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**Virtual Reality, Presence, and Attitude Change: Empirical Evidence from Tourism**

**Abstract**

The rapid development of virtual reality (VR) technology offers opportunities for a widespread consumption of VR tourism content. It also presents challenges to better understand the effectiveness of VR experience in inducing more favorable attitude toward tourism destinations and shaping visitation intention. Based on two studies, one conducted in Hong Kong with 202 participants and another in the United Kingdom with 724 participants, this research identified several positive consequences of the sense of presence in VR experiences. First, the feeling of being in the virtual environment increases enjoyment of VR experiences. Second, the heightened feeling of being there results in stronger liking and preference in the destination. Third, positive attitude change leads to a higher level of visitation intention. Therefore, this study provides empirical evidence to confirm the effectiveness of VR in shaping consumers' attitude and behavior.

*Keywords:* Virtual Reality; Presence; Attitude Change; Persuasion; Persuasive Technology; Tourism Marketing

## 20 **Introduction**

21 One of the important technological developments expected to greatly impact the tourism industry today is  
22 virtual reality (VR). Recent innovation in VR platforms, devices, and content production tools allows for  
23 VR to evolve from a niche technology mainly enjoyed within the gaming communities into the realm of  
24 everyday experiences. The availability of low cost VR viewers such as Google Cardboard and the  
25 abundance of tourism-related VR content make it easier for anyone to experience virtual tours of cities  
26 and tourism attractions from anywhere in the world. Therefore, VR today offers unbounded potentials for  
27 mass virtual visitation to actual tourism destinations. The discussions on the roles of VR in tourism and  
28 hospitality management and marketing have been found in tourism literature since the past three decades  
29 (e.g., Cheong 1995; Dewailly 1999; Guttentag 2010; Huang et al. 2016; Williams & Hobson 1995). With  
30 its unique ability to simulate intricate, real-life situations and contexts (Diemer et al. 2015), VR has been  
31 touted as a substitute to actual travel (Cheong 1995; Sussmann and Vanhegan 2009), which can be  
32 beneficial for the management of protected areas such as vulnerable natural and cultural heritage sites  
33 where limiting the number of tourists or restricting visitations is desirable. In this case, the use of VR is  
34 considered a positive contribution to environmental sustainability (Dewailly 1999). Studies also suggest  
35 VR as a powerful tourism marketing tool (Huang et al. 2016; Williams & Hobson 1995; Williams 2006)  
36 as it is able to offer more compelling imagery of tourism destinations to potential tourists by giving them  
37 a sense of what it is like to be there, a “try before you buy” experience. However, these studies are  
38 conceptual in nature, offering the potential benefits of VR applications in the tourism industry. Lacking,  
39 though, is theory-driven and evidence-based research to support these suggested potentials.

40 Research in psychology has sought to explain the reason behind the effectiveness of VR in  
41 shaping attitudinal and behavioral responses to virtual stimuli (Schuemie et al. 2001), most of these have  
42 focused on the concept of presence. VR provides an environment where users can retrieve information in  
43 multi-sensory modalities, including visual, auditory, and kinaesthetic, enabling users to perceive realistic  
44 representation of the environment it portrays (Slater and Usoh 1993). Further, VR environment offers  
45 situated affordances (Schuemie et al. 2001), action-supportive information on what users can do with the

46 environment. For example, to a human, the grounds afford walking. Therefore, users' perception of the  
47 VR environment is dependent on possible actions. This perception leads to the sense of being "present" in  
48 or "transported" to the virtual environment (Lombard and Ditton 1997; Schuemie et al. 2001; Slater 1999;  
49 Zahorik and Jenison 1998). The essence of travel and tourism experience is tourists' encounters with the  
50 destination environments, the "realities" of others. Tourists are tempted by the allure of places and  
51 landscapes; some mainly driven by desire to experience the visual sensations of distant territories  
52 (Steenjacobsen 2001), others by the deeper meaning behind interacting with the sociocultural aspects of  
53 tourism destinations (Gibson 2009). Drawing from Zahorik and Jenison (1998), successfully supporting  
54 actions such as sightseeing in a virtual tourism destination will lead users to perceive a sense of presence,  
55 of him/herself as being in the destination. Consequently, presence explains the effectiveness of VR as  
56 substitute to and/or simulation of travel.

57         Empirical evidence from various fields of studies, including in education, healthcare,  
58 entertainment, retailing, etc., demonstrate that VR experience leads to positive attitudinal and behavioral  
59 outcomes, such as consumer learning of products (Suh and Lee 2005), brand recognition, product recall,  
60 and memory of experiences (Kim and Biocca 1997; Mania and Chalmers 2001). These outcomes are  
61 suggested as the results of presence (Schuemie et al. 2001). However, these studies, as well as VR studies  
62 in tourism context (e.g., Huang et al. 2016), mainly dealt with simulated virtual worlds, such as a virtual  
63 office, a virtual seminar room, and 3D tourism attractions, where resemblances to real places were rather  
64 coincidental. Theoretically, researching VR experience in tourism (what this study encapsulates) will  
65 provide a better understanding of presence in VR experiences that involve virtual depictions of real  
66 environments, where possible actions, such as navigation and sightseeing, resemble (are often  
67 indistinguishable from) actual consumption. Thus, it will lead to better conceptualization of the roles of  
68 VR experience in shaping attitude towards actual consumption. From a managerial point of view,  
69 understanding how travel consumers respond to various VR stimuli, the attitudinal consequences of  
70 "having been" in a destination, is of practical importance as destination managers are increasingly faced  
71 with strategic decisions to invest in various technology platforms and modalities. Therefore, this study

72 aims to address the identified research gap in VR research in tourism context to address the  
73 aforementioned theoretical and managerial challenges. Specifically, the goal of this study is investigate  
74 the sense of presence during a virtual walkthrough of a tourism destination and how presence influences  
75 post-VR attitude change toward the destination. In order to achieve this goal, two studies were conducted  
76 to achieve the research goals. Study 1 was conducted with 202 participants in Hong Kong using VR street  
77 view of Tokyo, Japan, viewed with Google Cardboard or VR video of Porto, Portugal, viewed with  
78 Samsung Gear VR. Study 2 was conducted in the United Kingdom with 724 participants using 360-  
79 degree VR videos of Lake District National Park, United Kingdom, viewed with Samsung Gear VR.

80

### 81 **Virtual Reality and Tourism**

82 Since its early conception, VR has been described as a computer-simulated environment with and within  
83 which people interact (Diemer et al. 2015; Schuemie et al. 2001). Using VR devices, a user can  
84 experience the virtual environment as if he or she was part of it. The virtual environment is modified in  
85 real time as the device senses user's reactions and motions, allowing him or her to perceive a vivid mental  
86 representation of the environment, creating the illusion of interacting with and being immersed in the  
87 virtual world (Wirth et al. 2007). Table 1 presents an overview of VR technologies and their advantages  
88 within the tourism context. There are two kinds of established or commonly used headsets for VR, with  
89 numerous technical options within those two types. The first type includes untethered headsets (also  
90 referred to as mobile VR). These are headsets that work based on using a mobile device as a display. This  
91 can sometimes present a limitation due to the mobile devices processing power and limited ability to  
92 process real-time 3D content. The major benefits of these mobile-based systems are cost and uptake;  
93 many people already have a mobile device that is capable of displaying VR content to some degree  
94 (Byond, 2016). Examples of untethered or mobile VR headsets include Samsung Gear VR, Google  
95 Cardboard, and Google Daydream. The second common type is a tethered device, whereby the headsets  
96 contain a display alongside internal and/or external sensors to track the position of the user. These  
97 tethered headsets will usually require a personal computer (PC) to process the graphics and, thus, the user

98 is attached to the PC via a cable. This usually allows for superior quality graphics as well as real-time  
99 tracking and interaction. Established examples include the HTC Vive, Oculus Rift, and OSVR (Byond,  
100 2016).

101 Recently, a number of scholars explored the benefits of VR within the tourism context. From the  
102 tourists' point of view, the main benefits of VR include enhancement of tourism experiences (Bonetti et  
103 al., 2018; Moorhouse et al., 2018); facilitation of immersive, engaging, social, and entertaining  
104 experiences (e.g. Castro et al., 2017; Guttentag, 2010; Jung et al., 2018; Tromp, 2017), as well as the  
105 potential to provide accessible tourism for all (Guttentag, 2010; Hobson & Williams, 1995). From the  
106 perspective of businesses and destinations adopting VR, factors such as marketing and promotions, sales  
107 and distribution (Gibson & O'Rawe, 2018; Williams & Hobson, 1995; Huang et al., 2016; Moorhouse et  
108 al., 2018), additional revenue generation (Radde, 2017; Tromp, 2017), as well as sustainability and the  
109 preservation of heritage (Guttentag, 2010; Hobson & Williams, 1995) were identified as the benefits of  
110 VR. A full summary of previously explored benefits of VR is presented in Table 1.

111 == Table 1 about here ==

112

### 113 **Defining and Measuring Presence in Virtual Reality**

114 The key concept that explains the effectiveness of VR in various use contexts is presence. Presence is  
115 defined in literature as the psychological state where a user is feeling lost or immersed in the mediated  
116 environment, the degree to which he or she feels physically "present" in a virtual environment (Schubert,  
117 Friedmann, and Regenbrecht 2001; Slater and Steed 2000; Slater and Usoh 1993; Slater and Wilbur 1997;  
118 Steuer 1992). Lee (2004) defines presence as a psychological state in which the virtuality (artificiality) of  
119 an experience is unnoticed; presence is the "psychological similarities between virtual and actual objects  
120 when people experience–perceive, manipulate, or interact with– virtual objects" (p. 38).

121 Presence has been conceptualized in terms of its descriptive (the what) and structural (the how)  
122 models; the former focuses on delineating the dimensions of presence, while the latter on explaining how  
123 presence is generated in the mind of a user (Diemer et al. 2015). Following an extensive review of

124 literature, Lombard and Ditton (1997) summarize six explications of presence: presence as social  
125 richness, realism, transportation, immersion, social actor within medium, and medium as social actor (Lee  
126 2004; Schuemie et al. 2001). Schuemie et al. (2001) find that presence as transportation, which is the  
127 sensation of being transported to the virtual environment, dominates the discussion in presence literature.  
128 Heeter (1992) suggests three types of presence: personal, social, and environmental presence, each  
129 corresponds to the sense of self and encountered objects as being part of the interactive virtual  
130 environment. Similarly, Lee (2004) proposes three types of presence: physical presence (i.e., virtual  
131 physical objects experienced as actual physical objects), social presence (i.e., virtual social actors  
132 experienced as actual social actors), and self presence (i.e., virtual self/selves experienced as actual  
133 self/selves).

134 Kim and Biocca (1997) operationalize the transportation metaphor of presence with two  
135 measures: arrival, which describes a feeling of being present in the virtual environment, and departure, a  
136 feeling of separation from the physical environment. These were conceptualized following Gerrig's  
137 (1993) theory that through a medium, a user is first transported, then arrives at a mediated environment,  
138 and finally returns to the original physical environment. Kim and Biocca (1997) further argue that arrival  
139 and departure are not exactly equal and may exert different influence on the user's memory and/or  
140 attitude change (Kim & Biocca 1997). Slater and his colleagues (1993; 1994) propose a navigation  
141 metaphor of presence in virtual environments, which includes the user's sense of being there, the extent to  
142 which the VR experience becomes more real than everyday experience, and the locality of the virtual  
143 environment, in that users perceive it as a 'place' instead of set of images (Slater and Wilbur 1997). Slater  
144 (1999) suggest that experiencing-as-a-place is the meaning of presence: people are there, they respond to  
145 what is there, and they remember it as a place. It is important to note that Slater et al.'s (1993; 1994)  
146 measurement of presence, as explicated in SUS Questionnaire, include the state post VR experience,  
147 namely how a user remembers the virtual environment, while others focus only on the mental state during  
148 the VR experience. In fact, numerous studies regard memory of (objects within) the virtual environment  
149 as a consequence of presence (e.g., Keng and Lin 2006; Kim and Biocca 1997).

150           The experience of presence is a complex, multidimensional perception, which is formed through  
151 an interplay of multi-sensory information and various cognitive processes (Diemer et al. 2015). Lombard  
152 and Ditton (1997) describe presence as the perceptual illusion of being unmediated (non-mediation), an  
153 extent where the technology and the physical environment disappear from the user’s awareness. That is, a  
154 user experiences the sense of presence when he or she fails to perceive the existence of a medium (i.e., a  
155 VR device) and responds as if the medium were not there. The term “perceptual” in their description  
156 shows that the illusion of non-mediation involves real-time responses of the sensory, cognitive, and  
157 affective processing systems to objects in a person’s environment (Lombard and Ditton 1997). This  
158 emphasizes the attention-directing role of activity within complex interactive situations to generate the  
159 sense of presence, in addition to the immersive nature of the virtual environment (Diemer et al. 2015;  
160 Witmer and Singer 1998). Indeed, Witmer and Singer (1998) stress that both fundamental psychological  
161 states of involvement and immersion are necessary conditions for experiencing presence (see also  
162 Witmer, Jerome, and Singer 2005). They develop the measurement of presence using Presence  
163 Questionnaire (PQ) and found the following subscales of presence: involved/control, natural, and  
164 interface quality (Witmer and Singer 1998). Similarly, Schubert, Friedmann, and Regenbrecht (2001)  
165 conducted factor analyses and identified three dimensions of presence: spatial presence, involvement, and  
166 realness. A more recent operationalization by Wirth et al. (2007) associates spatial presence with two  
167 dimensions: self-location, which is the feeling of being located in mediated environments (the presence of  
168 self in the virtual environment), and perceived action possibilities.

169           Further, literature suggests that vital to presence is the suppression of information that is  
170 incompatible with the VR experience (Schuemie et al. 2001). With his estimation theory, Sheridan (1999)  
171 postulates that presence is the result of a continuously updated mental model of the environment. He  
172 assumes that people can never have true knowledge of objective reality and, instead, continuously make  
173 and refine a mental model that estimates reality. Through sensing and interacting with a virtual  
174 environment, designed to have a perceptual and functional similarity to a physical environment, a user  
175 would create a mental model of the virtual environment and of how he or she relates to it. The structure of





1997; Lombard and Ditton 1997). The propositions and findings from previous research on presence in VR demonstrate that the enhanced sense of reality during a VR experience increases enjoyment and values of the VR experience (in itself), generates positive consequences on attitude, belief, and intention, and increases performance (Bystrom, Barfield, and Hendrix 1999; Kim and Biocca 1997; Suh and Lee 2005; Schuemie et al. 2001; Vora et al. 2002). For example, research in education and training found that virtual presence promotes enjoyment and higher cognitive engagement for better learning outcomes (Bailenson et al 2008; Lee, Wong, and Fung 2010; Mikropoulos and Strouboulis 2004) and improves task performance in training simulations (Vora et al. 2002). Research in medical sciences identified presence as the main contributor to performance during rehabilitation intervention programs and immersive Virtual Reality Exposure Therapy (VRET) to eliminate phobias (Carlin, Hoffman, and Weghorst 1997; Hodges et al. 1995; Riva, Mantovani and Gaggioli 2004). The role of presence is also suggested in the field of marketing, especially with regards to advertising effectiveness, as sense of presence in mediated environments is positively correlated with more favorable attitude toward ad and brand, brand recall or product knowledge, and purchase intention (Choi, Miracle, and Biocca 2001; Klein 2003; Li, Daugherty, and Biocca 2001; 2002; Lombard and Snyder-Duch 2013). In the context of tourism, Hyun and O'Keefe (2012) found that presence via web-mediated information directly leads to positive virtual destination image.

In essence, the consequences of presence can be separated into those during and after the VR experience. During VR experience, a higher sense of presence is associated with enjoyment of virtual environment participation, the feeling of pleasure of interacting with virtual environment (Larsson, Västfjäll, and Kleiner 2001; Li, Daugherty, and Biocca 2001). That is, virtual environments that engender a high level of presence are perceived to be more enjoyable (Sadowski and Stanley 2002; Sylaiou et al. 2010). For example, Weibel et al. (2008) found a significant positive correlation between presence and enjoyment in the context of playing online games. The effect of presence on enjoyment, however, is mediated by the state of flow (Weibel et al. 2008). Still in the context of video game experience, Shafer, Carbonara, and Popova (2011) found that spatial presence is a significant predictor of enjoyment.

228 Ijsselsteijn et al. (2006) shows that greater spatial presence leads to greater enjoyment in an exercise-  
229 promoting virtual environment. More relevant to tourism, Zarzuela et al. (2013) demonstrate that through  
230 a VR Serious Game, educational tourism can be designed in a fun and entertaining way, implying an  
231 association between VR involvement and enjoyment, to allow tourists to learn different aspects of a city.  
232 Likewise, Sylaiou et al. (2010) investigated the relationship between presence and enjoyment in a virtual  
233 museum and identified a significant positive correlation between the two variables. Therefore, it can be  
234 suggested that the sense of presence during VR experience with a tourism destination leads to enjoyment  
235 of the VR experience.

236 *H1: Sense of Presence during VR experience has a positive effect on Enjoyment of VR Experience.*

237 Importantly, VR studies substantiate its persuasive role, suggesting that the subjective experience  
238 of presence in VR can translate into real world attitude and induce behavioral change (Fox, Christy, and  
239 Vang 2014). Indeed, VR applications have been designed for various persuasive goals, such as health  
240 behavior change (Fox, Bailenson, and Binney 2009; Girard, Turcotte Bouchard, and Girard 2009;  
241 Ijsselsteijn et al. 2006), promotion of prosocial behavior (Ahn, Le, and Bailenson 2013; Gillath, McCall,  
242 Shaver, and Blascovich 2008; Rosenberg, Baughman, and Bailenson 2013), advertising and e-commerce  
243 (Keng and Lin 2006; Li, Daugherty, and Biocca 2001; 2002; Suh and Lee 2005), etc. These studies found  
244 that the heightened sense of realism during VR experience leads to attitude change and the effect is  
245 transferred into the physical world, which is manifested in positive behavioral change. In marketing  
246 literature, higher levels of presence of various advertisements communicated in computer-mediated  
247 environments have been found to increase subject recall and recognition (Keng and Lin 2006), leading to  
248 more positive attitude and liking toward the ad and the advertised product (Klein 2003; Sundar and Kim  
249 2005). In tourism, VR provides tangible images of and experiences with the destination, inducing the  
250 construction of a mental image about destination attributes (i.e., destination image) and its affordances  
251 (Govers, Go, and Kumar 2007; Nicoletta and Servidio 2012), which can be a manifest of spatial presence.  
252 Previous studies suggest that the ability to visit a tourism destination through VR may assist tourists in  
253 developing a set of realistic expectations of tourism experience with the destination (Cheong 1995;

254 Guttentag 2010; Williams and Hobson 1995). Studies also show that encounters with images of tourism  
255 destinations in mediated environments shape interest and attitude toward the destinations (Thomas and  
256 Carey 2005; Tooke and Baker 1996). A potential tourist who has experienced various destinations  
257 through VR will be in a better position to make an informed decision and initiate travel arrangements  
258 (Sussman and Vanhegan 2009).

259 *H2:* Sense of Presence during VR experience has a positive effect on Post VR Attitude toward  
260 destination.

261 *H3:* Enjoyment of VR experience has a positive effect on Post VR Attitude toward destination.

262 Attitude is a central concept in social psychology as well as consumer behavior literature as it is  
263 generally accepted that attitude predicts behavior, although the degree of attitude – behavior consistency  
264 may differ in various situations (e.g., Ajzen and Fishbein 1977; Glasman and Albarracín 2006; Smith and  
265 Swinyard 1983). Further, based on the Belief–Attitude–Intention–Behavior hierarchy (Fishbein and Ajzen  
266 1975), the relationship between attitude and (actual) behavior is mediated by behavioral intention (Kim  
267 and Hunter 1993). The link between attitude toward tourism destination (with its characteristics) and  
268 behavioral intention to visit the destination or to participate in tourism-related activities has been  
269 supported in previous studies (e.g., Huang and Hsu 2009; Lam and Hsu 2004; Phillips, Asperin, and  
270 Wolfe 2013; Ryu and Han 2010). Researching Beijing tourists’ revisit intention to Hong Kong, Huang  
271 and Hsu (2009) identified significant influence of attitude on intention. Similar results were identified by  
272 Lam and Hsu (2004). Phillips, Asperin and Wolfe (2013) found significant influence of attitude toward  
273 consuming Korean cuisine on intention to visit Korea and to try Korean cuisine. Similar results were  
274 identified by Ryu and Han (2010) in New Orleans. As supported by previous research, it can be  
275 suggested that attitude toward tourism destination as a result of VR experience is a predictor of visitation  
276 intention to the destination.

277 *H4:* Post VR Attitude toward destination has a positive effect on Intention to visit destination.

278

279

## 280 **Research Design**

281 The main goal of this research is to assess the effects of VR experience on post-VR attitude and  
282 behavioral intention to visit a tourism destination. Key to VR experience is the extent of presence, which  
283 contributes to the level of enjoyment of VR participation. In order to assess the relative contribution of  
284 VR experience in inducing more favorable attitude toward VR stimuli (i.e., the tourism destination), it is  
285 crucial to measure post-VR attitude change, comparing attitude before and after VR experience. That is,  
286 identifying whether and how much a user's attitude changes as a result of being exposed to the virtual  
287 environment will delineate the specific effect of VR experience. Previous studies suggest that VR induces  
288 more positive attitude toward stimuli. Therefore, a positive change in attitude (i.e., stronger attitude) after  
289 VR experience is expected. Finally, this research tests the influence of attitude change on visit intention to  
290 the destination. The research framework is illustrated in Figure 1.

291 == Figure 1 about here ==

292

### 293 *Measurement Items*

294 *VR Presence.* In order to assess presence in VR experience, subjective measures of spatial presence as  
295 conceptualized and operationalized in Wirth et al. (2007) and Vorderer et al. (2004) were utilized.  
296 Following the research framework, the main interest in this study is to assess presence as the subjective  
297 mental states of being in and interacting with the virtual environment during the VR experience. Two  
298 constructs from MEC Spatial Presence Questionnaire (MEC-SPQ; Vorderer et al. 2004): Self-Location  
299 and Possible Actions scales, each measured with four items, were included in the questionnaire. The  
300 measurement items were presented in a 5-point Likert-type scale with “Strongly disagree” – “Strongly  
301 agree” anchored statements (see Appendix A for a list of measurement items). VR presence was  
302 operationalized as a second-order variable, consisting of the two first-order constructs.

303 *VR Enjoyment.* In order to measure VR enjoyment, this research refers to Davis, Bagozzi, and Warshaw's  
304 (1992) definition of perceived enjoyment, which is the extent to which the activity of using VR  
305 technology to experience tourism destination is enjoyable in its own right. Measurement items from

306 previous research on technology acceptance and use (e.g., Moon and Kim 2001; Van der Heijden 2003)  
307 were consulted. As a result, a 5-item perceived enjoyment scale was utilized. The items were presented a  
308 5-point Likert-type scale with “Strongly disagree” – “Strongly agree” anchored statements.

309 *Post VR Attitude Change.* In literature, the measurement of attitude change has been conducted in a  
310 variety of different ways, mostly involving taking multiple measurements at different times (generally in  
311 longitudinal studies) to measure an increase or decrease in the level of attitude (see Hughes 1967). In this  
312 study, a limited time allotted for VR experiment and survey only allows for the questionnaire to be  
313 distributed to participants after they have experienced VR. Therefore, attitude change was measured using  
314 self-reported change in intensity of preference, liking, and interest in the destination after experiencing  
315 VR on a 5-point Likert-type scale from 1 – “Much weaker” to 5 – “Much stronger,” with 3 – “About the  
316 same” as the middle point.

317 *Visit Intention.* Visit Intention was measured by 3-item scale targeting behavioral intention to visit the  
318 destination in the future, validated in previous studies on tourists’ intention to visit or revisit a destination  
319 in the future (e.g., Kozak and Rimmington 2000; Phillips, Asperin and Wolfe 2013). The scale was  
320 presented a 5-point Likert-type scale with “Strongly disagree” – “Strongly agree” anchored statements.

### 321

### 322 *Data Analysis*

323 In order to assess the measures given the data in this study context and test the hypotheses, data analyses  
324 were conducted using covariance-based structural equation modeling (CB-SEM) following the two-step  
325 approach suggested by Anderson and Gerbing (1988). The first step was to test the adequacy of the  
326 measurement model with a confirmatory factor analysis (CFA), then the second step to assess the  
327 adequacy of the structural model for hypotheses testing. The analysis was performed using MPlus  
328 program (Muthén and Muthén 1998-2012). Based on skewness and kurtosis values of all variables, an  
329 appropriate parameter estimate was selected. Several criteria were used to assess the model fit. The  
330 analysis will determine if the complete set of paths specified in the model is plausible given the sample,

331 thus the proposed causal model is a sufficiently “good” way to model the relationships among the  
332 variables (Gefen, Straub, and Boudreau 2000).

333

### 334 **Study 1. Stimuli: Tokyo, Japan or Porto, Portugal**

335 In March 2016, undergraduate and graduate students enrolled in a university in Hong Kong were invited  
336 to participate in the study as part of an experiential component of a course on tourism and technology  
337 strategy. In order to ground this research in the context of personal use of VR, existing free VR  
338 applications and personal VR devices were used in the study. Participants with Apple’s iOS smartphones  
339 were asked to download the Cardboard app and use Google Cardboard VR viewer to experience a virtual  
340 walkthrough of Tokyo, Japan, experiencing VR street view with Urban Hikes on Cardboard app  
341 (developed by Google). Other participants were asked to use Samsung Gear VR with a Samsung  
342 smartphone to visit Porto, Portugal, experiencing interactive 360-tour with Porto Interactive app  
343 (developed by Vertigo VR Studios). Participants experienced VR for about 10 minutes after a short period  
344 of familiarization with the device. After the VR experience, all participants were asked to complete the  
345 questionnaire online. A total of 202 participants completed the questionnaire. As presented in Table 3, the  
346 majority of participants are between the ages of 18 and 24 (98%), female (79%), and have a 4-Year  
347 University Degree (76%). Most participants (N = 136; 67%) used Google Cardboard, and most had never  
348 visited the destination portrayed in the VR experience (N = 144; 71%). In order to account for non-  
349 normality in the data distribution (see Table B1 in Appendix B), the analysis was performed using  
350 maximum likelihood parameter estimate with standard errors and a mean adjusted Chi-square test statistic  
351 (Satorra-Bentler corrections) that are robust to non-normality (MLM).

352 == Table 3 about here ==

353

### 354 *Findings*

355 The results from the analysis suggest that the measurement model is adequate based on several criteria.

356 As presented in Table 4, all factor loadings are above .6 and the average variance extracted (AVE) values

357 of all latent variables are above the cutoff point of .5 (Hair, Black, Babin, and Anderson 2010). Therefore,  
358 convergent validity was supported. The composite reliability (CR) values of all latent variables are above  
359 the cutoff criteria of .7 (Hair et al. 2010). Further, the values of square roots of AVE of all latent  
360 variables, which are presented in the diagonal, are larger than the correlations between the corresponding  
361 variable and any other variables (see Table 5). This indicates that discriminant validity is supported.  
362 Further, the fit indices are above the thresholds of .9 (Hu and Bentler 1999): Comparative Fit Index (CFI)  
363 = .963 and Tucker Lewis Index (TLI) = .957. The value of Root Mean Square Error of Approximation  
364 (RMSEA = .056) indicates good model fit (Hu and Bentler 1999) and the value of Standardized Root  
365 Mean Square Residual (SRMR = .047) is below the threshold of .09 (Hu and Bentler 1999). These criteria  
366 suggest the adequacy of the measurement model.

367 == Table 4 about here ==

368 == Table 5 about here ==

369 In order to estimate the relationships between the variables hypothesized in the research  
370 framework, the structural model was consulted (see Figure 2). As a second-order variable, the paths from  
371 VR Presence to its two lower-order variables are significant (Presence → Self-Location = .894,  $p = .000$ ;  
372 Presence → Possible Actions = .849,  $p = .000$ ). As hypothesized, Presence has a significant positive  
373 effect on Enjoyment of VR participation ( $\beta = .620$ ;  $p = .000$ ;  $R^2 = .384$ ;  $p = .000$ ), providing support for  
374 H1. Both Presence and Enjoyment have significant positive effects on attitude change (Presence →  
375 Attitude Change = .240,  $p = .000$ ; Enjoyment → Attitude Change = .255,  $p = .000$ ;  $R^2 = .198$ ;  $p = .000$ ),  
376 supporting H2 and H3. It can be observed from the  $R^2$  value that about 20% of the amount of variance in  
377 Post VR attitude change can be explained by the model. Finally, a significant positive effect of Attitude  
378 Change on Intention ( $\beta = .333$ ;  $p = .000$ ) was also identified ( $R^2 = .111$ ;  $p = .000$ ), providing support for  
379 H4. About 11% of variance in visit intention can be explained by the model.

380 == Figure 2 about here ==

381

382 *Discussion*



383 The results provide support for all hypothesized relationships in the model (see Table 6). The sense of  
384 presence during VR experience significantly leads to enjoyment of the experience, supporting Hypothesis  
385 1. With regards to the consequences of presence on post VR attitude change, a significant effect was also  
386 identified, supporting Hypothesis 2. Further, enjoyment of VR experience also positively impacts post  
387 VR attitude change with a similar magnitude as the effect of VR presence, supporting Hypothesis 3.  
388 Finally, the relationship between post VR attitude change and visit intention is also significantly positive,  
389 which supports Hypothesis 4. Therefore, it can be suggested from these results that VR can be an  
390 effective tool for tourism marketing as it induces the sense of presence, which leads to enjoyment. These,  
391 in turn, induce positive attitude change that contributes to visit intention to the tourism destination  
392 portrayed in VR. Further, the indirect effects of VR presence and enjoyment on visit intention were  
393 calculated (see Table 7). Specifically, a significant positive indirect effect of VR presence on post VR  
394 attitude change, by way of enjoyment, was found. Other indirect effects, although smaller in magnitude,  
395 were also significant. The total effects of VR presence on post VR attitude change is .778; while total  
396 effects on visit intention is .133.

397 == Table 6 about here ==

398 == Table 7 about here ==

399 While the data confirmed the hypotheses, this study has some limitations. First, the participants in  
400 this study are dominated by young, female consumers. Recent studies have found that the younger the  
401 customers, the more likely they are to be interested in VR (eMarketer, 2015; Global Web Index, 2016). It  
402 can be suggested that participants in this study represent a group of customers who are highly likely to  
403 experience and be influenced by VR. However, the imbalance in gender may or may not influence the  
404 results. Second, participants were exposed to different stimuli with an unbalanced ratio: 67% used Google  
405 Cardboard. Several independent-samples *t*-tests were conducted to identify the differences across stimuli  
406 in terms of all variables (i.e., presence, enjoyment, attitude change, and intention). The differences were  
407 not statistically significant. Nonetheless, conducting a follow up study with consistent stimuli is desirable  
408 to verify the results further. Lastly, the sample size is relatively low ( $N = 202$ ). Previous literature

409 suggests a minimum 100 – 150 sample size to test a simple model (Anderson and Gerbing 1988; Ding,  
410 Veliver, and Harlow 1995) or 10 observations for every indicator variable (Nunnally 1967). Based on a  
411 power analysis suggested by MacCallum, Browne, and Sugawara (1996), the minimum sample size for a  
412 close of fit (Power = 90%, significance level = .05; RMSEA<sub>1</sub> = .05, and RMSEA<sub>0</sub> = .08) is 128. A further  
413 study to test the model with a larger sample size will further support these findings.

414

#### 415 **Study 2. Stimuli: Lake District National Park, UK**

416 Festival goers visiting Kendall Calling Festival in July 2016 and Lakes Alive Festival in August 2016 in  
417 the Lake District, UK were invited to participate in this study. Participants were asked to experience Bird  
418 Hive Lake District National Park VR application using Samsung Gear VR headset for about five minutes.  
419 The content for VR experience was captured by a drone and it contained a flight over the natural  
420 landscape of the Lake District National Park including its mountains, lakes, and forests. After the VR  
421 experience, all participants were asked to complete a questionnaire. A total of 741 participants completed  
422 the questionnaire. After eliminating responses with missing data and outliers, 724 responses were  
423 included in the analysis (see Table 8). In contrast with Study 1, participants in Study 2 are relatively  
424 balanced in gender (57% female). While the majority of participants is young (41% younger than 35),  
425 older participants are also represented in this study (about 34% are 45 years or older). A majority of  
426 participants make less than £60,000 annually. A quarter of participants (25%) have tried VR before the  
427 experience. Contrary to Study 1, most participants in Study 2 (89%) have visited the destination before  
428 being exposed to this study. Data from Study 2 are presented in Table B2 in Appendix B. The analysis  
429 was performed using the same approach as in Study 1 (covariance-based SEM with MLM).

430 == Table 8 about here ==

431

#### 432 *Findings*

433 Based on several criteria, it can be suggested that that the measurement model in this study is adequate.  
434 As presented in Table 9, all factor loadings are above .6 and the AVE values of all latent variables are

435 above the cutoff point of .5 (Hair et al. 2010). Therefore, convergent validity was supported. The CR  
436 values of all latent variables are above the cutoff criteria of .7 (Hair et al. 2010). Further, the values of  
437 square roots of AVE of all latent variables, which are presented in the diagonal of Table 10, are larger  
438 than the correlations between the corresponding variable and any other variables. This demonstrates that  
439 discriminant validity is supported. The fit indices are above the thresholds of .9 (Hu and Bentler 1999):  
440 CFI = .945 and TLI = .935. The value of RMSEA (.071) indicates moderate fit (Hu and Bentler 1999) and  
441 the value of SRMR (.087) is below the threshold of .09 (Hu and Bentler 1999).

442 == Table 9 about here ==

443 == Table 10 about here ==

444 The structural model is illustrated in Figure 3. The paths from VR Presence as a second-order  
445 variable to its two first-order variables are significant (Presence → Self-Location = .838,  $p = .000$ ;  
446 Presence → Possible Actions = .833,  $p = .000$ ). Presence has a significant positive effect on Enjoyment of  
447 VR participation ( $\beta = .519$ ;  $p = .000$ ;  $R^2 = .270$ ;  $p = .000$ ), providing support for H1. Both Presence and  
448 Enjoyment have significant positive effects on attitude change (Presence → Attitude Change = .567,  $p =$   
449  $.000$ ; Enjoyment → Attitude Change = .116,  $p = .000$ ;  $R^2 = .403$ ;  $p = .000$ ), supporting H2 and H3. This  
450 indicates that 40% variation in the Post VR attitude change can be attributed to variations in VR presence  
451 and enjoyment. Finally, a significant positive effect of Attitude Change on Intention ( $\beta = .305$ ;  $p = .000$ )  
452 was also identified ( $R^2 = .093$ ;  $p = .000$ ), providing support for H4. The low  $R^2$  value, however, indicates  
453 that only extremely small portion of variation in visit intention to the national park (less than 10%) can be  
454 explained by Post VR attitude change.

455 == Figure 3 about here ==

456

#### 457 *Discussion*

458 As with Study 1, the results from Study 2 also provide support for the hypothesized model (see Table 11).  
459 The sense of presence during VR experience significantly leads to enjoyment of VR participation,  
460 supporting Hypothesis 1. Presence's influence on post VR attitude change is positive and significant,

461 supporting Hypothesis 2. The positive effect of enjoyment of VR experience on post VR attitude change  
462 is also significant, although with less magnitude than the VR presence, supporting Hypothesis 3. Finally,  
463 the relationship between post VR attitude change and visit intention is significant, albeit resulting in a  
464 small  $R^2$  value. This supports Hypothesis 4. In summary, these results demonstrate the effectiveness of  
465 VR for tourism marketing as VR induces the sense of presence, leading to enjoyment, which affects  
466 positive attitude change that contributes to visit intention. Further, the indirect effects of VR presence and  
467 enjoyment on visit intention were calculated (see Table 12). Specifically, a significant positive indirect  
468 effect of VR presence on visit intention, by way of post VR attitude change, was found. Other indirect  
469 effects, although smaller in magnitude, were also significant. The total effects of VR presence on post VR  
470 attitude change is .569; while total effects on visit intention is .191.

471 == Table 11 about here ==

472 == Table 12 about here ==

473 From the results, it can be observed that the Satorra-Bentler corrected Chi-square value is quite  
474 large (Chi-square = 673.059;  $df = 146$ ), which is likely due to large sample size ( $N = 724$ ). As suggested  
475 in previous research, with large sample size, the chi-square values will be inflated (statistically  
476 significant), thus might erroneously implying a poor data-to-model fit (see Schumacker and Lomax  
477 2004). However, the relative Chi-Square value (Chi Square / degree of freedom ratio) in this study is  
478 smaller than the suggested ratio of 5:1 as a rule of thumb for a reasonable fit (Marsh and Hocevar 1985;  
479 Schumacker and Lomax, 2004).

480

#### 481 *An Alternative Model*

482 In order confirm the significance of post VR attitude change as a consequence of presence and to test if  
483 there are direct effects of VR presence and VR enjoyment on visit intention, an alternative model was  
484 tested. As can be seen in Figure 4, a positive direct effect of VR enjoyment on visit intention was  
485 identified ( $\beta = .250$ ;  $p = .000$ ), with a slightly larger magnitude compared to that of Post VR attitude  
486 change. However, the direct effect of VR presence on visit intention was not identified. Therefore, it can

487 be confirmed that the effect of the sense of presence during VR experience on visit intention is mediated  
488 by post VR attitude change. Compared to the main model, the  $R^2$  value of visit intention increases in the  
489 alternative model ( $R^2 = .139, p = .000$ ), indicating that the alternative model better explains the variance  
490 in visit intention. That is, the sense of being in the virtual environment directly results in more positive  
491 attitude toward the environment. On the other hand, the significant effect of VR enjoyment on visit  
492 intention demonstrate the role of hedonic experience with technological device in instilling behavioural  
493 intention. That is, the inflated sense of pleasure and/or excitement during a virtual walkthrough leads to  
494 positive intention for an actual walkthrough. Considering that 25% of participants have tried VR and 89%  
495 have visited destination before, the model was run for the different groups of participants (prior use of  
496 VR, prior visitation to destination) to further explicate the role of novelty. However, no significant  
497 differences were identified.

498 == Figure 4 about here ==

499

## 500 **General Discussion**

501 This study hypothesized that the sense of presence during a VR experience with a tourism destination will  
502 lead to positive consequences, which include positive VR experience from enjoyment of VR participation  
503 and, importantly, an increased level of preference, liking, and interest in the tourism destination, which  
504 leads to visit intention. The results of two studies, conducted in with different stimuli (i.e., cities and  
505 national parks) among participants with varied characteristics (i.e., students and festival goers), support  
506 all hypotheses. Firstly, significant support was found for VR presence as a second-order variable  
507 consisting of self-location and possible action, as suggested in Wirth et al.'s (2007) measures of spatial  
508 presence. Self-location denotes the sense of locating the self in the virtual environment, which is  
509 consistent with the definition of personal presence (Heeter 1992) or self presence (Lee 2004), although it  
510 is not about perceiving the existence of virtual self in the virtual environment, but about being part of the  
511 virtual environment. To some extent, this can support the concept of arrival (Kim and Biocca 1997), as  
512 participants feel present in the city or national parks depicted in VR. Possible Actions denote the

513 immersive nature and affordances of the virtual environments, which is consistent with the definition of  
514 physical presence (Lee 2004) and environmental presence (Heeter 1992). Importantly, it is about  
515 participants recognizing the action-supportive information from the virtual environment; the virtual  
516 environment conveying its situated affordances (Schuemie et al 2001).

517         Secondly, the significant effect of presence on enjoyment of VR confirms the positive value of  
518 VR as a hedonic experience. This is consistent with Shafer et al. (2011), Sylaiou et al. (2010), and Weibel  
519 et al. (2008). However, this study shows the direct effect that the sense being in the tourist city or the  
520 national park has on the feeling of pleasure while doing the virtual walkthrough. Meanwhile, Weibel et al.  
521 (2008) found the effect of presence on enjoyment to be mediated by the perceived state of flow in the  
522 context of playing video games. In the context of virtual museum, Sylaiou et al. (2008) only demonstrated  
523 positive correlations between presence and enjoyment. Therefore, this study contributes to a better  
524 understanding of the causal relationship between the two experiences in VR that involves interactions  
525 with tourism destinations, with enjoyment being the consequence of the sense of presence.

526         Thirdly, a significant direct effect of presence on attitude change confirms that the extent to  
527 which participants process information in the virtual environment influences changes in liking,  
528 preference, and interest in the actual environment. While previous research in advertising identified  
529 positive correlations between presence and more favorable attitude toward ad and brand (Choi, Miracle,  
530 and Biocca 2001; Klein 2003; Li, Daugherty, and Biocca 2001; 2002), this study clarifies that presence  
531 indeed leads to attitude change. In this case, the feeling of being part of a city or a park and afforded the  
532 action of sightseeing results in more favorable attitude toward the city and the park. Similar result was  
533 identified by Hyun and O’Keefe (2012), where presence results in positive virtual destination image.  
534 Furthermore, by measuring Post VR attitude change instead of attitude, this study was able to delineate  
535 specific role of VR presence on attitude formation.

536         Lastly, the change in attitude positively leads to visit intention. Those whose preference, liking,  
537 and interest in the city or park become stronger (i.e., more favorable attitude) after the VR experience  
538 tend to have higher level of visit intention. It is important to note that while in Study 1 the proportion of

539 participants who have visited the destination prior to the VR experience is small, most participants in  
540 Study 2 have visited the park. Therefore, the novelty effect of VR might be lacking and its role is more of  
541 a reminder rather than product introduction. Further, it is also important to note that the nature of  
542 traveling to the cities and the attraction depicted in stimuli is different: traveling to Tokyo or Porto for  
543 participants in Hong Kong may require a substantial effort compared to visiting a local national park for  
544 participants in the UK. It can be observed that the mean values of visit intention items in Study 2 are  
545 positively skewed, indicating that most participants intend to visit the national park in the future.  
546 Nevertheless, both studies yielded positive results, indicating that VR presence can be effective to induce  
547 intention for first time visitation and/or revisit intention, to visit faraway destinations or domestic tourism  
548 attractions. In conclusion, this study demonstrates that VR allows subjective experience in a virtual  
549 environment (e.g., virtual walkthrough or sightseeing in a tourist city or a national park) to eventually  
550 translate into real behavior (i.e., actual visitation), confirming the persuasive power of VR for tourism  
551 marketing.

552

### 553 **Conclusion and Implication**

554 The development of VR platforms and devices for convenient personal use in recent years offers great  
555 potential for a widespread consumption of VR tourism content. As suggested in earlier literature, the  
556 replication or creation of tourism experiences through VR will greatly impact the tourism industry  
557 (Williams and Hobson 1995). VR development presents research challenges to better understand the  
558 effectiveness of VR in providing alternative or surrogate tourism experiences and shaping consumer  
559 attitudes toward tourism destinations. Moreover, destination managers are also faced with challenges to  
560 make strategic investment decisions in order to leverage VR technology to influence consumers' travel  
561 decisions. In order to answer these challenges, this study investigates the sense of presence during VR  
562 experience involving virtual walkthrough of tourism destinations and attractions using personal devices.  
563 This study contributes to a better understanding of presence and its consequences on user attitudes in  
564 experiences involving depictions of real tourism destinations. The results show that presence contributes

565 positively to attitude change toward destinations. That is, a higher sense of presence during VR  
566 experiences leads to stronger interest and liking toward the destinations. Therefore, it provides theoretical  
567 explanation for the effectiveness of VR in influencing users' response to marketing stimuli, which is  
568 helpful for destination marketers justifying investment in VR and empirical support for previous  
569 conceptual research suggesting the role of VR in tourism marketing and management (e.g., Cheong 1995;  
570 Dewailly 1999; Guttentag 2010; Huang et al. 2016; Williams and Hobson 1995).

571 Williams and Hobson (1995) suggested that "VR has the potential to revolutionize the promotion  
572 and selling of tourism" (p. 425) as it has the ability to offer interactive experience and provide rich data to  
573 potential tourists seeking destination information (Guttentag 2010). Cheong (1995) argued that through  
574 VR, potential tourists can "'sample' the delights and have a 'feel' of each destination's atmosphere before  
575 making their decision" (p. 419). This study shows how VR users interact with the destination's  
576 characteristics, 'feel' the destination's atmosphere, and, thus, sample the destination experience as  
577 indicated by the sense of presence. It is reflected in the ability to locate the self in the destination and  
578 perceive the affordances of the destination (action possibilities), as significantly found in this study to  
579 form the sense of spatial presence in the virtual environment (Wirth et al. 2004; Vorderer et al. 2007). To  
580 justify the effectiveness of VR as marketing tools, this study demonstrates how VR capabilities in  
581 inducing the sense of presence actually lead to users having more favorable attitude toward the  
582 destinations depicted in VR, which, in turn, affects intention to visit the destinations. Results from two  
583 studies, conducted with different groups of participants using different stimuli, consistently support the  
584 hypotheses. The consequences of presence on positive attitude change is observed in situations involving  
585 experience with faraway tourism destinations (international tourism) as well as local attractions (domestic  
586 tourism). No significant differences were found between participants who have visited the destinations  
587 depicted in VR and those who have not (in both studies), between participants who have used VR before  
588 and those who used it for the first time during the study (in Study 2), and between participants using  
589 different VR viewers (in Study 1). Therefore, this study provides empirical evidence from the field of  
590 tourism to support previous research suggesting the positive consequences of presence in VR on attitude



591 and behavior (e.g., Choi, Miracle, and Biocca 2001; Klein 2003; Li, Daugherty, and Biocca 2001; 2002;  
592 Lombard and Snyder-Duch 2013).

593           Despite of the contributions, this study has some limitations, which should be addressed in future  
594 research. First, as a result of data collection procedure, the proportion of female participants in Study 1 is  
595 way larger than male participants and all of them are younger than 35 years. This generate a concern in  
596 terms of representativeness when interpreting the results. However, Study 2, which included more  
597 balanced proportion of gender and age groups, also yields the same results. This confirms that the results  
598 from Study 1 can be replicated in a different context with a more representative sample. Nevertheless,  
599 future studies applying this model in different contexts will further verify the results. Second, this study  
600 uses subjective measurements of VR presence and enjoyment, which are experienced during VR, based  
601 on participants' evaluation after VR experience. Therefore, it relies on participants' recall of the VR  
602 experience. Even though participants responded to the questionnaire right after the experience, responses  
603 may still contain inaccurate information and biases. Future research should include objective  
604 measurements of presence and enjoyment, such as using sensors and psychophysiological analysis, to  
605 eliminate potential bias. Third, while in Study 1 different groups of participants used different devices and  
606 stimuli, the small number of participants using Samsung Gear VR compared to Google Cardboard does  
607 not allow for testing a meaningful comparison. Experimental studies testing the model with devices with  
608 varying levels of immersive capabilities and content with varying levels of affordances (e.g., stimulating  
609 different types of action and interaction) will add to better understand how presence comes about. The  
610 same goes for differences between participants with prior experience and those without, in order to  
611 explicate the role of novelty in effectiveness of VR experience. Last, this study focuses mainly on the  
612 consequences of presence, but not on its antecedents. Future studies focusing on antecedents and different  
613 correlates of VR presence will be helpful to inform the design of VR for tourism and better predict the  
614 resulting visit intention.

615           Finally, the results of this study provide destination marketers, travel agents, and other tourism  
616 suppliers with validation that VR can be an effective marketing tool. As personal VR devices becomes

617 more accessible to a wider group of consumers, investing in VR technology for tourism marketing can be  
618 a good strategy. However, as various tourism destinations have started to embrace this technology, it is  
619 important to develop an overall VR experience that is presence-inducing and all around enjoyable in order  
620 to make sure the user experience with VR will translate into stronger interest in the tourism destination.  
621 The key is to generate VR content that can transport participants to the destination, heighten the senses of  
622 being in the virtual environment and suspend sensory stimuli from the actual physical environment.  
623

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