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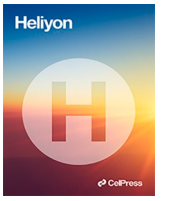

Research article

Understanding the acceptance of online tourism programs: Perspectives of generic learning outcomes and theory of planned behavior

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ABSTRACT

The integration of information technology, particularly the Internet, with the tourism industry has laid a solid foundation for the widespread popularity of online tourism. Online tourism offers numerous advantages such as being unconstrained by time, space, and region, having low costs, and providing strong interactive features, making it increasingly popular worldwide. Nevertheless, not all individuals are willing to adopt online tourism, and the factors and mechanisms that influence online tourism require further investigation. This study aims to examine the factors that influence the intention to adopt online tourism by integrating the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and the Generic Learning Outcomes (GLOs). Using the Yunyou Dunhuang Online Program (云游敦煌), the current study invited tourists to participate in the online tourism experience, and collected 536 pieces of data. The results of structural equation modeling reveal that: **(1)** attitude toward using and perceived usefulness positively predict behavioral intention to use; **(2)** perceived ease of use, perceived usefulness, and subjective norm significantly and positively predict attitude toward using; **(3)** perceived ease of use significantly and positively predicted perceived usefulness, while knowledge and understanding, activity, behavior, and progression had no significant effect on perceived usefulness; **(4)** knowledge and understanding positively predicted perceived ease of use, while activity, behavior, and progression had no significant effect on perceived ease of use. This study explores the factors influencing online tourism adoption intention in a comprehensive way. The findings hold practical significance for the design of online tourism programs for intangible cultural heritage, providing theoretical guidance for cultural heritage and development.

1. Introduction

Online tourism, as described by Zhang, is a form of virtual on-site tourism that utilizes network and virtual technology [1]. The outbreak of the global pandemic in 2020 has significantly impacted industries that rely on on-site experiences, especially tourism. To

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counteract this, the cultural tourism industry in China has adopted digital cultural tourism projects, such as live broadcasting, cloud tourism, cloud viewing exhibitions, and digital scenic spot construction, which have injected new vitality into the industry [2].

In recent years, new media technology has transformed the development model of the China's tourism industry, providing tourists with a more convenient and information-based travel experience. New media technology has become the best choice for building an online smart tourism system [3]. Therefore, expanding online tourism, promoting the application of digital creative technology in tourism, and building a tourism information platform are crucial for the future development of tourism [4]. The construction and development of digital information platforms are essential to change the new direction of online smart tourism. This has been seen as a new opportunity for the future development of the tourism industry in China [5].

On January 28, 2020, China's National Cultural Heritage Administration directed the China Cultural Heritage Newspaper (中国文物报社) to collaborate with cultural institutions and museums across the country to urgently expand a series of online exhibition content on the "Museum Online Exhibition Platform" on the government website of the China's National Cultural Heritage Administration. From February 1 to 26, 250 online display projects were launched consecutively in five batches, including online virtual exhibition projects, digital panorama exhibition hall projects, digital display of cultural relics, and museum big data platform projects.

To illustrate, programs such as Yunyou Dunhuang and Digital Jinling (数字金陵) were typical representatives of this initiative. These programs took advantage of the interactive features of the Internet and integrated the offline exhibition hall to the online program, enabling visitors to access various exhibition information, view exhibit pictures and introductions, and interact with other audiences without being limited by time, space, or region [4].

Currently, scholars mainly focused on the construction of online tourism platforms, product research and development, and online tourism consumer behavior. Nevertheless, their researches only provided a description of the phenomenon and discussions over development strategies, lacking an understanding of how digital technology will be applied to traditional culture. Furthermore, little attention has been paid to tourists' learning outcomes and technology experience after using online travel programs. Therefore, exploring the crucial factors influencing the acceptance of online travel programs is of great importance, which will provide valuable evidence to improve the quality of online intangible cultural heritage tourism experience. Thus, taking Yunyou Dunhuang, an online program that digitally presents traditional Chinese tourist cultural attractions, as an example, this study aims to examine users' acceptance of online tourism by integrating the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), and the Generic Learning Outcomes (GLOs). The results of the study will provide empirical support for the design and development of online travel programs.

In the following sections, we first reviewed the literature on Dunhuang Culture and the theoretical models (i.e., TAM, TPB and GLOs), and formulated our research model. Secondly, we tested the research model and hypotheses empirically and showed the findings. Thirdly, we discussed the findings and implications. Conclusion was made in the last part.

2. Literature review

2.1. Dunhuang culture and the Yunyou Dunhuang Online Program

The Dunhuang culture is a unique and integrated cultural heritage that has inherited the essence of traditional Chinese culture while showcasing the brilliance of ancient Indian, Persian, and Greek civilizations.

The Dunhuang Mogao Grottoes (see Fig. 3), a cultural heritage comprising of architecture, murals, and painted sculptures, have retained their historical, artistic, and scientific value over thousands of years [6]. The Dunhuang grotto art not only represents traditional Chinese art but is also a result of global communication and globalization [7]. The Dunhuang Mogao Grottoes were recognized by the UNESCO World Heritage Committee on December 11, 1987. This recognition has elevated the Dunhuang Mogao Grottoes to the "World Heritage List," signifying its outstanding universal value and cultural significance [8].

The protection of cultural heritage requires the application of new information science technologies such as virtual reality and graphic image processing to promote modernization and scientific protection techniques [9]. The integration of digital media technology and communication has facilitated the development of visual and cultural communication forms. The digitization and virtualization of visual communication has opened new avenues in cultural communication, enabling the permanent preservation, comprehensive interpretation, and wide dissemination of material culture. Digital technology has improved the efficiency and quality of cultural heritage protection, reduced the usage and damage of cultural relics originals, and brought to light the artistic charm and cultural significance of heritage. The digitization of cultural heritage is exemplified by the Yunyou Dunhuang Online Program, which applies information technology to protect and develop cultural heritage [10].

The Dunhuang Academy was forced to suspend the opening of its scenic spots due to the outbreak of the COVID-19 pandemic, which disappointed many tourists who were fascinated by Dunhuang culture. To address this issue, the Dunhuang Academy, People's Daily New Media, and Tencent jointly launched the Yunyou Dunhuang Online Program on WeChat, which integrated the functions of exploring, visiting, and protecting the art of Dunhuang Grottoes. This online program focuses on Dunhuang culture, which encompasses architectural art, painted sculpture art, mural art, and Buddhist art. By adopting the model of "Technology + Culture", this program facilitates the inheritance and innovation of cultural heritage and offers a comprehensive interpretation of the core connotation of Dunhuang culture. The Yunyou Dunhuang Online Program enabled the public to appreciate the brilliant civilization of the Dunhuang Mogao Grottoes on the small screen of their mobile devices, providing them with access to the profound cultural heritage and high aesthetic value of Dunhuang [11].

The Yunyou Dunhuang Online Program (see Fig. 4) provides a unique and accessible means for the public to experience and appreciate Dunhuang culture, which was previously restricted to researchers and visitors who were able to attend on-site tours.

Compared to on-site tours, the Yunyou Dunhuang Online Program offers several advantages, including the ability to view the grottoes clearly and meticulously without the constraints of time and space, and the avoidance of damage to the grotto murals caused by on-site tours [12]. Furthermore, users can gain in-depth knowledge about cultural relics protection, including understanding the types of mural damages, thus participating in the protection of cultural relics in Dunhuang.

After logging into the Yunyou Dunhuang Online Program, users can access exclusive mural stories, integrate ancient wisdom, and customize thematic content, allowing them to have a close encounter with Dunhuang. By clicking on the "Enter the Scripture Cave" on the homepage, users can enter a high-definition reproduction of the cave and observe the details of the murals, painted sculptures, inscriptions, and other elements up close. By clicking on "Explore," users can begin their exploration of Dunhuang through videos, artistic forms, dynasties, colors, and panoramic views of the caves. Furthermore, by clicking on "Tour," users can access an intelligent guide of the scenic area, which helps them plan their itinerary and provides necessary knowledge before entering the caves. Clicking on "Protection" allows users to participate in the Dunhuang Digital Patronage Project and learn about the various types of damage that murals can suffer from. Additionally, by clicking on "New Cultural and Creative Products," users can unlock the world of Dunhuang cultural relics and animated short dramas. They can also use the "Dunhuang Poetry Scarf" creative program to extract elements from Dunhuang murals and design and customize silk scarves. The Yunyou Dunhuang Online Program seamlessly integrates online digital exhibitions with offline visits, providing users with an online experience of cultural beauty, offline reservation experiences, online purchases of cultural and creative products, and even smart management of visitors. This innovative approach establishes a new model for cultural tourism that combines online and offline elements.

The Yunyou Dunhuang Online Program features a unique interface design, a well-structured logical framework, and a comprehensive emotional interaction design. Through these designs, users are able to explore the Dunhuang Mogao Grottoes layer by layer, providing them with a sense of walking through the caves even if they are not physically present in Dunhuang [11]. The digital exploration of Dunhuang presented in this program is characterized by duplication, dynamics, three-dimensionality, and interaction, offering a new approach to the transmission and transformation of material cultural heritage [10].

2.2. Learning traditional culture through online tourism

According to UNESCO, education is a key tool for safeguarding, inheriting, and disseminating intangible cultural heritage, with both formal and non-formal learning playing important roles [13–16]. Formal learning in schools helps to preserve and inherit traditional culture, while non-formal learning in settings such as museums, exhibitions, and tourism can enhance individuals' practical skills, knowledge, and intercultural awareness, promoting their intellectual and professional development [16]. Technology can also play a significant role in enhancing the learning experience for tourists, allowing them to learn more about the environment, culture, religion, tradition, and history while traveling [17].

World-renowned heritage brands provide assurance for tourists to make appropriate choices when visiting cities or countries. A strong brand or reputation stimulates purchases by simplifying the customer decision-making process [18]. This encourages consumer trust in the product or promotes travel experiences that immerse them in a specific culture. Moreover, heritage resources are often incorporated into national identity shaping initiatives and extensively integrated into the tourism market [19]. The development of tourism in Dunhuang Mogao Grottoes has created a contradiction between economic growth and the protection of world heritage. While tourism can bring economic benefits to the local area, it has also had a negative impact on the preservation of the endangered murals and statues in the grottoes. It is important to find a balance between satisfying the contemporary aesthetic desires of tourists and preserving the cultural heritage for future generations. This requires the participation of the public, as well as the use of media and education to promote the inheritance, protection, and dissemination of intangible cultural heritage [20].

In the context of the "Internet+" era, the tourism industry has encountered development opportunities and has given rise to online travel models. Online travel marketing enables people to make purchasing decisions without physically visiting the tourist attractions [21]. Within the framework of holistic tourism, the industry chain is extended, and core tourism elements such as dining, entertainment, and shopping are developed into distinctive products and brand features. By leveraging virtual reality technology, destinations, scenic spots, and projects can be fully showcased in marketing efforts, providing tourists with an immersive experience that feels like being there in person. In recent years, rapid advancements in information technology, particularly in mobile internet represented by the development of online travel enterprises, have created opportunities for online travel companies in network marketing. The widespread adoption of internet technology, in particular, has provided the technical support for precise online marketing for these companies [22].

2.3. Theoretical background

2.3.1. Technology acceptance model

In 1989, Davis introduced the Technology Acceptance Model (TAM), which is based on the rational behavior theory and includes external variables such as beliefs, attitudes, intentions, use attitudes, use intentions, actual use, perceived ease of use and perceived usefulness [23]. Behavioral intention to use and attitude toward using are important components of the theory and are the focus of research on the use behavior of tourists and users. An examination of behavioral intention to use or accept new technologies can provide a more accurate picture of the factors that influence use behavior, and the stronger the willingness to use, the more likely it is to promote the adoption of new technologies [24]. People's rational behavior refers to the inherent habitual ways of approving or disapproving of a particular object, and positive approving attitudes can inspire a stronger willingness to behave. Therefore, for the purpose of this study, attitude is defined as tourists' favorable or unfavorable attitudes toward using online programs for excursions.

Perceived usefulness and perceived ease of use are the primary factors that explain user behavioral intentions [25–27]. The former refers to individuals achieving their goals and improving their work performance or efficiency through the use of online programs, while the latter represents the ease of using the program [25]. We believe that perceived usefulness is manifested in online travel by allowing tourists to experience the local customs and enrich their understanding of traditional culture, thereby alleviating their life stress and improving their quality of life. Simultaneously, with the promotion of smart tourism, consumers can select, book, and provide feedback on tourism projects without leaving their homes. Therefore, we believe that perceived ease of use is mainly reflected in aspects such as ticket reservation, smart scenic area navigation, and traditional cultural experiential courses [28].

2.3.2. Theory of planned behavior

The Theory of Planned Behavior (TPB) was initially proposed by Ajzen and is a classic analytical framework that explores individual behavioral decision-making [29]. The theory consists of three main components: behavioral attitude, subjective norm, and perceived behavioral control [30]. Behavioral attitude refers to an individual's positive or negative feelings about a specific behavior [29,31,32]. Subjective norm involve the external pressures that an individual perceives regarding whether or not to engage in a certain action [29,33]. Perceived behavioral control relates to the individual's perception of the level of control they have over resources, information, or opportunities, with higher perceived behavioral control associated with a greater likelihood of taking action [29,34]. In addition, subjective norm refers to the extent to which individuals are impacted by the opinions of people with whom they have interacted when making a particular action or intention [35]. Therefore, this study defines subjective norm as the extent to which tourists are influenced by the viewpoints of their close friends and family members regarding online program excursions when they use or plan to use them [36]. The TPB is considered one of the most powerful models for predicting behavior. In the field of tourist behavior research, most scholars agree that intention is one of the most important predictors of behavior. Intention reflects the extent to which users are willing to engage in a certain behavior [37]. Based on the TPB, Ding analyzed the virtual tourism intentions of the elderly population [38]. Scholars like Wang and Lu utilized the TPB to analyze the influencing factors of traditional cultural study tour behaviors [39]. Online travel intention is a typical individual decision-making behavior, and the Yunyou Dunhuang Online Program offers strong interactivity. Therefore, in this study, the subjective norm embedded model was chosen to examine whether visitors' usage of the program would be influenced by the people around them.

2.3.3. Generic learning outcomes

In April 2000, the British government established the Council for Museums, Archives, and Libraries, which appointed the Research Center for Museums and Galleries at the University of Leicester in September 2001 to develop methods to "measure" cultural and educational outcomes [40]. The resulting Learning Impact Research Project (LIRP) aimed to find a way to measure learning outcomes and impact for all archives, library, and museum users, defining the concepts of "learning" and "outcome" and identifying a series of learning outcomes [41–45]. These outcomes were consolidated into the concept of "Generic Learning Outcomes" (GLOs), which consists of five components: (1). knowledge and understanding, (2). skills, (3). attitudes and values, (4). enjoyment, inspiration, and creativity, and (5). activity, behavior, and progression [40]. The GLOs theory has become a framework for assessing arts and culture, providing a conceptual and interpretive framework for different researchers to use [46–48].

In the context of the GLOs, knowledge and understanding refer to the acquisition of new cognitive insights. In the case of visiting and experiencing the Yunyou Dunghuan Online Program, tourists have a certain understanding of the exhibits and related cultural relics. Activity, behavior, and progression refer to tourists recommending the program to others or exploring cultural and historical artifacts in other places. Among the GLOs, knowledge and understanding can test visitors' comprehension of exhibits and related artifacts during online tours. Activity, behavior, and progression, on the other hand, can gauge the willingness of visitors to engage in relevant activities in the future, or to explore other local cultures and artifacts. Thus, the evaluation of knowledge and understanding and activity, behavior, and progression can address the shortcomings of the TAM.

The GLOs theory has been applied to research on the learning experience of adults in museums, art galleries, and libraries, including multinational museums. It has become one of the most commonly applied models for studying tourists' learning experiences and outcomes of cultural heritage after using online travel programs [49]. Li et al. conducted a study on the tourism experience of the intangible cultural heritage Lantern Festival by constructing a model that combines the GLOs and the TAM. Learning outcomes are an important factor that affects users' adoption intentions, and the GLOs framework provides a useful tool for assessing the impact of cultural heritage programs on users' learning outcomes [50].

2.3.4. The present study

Although both the TAM and the TPB have been widely used in predicting individual intentions and behaviors, they also have their limitations. The TAM emphasizes the influence of individual technological perceptions on decision-making behavior but lacks consideration of social and objective factors [30]. Therefore, Lee believes that the subjective norm in the TPB is an extension of the TAM and can address the shortcomings of the TAM [50]. The combination of these two models has theoretical compatibility and complementarity, enabling a more detailed explanation of the factors that influence individual behavioral intentions [51].

Based on this, this study integrates the main variables of the TAM, the subjective norm from the TPB, and the knowledge and understanding as well as activity, behavior, and progression from the GLOs. This combination provides a more scientifically reasonable approach to studying the factors influencing the adoption of online travel intentions.

2.4. Generic learning outcomes, perceived ease of use and perceived usefulness

When considering the adoption of new technologies, users are influenced by various factors, including perceived usefulness, perceived ease of use, attitude to use, and behavioral intention to use [49]. Perceived usefulness refers to the degree to which individuals believe that a new technology provides them with advantages and convenience, which can influence their acceptance and use of the technology [52]. Perceived ease of use, on the other hand, pertains to how easy it is for individuals to use a specific information system technology. The stronger the user's perceived ease of use when using or preparing to use a certain information system technology, the more likely they are to use it. A positive attitude to use can also influence users' willingness to use the entire system [23]. Ultimately, behavioral intention to use is determined by users' attitude to use towards the technology.

Davis proposed that external variables can enhance the ability of the TAM to predict people's future technology acceptance and may affect perceived usefulness and perceived ease of use. Subsequent studies [53,54,55] have supported this idea. The GLOs have been used to explore how online programs can improve visitors' understanding and value, influencing their future behavior [46]. Researches have shown that user liking of new technology can positively impact perceived usefulness and perceived ease of use [56]. It is confirmed by scholars that knowledge and understanding, as well as activity, behavior, and progression, have a significant impact on perceived usefulness and perceived ease of use [49]. Therefore, understanding external variables such as the GLOs and the TPB is important in explaining users' technology acceptance.

Based on these concepts, the following hypotheses are proposed.

H1. Knowledge and understanding (H1a) and activity, behavior, and progression (H1b) are positively correlated with perceived usefulness.

H2. Knowledge and understanding (H2a) and activity, behavior, and progression (H2b) are positively correlated with perceived ease of use.

2.5. Perceived ease of use, perceived usefulness, users' attitude and acceptance

According to Fan, users' attitudes towards a technology determine its viability [57]. The relationship between perceived ease of use, perceived usefulness, and users' attitudes is based on inferential behavior theory, which suggests that perceived ease of use and perceived usefulness have a significant impact on attitude to use [25,58]. Scholars like Li and Zhang have confirmed that perceived usefulness and perceived ease of use have a significant impact on users' attitudes towards usage [59]. Therefore, the following hypotheses are proposed.

H3. Perceived usefulness is directly and positively correlated with attitude to use.

H4. Perceived ease of use is directly and positively related to attitude to use.

Research has shown that perceived ease of use has a significant impact on perceived usefulness [60–64]. Therefore, the following hypothesis is proposed.

H5. Perceived ease of use is directly and positively correlated with perceived usefulness.

Users' higher attitude to use towards online travel can affect their behavioral intention to use [49,63,65–67]. Therefore, the following hypothesis is proposed.

H6. Attitude to use is positively correlated with behavioral intention to use.

The use of new technologies depends on users' behavioral intentions [58], and Davis stated that if a technology can improve users' work or study performance, they will have a high behavioral intention to use it [25]. Additionally, Dai et al. have found that perceived usefulness has a significant impact on users' behavioral intentions to use a particular system or service [28]. Therefore, the following hypothesis is proposed.

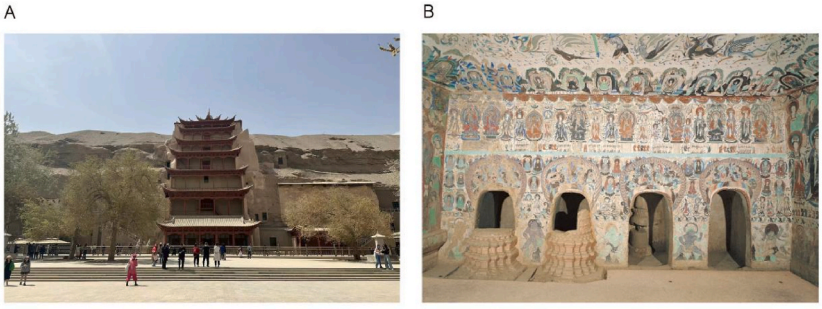

Fig. 1. Theoretical n measurement model of the research.

H7. Perceived usefulness is positively correlated with behavioral intention to use.

2.6. Subjective norm and attitude to use

Subjective norm refer to the extent to which an individual is influenced by the opinions of people they have a relationship with when making a certain action or intention. When using or considering using online travel programs, users are likely influenced by the opinions of friends and family, and subjective norm can significantly impact individual users' technology acceptance and use [68]. Therefore, the following hypothesis is proposed.

H8. Subjective norm is positively correlated with attitude to use.

This paper discussed the external factors of the GLOs of the Yunyou Dunhuang Online Program and the TPB within the framework of the TAM, and proposed the assumptions shown in Fig. 1.

3. Methods

3.1. Questionnaire

In this study, a questionnaire was used to measure the proposed research model and test the research hypotheses. A quantitative approach was employed to substantiate the proposed research model. The questionnaire was modified based on previous studies to enhance its efficiency. To ensure consistency with the original meaning, a back-translation method was employed during the translation process. The questionnaire consisted of four parts: (1) Basic information including gender, age, educational background, and whether participants had visited Dunhuang (Table 1). (2) Measurement items for technology acceptance [23]. It mainly involves an examination of tourists' use of online program technology, and contains the content of four indicators: perceived usefulness, perceived ease of use, attitude towards using, and behavioral intention to use. (3) Measurement items for planned behavior [23], which examined the attitudes of tourists' close friends and family members towards their use of online programs for excursions and their influences on tourists, encompassing subjective norm. And (4) measurement items for learning outcomes [49,69,70], an examination of the acquired information and future activities of tourists when they use online travel programs, incorporating elements of both knowledge and understanding as well as activity, behavior, and progression (Table 2). Likert scales were used, ranging from strongly disagree, disagree, slightly disagree, undecided, slightly agree, agree, to strongly agree. Additionally, in the questionnaire design, participants were instructed to select the third option for the last question, and any questionnaire selecting other options was considered invalid. The final questionnaire consisted of 28 items, including 4 items of basic information, 12 measures of technology acceptance, 4 measures of planned behavior, 7 measures of learning outcomes, and 1 polygraph question.

3.2. Participants

The data collection process was conducted in three stages. Firstly, the purpose and significance of the study were explained to the tourists, ensuring voluntary participation. Secondly, participants were invited to visit and experience the Yunyou Dunhuang Online Program with their consent. The duration of the tour experience varied based on personal preferences, but each person was told to spent no less than 5 min on the platform. Finally, after enabling the tourists to gain a comprehensive understanding of Dunhuang and

Table 1
Participants' profile.

Demographic	Frequency	Percent
Gender		
Female	320	63.62
Male	183	36.38
Age		
Under 20	69	13.72
21–30	349	69.38
31–40	48	9.54
41–50	27	5.37
51–60	10	1.99
Total	503	100
Education		
Elementary school	5	0.99
Junior high school	21	4.17
Senior high school	43	8.55
College	311	61.83
Master/Ph.D.	123	24.45
Previous visit to Dunhuang		
Yes	104	20.68
No	399	79.32
Total	503	100

Table 2
Items in the questionnaire and constructs in the conceptual model.

Index	Question items	Source
	Visit Dunhuang with the Yunyou Dunhuang Online Program	
PU1	More convenient than offline tours	Guo et al., 2018
PU2	Significant cost and time savings	Guo et al., 2018
PU3	It's a great idea	Guo et al., 2018
	When using the Yunyou Dunhuang Online Program, I think	
PEOU1	Its interface is simple and easy to understand	Guo et al., 2018
PEOU2	Very easy to use	Guo et al., 2018
PEOU3	Its operation method is easy to master	Guo et al., 2018
	I would like to …. … about the Yunyou Dunhuang Online Program	
ATU1	The opportunity to continue to use in the future	Guo et al., 2018
ATU2	Recommend to friends and relatives to use	Guo et al., 2018
ATU3	Use the online program to visit other attractions	Guo et al., 2018
	The process of visiting Dunhuang using the Yunyou Dunhuang Online Program …. …	
BIOU1	It was very pleasant for me	Guo et al., 2018
BIOU2	It has benefited me a lot	Guo et al., 2018
BIOU3	Is a very wise choice	Guo et al., 2018
SN1	People who are important to me (e.g., family, friends) think I can benefit from using the Yunyou Dunhuang Online Program	Guo et al., 2018
SN2	The people who are important to me think it's a good idea for me to use the Yunyou Dunhuang Online Program	Guo et al., 2018
SN3	The people who are important to me recommended me to use the Yunyou Dunhuang Online Program	Guo et al., 2018
SN4	When people around me use the Yunyou Dunhuang Online Program, it will affect my usage …. …	Guo et al., 2018
	After using the Yunyou Dunhuang Online Program, I …. …	
KU1	Have learned new knowledge	Chen et al., 2020
KU2	New insights into Dunhuang	Chen et al., 2020
KU3	Learn about frescoes and other cultural preservation-related knowledge	Su, 2020
KU4	Be able to give an overview of Dunhuang culture in your own way	Wu, 2021
	After using the Yunyou Dunhuang Online Program, I will …. …	
ABP1	Focus on the dissemination and development of Dunhuang culture	Chen et al., 2020
ABP2	Recommend others to use this program	Wu, 2021
ABP3	Observe other local cultures or artifacts	Su, 2020
	Please select the third option for this question	

experiencing online immersive tours, electronic questionnaires were distributed to them using the WJX.cn (a Chinese online questionnaire platform). All respondents were encouraged to answer the questionnaire personally based on his or her authentic feelings.

The Yunyou Dunhuang Online Program presents and provides in-depth interpretations of the content of Dunhuang Grottoes. During the virtual tour, visitors can closely appreciate the artistic charm of the Dunhuang Grottoes, perceive the rich cultural connotations and aesthetic values depicted in the murals, and understand the marked areas of interest for further exploration during future on-site visits. In the later stage of questionnaire collection, the impact of visitors' knowledge and understanding on their online travel experience can be examined.

Additionally, the Yunyou Dunhuang Online Program integrates features such as ticket booking, smart scenic area guidance, and traditional cultural experiential courses, providing comprehensive offline innovative services for visitors to the Mogao Grottoes. In the subsequent questionnaire collection, the influence of visitors' perceived usefulness, perceived ease of use, and intention to use on their online travel experience can be examined.

A total of 536 questionnaires were collected, and 33 invalid questionnaires were eliminated, resulting in 503 valid questionnaires (see Table 1). The effective response rate is 93.8 %. Given that research on dimensions related to online tourism experience necessitates tourists to possess certain perceptual ability, independent judgment, and the ability to articulate their experience, participants aged 18 to 60 were chosen for this study, who are proficient in Simplified Chinese. The research materials were provided in Simplified Chinese to ensure participant comprehension. The sample consisted of 320 female visitors, comprising 63.62 % of the participants, and 183 male visitors, comprising 36.38 %. The majority of the participants (69.38 %, 349 in number) were aged between 21 and 30 years, while those under 20 years (69 in number) accounted for 13.72 %, 9.54 % were aged 31–40 (48 in number), 5.37 % were aged 41–50 (27 in number), and 1.99 % were aged 51–60 (10 in number).

3.3. Data analysis

The study data were analyzed using SPSS 24.0 and AMOS 24.0, including Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM).

4. Results

4.1. Reliability analysis

Prior to model verification, the reliability of the three scales was assessed through Cronbach's α coefficient. The Cronbach's α coefficients for the three scales ranged from 0.791 to 0.958, with all values exceeding the widely accepted threshold of 0.7. These results indicate that all three scales demonstrate high internal consistency (refer to Table 3).

4.2. Measurement model

Confirmatory Factor Analysis (CFA) was conducted to assess the reliability and validity of the data collected from the tourist sample. The results are presented in Table 4. Firstly, the overall fit between the data and the measurement model is satisfactory, with CMIN/DF = 3.423, GFI = 0.882, AGFI = 0.850, NFI = 0.933, IFI = 0.952, CFI = 0.952, TLI = 0.944, and RMSEA = 0.069, all of which meet the ideal criteria. Secondly, the measurement paths between all the manifest variables and the latent variables are significant within the 99 % confidence interval (two-tailed), and the standardized loadings of each factor, except for SN4 (0.395), are greater than 0.70, exceeding the critical value of 0.5. Finally, the Combined Reliability (CR) of the seven latent variables exceeds 0.8, and the Average Variance Extracted (AVE) is higher than the recommended threshold of 0.5, indicating that the latent variables demonstrate good internal consistency and convergent validity. Combined with the corresponding manifest variables, the structural variables can effectively explain the observed variables of the model.

Discriminant validity is used to determine whether different constructs are distinct from one another and whether the correlations between different constructs are significantly different. This can be achieved by comparing the square root of the Average Variance Extracted (AVE) and the inter-construct correlations [71,72]. According to the criteria set forth by Fornell and Larcker, an AVE value greater than 0.5 indicates high internal consistency, while high correlations between constructs suggest that they measure the same underlying construct [71]. In this study, the AVE values for each item in the questionnaire exceeded 0.5, and the square root of the AVE was greater than the correlation coefficients between the variables, indicating strong convergent validity and discriminant validity among the different variables (see Table 5).

The fit indices presented in Table 6 indicate that the model fits the data well. Although the chi-square degree of freedom ratio (df) value of 3.423 is slightly above the ideal value, it is still close to 3. This suggests that the complexity of the model could be improved, and further research is required to refine the model. In summary, the measurement model shows good validity and fits the data well, as most of the absolute fit indices meet the recommended criteria (GFI = 0.882, NFI = 0.933, IFI = 0.952, CFI = 0.952, TLI = 0.944, AGFI = 0.850).

4.3. Hypothesis test

Path coefficient analysis was conducted to determine the causal relationships between the seven driving factors of tourists' willingness to use online tourism programs and their impact on tourists' willingness to use. The results revealed that 7 out of the 10 hypothetical path coefficients were significant at the 0.05 level (see Table 7).

(1). H1, which reflects the insignificant path coefficients between knowledge and understanding and activity, behavior, and progression and perceived usefulness (0.251, $p > 0.05$ and 0.216, $p > 0.05$, respectively), failed to hold H1a and H1b.
(2). A positive correlation was found between knowledge and understanding and perceived ease of use ($\beta = 0.465$, $p < 0.01$), thereby supporting H2a. The path coefficient between activity, behavior, and progression and perceived ease of use ($\beta = 0.257$, $p > 0.05$) does not support H2b.
(3). H3 and H4 reflect the degree of influence of perceived usefulness and perceived ease of use on attitude toward using, and their path coefficients were 0.358 ($p < 0.001$) and 0.391 ($p < 0.001$), respectively, indicating that the hypotheses were valid.
(4). H5 reflected the degree of influence of perceived ease of use on perceived usefulness, and its path coefficient was 0.421 ($p < 0.001$), which supported the hypothesis.
(5). H6 and H7 reflected the degree of influence of attitude toward using and perceived usefulness on behavioral intention to use, and their path coefficients were 0.828 ($p < 0.001$) and 0.150 ($p < 0.001$), respectively, indicating that the hypotheses were valid.
(6). H8, which reflected the significant path coefficient between subjective norm and attitude toward using ($\beta = 0.252$, $p < 0.001$), was supported.

Table 3
Reliability statistics.

Reliability statistics	N	Cronbach's alpha
Technology Acceptance Model (TAM)	12	0.958
Theory of Planned Behavior (TPB)	4	0.791
Generic Learning Outcomes (GLOS)	7	0.938

Table.4
Confirmatory factor analysis.

Construct	Item	Significance of estimated parameters				Item reliability		Construct reliability	
		Unstd.	SE	t-Value	P-Value	STD	SMC	CR	AVE
PU	PU1	1.000				0.874	0.764	0.898	0.745
PU	PU2	0.846	0.036	23.174	***	0.844	0.712		
PU	PU3	1.012	0.042	23.959	***	0.872	0.760		
PEOU	PEOU1	1.000				0.909	0.826	0.940	0.838
PEOU	PEOU2	1.036	0.031	33.521	***	0.928	0.861		
PEOU	PEOU3	1.019	0.032	32.249	***	0.910	0.828		
ATU	ATU1	1.000				0.901	0.812	0.918	0.788
ATU	ATU2	0.971	0.036	26.881	***	0.871	0.759		
ATU	ATU3	1.043	0.038	27.731	***	0.890	0.792		
BIOU	BIOU1	1.000				0.886	0.785	0.910	0.771
BIOU	BIOU2	1.054	0.041	25.437	***	0.868	0.753		
BIOU	BIOU3	1.053	0.041	25.906	***	0.881	0.776		
SN	SN1	1.000				0.831	0.691	0.841	0.588
SN	SN2	1.109	0.049	22.795	***	0.898	0.806		
SN	SN3	1.074	0.050	21.473	***	0.835	0.697		
SN	SN4	0.678	0.078	8.722	***	0.395	0.156		
KU	KU1	1.000				0.879	0.773	0.906	0.708
KU	KU2	1.014	0.037	27.179	***	0.891	0.794		
KU	KU3	0.999	0.038	26.482	***	0.877	0.769		
KU	KU4	0.963	0.052	18.484	***	0.705	0.497		
ABP	ABP1	1.000				0.867	0.752	0.890	0.729
ABP	ABP2	1.087	0.050	21.736	***	0.824	0.679		
ABP	ABP3	1.014	0.044	22.877	***	0.870	0.757		

Note: ***states the parameter being significant within the 99.9 % confidence interval.

Table 5
Discriminant validity of the measurement model.

	AVE	PU	PEOU	ATU	BIOU	SN	KU	ABP
PU	0.745	0.863						
PEOU	0.838	0.683**	0.915					
ATU	0.788	0.713**	0.711**	0.888				
BIOU	0.771	0.717**	0.728**	0.858**	0.878			
SN	0.588	0.527**	0.459**	0.571**	0.559**	0.767		
KU	0.708	0.669**	0.649**	0.703**	0.705**	0.615**	0.841	
ABP	0.729	0.643**	0.623**	0.697**	0.709**	0.597**	0.849**	0.854

Table 6
Fitness test of the measurement model.

Fit indices	Criteria	Research model	Pattern fitting
Chi-square (x^2)	The smaller the better	742.858	Pass
Degree of freedom (df)	The smaller the better	217	Pass
Normed Chi-square (x^2/df)	<5	3.423	Pass
RMSEA	<0.08	0.069	Pass
TLI (NNFI)	>0.9	0.944	Pass
CFI	>0.9	0.952	Pass
GFI	>0.8	0.882	Pass
AGFI	>0.8	0.850	Pass
NFI	>0.8	0.933	Pass
IFI	>0.9	0.952	Pass

Overall, the majority of the research hypotheses were supported after statistical verification, as depicted in Fig. 2.

4.4. SEM analysis

The measurement model structure is illustrated in Fig. 2. Knowledge and understanding, as well as subjective norm, have a

Table 7
Structural equation modeling (SEM) and hypothesis test results.

Hypothesis		Relationship	β	t	Result
H1	H1a	KU→PU	0.251	1.920	Not supported
	H1b	ABP→PU	0.216	1.680	Not supported
H2	H2a	KU→PEOU	0.465	3.236**	Supported
	H2b	ABP→PEOU	0.257	1.791	Not supported
H3		PU→ATU	0.358	7.099***	Supported
H4		PEOU→ATU	0.391	8.297***	Supported
H5		PEOU→PU	0.421	8.557***	Supported
H6		ATU→BIOU	0.828	16.292***	Supported
H7		PU→BIOU	0.150	3.308***	Supported
H8		SN→ATU	0.252	5.667***	Supported

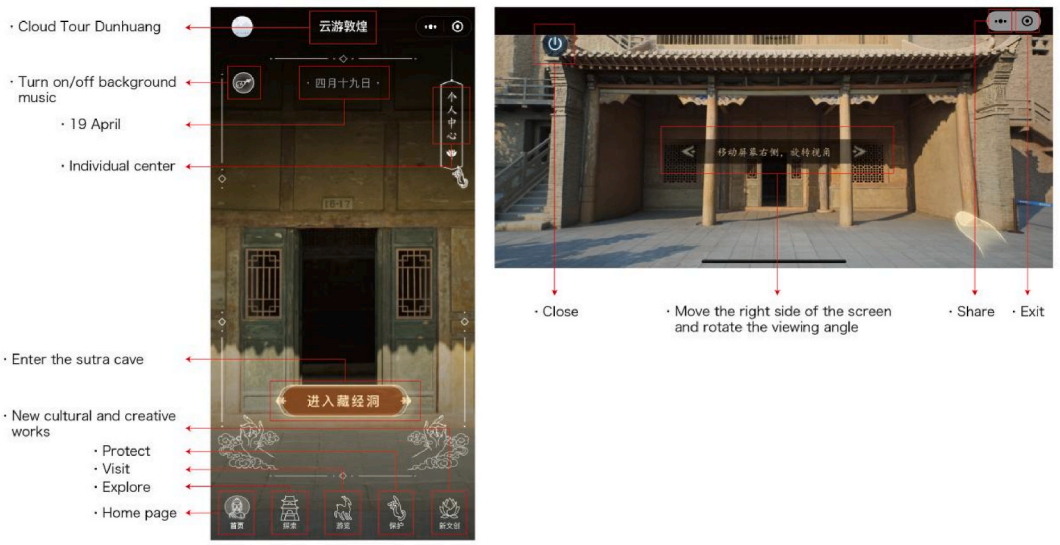

Fig. 2. The measurement model and its standardized path coefficients.

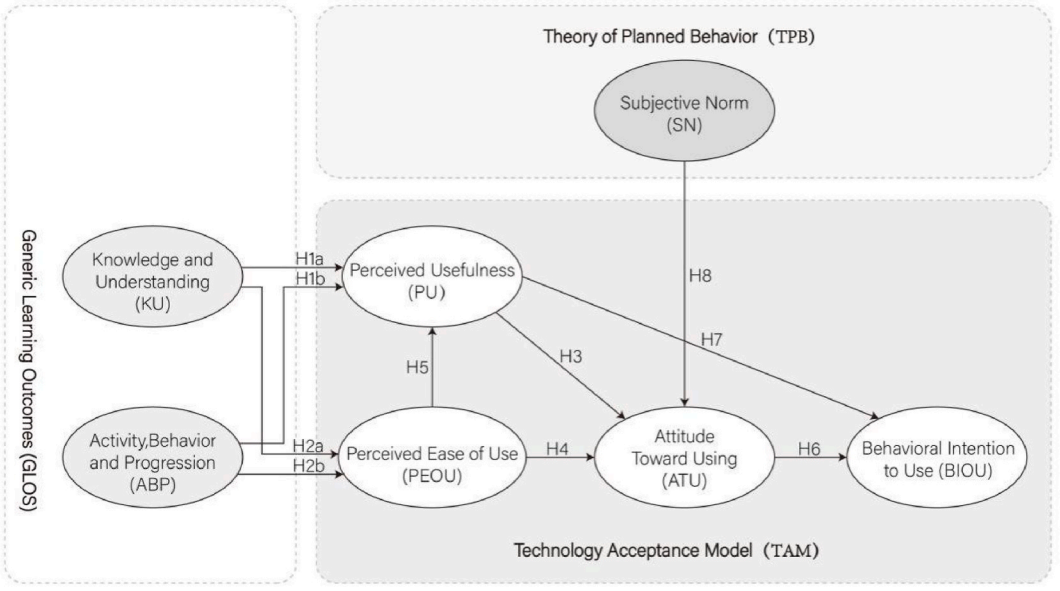

Fig. 3. The dunhuang mogao grottoes.

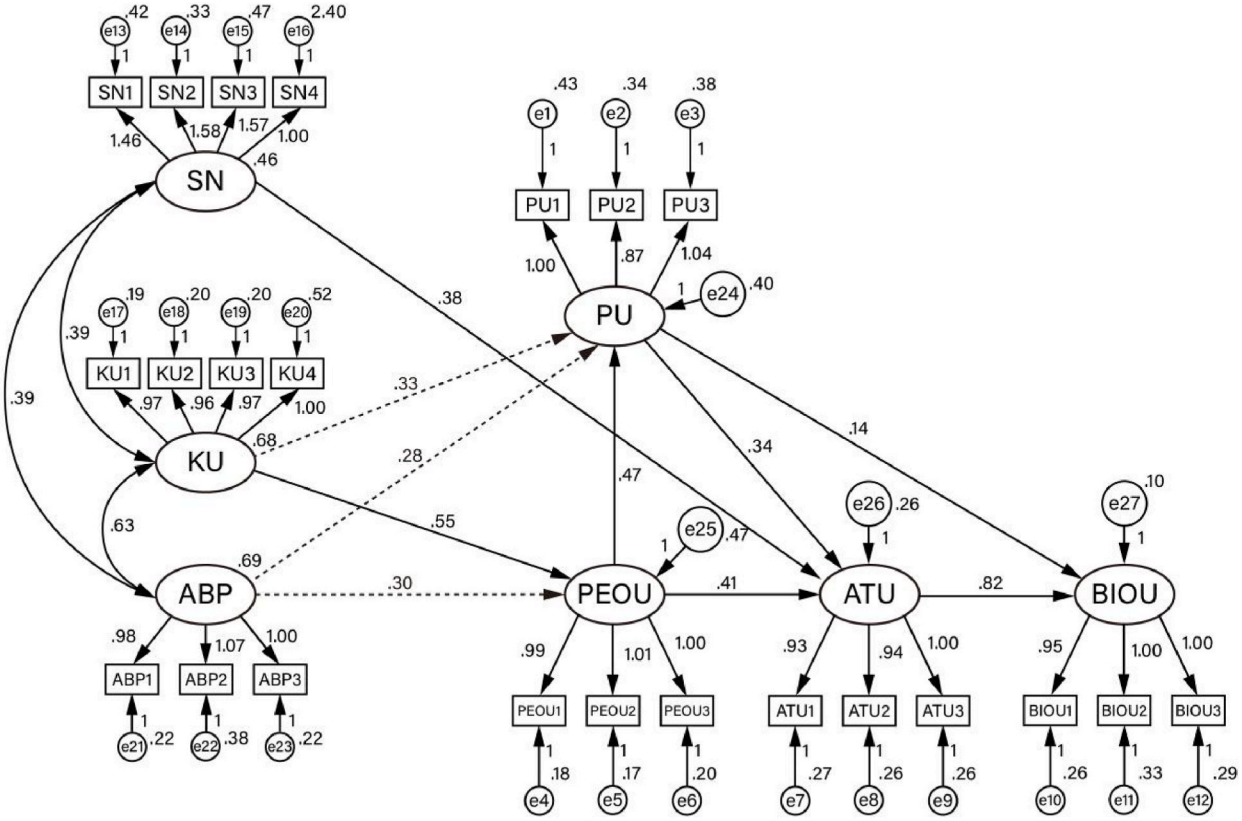

Fig. 4. Home pages of the Yunyou Dunhuang Online Program.

significant impact on the tourist experience. This suggests that visitors prefer online programs with well-organized and simple design. Tourists who use online programs to travel proritize the accessibility of program content. Users find it easier to operate if they can easily understand the information based on their previous experience. Online programs have become the best medium for information dissemination because of the advantages of remote interaction. At the same time, visitors are influenced by their friends and will engage in online program when people around them are using it. Therefore, tourists can enhance their travel experience through increased communication with the people around them when using online programs. In non-formal learning environments, such as online tours, visitors are often influenced by emotions [16]. Gaining knowledge proves the understanding of things. By using the Yunyou Dunhuang Online Program to visit Dunhuang, tourists can acquire new knowledge and understanding of Dunhuang. Through the program, tourists can not only learn about murals and other cultural protection-related knowledge but also gain a comprehensive overview of Dunhuang culture in their own unique way. New technologies have expanded the ways in which people learn. With the help of technology, individuals can experience the knowledge and cultural atmosphere of offline tourist attractions and learn traditional culture at home. Furthermore, influenced by their families and friends, more people are using online programs to explore Dunhuang, contributing to the protection of Dunhuang's cultural relics.

The attitude towards use is an important influencing factor for the intention to continue using online platforms, and the attitude towards using the Yunyou Dunhuang Online Program has a significant positive impact on the intention to use. This suggests that the more positive the attitude towards use, the stronger the driving intention [73]. Visitors' perceived usefulness during the use of the Yunyou Dunhuang, mediated through the attitude towards use, indirectly influences the intention to continue using, indicating that the attitude towards use facilitates visitors' ultimate intention to use [51]. Therefore, to enhance visitors' acceptance of the online program, museums or tourist attractions should motivate visitors and provide favorable conditions for visitors to use digital technology.

Furthermore, the impact of knowledge and understanding, as well as activity, behavior, and progression, on perceived usefulness is not significant. Activity, behavior, and progression refer to the potential for visitors to engage in new behaviors, ways of behaving, or progression (in terms of further learning or utilization) [49]. Some experts have noted that the Dunhuang culture may be perceived as obscure and difficult to understand, and the vastness of Dunhuang's history can be overwhelming. Although many tourists are attracted by the "Dunhuang tourism craze," they often find it challenging to share their experiences with others. Therefore, for most individuals without specialized training, it can be difficult to gain a deep understanding of Dunhuang culture and engage in further learning or utilization. Additionally, since Dunhuang culture, situated in the geographically remote northwestern region, features unique folk style and distinctive customs derived from the surrounding living environment, individuals lacking local familiarity or

professional expertise may encounter challenges in gaining a deeper comprehension of Dunhuang culture. Meanwhile, some tourists consider themselves too removed from Dunhuang culture to interact with it in a new way in the future, and are hence reluctant to invest too much time and efforts on it.

5. Discussion

This study employs a combination of the TAM, the TPB, and the GLOs to examine the factors that influence the intention to adopt online tourism. The results indicate that knowledge and understanding has a significant positive impact on perceived ease of use. In addition, perceived ease of use has a significant impact on perceived usefulness and attitude toward using, perceived usefulness has a significant impact on attitude toward using and behavioral intention to use, attitude toward using has a significant impact on behavioral intention to use, and subjective norm has a significant impact on attitude toward using.

Firstly, the study findings demonstrate that knowledge and understanding has a significant positive impact on perceived ease of use concerning external variables, which aligns with previous research [56,74,75]. This suggests that users are more concerned about the ease of understanding the knowledge and information within online travel programs, which directly affects the perceived difficulty of using the program. If users can easily grasp the content of the program based on their previous understanding, they perceive the operation to be simpler. In recent years, there has been a proliferation of online programs on the internet, and users tend to prefer programs that are well-organized, have a clean interface, and offer comprehensive functionality [65,76].

Furthermore, it also means that knowledge and understanding should be a primary focus when developing online travel programs. Online platforms have the advantage of remote interaction, making them an effective medium for conveying information. As such, online programs not only stimulate tourists' interest in utilizing them but also improve their cultural awareness of Dunhuang and potentially influence their future behavior [46,77].

External variables were found to affect attitude toward using. Specifically, subjective norm had a significant positive impact on attitude toward using, which is consistent with prior research [23]. These results suggest that tourism attitudes are significantly correlated with subjective norm, and tourism subjective norm have a positive influence on tourism intentions. It is important for users that their acquaintances perceive the use of the Yunyou Dunhuang Online Program as a good idea and beneficial, and recommend its usage. Additionally, when users observe that those around them are using the program, it also influences their own usage. Tourists often consider the opinions of those around them when making decisions about tourism behavior. Family supports can be influential under such circumstances [78]. Therefore, it is recommended that users engage in more discussions and exchange ideas with people in their network when using online programs to travel, as this can help them obtain a more comfortable travel experience.

In addition, the study findings revealed that activity, behavior, and progression did not affect perceived usefulness and perceived ease of use. One possible explanation for this is the limited availability of learning activities related to Dunhuang culture, as well as the difficulty in integrating Dunhuang elements into daily life. Non-professionals may have difficulty finding guides and furthering their understanding of Dunhuang culture. Additionally, Dunhuang's remote geographical location, inconvenient transportation, and high travel costs may deter some individuals from visiting. Furthermore, users may perceive the distance between themselves and Dunhuang culture as too great, making it challenging to generate new intersections in their future lives and deterring them from investing more time in it [79]. As a result, activity, behavior, and progression may not motivate users to use the Yunyou Dunhuang Online Program or pay attention to the spread and development of Dunhuang culture.

Secondly, the study findings indicate that perceived ease of use has a significant positive impact on perceived usefulness and attitude toward using, which is consistent with the original rationale for the TAM [25]. When users perceive online programs as easy to use, the frequency of their use is likely to increase. Moreover, perceived usefulness had a significant positive effect on attitude toward using and behavioral intention to use, which aligns with prior research [25,57,58]. When users perceive online programs as useful, positive attitudes and behavioral intentions towards them are likely to develop, consistent with previous studies [25,63,66,67,80]. Additionally, when users hold positive attitudes towards online programs, their behavioral intention to use for them is likely to increase.

Thirdly, the data revealed that the majority of tourists (79.32 %) had never visited Dunhuang before. However, the combination of Dunhuang artifacts with digital technology successfully attracted numerous visitors. When a 2D image appears on the screen of an electronic device, it piques tourists' curiosity [81]. These results indicate that new media technologies can increase tourists' motivation to engage in traditional cultural activities and provide them with meaningful learning experiences, thereby enhancing their cultural awareness [81–84].

Fourthly, with the help of online platforms, cultural and heritage organizations, as well as governments, can visually showcase the content of museum exhibitions and tourist attractions to visitors, facilitating their learning and exploration and improving efficiency. Additionally, through AR (Augmented Reality) technology, visitors can experience the charm of attractions without leaving their homes, enhancing the appeal of traditional culture and capturing the attention of tourists. At the same time, tourism marketers can gain insights into the diverse needs of visitors by reviewing their online feedback and experiences, enabling them to improve the program's processes, increase visitor satisfaction, and enhance the visibility and competitiveness of the online program [85–87]. The effective integration of information technology plays a positive role in the development of traditional culture and heritage tourism [88].

Finally, it is better to mention that many tourists shared in their feedback that online program technology has closed the gap between them and Dunhuang and enhanced their interaction with the cultural relics. Online programs have transformed the way tourists learn about traditional cultures [66,82,89]. The integration of digital technologies can inspire positive experiential behavior in visitors [81,84]. Some tourists mentioned that the combination of Dunhuang cultural relics with online programs is very innovative,

and they look forward to similar online programs in the future. Additionally, some tourists found it convenient to use online programs to visit Dunhuang, as they could experience tourist attractions from far away without any fees, saving them time and money. Furthermore, some tourists expressed an interest in learning more about the allusions found in the Dunhuang murals and wanted to involve their family and friends in the experience. They emphasized that learning and preserving traditional culture is a responsibility that each of us should undertake.

6. Conclusion

This paper utilized a combination of the TAM, the TPB, and the GLOs to investigate the experience of tourists using the Yunyou Dunhuang Online Program. Based on survey data collected from 536 tourists, the study findings indicate that knowledge and understanding significantly impacts perceived ease of use, and subjective norm significantly affects attitude toward using. Moreover, attitude toward using and perceived usefulness significantly influence users' intention to use online programs, while behavioral intention to use determines the actual usage of the user. Thus, learning procedures are not limited to specific activities or facilities. The online tourism indeed provides certain user experiences, regardless of the learning outcomes or the quality of tourism.

In addition, the impact of knowledge understanding on perceived usefulness is not significant. One possible explanation is that Dunhuang culture has a strong regional identity and differs significantly in cultural construction from the general sense of culture. Moreover, with the succession of dynasties, each period of Dunhuang art showcases distinct characteristics and styles. For viewers, a higher level of professional literacy is required [90]. Therefore, it is difficult for visitors to exert subjective initiative and have unique perceptions and imaginings based on their understanding of the subject matter.

This study provides a comprehensive exploration of the factors influencing online tourism adoption intention, which has practical value for designing online tourism programs and improving the quality of online tourism experiences. Designing well-crafted online programs plays a positive role in promoting the dissemination of traditional culture and enhancing the tourism experience. It drives the development and transformation of traditional culture by integrating digital technology into cultural and heritage organizations, creating smart cultural tourism platforms. This not only provides convenience for visitors but also increases the attractiveness of local traditional culture and captures the attention of tourists. Additionally, it provides tourism marketers with valuable feedback channels to understand the visitor experience, enabling them to improve their shortcomings and enhance visitor satisfaction. The effective integration of information technology has a positive impact on inheriting traditional culture and promoting heritage tourism. Moreover, the developed model in this study not only enriches the theoretical framework of online tourism research but also contributes to future applications of digital technology in online tourism experiences.

Nonetheless, this research has some limitations. (1) The results of the study exhibit cultural and regional limitations. Hence, it is recommended to expand the scope of studies to encompass diverse geographic regions, in order to comprehensively examine the factors that influence online program travel experience. (2) Moreover, this study is limited to the relationship between digital technology and traditional cultural tourism, and future research should expand the sample size to conduct a more comprehensive study. (3) This study only proposed three theoretical models: the TAM, the TPB, and the GLOs. Other interesting theoretical models can also be used to investigate the factors influencing the adoption intention of online travel programs or software. For example, theories related to brand engagement or communication can further promote the development of the online tourism industry. Therefore, future research can explore the construction of other theoretical models for more detailed investigations in this area.

As protectors and disseminators of traditional culture, the public plays a significant role in promoting sustainable traditional culture [91]. Cultural tourism can influence tourists' cultural awareness and learning [92]. Active participation from tourists is crucial in determining the effectiveness of information communication and the quality of travel experiences. Opinions on tourism vary between individuals [83]. In the digital age, tourists seek unique, personalized, and technological experiences [93]. Therefore, it is recommended that more museum exhibitions or tourist attractions integrate digital technology into their planning and design to provide tourists with novel and interesting experiences, improve their awareness of the protection and inheritance of traditional culture, and attract more public participation.

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Additional information

No additional information is available for this paper.

Ethics declarations

This study was reviewed and approved by Beijing Institute of Graphic Communication.
All participants provided informed consent to participate in the study.
All participants provided informed consent for the publication of their anonymised case details and images.

Data availability statement

Data included in article/supp. material/referenced in article.

CRediT authorship contribution statement

Shaomin Yan: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Xiaofan Yu:** Writing – original draft, Supervision, Software, Resources, Formal analysis, Data curation. **Zongdeng Zhang:** Writing – original draft, Supervision, Software, Resources, Funding acquisition, Conceptualization. **Li Gan:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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