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EXPLORING THE INTENTION OF VISITING THE MUSEUM USING IMMERSIVE VIRTUAL REALITY TECHNIQUE AND FLOW EXPERIENCE

Shih-Han Wu*
Department of Industrial Management
I-Shou University, Kaohsiung, Taiwan, R.O.C
kwu8822@hotmail.com*
*Corresponding Author

Nai-Chieh Wei
Department of Industrial Management
I-Shou University, Kaohsiung, Taiwan, R.O.C
ncwei@isu.edu.tw

Hsiang-Chen Hsu
Department of Industrial Management
I-Shou University, Kaohsiung, Taiwan, R.O.C
hchsu@isu.edu.tw

Tse-Chun Pu
Department of Industrial Management
I-Shou University, Kaohsiung, Taiwan, R.O.C
pu.bruce@gmail.com

Abstract

With the rapid development of computer technology, human living style has been changed dramatically. In recent years, virtual reality (VR) has been widely used in entertainment, and its application has been applied to various field. As people's choices of leisure activities increased, traditional museum became less attractive and began to lose their tourists. The rise of the digital or virtual museum seems to be a solution for the digital age, but the traditional museum struggled to retain their visitors. The National Museum of Marine Biology and Aquarium (NMMBA) opened in 2000, and faced the same problem of visitor loss. They decided to enhance their visitor experiences by outsourcings. A marine-related VR theme space was created as a new attraction to the public. This study adopted Hedonic-Motivation System Adoption

Model (HMSAM), Flow Theory, and incorporate subjective well-being to investigate the revisit intention of the museum tourists who experienced the VR games. The results demonstrated perceived enjoyment had significant positive impact on immersion. In addition, both flow status and subjective well-being had significantly positive influence on user intention and immersion. Finally, the results of this study provide theoretical contributions, managerial implications for museum that might adopt Virtual Reality in the future.

Keywords: virtual reality; museum; Hedonic Motivation System Acceptance Model (HMSAM); flow theory; subjective well-being

Introduction

The history of modern museums is about 150 years. The museum boomed during the late 19th century in Europe. The purpose of museums is to collect, preserve, interpret, and display objects made available for public viewing through exhibitions that are permanent or temporary [1]. Good museums should be able to aide visitors in understanding information and context, and deepen their interest in the subjects that presented via an interaction in their short duration. Museums should also have feasible ways to present complex issues that are both informative and entertaining to the visitors with a wide variety of backgrounds, because visitors tend to be more interactive with museum if they have prerequisite knowledge, previous experiences, related interests or objectives to bond with [2].

The rise of the digital or virtual museum is a convenient or cheap solution for the audiences that are needless to travel and to visit the museum. In addition, with the prevail of Internet applications, people tend to more enjoy living in the cyberspace than walking outdoors. The change of lifestyle increases pressure on museums, so they widen their appeal to increase their competitive advantage with new ideas, in order to satisfy the needs and desires of visitors with a more diverse range [3].

The idea called “serious games” or “applied games” draw museums’ attention. The simulation games are more “serious” because they are designed to arouse the educational value brought by fun or competition such as defense, education, scientific exploration, medical care, and emergency management, urban planning, engineering, politics or other industries [4]. Through interacting with the game in a virtual world, the audience can obtain entertaining experience and be educated with embedded information [5].

The National Museum of Marine Biology and Aquarium (NMMBA) in Taiwan opened in 2000. In addition to the educational purpose, the museum contains an aquarium that has the largest underwater tunnel in Asia, and surrounded by an outdoor water park. Even though the NMMBA designed in 1991 was multi-functioned unlike other museums for single exhibition purpose only, it still faced a great challenge of tourists decreasing because of the growth of entertainment choices nowadays.

To solve this problem, NMMBA learned from the others museums to enhance their visitor experiences [6] by increasing its competitive advantage, and create its value by improving the quality of the visitor experience [7]. Since over a half of the visitors is under 22 years old, NMMBA decide to enhance the young visitors' experiences by outsourcing "serious games" [8]. Due to the original design and physical limitation of the NMMBA, it is very difficult for them to redesign or expand the inner space of the museum for the new display. Therefore, they created a new Virtual Reality (VR) theme space in a building next to the main entrance. Most VR games are marine related in the theme space, and the most popular one is the VR submarine with motion sense.

The hedonic motivation system has been accepted as a key theory to understand the impact on the audience and visitors of virtual reality experience. In the museum context, there are very little research to examine factors that can enhance visitor experience by using VR. In addition, there are limited studies on exploring users' flow state after they experienced VR games.

This study adopts the Hedonic-Motivation System Adoption Model (HMSAM) and Flow theory to understand how the antecedents (flow state and perceived enjoyment) impact the consequences (user intention and immersion) in museum visitors setting. The aim of this paper is to understand whether the visitor's experience of using VR will induce revisit intention to NMMBA.

Literature Review

Hedonic Motivation System Adoption Model (HMSAM)

Van der Heijden [9] pointed out Cognitive Absorption (CA) is a more effective factor than Perceived Ease of Use (PEOU) or joy to predict behavioral intention to use (BIU). In addition, the effect of PEOU on BIU is completely intervened by the CA. Based on the model of hedonic system adoption [9], Lowry et al. [10] proposed HMSAM. Grounded in flow-based cognitive absorption, HMSAM included Technology Acceptance Model (TAM) constructs such as perceived usefulness, perceived ease of use, and behavior intention to use, and other factors like curiosity, joy, control, and immersion.

HMSAM is particularly useful in the study of games. Researchers adopt HMSAM to understand importance and continuity of the online games [10][11]. Players who are immersed in online games will have a sense of entertainment, accomplishment, and pleasure if they can enter the next level. This repeating process will encourage players keep playing until to the goal. Similar, when users experienced VR games, HMSAM can explain why the users have fun [12]. After the users enjoyed the VR, they changed their attitude, which proves that the VR experience is a way of behavioral enjoyment [13].

Van Der Heijden [9] believes that sensation enjoyment refers to the degree of enjoyment that consumers get from hedonic technology systems. The relationship between enjoyment and personal technical performance to achieve the highest effectiveness of experience exchange is very important [14]. Keller et al. [15] found that enjoying an activity that requires challenging skills and tasks

brings a sense of inner flow. Moneta [16] found that the experience awareness of flow comes from the interactive enjoyment of personality attributes. For personal intrinsic motivation, the enjoyment of social media activities greatly affects the flow experience among users [17]. In the case of VR games, enjoyment has a great influence on the immersive flow state, which in turn affects the behavioral motivation to continue playing the games [18]. If the fun of the player increased during the VR game, the player will be immersed in the game and reached a higher flow state [10]. Jennett et al. [35] believe that immersion is the appearance that users enjoy the game. Immersion results from a good gaming experience. Liu et al. [36] argued that the visual effects embedded in the game will enhance user immersion and affect game entertainment and performance. Therefore, this study believes that when visitors use the VR games, their perceived enjoyment will affect immersion.

Based on the review above, the following hypothesis is proposed:

Hypothesis 1: Museum VR users' perceived enjoyment will have a significant positive effect on immersion.

Based on the review above, this study extended the HMSAM to include the flow state as a cognitive absorption factor to identify the influence of VR user behavior intention in the NMMBA.

Flow Theory

Csíkszentmihályi [19] described the flow state as the "optimal experience", and people can have a high degree of satisfaction from the experience [20]. However, to achieve this kind of satisfaction depends on each individual's ability. The ability and desire of individuals to overcome challenges to achieve their ultimate goals not only brings the best experience, but also brings overall life satisfaction.

Nakamura and Csíkszentmihályi [20] identified six characteristics when people experienced flow. There are concentrate on the present, the fusion of action and consciousness, loss of reflection, feeling of personal control or agency over the situation or activity, one's experience is distorted and experience of time is changed, and the experience of the activity is an inherent reward. Huang et al. [21] demonstrated a positive connection between VR tourists' participation, flow experience and their intentions. In addition, flow is a key factor in explaining consumer beliefs, attitudes and behaviors. Similarly, perceived enjoyment plays a key role in a flow state [22], so is the virtual games [18]. NMMBA wants to enhance their young visitors' experiences by using VR games. Thus, Flow theory has been adopted in this study.

Flow theory has been adopted to test user behavior in experiencing VR, and forming the theoretical framework of hedonism [23][24]. Therefore, flow theory is one of the most valuable tools for identifying personal experience, and the flow state is identified as the element in the relationship with other factors [21][25]. Therefore, this study believes that when the tourists enjoy VR games, their flow state will affect their perceived enjoyment. This study proposed the following hypothesis.

Hypothesis 2: Museum VR users' flow state will have a significant positive effect on perceived enjoyment.

Huang [26] found that the flow state had a significant impact on VR users' behavioral intentions. Therefore, this study proposed the following hypotheses.

Hypothesis 3: Museum VR users' flow state will have a significant positive effect on user intention.

Procci and Bowers [27] investigated the terms "flow" and "immersion" that were commonly mentioned in the game studies, and found that they were not overlapped in the game field. However, when Michailidis et al. [28] studied the video game players, they concluded that there is no significant difference between the "flow" and "immersion". Due to the controversy of the findings, this study wants to clarify whether the flow state is related to the immersion when tourists enjoy VR games. The following hypothesis is proposed.

Hypothesis 4: Museum VR users' flow state will have a significant positive effect on immersion.

Subjective well-being

Subjective well-being is a form of life satisfaction. Subjective well-being is one of the main reasons that users want to interact with the 3D virtual world in their VR experience [29]. When consumers entertain themselves, they hope they can experience subjective well-being or feel happiness. If the player cannot go outdoors, the VR game can bring player a sense of subjective well-being even he stays at home [30][31]. Veenhoven [32] believes that happiness, satisfaction and subjective well-being have the same meaning. Gavala and Flett [33] found that college students who feel stressed, uncomfortable, and have lower academic control will experience lower well-being, academic enjoyment, and motivation. Granow et al. [34] has proven the relationships among autonomy, media acceptance, media enjoyment, and well-being. Therefore, it is necessary to investigate the relationship between perceived enjoyment and subjective well-being when visitors enjoy VR games. The following hypothesis is proposed.

Hypothesis 5: Museum VR users' perceived enjoyment will have a significant positive effect on subjective well-being.

The study of Ma et al. [37] suggested that users' willingness to share is one of the important factors affecting subjective well-being. Cho et al. [38] studied the relationship among nostalgia, psychological input, subjective well-being, and travel intention. They found that the influence of nostalgia on travel intention was mediated by psychological input and subjective well-being, and subjective well-being had a significant impact on travel intention. Therefore, this study believes that when tourists enjoy VR games, their subjective well-being will affect their intentions. The following hypothesis is proposed.

Hypothesis 6: Museum VR users' subjective well-being will have a significant positive effect on behavior intention.

Wood and Smith [39] tried to understand the well-being of performers and listeners in concerts, and found that the happiness of the performers and listeners was enhanced as the they were immersed. Gaiswinkler et al. [40] studied the relationship between subjective well-being and physical health in yoga,

and found that yoga practitioners' immersion level is highly positively correlated with mindfulness, internal correspondence, and subjective well-being. Therefore, this study believes that when tourists enjoy VR games, their subjective well-being will affect immersion. The following hypothesis is proposed.

Hypothesis 7: Museum VR users' subjective well-being will have a significant positive effect on immersion.

The research model and proposed hypotheses were shown on Figure 1.

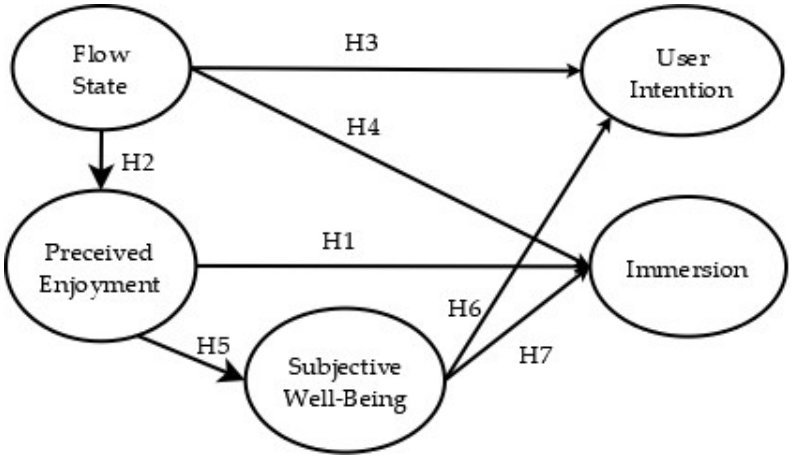

Figure 1 Research model

Research Methodology

To test the seven hypotheses above, a questionnaire is designed to measure and understand how museum tourists' flow state, perceived enjoyment, and subjective well-being can affect their behavior intention and immersion. For content validity, all the measurement items for each constrict were adopted from the previous studies. Constructs in HMSAM such as of perceived enjoyment, behavior intention, and immersion were adopted from Lowry et al., 2013. The flow state was modified from Csíkszentmihályi [41] and Nah et al. [42], and the subjective well-being was adopted from Diener et al. [43], and Ellison et al. [44]. Each item used seven-point Likert's scale, ranging from 1"strongly disagree" to 7"strongly agree".

A pilot study was performed by inviting experts to examine the questionnaire, to ensure the questionnaire validity. Formal investigation were conducted after tourists visited the VR theme space. Convenience sampling is adopted, and the collected data were analyzed by the SPSS 22 and the AMOS 22. After removing invalid questionnaires, the valid samples were 284.

Data Analysis And Results

Among respondents, 44.2% were male and 55.8% were female. Visitors aged under 23 were 55.2%. Most of them (68.6%) had experience of VR games before. Because the sample size exceeded 100, this study used the Maximum Likelihood Estimation (MLE) suggested by Hair et al. [45] to assure the observed data was most probable

under statistical model. This study used the measurement model to test item factor loading. None of the survey items were removed (as shown in Table 6) because their factor loadings were all above 0.5, as suggested by Hair et al [45].

According to Fornell and Larcker [46], a model exhibited convergent validity if the factor loadings were significant, Composite Reliability (CR) was 0.6 or above, and Average Variance Extracted (AVE) was 0.5 or larger. The research model met all the standards so convergent validity was proven, as shown in Table 1.

Table 1. The descriptive statistics, factor loadings, reliability, and AVE of all constructs

Construct	Item	Factor Loading	Composite Reliability	AVE
FS	FS1	0.902	0.912	0.723
	FS2	0.857		
	FS3	0.871		
	FS4	0.765		
PE	PP1	0.928	0.953	0.836
	PP2	0.918		
	PP3	0.914		
	PP4	0.896		
SWB	SWB1	0.850	0.949	0.823
	SWB2	0.922		
	SWB3	0.931		
	SWB4	0.924		
IMM	IMM1	0.893	0.954	0.838
	IMM2	0.925		
	IMM3	0.925		
	IMM4	0.918		
UI	UI1	0.912	0.945	0.851
	UI2	0.917		
	UI3	0.939		

In Table 2, Each construct' square root of AVE on the diagonal exceeded its standardized correlation coefficient outside the diagonal (each paired constructs), so the constructs in the research model exhibited discriminative validity, as suggested by Fornell and Larcker [46].

Table 2,. Correlation coefficient matrix and square root of AVE

	AVE	FS	PE	SWB	IMM	UI
FS	0.723	0.85				
PE	0.836	0.714	0.914			
SWB	0.823	0.485	0.679	0.907		
IMM	0.838	0.585	0.632	0.669	0.915	
UI	0.851	0.576	0.571	0.646	0.635	0.922

Note: FS=Flow State; PE=Perceived Enjoyment; SWB=Subjective Well-Being; IMM=Immersion; UI=User Intention

The tests of model fit determine how related actual values are to the predicted values in a model. Several model fits indicators and criteria suggested by previous studies [47][48][49] were presented in Table 3. All model fits indicators complied with the recommended standards, meaning the research model demonstrated a good model fit. Thus, the results which generated by the analysis of the collected data are proper for the future inference.

Table 3. Goodness-of-fit indices of Measurement and structural model

Model fit	Criteria	Model fit indicates
χ^2	Smaller the better	2237.781
Degree of freedom	Greater the better	646.000
Normed Chi-sqr	$1<\chi^2/df<3$	3.464
GFI	>=0.9	0.875
AGFI	>=0.9	0.864
RMSEA	<=0.08	0.079
SRMR	<=0.08	0.182
TLI	>=0.9	0.900
CFI	>=0.9	0.908

Note: Normed Chi-sqr= Chi-squared divided by Degrees of Freedom; GFI= goodness of fit index; AGFI=adjusted goodness of fit index; RMSEA=Root Mean Square Error of Approximation; SRMR=standardized root means square residual; TLI=Tucker-Lewis Index; CFI=Comparative-Fit Index

To examine the research hypothesis is to understand the degree of significance that the independent variables impact on the dependent variable in the research model. In SEM analysis, the power that independent variable can explain the dependent variable is called R^2. The larger the R^2 value, the better the power. If R^2 is greater than 0.670, it means good explanatory power. If R^2 falls between 0.330 and 0.670, it has acceptable explanatory power. If R^2 is less than 0.190, it has no explanatory power [50]. The results of hypotheses test results shown as Table 4. Even though all 7 research hy-

potheses were significant, only H2 and H5 had moderate explanatory power, and H6 and H7 had little explanatory power in the research model.

Besides investigate the direct effects, this study also examined the mediating effect among constructs. There are four mediating effects in the research model: 1. flow state affect subjective well-being through perceived enjoyment; 2. flow state affect immersion through perceived enjoyment and subjective well-being; 3. flow state affect user intention through perceived enjoyment and subjective well-being; 4.

Table 4. Test results of research hypotheses

Hypothesis	R^2	*p*	Result
H1: Perceived enjoyment has positive effect on immersion	0.018	0.041	supported
H2: Flow state has positive effect on perceived enjoyment	0.510	0.000	supported
H3: Flow state has positive effect on user intention	0.013	0.029	supported
H4: Flow state has positive effect on immersion	0.020	0.015	supported
H5: Perceived enjoyment has positive effect on subjective well-being	0.461	0.000	supported
H6: Subjective Well-being has positive effect on user intention	0.229	0.000	supported
H7: Subjective Well-being has positive effect on immersion	0.198	0.000	supported

Table 5. Tests of Mediating effects

Effect	Point Estimate	product of coefficients			Bootstrap 1000 times Bias-corrected 95%	
		S.E.	z-value	*p*-value	lower bound	upper bound
Total effect						
FS→SWB	0.494	0.07	6.95	0.00	0.361	0.631

		1	4	0		
Total indirect effect						
FS→PE→SWB	0.494	0.071	6.954	0.000	0.361	0.631
Total effect						
FS→IMM	0.471	0.095	4.946	0.000	0.306	0.669
Total indirect effect						
FS→PE→SWB→IMM	0.325	0.056	5.784	0.000	0.223	0.435
Specific indirect effect						
FS→PE→IMM	0.100	0.070	1.425	0.154	-0.056	0.229
FS→PE→SWB→IMM	0.224	0.059	3.813	0.000	0.127	0.373
Direct effect						
FS→IMM	0.146	0.086	1.704	0.088	0.030	0.360
Total effect						
FS→UI	0.369	0.106	3.482	0.000	0.183	0.579
Total indirect effect						
FS→PE→SWB→UI	0.249	0.061	4.082	0.000	0.147	0.394
Direct effect						
FS→UI	0.120	0.092	1.314	0.189	-0.051	0.306
Total effect						
PE→UI	0.345	0.077	4.466	0.000	0.215	0.528
Total indirect effect						
PE→SWB→UI	0.345	0.077	4.466	0.000	0.215	0.528

Perceived enjoyment affect user intention through subjective well-being. Table 5 lists the test results of the mediating effects.

Discussion

This study investigated the impact of museum tourists with different demographic characteristics on con-

structs such as flow state, perceived enjoyment, subjective well-being, user intention and immersion.

Gender or marital status had no significant differences in mind flow, perceived enjoyment, subjective well-being, immersion, and user intention. Age did not differ significantly in flow state, but were different in perceived enjoyment, subjective well-being, immersion, and intention to use, indicating that different age groups had different level of perceived enjoyment, subjective well-being, immersion, and user intention when enjoyed VR games. Therefore, museum should target the younger (age 12 and under) to enhance their visiting experience. Tourists with different education had no significant difference in flow state, subjective well-being, and user intention, but has significant differences in perceived enjoyment, and immersion, indicating that visitors with different education have different lever of perceived enjoyment, and immersion when experiencing VR games. Therefore, museum should focus on the tourists with higher education (college or above) to enhance their visiting experience. Tourists with different VR experience had no significant differences in subjective well-being, and intention to use, but there were significant differences in flow state, perceived enjoyment, and immersion, indicating that users with different VR experiences had different levels of flow status, perceived enjoyment, and immersion when enjoying the VR games. Therefore, museum should pay more attention on the tourists that had VR gaming experience to enhance their visiting experience.

This study examined the proposed hypotheses, and the results were as follows.

H1:Perceived enjoyment has a positive significant effect on immersion,
H2: flow state has a positive significant effect on perceived enjoyment,

H4: flow state has a positive significant effect on immersion,
H5:perceived enjoyment has a positive significant effect on subjective well-being,

H7:Subjective well-being has a positive significant effect on immersion.

All the above five hypotheses were supported, confirming the relationship between perceived enjoyment on subjective well-being [51], subjective well-being on immersion [52], and perceived enjoyment on immersion [36].

Since flow state is a useful tool for identifying emotional responses when individuals experience virtual reality [21][53], when tourists enjoyed VR games, the better their mind flow state, i.e., VR experience, the higher their perceived enjoyment (H2), and the more immersed they are in the game (H4). The more fun VR gamers feel, the more they can increase their happiness, and are more immersive in the game. Huang et al. [29] suggested that users experience VR as a result of their desire to feel happy, and Jennett et al. [35] suggested that immersion is also a result of good gaming experience. When tourists enjoyed VR games, the higher their subjective well-being, the deeper the immersion effect will be caused by continued use (H7).

This study hypothesized that H3: flow state has a positive and significant effect on user intention, and H6: Subjective well-being has a positive and significant effect on user intention of imagery, and both two hypotheses were validated. The results are in agree with the previous studies on flow state on user intention [54][26], and subjective well-being on using intention [55]. When tourists enjoyed VR games, the higher their flow state of engagement, or the stronger the happiness they feel, the more they will want to use.

The test of mediating effect is to confirm whether the independent variable influences the dependent variable through the mediating variable or not. There are four mediation effects in this study as follows.

There is a positive mediating effect between flow state and subjective well-being, user intention, and immersion. Perceived enjoyment is the mediator between flow state affect subjective well-being. Perceived enjoyment and subjective well-being are mediators between flow state affect user intention, and flow state affect immersion. In addition, subjective well-being is a mediator between perceived enjoyment and user intention. As flow state, perceived enjoyment, subjective well-being, user intention, and immersion are all interconnected together, to raise the tourists' revisit intention, adopting VR to increase visitors' experience is a good strategy for the museum.

Conclusions

The results of this study confirm that flow state has a critical effect on visitors' immersion and use of intention. This finding is consistent with Cho and Youn-Kyung's [54] and Huang's [26] findings that mind-flow state affects consumers' purchase intention. Michailidis et al. [28] concluded that there is no difference between flow state and immersion, but Procci and Bowers [27] concluded that mind-flow and immersion are not conceptually different in game contexts However, this study supports the conclusion of Procci and Bowers [27] because this study demonstrates that the state of mind flow affects immersion and therefore clarifies the relationship between mind flow state and immersion.

The results of this study confirm that subjective well-being has a critical effect on visitors' immersion and intention to use. This conclusion is in line with Cho et al. [38], who concluded that mind-flow state affects tourists' travel intentions, and Wood and Smith [39] and Gaiswinkler et al. [40], who only demonstrated that immersion and subjective well-being are currently correlated. immersion.

There are some suggestions for the future research: First, to expand the area and number of survey samples to increase the breadth of the survey. Second, in addition to museums, visitors using VR equipment in amusement parks or hotels can be included in the survey to expand the coverage of the research industry. Third, to explore other theories or variables that may be included in the research model. Fourth, this study is based on the perspective of tourists, organizations' view might be included to comparison the different viewpoints. Finally, qualitative research methodology might incorporate with quantitative studies, and other sta-

tistical software such as PLS, or other statistical methods such as HLM can be used.

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