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Understanding continued use intention of digital intangible cultural heritage games through the SOR model

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Guanning Wang[1] & Delai Men[2] ✉

Digital games have emerged as a popular method for disseminating intangible cultural heritage (ICH). However, research on the motivations driving continuous intention to play digital ICH games remains limited. Therefore, this study aims to investigate the factors influencing users' continuous intention to play digital ICH games. We applied the SOR framework to investigate how two primary external stimuli-game factors and social factors-impact users' hedonic and utilitarian perceptions. Furthermore, we analysed how these perceptions influence users' continuous intention and assessed the moderating effects of cultural identity and value co-creation. With data collected from a survey of 338 gamers, the results revealed that both utilitarian and hedonic performance confirmations drive the use of digital ICH games. System quality and information quality exclusively influence utilitarian performance confirmation, while critical mass and social interaction positively influence both utilitarian and hedonic performance confirmations. Additionally, cultural identity positively moderates the relationships between utilitarian performance confirmation and continuous intention, as well as hedonic performance confirmation and continuous intention. The research highlighted the relative importance of specific factors, offering more profound insights into the continuous intention of digital ICH gamers.

Playing games is an inherent aspect of human nature, as explained by the Dutch historian Johan Huizinga in his book Homo Ludens[1]. In recent years, the digital game industry has been experiencing rapid growth worldwide[2], and the dissemination of intangible cultural heritage (ICH) through digital games has begun to attract the attention of the academic community[3–5]. Digital ICH games can enhance the accessibility of ICH, allowing users to develop interest and actively engage in cultural communication activities. Therefore, intangible cultural heritage, particularly traditional craftsmanship, has discovered new avenues for dissemination. To be specific, digital games facilitate the long-term preservation and updating of ICH content, ensuring its survival over time while continuously optimising its dissemination through technological advancements[6].

Some researchers have explored the correlation between quality factors and user churn[7], the design pathways of cultural elements[8], and the application of new technologies, such as virtual reality (VR), in ICH games[3,9].In the context of serious games, a few studies have also examined the connection between gamification and learning effectiveness[10,11]. Although previous studies have explored how game quality affects players' intentions in serious ICH games[7,12]and how new technologies like AR and VR can either encourage or discourage user engagement[3,13], little is known about whether and how social and cultural factors contribute to the adoption of ICH games. In addition, although social interaction and cultural uniqueness have received considerable attention in the realm of ICH tourism and the acquisition of ICH handicrafts, little research has explored these aspects in digital ICH games.

Therefore, to bridge this research gap, this paper aims to integrate cultural, social, and game quality factors to analyse users' perceptions and validate how these perceptions influence their intention to continue using digital ICH games. We employ the Stimulus–Organism–Response (SOR) model as theory background, as SOR theory has demonstrated strong explanatory power for continuance intention[14,15]. The SOR model includes external stimuli, organisms, and responses, which is helpful for conducting a comprehensive analysis of user behaviour. Drawing on the SOR framework, we investigated how stimuli in digital ICH games affect users' cognitive and emotional perceptions, particularly regarding their utilitarian and hedonic performance confirmations, and how cultural identity and value co-creation shape users' perceptions of continued ICH game usage.

[1]Faculty of Innovation and Design, City University of Macau, K.C.Wong Building, Avenida Padre Tomás Pereira, Taipa, Macau, China. [2]School of Design, South China University of Technology, Guangzhou Higher Education Mega Centre, Guangzhou, Guangdong, China. ✉e-mail: Mendelai@scut.edu.cn

The game "Master of Pottery" was chosen as a case study because it has a relatively large game population and a wide reach for the dissemination of ICH. It has also received a good reputation for promoting player interaction, effectively conveying intangible cultural heritage (ICH) content, and providing users with an entertaining experience. Cultural identity and value co-creation, as the internal psychological perception of players, are often ignored by previous research on gamer behaviour. Therefore, the novelty of this study lies in its categorisation and integration of relevant variables from previous research, along with the introduction of cultural identity and value co-creation as moderating variables. This study aims to contribute to the existing literature on ICH game adoption and further clarify the critical role of cultural identity in these games.

Methods

Intangible cultural heritage (ICH)

The UNESCO Convention for the Safeguarding of Intangible Cultural Heritage uses a five-domain categorisation system to classify ICH. The five domains are as follows: (1) oral traditions and expressions, including language; (2) performing arts; (3) social practices, rituals, and festive events; (4) knowledge and practices related to nature and the universe; (5) traditional craftsmanship[16]. Unlike tangible cultural heritage, ICH prioritises the transmission of skills and knowledge through human interaction rather than the relatively static nature of tangible cultural heritage[17]. In the context of globalisation, where cultural boundaries are rapidly dissolving, UNESCO has highlighted the imminent risk of ICH being destroyed or disappearing. This recognition underscores the increasing importance of protecting such heritage to preserve cultural diversity[16]. Awareness of the importance of preserving and disseminating intangible cultural heritage (ICH) has grown significantly in recent years, mainly driven by its multifaceted cultural, educational, and economic value[9]. Culturally, ICH represents the essence of long-standing human practices, serving as a vital link to historical continuity[18]. Educationally, studies suggest that exposure to traditional cultural practices—particularly those that resonate personally enhances individuals' acceptance and advocacy of ICH, deepening their cultural engagement and sense of belonging[19]. Economically, the innovative development of ICH has spurred the creation of digital products and creative derivatives, unlocking untapped markets and diversifying consumption opportunities[20]. These cultural, educational, and economic dimensions underscore ICH's evolving role as both a bridge to the past and a driver of contemporary societal progress.

Digital games in ICH

Gamification is a popular strategy for preserving intangible heritage[21]. Integrating ICH into gaming can attract younger audiences, allowing them to engage with and understand traditional culture while having fun[22,23]. Digital games related to ICH with educational attributes have been widely developed by researchers in many countries. For instance, Dagnino et al. developed the "Canto a Tenore game," an adventure game, designed to support the learning of an ancient Italian tune[24]. David et al developed "HieroQuest" a serious game designed to spread the Middle Egyptian language through immersive storytelling[25]. Many studies have confirmed that serious games do have effectiveness to disseminate knowledge of intangible cultural heritage[5]. However, Bai et al argued that serious ICH games often offer a 'disposable' cultural experience, which fails to maintain sustained player interest[26]. To keep digital ICH games engaging, some studies suggest that developers should prioritise replicating or reconstructing heritage, restoring traditional processes and key technical aspects of ICH, and encouraging users to exercise their imagination[27,28]. With the development of the ICH game market, in-depth research on users' intentions toward digital ICH games is essential.

A few scholars have undertaken empirical studies to explore the factors influencing users' ongoing engagement with digital ICH games. From a technology acceptance perspective, Qiu et al. and Bai et al. identified the main elements influencing gamers' willingness to keep playing ICH games. The elements include immersion, visual attractiveness, pleasure, perceived utility, and ease of use[3,26]. From a user churn perspective, Ting and Min emphasised that game design, subjective norms, and system quality significantly influence perceived ease of use and usefulness, which could affect continuous intention[7]. Wang et al also highlighted the impact of system fluency and aesthetics on users' continued intention toward AR-based ICH websites[29]. Jiang et al. further examined how the utilitarian and hedonic characteristics of ICH games influence users' perceived usefulness and enjoyment, thereby encouraging their behavioural intention[4]. Overall, previous research indicates that the external factors influencing player adoption of ICH games can be summarised as game quality and social interaction. The former encompasses visual and systemic quality as well as cultural information. The latter includes media communication, user reviews, and player interactions. Players' psychological perceptions can be categorised into utilitarian and hedonic dimensions. Furthermore, empirical studies examining the influence of additional factors on ICH games still need to be explored. For instance, factors such as cultural identity and value co-creation should be considered, as they have been explored within the context of ICH tourism and handicrafts[30,31]. Similarly, in the context of ICH games, cultural identity and value co-creation may affect players' psychological responses, thereby influencing their continuance intentions. Therefore, a gap exists in research on how these factors affect users' continuance intentions regarding ICH games. Due to the frequent challenges these games face regarding low user retention[32], further research examining these factors influencing users' ongoing willingness to engage with ICH is urgently needed.

Stimulus–organism–response model

The SOR theory originated from Woodworth's research in 1929, which was built upon Pavlov's Stimulus–Response (S–R) theory in behavioural science[33]. From an environmental psychology perspective, Russell and Mehrabian introduced the concept of internal cognition and emotional activities, which they termed "organism" factors[34]. This enabled a deeper understanding of internal human reactions, leading to the development of the SOR theory. They explained that research should begin with external stimuli affecting users' emotions in the environment, influencing their subsequent behaviours[34]. The model is comprised of three components: 'S' (Stimulus), which represents environmental features like essential functions, layout, and services; 'O' (Organism), representing an individual's emotional and cognitive state; and 'R' (Response), which represents the behavioural reaction elicited by the individual[35]. The SOR theory has strong explanatory power regarding users' continuance intention[14,15] and serves as a frame in various behavioural studies[3,36–40]. This indicates that SOR theory is a well-established framework for examining users' continuance intention within the context of digital ICH.

Conceptual model development

Based on the above discussion of the ICH game and SOR theory, we develop a research model, which is illustrated in Fig. 1. The external stimulus variables are based on the McLean IS success model and the critical mass theory. The IS success model was first used to explain how the attributes of information technology affect the internal state of users and subsequent adoption behaviour[41], while critical mass theory is essential for predicting user adoption of interactive communication technologies[42]. Digital ICH games can be seen as an interactive communication system[43]. Therefore, the tests of the variables proposed in the relevant theories are of reference significance.

The user perception variables we developed in the model are grounded in expectation confirmation theory (ECT). Narvadha et al. emphasised the importance of extending the concepts of the ECT theory by modifying context-related variables[44]. Thus, we considered the context of digital ICH games and adjusted the user expectation variables accordingly. A few studies indicate that users' confirmation of utilitarian values is more obvious in the context of serious games[7]. However, the current trend of transitioning from serious games to entertainment games shows that users' expectations of hedonic values also play a crucial role in their willingness to play[4,26,45]. Thus, regarding user perception, performance expectations should be considered

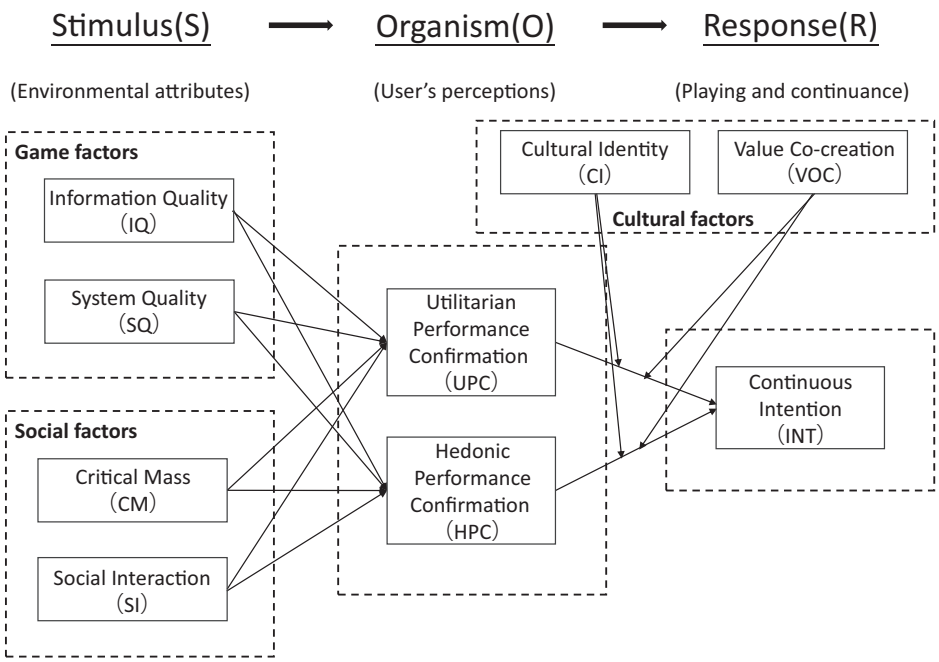


Fig. 1 | Proposed research model. A conceptual model was developed using the SOR framework, incorporating variables from the McLean IS Success Model, Critical Mass Theory, and Expectancy Confirmation Theory. Information quality and system quality (game factors), along with critical mass and social interaction (social factors), are anticipated to influence users' utilitarian and hedonic performance confirmations. These confirmations, in turn, impact users' continuous intention to adopt digital intangible cultural heritage (ICH) games. Two intrinsic factors (cultural identity and value co-creation) are proposed to mediate the relationship between user perceptions and their willingness to continue usage.

as two dimensions-utilitarian and hedonic-to effectively examine users' intention to continue using digital ICH games. Additionally, two intrinsic user factors, cultural identity, and value co-creation, are proposed to mediate the relationship between user perceptions and their willingness to continue usage. This is because cultural identity and value co-creation are not perceptions generated by external stimuli. To be specific, the former is an individual's sense of belonging to a specific culture[46], and the latter is the recognition of the value of culture and self-creativity[31,47].In order to better capture the impact of these intrinsic factors on user behaviour, we supplemented these two factors as moderating variables in the SOR model.

System quality and information quality (game quality factors)

System quality refers to usability, user interface design, response speed, consistency, and system stability[48]. Information quality refers to information's relevance, sufficiency, precision, and timeliness[44,49]. Many scholars classified games as a novel information system within studies on game quality, utilising the revised information system success model to examine user engagement[50]. These studies have confirmed that users' behaviour is influenced by both system quality and information quality. Specifically, if the information is irrelevant, inaccurate, or deviates from established standards, users may question the system's capability and reliability in delivering quality services[51]. Furthermore, low system quality also negatively impacts users' attitudes towards perceived value[52,53]. Ting and Min confirmed that system quality, including server performance and stability, influences users' ongoing engagement with ICH games[7]. A few studies also indicated a significant relationship between information quality and user's perceived hedonic and utilitarian values[54]. Although there is no direct evidence of a correlation between system quality and users' hedonic and utilitarian perceptions of ICH games, some studies have validated this relationship within a mobile service context. Based on these studies, Abbasi et al summarise that all mobile users seek mobile services for two main reasons: utilitarian (functional) and hedonic (entertainment) benefits[55]. Similarly, since digital ICH games can be seen as mobile service providers, we hypothesise that a relationship exists between these values and system quality. Based on the preceding discussion, the subsequent hypotheses are proposed:

H1: Information quality has a positive impact on utilitarian performance confirmation.

H2: Information quality has a positive impact on hedonic performance confirmation.

H3: System quality has a positive impact on utilitarian performance confirmation.

H4: System quality has a positive impact on hedonic performance confirmation.

Critical mass and social interaction (social factors)

Critical mass refers to the minimum number of individual acts necessary to promote the common interests of others[56]. In particular, it is anticipated that people would consider other people's behaviour when making judgements[57–59]. It is posited that the adoption of online games by others significantly affects individuals' acceptance[60]. Previous studies have primarily analysed one-off game scenarios where players do not engage with the same opponents multiple times[61,62]. In contrast, digital ICH games now increasingly emphasise realistic scenarios with repetitive interactions. This dynamic nature enables players to develop a broader range of strategies over time[61]. Therefore, a critical mass of game platforms needs to be reached in order to attract more players[63] and ICH-based content creators. The concept of critical mass emphasises the transition from quantitative to qualitative change[58]; once a certain population size is reached, significant shifts occur within the game's social system[59]. Therefore, this study defines critical mass as the essential number of individuals participating in digital ICH games. Similarly, the number of adopters may impact individuals' perceived values and cognitive states. As two main factors reflecting perceived values and cognitive states, perceived hedonic and utilitarian confirmations are likely triggered by users' awareness of the number of participants in ICH games. Finally, we propose that critical mass may influence both hedonic and utilitarian performance confirmation.

Social interaction refers to the ways individuals act and respond to others in their environment[64]. Player interaction is a crucial element in the design and operation of digital ICH games, significantly influencing players' gaming experiences, engagement levels, and perceptions of ICH[65]. Moreover, interaction mechanisms, such as social sharing and multiplayer collaboration, promote the dissemination of ICH among a broader audience[66,67]. Players share their game results on social platforms, enabling them to perceive their impact on the real world, which increases their engagement[68]. Additionally, players observe creations by others, fostering a

competitive dynamic that strengthens social networks and enhances game stickiness[4]. The above points show that social interaction has the potential to influence players' perceived entertainment and perceived utilitarian value of ICH games. Consequently, we predicted that social interaction enhances user intentions in both hedonic and utilitarian dimensions. Therefore, the following hypotheses are proposed:

H5: Critical mass has a positive impact on utilitarian performance confirmation.

H6: Critical mass has a positive impact on hedonic performance confirmation.

H7: Social interaction has a positive impact on utilitarian performance confirmation.

H8: Social interaction has a positive impact on hedonic performance confirmation.

Confirmations of utilitarian and hedonic performance

Utilitarian performance confirmation refers to the comprehensive evaluation of practical advantages[69], reflecting users' goal-oriented and rational behaviour[70,71]. One of the potential objectives for users engaging with ICH games is to acquire knowledge about intangible cultural heritage (ICH). This learning objective was confirmed to affect users' willingness to continue engaging with ICH games[7]. In addition, another study also identified a utilitarian expectation among digital ICH gamers: the richness of cultural information, which is considered essential for satisfying users' learning objectives and enhancing their willingness to engage further[4]. Therefore, it is hypothesised that the utilitarian performance confirmation of ICH positively influences ICH gamers' intention to continue using the game.

Hedonic performance confirmation refers to the enjoyment and playfulness users experience while achieving performance outcomes[72,73]. Xinjie et al explored the intention to adopt digital ICH and found that high hedonic motivation significantly enhances consumers' willingness to engage with the ICH content[74]. Previous studies on user behaviour regarding digital ICH games have primarily concentrated on interactivity[4], entertainment experience[7], and aesthetics quality[26]. For instance, in VR ICH games, higher interactivity correlates with greater user retention[3], and a lack of entertainment experience in ICH serious games can lead to user churn[7]. Although some studies have integrated interactivity and aesthetics as key hedonic values[4], and acknowledged that hedonic motivation influences continued adoption[74], there's still a gap in understanding how users perceive and confirm hedonic value and how this identification influences their willingness to engage with digital ICH. Based on the above discussion, it can be reasonably predicted that if digital ICH game users confirm the perceived hedonic value of the game, it will enhance the users' intention to continue playing. In light of this discussion, the subsequent hypothesis is presented:

H9: Utilitarian performance confirmation has a positive impact on continuous intention.

H10: Hedonic performance confirmation has a positive impact on continuous intention.

Cultural identity and value co-creation

From a societal perspective, cultural identity is rooted in a sense of identification and belonging, shaped by tradition, lifestyle, and values[75]. It differentiates cultures by encompassing their unique knowledge and value systems[76]. Consumers tend to respond more positively to products that align with their cultural orientation, whether global or local. Individuals with strong local cultural identities favour brands and products embodying local characteristics[77]. Products infused with national cultural elements elicit stronger positive responses from consumers who share that cultural identity. As a popular form of ICH product, ICH games may follow similar patterns. Users engaging with digital cultural heritage games, influenced by the presented cultural content, develop an affinity for cultural consistency, deepening their understanding of the game's inherent value[26]. This study hypothesises that hedonic and utilitarian performance confirmations encourage users to continue playing ICH games, while cultural identity may amplify this positive effect on their intention to continue using ICH games.

H11a: Cultural identity has a positive moderating effect on the relationship between utilitarian performance confirmation and the continuous intention to use digital ICH games.

H11b: Cultural identity has a positive moderating effect on the relationship between hedonic performance confirmation and the continuous intention to use digital ICH games.

Value co-creation was initially characterised by firm–customer interactions through personalised, dialogical exchanges, facilitating joint value creation[78]. In the last decade, the concept of value co-creation has been applied to cultural festivals[79,80] and cultural heritage settings[81], where co-creation is defined as the collaborative creativity of users[82]. Value refers to the user's acknowledgement of the cultural value of the heritage as they participate and share cultural ownership[80]. In the context of digital ICH games, it is notable that users engage in-game environments that feature virtual assets, which could be regarded as a vital component of value co-creation. A study on the digital ICH trading platform indicates that users' perceptions of value co-creation influence their willingness to engage with the platform[30]. Value co-creation involves recognising both the cultural value and the value of self-creativity within the context of digital ICH games and is consequently regarded as an inherent attribute of the player. Therefore, this study suggests that as perceptions of value co-creation increase, the positive influence of both utilitarian and hedonic performance confirmations on continuous intention also grows.

H12a: The value co-creation has a positive moderating effect on the relation between utilitarian performance confirmation and continuous intention.

H12b: The value co-creation has a positive moderating effect on the relation between hedonic performance confirmation and continuous intention.

Subject and case selection

"Master of Pottery", a representative digital ICH game, was chosen as a case study for detailed analysis. The game immerses players in the traditional craft of Chinese pottery, offering a variety of traditional Chinese vessel shapes, glazes, and decorative patterns to inspire creativity (Fig. 2). The game allows players to engage in the fundamental steps of pottery-making, including throwing, firing (drying, preheating, high temperature), attaching parts, glazing, and painting through 3D effects. Additionally, players can display their works in a showroom for virtual visitors and earn coins from ticket sales, which can be used to purchase traditional decorative patterns, glazes, or paints. The game also features a trading system where players can accept or reject bids through in-game messages, further supporting the preservation and dissemination of traditional crafts, as shown in Fig. 2.

"Master of Pottery" enables players to appreciate cultural uniqueness while enjoying an entertaining experience, unleashing their creativity, and interacting with others. The game has received numerous domestic and international accolades and was selected for the 2nd China Original Art Excellence Game Competition in 2022[83].

Participants

Participants were recruited through online channels (the official WeChat group) and offline methods (on-site experiences). We invited real players from the official group who had previously provided feedback on bugs or had commented within the group to complete the questionnaire. After obtaining permission from the game developers, we communicated individually with players, collected their game information anonymously, and encouraged them to voluntarily complete the questionnaire. They need to display the trading information, showing the ability to master the game. Each participant received a cash prize through an e-wallet after completing the questionnaire. In addition, offline invitations were issued by having participants fill out questionnaires on-site at the end of their experience, primarily at colleges and nearby cultural conventions. This offline survey is classified as low-risk research and received approval from the ethics committee. All recruiters signed an informed consent form before the survey. We first asked them to play the game on an electronic device we provided.

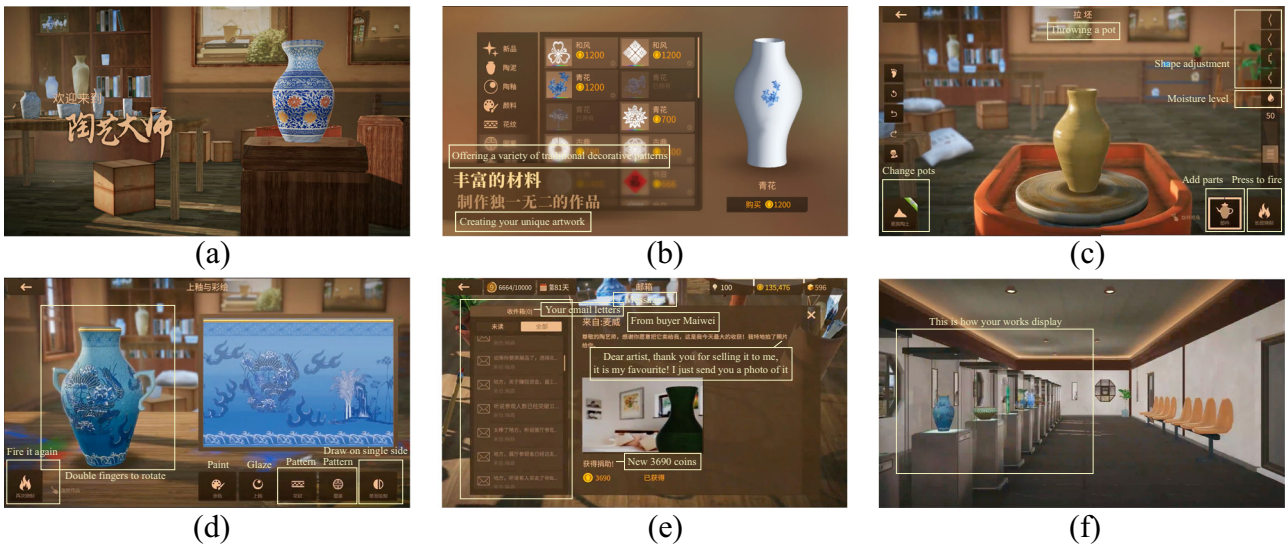


Fig. 2 | The interface of "Master of Pottery" and the display of its in-game interaction system. a Start page. **b** Traditional pattern selection interface. **c** Pottery shape creation and console interface. **d** Interface for drawing Intangible Cultural Heritage (ICH) patterns. **e** Pottery works trading and player interaction interface. **f** Pottery works display interface. This figure illustrates the complete steps of user engagement, highlighting that users can unleash their creativity based on Intangible Cultural Heritage (ICH) content while also interacting and trading with other players.

Table 1 | Demographic information of the participants

		Number	Percentage
Gender	Female	248	73.4
	Male	90	26.6
Age	19–40	323	95.6
	41–60	15	4.4
Year of gaming experience	<1 year	72	21.3
	1–5 years	170	50.3
	6–10 years	62	18.3
	11–15 years	19	5.6
	16–20 years	8	2.4
	More than 20 years	7	2.1
Level of education	PhD	25	7.4
	Masters	131	38.8
	Degree	153	45.3
	Diploma	15	4.4
	Others	14	4.1

Participants used in-game prompts to shape clay blanks, fire them, and select colours and patterns offered by the system for decoration. Finally, the completed works were archived and displayed in the showroom in exchange for in-game currency, as well as likes and favourites from other players. The game also offers participants the opportunity to learn about ICH and appreciate others' works. Participants were required to complete their work in more than 15 min; those who played for less time or failed to finish were considered to have withdrawn from the experiment. After the experience, participants were required to complete a questionnaire. The questionnaire included the question, "Have you played this game before?", which ensured genuine feedback regarding gameplay from the participants. The questionnaire was designed in the local language and reviewed by both authors. During back-translation, standardised formulations of relevant terms were referenced to enhance respondents' understanding of the questions. Of the 369 users who completed the survey on www.WJX.com, 338 valid responses remained after excluding those completed in under 60 seconds, users who had never used Master of Pottery, and duplicate entries. Demographic information is presented in Table 1.

Questionnaire development

The questionnaire was segmented into two sections. The first section gathered demographic information (e.g., gender, age, years of gaming experience, and level of education). The second part comprised nine subscales totalling 30 items adapted from established measurements to evaluate the study's nine latent variables. A 5-point Likert scale was used for all subscales. For the internal characteristics of the digital ICH game, the measurements of both the system quality subscale and information quality subscale were adapted from the items used by Gao et al.[51]. The information quality subscale evaluates users' perceptions of the immediacy and accuracy of ICH information, as their ability to perceive this information is crucial for meeting operational requirements. The system quality subscale evaluates users' perceptions of the smoothness and stability of the gaming system. For the external social factors of the game adoption, critical mass and social interaction were measured. The critical mass subscale was developed based on the scale by Yoon et al.[63]. The three items in the social interaction subscale were adapted from the questionnaire created by Choi and Kim[84] and Lee[85], whose original items aimed to explore the behavioural intention to engage in online gaming. The critical mass subscale assesses users' perceptions regarding the size of the ICH gaming population, whereas social interaction evaluates their perceptions of interactions between users. In addition, translations and revisions were made to the utilitarian performance confirmation subscale (UPC) and the Hedonic performance confirmation subscale (HPC) from the instruments developed by Abbasi et al. [55], whose items sought to examine determinants of influencing users' continuous intention to engage with digital services. The value co-creation subscale (VOC) was adapted from Hu et al. [30] whose items were designed to assess users' intention to purchase ICH products online, and the cultural identity subscale (CI) was adapted from Bai et al. [26] with items created to understand users' intentions regarding ICH serious games. The continuous intention subscale (INT) was adapted from Lee and Tsai[86], whose original items aimed to understand the factors of continuously playing online games.

More information about the questionnaire is presented in the Supplementary Information section. Given that the original authors of the VOC and CI questionnaires provided bilingual versions, the language translation for the other scales was conducted by two experts—one specialising in ICH

Table 2 | Results of construct validity and reliability analysis

Latent variable	Measurement variable	Mean	Std. dev.	VIFs	Factor loadings	α	CR	AVE
IQ	IQ1	3.98	0.83	1.358	0.841	0.880	0.882	0.651
	IQ2				0.780			
	IQ3				0.793			
	IQ4				0.811			
SQ	SQ1	3.87	0.96	1.286	0.865	0.903	0.905	0.704
	SQ2				0.772			
	SQ3				0.864			
	SQ4				0.851			
CM	CM1	3.12	1.09	1.530	0.875	0.915	0.917	0.734
	CM2				0.897			
	CM3				0.860			
	CM4				0.790			
SI	SI1	3.70	1.07	1.480	0.879	0.891	0.892	0.735
	SI2				0.800			
	SI3				0.890			
UPC	UPC1	4.12	0.85	1.739	0.835	0.836	0.838	0.634
	UPC2				0.784			
	UPC3				0.767			
HPC	HPC1	4.23	0.72	1.462	0.755	0.815	0.819	0.603
	HPC2				0.713			
	HPC3				0.855			
CI	CI1	1.99	0.85	1.400	0.748	0.799	0.799	0.570
	CI2				0.783			
	CI3				0.732			
VOC	VOC1	4.21	0.76	1.363	0.790	0.800	0.806	0.584
	VOC2				0.652			
	VOC3				0.838			
INT	INT1	3.93	1.03	–	0.890	0.905	0.907	0.765
	INT2				0.810			
	INT3				0.920			

and the other in linguistics. Their individual translations were compared, synthesised into a cohesive version, and finalised through consensus. Before conducting the questionnaire, a pilot test was carried out with 23 college students to enhance the survey's readability and content validity. During the test, we found that some translations were vague and ambiguous, particularly the distinctions between 'game elements' and 'game mechanism,' as well as between 'creative sharing' and 'learning from others.' We adjusted the wording for clarity. We also supplemented ICH and MOP with the full description of the traditional pottery making and the game's full name, in order to increase the comprehensibility of the survey. Using real-time feedback, we improved the wording concurrently to eliminate any ambiguity or misunderstanding encountered during the test.

Data analysis

The data were analysed using IBM SPSS 29.0.1 and AMOS 24.0.1, which are considered advanced tools for analysing structural equation modelling (SEM) in social science research[87,88]. Based on 338 valid questionnaires, the variables were first tested for multivariate normality. By using quantile–quantile plots in SPSS, we did not find deviations from the normal distribution, and all data were consistent with normality. In addition, we measured variance inflation factors (VIFs), which are used to assess the problem of multicollinearity, and no multicollinearity problem was presented. The data were analysed through the missing data module in SPSS, and no missing data were found in the variables. Then, confirmatory factor analysis (CFA) was conducted to assess the instrument's reliability and validity, and Cronbach's alpha coefficients were computed to evaluate each subscale's internal consistency. Finally, we conducted the moderating effects test using the PROCESS V 4.2 Plug-in to explore the influence of the two moderating variables. The interaction terms of the variables were tested for significance by setting a confidence interval of 95/100 and randomly sampling 5000 times. Moderating variables (CI and VOC) are treated as observed variables for moderation analysis. Simple slope tests were generated in PROCESS to assess the effects at various levels of mediation. The specific results of the data analysis can be found in the section "Results".

Results

The measurement model

Standardised factor loadings, Cronbach's alpha coefficients, convergent validity, discriminant validity, and model fit were employed as indicators to assess the validity and reliability of the measurement model. According to Fornell and Larcker, it is fundamental that the items' standardised factor loadings stay above 0.50[89]. With standardised factor loadings over 0.60 (range from 0.652 to 0.920), every item in our research met this requirement. With values ranging from 0.799 to 0.915, the five constructs' Cronbach's alpha coefficients showed strong internal consistency, all exceeding 0.70 (Table 2). In addition, the value of means ranged from 1.99 to 4.21, with

Table 3 | Discriminate validity of the research model

	IQ	SQ	CM	SI	UPC	HPC	VOC	CI	INT
IQ	0.807								
SQ	0.274	0.839							
CM	0.362	0.269	0.856						
SI	0.398	0.273	0.424	0.857					
UPC	0.422	0.389	0.497	0.415	0.796				
HPC	0.326	0.254	0.430	0.414	0.415	0.776			
VOC	−0.247	−0.362	−0.265	−0.293	−0.382	−0.307	0.755		
CI	0.271	0.280	0.291	0.347	0.408	0.378	−0.401	0.764	
INT	0.301	0.292	0.521	0.361	0.334	0.334	−0.293	0.341	0.874

The diagonal elements are the square roots of AVEs.

Table 4 | The goodness of fit indices for the measurement model and research model

Model	X^2	X^2/df	AGFI	TLI	CFI	RMR	RMSEA
Measurement model	313.103	1.355	0.906	0.981	0.984	0.039	0.032
Research model	373.811	1.584	0.892	0.969	0.973	0.072	0.042
Recommended criteria	–	<3	>0.9	>0.9	>0.9	<0.05	<0.1

standard deviations between 0.72 and 1.09. Notably, the mean scores for utilitarian performance confirmation (UPC) and hedonic performance confirmation (HPC) both exceeded 4, suggesting that users hold a very positive view of the game. In addition, the level of multicollinearity between the independent variables in the table is low, with all VIF values below 3 considered not to be a problem of multicollinearity[90].

Composite reliability (CR) and average variance extracted (AVE) were used to assess convergent validity. According to Fornell and Larcker, the average variance extracted should be more than 0.50, and the composite reliability for all constructs must be at least 0.70[89]. In this study, all nine components met both requirements (Table 2). The square root of the average variance extracted (AVE) must be greater than the correlation coefficients between the relevant item and other components in order to demonstrate discriminant validity[91]. By meeting this criterion, the measurement model showed good discriminant validity (Table 3).

Furthermore, the fit of the measurement model ($X^2 = 313.103$, X^2/df = 1.355, TLI = 0.981, CFI = 0.984, RMR = 0.039, RMSEA = 0.032) was deemed satisfactory based on the criteria established by F. Hair Jr et al.[92] (Table 4).

The structural model

Structural equation modelling (SEM) was used to validate the research model. With χ^2/df = 1.584, AGFI = 0.892, TLI = 0.969, CFI = 0.973, RMR = 0.072, and RMSEA = 0.042, the model's fit was deemed adequate (Table 4). According to the test, all eight of the remaining hypotheses were supported, with the exception of H2 and H4 (Table 5). The results confirmed hypotheses H1 and H3 by showing that System Quality ($\beta = 0.207$, $P = 0.000$) and Information Quality ($\beta = 0.214$, $P = 0.001$) are positively correlated with utilitarian performance confirmation. Critical mass exhibited a significant positive association with both utilitarian and hedonic performance confirmations (UPC and HPC) ($\beta = 0.266$, 0.194; $P = 0.000$), supporting hypotheses H5 and H6. Social interaction was positively associated with UPC and HPC ($\beta = 0.132$, 0.155; $P = 0.003$, 0.000), providing support for hypotheses H7 and H8. The results show that UPC and HPC with Continuous Intention are positively correlated ($\beta = 0.385$, 0.486; $P = 0.000$). H2 and H4 were rejected because neither Information Quality ($\beta = 0.095$, $P = 0.076$) nor System Quality ($\beta = 0.062$, $P = 0.122$) showed a significant correlation with HPC. This lack of correlation may stem from respondents' familiarity with the game, which could lower the impact of system and information quality on their hedonic perceptions.

The moderating effects analysis

A moderation analysis was performed using bootstrapping procedures to examine the moderating effects of cultural identity (CI) and value co-creation(VOC) on the relationships between utilitarian and hedonic performance confirmations (UPC and HPC) and the continuous intention(INT) to use digital ICH games. This study used Hayes' recommended bootstrapping method to test the moderating effect (with 5000 iterations)[93] and set the confidence interval for indirect effects to 95%[94]. The PROCESS macro in SPSS was utilised to test hypotheses H11 and H12.

Table 6 presents the results of the PROCESS analysis. The relation between cultural identity (CI) and utilitarian performance confirmation (UPC)/hedonic performance confirmation (HPC) was significantly associated with continuous intention (INT) ($\beta = 0.165$ and 0.116; $p = 0.005$ and 0.049, respectively). This indicates that regression coefficients of the independent variables (UPC and HPC) on the dependent variable (INT) rise by 0.165 and 0.116 units, respectively, for each unit increase in the moderating variable CI. The moderating role of cultural identity (CI) was confirmed.

We also calculated the effects at low and high levels of cultural identity (CI) based on the results (Table 7). The conditioning values for the variables were set at the 16th, 50th, and 84th percentiles. Compared to low CI levels, the effect of the independent variables on the dependent variable is significantly heightened at high CI levels. Thus, Hypothesis 11 was supported. However, the interaction between value co-creation (VOC) and utilitarian performance confirmation (UPC)/hedonic performance confirmation (HPC) was not significantly associated with continuous intention (INT) ($\beta = -0.067$ and -0.537; $p = 0.244$ and 0.353, respectively), indicating that the moderating role of value co-creation(VOC) was not present, thus rejecting Hypothesis H12.

In addition, in order to clearly show the moderating effect of CI and the non-moderating effect of VOC in the paths of the HPC and the UPC to INT, this study plotted the simple slope chart between the independent and

Table 5 | The results of structural equation modelling path

Hypotheses	Hypothesised path	*B*	*β*	SE	*t*	Result
H1	IQ → UPC	0.214	0.205	0.062	3.446**	Supported
H2	IQ → HPC	0.095	0.115	0.054	1.774	Rejected
H3	SQ → UPC	0.207	0.237	0.047	4.419***	Supported
H4	SQ → HPC	0.062	0.090	0.040	1.547	Rejected
H5	CM → UPC	0.266	0.351	0.045	5.941***	Supported
H6	CM → HPC	0.194	0.323	0.039	4.948***	Supported
H7	SI → UPC	0.132	0.179	0.044	2.982**	Supported
H8	SI → HPC	0.155	0.264	0.039	3.944***	Supported
H9	HPC → INT	0.385	0.289	0.086	4.473***	Supported
H10	UPC → INT	0.486	0.290	0.110	4.405***	Supported
Moderation	**Coeff**	**LLCI**	**ULCI**	***P***		
H11a	CI*UPC → INT	0.165	0.0499	0.2805	0.005**	Supported
H11b	CI*HPC → INT	0.116	0.0003	0.2308	0.049*	Supported
H12a	VOC*UPC → INT	−0.067	−0.1793	0.0457	0.244	Rejected
H12b	VOC*HPC → INT	−0.0537	−0.1673	0.0599	0.353	Rejected

B unstandardised coefficient, *β* standardised coefficient.
***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

dependent variables at different levels of two moderators, based on 1 standard deviation above and below the mean, respectively (Figs. 3 and 4).

Based on the above verification, all the results of the hypothesis test are shown in Fig. 5.

Discussion

The above results show that information quality and system quality have a positive impact on users' utilitarian performance confirmation, while they have no impact on users' hedonic performance confirmation. This is in line with the findings of Koivumaki and Kesti[95] and Kim and Han[96] and is also supported by the relations presented by the Expectation confirmation theory (ECT) and flow theory. Expectation confirmation theory (ECT) emphasises that users compare their actual experience with their psychological expectations[97]. In the context of ICH games, clear instructions (information quality) and smooth operation (system quality) make the ICH game easier to play, thereby confirming the users' utilitarian expectations. Previous research indicates that information and system quality may possess only a tool attribute, ensuring users receive relevant services[98]; thus, they may not facilitate users' emotional changes or perceived enjoyment[96]. In addition, flow theory also indicates that users' hedonic expectations arise from sensory or emotional stimulation, which relies more on interactive mechanisms (such as social interaction or competition)[99] and flow states (experiences of overcoming challenges)[100]than on information or system functionality alone[101]. Thus, in the context of ICH digital games, information and system quality solely ensure effective game task completion and the transmission of ICH information. The above analysis suggests that the development of ICH digital games cannot rely solely on optimising the game system and information qualities while neglecting user–user interactions and user–ICH element interactions, otherwise, it will be difficult to enhance users' hedonic expectation confirmation. Additionally, the lack of impacts of system quality and information quality on hedonic performance confirmation may be due to the data being largely collected from users who are familiar with the game. In the early stages of adoption, system quality may significantly influence hedonic perception. However, as users gain familiarity with the game, the significance of its contribution to visual appeal decreases[102,103]. Further research could investigate whether users' familiarity with digital ICH games affects their perceptions of system and information quality, as well as the effects of these perceptions on hedonic performance confirmation.

The results confirm that critical mass significantly impacts both utilitarian and hedonic performance confirmation. This finding aligns with the research conducted by Chang et al.[72], which indicates that as gamers perceive the behaviours of a broader network, they are more influenced by these behaviours, thereby affecting their cognitive state and increasing their intention to continue playing. Additionally, we found that social interaction significantly influences both utilitarian and hedonic performance confirmation. The findings of Chang et al.[72] and Liew et al.[104] are corroborated by this result, which shows that consistent participation and engagement enhance people's emotional bond with their goals. According to Li et al. this phenomenon is particularly apparent in the digital gaming environment, where players interact with members of social media groups to gather and disseminate information about the game[105].

The results also indicate that both utilitarian and hedonic performance confirmations significantly influence the continuous intention to use digital ICH games. These findings align with those of Qiu et al., Jiang et al. and Bai et al.[3,4,26]. They suggest that ICH games should enhance users' perceived usefulness and perceived ease of use—two key utilitarian aspects—while also boosting the perceived entertainment value to foster continuance intention. A study on another mobile service also confirmed this relationship[55]. Collectively, these studies imply that ICH gamers have both hedonic and utilitarian perceptions, stimulating their continuous usage.

The findings of this study indicate that cultural identity plays a positive role in moderating the relationship between both utilitarian and hedonic performance confirmations and continuous intention. This suggests that the influences of both confirmations are amplified when ICH gamers have a more announced sense of cultural identity. Bai et al found that cultural identity is an important environmental stimulus[26]. However, we posit that cultural identity serves as a positive moderator because it often stems not from the game itself but from users' cognitive processes. Additionally, the moderating effect of cultural identity may be influenced by the relatively younger age of the respondents. Generation Z and millennials are two distinct demographic groups that exhibit a strong appreciation for culture[106], while digital ICH games provide them with a platform for understanding ICH.

Earlier investigations within the domain of cultural heritage handicrafts have recognised value co-creation as an important factor[30]. However, our findings confirmed that there was no moderating effect of value co-creation between utilitarian and hedonic performance confirmation and continuous intention. This may be due to the complexity of the cognitive

Table 6 | The moderation effect of CI and VOC between UPC and HPC

Variable	Dependent variable: continuous intention(INT)			
	β	Se	*t*	*p*
Utilitarian performance confirmation (UPC)	−0.079	0.155	−0.5-10	0.6-11
Cultural identity (CI)	−0.899	0.244	−3.6-76	0.0-00
UPC × CI	0.165	0.059	2.819	0.0-05
R^2			0.163	
F			21.7-46	
Hedonic performance confirmation (HPC)	0.113	0.156	0.724	0.4-70
Cultural identity (CI)	−0.730	0.249	−2.9-30	0.0-04
HPC × CI	0.116	0.059	1.972	0.0-49
R^2			0.161	
F			21.4-41	
UPC	0.544	0.233	2.340	0.0-20
Value co-creation (VOC)	0.584	0.226	2.581	0.0-10
UPC × VOC	−0.067	0.057	−1.1-68	0.2-44
R^2			0.165	
F			22.0-52	
HPC	0.549	0.236	2.322	0.0-21
Value co-creation (VOC)	0.546	0.233	2.350	0.0-19
HPC × VOC	−0.054	0.058	−0.9-30	0.3-53
R^2			0.168	
F			22.4-40	

load required for the virtual interactions. Weinert et al examined the relationship between cognitive load and value co-creation in the field of online learning. A co-creation system was built to facilitate learners in collaboratively creating learning materials, considering cognitive load (CL) and promoting value co-creation in knowledge development[107].In this context, users' perceptions of value co-creation are affected by cognitive load while completing a task stream; complex tasks may result in cognitive overload during this process. Since the emotional mechanics of gamification and value co-creation through experiences have been poorly studied[108], the findings from the study exploring the relationship between cognitive load and value co-creation in the online learning context offer additional insights into users' perceptions of the complexity of the value co-creation process. Moreover, in the context of digital ICH games, it seems that user perception of value co-creation is not easy to achieve. Regardless of how impressive and innovative the virtual 3D models or ICH elements may be, players might remain focused on self-worth fulfilment, particularly self-creativity. The user's perception of value co-creation may only be recognised when the cultural elements align perfectly with the user's cultural uniqueness. Future research could investigate whether the liveliness and interactivity of games can enhance users' appreciation of cultural uniqueness, potentially positively influencing their perception of value co-creation.

Our primary theoretical contribution to digital ICH game research lies in extending the focus from technology acceptance to encompass social dimensions. Furthermore, this study offers insights into understanding cultural identity within the ICH gaming context, providing empirical guidance for developing digital ICH games from cultural perspectives. This study employs the SOR model, incorporating game quality factors, social factors (critical mass and social interaction), and cultural factors (cultural identity; value co-creation), thereby enriching the existing literature on digital ICH games. This study offers crucial insights for future research on the creation and design of ICH games by examining utilitarian and hedonic perceptions as equally significant aspects influencing players' continuing intention, which is different from the conventional perspective of serious games in the ICH context.

Our findings could be further applied to the development of other digital ICH games. First, the cultural elements from the case study are notably representative, and we examined and discussed two general external stimuli influencing users' continuous intention—game quality and social interaction—along with two main perceptions of ICH gamers, ensuring the broad applicability of the results within the context of ICH games. The results may be applicable in various cultural contexts; however, it is essential that cross-cultural comparisons are conducted to validate these findings in future research.

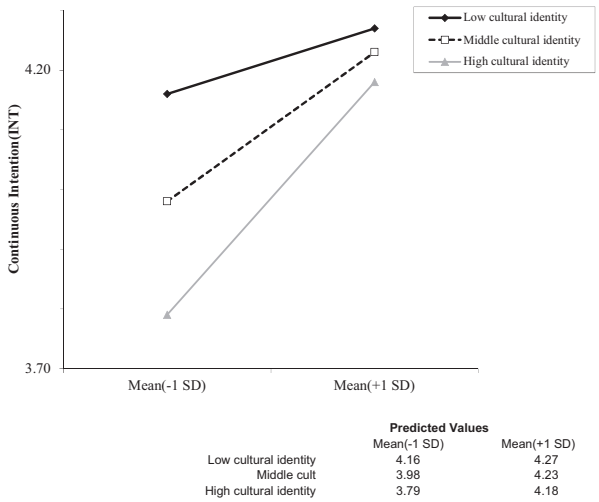
The findings yield several recommendations: First, it is common for game developers to use engaging narratives and compelling audio–visual designs to enhance interactions between users and ICH content, but they are likely to overlook the significance of user-to-user interactions. The findings of this study highlight the positive impact of social factors within the context of ICH games. Thus, developers should modify game mechanics to enhance user-to-user interactions, providing opportunities for users to share ICH knowledge with one another, thereby indirectly promoting the transmission of ICH. Second, the design team must honour the traditions of ICH and avoid excessive gamification or alteration of ICH elements to foster a more authentic cultural identity among users. This can positively influence users' willingness to engage with the game. Finally, for educators and practitioners using ICH games for ICH preservation and learning, they need to establish game-related ICH discussion platforms, as this can bridge the knowledge gaps between cross-cultural users. Enhancing cross-cultural users' appreciation of local culture will effectively increase their willingness to use the game and help them better understand ICH content.

This study still has limitations. First, the research collected data only from a single game, Master of Pottery. While the case study is representative, digital ICH games of the same type can still exhibit significant variability. Second, while the recruited users in this study had culturally diverse backgrounds, they all came from the same country. This may lead to a reduced applicability of the research findings in cases of different countries. Third, although we established a recruitment threshold for players with Master of Pottery gaming experience, differences in digital literacy among participants may influence their engagement with the game and ultimately affect the results.

Based on the above limitations, future research could focus on the following two aspects: First, the applicability of the research findings should be further clarified, and subsequent work should be compared in a cross-cultural context by selecting different cases. This may help us better understand the mechanism of cultural identity. Additionally, future research should expand the sample size or explore alternative data collection methods. For instance, analysing users' behavioural data, such as activity logs from in-game play, could further validate the accuracy of this study's findings.

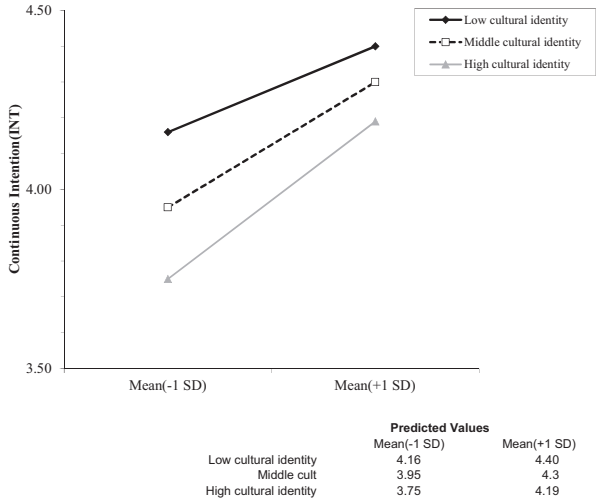
Table 7 | Conditional effects of the focal predictor at high and low levels of the moderator cultural identity (CI).

Moderator	Independent Variable	Dependent variable: INT					
		Level	Effect	Se	*t*	Boot 95% LLCI	Boot 95% ULCI
CI	UPC	High	0.362	0.068	5.340	0.229	0.495
		Low	0.142	0.090	1.567	−0.036	0.319
	HPC	High	0.421	0.077	5.453	0.269	0.573
		Low	0.267	0.096	2.799	0.079	0.455



Predicted Values	Mean(-1 SD)	Mean(+1 SD)
Low cultural identity	4.16	4.27
Middle cult	3.98	4.23
High cultural identity	3.79	4.18

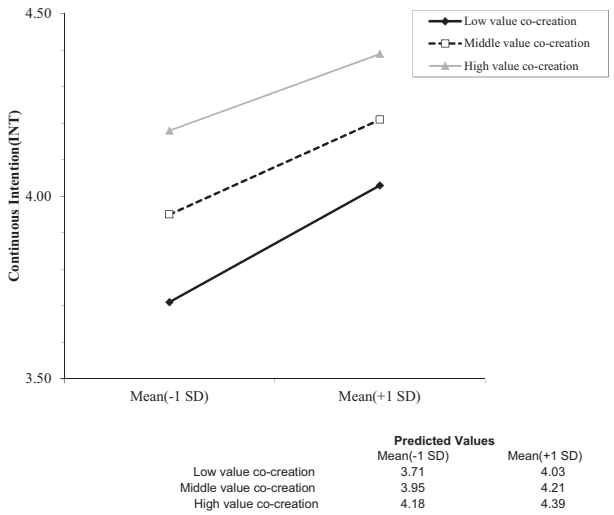
(a)



Predicted Values	Mean(-1 SD)	Mean(+1 SD)
Low cultural identity	4.16	4.40
Middle cult	3.95	4.3
High cultural identity	3.75	4.19

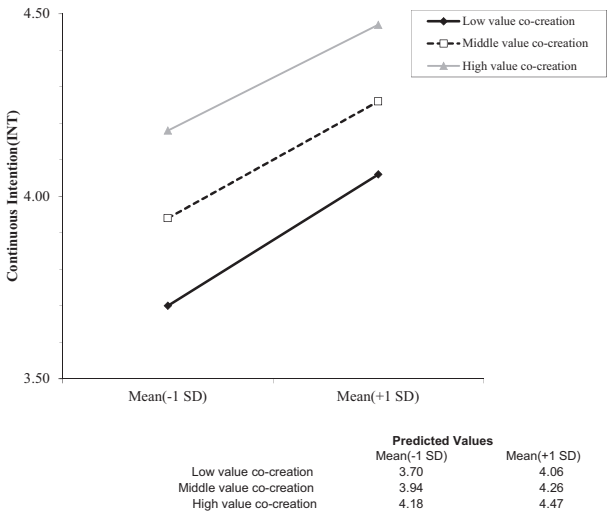
(b)

Fig. 3 | Simple slope of the moderating effect of cultural identity. a UPC × INT, **b** HPC × INT;| **a** The slope of the utilitarian performance confirmation (UPC) changes more dramatically at high levels of the moderator variable Cultural Identity (CI) and appears flatter at low levels of CI. The straight line slopes from the lower left to the upper right, indicating a positive moderating effect of CI between UPC and continuous intention (INT). **b** The slope of the hedonic performance confirmation (HPC) changes more dramatically at high levels of the moderator variable cultural Identity (CI) and appears less sharply at low levels of CI. The straight line also slopes from the lower left to the upper right, indicating a positive moderating effect of CI between HPC and continuous intention (INT).



Predicted Values	Mean(-1 SD)	Mean(+1 SD)
Low value co-creation	3.71	4.03
Middle value co-creation	3.95	4.21
High value co-creation	4.18	4.39

(a)



Predicted Values	Mean(-1 SD)	Mean(+1 SD)
Low value co-creation	3.70	4.06
Middle value co-creation	3.94	4.26
High value co-creation	4.18	4.47

(b)

Fig. 4 | Simple slope of the moderating effect of value co-creation. a UPC × INT and **b** HPC × INT;| Although the straight lines in **a** and **b** slope from the lower left to the upper right, there is no significant trend in the slope changes at both high and low levels of the moderating variable (VOC).

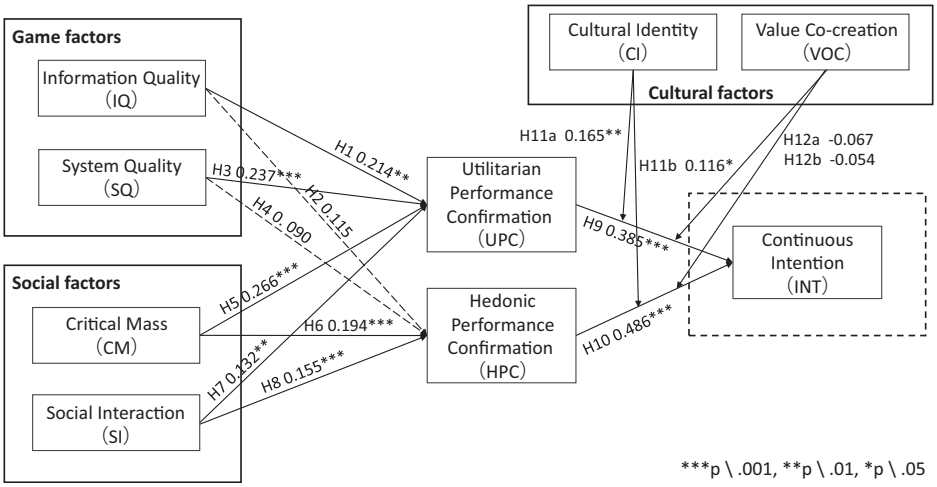


Fig. 5 | The results of the research model ($n = 338$). The results of the hypothesis validation for this structural equation model are shown in this figure. System quality ($\beta = 0.207$, $P = 0.000$) and Information Quality ($\beta = 0.214$, $P = 0.001$) are positively correlated with utilitarian performance confirmation. Neither information quality ($\beta = 0.095$, $P = 0.076$) nor system quality ($\beta = 0.062$, $P = 0.122$) showed a significant correlation with HPC. This suggests that game quality did not lead to psychological changes in players' hedonic performance confirmations; however, it was positively correlated with their utilitarian performance confirmations. Both social factors influence players' confirmations of hedonic and utilitarian performance ($\beta = 0.266$, 0.194; $P = 0.000$) ($\beta = 0.132$, 0.155; $P = 0.003$, 0.000). Collectively, these two performance confirmations affect players' willingness to continue using the game ($\beta = 0.385$, 0.486; $P = 0.000$). Cultural identity significantly moderated the relationship between users' two performance confirmations and their continued use ($\beta = 0.165$ and 0.116; $p = 0.005$ and 0.049, respectively), while value co-creation demonstrated no moderating effect ($\beta = -0.067$ and -0.537; $p = 0.244$ and 0.353, respectively).

Data availability

Data is provided within the supplementary information files.

Abbreviations

SOR	stimulus–organism–response
ICH	intangible cultural heritage
AR	augmented reality
ECT	expectancy confirmation theory
SQ	system quality
IQ	information quality
CM	critical mass
SI	social interaction
UPC	utilitarian performance confirmation
HPC	hedonic performance confirmation
CI	cultural identity
VOC	value co-creation
INT	continuous intention
VIFs	variance inflation factors
SEM	structural equation modelling
CFA	confirmatory factor analysis
AVE	average variance extracted
CR	composite reliability
X2	Chi-square test
df	degree of freedom
TLI	Tucker–Lewis index
CFI	comparative fit index
RMSEA	root mean square error of approximation

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References

1. Sousa, I. C. D. *Culture as a Play: Johan Huizinga 'Homo Ludens'*. (Macao Polytechnic University, 2014).
2. Goh, E., Al-Tabbaa, O. & Khan, Z. Unravelling the complexity of the video game industry: an integrative framework and future research directions. *Telemat. Inform. Rep.* **12**, 100100 (2023).
3. Qiu, T., Li, H., Chen, Y., Zeng, H. & Qian, S. Continuance intention toward VR games of intangible cultural heritage: a stimulus–organism–response perspective. *Virtual Real.* **28**, 149 (2024).
4. Jiang, Y., Zhan, Q. & Pashkevych, K. Exploring the key factors influencing the continuance use of serious games of intangible cultural heritage. *Int. J. Hum.–Comput. Interact.* 1–14 (2025).
5. Capecchi, I., Bernetti, I., Borghini, T., Caporali, A. & Saragosa, C. Augmented reality and serious game to engage the alpha generation in urban cultural heritage. *J. Cult. Herit.* **66**, 523–535 (2024).
6. Zhang, Y., Sun, Z. & Guo, S. Exploration of "ICH+ digital game" mode under the threshold of culture and tourism integration. In *Lecture Notes in Computer Science,* Vol. 14719 (eds Streitz, N. A. & Konomi, S.) 153–171 (Springer, Cham, 2024).
7. Ping Ting, M. & Dong Min, C. What drives user churn in serious games? An empirical examination of the TAM, SOR theory, and game quality in Chinese cultural heritage games. *Entertain. Comput.* **52**, 100758 (2025).
8. Cui, C., Zhao, Y. & Wang, L. Protection and dissemination of Chinese intangible cultural heritage based on digital games. In *Int. Commun. Chin. Cult.* Vol. 8 (ed. Huang, H.) 483–491 (Springer Nature, 2021).
9. Alivizatou-Barakou, M. et al. Intangible cultural heritage and new technologies: challenges and opportunities for cultural preservation and development. In *Mixed Reality and Gamification for Cultural Heritage* 129–158 (2017).
10. Kara, N. A mixed-methods study of cultural heritage learning through playing a serious game. *Int. J. Hum.–Comput. Interact.* **40**, 1397–1408 (2024).
11. Mortara, M. et al. Learning cultural heritage by serious games. *J. Cult. Herit.* **15**, 318–325 (2014).
12. Zhao, S., Wang, L. & Zhang, M. Research on serious game design based on the dissemination of intangible cultural heritage: a case study of Tu nationality's plate embroidery. *Desicion Explor.* **09**, 24–25 (2020).
13. Caspani, S., Brumana, R., Oreni, D. & Previtali, M. Virtual museums as digital storytellers for dissemination of built environment: possible narratives and outlooks for appealing and rich encounters with the

past. *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **42**, 113–119 (2017).
14. Lim, X.-J., Cheah, J.-H., Ng, S. I., Kamal Basha, N. & Liu, Y. Are men from Mars, women from Venus? Examining gender differences towards continuous use intention of branded apps. *J. Retail. Consum. Serv.* **60**, 102422 (2021).
15. Nikhashemi, S., Knight, H. H., Nusair, K. & Liat, C. B. Augmented reality in smart retailing: *a*(*n*) (*A*) symmetric approach to continuous intention to use retail brands' mobile AR apps. *J. Retail. Consum. Serv.* **60**, 102464 (2021).
16. Deacon, H.*Convention for the Safeguarding of the Intangible Cultural Heritage* (UNESCO, 2003).
17. Cominelli, F. & Greffe, X. Intangible cultural heritage: safeguarding for creativity. *City Cult. Soc.* **3**, 245–250 (2012).
18. Bortolotto, C. & Skounti, A. *Intangible Cultural Heritage and Sustainable Development* Vol. 1 (Routledge, 2023).
19. Dangol, S., Dangal, M. R. & Dangal, M. Community participation in identifying, inventorying, managing, and safeguarding intangible cultural heritage (ICH) in Nepal. *Open J. Anthropol. Stud.* **8**, 57–66 (2024).
20. Shi, M. Research on value-increment of the intangible cultural heritage industrial chain reactivation based on value co-production. *Ecol. Rev. J.* **12**, 118–124 (2022).
21. Cunha, C. R., Mendonça, V., Morais, E. P. & Carvalho, A.*The Role of Gamification In Material and Immaterial Cultural Heritage* (International Business Information Management Association (IBIMA), 2018).
22. Dagnino, F. M. et al. Designing serious games for ICH education. *Digit. Herit.* **2**, 615–618 (2015).
23. Grammatikopoulou, A. et al. An adaptive framework for the creation of exergames for intangible cultural heritage (ICH) education. *J. Comput. Educ.* **6**, 417–450 (2019).
24. Dagnino, F. M., Pozzi, F., Cozzani, G. & Bernava, L. Using serious games for intangible cultural heritage (ICH) education: a journey into the canto a tenore singing style. *Spec. Sess. Comput. Vis. Imaging Comput. Graph. Cult. Appl.* **6**, 429–435 (2017).
25. Plecher, D. A. et al. HieroQuest—a serious game for learning Egyptian Hieroglyphs. *J. Comput. Cult. Herit.* **13**, 1–20 (2020).
26. Bai, Y., Wu, S., Liu, R. & Zheng, F. Understanding users' behavior intention of serious games for intangible cultural heritage based on the stimulus–organism–response model. *Int. J. Hum.–Comput. Interact.* **41**, 5137–5149 (2024).
27. Meng, M. & Qinghua, Z. Construction and empirical research of user experience model for mobile visual search. *Libr. Inf. Serv.* **66**, 80–92 (2022).
28. Feng, H. The application of digital technology in the protection and inheritance of intangible cultural heritage. In *Proc. International Conference on Arts and Humanities.* Vol. 11 (ed. Tsabary, E.) 1–13 (TIIKM, 2024).
29. Wang, H. et al. Gamifying cultural heritage: exploring the potential of immersive virtual exhibitions. *Telemat. Inform. Rep.* **15**, 100150 (2024).
30. Hu, X., Au, N. & Xia, R. The impact of mobile augmented reality on the purchase intention of intangible cultural heritage handicrafts. *J. China Tour. Res.* **21**, 156–190 (2025).
31. Jung, T. H. & Tom Dieck, M. C. Augmented reality, virtual reality and 3D printing for the co-creation of value for the visitor experience at cultural heritage places. *J. Place Manag. Dev.* **10**, 140–151 (2017).
32. Theodoropoulos, A. & Antoniou, A. VR games in cultural heritage: a systematic review of the emerging fields of virtual reality and culture games. *Appl. Sci.* **12**, 8476 (2022).
33. Woodward, W. R. The" discovery" of social behaviorism and social learning theory, 1870–1980. *Am. Psychol.* **37**, 396 (1982).
34. Russell, J. A. & Mehrabian, A. Distinguishing anger and anxiety in terms of emotional response factors. *J. Consult. Clin. Psychol.* **42**, 79–83 (1974).
35. Sherman, E., Mathur, A. & Smith, R. B. Store environment and consumer purchase behavior: mediating role of consumer emotions. *Psychol. Mark.* **14**, 361–378 (1997).
36. Gatautis, R., Vitkauskaite, E., Gadeikiene, A. & Piligrimiene, Z. Gamification as a mean of driving online consumer behaviour: SOR model perspective. *Eng. Econ.* **27**, 90–97 (2016).
37. Helmefalk, M. & Marcusson, L. Gamification in a servicescape context: a conceptual framework. *Int. J. Internet Mark. Advert.* **13**, 22–46 (2019).
38. Triantoro, T., Gopal, R., Benbunan-Fich, R. & Lang, G. Would you like to play? A comparison of a gamified survey with a traditional online survey method. *Int. J. Inf. Manag.* **49**, 242–252 (2019).
39. Nguyen, T. B. T., Le, T. B. N. & Chau, N. T. How VR technological features prompt tourists' visiting intention: an integrated approach. *Sustainability* **15**, 4765 (2023).
40. Han, S.-L., Kim, J. & An, M. The role of VR shopping in digitalization of SCM for sustainable management: application of sor model and experience economy. *Sustainability* **15**, 1277 (2023).
41. Benlian, A. It feature use over time and its impact on individual task performance. *J. Assoc. Inf. Syst.* **16**, 2 (2015).
42. Chesney, T. & Lawson, S. Critical mass and discontinued use of social media. *Syst. Res. Behav. Sci.* **32**, 376–387 (2015).
43. Hsiao, C.-H. & Tang, K.-Y. Who captures whom—pokémon or tourists? A perspective of the stimulus–organism–response model. *Int. J. Inf. Manag.* **61**, 102312 (2021).
44. Veeramootoo, N., Nunkoo, R. & Dwivedi, Y. K. What determines success of an e-government service? Validation of an integrative model of e-filing continuance usage. *Gov. Inf. Q.* **35**, 161–174 (2018).
45. Caserman, P. et al. Quality criteria for serious games: serious part, game part, and balance. *JMIR Serious Games* **8**, e19037 (2020).
46. Zhang, G., Chen, X., Law, R. & Zhang, M. Sustainability of heritage tourism: a structural perspective from cultural identity and consumption intention. *Sustainability* **12**, 9199 (2020).
47. Braun, E., Kavaratzis, M. & Zenker, S. My city—my brand: the different roles of residents in place branding. *J. Place Manag. Dev.* **6**, 18–28 (2013).
48. DeLone, W. H. & McLean, E. R. Information systems success: the quest for the dependent variable. *Inf. Syst. Res.* **3**, 60–95 (1992).
49. Sharma, S. K. & Sharma, M. Examining the role of trust and quality dimensions in the actual usage of mobile banking services: an empirical investigation. *Int. J. Inf. Manag.* **44**, 65–75 (2019).
50. Duan, J. From awareness to behaviour: factors affecting the continued usage intention of adolescent gamers in the innovation diffusion path. *J. Shanxi Youth Vocat. College.* **35**, 24–31 (2022).
51. Gao, L., Waechter, K. A. & Bai, X. Understanding consumers' continuance intention towards mobile purchase: a theoretical framework and empirical study—a case of China. *Comput. Hum. Behav.* **53**, 249–262 (2015).
52. Zhou, W., Tsiga, Z., Li, B., Zheng, S. & Jiang, S. What influence users' e-finance continuance intention? The moderating role of trust. *Ind. Manag. Data Syst.* **118**, 1647–1670 (2018).
53. Yuan, S., Liu, L., Su, B. & Zhang, H. Determining the antecedents of mobile payment loyalty: cognitive and affective perspectives. *Electron. Commer. Res. Appl.* **41**, 100971 (2020).
54. Chen, W.-K., Chang, D.-S. & Chen, C.-C. The role of utilitarian and hedonic values on users' continued usage and purchase intention in a social commerce environment. *J. Econ. Manag.* **13**, 193–220 (2017).
55. Abbasi, G. A., Goh, Y. N., Iranmanesh, M. & Liebana-Cabanillas, F. Determinants of continuous intention to use retail apps: a hybrid pls–ann approach. *J. Mark. Theory Pract.* **32**, 413–434 (2024).
56. Marwell, G. & Oliver, P. *The Critical Mass in Collective Action* (Cambridge University Press, 1993).

57. Deutsch, M. & Gerard, H. B. A study of normative and informational social influences upon individual judgment. *J. Abnorm. Soc. Psychol.* **51**, 629 (1955).
58. Lou, H., Luo, W. & Strong, D. Perceived critical mass effect on groupware acceptance. *Eur. J. Inf. Syst.* **9**, 91–103 (2000).
59. Hsu, C.-L. & Lu, H.-P. Why do people play on-line games? An extended tam with social influences and flow experience. *Inf. Manag.* **41**, 853–868 (2004).
60. Yoo, J., Choi, S., Choi, M. & Rho, J. Why people use Twitter: social conformity and social value perspectives. *Online Inf. Rev.* **38**, 265–283 (2014).
61. He, Z., Shen, C., Shi, L. & Tanimoto, J. Impact of committed minorities: unveiling critical mass of cooperation in the iterated prisoner's dilemma game. *Phys. Rev. Res.* **6**, 013062 (2024).
62. Sun, T. et al. Restoring Dunhuang Murals: crafting cultural heritage preservation knowledge into immersive virtual reality experience design. *Int. J. Hum.–Comput. Interact.* **40**, 2019–2040 (2024).
63. Yoon, G., Duff, B. R. L. & Ryu, S. Gamers just want to have fun? Toward an understanding of the online game acceptance. *J. Appl. Soc. Psychol.* **43**, 1814–1826 (2013).
64. Wallace, W. L. Socialization after childhood: two essays. By Orville G. Brim, Jr. And Stanton Wheeler. New York: John Wiley & Sons, 1966. 116 Pp. $2.25. Paper. *Soc. Forces* **45**, 307–307 (1966).
65. Hew, J.-J. et al. Are online mobile gamers really happy? On the suppressor role of online game addiction. *Inf. Syst. Front.* **26**, 217–249 (2024).
66. Xie, Y., Su, M., Nie, X. & Li, X. Digital storytelling of intangible cultural heritage: a multimodal interactive serious game for teaching folk dance. In *Lecture Notes in Computer Science* Vol. 14717 (ed. Rauterberg, M.) 325–335 (Springer, Cham, 2024).
67. Shen, Y., Wu, Z., Fang, X. & Yue, W. Enhancing digital interaction with intangible cultural heritage: a study on user experience and acceptance of the Zhuhai intangible cultural heritage database. In *Communications in Computer and Information Science* Vol. 2116 (eds Stephanidis, C. et al.) 325–334 (Springer, Cham, 2024).
68. Vidaurre-Rojas, P. et al. A social media adoption strategy for cultural dissemination in municipalities with tourist potential: Lamas, Peru, as a case study. *Built Herit.* **8**, 12 (2024).
69. Overby, J. W. & Lee, E.-J. The effects of utilitarian and hedonic online shopping value on consumer preference and intentions. *J. Bus. Res.* **59**, 1160–1166 (2006).
70. Venkatesh, V., Thong, J. Y. & Xu, X. Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Q.* **36**, 157–178 (2012).
71. Javornik, A. et al. An experimental study on the role of augmented reality content type in an outdoor site exploration. *Behav. Inf. Technol.* **38**, 9–27 (2019).
72. Chang, I.-C., Liu, C.-C. & Chen, K. The effects of hedonic/utilitarian expectations and social influence on continuance intention to play online games. *Internet Res.* **24**, 21–45 (2014).
73. Wang, X., Goh, D. H.-L., Lim, E.-P. & Vu, A. W. L. Understanding the determinants of human computation game acceptance: the effects of aesthetic experience and output quality. *Online Inf. Rev.* **40**, 481–496 (2016).
74. Ye, X., Ruan, Y., Xia, S. & Gu, L. Adoption of digital intangible cultural heritage: A configurational study integrating UTAUT2 and immersion theory. *Humanit. Soc. Sci. Commun.* **12**, 23 (2025).
75. Sussman, N. M. The dynamic nature of cultural identity throughout cultural transitions: why home is not so sweet. *Personal. Soc. Psychol. Rev.* **4**, 355–373 (2000).
76. Zhuang, W. & Luo, X. The influence of domestic brand advertising strategy on new product diffusion: based on the role of cultural identity and self-expression. *Mark. Manag.* 87–90 (2022).
77. Swoboda, B., Pennemann, K. & Taube, M. The effects of perceived brand globalness and perceived brand localness in China: empirical evidence on Western, Asian, and Domestic Retailers. *J. Int. Mark.* **20**, 72–95 (2012).
78. Prahalad, C. & Ramaswamy, V. Co-creation experiences: the next practice in value creation. *J. Interact. Mark.* **18**, 5–14 (2004).
79. Liang, A. R.-D., Tung, W., Wang, T.-S. & Hui, V. W.-s The use of co-creation within the community-based tourism experiences. *Tour. Manag. Perspect.* **48**, 101157 (2023).
80. Chen, Z., King, B. & Suntikul, W. Co-creation of value for cultural festivals: behind the scenes in Macau. *Tour. Recreat. Res.* **45**, 430–444 (2020).
81. Panhale, T., Bryce, D. & Tsougkou, E. Augmented reality and experience co-creation in heritage settings. *J. Mark. Manag.* **39**, 470–497 (2023).
82. Guo, J., Xu, J. & Pan, Y. How do location-based AR games enhance value co-creation experiences at cultural heritage sites? A process perspective analysis. *Appl. Sci.* **14**, 6812 (2024).
83. Taptap. *The 2nd China Art Games Competition* https://www.taptap.cn/events/art-game/games (2022).
84. Choi, D. & Kim, J. Why people continue to play online games: in search of critical design factors to increase customer loyalty to online contents. *CyberPsychol. Behav.* **7**, 11–24 (2004).
85. Lee, M.-C. Understanding the behavioural intention to play online games. *Online Inf. Rev.* **33**, 849–872 (2009).
86. Lee, M.-C. & Tsai, T.-R. What drives people to continue to play online games? An extension of technology model and theory of planned behavior. *Int. J. Hum.–Comput. Interact.* **26**, 601–620 (2010).
87. Collier, J. *Applied Structural Equation Modeling using AMOS: Basic to Advanced Techniques* (Routledge, 2020).
88. Blunch, N. J. *Introduction to Structural Equation Modeling using IBM SPSS Statistics and AMOS* (Sage Publications Ltd, 2012).
89. Fornell, C. & Larcker, D. F. Structural equation models with unobservable variables and measurement error: algebra and statistics. *J. Mark. Res.* **18**, 382–388 (1981).
90. Bayman, E. O. & Dexter, F. Multicollinearity in logistic regression models. *Anesth. Analg.* **133**, 362–365 (2021).
91. Chin, W. W. Issues and opinion on structural equation modeling. *MIS Q.* **22**, 7–16 (1998).
92. Hair, J. F. Jr, Sarstedt, M., Hopkins, L. & Kuppelwieser, V. G. Partial least squares structural equation modeling (PLS-SEM) an emerging tool in business research. *Eur. Bus. Rev.* **26**, 106–121 (2014).
93. Igartua, J.-J. & Hayes, A. F. Mediation, moderation, and conditional process analysis: concepts, computations, and some common confusions. *Span. J. Psychol.* **24**, e49 (2021).
94. Hayes, A. F. Introduction to mediation, moderation, and conditional process analysis: a regression-based approach. In *Methodology in the Social Sciences* 3rd edn (The Guilford Press, New York, London, 2022).
95. Koivumäki, T., Ristola, A. & Kesti, M. The effects of information quality of mobile information services on user satisfaction and service acceptance—empirical evidence from Finland. *Behav. Inf. Technol.* **27**, 375–385 (2008).
96. Kim, B. & Han, I. The role of utilitarian and hedonic values and their antecedents in a mobile data service environment. *Expert Syst. Appl.* **38**, 2311–2318 (2011).
97. Hossain, M. A. & Quaddus, M. Expectation–confirmation theory in information system research: a review and analysis. In *Information Systems Theory: Explaining and Predicting Our Digital Society* Vol. 28 (eds Dwivedi, Y. et al.) 441–469 (Springer, New York, NY, 2012).
98. Zheng, Y., Zhao, K. & Stylianou, A. The impacts of information quality and system quality on users' continuance intention in information-exchange virtual communities: an empirical investigation. *Decis. Support Syst.* **56**, 513–524 (2013).

99. Liu, C.-C. A model for exploring players flow experience in online games. *Inf. Technol. People* **30**, 139–162 (2017).
100. Kim, Y. Y., Oh, S. & Lee, H. What makes people experience flow? Social characteristics of online games. *Int. J. Adv. Media Commun.* **1**, 76 (2005).
101. Gao, L. & Bai, X. An empirical study on continuance intention of mobile social networking services: integrating the is success model, network externalities and flow theory. *Asia Pac. J. Mark. Logist.* **26**, 168–189 (2014).
102. Larson, L. Visual fluency and the consumer experience: how image features alter preference and subjective familiarity. *Int. J. Image.* **2**, 199–210 (2012).
103. Van Der Spek, E. D., Sidorenkova, T., Porskamp, P. & Rauterberg, M. The effect of familiar and fantasy aesthetics on learning and experience of serious games. In *Entertainment Computing—ICEC 2014: 13th International Conference, ICEC 2014, Sydney, Australia,* October 1–3, 2014*. Proceedings,* 13, 133–138 (2014).
104. Liew, T. W., Gan, C. L., Tan, S.-M., Koh, Y. P. & Yeo, S. F. How social influence and hedonic/utilitarian outcome expectations affect continuance intention to play online games. In *2022 International Conference on Digital Transformation and Intelligence (ICDI)* (ed. Saidjadid, A.) 161–167 (IEEE, 2022).
105. Li, H., Liu, Y., Xu, X., Heikkilä, J. & Van Der Heijden, H. Modeling hedonic is continuance through the uses and gratifications theory: an empirical study in online games. *Comput. Hum. Behav.* **48**, 261–272 (2015).
106. Robaina-Calderín, L., Martín-Santana, J. D. & Muñoz-Leiva, F. Immersive experiences as a resource for promoting museum tourism in the *Z* and millennials generations. *J. Destin. Mark. Manag.* **29**, 100795 (2023).
107. Weinert, T., Billert, M., De Gafenco, M. T., Janson, A. & Leimeister, J. M. Designing a co-creation system for the development of work-process-related learning material in manufacturing. *Comput. Support. Coop. Work* **32**, 5–53 (2023).
108. García-Magro, C., Martín-Peña, M.-L. & Sánchez-López, J. M. Emotional mechanics of gamification and value co-creation: the digital platform nike+ as a b2b2c ecosystem. *J. Bus. Ind. Mark.* **38**, 414–428 (2022).

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Author contributions

Guanning Wang conceived this study, designed the research process, performed the statistical analysis, and drafted the main manuscript text. Delai Men supervised the research design, coordination, data analysis, and helped review and edit the original draft. Both authors read and approved the final manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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Correspondence and requests for materials should be addressed to Delai Men.

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