

The Metaverse: Perceived Impacts of the New Frontier in Sustainable Tourism

Abstract

Modjadji Matilda MASHAPA 

School of Tourism and Hospitality,
University of Johannesburg, South Africa,
Email, mmashapa@uj.ac.za
Corresponding Author

Prudence HASSEN 

School of Tourism and Hospitality,
University of Johannesburg, South Africa,
Email, pruhassen@gmail.com

This study uses cross-sectional and quantitative research methods to explore the potential of the metaverse as a new frontier for sustainable tourism. Data from 260 respondents were collected using an online questionnaire and analysed using inferential statistics. The results suggest that the metaverse can contribute to sustainable tourism by improving accessibility and reducing the need for physical travel through immersive virtual experiences. Additionally, it provides opportunities to educate travellers about eco-friendly practices and conservation projects that improve the long-term viability of the tourism industry. However, the study acknowledges concerns about digital infrastructure and energy consumption related to the metaverse. To address these issues and ensure a more equitable and sustainable tourism sector, it is recommended that tourism stakeholders prioritise sustainability in their metaverse initiatives. This approach aims to harness the potential benefits of virtual tourism while mitigating its potential negative impacts, ultimately contributing to a more sustainable and accessible tourism industry. The study offers a fresh perspective to academics, managers and policymakers.

Keywords Access to finance, internal factors, rural tourism, managerial competency, tourism SMMEs.

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Introduction

Tourism provides many services to meet travellers' needs, yet environmental challenges still exist, especially in popular destinations (Cordova-Buiza et al., 2021). Sustainable tourism guided by Sustainable Development Goals (SDGs) is key to balancing tourism growth and environmental conservation (Siakwah et al., 2020). It creates strategic plans to conserve natural resources for future generations (Dillette & Ponting, 2021; Mestanza-Ramon et al., 2022). As sustainable tourism becomes more relevant with an increasing number of global tourists, the COVID-19 pandemic has led stakeholders to consider metaverse tourism as a solution to sustainable tourism (Gosling & Schweiggart, 2022; Rogerson et al., 2021). The metaverse, a technology beyond Augmented Reality (AR) and Virtual Reality (VR), offers experiences that can play a significant role in the growth of the tourism industry (Boyd & Holton, 2018; Buhalis et al., 2023). However, can the metaverse replicate physical tourism experiences? (Lee & Lim, 2020). Research in various countries, including the United States, Thailand, and several African countries, has shown the potential of metaverse in promoting sustainable tourism (Allam et al., 2022; Hui et al., 2023; Suanpang et al., 2022). For example, in Swaziland, Gemiverse uses blockchain to authenticate sustainability data, and in Nigeria, the metaverse is a platform for digital activism (Wei, 2022; Achmirowicz & Martin, 2023). Despite its growing importance, a gap remains in our understanding of the environmental impact of the metaverse and its contribution to sustainable tourism, especially in developing African countries. This study explores the perceived impacts of metaverse on sustainable tourism and the changes brought about by the COVID-19 pandemic. The pandemic has accelerated the adoption of the metaverse and new ways to experience tourism destinations and products. According to Gursoy et al. (2022), the metaverse can enhance tourism resilience and align with SDGs to prepare for future crises (Allam et al., 2022; Hui et al., 2023; Tlili et al., 2023). While the metaverse can revolutionise tourism through virtual exploration, there is a need to critically evaluate its environmental impact (Dwivedi et al., 2022). Energy consumption is a significant concern because the metaverse relies on colossal computing power and infrastructure. This will increase electricity demand and carbon footprint if powered by non-renewable sources (Mashapa et al., 2019; Murphy & Paulsen, 2023). Virtualisation of physical tourism may reduce economic benefits to local communities, resulting in job losses and socioeconomic impacts (Chirisa et al., 2020). Moreover, the metaverse may disconnect humanity from the physical world, undermining conservation efforts and environmental awareness (Said, 2023). Virtual experiences may reduce appreciation of and motivation to protect real-world environments, countering sustainable tourism (Abdela, 2020; Allam et al., 2022). Thus, there is a need to assess the perceived impacts of metaverse on sustainable tourism to guide its development in line with sustainability goals and minimize negative impacts (Hui et al., 2023; Neethirajan, 2023). The remainder of this article is organized as follows: Sustainable Development and metaverse perspectives, Impacts of the Metaverse on Sustainable Tourism, Metaversal Sustainability, Methodology, Findings and Discussions. Recommendations and Conclusions are provided to offer a thorough, critical, and forward-looking analysis of metaversal sustainability in tourism, offering essential insights into both scholarly discussion and practical application in this field.

Literature review

Sustainable development and metaverse perspectives

Current research in sustainable tourism is looking at regenerative tourism, which leaves destinations better than before (Ateljjevic, 2020), and better methods for measuring the overall impact of tourism across all environmental, social, and economic dimensions (Font et al., 2023). How to change tourist behaviour to be more sustainable (Doinicar, 2020), use new technologies like the metaverse to support sustainability (Salloum et al., 2023), tourism in climate change mitigation strategies and how to adapt to it (Scott et al., 2021; Dube & Nhamo, 2024). How sustainable tourism can contribute to SDGs, especially



in developing countries (UNWTO, 2022). Sustainable development is an all-encompassing approach to achieving long-term sustainability across various sectors, including tourism (Santos, 2023). It balances social, environmental, and economic factors so that development meets the needs of the present without compromising the ability of future generations to meet their needs. In tourism, sustainable practices aim to reduce negative impacts on the environment and local cultures and to conserve and use resources responsibly (Streimikiene et al., 2021; Baloch et al., 2023). Sustainable tourism helps preserve natural and cultural assets and benefits both host communities and visitors by fostering tourism and environmental stewardship. Technology offers many tools to enhance tourism sustainability (Mashapa & Dube, 2023). Innovations like the metaverse, which combines virtual and physical experiences, can change how tourists interact with destinations. The metaverse includes VR and AR, which allow users to explore and interact with virtual environments, thus reducing the need for physical travel (Dudley et al., 2023). This virtual engagement can reduce traditional tourism's environmental footprint, such as carbon emissions from transportation and resource consumption at tourist sites. Technology also helps in resource management and reduces environmental impact through efficiencies and innovations (Ahmad et al., 2020). The metaverse, which offers immersive virtual experiences, can support sustainable tourism by promoting environmental awareness and educating users about conservation efforts.

Impacts of metaverse on sustainable tourism

The metaverse as a new environment in the 21st century represents a new frontier for sustainable tourism research and practice. Mihalic (2024) states that as sustainability is generally understood in terms of planetary boundaries, the metaverse offers a new way to experience tourism without traditional travel's physical and environmental impact. This virtual world can address several key sustainability issues, such as reducing carbon emissions from transport, mitigating over-tourism in popular destinations, and preserving fragile ecosystems. It can also democratise access to cultural and natural heritage sites and provide more inclusive and equitable tourism experiences (Buhalis et al., 2023). However, it also raises new questions about the sustainability of digital infrastructure, the energy consumption of VR, and the socioeconomic impact on traditional tourism-dependent communities. Integrating the metaverse into sustainable tourism offers both opportunities and challenges. On the positive side, virtual tourism experiences in the metaverse can reduce the environmental impact of physical travel. For example, according to Schiopu et al. (2021), virtual tours allow users to explore destinations from their homes, thus reducing carbon emissions and strain on popular tourist sites. Virtual exploration can alleviate overtourism and its environmental degradation by providing alternative ways to experience destinations. The metaverse is also a platform for environmental awareness. By engaging with virtual environments, users can learn about sustainable practices and the impact of human activities on the environment (Wang et al., 2022; Allam et al., 2022). Educational virtual experiences can promote responsible behaviour and conservation efforts and a more informed and environmentally conscious public. Furthermore, Nunkoo et al. (2024) explored how temporal distance, multimodal interfaces and conspicuous consumption impact consumer assessments in the metaverse, revealing novel facets of virtual tourist interactions that influence engagement and decision-making. However, the metaverse faces several challenges. It consumes a lot of energy, often from non-renewable sources, and contributes to climate change (Dwived et al., 2022). The growth of the metaverse means more energy consumption and electronic waste, such as in old VR headsets and other devices (Stoll et al., 2022). The digital divide is a challenge, as not everyone has equal access to technology to participate in the metaverse, potentially widening social inequalities (Bibri & Allam, 2022).

The metaverse offers access to tourism experiences for those who cannot physically travel. Virtual environments can accommodate people with disabilities or those in remote locations to explore destinations and interact with others without physical barriers (Müller et al., 2022). Additionally, Chamboko-Mpotaringa (2024) argued that by establishing virtual environments that support equality and inclusivity in online travel experiences, the metaverse can help Africa's gender-inclusive travel possibilities. The metaverse also offers environmental education and awareness, by helping users understand the importance of sustainable practices, and creates a culture of environmental responsibility (Allam et al., 2022; Hui et al., 2023). Conversely, the metaverse may also widen socioeconomic inequalities, especially in regions with limited access to advanced technology (De Giovanni, 2023). This can exclude local populations from the benefits of virtual tourism and create social tensions. More virtual interactions can reduce the quality of face-to-face cultural exchanges and social interactions, which are the essence of traditional tourism (Ponsignon & Derbaix, 2022). According to Go & Kang (2023), the metaverse can increase eco-friendly sites' economic profits by attracting virtual tourists and opening up new revenue streams through virtual tours and experiences. In the virtual tourist industry, it generates employment prospects for designers, builders, and content producers (Arpaci et al., 2022). In addition, by providing substitute methods of experiencing destinations without actual travel, virtual tourism can lessen overtourism (Mkono & Hughes, 2020). On the other hand, local economies that depend on conventional tourism can suffer from the emergence of the metaverse. Reductions in physical travel may result in job losses and business closures for companies that rely on in-person tourism (Gössling & Schweiggart, 2022). According to Tichaawa & Chamboko (2024), elements like market accessibility, business acumen, and community involvement are essential to the prosperity of regional craft tourism enterprises. The emergence of virtual tourism may worsen these issues unless plans are made to incorporate regional crafts into metaverse experiences. Furthermore, economic inequality could result from the shift to virtual tourism because some communities may find it difficult to adopt or benefit from virtual tourism Ndlhovu and Dube (2023).

The metaverse presents opportunities to encourage environmentally friendly travel by offering virtual experiences that lessen the need for actual travel and its carbon emissions (Buhalis et al., 2023; Go & Kang, 2023). By teaching users about conservation and ethical resource use, virtual environments can help them achieve larger environmental objectives (Asimah et al., 2022; Hui et al., 2023). Additionally, the metaverse can preserve natural resources and increase public awareness of



environmental issues through virtual conservation zones and instructional programs (Zaman et al., 2022). Despite these advantages, ignoring the metaverse's environmental impact is impossible. Greenhouse gas emissions and climate change are intensified by the increased energy consumption required to run metaverse platforms (Cao et al., 2023; De Giovanni, 2023). Moreover, improper e-waste management from abandoned or out-of-date metaverse technology could have adverse environmental effects (Kshetri & Dwivedi, 2023). According to Chamboko-Mpotaringa & Tichaawa (2024), the increasing popularity of virtual tourism may also reduce the demand for traditional tourism, which could affect the viability of regional tourism-related enterprises. Regarding sustainable tourism, the metaverse offers both creative opportunities and formidable obstacles. Virtual experiences can lessen environmental effects and improve accessibility, but issues with energy use, digital inequality, and environmental damage must be addressed. These concerns must be carefully considered, and measures to lessen adverse effects must be implemented if the metaverse is to develop sustainably.

Mertaversal sustainability

The reason for extending sustainability principles to maritime travel lies in the challenges and opportunities presented by this emerging technology. Mertaversal sustainability as a concept requires a whole system approach that incorporates both digital and physical environmental aspects (Dwivedi et al., 2022). This is important because while the metaverse may reduce physical travel, it also introduces new environmental challenges in the digital realm. Including energy consumption metrics for data centers and equipment (Nleya & Velepini, 2024) and the carbon footprint of hardware production (Belkhir & Elmeligi, 2018) means we account for the full lifecycle impact of mertaversal tourism. By factoring in the reduction in physical travel emissions (Zhang & Hwang, 2020) we recognize the positive environmental benefits of mertaversal tourism. According to Dolata and Schwabe (2023), digital pollution is a key aspect of sustainable mertaversal, as it addresses the often overlooked environmental costs of managing data in virtual environments. Virtual experiences can enhance environmental education, which is in line with the broader goals of sustainable tourism by promoting environmentally friendly behaviors (Streimikiene et al., 2021). Incorporating socioeconomic impacts means accountability for the holistic well-being of destination communities, a core principle of sustainable tourism (Bibri et al., 2022). Moreover, incorporating digital ethics and inclusivity principles means metaverse sustainability aligns with social sustainability goals and equal access to virtual tourism experiences (Mourtzis, 2023). Furthermore, sustainability transfer bridges the gap between virtual and physical environments, a critical consideration in mertaversal sustainability as it measures the real-world impact of virtual experiences on conservation and sustainable practices (Allam et al., 2022). Therefore, not only does this framework justify extending sustainability principles to mertaversal travel, but it also means that mertaversal sustainability is part of the broader sustainable tourism effort, taking into account the unique challenges and opportunities that this new frontier in tourism brings.

Methodology

This study adopted a positivist approach because we aimed to measure tourists' perceptions of the metaverse in sustainable tourism (Corry & Mckenna, 2019). A quantitative approach was used to conduct statistical analysis and generalize the findings (Shaffer & Serlin, 2004). The online questionnaire was chosen for its efficiency in reaching a large audience and for collecting standardized data (Evans & Mathur, 2018). Convenience sampling, although limited in generalizability, was justified due to resource constraints and the exploratory nature of the study (Etikan et al., 2016). A sample size of 260 was determined via power calculations to ensure the reliability of the results (Cohen, 2016). The survey instrument was developed based on a literature review and existing validated scales. The questionnaire had three main sections: demographics, perceived metaverse benefits, and perceived impacts on sustainable tourism. The questions were adapted from previous studies on technology adoption in tourism (Gretzel et al., 2020; Tussyadiah et al., 2018) and were tailored to the metaverse in sustainable tourism. The questions were carefully crafted to align with the research objectives and were peer-reviewed and pilot-tested to ensure clarity and relevance. The survey began with screening questions to ensure that respondents had a basic understanding of Metaverse concepts and some experience with virtual or augmented reality technologies. Participants were asked about their familiarity with specific Metaverse platforms and frequency of use; those without relevant experience were excluded from the study. In addition, they were asked to rate their level of agreement using a 5-point Likert scale. A 5-point Likert scale was used for nuanced responses and statistical analysis (Shukla et al., 2019). The combination of primary data from the questionnaire and secondary data from the literature review increased the validity of the study through methodological triangulation (Heale & Forbes, 2013). Johannesburg was chosen as the case study for several reasons: As South Africa's largest city and main economic centre, it represents a microcosm of the country's diverse tourism landscape and has both urban and nearby natural attractions. This diversity allows for a comprehensive study of the metaverse in different tourism contexts. Furthermore, Johannesburg is a technology hub in Africa, making it an ideal location for exploring the intersection between digital innovation and tourism (Aghimien et al., 2022). Inferential statistics were used to draw meaningful conclusions from the data and test claims about the relationship between metaverse adoption and sustainable tourism practices (Field, 2013).

According to Table 1 the demographic profile of respondents revealed that 58.1% identified as male and 39.9% as female. Only 2% of respondents did not disclose their gender. Regarding age, most responders were younger, 36% were between the ages of 26 and 33, and 42% were between the ages of 18 and 25. In the other age groups, the percentage was much smaller. With 37.8% of respondents possessing a university degree, this is the most prevalent educational qualification among respondents. 19.3% hold a college degree, while only 5.4% have completed high school or less.



Table 1: Demographic profile of respondents

Items	Category	n (%)
Gender	Male	58.1%
	Female	39.9%
	Prefer not to say	2%
Age	18-25	42 %
	26-33	36%
	34-40	14%
	41-48	7.6%
	49 and above	0.4%
Highest level of education	High school	5.4%
	Matric	19.3%
	Learnership/apprenticeship	15.8%
	College	19.7%
	University degree	37.8%
	Other	2.0%

Findings

To obtain a more profound understanding of the results, inferential statistics were employed to facilitate more extensive generalizations outside the immediate sample. To aid in factor analysis, a scree diagram was made as part of this investigation. Researchers can determine the optimal number of components to retain using a scree plot, which visually displays the eigenvalues associated with each factor in descending order (Alves-Pimenta, 2015). The elbow, or the point at which the curve starts to flatten, is often used by researchers to pinpoint the main causes of data variability. Known as the elbow criteria or scree test, this technique preserves equilibrium between the model's simplicity and explanatory capacity (Saputra, 2020). Five factors were accepted in the scree plot.

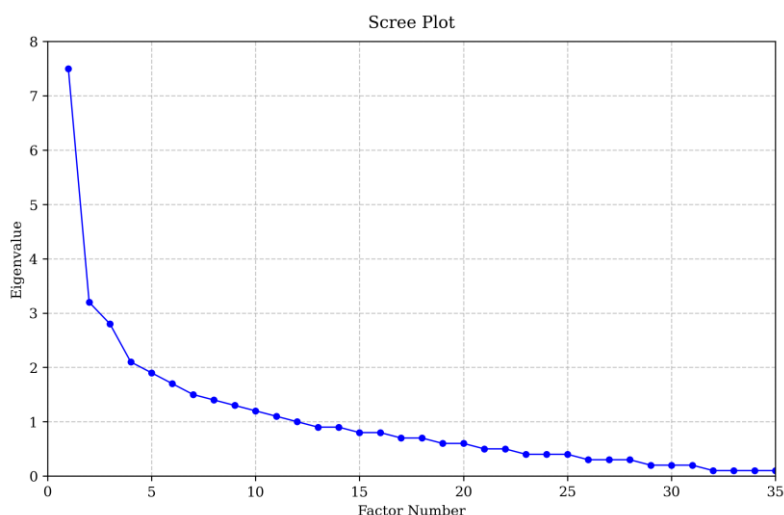


Figure 1: Scree plots of accepted factors
 Source: Authors' compilation

Table 2: Factor analysis of the impacts of metaverse on Sustainable tourism

Factor	Description	Key variables
Positive Impact and Opportunities	Highlights the potential benefits of metaverse on sustainable tourism, including education, competitiveness, and employment.	- The Metaverse provides virtual education about sustainable tourism (0.69) and creates new job opportunities in the tourism industry (0.63)
Economic and Social Concerns	Address issues related to inequality and implementation challenges.	- The competitiveness of developing countries in terms of ICT readiness will decline due to the digital divide (0.66)
Environmental Impacts	Focusing on the potential environmental benefits of the metaverse, such as reduced carbon emissions and resource consumption.	- Using the metaverse reduces carbon emissions from transportation (0.66) and creates virtual experiences that reduce natural resource consumption (0.59)
Authenticity and Social Interaction	Explores potential drawbacks of the metaverse, including loss of authenticity and social interaction.	- Virtual experiences do not represent the authenticity of physical destinations (0.42) - Applying the metaverse in tourism results in social isolation and the absence of face-to-face interaction (0.41)
Implementation Challenges	Identifies practical difficulties in implementing the metaverse in tourism, particularly in developing countries.	- The Metaverse may be difficult to implement at scale in developing countries because of machine costs and the digital divide (0.37)

Source: Calculated from survey results.

A factor analysis of the perceived impacts of the metaverse on sustainable tourism revealed five factors, each capturing different aspects of this complex relationship. Factor 1, labelled Positive Impact and Opportunities, had strong positive loadings for variables related to education, competitiveness, and employment opportunities. Key variables in this factor are as follows: The Metaverse provides virtual education about sustainable tourism (0.69) and creates new job opportunities in the tourism industry (0.63); thus, the metaverse is good for tourism (Kouroupi & Metaxas, 2023). Factor 2, called economic and social concerns, had mixed loadings with both positive and negative correlations. The highest positive loading was for the variable “The competitiveness of developing countries in terms of ICT readiness will decline due to the digital divide (0.66), so this factor is about inequality and challenges of implementing metaverse in tourism (Qadir & Fatah, 2023). Factor 3, the factors identified as environmental impacts had strong positive loadings on variables related to carbon emissions reduction and natural resource



use. Key variables in this factor are as follows: Using the metaverse can reduce carbon emissions from transportation (0.66) and using the metaverse can create virtual experiences that reduce natural resource consumption (0.59), so metaverse is beneficial to the environment (Mashapa & Atanga, 2023). Factor 4, labeled authenticity and social interaction, had moderate loadings for variables related to authenticity of tourist experiences and social aspects of travel. Notable variables in this factor are as follows: Virtual experiences do not represent the authenticity of physical destinations (0.42), and the application of the metaverse in tourism results in social isolation and the absence of face-to-face interaction (0.41). Thus, metaverse tourism may lose authentic experiences and human connections (Hui et al., 2023; Maziriri et al., 2023). Finally, factor 5, called implementation challenges, had relatively weaker loadings overall but still captured key aspects of metaverse implementation in tourism. The highest loading variable in this factor was that the metaverse may be difficult to implement at scale in developing countries due to machine costs and the digital divide (0.37). Thus, implementing the metaverse is regarded a challenging and complex exercise in many tourism contexts especially in developing countries (Bibri, 2022; Bibri et al., 2022).

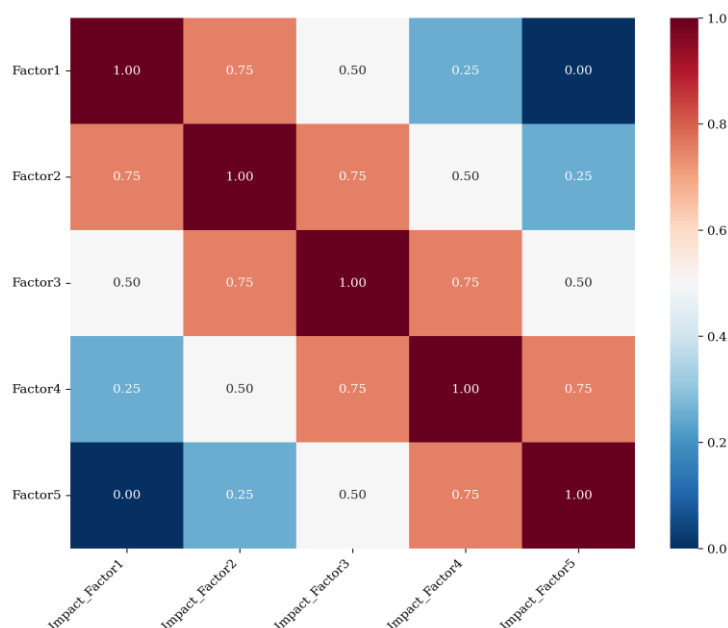


Figure 2: Correlations between metaverse benefits and perceived impacts factors
 Source: Calculated from survey results

In addition, a correlation analysis was conducted between the benefits and impact factors of the metaverse. The heatmap (Fig. 2) shows the correlations between the factors. The darker colours indicate stronger correlations, positive or negative. The results show a perfect correlation (1.0000) between each factor and its corresponding influencing factor; thus, each benefit factor is strongly connected to its perceived impact (Qiu et al., 2023). Different degrees of correlation are observed between the factors; some are moderate to strong, while others are weak (Qadir & Fatah, 2023; Jung, 2023). All correlations are positive, such that as one-factor increases, others also increase to a different extent (Buhalis et al., 2023). The heatmap also shows which factors are more related to each other. For example, Factors 1 and 4 are more related to each other than to Factor 3. These results show that the benefits of metaverse in sustainable tourism are aligned with their impacts (Ali et al., 2023). The strong correlations also mean that those who see significant benefits in one metaverse use area in tourism also see major impacts in the corresponding area (Allam et al., 2022).

Table1.3: ANOVA for factor clusters

Factor	F-value	p-value	Significance
Factor 1	321.4057	0.0000	Significant
Factor 2	120.7791	0.0000	Significant
Factor 3	151.6287	0.0000	Significant
Factor 4	119.6462	0.0000	Significant
Factor 5	91.3241	0.0000	Significant
Impact_Factor 1	321.4057	0.0000	Significant
Impact_Factor 2	120.7791	0.0000	Significant
Impact_Factor 3	151.6287	0.0000	Significant
Impact_Factor 4	119.6462	0.0000	Significant
Impact_Factor 5	91.3241	0.0000	Significant

Source: Calculated survey results

Table 3's ANOVA findings demonstrate that all factors have statistically significant differences between clusters (p-values < 0.05). The factors that contribute most to the differences between clusters are Factor1 and Impact_Factor1, as indicated by their greatest F values. Additionally, a cluster analysis of the metaverse impact and benefits aspects on sustainable tourism was

conducted. Several important conclusions were drawn from an analysis of respondents' opinions regarding the advantages and disadvantages of the Metaverse in sustainable tourism. Three distinct response groups were found, each with varying degrees of perception. Interestingly, Cluster 2 consistently scored higher on the majority of variables, suggesting a more optimistic view of the metaverse's role in sustainable tourism. This implies that respondents in this category are more receptive or excited about the incorporation of metaverse technology into the travel industry (Abass & Zohry, 2022).

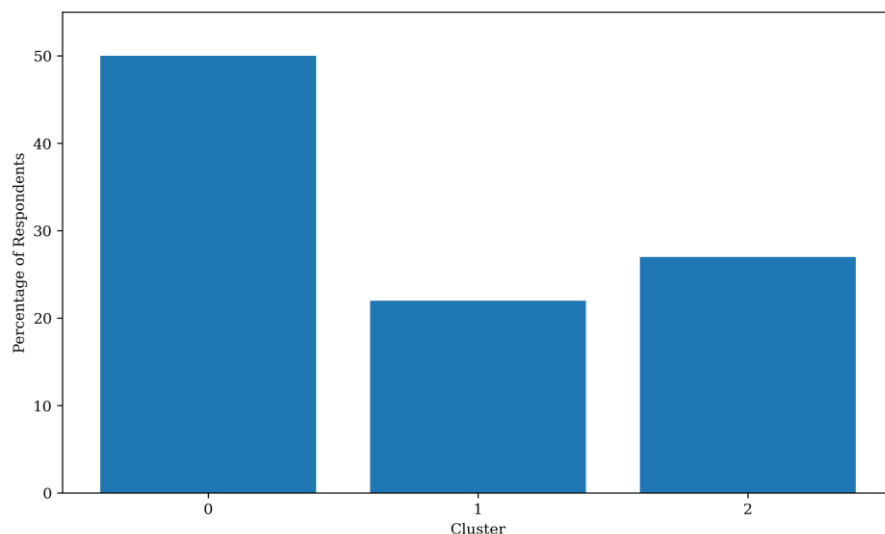


Figure 3 Distribution of respondents across clusters
 Source: Calculated from survey results

Factor 1 and Impact Factor 1 had the highest values across all clusters, thereby making them stand out among all factors examined. This finding suggests that respondents from all groups believe these specific elements of metaverse application in sustainable tourism are the most important or influential (Bravo et al., 2023).

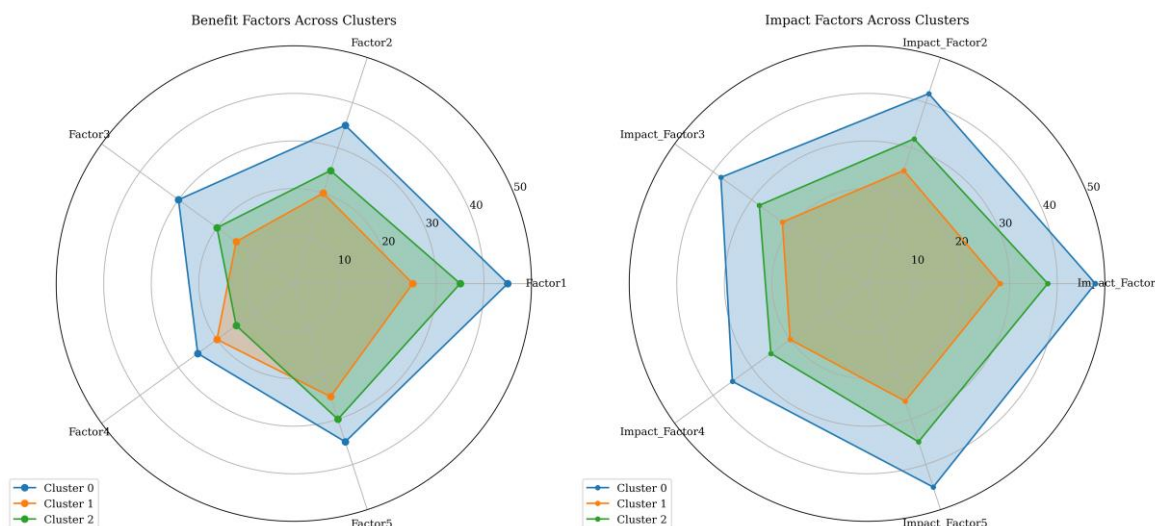


Figure 4 Radar plots of respondents' cluster views
 Source: Calculated from survey results

The radar plots demonstrate the cluster views and similar patterns but different intensities. This pattern similarity means respondents generally agreed on the importance of various factors but differed in their level of enthusiasm or scepticism (Gu et al., 2020). Differences in intensity can be due to personal experiences, technological familiarity, or individual attitudes toward innovations in tourism (Saraswat, 2023). In addition to radar charts, such information would be very useful for tourism industry stakeholders considering metaverse technologies because it provides insights into which aspects are more widely accepted and which need more attention or explanation. Overall, these results show a more comprehensive view of how different groups perceive the benefits and impacts of the metaverse in sustainable tourism. The different clusters suggest that strategies to implement or promote metaverse technologies in tourism should be tailored to different audiences (Dwivedi et al., 2023). The consistently high rating of some factors across all clusters indicates that commonalities can be a starting point for broader discussions or initiatives in this area.



Discussion

The metaverse of sustainable tourism has several key directions and implementation strategies. The three clusters suggest that a segmented approach is needed because one size fits all may not work (Allam et al., 2022). Factor1 and Impact_Factor1 are consistently high across all clusters; thus, these are areas to focus on in development and communication strategies (Murray, 2020). The differences across clusters indicate that targeted education and awareness campaigns are needed to increase understanding and acceptance of metaverse technologies in sustainable tourism (Oh et al., 2023; Hennig-Thurau et al., 2023). Specific strategies can be applied based on cluster characteristics. For the enthusiast cluster (Cluster 2), stakeholders can engage them in beta testing and create ambassador programs. The moderate cluster (Cluster 1) may benefit from targeted educational programs and hands-on experiences. For the skeptic cluster (Cluster 0), focus groups and case studies demonstrating tangible benefits could be effective (Saraswat, 2023). Cross-cluster strategies, such as comprehensive communication plans and inter-cluster dialog platforms are also recommended. These findings can inform sustainable tourism policymaking. They provide a basis for evidence-based policy development, encourage inclusive policy approaches and help prioritize resources. The identification of potential barriers can guide the creation of policies to address these issues through incentives, regulations, or support programs (Oh et al., 2023). A phased implementation approach based on cluster characteristics can be practical for rolling out metaverse in sustainable tourism.

Conclusions

This study set out to explore the perceived impacts of the metaverse within the context of sustainable tourism, with a focus on two primary objectives: examining the metaverse's potential to enhance sustainable tourism and evaluating its impacts. The results revealed that respondents' attitudes and perceptions were complex. According to Dudley et al. (2023), the metaverse is an efficient means of enhancing accessibility to travel experiences, especially for people who live in distant locations or have disabilities (Dudley et al., 2023). Virtual experiences may lessen the negative social and environmental effects usually connected with traditional tourism, according to a significant percentage of respondents who recognised the metaverse's potential to encourage eco-friendly travel behaviours (Hui et al., 2023). Additionally, the metaverse was acknowledged as a valuable medium for online instruction on eco-friendly travel, providing a way to promote ethical conduct and increase awareness (Hui et al., 2023; Su et al., 2023). According to Polishchuk et al. (2023), this is consistent with the increasing awareness of the metaverse as an alternative to conventional tourism that can help with problems like overcrowding and environmental damage in well-known tourism destinations. Furthermore, the findings showed that although the metaverse is seen as a tool that could lessen the carbon footprint of traditional tourism, including transportation-related emissions and the environmental effects of tourism operations, there were also serious worries about the metaverse's environmental impact (Buhalis et al., 2023). Many respondents raised the possible drawbacks of the metaverse, especially with regard to data centers and hardware energy usage, which would cancel out some of the sustainability advantages (Cao et al., 2023). Incorporating metaverse-based experiences into the tourism sector requires careful evaluation of environmental trade-offs and additional research, as these conflicting views highlight. According to Wu et al. (2023), the tourism sector should incorporate sustainability into the planning and executing metaverse experiences, prioritising advancing green technologies, power-efficient infrastructures, and renewable energy sources to reduce adverse effects. More cooperation between metaverse developers and eco-friendly travel agencies is also required to produce low-impact alternatives. Furthermore, continuous observation, focused educational programs, and open dialog regarding the consequences of metaverse activities are crucial. In particular, for local communities, community engagement is essential to guarantee that the advantages of metaverse tourism are equal and accessible (Kouroupi & Metaxas, 2023).

Despite its contributions, the study admits certain limitations, such as its narrow emphasis on a particular community and the omission of qualitative data that may have offered a more profound understanding of the feelings and motives influencing respondents' perceptions. Even though Johannesburg is the main focus, it might not adequately represent the variety of tourist experiences available throughout South Africa, especially in more rural or seaside regions. Moreover, the study's dependence on Likert scales for self-reported views might not adequately represent the complexity of attitudes toward metaverse tourism or account for discrepancies between declared intentions and actual actions (Juvan & Dolnicar, 2014). One of the challenges posed by the novelty of Metaverse technology is that respondents might not have much experience or knowledge of virtual tourism, which could compromise the validity of their answers. In order to overcome these limitations, future research could use mixed methods techniques, such as qualitative interviews or observational studies of real-world metaverse tourism experiences and broaden the geographic scope to encompass a wider variety of South African and international tourist destinations. While identifying issues that must be resolved, the study provides insightful information on the metaverse's potential in sustainable tourism. To fully realise the metaverse's promise as a driver of inclusive and sustainable tourism, cooperation among tourism stakeholders, technological advancements, and community involvement will be essential. This research establishes a significant basis for subsequent investigations and industry procedures, opening the door to a more inventive and sustainable travel approach in the digital age.

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