BEYOND THE SCREEN: HOW VIRTUAL REALITY SHAPES SUSTAINABLE BEHAVIOURS IN ECOTOURISM THROUGH USES AND GRATIFICATIONS THEORY

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Abstract
This study examines the relationships between ascribed responsibility, uses and gratifications, behavioural involvement, and visit intentions among Sicilian tourists using virtual reality (VR) to explore Romanian rural ecotourism destinations. Utilizing the Uses and Gratifications theory, it investigates how VR content's informativeness, playfulness, and social interactivity impact user engagement and behavioural intentions. Findings reveal that higher ascribed responsibility enhances gratifications from VR experiences, which increases behavioural involvement, essential for ecotourism. However, ascribed responsibility alone does not directly influence visit intentions, indicating the role of additional factors. A significant contribution of this research is the identification of a serial mediation model where uses and gratifications and behavioural involvement totally mediate the ascribed responsibility-visit intention relationship. This model highlights the complex interplay between cognitive, affective, and behavioural responses, demonstrating that ascribed responsibility enhances uses and gratifications, leading to increased behavioural involvement and, ultimately, visit intentions. The study extends the Uses and Gratifications theory into VR and ecotourism, emphasizing environmental responsibility in media engagement. Practical implications include strategies for tourism marketers to foster environmental responsibility and for VR developers to create engaging, informative, and interactive experiences. Policymakers can use these insights to promote sustainable tourism through supportive VR content development.

1. Introduction

In recent years, the fusion of technology and tourism has sparked substantial academic and practical interest, especially within the realm of ecotourism. Virtual reality (VR) has emerged as a key technology capable of significantly influencing tourist behaviour (Hornoiu et al., 2023; Schiopu et al., 2022) by providing immersive experiences that boost both engagement (Kim et al., 2020) and environmental awareness. As the demand for sustainable tourism practices grows, it is essential to understand how VR can impact these practices. The Uses and Gratifications theory offers a strong framework for examining how media technologies meet various user needs – such as enjoyment, integration, and convenience – and subsequently shape attitudes and behaviours (Katz, Blumler and Gurevitch, 1973). This theory is particularly pertinent to VR, where the technology's immersive nature can deliver rich, engaging experiences that surpass traditional media consumption. Studies have investigated how informativeness, playfulness, and social interactivity – central elements of the Uses and Gratifications approach – affect attitudes toward technologies such as social networking services (Chiang, 2013). However, these attributes have been less explored in the context of VR in ecotourism, where they may enhance the authenticity of the experience and encourage sustainable behaviours. While existing

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literature, such as Chiang (2013), has mainly focused on the adoption and use of online communication technologies, less is known about how these factors lead to behavioural changes in the context of VR and ecotourism. This study aims to address this gap by applying the Uses and Gratifications theory to understand how VR can influence ecotourism experiences, specifically among Sicilian tourists engaging with VR content related to Romanian rural ecotourism destinations. It examines how ascribed responsibility (AR) and the gratifications obtained from VR experiences (informativeness, playfulness, and social interactivity) impact behavioural involvement and, ultimately, the intention to visit ecotourism destinations. The primary goal of this study is to explore the pathway from ascribed responsibility through the uses and gratifications provided by VR to behavioural involvement and visit intentions in the context of ecotourism. By understanding these relationships, this research aims to provide actionable insights for stakeholders in the tourism industry to design VR experiences that not only entertain but also educate tourists about their potential impact on ecotourism destinations.

2. Literature review

2.1 Ascribed Responsibility

Ascribed responsibility (ASR) refers to how much individuals feel accountable for environmental issues caused by tourism activities. Research indicates that a higher sense of AR can drive more responsible behaviour and increased engagement with sustainability-related media (Hartmann and Apaolaza, 2009). In virtual reality (VR), this implies that AR can significantly boost user engagement with ecotourism content, leading to greater behavioural involvement and visit intention. Hofman et al. (2021) found that VR experiences can be as effective as real-life experiences in promoting conservation behaviours, highlighting AR's potential to enhance VR's impact on environmental awareness and actions. These findings collectively support the hypothesis that AR can significantly enhance engagement with ecotourism content in VR, leading to greater behavioural involvement and visit intentions, reinforcing AR's critical role in promoting sustainable tourism behaviours through immersive media.

2.2 The Uses and Gratifications Theory

The Uses and Gratifications Theory, developed by Katz, Blumler, and Gurevitch (1973), suggests that media users actively seek specific content to satisfy various needs, such as pleasure-seeking, information and learning, and ease of use. More, informativeness and playfulness have been shown to positively affect attitudes toward online communication technologies (Chiang, 2013), implying these factors may enhance the authenticity and engagement of VR experiences in ecotourism. Recent studies further support these claims. Kim et al. (2020) developed a framework combining innovation diffusion and Uses and Gratifications theories to explain VR tourism participation, revealing that informativeness, social interactivity, and playfulness significantly influence users' well-being and behavioural intentions. Similarly, Rather et al. (2023) found that gratifications such as informativeness and social interactivity are essential for VR-based brand engagement and loyalty intent. Cheng et al. (2022) emphasized the importance of utilitarian, hedonic, and social gratifications in motivating users to engage with immersive VR videos during the COVID-19 pandemic. Alyahya and McLean (2021) demonstrated that varying levels of sensory information in VR experiences lead to significant differences in mental imagery, presence, attitudes toward the destination, and visit intentions, highlighting the importance of gratifications in enhancing VR experiences. Nguyen et al. (2023) explored how VR's vividness and interactivity influence tourists' attitudes and behaviours, finding that VR experiences significantly impact psychological well-being and intention to visit destinations. These findings align with the Uses and Gratifications theory, suggesting that informativeness, playfulness, and social interactivity in VR can enhance user satisfaction and behavioural intentions. Collectively, these studies underscore the essential role of Uses and Gratifications theory in understanding user engagement and satisfaction with VR technologies, particularly in tourism.

2.3 Behavioural Involvement

Behavioural involvement in VR ecotourism has received significant attention due to its potential to influence tourists' engagement and subsequent behaviours. Wang et al. (2022) explored the relationships among virtual reality tourism involvement, place attachment, and behavioural intentions,

finding that VR involvement positively affects place attachment and behavioural intentions, emphasizing the role of immersive experiences in fostering deeper connections and proactive behaviours. Yuan and Hong (2023) examined how VR influences tourism experiences and behavioural intentions, finding that VR presence and flow significantly enhance tourism experiences and behavioural intentions, moderated by novelty seeking. These studies collectively underline the critical role of behavioural involvement in VR contexts, demonstrating that engaging and high-quality VR experiences can significantly influence tourists' behavioural intentions and attachment to destinations, thereby promoting sustainable tourism practices.

2.4 Ascribed responsibility (AR) among tourists and uses and gratifications obtained from VR experiences

Cheng et al. (2022) examined how VR can enhance engagement in corporate social responsibility (CSR) activities, finding that gratifications such as being there, enhancement, interaction, and fun positively influenced CSR engagement. This study suggests that AR can amplify these gratifications, thereby enhancing user engagement with VR content focused on environmental issues (Cheng et al., 2022). Nelson et al. (2020) demonstrated that VR could raise awareness of environmental threats and encourage pro-environmental behaviour, showing that VR experiences tailored to target groups significantly influenced users' emotions and behaviours, suggesting that AR can enhance these outcomes by making the VR content more relevant and engaging (Nelson et al., 2020). Lastly, Sánchez et al. (2021) explored the relationship between eco-friendly performance and the intention to use VR in national parks, finding that tourists who felt responsible for the environment were more likely to use VR to contribute to eco-friendly performance, supporting the hypothesis that AR enhances the gratifications obtained from VR, leading to higher engagement and positive environmental behaviours (Sánchez et al., 2021). This hypothesis is based on the premise that tourists who feel responsible for environmental issues will seek out and engage more deeply with VR content that is informative, enjoyable, and socially interactive. Therefore, we posit:

Hypothesis 1: Ascribed responsibility (ASR) among tourists will influence the uses and gratifications obtained from VR experiences

2.5 Ascribed responsibility (AR) among tourists and behavioural involvement

Empirical evidence supporting the hypothesis that ascribed responsibility (AR) has a direct influence on behavioural involvement can be found in several recent studies. Lee et al. (2021) examined the effects of sustainable intelligence, destination social responsibility (DSR), and biospheric value on pro-environmental behaviour in ecotourism sites. Their findings revealed that AR, in the form of sustainable intelligence and DSR, directly influenced visitors' pro-environmental behaviours, highlighting the role of AR in driving behavioural involvement. Azinuddin et al. (2023) investigated the effects of perceived ecotourism design affordance and destination social responsibility on tourists' pro-environmental behaviour and destination loyalty, demonstrating that AR, in the form of destination social responsibility, directly enhances tourists' pro-environmental behaviours and engagement. Coghlan (2021) conducted a quasi-experimental field study involving a VR game to encourage tourists' connection with the Great Barrier Reef, finding that AR significantly influenced tourists' selection of conservation-related behaviours, directly linking AR to behavioural involvement. These findings collectively support the hypothesis that:

Hypothesis 2: ASR influences behavioural involvement.

2.6 Ascribed responsibility (AR) among tourists and visit intention

Recent studies provide empirical evidence that ascribed responsibility (AR) impacts visit intentions in VR ecotourism. Lim et al. (2023) utilized the Model of Goal-Oriented Behaviour (MGB) to predict tourist attitudes and sense of responsibility as a moderator, finding that AR significantly moderated the relationship between visitors' intention to visit and preserve ecotourism destinations. This suggests that AR enhances tourists' engagement and attitudes, which subsequently influence their visit intentions. Additionally, Nelson et al. (2020) demonstrated that VR experiences could raise awareness of environmental threats and encourage pro-environmental behaviour, suggesting that AR can enhance the

relevance and engagement of VR content, leading to stronger visit intentions (Nelson et al., 2020). Additionally, Ouerghemmi et al. (2023) investigated the effect of telepresence on visit intentions in VR tourism, demonstrating that telepresence, influenced by AR, both directly and indirectly affects actual visit intentions. Collectively, these findings support the hypothesis that:

Hypothesis 3: AR influences visit intentions.

2.7 Uses and Gratifications and Tourists' Behavioural Involvement

There is empirical evidence supporting the hypothesis that the gratifications from VR ecotourism experiences—such as informativeness, playfulness, and social interactivity—positively impact tourists' behavioural involvement. Kim et al. (2020) utilized a framework combining innovation diffusion and Uses and Gratifications theories to explain why people participate in VR tourism, finding that attributes like informativeness, social interactivity, and playfulness significantly influenced users' subjective well-being and behavioural intentions, aligning with the hypothesis that these gratifications lead to higher engagement with VR content. Rather et al. (2023) explored VR-based brand engagement and found that tourists' VR involvement significantly influenced their brand engagement and subsequent behaviours such as brand co-creation and loyalty, indicating that gratifying VR experiences enhance behavioural involvement. Cheng et al. (2022) highlighted those various gratifications, including utilitarian (navigation), hedonic (enjoyment), sensual (realism), social (community), and symbolic (coolness), significantly motivated users to engage with 360-degree VR videos, and these gratifications influenced cognitive engagement, supporting the idea that gratifying VR experiences enhance user involvement. Furthermore, Dieck et al. (2021) found that usability and gratification factors influenced users' behavioural intention to engage with VR applications at festivals, demonstrating the impact of gratifying experiences on behavioural involvement. These findings collectively support:

Hypothesis 4: Uses and gratifications derived from VR ecotourism experiences positively influence tourists' behavioural involvement.

2.8 Uses and Gratifications and Visit Intentions

Yersüren and Özel (2023) investigated the effect of VR experience quality on destination visit intention through the technology acceptance model (TAM), finding that the perceived ease of use and usefulness of VR significantly influenced attitudes and visit intentions, further supporting the role of U&G in shaping visit intentions. Additionally, An et al. (2021) found that VR travel's sense and information quality positively influenced tourists' flow experiences, which in turn significantly predicted satisfaction and visit intentions, emphasizing the importance of gratifying experiences in driving visit intentions. Ouerghemmi et al. (2023) demonstrated that telepresence in VR both directly and indirectly affects actual visit intentions, with cognitive engagement and mental imagery playing mediating roles, underscoring the influence of U&G on visit intentions. These findings collectively support:

Hypothesis 5: Uses and gratifications derived from VR experiences significantly influence tourists' visit intentions.

2.9 Tourists' behavioural involvement and intention to visit actual ecotourism destinations

Empirical evidence supporting the hypothesis that increased behavioural involvement, facilitated by satisfying VR experiences, significantly predicts tourists' intention to visit actual ecotourism destinations is robust and multifaceted. Sobarna (2023) highlighted that VR content quality significantly impacts visitor behavioural intention in VR tourism, supporting the idea that engaging VR experiences can lead to higher intentions to visit the destinations represented virtually. Furthermore, Wang et al. (2022) explored the effects of VR tourism involvement on place attachment and behavioural intentions, finding significant positive influences of pleasure and sign (elements of VR involvement) on behavioural intentions to visit real destinations. Additionally, Nelson et al. (2020) demonstrated that VR experiences could raise awareness of environmental threats and encourage pro-environmental behaviour, suggesting that behavioural involvement through VR can translate into visit intentions. Therefore, we can posit:

Hypothesis 6: Increased behavioural involvement, facilitated by satisfying VR experiences, will significantly predict tourists' intention to visit actual ecotourism destinations.

2.10 Uses and Gratifications and behavioural involvement as serial mediators between ascribed responsibility and visit intention

Some studies suggests that ascribed responsibility (AR) impacts visit intentions through the mediators of Uses and Gratifications and Behavioural Involvement. Lim et al. (2023) employed the Model of Goal-Oriented Behaviour to predict tourist attitudes and found that AR moderated the relationship between visitors' intention to visit and preserve ecotourism destinations, indicating that AR can influence visit intentions through its impact on tourists' engagement and attitudes. Lee et al. (2021) studied the effects of sustainable intelligence and destination social responsibility on pro-environmental behaviour, revealing that these factors, which are closely related to AR, significantly influence visit intentions through their impact on cognitive and affective engagement. Azinuddin et al. (2023) highlighted that perceived ecotourism design affordance and destination social responsibility enhance pro-environmental behaviour and destination loyalty, suggesting that AR and the resulting gratifications can lead to higher engagement and visit intentions. Finally, Ying et al. (2021) extended the stimulus-organism-response (SOR) model to include telepresence and social presence, showing that these factors mediated the effects of VR experiences on visit intentions through cognitive and affective pathways. Collectively, these studies support:

Hypothesis 7: Uses and Gratifications and Behavioural Involvement mediate the relationship between ascribed responsibility and visit intention.

In this context, based on the above hypotheses, the following research model have been developed (see Figure 1).
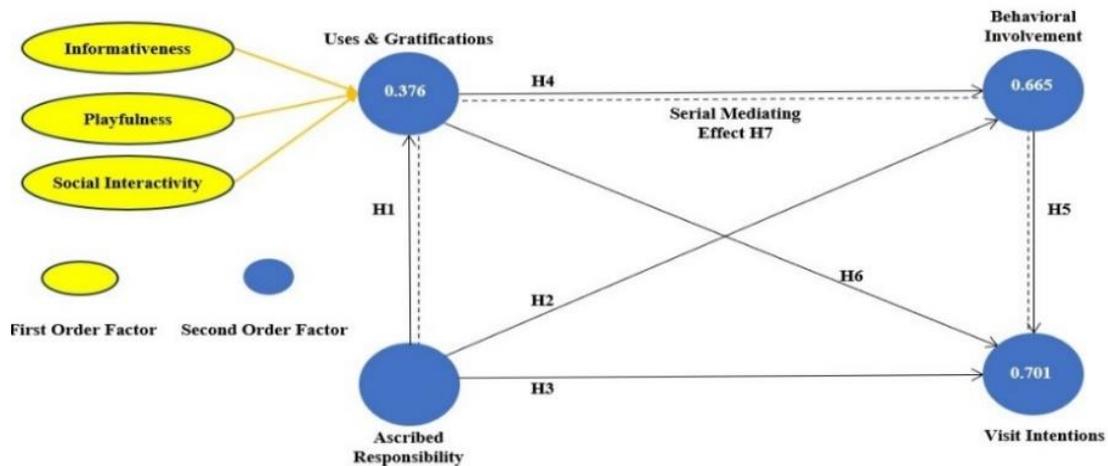

Figure 1. Proposed research model
Orange lines are formative indicators and bold lines are hypotheses. Dashed lines denote serial mediating role (H7).
Source: Self-developed based on SmartPLS calculations

3. Methodology

3.1 Measurements

Following Churchill's (1979) methodology, this study employs multi-item measures to overcome the limitations of single-item measures. Specifically, 28 items were used to assess six key concepts: informativeness (INF), social interactivity (SOC), playfulness (PLE) – all attributes of Uses and Gratifications (U&G) theory – along with ascribed responsibility (ASR), behavioural involvement (BIV), and visit intention (VIT). Informativeness (INF): four indicators for evaluating INF were adapted from previous research, including studies by Kim et al. (2020) (e.g., "I appreciate various aspects (e.g., environmental/social/economic solutions) of the ecotourism-related VR activity."). Social Interactivity (SOC): measured using four items developed from prior research by Kim et al. (2020) (e.g., "Engaging

with the tourism-related VR activity allows me to form social connections with other users."). Playfulness (PLE): assessed with four questions based on earlier work by Kim et al. (2020) (e.g., "Using the ecotourism-related VR activity is enjoyable for me."). Ascribed Responsibility (ASR): measured using three items derived from studies by Wu et al. (2022) (e.g., "Environmentally irresponsible behaviour can lead to ecological degradation and depletion of natural resources in ecotourism destinations."). Behavioural Involvement (BIV): assessed with five items from Nguyen et al. (2023) (e.g., "I am inclined to search for information about ecotourism experiences in Romanian ecotourism destinations online after watching the VR video"). Visit Intention (VIT): evaluated using five items based on research by Nguyen et al. (2023) (e.g., "I intend to visit the place featured in the ecotourism-related VR activity."). Responses were recorded using 7-point Likert-type scales. The questionnaire was originally developed in English and then translated into Italian by two bilingual experts. It was subsequently back-translated into English, and any discrepancies were addressed.

3.2 Data Collection

With the proliferation of the internet, online surveys have become an efficient method for hospitality and tourism researchers to reach a broader audience (Kim et al., 2020). In this study, data were gathered through an online survey platform (Google Forms), targeting potential Sicilian tourists. This approach yielded 110 completed questionnaires, which were then coded for analysis. The data collection took place from February 5, 2023, to April 15, 2023. The survey incorporated questions on participants' demographic and social details, such as gender, age, and education, using specific measurement scales. Additionally, a yes/no question was included to evaluate participants' prior experiences with VR. Although the sample size of 110 participants may seem modest, it is sufficient for this research. Similar studies on digital experiences in tourism have successfully utilized smaller samples, such as Huang et al. (2013) with 42 participants, producing significant insights. Thus, our sample size of 110 not only meets but surpasses this sample, confirming its adequacy for the study.

3.3 Data Analysis

The data were analysed using SmartPLS 4.1.02 (Ringle et al., 2015). Partial least squares-structural equation modelling (PLS-SEM) was employed to evaluate the statistical significance of the influence of independent variables on the dependent variable. According to Sarstedt and Cheah (2019), PLS-SEM criteria are less stringent regarding measurement scales, sample size, and residual distributions compared to covariance-based SEM (CB-SEM). The PLS-SEM approach concurrently analyses formative and reflective indicators (Hair et al., 2020). Initially, confirmatory factor analysis was used to identify the structure of systematically measured factors and variables in underlying constructs, reducing multicollinearity or correlations of error variance between indicators (Wondola et al., 2020). Structural equation modelling followed a two-step hybrid method by specifying a measurement model for confirmatory factor analysis and testing a latent structural model derived from the measurement model (Kline, 2005).

4. Results

4.1 Respondents' profile

The respondent profile consisted of 52.72% males and 47.28% females. The largest age group was Generation Z, comprising 43.63% of the sample with 46 individuals. This was followed by Millennials (Generation Y) at 36.36%, Generation X at 18.18%, and Baby Boomers representing 0.009% of the total respondents. In terms of educational attainment, 29.09% of participants had a high school diploma, 28.18% held a bachelor's degree, 34.54% had a master's degree, and the remaining respondents possessed PhD degrees.

4.2 Measurement model

The measurement model was evaluated through confirmatory factor analysis (CFA), following guidelines from Hair et al. (2014), 28 were retained for the analysis. Reliability and validity assessments were conducted subsequently. Cronbach's alpha values for internal consistency reliability exceeded the recommended threshold of 0.70 for all constructs, indicating strong reliability (Hair et al., 2014).

Composite reliability (CR) tests also confirmed internal consistency across measurement items, with all values above the 0.70 benchmark, ranging from 0.857 to 0.985 (Sarstedt et al., 2017). For convergent and discriminant validity, the average variance extracted (AVE) values were calculated. All AVE values surpassed the minimum recommended value of 0.50, ranging from 0.781 to 0.958, demonstrating good convergent validity (Fornell and Larcker, 1981). Additionally, the squared AVE values for each construct were higher than the correlations between any pair of constructs, supporting discriminant validity. More, all VIF values were below 5, indicating no collinearity issues (Sarstedt et al., 2017). Therefore, the measurement model's reliability and validity are robustly supported (Table 1). The Uses and Gratifications (U&G) model was assessed as a formative variable with three sub-constructs. This approach helps identify multiple characteristics, each with several dimensions. In this study, U&G was treated as a Second Order Factor (SOF) built upon three First Order Factors (FOF): informativeness (INF), social interactivity (SOC), and playfulness (PLE).

Table 1. The results of measurement model (n=110)

Variable	ASR	BIV	INF	INV	PLE	SOC	Factor loading	Cronbach's α	CR	AVE (√AVE)
ASR	1							0.857	0.914	0.781
ASR1							0.790			(0.884)
ASR2							0.937			
ASR3							0.917			
BIV	0.814	1						0.973	0.979	0.903
BIV1							0.929			(0.950)
BIV2							0.964			
BIV3							0.932			
BIV4							0.971			
BIV5							0.956			
INF	0.612	0.671	1					0.950	0.964	0.869
INF1							0.935			(0.932)
INF2							0.906			
INF3							0.964			
INF4							0.923			
INV	0.606	0.781	0.711	1				0.981	0.985	0.930
INV1							0.949			(0.964)
INV2							0.976			
INV3							0.925			
INV4							0.987			
INV5							0.983			
PLE	0.648	0.668	0.742	0.640	1			0.955	0.967	0.880
PLE1							0.935			(0.938)
PLE2							0.906			
PLE3							0.964			
PLE4							0.923			
SOC	0.590	0.669	0.718	0.772	0.788	1		0.985	0.989	0.958
SOC1							0.977			(0.979)
SOC2							0.988			
SOC3							0.983			
SOC4							0.966			

Source: Self-developed based on SmartPLS calculations

To confirm the validity of the SOF, several criteria were evaluated, including outer weights, t-statistics, p-values, outer loadings, and the variance inflation factor (VIF), as detailed in Table 2. The outer

loadings were significant, all exceeding the 0.50 threshold (Hair et al., 2014). Additionally, all VIF values were below 5, indicating no collinearity issues (Sarstedt et al., 2017). Since all criteria were satisfied, the SOF's validity was confirmed (see Table 2).

Table 2. Second Order Factor (SOF) Validity

SOF	FOF	Outer Weight	T Statistics	P Values	Outter Loadings	VIF
U&G	INF	0.404	2.864	0.004	0.895	2.283
	PLE	0.218	1.262	0.207	0.874	2.839
	SOC	0.481	2.899	0.004	0.930	2.737

Source: Self-developed based on SmartPLS calculations

4.3 Structural Model

The structural model illustrates the relationships (paths) between constructs in the proposed study. The R^2 values indicate that the model explains 66.7% of the variance in behavioural involvement and 70.10% of the variance in visit intention. Due to the lack of multivariate normality in the data, path estimates and *t*-statistics for these relationships were analysed using the bootstrapping method (Hair et al., 2014). The PLS bootstrap method, involving 5000 resamplings, was employed to assess the shape of the sampling distribution non-parametrically.

Table 3. Mediation analysis

Hypothesis	Total Effects		Direct Effects			Indirect Effects		
	β	t-value	β	t-value	Hypothesis	β	t-value	p value
ASR - INV	0.555	6.577	-0.121	1.186	ASR -> U&G -> BIV -> INV	0.128	2.479	0.013

Source: Self-developed based on SmartPLS calculations

Hypothesis testing:
H1: The relationship between ASR and U&G was assessed. The results showed that ASR significantly impacts U&G (β=0.613, t=7.826, p<0.05), supporting H1.
H2: The impact of ASR on BIV was examined. The results indicated a significant impact (β=0.488, t=4.616, p<0.05), supporting H2.
H3: The impact of ASR on INV was tested. The results showed no significant impact (β=-0.121, t=1.186, p=0.236), leading to the rejection of H3.
H4: The relationship between U&G and BIV was evaluated. The results demonstrated a significant impact (β=0.419, t=4.819, p<0.05), supporting H4.
H5: The impact of U&G on INV was assessed. The results indicated a significant impact (β=0.497, t=4.512, p<0.05), supporting H5.
H6: The relationship between BIV and INV was examined. The results showed a significant impact (β=0.498, t=4.123, p<0.05), supporting H6.
H7: The mediating role of U&G and BIV in the relationship between ASR and INV was assessed. The total effect was significant (β=0.555, t=6.577, p<0.001). Although ASR did not have a significant direct impact on INV (β=-0.121, t=1.186, p=0.236), the indirect effect with mediators included was significant (β=0.128, t=2.479, p=0.013), indicating a total serial mediation. This shows that ASR indirectly influences INV through U&G and BIV, supporting H7 (see Table 3).

5. Discussions and conclusions

This study provides comprehensive insights into the complex interplay between ascribed responsibility (AR), uses and gratifications (U&G), behavioural involvement, and visit intentions among Sicilian tourists engaging with VR experiences of Romanian rural ecotourism destinations. The findings align with and extend the current body of literature, enhancing our understanding of the psychological mechanisms that drive tourism behaviours. The research confirms that higher levels of AR among Sicilian tourists significantly enhance the gratifications obtained from VR experiences. This is consistent with the findings of Hartmann and Apaolaza (2009), which suggest that individuals with a strong sense of environmental responsibility are more likely to engage deeply with media content that

meets their informational, integrative, and hedonic needs. This result highlights the importance of fostering a sense of responsibility in tourists, as it enhances their engagement with VR content, making it an essential factor in effective ecotourism marketing and education.

The study also indicates that AR among Sicilian tourists positively influence their behavioural involvement with Romanian ecotourism-related VR content. This aligns with findings from Lee et al. (2021) and Lim et al. (2023), who observed that a sense of responsibility directly enhances pro-environmental behaviours and engagement. These results suggest that instilling a sense of environmental responsibility in tourists can lead to more proactive and engaged behaviours, which are vital for promoting sustainable tourism practices. Contrary to expectations, the study found that AR does not significantly influence Sicilian tourists' visit intentions to Romanian ecotourism destinations. This unexpected result may stem from various factors, including potential barriers to travel such as financial constraints, convenience, or personal preferences that may outweigh the sense of responsibility. This finding highlights a gap between environmental responsibility and actual travel behaviour, suggesting that while AR enhances engagement with VR content, it does not necessarily translate into concrete travel intentions.

The research further demonstrates that gratifications derived from VR ecotourism experiences—such as informativeness, playfulness, and social interactivity—significantly influence behavioural involvement. This finding reinforces the notion established by Chiang (2013) that satisfying and engaging VR experiences can drive tourists to seek further information and engage more deeply with the content, which is essential for the promotion of ecotourism. Moreover, the study shows that U&G derived from VR experiences significantly influence Sicilian tourists' visit intentions. This aligns with the work of Kim et al. (2020) and Rather et al. (2023), who highlighted the role of gratifying media experiences in shaping behavioural intentions. This underscores the potential of well-designed VR experiences to convert virtual engagement into real-world travel intentions, highlighting the effectiveness of VR as a tool in tourism marketing.

The research also confirms that behavioural involvement significantly predicts Sicilian tourists' intention to visit actual Romanian ecotourism destinations. This finding is consistent with the study by Nguyen et al. (2023), which found that deep engagement with VR content can lead to higher visit intentions. This emphasizes the importance of fostering active involvement in VR experiences to drive actual travel behaviour. Furthermore, the study supports the serial mediation model, indicating that U&G and behavioural involvement totally mediate the relationship between AR and visit intentions. The study reveals that AR enhances U&G, which in turn increases behavioural involvement, ultimately leading to stronger visit intentions. This serial mediation effect is essential as it highlights that the path from AR to visit intention is not direct but is facilitated through the gratifications obtained from VR experiences and the behavioural involvement they foster.

The findings of this study have several important theoretical implications. First, they extend the application of U&G theory into the context of VR and sustainable tourism. By demonstrating that AR enhances the gratifications obtained from VR experiences, this study highlights the role of environmental responsibility in shaping media engagement. This suggests that U&G theory can be effectively used to understand and predict tourist behaviour in VR contexts, particularly in relation to environmental and sustainability issues. Second, the research supports the notion that cognitive and affective responses are critical in driving behavioural intentions, as suggested by the SOR framework. The findings that U&G and behavioural involvement mediate the relationship between AR and visit intentions add depth to our understanding of how media experiences translate into real-world behaviour's. This serial mediation model underscores the importance of considering multiple layers of cognitive and affective engagement when studying the impact of media on behaviour. Finally, the study challenges the direct influence of AR on visit intentions, suggesting that while environmental responsibility enhances engagement and involvement with VR content, additional factors may moderate the translation of this engagement into actual travel behaviour. This highlights the need for further research into the barriers that prevent responsible tourists from converting their engagement into visits.

The practical implications of this study are significant for tourism marketers, developers of VR content, and policymakers. For tourism marketers, the findings suggest that enhancing the sense of

environmental responsibility among tourists can lead to deeper engagement with VR content. Marketing strategies should therefore emphasize the environmental impacts of tourism and encourage a sense of responsibility among potential tourists. For developers of VR content, the study highlights the importance of creating experiences that are not only engaging and entertaining but also informative and interactive. By addressing the informational, integrative, and hedonic needs of users, VR experiences can foster deeper engagement and drive behavioural involvement, ultimately leading to higher visit intentions. This is particularly relevant for promoting sustainable tourism practices, as engaging VR experiences can raise awareness and encourage pro-environmental behaviours.

Policymakers can leverage these insights to promote ecotourism. By supporting the development and dissemination of VR content that highlights environmental issues and encourages responsible behaviour, policymakers can enhance the effectiveness of tourism campaigns and contribute to the sustainability of ecotourism destinations. Additionally, understanding the barriers that prevent responsible tourists from translating their engagement into visits can help policymakers design interventions that address these obstacles, thereby promoting more sustainable travel behaviours.

Future research should explore the barriers preventing responsible tourists from translating their engagement into actual visits and investigate the long-term effects of VR experiences on travel behaviour. This expanded understanding can help develop more effective strategies for using VR to promote sustainable tourism and enhance tourists' pro-environmental behaviours.

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