented a real usage scenario to get participants actually and bodily experience virtual tourism in the field. The few users who already experience virtual tourism products were not directly selected for this study. In this way, researchers can measure users' temporal-sensitive experience and concurrent travel intention after the tourists have touched and used the virtual tourism device. The specific method can be referred to as "usability testing (Dumas et al., 1999)". The concept of usability testing was first introduced in 1981 (Krahmer, 2004). Usability testing evaluates the usability and unavailability of a product based on certain usability criteria. Usability testing is also a programmed process used to identify problems that may occur during user-product interaction. In a narrow sense, Usability testing refers to user testing methods that allow a representative group of users to perform typical operations on a product. At the same time, observers and design developers observe, listen, and record. It is a process used to evaluate a product or system's external form, functional operation, and interaction patterns (Dumas et al., 1999).

Previous studies investigated the research and application of usability tests from multiple aspects and dimensions in tourism research. Researchers discuss usability test methods and applications from different perspectives, including usability evaluation methods such as user testing (Othman et al., 2021), questionnaire survey (Pratidina & Setyohadi, 2021), and eye-tracking technology (Font et al., 2021). And the researchers also make practical exploration of usability test research. We can consider usability tests an effective verification method for analyzing user behavior and experience. This lays an important theoretical foundation for this study.

3.3 Participants

Our research team obtained the research sample (Table I) in two ways: First, we recruited virtual tourism experience participants (52% of the total number) through the online social media platform Sina Weibo. With over 300 million monthly active users, Sina Weibo is the largest public social media platform in China. The researcher recruited participants by posting recruitment posts on the Sina Weibo platform. The research team then used the Weibo targeted promotion service to promote the recruitment posts to users who were potentially willing to participate in the virtual tourism experience. Second, the research team recruited users who were willing to participate in virtual tourism through offline in-person networks (48% of the total population). In the data collected, we found that the number of users aged 18-25 who had experienced virtual travel was higher than those in other age groups. This is consistent with Li & Chen's (2019) findings. Therefore, we believe that the research sample obtained is highly credible, reliable, and reproducible in terms of feedback effects. Our research team was trained to strictly follow the test procedures to ensure data quality. The participants were also asked to follow the test procedures strictly.

SPSS 25.0 was used to perform descriptive statistical analysis on the sample data to investigate the sample's demographic characteristics, as shown in Table 1. A total of 390 subjects were recruited to participate in the virtual tourism experience, of which 53.6% and 46.4% were male and female, respectively. In terms of age, users aged 18-25 account for the most significant proportion, 33.8 percent, followed by users younger than 18, accounting for 25.1 percent; in terms of education, bachelor's education is the mainstay, accounting for 64.6 percent.

Table 1. Distribution of participants (N = 390).

Measure	Category	Frequency	Percentage (%)
Gender	Male	209	53.6
	Female	181	46.4
Age	<18	108	25.1
	18-25	142	33.8
	26-34	79	19.2
	35-45	70	17.4
	>45	17	4.4
Education	Junior college	167	17.2
	Bachelor	182	64.6
	Master	59	15.1
	Doctor	8	3.1

3.4 Material and Procedure

Quan Jing Wang (http://www.vra.cn/#/home) has rich virtual tourism scenic spots resources and contains pictures, videos, texts, audio, and other forms. Therefore, we chose the virtual tourism of "VR Panorama of the Palace Museum" launched by Quan Jing Wang as the tourists' tour material, as shown in Figure 2. The usability testing process was broken down into four main steps, as shown in Figure 3. In the first step, the researcher introduced the participants to the content of this usability test and the VR equipment that they would need to use to conduct the virtual tourism. In the second step, the researcher showed the participants an instructional video on using the VR device for virtual tourism. In the third step, the researcher asked the participants if they had learned how to use the VR device for virtual tourism. If the participant answered yes, the participant moved on to the next step. If the participant answered no, the participant had to go back to the second step and continue learning until the participant learned to move on to the next step. In the fourth step,

the participant begins to experience virtual tourism for 40 minutes. In the fifth step, the research team personnel collected feedback from all participants utilizing a questionnaire and randomly selected participants for a brief interview. In this way, the participants were urged to complete the test as required until the end of the test and start filling in the feedback questionnaire.

Figure 2. VR Panorama of the Palace Museum

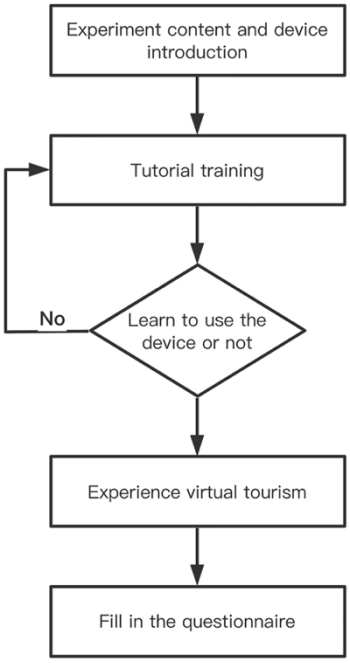

Figure 3. Tourist experience process

This research focuses on virtual tourists' psychological processes and behavioral intentions. The question scale content was developed using correlation theories and a conceptual model. The questionnaire includes two parts: basic information about the subjects and feelings about using virtual tourism. The relevant scales in this study were all fine-tuned using mature scales or based on mature scales to fit this paper's virtual

tourism research context. The stimulus factors were measured using the variables of content quality (three items), system quality (four items), and interaction quality (three items) adopted from (Aladwani & Palvia, 2002; Babin & Burns, 1998; Chae et al., 2002; Chu & Yuan, 2013; DeLone & McLean, 1992; Kim et al., 2004; Kuo, 2010; Yang et al., 2005). The organism factors were measured using the variable of tourism experience (four items) and virtual attachment (five items) adopted from (Jung et al., 2015; Jung et al., 2016; Mintz et al., 2001; Oh et al., 2016; Pine et al., 1999; van der, 2004; Wang & Yu, 2018; Wu et al., 2019; Xiaozhou & Zhuanqing, 2015). The response factor was measured using the variable of travel intention (three items) adopted from (Woodside & Lysonski, 2016).

To ensure the accuracy and scientific validity of the questionnaire, the research team first conducted a small-scale questionnaire pre-test. The test results were also given back to five researchers in virtual tourism, information behavior, and news communication. The questionnaire questions followed the Delphi method to adjust, correct, and calibrate the questionnaire repeatedly until the error was controlled within the appropriate range.

3.5 Descriptive analysis of demographic characteristics

SPSS 25.0 was used in this study to perform descriptive statistical analysis on the sample data to investigate the sample's demographic characteristics. According to demographic characteristics, as shown in Table I. A total of 390 subjects were recruited to participate in the virtual tourism experience in this study, of which 53.6% and 46.4% were male and female, respectively. In terms of age, users aged 18-25 account for the most significant proportion, 33.8 percent, followed by users younger than 18, accounting for 25.1 percent; in terms of education, bachelor's education is the mainstay, accounting for 64.6 percent.

4. Results

4.1 Measurement model analysis

4.1.1 Common method variance

The question of common method variance in the sample was first tested for correlation. To prevent the effect of common method variance on the sample, we hid the names of variables and measurement items in the questionnaire beforehand and randomly assigned the measurement items in the questionnaire. The Harman one-way test for common method variance was used. The results of the unrotated factor analysis showed that there were five factors with characteristic roots greater than one, explaining a total of 75.598% of the variance variation. The first factor explained 36.722% of the method variance. Therefore, there is no significant common method bias problem.

4.1.2 Measurement model

This study performed structural equation modeling on 390 samples using "PLS-SEM." The SmartPLS 3.3.2 software settings were: "weighting scheme" using "path weighting scheme", "maximum number of iterations" = 300, and end criterion = 1*10-7. The Bootstrapping test for significance of each indicator: subsample = 5000, confidence interval method using Bias-Corrected and Accelerated (BCA) Bootstrap, test type using the two-tailed test, significance level = 0.05.

The reliability, convergent validity, and VIF values of the measurement models are shown in Table 2: in terms of reliability, Cronbach's α were above the critical value of 0.7 (Fornell & Larcker, 2018), from 0.868 (SQ) to 0.931 (VA); the Composite Reliability is also more significant than the critical value of 0.7 (Hair Jr

et al., 2021), from 0.910 (SQ) to 0.948 (VA). Thus, the measurement model has good reliability. In terms of validity, the factor loadings (λ) for all measurement questions were more significant than the critical value of 0.7 (Hair Jr et al., 2021), from 0.795 (SQ4) to 0.921 (CQ3). In addition, the AVE for all variables were more significant than the critical value of 0.5 (Hair Jr et al., 2021), from 0.718 (SQ) to 0.822 (CQ). Thus, the measurement model has good convergent validity. In terms of VIF, the Outer VIF Value were all less than the standard value of 5 (Hair Jr et al., 2021), from 1.821 (SQ4) to 3.629 (TE3). The Inner VIF Value were also less than the standard value of 5, from 1.217 (VA) to 1.531 (SQ), so the structural model did not have serious multicollinearity problems. The square root of each variable AVE is greater than the correlation coefficient of that variable with any other variable by the discriminant validity test, and the measurement model has good discriminant validity, as shown in Table 3.

Table 2. Reliability and convergent validity analysis (N = 390).

Construct	Items	Factor Loading	Cronbach's α	CR	AVE	Outer VIF Value	Inner VIF Value
Content quality (CQ)	CQ1	0.917	0.892	0.933	0.822	2.856	1.321
	CQ2	0.882				2.338	
	CQ3	0.921				2.893	
System quality (SQ)	SQ1	0.850	0.868	0.910	0.718	2.291	1.531
	SQ2	0.840				2.129	
	SQ3	0.901				2.849	
	SQ4	0.795				1.821	
Interaction quality (IQ)	IQ1	0.899	0.870	0.920	0.794	2.384	
	IQ2	0.881				2.180	
	IQ3	0.894				2.364	
Tourism experience (TE)	TE1	0.870	0.918	0.942	0.804	2.475	1.262
	TE2	0.880				2.760	
	TE3	0.919				3.629	
	TE4	0.916				3.540	
Virtual attachment	VA1	0.906	0.931	0.948	0.784	3.495	1.217

(VA)							
	VA2	0.869				2.765	
	VA3	0.879				2.920	
	VA4	0.874				2.836	
	VA5	0.900				3.521	
Travel intention (TI)	TI1	0.912	0.883	0.928	0.810	2.766	/
	TI2	0.889				2.239	
	TI3	0.899				2.595	

Table 3. Discriminant validity analysis (N = 390).

	CQ	IQ	SQ	TE	TI	VA
CQ	**0.907**					
IQ	0.346	**0.891**				
SQ	0.409	0.458	**0.847**			
TE	0.306	0.303	0.410	**0.896**		
TI	0.326	0.352	0.493	0.678	**0.900**	
VA	0.310	0.345	0.303	0.102	0.351	**0.885**

Note: The diagonal elements (in bold) are the square root of variance shared between the AVEs, whereas the off-diagonal elements are correlations among constructs.

4.2 Structural model analysis

4.2.1 Path analysis

In terms of path analysis, as shown in Table 4 and Figure 4, CQ had a significant positive effect on TE with a path coefficient of 0.144 ($p<0.05$); SQ had a significant positive effect on TE with a path coefficient of 0.298 ($p<0.001$); IQ had a significant positive effect on TE with a path coefficient of 0.116 ($p<0.05$); CQ had a significant positive effect on VA with a path coefficient of 0.195 ($p<0.05$); SQ has a significant positive effect on VA with a path coefficient of 0.153 ($p<0.05$); IQ has a significant positive effect on VA with a path coefficient of 0.235 ($p<0.001$); TE has a significant positive effect on TI with a path coefficient of 0.577 ($p<0.001$); VA has a significant positive effect on TI with a path coefficient of 0.577 ($p<0.001$); SQ has a significant positive effect on TI with a path coefficient of 0.180 ($p<0.01$). Therefore, H1-H8 were established. On the other hand, there is no significant effect of TE on VA; there is no significant effect of CQ and IQ on TI. Therefore, H9 was not valid. Meanwhile, when performing model fitting and hypothesis testing, the researchers found that system quality also had a positive effect on travel intention to some extent. So, this study added hypothesis H16: System quality positively affects travel intention.

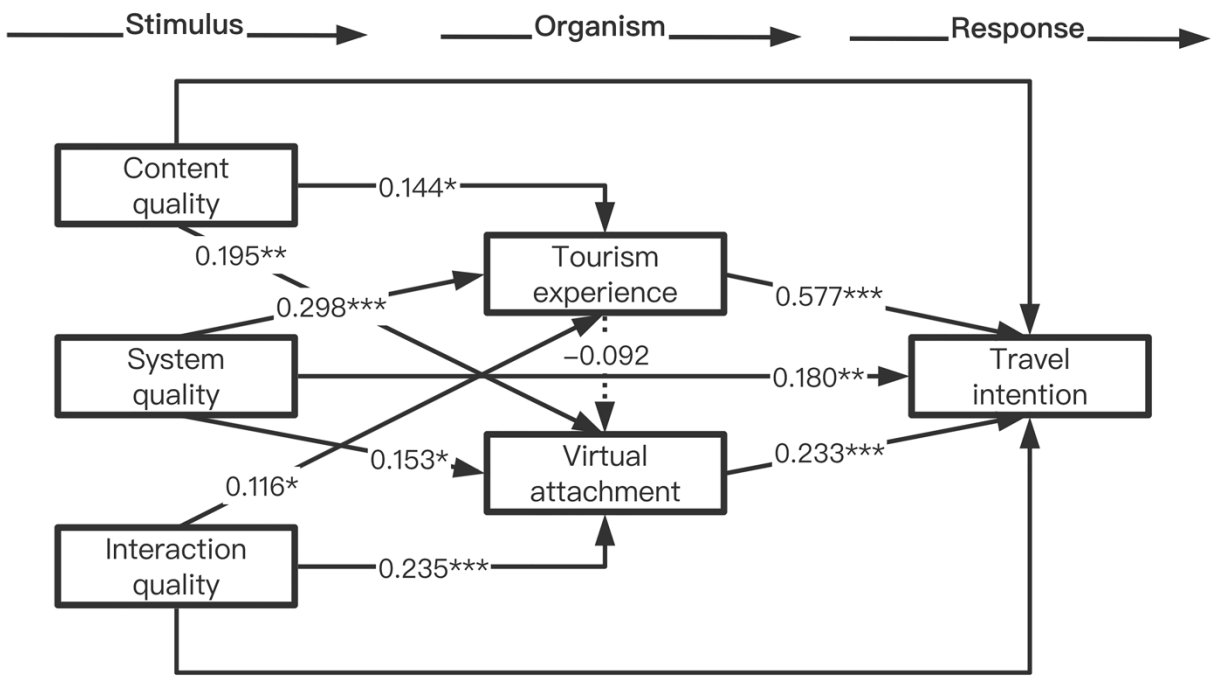

Figure 4. PLS results of the structural model.

Note: The dotted line indicates that the relationship is not valid.

**p < 0.001; **p < 0.01; *p < 0.05.

Table 4 Path coefficients and research hypothesis testing results.

	Path coefficients	Mean	T-value	P-value	Hypothesis testing results
CQ → TE	0.144	0.143	2.493	0.013	H1 Establish
SQ → TE	0.298	0.299	5.053	0.000	H2 Establish
IQ → TE	0.116	0.117	2.164	0.031	H3 Establish
CQ → VA	0.195	0.194	3.477	0.001	H4 Establish
SQ → VA	0.153	0.153	2.524	0.012	H5 Establish
IQ → VA	0.235	0.235	4.193	0.000	H6 Establish
TE → TI	0.577	0.579	10.737	0.000	H7 Establish
VA → TI	0.233	0.231	4.339	0.000	H8 Establish
TE → VA	-0.092	-0.092	1.850	0.064	H9 Not valid
CQ → TI	-0.002	-0.002	0.041	0.967	/
SQ → TI	0.180	0.180	3.285	0.001	H16 Establish
IQ → TI	0.015	0.015	0.345	0.730	/

***p < 0.001; **p < 0.01; *p < 0.05.

4.2.3 Mediating effect analysis

For the mediating effects, TE and VA acted as mediating variables in the relationship between the effects of CQ on TI, with indirect effects of 0.083 (p<0.05) and 0.045 (p<0.01) and total effects of 0.081 (p<0.001) and 0.043 (p<0.001), respectively; TE and VA acted as mediating variables in the relationship between the effects of SQ on TI, with indirect effects of 0.172 (p<0.001) and 0.036 (p<0.05) and total effects of 0.352 (p<0.001) and 0.216 (p<0.05), respectively. indirect effects of 0.172 (p<0.001) and 0.036 (p<0.05), respectively, and total effects of 0.352 (p<0.001) and 0.216 (p<0.001), respectively; TE and VA acted as mediating variables in the relationship between the effects of IQ on TI, with indirect effects of 0.067 (p<0.05) and 0.055 (p<0.01),

with total effects of 0.082 ($p<0.001$) and 0.070 ($p<0.001$), respectively. Since all the above indirect effects were positive, the mediating effects were all Complementary mediation (Hair Jr et al., 2021), and H10-H15 were established, as shown in Table 5.

Table 5. Mediating effect

	Indirect effect value	Indirect effect P-value	Direct effect value	Direct effect P-value	Total effect value	Total effect P-value	Hypothesis testing results
CQ→TE→TI	0.083	0.014	-0.002	0.967	0.081	0.000	H10 Establish
CQ→VA→TI	0.045	0.006	-0.002	0.967	0.043	0.000	H11 Establish
SQ→TE→TI	0.172	0.000	0.180	0.001	0.352	0.000	H12 Establish
SQ→VA→TI	0.036	0.025	0.180	0.001	0.216	0.000	H13 Establish
IQ→TE→TI	0.067	0.027	0.015	0.730	0.082	0.000	H14 Establish
IQ→VA→TI	0.055	0.006	0.015	0.730	0.070	0.000	H15 Establish

4.2.4 Predictive power assessment

The predictive power assessment showed R^2=0.201 for TE, R2=0.566 for TI, and R^2=0.178 for VA. Q^2 was calculated based on Blindfolding, and $Q^2>0$ indicates that the structural model has predictive relevance for the endogenous variables and vice versa (Hair Jr et al., 2021). The calculated Q^2=0.158 for TE, Q^2=0.450 for TI, and Q^2=0.135 for VA, all of which are greater than 0. This indicates that the structural model has predictive relevance for TE, TI, and VA.

5. Discussion and conclusions

5.1 Key findings

This study adopts a psychologically derived SOR theoretical framework to explore the impact of virtual tourism on tourists' travel intention in the field. The findings and implications are described below.

RQ1 was clearly answered（Does virtual tourism experience increase users' travel intention in the field?）. This research revealed a significant positive relationship between content quality, system quality, and interaction quality of virtual tourism on tourists' tourism experience, virtual attachment, and travel intention through model testing and mediating effect testing, which is consistent with previous studies (Ghose & Huang, 2009). During home quarantine, the recurrence of the pandemic and the disclosure of various negative information led to a surge in stress and anxiety (Xi & Junyi, 2020). Many people were compelled to cancel their travel plans. With the intrinsic motivation to travel (Crompton, 1979) and negative information about the pandemic, people's psychological need to escape and be free from bondage is triggered to a certain extent. The magnificent scenery of virtual tourism attractions provides people with the opportunity to shortly escape from reality. It brings a visual feast of beauty, facilitating the creation of virtual attachment. In addition, the quality of content, system quality, and interaction of virtual tourism (Deng et al., 2019) enable tourists to obscure the boundaries between the virtual and physical realities (Biocca, 1992; Deng et al., 2019), which generates a higher degree of authenticity in the tourism experience (Kim et al., 2018). In the virtual environment created by virtual tourism, tourists develop virtual attachments and experience unique tourism experiences distinct from natural tourism. These factors ultimately impact tourists' travel intention in the field. As a new type of tourism, virtual tourism has novel and unique characteristics that attract tourists and inspire their curiosity. As a result, virtual tourism strengthens tourists' intention to run to the destinations promoted

in virtual tourism by providing immersive tourism experiences and realistic virtual attachments.

The following findings can be reported for RQ2（What factors change tourists' travel intention in the field of virtual tourism?). Tourism experience and virtual attachment are critical variables which influence tourists' travel intention in the field and relates to in whether virtual tourism can attract more tourists. This empirical analysis revealed that tourism experience and virtual attachment positively impact tourists' travel intention in the field. Tourism experience has the most significant impact on travel intention in the field, followed by virtual attachment, which is mainly relevant to the form and nature of virtual tourism. As a new form, the ultimate goal of virtual tourism is to provide tourists with an ideal tourism experience. Thus, virtual tourism will be designed to consider tourists' needs to meet the tourism experience, enabling tourists to gain desired virtual experience. Thus, the tourism experience has the most significant impact on the travel intention in the field. In addition, tourists may develop emotional attachment to the actual tourist place through the interaction between the virtual space and the 3D reconstructed scenery, creating an emotional connection with the place they have not visited, which further influences the travel intention in the field.

The following findings can be reported for RQ3（How do influencing factors of virtual tourism experience <content quality, system quality, interaction quality>, tourism experience, virtual attachment, and travel intention interact with each other?). System quality may directly and significantly affect travel intention positively. Tourism experience and virtual attachment play a complementary mediating role in influencing relationships of content quality, system quality, and interaction quality. As shown by the relative effect values of the mediating effects, the indirect effects are significant in proportion. Tourists' knowledge of the scenery presented in virtual tourism drives their travel intention while granting them real tourism experience and virtual attachment during the tour, further motivating travel intention. In addition, there was no significant positive impact of tourism experience on virtual attachment. The results of this study contradict the findings of Guest & Lee (2016) and St. John et al. (1986). The emergence of virtual attachment requires a deeper connection between the tourist and the destination. The positive perceptions and memorability developed from limited tourism experiences do not allow for emotional connection or psychological identification with the virtual destination. Thus, tourism experiences and virtual attachment do not have a direct correlation.

5.2 Theoretical implications

This study's theoretical contributions are categorized into three parts.

First, we studied the three contributing dimensions of virtual tourism experience and travel motivation under the immersive "S-O-R" research design. Namely, content quality, system quality, and interaction quality (Gorla et al., 2010; Korfiatis et al., 2012; Pelau et al., 2021). Further, we expanded their meaning under the scope of VR tourism. Content quality refers to the intrinsic values, i.e., objectivity, credibility, and the amount of information the virtual tourism provides. System quality refers to the quality of the tourist's use of virtual tourism and its design in terms of structure, presentation, and connectivity. Interaction quality is the ability of virtual tourism to provide interactive features to tourists. With these delimitations, this study constructs a relational model which suggests a positive relationship between those qualities and tourism intention through the mediation of virtual content characteristics. Together, the results should be carefully considered in building virtual tourism interactions, providing information to tourists, and understanding tourists' preferences.

Second, prior Studies have conducted empirical tourism research for VR only in a limited number of areas. First, web-based visual images, such as 360°panoramic images (Caciora et al., 2021; Hu et al., 2020; Lu et al., 2021). Second, virtual environments are based on fictional worlds in VR games (Coghlan & Carter, 2020; Gao et al., 2022). Third, virtual environments are displayed on a two-dimensional computer screen (Chiquet

et al., 2020; Tian & Tsai, 2021). In addition, few tourism studies have used VR devices to conduct usability tests on live-action virtual tourism products. By focusing on the sensory stimuli evoked by VR technology, our work examines the psychological processes of tourists' travel experiences and reactions to virtual tourism products. Since VR technology is constantly evolving, this study will be a good reference paradigm for future usability studies of virtual tourism products based on VR technology.

Third, scholars' prior studies on travel intention have focused on influencing factors of travel intention (Shin et al., 2022; Wang et al., 2022), relationship studies (Moon & Han, 2018a; Piramanayagam et al., 2020), and place attachment (Lalicic & Garaus, 2020; Tasci et al., 2021). Researchers' work on travel intention was first extended from social behavior, where it was generally accepted that "travelling" is also a social behavior. The research methods used by scholars for research in this area are mainly quantitative methods, such as factor analysis and constructive modeling. In terms of research content, scholars have expanded from the factors influencing its formation to the study of relationships. Later scholars have focused more on the emotional expression of individual tourists and explored the relationship between tourism intention and place attachment. This study builds on the prior studies and further explores a research model more consistent with Chinese tourists' travel intention to virtual tourism destinations in the post-COVID-19 era.

Finally, this study identified virtual attachment as an antecedent factor influencing tourists' travel intention in the field, which is rarely seen in virtual tourism research. The study revealed that virtual attachment is a prominent variable influencing tourists' travel intention in the field. Virtual attachment differs from other variables as it incorporates more of the tourists' affective experiences. In such a new way of tourism, tourists' emotions are evident in their subsequent behavior and they develop emotional attachments to real travel destinations through interactions with three-dimensional reconstructions of scenic areas in virtual space, creating emotional connections to places they have not visited and further influencing their travel intention to the field. The findings empirically develop the ternary space theory of tourist places, i.e., the traditional two-dimensional perspective of the tourist-place relationship is extended to a three-dimensional ternary space, further illustrating the interrelated, interactive, and dynamic response characteristics of the ternary area (Chen & Zhenfang, 2020). Since the individual variability of tourist groups, the influence of virtual attachment on tourists' travel intention in the field cannot be neglected.

5.3 Practical implications

First, this study discovered that tourism experience positively impacts travel intention (p=0.001). The path coefficient of the variable of the tourism experience is 0.577, which is greater than other variables. This indicates the magnitude of tourists' perceptions of their experiences during virtual tours on their subsequent travel intentions in the field. Virtual tourism changes the way tourists visit a scenic area by providing them with more opportunities to interact, contextualize, and share with others. This study finds that content quality, system quality, and interaction quality can affect tourists' tour experience. Hence three perspectives of content, system, and interaction can be adopted to enhance their experience.

From a system perspective, the system quality of virtual tourism impacts the tourist experience, virtual attachment, and travel intention. Hence, the design of the presentation form as the carrier of the system quality is essential. The current way of virtual tourism, in addition to traditional AR, VR, as a powerful means of augmented reality - holographic projection technology also has a vast space for development. This technology is not unattainable, and holographic projection technology has been used in many scenarios, such as virtual idol concerts. However, holographic projection technology has rarely been used in the tourism industry. Future virtual tourism technology researchers can make this technology universal so that tourists' homes become distant scenic spots.

From an interactivity perspective, the interactivity quality affects tourists' tourism experience and virtual attachment, which affects their travel intention. Currently, virtual tourism has a lot of room for development in the interactivity aspect. Granted, the rise of the Internet has brought a completely different experience to virtual tourism interactivity than in the past. Tourists can communicate and interact through real-time voice and other means. When tourists travel in the field, on the one hand, they can interact with people; on the other hand, the interaction between people and scenery, people and things are also essential for tourists when traveling in the field. Photographing is usually one of how people interact with the scenery. Developers of virtual tourism can use cinematic stunts to allow users to pose for photos with scenes in virtual scenes. Techniques such as AR photography and Photoshop (PS) can also increase tourists' engagement. In terms of human-object interaction, virtual tourism does not allow tourists to taste the specialties of the tourist destination as much as onsite tourism. Therefore, virtual tourism developers can incorporate the function of take-out recommendation during the virtual tourism scenario setting. Tourists can order a local specialty dish at home, such as Hangzhou dish, during virtual tourism in Hangzhou. In addition, developers can also add restaurant recommendations. For example, the system can recommend local Sichuan cuisine restaurants in Sichuan virtual tourism. Users can go straight to the restaurants in the tourist destination after virtual tourism to satisfy the tourists' desire for food, which is one of the most effective ways to increase tourists' travel intention in the field. Finally, future virtual tourism developers can optimize virtual tourism from other perspectives, such as growing tourists' olfactory or tactile experience.

From a content perspective, content quality affects tourists' tourism experience and virtual attachment, affecting their travel intention. At the beginning of the pandemic, virtual tourism took up a large amount of demand for outbound travel. While domestic travel in China has thawed after the pandemic has been alleviated, outbound travel remains ice-bound. Content quality has become almost the only growth area in the post-pandemic era that can increase tourists' travel intentions onsite. The quality of content for virtual tourism requires inspiring tourists and providing practical travel information, and generating real value for tourist attractions and local government departments for tourism. The pandemic has further deepened the importance of tourism content quality. From the perspective of tourists' needs, in the post-pandemic era, faced with new information gaps, tourists increasingly need tourism information related to COVID-19 precautionary measures, such as the need for Polymerase Chain Reaction (PCR) test reports and unique business hours schedules for attractions. This information needs to be updated by virtual tourism operators in the first instance in the virtual tourism scenario. Virtual tourisms need to provide tourists with the fastest and most accurate information related to the pandemic.

Finally, virtual attachment directly and positively affects the travel intention, highlighting the importance of constructing a person-place emotional identity in virtual tourism (Kim et al., 2018). When tourists develop heartfelt and emotional attachments (e.g., desire for spiritual purification and pilgrimage experiences (Chang et al., 2020)) to tourist places during virtual tours, and these needs are challenging to satisfy through the mirroring experience of virtual tourism, travel intention in the field are significantly enhanced in the future. In this regard, the virtual tourism design process should focus on the realistic simulation of beautiful scenery and stimulating tourists' spiritual resonance and emotional identification with the tourist destination, thus enhancing the effectiveness of virtual tourism as a marketing method. In addition, virtual tourism must not develop independently due to the inseparable relationship between online and offline. Specifically, virtual tourism will not wholly replace offline tourism because offline tourism is the root of virtual tourism. Without the development of offline tourism, virtual tourism will also lose the creative material. Although virtual tourism is not the pure auxiliary tool it used to be, an essential role of virtual tourism in the post-pandemic era is still to provide a reference for people to travel offline. After all, there is no substitute for offline travel

that brings tourists a natural feeling.

5.4 Limitations and future research

There are some shortcomings in this research on the effect of virtual tourism on tourists' travel intention. First, the quantitative dimensions of virtual tourism can be further enriched and deepened. The quality of virtual tourism in this study was manifested in three aspects: interactivity quality, content quality, and system quality. With the development of technology however, new quantitative dimensions of virtual tourism display are bound to emerge, so future research may explore new quantitative dimensions of virtual tourism through methods such as grounded theory and big data mining. Second, since the data collection of this study was completed during the pandemic, the virtual attachment of virtual tourists may be affected by the pandemic itself. When there is a risk of infection during the trip, tourists in a housebound state may generate higher attachment levels than during the unusual period. In other words, attachment to virtual tourism experience may be weakened when tourists are free to physically travel and experience destinations. Thus, the transformational relationship between tourists' virtual attachment and travel intention in the field when going out is unrestricted and can be further investigated in the future. Third, the data collected in this study came from virtual tourists in China. The underlying collectivism and high-power distance, as well as the relational culture characteristics of China (Zhao et al., 2008) may also impact interpersonal relationships and social interactions, which may be very different from the perceptions of virtual tourism by tourists in other countries and cultures. Therefore, regarding the impact of cultural differences, cross-cultural comparisons could be enhanced in future research endeavors to understand the effects and impact mechanisms of virtual tourism on tourists from different cultural backgrounds.

Conflict of interest statement

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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