Metaverse in Tourism: From Virtual Worlds to Sustainable Worlds

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Purpose

This study investigates the metaverse's capability to foster sustainable tourism through word-of-mouth (WoM), by integrating embodied social presence theory with social identity theory. It aims to unveil how the interplay between metaverse technology and user attributes enhances tourists' experiences and satisfaction, thereby promoting WoM for sustainable tourism practices.

Design/methodology/approach

A scenario-based survey research design was utilised, comprising a survey of 528 respondents. The study employed structural equation modelling to analyse the data, focusing on the relationships between technological features, user attributes, social presence, and their combined effect on promoting sustainable tourism through WoM.

Findings

Results indicate that the metaverse significantly enhances social presence and tourist satisfaction, which in turn, fosters WoM for sustainable tourism. Key factors include technological attributes (individuality, empathy, naturalness, and immersion) and user attributes (prior experience and interest in sustainable practices), which collectively influence the propensity for sustainable WoM, also impacted by prosocial identity and subcultural identification.

Originality/value

This research contributes to the literature by demonstrating the metaverse's potential in enhancing sustainable tourism promotion through innovative technological engagement. It offers practical insights for destination marketers and service providers on leveraging metaverse technology to engage a wider audience in sustainable tourism practices, marking a significant step towards integrating digital innovations with ecological sustainability efforts.

Keywords: Metaverse, Sustainability, Word-of-mouth, Avatar, Embodied social presence theory, Social identity theory, Sustainable practices

Introduction

In today's post-pandemic, ever-changing marketplace, the tourism field must integrate the rapidly evolving technology into its processes to remain competitive (Koohang *et al.*, 2023; Tran, 2024). Leveraging the metaverse, as explored by Chon and Hao (2024), presents an unprecedented opportunity for tourism to overcome geographical barriers and captivate global audiences with immersive experiences that closely replicate the physical world and transform their travel experiences. The integration of the metaverse and sustainability has the potential to minimise the ecological footprint of tourism by offering virtual access to destinations, thus reducing the need for physical travel and its associated environmental impacts whilst providing educational content on sustainability practices and cultural preservation (Monaco and Sacchi, 2023; Zhang *et al.*, 2024; Zhong *et al.*, 2023). Extant research on the confluence of the metaverse and sustainability has predominantly used qualitative methodologies (Buhalis *et al.*, 2023; Go and Kang, 2023; Monaco and Sacchi, 2023; Tran, 2024). Hence, the tourism literature urgently requires in-depth quantitative insights into the factors that influence tourists' intentions to participate in metaverse-driven sustainable tourism endeavours.

Word of mouth (WoM) is a powerful tool in tourism marketing and serves as a primary source of information about various tourist destinations (Nukhu and Singh, 2024). It plays a pivotal role in shaping tourist satisfaction and influencing their decision-making process (Lai *et al.*, 2018). In the context of sustainable tourism, WoM has taken on a new dimension, that is, sustainable WoM, which describes the process in which tourists, having gained a positive understanding and experience of sustainable practices at a destination, share their insights with their social circles. This information sharing can inspire others to adopt similar sustainable behaviours (Wu and Chiang, 2023). Virtual platforms that simulate real-life scenarios can provide immersive experiences (Buhalis *et al.*, 2022) that help tourists understand the importance of sustainable tourism practices. This understanding, in turn, can motivate tourists to adopt sustainable behaviours and engage in sustainable WoM.

Embodied social presence theory (ESPT) (Mennecke *et al.*, 2010) described the process of how social presence is generated in virtual reality (VR) environments. Notably, it emphasised the importance of various attributes in influencing sense of presence, especially technology factors. Creating authentic and immersive virtual spaces is instrumental in shaping tourist behaviour and engagement (Robaina-Calderín *et al.*, 2023). Mennecke *et al.* (2011) emphasised the role of user interest and past experiences in determining engagement levels within the metaverse. Buhalis *et al.* (2023) argued that enhancing the sense of presence is vital for crafting an immersive

and effective metaverse-based sustainable travel experience. This innovative approach has the potential to make travel more inclusive, accessible, and environmentally conscious, thereby aligning with the global shift towards sustainability (Abou Kamar *et al.*, 2024).

The question of whether social presence can directly translate into behavioural intention has yielded different conclusions depending on the context. Drawing on the ESPT, social presence can lead to various effects, including physiological responses (e.g., movement), psychological responses (e.g., engagement), and other psychological responses (e.g., real actions or intentions; Mennecke *et al.*, 2011). Specifically, Zhu *et al.* (2023) emphasized the role of user satisfaction in mediating the relationship between presence in virtual environments and travel intentions. Similarly, Wei *et al.* (2019) explored the direct influence of tourists' perceived presence on their intentions to revisit and recommend in the context of virtual theme park visits. This study introduces overall satisfaction and overall experience as key factors that connect social presence to sustainable WoM, providing a more comprehensive understanding of the processes that promote sustainable behaviours in virtual tourism environments.

Additionally, the alignment of users' social identities with the ethos of sustainable initiatives has emerged as a significant factor in shaping self-perception and consequent behaviour in the metaverse-driven sustainable tourism context (Ashforth and Mael, 1989). Social identity theory (SIT), as articulated by Ellemers and Haslam (2012), suggests that individuals classify themselves into social groups based on shared attributes, thus fostering a sense of belonging that influences behaviour through in-group favouritism and adherence to group norms. Understanding individuals' identification is pivotal for deciphering and forecasting individual behaviours (Ashforth and Mael, 1989). Huang *et al.* (2024) emphasised the positive relationship between consumer identification and positive WoM in the context of green marketing for peer-to-peer accommodation. However, the existing literature does not comprehensively discuss sustainable WoM, particularly its role in integrating technological capabilities, user factors, and personal identifications in the metaverse-driven sustainable tourism context. This gap highlights the need for further research into how these elements collectively contribute to the WoM in sustainable tourism, a field increasingly mediated by digital and virtual experiences.

This study elucidates the specific attributes of metaverse travel that catalyse travellers' WoM for sustainable tourism. Anchored in the frameworks of ESPT (Mennecke *et al.*, 2011) and SIT (Ashforth and Mael, 1989), this study aims to answer the following critical research questions: 1) How do key technology attributes, namely, individuality, empathy, naturalness, and immersion, impact social presence in the

metaverse? 2) In what ways do user attributes, such as prior experience with the metaverse and interest in sustainable practices, shape social presence? 3) What is the relationship between social presence and the propensity for sustainable WoM? 4) How do aspects of individuals' identities, specifically prosocial and subcultural identities, influence their inclination towards sustainable WoM?

Theoretically, this study groundbreakingly merges ESPT with SIT, thereby enhancing our understanding of how technological capabilities, user factors, and personal identification enrich tourism experiences, particularly within the sustainability context. This refined perspective elucidates the complex mechanisms underlying customer engagement in virtual tourism spaces. Practically, this study will benefit a wide range of stakeholders, including destination marketers and service providers. It underscores the utility of avatars as a promotional tool designed to motivate tourists to interact with and show respect for the people, places, and cultures of local communities. This approach is expected to yield wider reach amongst potential tourists, deepen their engagement with sustainability efforts, and ultimately foster the widespread adoption of sustainable travel habits.

Literature Review

Metaverse-Driven Sustainable Tourism

Sustainable tourism encompasses tourism practices that conscientiously consider current and future economic, social, and environmental repercussions, while catering to the requirements of tourists, industry stakeholders, the environment, and local communities (Mihalic, 2024). The advancement of sustainable tourism is of paramount importance given the severe economic challenges of the industry and the escalating environmental crises and climate changes worldwide (Tran, 2024).

Li *et al*. (2024) conducted a comprehensive bibliometric analysis on digital tourism, which highlighted the emerging trend of leveraging transformative technologies to promote sustainable tourism development. The metaverse provides a virtual platform that expands the accessibility of sustainable tourism (Go and Kang, 2023; Mihalic, 2024; Tran, 2024), thereby allowing more people to participate and contribute to sustainable practices. Moreover, the metaverse offers immersive and interactive experiences (Buhalis *et al.*, 2022) that can enhance visitors' understanding of and engagement with sustainable tourism principles (Buhalis *et al.*, 2022). Metaverse-driven sustainable tourism suggests harmony between societal norms, technological advancements, and sustainability objectives (Tran, 2024). This approach allows stakeholders to evaluate the viability and identify the potential hurdles of

sustainable practices, thereby facilitating well-informed decision making and fostering sustainable results as these initiatives are applied in practical scenarios. More importantly, the integration of sustainable tourism and the metaverse increases the awareness of and advocacy for sustainable practices on a larger scale (Go and Kang, 2023).

Embodied Social Presence Theory

Mennecke *et al*. (2010) introduced ESPT, portraying the process of interpersonal interaction giving rise to social presence in the virtual world. The ESPT offers a framework for understanding user interactions in virtual contexts from a psychological perspective. It examines their behaviours in virtual worlds by explaining the various stages of social presence. When a user experiences embodied presence, feeling their own presence in the virtual world through verbal or non-verbal messages from other avatars, they enter a state of embodied co-presence. Once a sense of presence and co-presence is established, the user begins to perceive social presence through interaction and shared participation, thereby developing an awareness of both themselves and others in the virtual world (Zhang *et al.*, 2022). The degree of presence within virtual environments is significantly shaped by the various attributes, especially technological capabilities (Mennecke *et al*., 2011). Tran (2024) argued that technological features such as authenticity and immersion constitute integral aspects of tourists' experiences and exert a consequential effect on their behaviours within virtual environments. Moreover, the role of individual variables, such as interests and prior experiences with virtual spaces, is pivotal in modulating engagement in the metaverse (Mennecke *et al*., 2011). Kim *et al.* (2023) elucidated that individuals' previous encounters and familiarity with avatars enhance their social presence, thereby enriching the enjoyment derived from interactions within these digital realms.

Social Presence

Social presence is critically significant in the metaverse and VR, fundamentally influencing the calibre of user experiences and interactions (Gursoy *et al.*, 2022; Oh *et al.*, 2023; Zhang *et al.*, 2024). Social presence encompasses co-presence, which entails feeling socially connected to someone at a distant location; and psychological involvement, which involves perceiving the presence of another intelligence with access to their thoughts, intentions, and intimacy (Biocca *et al.*, 2003). Within the ambit of metaverse-driven sustainable tourism, opportunities to interact with local communities, engage in cultural experiences, and contribute to sustainability projects not only foster a sense of belonging and social connectivity but also significantly amplify social presence, thereby enriching user experience in virtual environments.

Technology Attributes

Authenticity refers to consumer sensibility regarding the genuineness, novelty, originality, and uniqueness of experiences, services, or products (Gilmore and Pine, 2007). In the metaverse context, authenticity refers to the degree to which the virtual environment represents avatars as genuine individuals capable of exhibiting empathy and engaging in natural communication (Du *et al.*, 2023). Authenticity plays an important role in tourism because it shapes consumers' unique experiences, satisfaction, and behavioural intentions (Robaina-Calderín *et al.*, 2023).

Jones *et al.* (2022) identified three dimensions of authenticity in a virtual chat-based service context: individuality, empathy, and naturalness. Regarding individuality, Wentzel (2009) found that employee behaviour greatly influences customers' authentic experiences, including the formation of brand image and attitudes towards the brand. In metaverse travel, individuality pertains to the degree to which individuals perceive their avatars to be unique. According to the ESPT, the characteristics of avatar can influence user interactions and foster presence in virtual worlds. Different features may provide users with varying experiences and perceptions. By assessing the individuality of avatars, individuals can develop impressions of authenticity based on the perception that avatars possess distinctive qualities and personal identities (Inamura *et al.*, 2022), thereby enhancing social presence in a virtual context (Mennecke *et al*., 2011). Thus, the following hypothesis was formulated:

H1: The individuality of avatars is positively associated with social presence.

Avatars' empathy refers to the ability of the virtual environment and its inhabitants to evoke emotional connections and understanding (Ling *et al.*, 2013). Previous studies have demonstrated that individuals with higher empathy report a significantly enhanced sense of presence (Dewez *et al.*, 2019; Ling *et al.*, 2013). Integrating empathy into metaverse tourism allows for a deepened authentic experience, enabling users to form profound connections and identify emotionally with the virtual entities they meet. This emotional investment and interaction with avatars lead to a richer and more satisfactory metaverse experience, thereby augmenting the overall perceived authenticity and enjoyment of virtual travel interactions. Thus, the following hypothesis was formulated:

H2: Avatars' empathy is positively associated with social presence.

Naturalness refers to the degree to which an avatar's appearance, behaviour, and interaction mimic or represent real-world human characteristics and dynamics (Zhu and Meyers-Levy, 2009). Hassan and Saleh (2023) elucidated how the performative naturalness of avatar-based virtual experiences significantly shapes user perceptions of

immersion and presence. The naturalness of an avatar is critical in enhancing user engagement and social presence within the metaverse, thereby contributing to a more authentic and meaningful virtual experience (Jones *et al.,* 2022). Thus, the following hypothesis was formulated:

H3: An avatar's naturalness is positively associated with social presence.

Immersion in the metaverse holds significant importance in the realm of virtual tourism (Jafar and Ahmad, 2024). The metaverse serves as a vibrant digital platform exhibiting tourist destinations, attractions, events, and hospitality services (Gursoy *et al.*, 2022; Talwar *et al*., 2023; Tran, 2024). It provides users with a virtual world experience that closely simulates the real world, thereby enabling interactive engagement with other users in an immersive environment (Robaina-Calderín *et al.,* 2023). Immersion involves the use of sensory devices, such as head-mounted displays, to immerse users' sensory organs into the virtual space (Buhalis *et al.*, 2023). Fostering immersion is vital as it contributes to the development of embodied social presence, enabling users to perceive themselves as part of the virtual environment and engage in social interactions within the metaverse (Oh *et al.*, 2023).

Building on ESPT, existing studies have empirically connected a higher sense of spatial context and objects in space to a higher social presence (Zhang *et al.*, 2022). Wei *et al.* (2019) emphasised the importance of involvement and immersion in enabling individuals to experience a sense of presence in virtual environments. By leveraging the immersive capabilities of the metaverse (Jafar and Ahmad, 2024), travellers can engage with tourism destinations virtually, formulate a social presence, and thereby enrich their real-life experiences. Hence, the following hypothesis was formulated.

H4: Immersion in virtual tourism is positively associated with social presence.

User Attributes

Prior experience with the metaverse involves individuals' previous interactions in immersive virtual environments. ESPT indicates that the perceived social presence in a virtual space is influenced by factors such as familiarity with avatar-mediated interactions (Mennecke *et al.*, 2011). Kim *et al.* (2023) demonstrated that prior avatar experience moderates the relationship between psychological distance and social presence in the metaverse. Enhanced familiarity with the metaverse can boost users' acceptance and engagement by positively affecting their enjoyment of the interactions in these environments (Kim *et al.*, 2023). Building upon ESPT, existing research has shown that users' previous experience with the virtual world influences perceived social presence (Mennecke *et al.*, 2010). Thus, comprehending the role of metaverse

experiences that contribute to embodiment and overall social presence is crucial. Consequently, the following hypothesis was developed:

H5: Previous metaverse experience is positively associated with social presence.

Personal interest, deeply embedded in the marketing and sociopsychological literature, influences information processing, decision making, and behaviours in consumer involvement (Zhang *et al.*, 2024). Existing research has primarily explored tourists' interests from a special interest perspective, such as cultural or adventure tourism. Wong (2015) found that tourists interested in cultural and heritage sites are more involved in the experience and inclined to purchase cultural products. Wong *et al.* (2016) determined that tourist interest significantly affects satisfaction and perceived trip value in hybrid cultural experiences. ESPT underscores the role of users' psychological readiness (e.g. motivations) and virtual world experience in shaping their perceived social presence in a virtual environment (Mennecke *et al.*, 2011). In metaverse-driven sustainable tourism, tourists' interest in sustainable practices signifies a mindful commitment to reducing environmental and social impacts, reflecting their values and beliefs (Mihalic, 2024). Thus, acknowledging and integrating tourists' sustainable practice interests is crucial for cultivating a vibrant, socially engaged virtual community. Accordingly, the following hypothesis was formulated:

H6: Interest in sustainable practices is positively associated with social presence.

Overall Experience and Satisfaction

Metaverse technology facilitates consumer immersion in a virtual world, where heightened presence becomes a mechanism elucidating how metaverse stimuli drive customer experiences (Go and Kang, 2023; Tran, 2024). Virtual world experience indicates the sense of 'flow within a virtual environment' (Cho *et al.*, 2002, p.4). Previous research has shown that consumers with a greater sense of presence in the metaverse tend to have more immersive and satisfying experiences. Jung *et al.* (2016) examined the effects of social presence on four realms of experience, namely, education, aesthetic, entertainment, and escape, in the context of a virtual museum tour. Kang and Gretzel (2012) recognised the importance of perceived social presence in shaping tourist experiences. Acknowledging and understanding the role of perceived social presence in shaping tourist experiences is crucial to businesses in the tourism industry. Hence, the following hypothesis was framed.

H7: Social presence is positively associated with overall experience.

Tourist satisfaction is defined as the extent to which tourists' desires and expectations are fulfilled by their experience with product or service features during their trip (Zhu *et al.*, 2023). The relationship between social presence and satisfaction has emerged as a significant research topic in the literature on 3D virtual worlds (Bulu, 2012). Moreover, existing research has established a connection between presence and satisfaction in the tourism context. Wei *et al.* (2019) demonstrated the influence of tourists' sense of presence on their satisfaction with information and communication technology tourism experiences. Zhu *et al.* (2023) reported the considerable impact of sense of presence (i.e. telepresence) on tourist satisfaction in virtual tourism. Understanding how social presence influences satisfaction can inform the creation of more immersive and socially engaging virtual environments that cater to users' needs and preferences (Bulu, 2012). On the basis of the literature, the following hypothesis was developed:

H8: Social presence is positively associated with overall satisfaction.

Sustainable WoM

WoM communication is a crucial aspect of marketing and business strategies because of its profound influence on consumer behaviour (Lai *et al.*, 2018). Intertwining WoM with sustainability principles and practices gives rise to the concept of sustainable WoM. Sustainable WoM encapsulates the phenomenon in which tourists, influenced by their positive experiences and understanding of sustainable practices, share their insights with their acquaintances, thereby encouraging them to adopt sustainable behaviours (Wu and Chiang, 2023). This form of advocacy is crucial in disseminating information on sustainable tourism, attracting new patrons, and catalysing transformative changes within the tourism sector.

Extensive research has established strong correlations between WoM and various consumer-related factors. Lai *et al.* (2018) investigated the interaction effects of the tourist–resident relationship, safety perception, and overall service quality on tourists' WoM. Nukhu and Singh (2024) illustrated that tourists' sensory experience, satisfaction, and perceived environmental sustainability significantly contribute to WoM. Similarly, WoM has been shown to significantly influence green purchase intentions (Wu and Chiang, 2023). A positive experience with a brand or service can lead to increased loyalty and trigger WoM recommendations. This insight is relevant in the context of sustainable tourism, in which positive experiences and satisfaction with sustainable practices can encourage tourists to advocate for the cause. From these insights, two hypotheses were formulated:

H9: Overall experience is positively associated with sustainable WoM.

H10: Overall satisfaction is positively associated with sustainable WoM.

Moreover, previous research has identified a positive correlation between presence and behavioural intentions. Zhang *et al.* (2022) affirmed the link between embodied presence, embodied co-presence, and intentions of continuous engagement in the metaverse. Similarly, Park and Lee (2013) provided empirical evidence that human presence in organisations' digital platforms promotes positive WoM communication. Applying these insights to the context of metaverse-driven sustainable tourism suggests that individuals' social presence in virtual spaces may significantly enhance sustainable WoM. On the basis of this logical extension, we formulated the following hypothesis:

H11: Social presence is positively associated with sustainable WoM.

Prosocial Identity

SIT provides a theoretical framework for understanding the dynamics of social identification and its influence on group members' behaviours. When individuals perceive a sense of affiliation with a particular social group, they tend to internalize the associated values, norms, and characteristics of that identity (Ashforth and Mael, 1989). This cognitive and emotional connection prompts them to engage in behaviours that advance the interests of the group or entity with which they identify (Tajfel and Turner, 1979). The process of social identification involves individuals incorporating aspects of the group's identity into their own self-concept. Prosocial identity, which denotes individuals' self-concept aligned with positive social behaviours that prioritise others' well-being, has been extensively explored in existing research (Giebelhausen *et al.*, 2017). For instance, studies have examined the correlation between individuals' prosocial identity and behaviours, revealing that when experiencing procedural injustice, individuals with high prosocial identity are likely to diminish prosocial behaviours (Grant *et al.*, 2009) and identification with green products, leading to favourable WoM (Huang *et al.*, 2024).

According to SIT, consumers perceiving brands as embodying their self-identity qualities develop a cognitive connection, which prompts instinctual, welfare-advancing actions toward these brands (Ashforth and Mael, 1989). Notably, recent studies have emphasised probing prosocial behaviours in tourism, acknowledging tourists' prosocial attributes as catalysts for transformative industry change (Agyeiwaah and Zhao, 2023). Tuan (2018) investigated the influence of corporate social responsibility initiatives and employee behaviours on tourists' prosocial identity and subsequent behaviours. In metaverse sustainable tourism, tourists with strong prosocial identities are likely to

champion sustainable concepts aligned with their altruistic beliefs, positively impacting sustainable WoM. Consequently, we formulated the following hypothesis:

H12: Prosocial identity significantly influences sustainable WoM.

Subcultural Identification

In contrast to mainstream cultures, subcultures provide individuals with a sense of uniqueness and coolness, allowing them to express their authentic selves (Cha, 2020). Subcultural identification is closely linked to notions of social differentiation and scarcity, which contribute significantly to the perceived 'coolness' (Sundar *et al.*, 2014). Cool activities within subcultures are characterised by their divergence from prevailing norms, attracting a niche user base that deviates from the majority (Sundar *et al.*, 2014). For instance, permaculture, developed by Bill Mollison and David Holmgren, emerged in the 1970s in response to mounting concerns about environmental degradation and social inequality (Holmgren, 2002). Permaculturalists often form tight-knit subcultural communities, such as organic farming cooperatives, community gardens, and eco-villages, where they bond over shared values and practices.

By engaging in these activities, individuals contribute to environmental sustainability whilst enhancing their sense of coolness by aligning with a subculture that challenges the dominant industrialised food system. The perception of metaverse sustainable tourism as 'cool' stems from its association with uniqueness, innovation, and the ability to positively influence the environment and local communities. In line with SIT, this coolness factor motivates individuals to engage in and promote sustainable tourism, contributing to its growth and appeal in virtual and real-world contexts. On the basis of the literature, we formulated the following hypothesis and the theoretical framework, as shown in Figure 1:

H13: Subcultural identification significantly influences sustainable WoM.

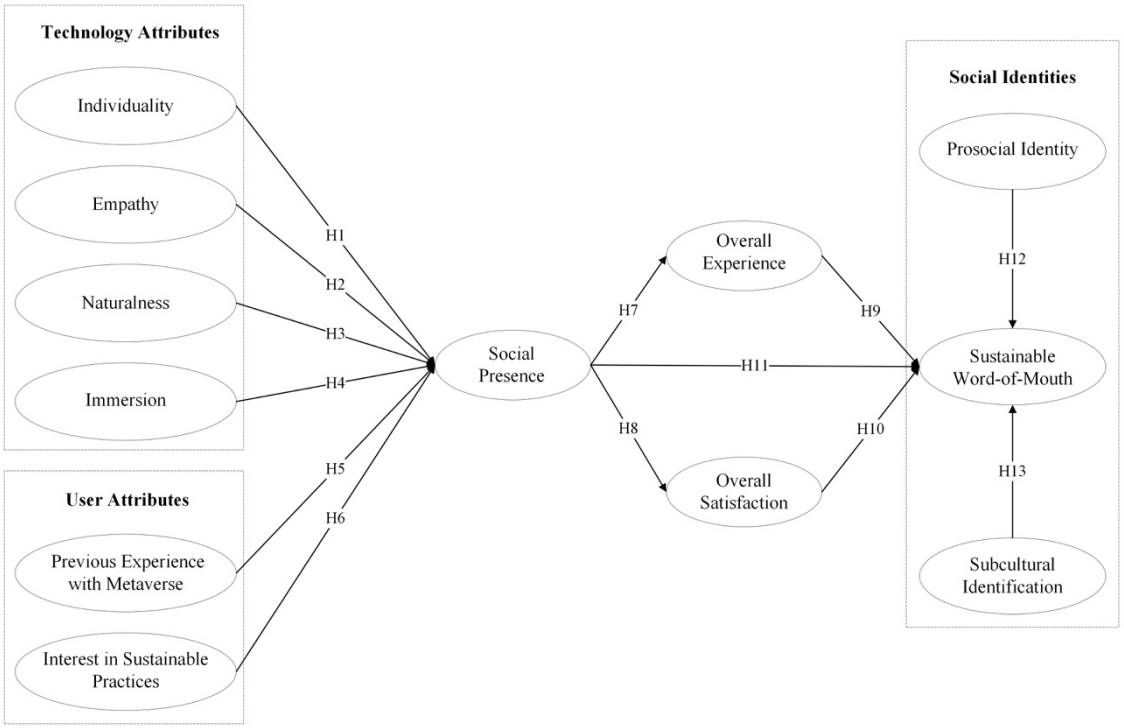

Figure 1: Conceptual framework
Source: Figure by authors

Method

This study employed a scenario-based survey approach to test the hypotheses and measure key variables whilst strictly adhering to the methodologies validated by Akbayrak (2000). A total of 528 respondents completed the survey, which was conducted on Prolific, a platform renowned for its efficacy in attracting a diverse and high-calibre respondent pool (Palan and Schitter, 2018). The selection criteria for participants included being at least 18 years old, being proficient in English, and having completed a minimum education level of high school or its equivalent. Screening questions, identifying the name and gender of the avatar, were implemented to ensure that all participants had viewed the video. The detailed demographic data of the participants are presented in Table I. Most of the participants in our study were aged below 55 years. This selection can be attributed to the nature of our research design, that is, a virtual sustainable tourism experience, which is likely to resonate more with the younger demographic who is typically more conversant with digital technology and virtual experiences (Koohang *et al.*, 2023; Zhang *et al.*, 2024). The study procedures were approved by the Institutional Review Board to ensure ethical compliance. During

the survey, the participants engaged in an immersive scenario set within the metaverse, in which they embarked on a virtual journey to explore sustainable tourism concepts.

Table I**:** Demographic profile of participants

Variable	Category	Frequency (n=528)	Percentage (%)
Gender	Female	273	51.70
	Male	255	48.30
Age	18-34 years	376	71.21
	35-54 years	130	24.62
	>55 years	22	4.17
Occupation	Employed full time	513	97.16
	Employed part time	10	1.89
	Unemployed/looking for work	5	0.95
Education	High school graduate	41	7.77
	Four-year degree	391	74.05
	Some college	9	1.70
	Professional degree	87	16.48

Source: Table by authors

The metaverse serves as an expansive constellation of virtual environments which are enabled through avatars, mixed reality/VR headsets, and a suite of compatible technologies (Buhalis *et al.*, 2023; Buhalis *et al.*, 2022). In response to the diverse accessibility requirements of different demographic groups, including older generations who may encounter difficulties with the intricate interfaces of advanced VR headsets (Song *et al.*, 2023), we developed an avatar-mediated scenario representing a critical format within the metaverse framework. Moreover, informed by the research of Jones *et al.* (2022), which indicated that women often exhibit more convergent and accommodating communication styles, we chose a female avatar as a guide for the participant interaction. Furthermore, the video was designed as a generic educational tool to increase public awareness of sustainable tourism rather than focusing on a specific destination. This strategy enhances its utility as an accessible and easily understandable resource aimed towards maximising educational reach across diverse audiences. The visual details of the avatar guide and demo video are available in the Online Appendix and Figure 2. The script of the avatar can be found in Appendix A.

Figure 2: Avatar guide
Source: Figure by authors

The measurement items for this study were carefully adapted from established scales with minor modifications to fit the research context. Authenticity from Jones *et al.* (2022) was measured through individuality, empathy, and naturalness, capturing the essential aspects of genuine customer service communication. Immersion was gauged using four items from Robaina-Calderín *et al.* (2023) to assess the participants' sense of physical presence in the virtual environment. Metaverse experience was determined using four specifically designed items from Kim *et al.* (2023) that focused on readiness for sustainable tourism experiences. Interest in sustainable practices was evaluated using four items from Gursoy and Gavcar (2003) to examine inclination towards sustainable activities and environmental initiatives. Social presence was measured using three items from Zhang *et al.* (2022). Overall experience and satisfaction were assessed using three items from Shin *et al.* (2022). Sustainable WoM was quantified using four items adapted from Nukhu and Singh (2024), and prosocial identity was evaluated using three items from Giebelhausen *et al.* (2017). Subcultural identification was measured using four items from Cha (2020), including perceptions of uniqueness when accompanied by the avatar. The questionnaire was structured using a 7-point Likert scale for all constructs.

Results

The measurement and proposed structural model were tested using partial least squares structural equation modelling (PLS-SEM) via SmartPLS4. PLS-SEM was chosen primarily because it is deemed more suitable than covariance-based SEM for evaluating complex models (Hair *et al.*, 2017). To address common method bias, a variance inflation factor (VIF) analysis was performed to assess the potential for multicollinearity. The VIF values for our constructs ranged from 1.1 to 3.6 and were thus below the recommended threshold of 5.0, indicating that multicollinearity was not a significant concern in our dataset (Hair *et al.*, 2017). Moreover, we employed Harman's one-factor test, which examines the variance explained by a single factor (Podsakoff *et al.*, 2003). The results of this test indicated no significant bias as the variance explained by a single factor was below the 50% threshold. Henseler *et al.* (2014) introduced the standardised root mean square residual (SRMR) to examine goodness of fit and avoid model misspecification. The SRMR value in this study was 0.061, which is less than 0.10 or 0.08, thereby indicating a good model fit.

Measurement Analysis

The reliability and validity of the reflective measure constructs were assessed, and the results are shown in Figure 3. All outer loadings were statistically significant and exceeded the minimum threshold of 0.6. Additionally, the Cronbach's α and composite reliability values surpassed the recommended threshold of 0.7, demonstrating satisfactory internal consistency reliability. Furthermore, we employed the Fornell–Larcker criterion (1981) to assess the discriminant validity of our constructs, ensuring that they were distinct and not merely reflections of one another. Our analysis confirmed that our model met the Fornell–Larcker criterion, thereby indicating robust discriminant validity amongst the constructs.

Figure 3: Constructs, items, and reliabilities

	Mean	SD	Kurtosis	Skewness	VIF	Loading
Individuality (Jones *et al.,* 2022) (Cronbach's α = 0.715, CR =0.713, AVE = 0.638)						
When I think of the avatar, I see a person with a unique set of characteristics.	5.795	0.754	0.091	-0.441	1.588	0.818
I have a good idea about who and how the avatar really is.	5.903	0.814	-0.589	-0.264	1.235	0.749
I would think of the avatar as a unique individual rather than as an anonymous person.	5.898	0.769	-0.356	-0.274	1.617	0.826
Empathy (Jones *et al.,* 2022) (Cronbach's α = 0.734, CR =0.737, AVE = 0.654)						
I could relate to the avatar in the virtual tour.	5.941	0.773	-0.24	-0.368	1.626	0.829
I felt the avatar was right there in the virtual tour.	5.907	0.742	-0.246	-0.269	1.282	0.748
I was experiencing the same thoughts and feelings as the avatar.	5.943	0.784	-0.343	-0.35	1.666	0.845
Naturalness (Jones *et al.*, 2022) (Cronbach's α = 0.717, CR =0.720, AVE = 0.640)						
I would feel that the avatar is natural.	5.949	0.746	-0.2	-0.329	1.479	0.807
I would feel that the avatar is organic.	5.979	0.775	-0.478	-0.307	1.293	0.753
I would feel that the avatar is real.	6.044	0.754	-0.465	-0.338	1.552	0.837
Immersion (Robaina-Calderín *et al.*, 2023) (Cronbach's α = 0.796, CR =0.706, AVE = 0.706)						
I felt immersed in the virtual tour.	5.9	0.751	-0.117	-0.345	2	0.875
I felt like I was part of the virtual tour.	5.972	0.84	-0.319	-0.465	1.945	0.867
I was able to forget about the outside world during the virtual tour.	5.947	0.762	-0.239	-0.349	1.418	0.776
Previous experience with metaverse (Kim *et al.*, 2023) (Cronbach's α = 0.783, CR =0.789, AVE = 0.706)						
I'm familiar with metaverse technology.	5.848	0.71	0.131	-0.347	1.707	0.784
My past experiences with metaverse technology were positive.	5.972	0.757	-0.661	-0.189	1.493	0.74
I am comfortable using metaverse technology.	5.972	0.742	-0.182	-0.345	1.628	0.774
I understand how to navigate virtual environments.	6.002	0.775	-0.633	-0.273	1.657	0.814
Interest in sustainable practices (Gursoy and Gavcar, 2003) (Cronbach's α = 0.712, CR =0.715, AVE = 0.634)						
I am willing to pay extra for travel experiences that are environmentally friendly.	5.828	0.848	0.139	-0.394	1.368	0.808
I make an effort to minimize my ecological footprint while traveling.	5.902	0.91	-0.101	-0.592	1.367	0.769
I prefer travel experiences that align with my values of sustainability.	5.938	0.818	0.749	-0.593	1.457	0.811

Social presence (Zhang *et al.*, 2022) (Cronbach's α = 0.761 CR =0.763, AVE = 0.583)						
I can be aware of my presence in the virtual tour.	5.9	0.723	0.201	-0.42	1.496	0.76
There is a sense of human interaction in the virtual tour.	6.038	0.816	-0.715	-0.364	1.53	0.749
In the virtual tour, the avatar is sentient and alive to me.	6.044	0.781	-0.285	-0.459	1.58	0.773
The avatar made me feel like I was not alone on the virtual tour.	6.028	0.749	-0.22	-0.398	1.507	0.77
Overall Experience (Shin *et al.*, 2022) (Cronbach's α = 0.747, CR =0.752, AVE = 0.665)						
The virtual tour was enjoyable.	5.773	0.784	0.086	-0.45	1.612	0.839
The virtual tour was unforgettable.	5.756	0.818	-0.354	-0.313	1.592	0.839
The virtual tour was memorable.	5.877	0.787	-0.455	-0.246	1.366	0.766
Overall Satisfaction (Shin *et al.*, 2022) (Cronbach's α = 0.745, CR =0.754, AVE = 0.664)						
Overall, I was satisfied with the virtual tour.	5.761	0.776	0.134	-0.46	1.67	0.841
This virtual tour exceeded my expectations.	5.915	0.816	-0.518	-0.262	1.306	0.734
This virtual tour was close to my ideal experience.	5.936	0.773	0.147	-0.48	1.82	0.864
Sustainability Word-of-Mouth (Nukhu and Singh, 2024) (Cronbach's α = 0.711, CR =0.713, AVE = 0.634)						
I will encourage my friends and relatives to behave sustainably when traveling.	5.733	0.75	0.379	-0.462	1.418	0.81
I will speak favourably about sustainable behaviours to others.	5.812	0.844	0.216	-0.485	1.321	0.763
I am glad to recommend sustainable behaviours to others.	5.864	0.837	0.652	-0.612	1.463	0.814
Prosocial Identity (Giebelhausen *et al.*, 2017) (Cronbach's α = 0.712, CR =0.730, AVE = 0.633)						
Helpful	5.936	0.728	1.068	-0.669	1.434	0.842
Warm	5.922	0.781	0.676	-0.51	1.469	0.806
Compassionate	5.943	0.791	0.489	-0.474	1.312	0.735
Subcultural Identification (Cha, 2020) (Cronbach's α = 0.772, CR =0.792, AVE = 0.688)						
Engaging in sustainable behaviours makes me different from others.	5.712	0.754	0.499	-0.479	1.808	0.874
Taking sustainable behaviours looks great.	5.837	0.823	0.45	-0.486	1.766	0.86
Taking sustainable behaviours is considered leaders rather than followers.	5.835	0.81	0.402	-0.397	1.395	0.748

[1] All items measured on a 1-7 Likert type scale.

Source: Figure by authors

Structural Model Evaluation

The coefficient of determination (R^2) of the endogenous latent variables serves as a crucial criterion for assessing the structural models in PLS path models (Henseler *et al.*, 2014). R^2 values of 0.19, 0.33, and 0.67 are interpreted as weak, moderate, and substantial, respectively (Chin, 1998, p. 323). In this study, the R^2 values (explained variance) showed that overall experience, overall satisfaction, social presence, and sustainable WoM explained 27.7%, 29.5%, 68.6%, and 64.3% of the variance, respectively. Table II presents the results of the structural model test.

Table II: Structural model assessment

Hypotheses	**Path**	β	t
H1	Individuality -> Social Presence	0.155	3.369**
H2	Empathy -> Social Presence	0.15	3.599**
H3	Naturalness -> Social Presence	0.378	8.324**
H4	Immersion -> Social Presence	0.116	2.715**
H5	Previous Metaverse Experience -> Social Presence	0.082	3.192**
H6	Interest in Sustainable Practices -> Social Presence	0.193	4.812**
H7	Social Presence -> Overall Experience	0.526	13.711**
H8	Social Presence -> Overall Satisfaction	0.543	14.109**
H9	Overall Experience -> Sustainable Word-of-Mouth	0.247	5.075**
H10	Overall Satisfaction ->Sustainable Word-of-Mouth	0.359	6.268**
H11	Social Presence -> Sustainable Word-of-Mouth	0.046	1.286[N]
H12	Prosocial Identity -> Sustainable Word-of-Mouth	0.167	4.296**
H13	Subcultural Identification -> Sustainable Word-of-Mouth	0.159	3.261**

Note: **Statistical significance is below the 1% level. [N] Statistical significance is set at >5%.
Source: Table by authors

Hypothesis Testing

Bootstrap analysis was conducted following the procedure suggested by Hair *et al.* (2011), and 5,000 subsamples were generated from a dataset of 528 cases. The significance level was set at 0.05, and a minimum t-value of 1.96 was considered

necessary for statistical significance (Hair *et al.*, 2017). The results all showed a significant effect, thus verifying the following hypotheses: H1, which proposed a direct relationship between individuality and social presence ($\beta = 0.155$, $t = 3.369$, $p < 0.01$); H2, which assumed a direct positive relationship between empathy and social presence ($\beta = 0.150$, $t = 3.599$, $p < 0.01$); H3, which predicted a positive relationship between naturalness and social presence ($\beta = 0.378$, $t = 8.324$, $p < 0.01$); and H4, which predicted a positive relationship between immersion and social presence ($\beta = 0.116$, $t = 2.715$, $p < 0.01$).

Furthermore, H5 predicted the positive impact of previous metaverse experience ($\beta = 0.082$, $t = 3.192$, $p < 0.01$) on social presence. H6 posited a positive relationship between interest in sustainable practices ($\beta = 0.193$, $t = 4.812$, $p < 0.01$) and social presence. The results also showed that social presence had very strong direct relationships with overall experience ($\beta = 0.526$, $t = 13.711$, $p < 0.01$) and overall satisfaction ($\beta = 0.543$, $t = 14.109$, $p < 0.01$), thereby supporting H7 and H8. Sustainable WoM was positively influenced by overall experience ($\beta = 0.247$, $t = 5.075$, $p < 0.01$), overall satisfaction ($\beta = 0.359$, $t = 6.268$, $p < 0.01$), prosocial identity ($\beta = 0.167$, $t = 4.296$, $p < 0.01$), and subcultural appeal ($\beta = 0.159$, $t = 3.261$, $p < 0.01$); thus, H9, H10, H12, and H13 were supported.

However, H11 predicted that social presence had no significant direct effect on sustainable WoM ($\beta = 0.046$, $t = 1.286$, $p = 0.199 > 0.05$), indicating the full mediation effect between social presence and sustainable WoM through overall satisfaction and overall experience.

Discussion

This study investigates the influence of technology attributes, individual traits, and social identities on sustainable WoM intentions within metaverse-driven sustainable tourism. It emphasizes the critical role of authenticity and immersion in boosting tourists' perceived social presence. The naturalness of avatars stands out as a more significant factor for enhancing social presence than other technological features, as avatars' ability to replicate human behaviour fosters engagement and relatability, vital for immersive experiences in virtual settings. This is supported by Silva *et al*. (2020), who highlighted the importance of naturalness in human digital influencers for building genuine user connections. Compared to avatars, individual traits such as empathy play a lesser role in shaping social presence. This differs from Park *et al*.'s (2023) findings, which emphasize empathy as crucial in chatbot interactions, as chatbots depend on emotional cues rather than visual realism. This contrast suggests that in avatar-based

interactions, the visual and behavioural realism of avatars plays a more central role in determining social presence.

Additionally, the study explores the positive effects of tourists' interest in sustainability and prior metaverse experiences on perceived social presence. However, there is no direct link between social presence and sustainable WoM, highlighting the mediating role of sensory experiences and satisfaction in influencing WoM intentions. Furthermore, prosocial and subcultural identities positively impact sustainable WoM, aligning with findings by Grant *et al*. (2009) and Li *et al*. (2022) that prosocial identity drives behaviours promoting social well-being. Similarly, tourists drawn to the 'coolness' and 'innovation' of metaverse sustainable tourism are motivated to advocate for such offerings, supporting broader adoption of sustainable practices.

Theoretical Implications

This research significantly advances knowledge on metaverse-driven sustainable tourism in several key aspects. While most studies on the intersection of the metaverse and sustainability have used qualitative methods (Buhalis *et al*., 2023; Go and Kang, 2023; Monaco and Sacchi, 2023; Tran, 2024; Zhong *et al*., 2023), this study provides robust quantitative insights into the factors influencing tourists' intentions to engage in metaverse-driven sustainable tourism. It pioneers the investigation of sustainable WoM within an integrative theoretical framework, combining technological attributes, individual variables, and social identities relevant to sustainable travel in the metaverse, offering deeper insights into how these factors interact to promote sustainable practices.

Moreover, the study synthesizes ESPT and SIT to identify specific metaverse travel attributes that drive WoM for sustainable tourism. It examines how technological attributes and user characteristics shape satisfaction and advocacy behaviours. By exploring subcultural and prosocial identities, it reveals how stable self-characteristics influence behavioural intentions, offering a nuanced understanding of the interaction between technological immersion, identity, and user engagement in virtual environments.

This study extends ESPT by examining the relationship between social presence and behavioural intentions in metaverse-driven sustainable tourism, acknowledging the mediating role of satisfaction and experience. Additionally, it investigates how interest in sustainable practices and prior metaverse experiences enhance perceived social presence, contributing to a satisfying overall experience.

Furthermore, we make a notable contribution to the knowledge about SIT by exploring the impact of prosocial and subcultural identities on WoM in the context of

metaverse sustainable tourism. By examining the interplay between prosocial identity, subcultural identification, and sustainable WoM, this study advances the understanding of the underlying mechanisms that encourage advocacy behaviours and foster a sense of community and shared responsibility in the metaverse sustainable tourism context.

Managerial Implications

This research offers key managerial implications for stakeholders. It provides actionable insights for designing avatar-based metaverse experiences that align with tourists' socially responsible travel preferences. To create naturalistic avatars, it's essential to focus not only on body language fidelity but also on facial animations, such as eye and mouth movements during speech. These details can significantly enhance user satisfaction and promote positive endorsements, rooting virtual experiences in sustainable tourism.

Destination marketers can use these findings to strategically highlight sustainability, especially appealing to younger tourists under 55, who show strong positive perceptions of metaverse travel. By engaging this demographic, marketers can inspire broader sustainable behaviour among tourists' social circles, enriching the destination's appeal and tourism experience.

This study also empowers tourists by immersing them in culturally rich metaverse environments, fostering sustainable tourism advocacy. Beyond tourism, metaverse technology can transform sectors like education by creating immersive, experiential learning spaces. Public policies promoting metaverse integration in schools can reduce educational inequality while lowering the environmental impact of traditional learning methods. Such measures would enhance both educational outcomes and sustainability.

Limitations and Future Research

The measurements may not fully capture sustainable WoM, suggesting that future research should categorize WoM into positive and oppositional brand referrals while exploring stakeholder behaviours regarding sustainability. Although this study used a video-based survey for virtual environments, future research could enhance interactivity using VR headsets. Additionally, self-report bias may influence tourists to present a favourable image of sustainable behaviour. Future studies could use tools like face tracking or Electroencephalography to gain deeper insights into genuine reactions during metaverse journeys. While avatar traits like gender were examined, further research could explore facial dynamics, vocal variations, and their impact on engagement. Finally, focusing on older populations and considering individual

characteristics and cultural backgrounds could provide a more comprehensive understanding of metaverse sustainable tourism.

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