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Harnessing the power of virtual reality: Enhancing telepresence and inspiring sustainable travel intentions in the tourism industry

Sinh Duc Hoang [a,b,*], Sandeep Kumar Dey [a], Zuzana Tučková [a], Tien Phat Pham [c]

[a] Department of Business Administration at the Faculty of Management and Economics, Tomas Bata University in Zlin, Czech Republic
[b] Department of Economics - Finance, Ho Chi Minh City University of Foreign Languages - Information Technology, Ho Chi Minh, Viet Nam
[c] School of Economics, Can Tho University, Viet Nam

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ABSTRACT

This study investigates how virtual reality (VR) can enhance telepresence and stimulate VR use and travel intentions in the sustainable tourism industry. 512 local and international tourists in Vietnam participated in an online survey after experiencing a VR experiment. They interacted with an app presenting a sustainable tourist destination based on nature, with the treatment group using VR sets and the control group viewing it on a 2D screen. Results indicate that VR-based tours facilitate greater telepresence than 2D presentations. VR is not a substitute for actual travel, with higher intentions reported to use VR in the future and to visit the tourist destination in real life due to their greater telepresence and perceived enjoyment from VR. This has implications for nature-based sustainable tourism, with further research needed for other types of tourism, including extreme activities.

1. Introduction

Technological developments lead to new ways of marketing goods and services to customers. Traditional media such as TV and radio have been the main channels of advertising for decades; however, the developments of the internet led to the growing importance of digital channels such as online and mobile advertising [1,2]. Until recently, virtual reality (VR) was considered a fad that would go away similar to 3D glasses. However, the growing number of applications of this technology in such diverse fields as computer gaming, motion pictures, training, simulation, medicine and even metaverse developments suggest that it will continue to attract more and more users, which presents a lucrative opportunity for marketers to exploit this technology as an advertising channel [3]; M [4,5]. As of 2021, the global market size of VR was close to $28 billion, but it is expected to grow to $252 billion by 2028, which is more than a 35% growth per annum (Statista, 2022).

The main characteristic of VR that distinguishes it from the traditional media is full immersion associated with greater sensory activities of the user, which is referred to as telepresence [6]. As such, it can be a perfect marketing tool for industries that sell experience, such as the hospitality and tourism industries. In fact, there is evidence that VR implementation in the hotel industry helps stimulate impulsive consumer behaviour and intentions to visit [7].

Existing studies agree that tourists' intention to travel is impacted by destination image, which can be enhanced by VR technologies and their telepresence effects [7,8]; X [9]. However, there are arguments that the use of VR could be a double-edged sword as virtual tours to destinations can potentially replace the desire of tourists to make actual trips [10,11]. One of the reasons why marketing using the VR technology might not be able to stimulate actual travels to the advertised destination is that the VR experience could be addictive and make people want more of this experience as it can be achieved at lower cost and less efforts than making an actual trip to the marketed destination. Based on previous evidence from other immersive and addictive activities such as computer gaming [12,13] and health and psychological effects of social networks and smartphones [14], greater telepresence from VR could trigger the intentions of people to substitute real travel activities with virtual activities. However, previous studies do not provide the answer why the effect of VR could stimulate tourist intentions in one case and distract tourists from visiting the destination in other cases [15–18]. We hypothesise that the intention of people to use VR will be driven by their curiosity to explore new things, and if they find the content of the material marketed through VR attractive, the intention to use VR will also reinforce the desire to make the actual trip to the shown destination.

* Corresponding author. Department of Economics - Finance, Ho Chi Minh City University of Foreign Languages - Information Technology, Ho Chi Minh, Viet Nam.
E-mail addresses: sinhhd@huflit.edu.vn (S.D. Hoang), dey@utb.cz (S.K. Dey), tuckova@utb.cz (Z. Tučková), pptien@ctu.edu.vn (T.P. Pham).

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The aim of the present study is to assess the use of virtual reality as a tool for destination marketing of sustainable tourism. This is achieved by following several objectives:

To estimate the effect of telepresence from VR on perceived enjoyment and subsequent intentions to use VR for recreational purposes.

To explore the effect of the perceived enjoyment from the VR use on tourists' intentions to travel to the marketed destination;

To investigate the associations between the tourists intentions to use VR and their intentions to make actual travels to the marketed destinations.

2. Theoretical perspectives, literature review, and hypothesis development

The current study deploys the nomological capacities of the Technology Adoption Model [19]. The TAM is a widely used model in technology adoption research, including in tourism studies [20]. The theoretical framework can be customized to fit the specific context of VR in tourism, and can inform practical application by identifying the factors that influence technology adoption [21]. Among extant literature [22], found that certain aspects of TAM like perceived value and sensation-seeking behavior were important predictors of VR adoption for evaluating tourist destinations. In the same vein [23], found that perceived immersion, interest, enjoyment, and usefulness influenced the intention to use VR for travel planning. TAM has also been subjected to expansionist measures [24], expanded the TAM by incorporating social interactions and the strength of social ties, finding that these factors increased perceived enjoyment and influenced the intention to use VR. These findings collectively suggest that the TAM can be applied to understand travel intention and the intention to use VR.

2.1. Telepresence and perceived enjoyment

Numerous studies have revealed that one of the most important features of VR that marketers can exploit is telepresence [25,26]. The latter can be defined as a feeling of being in the world transmitted by the VR device [27,28]. Some refer to telepresence as a unique psychological state, which can affect behaviour [8,18]. In this study focused on marketing of nature-based destinations using VR technology, telepresence is viewed as a stimulator of the tourist perceived enjoyment. When people are exposed to VR, their telepresence will increase, compared to a regular 2D presentation, and through greater image vividness [29,30] and the ability to interact with the environment in VR [31], information processing will be enhanced [32,33]. This concentration of brain activity triggers the feeling of enjoyment similar to that experienced in the flow state [22,34]. In contrast to previous studies that attempted to explain telepresence by information processing characteristics such as sensory descriptiveness and interactivity [35], we argue that telepresence is an exogenous variable as people are exposed to it immediately when they enter VR. Only then does telepresence change affective and cognitive responses of the viewer leading them to the flow state and allowing them to experience greater enjoyment compared to traditional media. Based on this, the following hypothesis is formulated.

H1. Telepresence from VR technology stimulates greater perceived enjoyment in tourists.

2.2. VR and travel intentions

The relationship between emotions and consumer behaviour has been widely researched [36–38]. Hence, it is possible to predict that stronger perceived enjoyment brought by the VR technology to the tourist will stimulate the tourist travel intentions and the desire to experience the marketed destination in real life [27,39]. Many studies explain this phenomenon by observations that positive emotions from the VR use help form a more favourable destination image [40]; M. [4]; X [9]. Overall, the path from telepresence to perceived enjoyment to ultimate travel intention was documented in previous research that applied the Stimulus-Organism-Response (SOR) framework where telepresence is viewed as a stimulus which changes the psychological state (perceived enjoyment) of the organism prompting a response in the form of the desire to experience the destination in real life (J [24,41]. Based on this discussion, the next hypothesis is formulated.

H2. Perceived enjoyment experienced by tourists through VR has a positive effect on travel intentions.

Behavioural intentions, however, could be hampered if the VR technology is difficult to use or if the user perceives it as useless [15,16,42]. The Technology Acceptance Model (TAM) predicts that new technologies, including VR, will be adapted and embraced by users more quickly if their perceived usefulness and perceived ease of use are high [43,44]. Ease of use is associated with the learning curve required to comfortably use the new technology. However, perceived ease of use is a subjective construct and it depends on a number of socio-demographic factors such as the user age, gender, level of education, occupation and previous experience with the technology [24,45]. If it takes considerable amount of time or expertise to learn how to use the new technology, users will be reluctant to accept it and will not enjoy the process [46,47], which will lead to weaker behavioural intentions. This stream of arguments helps to formulate the following hypothesis.

H3. Perceived ease of use of VR has a positive effect on the perceived enjoyment and travel intentions.

Perceived usefulness of the VR technology is another major predictor of whether or not people will enjoy this technology and exhibit behavioural intentions (X [48]. Perceived usefulness can be defined as the utilitarian value that people receive from using the technology [49]. If a technology is useful and able to meet the user's needs, there will be greater perceived enjoyment and stronger travel intentions [17,26,31,43,44,50–52].

Based on this discussion, the next hypothesis is.

H4. Perceived usefulness of VR has a significant positive effect on the perceived enjoyment and travel intentions.

Thus, while the effects from telepresence to perceived enjoyment and travel intentions are explained by SOR Theory, the effects from perceived usefulness and ease of use on perceived enjoyment and travel intentions are explained by TAM [41,53,54].

2.3. VR and intentions to use

According to the original TAM, the constructs of perceived usefulness and perceived ease of use will have direct effects on the future intentions of people to use the technology, namely: VR in this case. These direct effects were documented in previous empirical studies [52,55]. Other studies attempted to extend TAM by singling out factors such as the cost of using VR, image quality of VR and interactivity features of VR and controls as significant determinants of future intentions to use [56].

Along with perceived ease of use and perceived usefulness, some studies distinguished perceived value as a potential driver of people's intentions to use VR technologies. In addition to this, the immersion experience and seeking new sensations were also considered influential in determining the VR implementation [22]. Some of these constructs such as immersion experience strongly correlate with the description of telepresence studied in this research. However, in contrast to Ref. [22]; we expect that telepresence will have an indirect effect on VR use through the mediating factor of perceived enjoyment. This leads to the following hypothesis.

H5. Telepresence channelled through perceived enjoyment has a significant influence on intentions to use VR.

The studies that previously argued that VR could be a "double-edge sword" in the tourism industry as it can replace real travels with VR

experience [57], do not consider the possibility that intentions to use VR can also reinforce future travel intentions. Evidence from other industries such as sports show that athletes use VR not as a replacement of their physical sport activities with virtual sport activities but as an instrument to train more effectively as the telepresence provided by VR allows for reaching a similar to real-life experience in training [58]. In the same way, we hypothesise that tourists who have been traveling to physical destinations may enjoy using VR for exploring new destinations but the virtual experience they have will reinforce their future intentions to make the actual travel. Hence, the final hypothesis is formulated as follows.

H6. Intentions to use VR are positively correlated with intentions to travel to the marketed destination.

The path diagram for the structural model of the study is illustrated in Fig. 1.

3. Methodology

3.1. Study design

The study uses an experiment as a between-subjects design distinguishing between two media types, namely VR and on-screen video. Participants are recruited from the population of tourists staying at hotels in Ha Noi. Even though previous studies found younger people to be more comfortable with the VR technology [59], limiting the sample to respondents of young age would weaken the ability to generalise the findings and make inferences for the whole population [17].

Participants with heterogeneous demographic characteristics are randomly assigned to either the VR condition or the 2D condition. In the treatment group, participants are exposed to an interactive video of a nature-based travel destination using a VR set. Participants in the control group are exposed to the same video presented on a regular 2D screen. The video app through which tourists interacted with the presentation remained the same. In both the VR and the 2D condition, the participants are told that they may request assistance and ask questions if needed. The video provides a general overview of the presented location and highlights the sustainability concerns regarding the environmental impact of tourism.

3.2. Sample instrument

We conducted a self-administered online survey to collect primary data from a diverse sample of international tourists visiting in Vietnam. The online survey followed a large-scale experiment we arranged with the help of tour operators and hotels in Vietnam. We received consent from 24 five-star and four-star hotels to make a video presentation of Son Doong cave, a nature-based attraction, before the hotel guests during the entertainment time. Using a randomiser, we divided the hotels into two equal groups of 12 hotels. The guests in one group of the hotels were considered the treatment group and they were shown the video presentation using VR sets and headphones with full emersion. The guests in the second group of hotels were considered the control group and they were shown the same video using a 2D large screen and projector with the same audio transmitted through speakers. At the end of the video presentation we shared a QR code with a link to the online questionnaire form requesting the audience to answer the survey questions. From the 12 hotels in the treatment group, the total number of 249 responses returned in total. From the control group of hotels, 263 valid responses were returned with completed questionnaires. This resulted in the total sample size of n = 512. Oculus Quest™ 2 VR head-mounted device was used as it does not require a PC or a smartphone to deploy the VR condition.

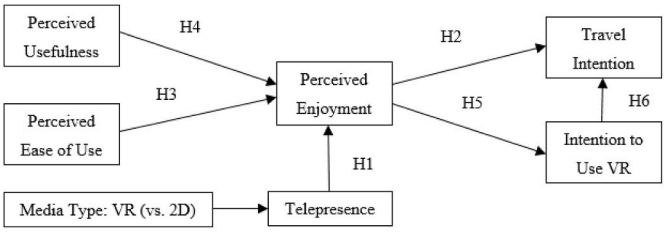

Fig. 1. Structural model of the study (Source: Authors' Own adapted from [19].

All participants completed a post-experiment questionnaire. The questionnaire includes items covering sociodemographic information and measures of the examined constructs from the conceptual framework (Appendix). The study adopted previously validated scales and adjusted them to fit the context of nature-based tourism [4,57]. These validated scales were not used in such a combination before. Furthermore, they have been re-coded using a 7-point Likert scale in order to improve the measurement of respondents' evaluations and to reduce the problem of interpolation when respondents seek a response that would be in-between two discrete choices [60,61].

The study controls for respondents' gender, age, past visits to the shown destination and whether they are local or foreign tourists. A pilot study administered among university students preceded the actual survey to ensure that the items were clear and had no ambiguity. In order to avoid the common method bias (CMB) [17], a Confirmatory Factor Analysis (CFA) marker was introduced. It was intended to capture patterns in responses that arise due to the use of the same instrument for measuring the dependent and independent variables. The CFA marker technique was previously proved to be more effective for dealing with CMB compared to the alternatives such as Harman's test and the correlation marker [62]. The analysis is performed using the lavaan package in the R statistical software.

In order to differentiate between respondents' intentions to use VR as a substitute for travel and intentions to travel to the shown destination, two outcome latent variables are introduced (VRI and TI). They have been modified from the [17] scale and extended to measure whether the viewers may, plan to or hope to visit the shown destination or use a VR tour instead.

3.3. Modelling approach

The study employs structural equation modelling (SEM) to test the research hypotheses [65,66]. Reduced-form regression analysis would not be effective in modelling relationships between latent variables [67]. In contrast, SEM allows for incorporating latent constructs that are not directly observed through experiment [68,69]. SEM has been widely used in the area of exploring travel intentions and assessing the role of media type and VR [17,43]. The analysis plan is given with Fig. 2.

The study applies and extends TAM with telepresence and perceived enjoyment in the context of VR adoption in the tourism industry. TAM is represented by constructs that capture the user's experience with the technology, namely: perceived usefulness and perceived ease of use. The model is extended by adding the construct of perceived enjoyment and the degree of telepresence allowed by the technology [70,71].

3.4. Sample characteristics

In total, there were 512 respondents, including 263 participants who were assigned the 2D condition and 249 who were assigned the VR condition. Table 2 summarises the demographic information about the sample.

Female tourists outnumber male tourists in our sample. The proportion of local tourists is also greater than the proportion of international tourists. However, most of the them, namely: 95.7% have not visited the shown destination before. In terms of age, the sample is dominated by young respondents aged 18–29. They comprise 43.75% of the sample. Other age categories are also present.

As the respondents were randomly assigned to one of the two groups

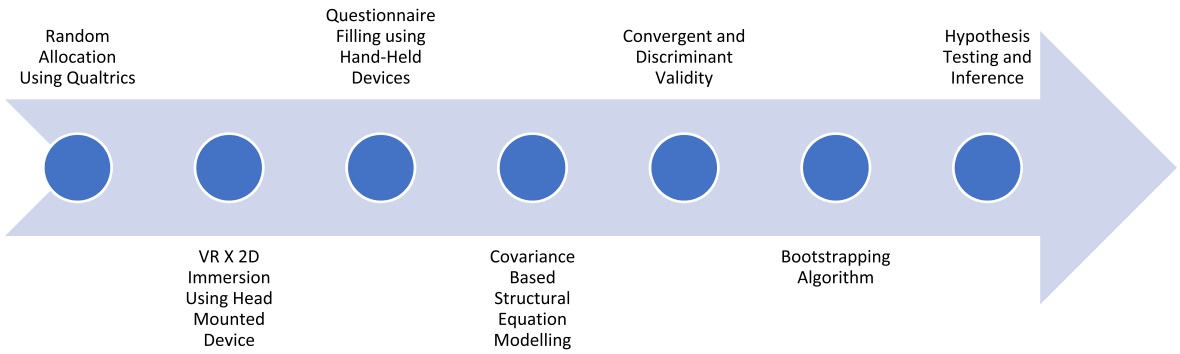

Fig. 2. Analysis Plan (Source: Author's Own adapted from Hair et al., 2017).

corresponding to 2D and VR treatments, it is important to check that this assignment does not translate into systematic bias. Fig. 3 shows the distribution of sample demographics by treatment group.

Overall, there appears to be no substantial differences between the distributions of individual characteristics in VR and 2D groups.

4. Analysis and results

Descriptive statistics of the questionnaire items are shown in Table 3.

On average, the respondents appear to agree with the statements related to the TAM constructs, as represented by the mean values of greater than 4.

Convergent validity was measured using Cronbach's alpha. The results are summarised in Table 4.

The alpha values for all constructs exceed the cut-off value of 0.70. These findings suggest that the constructs meet the criteria of reliability and convergent validity. In other words, the items corresponding to each construct tend to be related to each other, which supports the view that they measure some underlying latent variable.

Discriminant validity is assessed using two approaches, namely the Fornell-Larcker criterion and the heterotrait–monotrait (HTMT) ratio. The Hornell-Larcker criterion holds true if squared correlations of theoretical constructs are less than the average variance explained (AVE). Table 5 shows how squared correlations between latent constructs compare to the AVE.

None of the squared correlations exceed the corresponding AVE value. Overall, the larger correlations between latent constructs are in line with the expected linkages between the variables and do not exceed AVE, which supports the discriminant validity of the questionnaire.

The results of applying the HTMT ratio criterion of discriminant validity are presented in Table 6.

To sum up, the measurement model employed in the present study appears to be valid. Related variables correspond to similar constructs, while dissimilar constructs are easily differentiated. Having established construct validity, it is appropriate to estimate the structural model of travel intention and VR use intentions using the constructed latent variables.

4.1. Measurement model

Further analysis of factor loadings has been done using the Exploratory Factor Analysis (EFA) with oblimin rotation. EFA can suggest the optimal number of factors based not on theory but on statistical properties of the observed variables and their interrelations. Since our structural model is rooted in theory, the results of EFA will then be compared to Confirmatory Factor Analysis (CFA), which will check the quality of constructs based on the structure suggested by the theory rather than data. Table 7 shows that EFA clearly distinguished six factors based on data.

These loadings are very similar to those suggested by our theory and the items comprising each factor shown in Table 1.

Construct validity was assessed based on item loadings. The base line measurement model for CFA was estimated using six factors. The theory-based CFA model is also compared to several alternative models with different combinations of the factors in order to check whether the theoretical model produces the best fit based on measures such as the chi-square, CFI, TLI, RMSEA, and SRMR. In addition to this, the CFA includes the CMB testing by adding a CFA marker (CMV) (Table 8).

Among the competing models, the one theoretically justified and based on the provided conceptual framework in Fig. 1 demonstrates the best fit indicated by the highest values of CFI and TLI and the lowest values of chi-square, RMSEA and SRMR. The inclusion of the CFA marker (CMV) has only marginally improved the model. Since there is no substantial difference with the baseline model, it can be concluded that the study is not subject to the common method bias.

4.2. Structural model

The key output of estimating the structural model includes the estimated effects between constructs and their statistical significance. First, the direction of effects and paths coefficients are summarised in the following table (Table 9) while the goodness of fit of the final model compared to alternative models was presented previously.

The structural model shows seven statistically significant coefficients, which allows for accepting all hypotheses formulated in this study. In line with expectations, perceived enjoyment from using the VR technology does affect not only intentions to use this technology but also travel intentions.

Given the positive effect of telepresence on perceived enjoyment and subsequent travel intentions, this finding disproves previous fears that VR could become a substitute for actual travels. It is found to be both enjoyable on its own and able to stir emotions and appeal to intentions to make actual visits to the shown destinations. This confirms that VR can be an effective marketing Oculus Quest 2 to promote real nature-based destinations. In light of this, businesses in the tourism industry can be recommended to construct full-scale VR tours and use them as marketing instruments to promote destinations and attract more tourists.

The results of SEM estimation are graphically summarised in Fig. 4, showing the path diagram for the structural model.

These results of the testing of the hypotheses (Table 10) lead to the following decisions.

Overall, all structural relationships are supported by the statistical significance of corresponding effects.

5. Discussion, conclusion and implications

The study empirically tests six hypothetical dimensions to estimate VR usage and visit intentions drawing upon antecedents presented through the Technology Adoption Model. The first hypothetical

Table 1
Model constructs and corresponding scales.

Construct	Items	Scale	Items
Telepresence (TP)	TP1-TP3	(Pelet et al., 2017)	1. While I was watching the video presentation, I felt as if I were in another world 2. I had the feeling of really experiencing the destination shown in the video. 3. When I navigated through the video of Son Doong cave, I felt I was in a different place.
Perceived usefulness (PU)	PU1-PU5	[52]	1. Through the virtual reality application, I can more quickly get an impression of the Son Doong cave. 2. Due to the virtual reality application, I can easily evaluate the Son Doong cave. 3. PU3. By using the virtual reality application, I can better evaluate the Son Doong cave. 4. PU4. I find the virtual reality application useful to look at the Son Doong cave. 5. PU5. Overall, I find that the virtual reality application is useful to get an impression of the Son Doong cave.
Perceived ease of use (PEU)	PEU1-PEU4	[63]	1. The interaction with the VR is clear and understandable. 2. The interaction with the VR does not require a lot of effort. 3. I find VR app easy to use. 4. I find it easy to access the desired information through the VR app.
Perceived enjoyment (PE)	PE1-PE5	[64]	1. Using the virtual reality application is fun. 2. Using the virtual reality application is enjoyable. 3. Using the virtual reality application is pleasant. 4. Using the virtual reality application is entertaining. 5. Using the virtual reality application is exciting.
Intention to use VR (VRI)	VRI1-VRI3	[17]	1. I may use VR for exploring interesting nature-based destinations like Son Doong cave. 2. I plan to use VR for exploring interesting nature-based destinations like Son Doong cave. 3. I hope to use VR for exploring interesting nature-based destinations like Son Doong cave.
Travel intention (TI)	TI1-TI3	[17]	1. I may visit the Son Doong cave after watching the video. 2. I plan to visit the Son Doong cave after watching the video. 3. I hope to visit the Son Doong cave after watching the video.

Table 2
Sample characteristics: demographics.

Gender	Frequencies	Percent	Cumulative Percent
Female	302	58.98%	58.98%
Male	210	41.02%	100.00%
Total	512	100.00%	100.00%
Foreign vs Local			
Local	326	63.67%	63.67%
Foreign	186	36.33%	100.00%
Total	512	100.00%	100.00%
Prior Visit			
No	490	95.70%	95.70%
Yes	22	4.30%	100.00%
Total	512	100.00%	100.00%
Age			
18-29	224	43.75%	43.75%
30-39	129	25.20%	68.95%
40-49	89	17.38%	86.33%
50-59	47	9.18%	95.51%
60+	23	4.49%	100.00%
Total	512	100.00%	100.00%

dimension postulated that Telepresence from VR technology stimulates greater perceived enjoyment in tourists. According to the bootstrapping outcome, there indeed exists a positive relationship among the variables concerned. This implies that when tourists experience a higher level of telepresence in VR technology, they perceive greater enjoyment. The implications of this finding are that VR technology can be used as a tool to enhance the tourism industry by providing a more immersive and enjoyable experience for tourists. This can lead to increased visit intentions and repeat visits to destinations [72,73]. The results are pursuant to findings by Ref. [18] who deployed a similar 2 × 2 experiment model to predict intentions to visit through VR interventions.

The second hypothetical element studied the relationship between Perceived enjoyment and travel intentions. The current study detected a positive relationship and approved of this postulation in tandem with [64]. When tourists experience enjoyment through virtual reality, it positively influences their travel intentions. This finding has important implications for the tourism industry, as it suggests that virtual reality can be used as a tool to enhance telepresence and inspire sustainable travel intentions [21]. By providing tourists with immersive and enjoyable virtual experiences, tourism destinations can increase their appeal and encourage visitors to travel in a more sustainable way [18].

The third hypothetical stance of the study concerns a positive relationship between perceived ease of use and travel intentions. The CB-SEM outcome signals a positive connotation between the constructs in question. This finding has important implications for the tourism industry, as it suggests that virtual reality can be used as a tool to enhance telepresence and inspire sustainable travel intentions. By providing immersive and realistic virtual experiences, virtual reality can help tourists develop emotional attachments to destinations, which can ultimately lead to increased travel intentions. This is supported by research that shows that virtual tourism can enhance customer experience and destination interpretation [74], and that virtual tourism experiences can significantly enhance travel intention in the future [18]. The use of virtual reality in tourism destinations can also help develop tourist behavior perspective [75].

The fourth postulation of the technology adoption model suggests that the perceived usefulness of VR has a significant positive effect on perceived enjoyment and travel intentions. This hypothesis is supported by empirical evidence, indicating that individuals who perceive VR as useful are more likely to enjoy the experience and have a greater intention to travel [76]. This finding has important implications for the study, as it suggests that the perceived usefulness of VR is a critical factor in enhancing telepresence and inspiring sustainable travel intentions in the tourism industry. Therefore, it is important for tourism companies to focus on developing VR experiences that are perceived as useful by their target audience. Additionally, it is important to note that the perceived usefulness of VR is moderated by individual differences, such as openness to experience [77]. Therefore, it may be beneficial for tourism companies to consider these individual differences when designing VR experiences.

The fifth supposition estimated that telepresence channeled through perceived enjoyment has a significant influence on intentions to use VR was supported by sound statistical evidence. Similar studies done in fields like Gaming [56], Hotel booking [43], shopping and retail [27] and mobile augmented reality [78] are in-line with the revelations of the current study. Telepresence refers to the feeling of being present in a virtual environment, and perceived enjoyment refers to the degree to which using VR is perceived to be enjoyable. The results suggest that the more vivid and immersive the telepresence, the more positive the

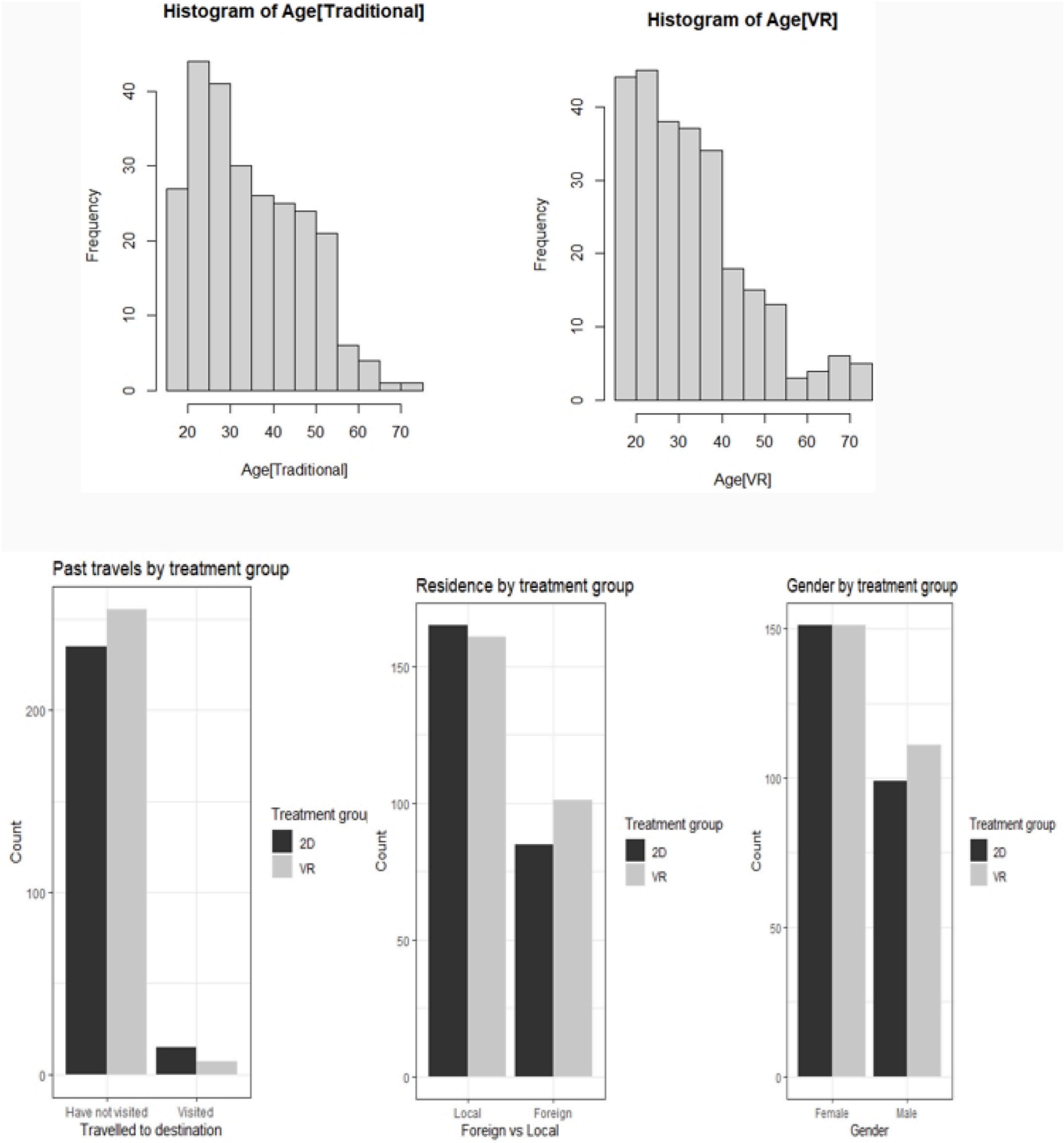

Fig. 3. Sample demographics by treatment.

perceived enjoyment, and the more likely the user is to intend to use VR [56]. Aligning with [51]; the authors detect that perceived enjoyment also mediates the relationship between telepresence and intention to use VR that implies that with the help of techniques that can enforce enjoyment of the virtual media like attractive user interface experience (UIx), marketers can leverage the propensity to use VR.

The sixth hypothesis projects that intentions to use VR are positively correlated with intentions to travel to the marketed destination. This hypothesis is supported by sound statistical evidence. This translates to the fact that individuals' intention to use VR expand their intention to travel to the destination that is being promoted in the virtual dimension [22]. The research results suggest that VR exposure leads to higher levels of mental imagery and happiness predictions, which in turn is associated with stronger travel intentions and purchasing [8]. The findings showed that interest in VR tourism had a strong hierarchical effect on the behavioral intention to a particular tourist visit which is in harmony with the findings of [47].

The key purpose of this study was to assess the use of VR as a tool for

Table 3
Sample summary statistics by questionnaire item.

	Mean	SD	Median	Min	Max
TP1	4.51	1.7	5	1	7
TP2	4.5	1.69	5	1	7
TP3	4.63	1.64	5	1	7
PU1	4.42	1.91	5	1	7
PU2	4.31	1.82	5	1	7
PU3	4.46	1.79	5	1	7
PU4	4.45	1.84	5	1	7
PU5	4.41	1.86	5	1	7
PEU1	4.45	1.86	5	1	7
PEU2	4.31	1.85	5	1	7
PEU3	4.35	1.81	5	1	7
PEU4	4.33	1.92	5	1	7
PE1	4.38	1.87	5	1	7
PE2	4.24	1.86	4	1	7
PE3	4.42	1.83	5	1	7
PE4	4.43	1.82	5	1	7
PE5	4.33	1.88	5	1	7
TI1	4.6	1.68	5	1	7
TI2	4.62	1.66	5	1	7
TI3	4.64	1.68	5	1	7
VRI1	4.53	1.64	5	1	7
VRI2	4.55	1.69	5	1	7
VRI3	4.62	1.62	5	1	7

Table 4
Measurement model: convergent validity.

Construct	Cronbach's alpha
TP	0.85
PU	0.90
PEU	0.833
PE	0.838
TI	0.866
VRI	0.875

Table 5
Measurement model: discriminant validity (Fornell-Larcker criterion).

Squared correlations	TP	PU	PEU	PE	TI	VRI
TP	1.000					
PU	0.118	1.000				
PEU	0.002	0.005	1.000			
PE	0.035	0.033	0.061	1.000		
TI	0.024	0.008	0.016	0.107	1.000	
VRI	0.040	0.005	0.007	0.080	0.636	1.000
AVE	**0.657**	**0.643**	**0.557**	**0.511**	**0.683**	**0.700**

Table 6
Measurement model: discriminant validity (heterotrait–monotrait ratio).

	TP	PU	PEU	PE	TI	VRI
TP	1.000					
PU	0.350	1.000				
PEU	0.045	0.055	1.000			
PE	0.137	0.160	0.237	1.000		
TI	0.153	0.083	0.093	0.309	1.000	
VRI	0.196	0.066	0.072	0.267	0.786	1.000

The criterion requires the HTMT ratio between two constructs to not exceed 0.90. Largest ratios of 0.786 exists between TI and VRI showing that these constructs are correlated but are still distinguished from one another. As such, discriminant validity is established between all pairs of included constructs.

destination marketing of sustainable tourism. A number of previous empirical studies documented that telepresence was an important feature that distinguished VR from alternative 2D technologies, which could amplify the marketing effectiveness of the VR channel in promoting sustainable tourism destinations [15,16,43]. Others feared that

Table 7
Factors from EFA.

	F1	F2	F3	F4	F5	F6
TP1	**0.748**	0.074	−0.021	0.024	0.048	−0.065
TP2	**0.867**	0.006	−0.032	−0.010	−0.038	0.040
TP3	**0.828**	−0.024	0.038	−0.002	−0.001	0.034
PU1	0.052	**0.808**	0.026	0.014	0.028	−0.037
PU2	−0.037	**0.862**	0.011	−0.068	0.032	−0.006
PU3	0.098	**0.752**	0.017	0.036	0.051	−0.081
PU4	−0.041	**0.829**	0.003	0.009	−0.014	0.031
PU5	−0.003	**0.835**	−0.037	0.034	−0.069	0.078
PEU1	−0.037	0.019	**0.831**	0.011	−0.098	0.063
PEU2	−0.068	0.045	**0.754**	−0.005	0.043	0.012
PEU3	0.060	−0.027	**0.736**	0.006	−0.078	0.028
PEU4	0.058	−0.028	**0.699**	0.032	0.199	−0.127
PE1	0.134	−0.043	0.023	**0.678**	0.040	0.043
PE2	−0.069	0.016	−0.032	**0.743**	−0.065	−0.002
PE3	0.002	0.023	−0.003	**0.789**	0.046	−0.016
PE4	0.048	−0.015	0.084	**0.708**	0.004	0.009
PE5	−0.077	0.014	−0.025	**0.724**	−0.003	−0.005
TI1	0.012	−0.013	0.020	−0.022	**0.865**	0.016
TI2	0.015	0.024	0.030	0.001	**0.761**	0.085
TI3	−0.027	0.026	−0.063	0.087	**0.763**	0.083
VRI1	−0.013	−0.043	0.008	0.029	0.264	**0.662**
VRI2	0.025	0.036	−0.009	0.038	−0.052	**0.883**
VRI3	0.021	−0.009	0.028	−0.039	0.075	**0.808**

Table 8
CFA and CMB testing.

Model	chi-sq	df	CFI	TLI	RMSEA	SRMR
(TP,PU,PEU,PE,TI, VRI)	**441.86**	**215**	**0.962**	**0.955**	**0.045**	**0.037**
(TP,PU,PEU,PE,TI, VRI,CMV)	**546.8**	**278**	**0.959**	**0.952**	**0.043**	**0.037**
(TP,PU + PEU,PE, TIVRI)	1940.29	220	0.712	0.669	0.124	0.138
(TP,PU,PEU,PE,TI + VRI)	623.68	220	0.933	0.922	0.060	0.041
(TP + PE,PU,PEU, TI, VRI)	1337.17	220	0.813	0.785	0.100	0.111
(TP + PE,PU + PEU, TI,VRI)	2088.04	224	0.688	0.648	0.127	0.140
(TP + PE,PU + PEU,TI + VRI)	2266.73	227	0.659	0.620	0.132	0.141
(TP + PU + PEU + PE, TI + VRI)	2877.33	229	0.557	0.511	0.150	0.157
(TP + PU + PEU + PE + TI + VRI)	4519.50	230	0.283	0.211	0.191	0.205

Table 9
Structural model: goodness-of-fit.

Effects	Coefficient	Std.Error	z	p-value
TREAT → TP	0.921***	0.069	13.326	0.000
PU → PE	0.114***	0.043	2.646	0.008
PEU → PE	0.206***	0.046	4.442	0.000
TP → PE	0.128***	0.047	2.718	0.007
PE → TI	0.395***	0.063	6.271	0.000
PE → VRI	0.356***	0.065	5.511	0.000
VRI → TI	0.513***	0.045	11.402	0.000
PEU → PU	0.044	0.033	1.350	0.177

Notes: *p < 0.10; **p < 0.05; ***p < 0.01.

the VR technology could become a substitute for outdoor activities and people would travel less. This could result in a decline of tourism.

This study has made a contribution by testing the effects of the VR technology on both the intentions to use VR and intentions to travel using the channels of perceived enjoyment and telepresence, which extended the original TAM model. Our findings contribute to literature by showing the positive effect of telepresence on perceived enjoyment [51], intentions to use VR and ultimate travel behaviour [27,39]. This

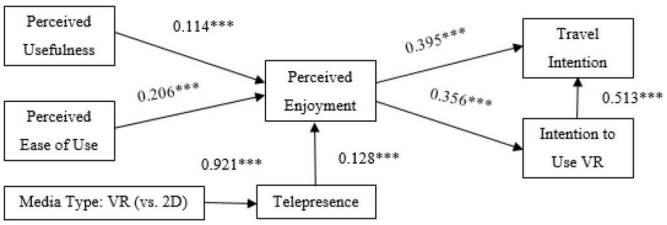

Fig. 4. Structural model: path diagram with estimated effects. Notes: All effects are standardised.

Table 10
Summary of hypotheses.

Hypothesis	Description	Decision
H1	Telepresence from VR technology stimulates greater perceived enjoyment in tourists.	Supported
H2	Perceived enjoyment experienced by tourists through VR has a positive effect on travel intentions.	Supported
H3	Perceived ease of use of VR has a positive effect on the perceived enjoyment and travel intentions.	Supported
H4	Perceived usefulness of VR has a significant positive effect on the perceived enjoyment and travel intentions.	Supported
H5	Telepresence channeled through perceived enjoyment has a significant influence on intentions to use VR.	Supported
H6	Intentions to use VR are positively correlated with intentions to travel to the marketed destination.	Supported

has practical implications. Companies can develop and sell virtual tours to nature-based destinations and use them to promote demand and attract even more tourists to these destinations. In contrast to the previously expressed fears, VR does not pose a threat to the tourism industry and is not a full substitute for actual travels.

Supporting a stream of research showing that VR-induced telepresence can enhance enjoyment through greater image vividness [29]; J [30]. and interactivity [31–33], this study documents that perceived enjoyment from VR is a significant mediating factor between telepresence and travel intentions and between original TAM's constructs and intentions to use VR. Furthermore, the two latent variables of travel intentions and VR use intentions are positively correlated, which confirms the usefulness of VR in marketing nature-based tourist destinations.

The study is subject to a few limitations that may be addressed in future research. First, the data collection method used a questionnaire as the main instrument. Since the data on planned travel behaviour is self-reported, rather than observed through purchase decisions, there is a possibility that the actual decision-making would deviate from the survey responses. This reflects the general difference between stated preference and revealed preference methods. Second, the estimated model does not provide a willingness-to-pay estimate that would be useful for decision-makers. Future research may address these limitations by considering a sample with more varied demographic characteristics and using revealed preference methods for estimating how the willingness-to-pay for low-impact tourism may be affected by the use of VR in destination marketing.

Declaration of competing interest

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

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.techsoc.2023.102378.

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Sinh Duc Hoang is a PhD scholar at the Department of Business Administration at the Faculty of Management and Economics, Tomas Bata University in Zlin, Czech Republic. He's also a lecturer at Ho Chi Minh University of Foreign Languages – Information Technology. His research interests are ecotourism, marketing, advanced technology. His contributions to this study include idea development, research framework conceptualization, literature review, survey development, data collection, data analysis, writing on the original draft, review and editing; he contributed during all rounds of revision. Email: sinhhd@huflit.edu.vn, ORCID: 0000-0001-6382-4056

Sandeep Kumar Dey is a PhD scholar at the Department of Business Administration at the Faculty of Management and Economics, Tomas Bata University in Zlin, Czech Republic. His interest lies in sustainable tourism development and applied econometrics. He has published several papers in his field in international peer-reviewed journals with impact factors and cite scores. He is also a student fellow with the Czech Mathematical Society under the aegis of the Union of Czech Mathematicians and Physicists, Prague. His contributions to this study include idea development, research framework conceptualization, literature review, survey development, data collection, data analysis, writing on the original draft, review and editing; he contributed during all rounds of revision. Email: dey@utb.cz, ORCID ID: 0000-0002-9103-5422

Tien Phat Pham is a PhD scholar at the Department of Business Administration at the Faculty of Management and Economics, Tomas Bata University in Zlin, Czech Republic. He's also a lecturer at Can Tho University, Vietnam. His research interest is business management. His contributions to this study include idea development, research framework conceptualization, literature review, survey development, data collection, data analysis, writing on the original draft, review and editing; he contributed during all rounds of revision. Email: pptien@ctu.edu.vn, ORCID: 0000-0001-9472-5878

Zuzana Tučková: A Professor and Dean of Faculty of Logistics and Crisis Management at Tomas Bata University in Zlín, Czech Republic. Her research interests are sustainable tourism, socially responsible tourism and BPM in tourism. Her contributions to this study include idea development, research framework conceptualization, survey development, data collection supervision, writing, review and editing; she contributed during all rounds of revision. She has publications in Tourism Management, International Journal of Hospitality Management, Journal of Competitiveness … Email: tuckova@utb.cz, ORCID: 0000-0001-7443-7078