ENGAGING VIRTUAL REALITY TECHNOLOGY TO DETERMINE PRO-ENVIRONMENTAL BEHAVIOUR: THE INDIAN CONTEXT

Sandeep Kumar DEY[*]
Tomas Bata University in Zlin, Faculty of Management and Economics, Zlin,
The Czech Mathematical Society, Prague, Czech Republic, e-mail: dey@utb.cz

Sinh Duc HOANG
Tomas Bata University in Zlin, Faculty of Management and Economics, Zlin, Czech Republic, e-mail: dhoang@utb.cz
Ho Chi Minh City University of Foreign Languages – Information Technology, Vietnam, e-mail : sinh.hd@huflit.edu.vn

Hoc Huynh THAI
Tomas Bata University in Zlin, Faculty of Applied Informatics, Zlin, Czech Republic, e-mail: huynh_thai@utb.cz

Quynh Giao Ngoc PHAM
Tomas Bata University in Zlin, Faculty of Multimedia Communication, Zlin, Czech Republic, e-mail: qpham@utb.cz

Abstract: The main purpose of this study is to capture key pro-environmental behaviours that are triggered when individuals are subjected to a virtual environment simulation of a pristine tourism destination. The study made use of virtual reality headsets to gauge potential predictors of pro-environmental behaviour. Pre and post intervention response differentials were recorded through a structured questionnaire on 100 individuals. The study was divided into two stages. The first stage comprised of the PLS-SEM algorithm which empirically tested postulations anchored on the Pro-Environmental Behaviour framework. The second phase of the study deployed the PLS-MGA algorithm to observe changes in propensities. Findings reveal that, virtual reality interventions partially effect how individuals perceive pro-environmental behaviour. The study advices policy makers and practitioners to cultivate industry 4.0 technologies like virtual reality to raise awareness about climate action among tourists. For academicians, the study expands the utility sprectrum of the Pro-Environmental Behaviour (PEB) framework and it is suggested that future studies inculcate virtual/augmented/extended reality competencies in experiment based investigations. The study maybe repeated in the context of other developing economies where sustainable tourism development remain a challenge.

Key words: Tourism management, virtual reality, sustainability, tourist behavior

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INTRODUCTION

A critical aspect of technological advancement assumed to significantly impact the tourism industry is virtual reality (VR). Contemporary developments in VR platforms, devices, and content production tools have proved to be conducive for VR technologies to progress from a niche technology consumed mostly by the gaming industry into the paradigm of everyday experiences. The access to affordable VR gadgets such as googles cardboard and the profusion of tourism-related VR content makes it easier for anyone to experience virtual tours of cities and tourist attractions from anywhere in the world. In the present-day scenario, VR has the potential to make virtually accessible a range of destinations, from the most visited to the least visited. The discourse on VR and its role in tourism emerge in the scientific literature in the last 3 decades (Cheong, 1995; Dewailly, 1999; Guttentag, 2010; Huang et al., 2016; Williams and Hobson, 1995).

Virtual realities can simulate complex and real-life situations and contexts (Diemer et al., 2015), authors like (Sussmann and Vanhegan, 2000) and (Cheong, 1995) observe that simulation can substitute for actual travel and that it is considered to be a positive contribution to environmental sustainability (Dewailly, 1999) as it is capable of virtually transmitted, captivating imagery and mimicking environments and contexts. Natural wonders, buildings, structures, artifacts, and habitats are all disappearing, which is a major issue for tourism destinations worldwide. Several human and natural factors, including tourism activity, climate change, and inadequate control, planning, and management, as well as political uncertainty, contribute to the deterioration (Bauer, 2015; De'Ath et al., 2012). According to (Little et al., 2018) the conservation of man-made and natural sites, works of arts, attractions, and destinations have gained academic interest in the last decade. A paradigm shift has been observed when considering the important role of sustainability, over the years, the focal point of research has turned from the realm of conservation to sustainability, which is now deep-rooted within contemporary tourism research and practice (Hall et al., 2015; Mowforth and Munt, 2015). Review of literature has identified several approaches towards sustainability as a discipline (Hall et al., 2021; Mowforth and Munt, 2015) have purported demarketing as

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an approach to sustainability, which implies systematically discouraging visitations; similarly authors like (Jamal and Higham, 2021) have appraised the efficacy of responsible tourism as an approach to understand sustainable development in the context of uplifting native communities at the destination level. Similarly, (Wallace and Russell, 2004) have proposed the eco-cultural framework to evaluate ways for the sustainable expansion of eco-cultural products in the most sensitive regions. Another important dimension of tourism sustainability is eco-tourism (Fennell, 2001), which are enlaid ethos to be adopted for a better understanding between the tourists and the environment. In an attempt to evaluate the psycho-social atmosphere conducive for the sustainable development of the tourism industry, several behavioural theories have been deployed to investigate the supply and demand side of the tourism industry (tourists, service providers and local communities), these include Theory of Planned Behaviour (Ajzen, 2002). Theory of Reasoned Action (Heller et al., 2013), Stimulus-Response-Action (Jacoby, 2002) and Norm Activation Model (De Groot and Steg, 2009). Contemporary studies in the sustainability domain have seeen a surge in scholastic interest towards understanding how tourists interact with the ethos of sustainability. In order to capture, assess and predict sustainable behaviour among the various tourism stakeholders, academicians have proposed robust psychometric frameworks. Prime examples being the New Environment Paradigm (Dunlap, 2008), Environmental Sustainability Index (Schmiedeknecht, 2013) and Ecological Footprint Analysis (Gössling et al., 2002).

In this study, the authors seek to extend the predicting capacity of a similar psychometric instrument known as the Pro-Environmental Behaviour (PEB). (Kurisu and Kurisu, 2015) defines PEB as set of compatible behaviours to cultivate environmental consciousness or in the words of authors (Kollmuss and Agyeman, 2010; Li et al., 2019; Stern, 2000) "….pro-environmental behavior is purposeful action that can reduce a negative impact on the environment". PEB has been deployed as a preferred research framework by the following highly cited studies (Table1).

Table 1. Few highly cited studies in PEB domain (Source: Authors' Own)

Study	Context	Gap Identified
(Gatersleben et al., 2014)	Implication of values and identity in PEB	Research beyond norms and narratives is required
(Coelho et al., 2017)	Negative and Positive Affects in PEB	Calls to action the interaction among other factors other than demographics
(Vicente-Molina et al., 2013)	Environemntal knowledge in PEB	Changes in Attitude due to VR exposure need to be investigated
(Blok et al., 2015)	PEB at the workplace	Contextual research is required to investigate the subjective impact
(Wang et al., 2021)	Biospheric Values and Environmental Identity concerning PEB	Call to action on the subjective impact on individuals

Through this paper, the authors attempt to extend the epistemological spectrum of the Pro-Environmental Behaviour through a Virtual Reality Intervention to derive the subjective transformation of eco-consciousness and predict pro-ecological behavior among potential tourists. Our study is in conjunction with literature like (Guttentag, 2015) who outlined the significant role played by virtual reality in determining tourist choice, (Lo and Cheng, 2020) who studied consumer response in tourism marketing through virtual reality media observed a positive mediating role of the VR intervention, an empirical investigation by (Muñoz-Saavedra et al., 2020) studied about the future direction of VR in tourism management emphasised the efficacy of virtual reality capabilities in predicting behavioural dynamics among tourist groups and an empirical design by (Scurati et al., 2021) on using virtual reality technology to support sustainable behaviour. On the basis of the above premises the author's have deviced the following hypothetical frameworks given via Figure 1 and Figure 2. On the basis of model given on Figure 1 and 2, this study endevours to respond to the following issues being faced by academia and industry: a. What is the efficacy of a virtual reality intervention in cultivating pro-eco behaviours?
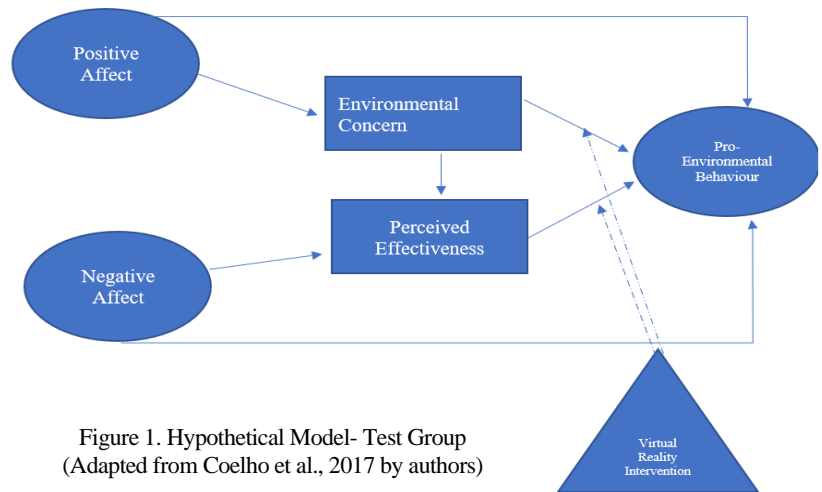

Figure 1. Hypothetical Model- Test Group
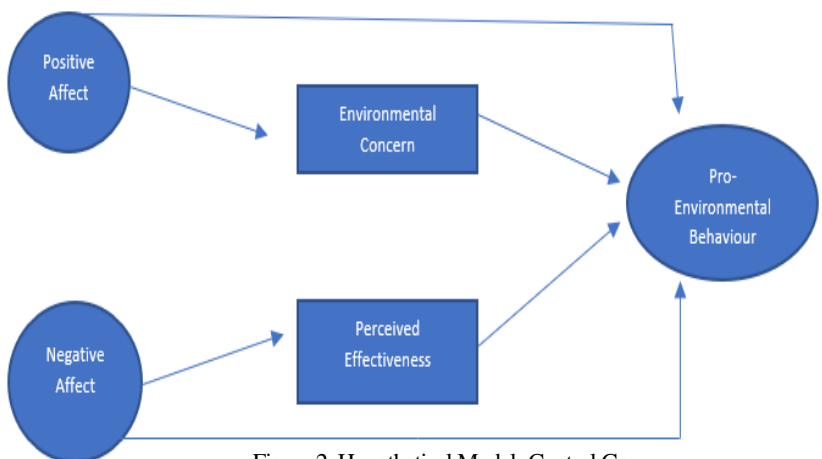(Adapted from Coelho et al., 2017 by authors)

Figure 2. Hypothetical Model- Control Group
(Adapted from Coelho et al., 2017 by authors)

LITTERATURE REVIEW
Positive Affect

Positive affectivity (PA) is an aspect of human behaviour that explains how many positive effects individuals have (sensations, feelings and feelings), and how they connect with other people and the environment (Ashby et al., 1999). Persons with strong positiveness are usually passionate, vigorous, confident, active and alarming (Schenk et al., 2018). Furthermore, (Clayton et al., 2017) who studied public support for bio-diversity explicated the catalysing role of positive affect on environmental concern among a large American consumer base.

Positive affectivity was connected with increased lifespan, improved sleep and reduction in stress hormones. Individuals with a very positive affinity are more healthy, positive self-quality and motivated towards the objective. Positive affectivity encourages openness, friendliness and assistance (Lee and Syah, 2018; Paterson et al., 2016).

Negative Affect

A variable of personnalities including unpleasant feelings and bad self-conceptions is a negative affection (NA). A wide array of negative emotions, including rage, dislike, guiltiness, anxiety, and anxiousness, comprise negative affectivity (Mustafa and Abdul, 2019; Watson and Clark, 1984). Low negative affectivity, together with trust, activities and excitement are characterized by frequent feelings of peace and peace. People differ in negative emotional responsiveness. Trait negativity connects in large part to the main personality element of anxiety and neuroticism that may be seen as emotional stability in the Big Five personality features (Koch et al., 2013). In this research NA has a negative connotation with PEB.

Environmental Concern

Environmental concern has been treated as an evaluation of, or an attitude towards facts, one'sown behaviour, or others' behaviour with conse-quences for the environment (Aries et al., 1983; Drottz-Sjöberg and Sjöberg, 1991; Lee and Kwag, 2013; Takala, 1991). It is related to egoistic, social-altruistic, and biospheric value orientations and also to beliefs about the consequences of environmental changes for valued objects (Stern and Dietz, 1994). In other words, one's attitudes toward specific environmental topics are distinct in some ways, but are ultimately reflections of a single, broad environmental attitude - what is sometimes referred to as environmental concern (Dunlap and Jones, 2002).

Perceived Effectiveness

PCE is an established predictor of pro-environmental behavior. Despite earlier studies demonstrating PCE's predictive value for knowledge, intentions, and aggregated action (Allen, 1982). Perceived effectiveness can be defined as the subjective likelihood that a message will have a persuasive impact. Reading a message is the first step of the persuasion process. If recipients find difficulty in reading and understanding the message, it is unlikely to have a persuasive impact (Suka et al., 2017).

Pro-Environmental Behaviour

Understanding what influences an individual's proclivity to engage in pro-environmental behavior (PEB) is a difficult problem that is still not fully understood (Coelho et al., 2017). PEBs include responsibly engaging with nature or recycling household garbage, but they may also be adaptive reactions to the effects of climate change, such as purchasing sustainable items (e.g., local food, green cleaning products), saving water or energy, or changing transport modes (e.g., from driving to walking or cycling) to purchasing an electric car or creating an off-grid home (van Valkengoed and Steg, 2019).

According to the above premises, we conclude the following hypothesis

H_1 : there exists a significant response differential among the test and control group in terms of the effect of Virtual Reality on Pro-Environmental Behaviour.

H_2: Environmental Concern significantly predicts pro-environmental behaviour

H_3: Negative affect has a negative relationship with perceived effectiveness

H_4: Perceived effectiveness has a significant relationship with pro-environmental behaviour

H_5: Positive Affect has a significant relationship with pro-environmental behaviour

RESEARCH METHODOLOGY

This is an experiment based research wherein the participants were treated with a bite- sized virtual reality rendition of a pristine tourist area being subjected to tourism activities over a particular time lapse. The study would like to investigate the efficacy of the theory of pro-environmental behaviour (Han and Hyun, 2018) when there is a simulated environment intervention. This was a phase wise study that will be done in two phases. Firstly, the participants were asked to fill up a questionnaire containing items from the pro-environmental behaviour theory (pre-testing) afterwhich the participant underwent the VR intervention through a HMD (Head Mounted Device) and were subjected to the same questionnaire to capture the behavioural differential. The study was conducted on college going students between the ages of 17-25 in India.

The investigation consists of two groups and two phases. In the first phase, the test group and the control group were formed from the available list of students who agreed to participate in the study through an online recruitment form, that contained basic questions pertaining to the inclusion criteria, the responses who adhered to the inclusion policy were selected. The test group consist of those respondents who were subjected to a 2 minute 15 second 3D audio/vedio on a VR enabled headset powered by a 6.5" mobile screen and the control group were shown the same audio/video clip on a normal 6.5" mobile screen. The second phase saw respondents interacting with the PEB measuring scale (Table1) through an online questionnaire from the comfort of their personal devices. This exercise was in conjunction with extant investigations like (Flavián et al., 2019) and (Huang et al., 2016) who litmus tested the prowess of virtual reality in capturing behavioural

tendencies by conducting such intervention-based experiments. (Yung et al., 2020) curated a literature review of augmented and virtual reality usage in tourism research, it is observed that a significant 17% of the articles in the last 5 years (2016-current) have successfully deployed VR based devices in attempt to gauge actual behaviour among tourists.

During the second phase, in order to capture, gauge and evaluate the psychometric propensities of the responses obtained from both the test and control group, the data was treated with a partial least square regression technique using the structural equation model approach provided by the GUI based SMART -PLS application, The primary reason as to why PLS-SEM was used is that the assumption of normality of data doesn't exist and it has been vehemently used in studies involving smaller sample sizes. PLS-SEM has a robust capacity in handling categorical data.

In order to determine the sample size, the study extrapolated key parameters and their ideal values (α =0.05; dF=25 and targeted RMSEA=0.80) from the critical literature review and imputed a sample size of 120 on a calculator known as quantpsy (Preacher and Coffman, 2006) which uses a lean client interface of the statistical program R to execute various apriori analysis. The output of the computer program returns a power of 0.8584197 which is robust for 120 samples. Out of 120 questionnaires, 100 were found to be usable. According to the RMSEA projection a sample size > 90 is acceptable. The plot of the power and sample size estimation is given in Figure 2. This process of determining the sample size by estimating the RMSEA is in cojunction with (MacCallum et al., 1996) and (Steiger, 1998).

As for the sampling design is concerned, the study adopts non-random selection approach as there is an inclusion policy that qualifies an individual's likelihood to be a participant in the study (Acharya et al., 2013). The statistical interventions were applied in 2- stages. Firstly, the data was treated with a PLS algorithm to gauge the robustness of vital components of the structural equation model (AVE, Chronbach's α, Composite Reliability, Fornell-Larcker Criterion). The second stage involved the implementation of the MGA algorithm (Multigroup Analysis) to investigate the existence of any variance among the test and control groups reponses.
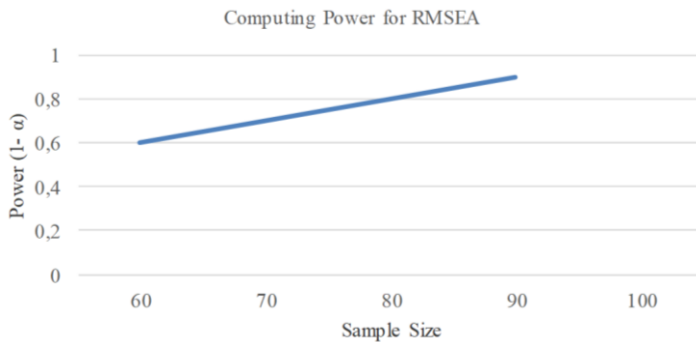

Figure 3. Power-Sample Size analysis (Source: Preacher and Coffman, 2006)

Table 2. Model Validity (SMARTPLS Software v. 3.3.3)

	Cronbach's α	rho_ A	Composite Reliability	Average Variance Extracted (AVE)
Environment Concern	0.616	0.613	0.79	0.557
Negative Affect	0.858	0.878	0.902	0.697
PEB	0.67	0.689	0.768	0.526
Perceived Effectiveness	0.725	0.742	0.844	0.643
Positive Affect	0.863	0.871	0.907	0.711

As per Figure 4, all loading values of the indicators to their respective constructs are observed to be in satisfactory conditions, that is <0.5 (Hair et al., 2017). In Table 4, it can be observed that for both the groups the interaction among the constructs remains significant at p<0.01 The robust observations from above Table 4 encourage the researchers in conducting the Multi-Group Analysis for the test group against the control group in the second stage of the study.

FINDINGS AND ANALYSIS
First stage: model robustness and assessment

In order to evaluate the robustness of the hypothetical dimensions so formed, it is an imperative that the study investigates the various vital parameters to gauge the effectiveness of the operational model (Hair et al., 2019) in predicting pro-environmental behaviour. Table 2 describes the vital parameters of the outer and measurement model(s). The Cronbach's alpha values are in the stable range as all values are < 0.6 (Bagozzi and Yi, 1988), followed by the rho_A which has reported values to be at <0.6 (Dijkstra and Henseler, 2015). The composite reliability values have also
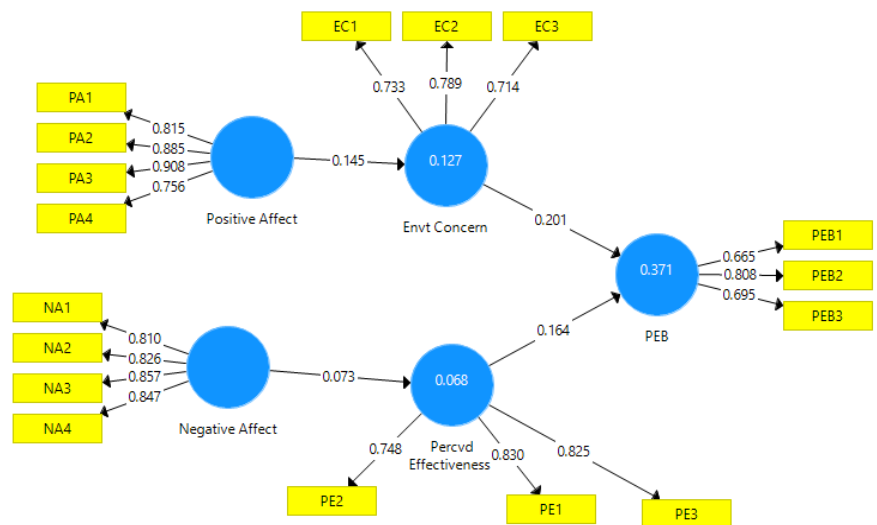

Figure 4. PLS Algorithm Output (SMART PLS v. 3.3.3)

been observed to be in the admissible range (<0.7) as recommended by (Jr. et al., 2017). And the Average Variance Extracted values (<0.5) are also observed to be in the normal range for acceptance into the study. Table 3 depicts the Fornell-larcker criterion, which is the capacity of the latent variable in loading its corresponding observed values. The

values in Table 3 which are in bold and are represented in the diagonal are the readings of the F-L criterion and are observed to be robust in nature due to the fact they are larger than the other values in the same row (Henseler et al., 2014).

Second stage: a multi-group analysis

From the below table 5, it may be deciphered that there exists a substantial difference between positive affect and environmental concern with the p-value being significant at p<0.05. This observation may only partially permit the researchers to accept the presumption that there exists a difference between the two groups.

Table 3. Fornell-Larcker Criterion (SMARTPLS Software v. 3.3.3)

	Environment Concern	Negative Affect	PEB	Perceived Effectiveness	Positive Affect
Environment Concern	**0.746**				
Negative Affect	0.492	**0.835**			
PEB	0.517	0.501	**0.725**		
Percvd Effectiveness	0.382	0.261	0.495	**0.802**	
Positive Affect	0.356	0.455	0.445	0.205	**0.843**

Table 4. PLS-SEM Execution Report (SMART PLS v. 3.3.3)

	Original Sample (β)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Envt Concern -> PEB	0.384	0.390	0.051	7.504	**0.000****
Negative Affect -> Percvd Effectiveness	0.261	0.270	0.045	5.742	**0.000****
Percvd Effectiveness -> PEB	0.348	0.349	0.056	6.240	**0.000****
Positive Affect -> Envt Concern	0.356	0.364	0.054	6.544	**0.000****

**significant at p-value <0.01

Table 5. PLS-MGA Analysis (SMART PLS v 3.3.3)

	Path Coefficients-diff (GROUP_Test(1.0) - GROUP_Control(2.0))	p-Value original 1-tailed (GROUP_Test(1.0) vs GROUP_Control(2.0))	p-Value new (GROUP_Test(1.0) vs GROUP_Control(2.0))
Envt Concern -> PEB	-0.145	0.948	**0.104**
Negative Affect -> Percvd Effectiveness	0.029	0.375	**0.749**
Percvd Effectiveness -> PEB	-0.118	0.863	**0.273**
Positive Affect -> Envt Concern	0.218	0.992	**0.016****

**significant at p-value <0.05

DISCUSSION

The PLS-MGA and PLS-SEM analyses both suggest that positive affect (PA) has a significant and positive impact on environmental concern among the test and control groups. This implies that the virtual reality intervention has been partially successful in cultivating a significant behavioural change among the people who were subjected to the VR video vis-à-vis the respondents who were subjected to the video on a non-VR gadget. Observations from this study reflect extant literature like (Ashby et al., 1999); (Schenk et al., 2018) (Lee and Syah, 2018). The findings are in tandem with (Subawa et al., 2021) and (Bec et al., 2021) who have demonstrated a significant role of Virtual Reality Immersion (VRI) in capturing pro-environmental behaviour. (Chang et al., 2015), in their study of message framing in green advertising context reveal that positive affect at the construal level impacts the environmental concern of individuals in the long run. Similarly, (Thananusak et al., 2017) studied the factors affecting the intention to buy electric vehicles, a robust interaction has been recorded among positive affect and environmental concern. Furthermore, (Kim and Koo, 2020) have highlighted a positive causal relationship among the two constructs of positive affect and environmental concern. Lastly, this study answers a pertinent call to action by (Harris et al., 2020) who has expressed the importance of subjective immersion to extract pro-environmental consciousness.

Through the PLS-SEM analysis given in Table 4, it is understood that the hypothetical dimensions formulated through this study are accepted under significant and robust conditions. The first hypothetical assumption which tests the relationship between environment concern and pro-environment behaviour has been expedited to be true with a β=0.384 and corresponding t=7.504. The finding resonates with studies (Huddart Kennedy et al., 2014) who have identified the symmetry between environmental attitude and pro-environmental behaviour. Furthermore, in their review of previous literature authors, (Gifford and Nilsson, 2014) observed the positive correlation among environmental concern and eco-friendly behaviour across a broad sprectrum of studies in the field of tourism, sociology and psychology. The second hypothetical element of the study aims to examine the association between Negative affect and perceived effectiveness. This negative relationship is significant at p<0.01 with a β=0.261 and a t=5.742. Review of recent literature reveal that studies conducted in fields like consumer behaviour, food preferences and environmental psychology indicate that Negative affect is negatively associated with making pro-environmental choices (Staub et al., 2022), (Kraus et al., 2022) and (Osborne and Atkinson, 2022). The third hypothetical pathway that assumed a positive relationship between Perceived effectiveness and Pro-environmental behaviour was observed to be significant (β=0.348, t=6.240). The findings of this study concur with extant literature like (Vicente-Molina et al., 2013), (Coelho et al., 2017) and (Alshurideh et al., 2020) who have detected a positive association between these variables.

The study extends the theory of pro-environmental behaviour by imbibing the essence of environment simulation. It also sheds the light on the need for advanced interventions like augmented and virtual reality in the investigation of human behaviour towards a sustainable future. This study is a response to the call for action stated in extant literature in the field of virtual reality to make the technology as an instrument to foster behavioural corrections. The study beacons managers and executives of DMOs, tourism authorities to take note of the growing importance of virtual reality in tourism. This study is a step towards understanding the prowess of virtual reality interventions in determining pro-environmental consciousness which simoultenously serves as the study's novelty.

CONCLUSIONS

The emergence of immersive technologies have paved way for further deliberations in the field of sustainable tourism. The study aimed to provide empirical basis to support the usage of virtual reality technology in the cultivation of pro-environmental behaviour, which has been partially accepted to due to the respondent differential observed through the MGA analysis in terms of the positive effect dimension triggering the environmental concern. The study has a two-fold contribution. Firstly, the study aims to widen the epistemological spectrum of the theory of pro-environmental behaviour by introducing the virtual reality intervention through a wearable device which captured a significant behavioural differential among the test and control groups. Secondly, the study advises marketers of eco-delicate destinations to employ virtual reality in corrective behaviour among potential tourists. Through the study the authors would like to recommend VR devices for travel agents and tour operators to better market eco-tourism regions which are vulnerable to the ill effects of mass tourism. Such excercises can take place at travel industry fairs like ITB Berlin, Arab Travel Mart and SATTE where there is both B2B and B2C oppurtunities available. While the study is partially successful in addressing the issue of simulated and immersive environments towards the evaluation of pro-environmental behaviour (significant virtual reality immersion impact on Positive Affect on environmental Envt Concern), future studies are encouraged to experiment with larger sample sizes and advanced virtual reality gear.

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