Virtual reality tourism: intention to use mediated by perceived usefulness, attitude and desire

Yi-Man Teng, Kun-Shan Wu and Fang-Ju Kuo

Abstract

Purpose – *COVID-19 halted global tourism, prompting stakeholders to use virtual reality (VR) tourism to maintain interest. Due to technological advancements and wider internet access globally, VR tourism has become increasingly popular. Guided by the attention-interest-desire-action (AIDA) model and the technology acceptance model (TAM) frameworks, and with the inclusion of personal innovativeness, this study aims to clarify consumer intentions toward engaging with VR tourism by investigating factors such as personal innovativeness, interest, perceived usefulness (PU), perceived ease of use (PEOU), attitude and desire.*

Design/methodology/approach – *Data was gathered from 252 participants using a cross-sectional approach, with partial least squares structural equation modeling used to assess the research model.*

Findings – *The findings indicate consumers' personal innovativeness strongly influences VR tourism intention, mediated by PU, attitude and desire. VR tourism intention is also significantly impacted by interest in VR tourism and is mediated by PU and PEOU, attitude and desire. PEOU and PU are significantly linked to interest and determine attitude. Attitude, both directly and indirectly, significantly influences VR tourism intention through users' desire, which mediates the relationship. Through multiple group analysis, the path from desire to intention is found to be moderated by age, education and marital status.*

Practical implications – *Theoretically, this study pioneers a framework that merges AIDA, TAM and personal innovativeness to advance the understanding of VR tourism adoption dynamics and enrich tourism research. Managerially, it provides valuable guidance on targeting communications and technology toward increasing VR tourism engagement and presents a roadmap for industry practitioners.*

Originality/value – *This research addresses the identified gaps in extant literature by combining TAM and AIDA with personal innovativeness to investigate the process of consumers' VR tourism intention, triggered by consumers' personal innovativeness and interest in VR tourism. The study highlights significant managerial insights for both tourism industry practitioners and academic researchers, which can assist with decision-making to promote VR tourism development.*

Keywords *VR tourism, AIDA model, TAM, Personal innovativeness, Multiple group analysis*

Paper type *Research paper*

虚拟现实旅游：通过感知有用性、态度和渴望调节使用意图

摘要

研究目的： *COVID-19* 使全球旅游业停滞不前，促使利益相关者使用虚拟现实 *(VR)* 旅游来保持兴趣。由于技术进步和全球互联网接入的增长，*VR* 旅游变得越来越受欢迎。基于注意-兴趣-渴望-行动模型 *(AIDA)* 和技术接受模型 *(TAM)* 框架，并纳入个人创新性，本研究旨在通过调查个人创新性、兴趣、感知有用性、感知易用性、态度和渴望等因素，澄清消费者对参与 *VR* 旅游的意图。

研究设计/方法论： 使用横截面方法收集了*252*名参与者的数据，并使用偏最小二乘结构方程建模来评估研究模型。

研究发现： 研究结果表明，消费者的个人创新性通过感知有用性、态度和渴望显著影响 *VR* 旅游意图。*VR* 旅游意图也受到对 *VR* 旅游兴趣的显著影响，并通过感知有用性、感知易用性、态度和渴望进行调节。感知易用性和感知有用性显著与兴趣相关，并决定态度。态度通过用户的渴望直接和间接地显著影响 *VR* 旅

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Received 24 February 2024
Revised 27 April 2024
15 June 2024
Accepted 15 July 2024

游意图，这些渴望调节了这种关系。通过多群组分析，发现年龄、教育和婚姻状况对渴望与意图之间的路径具有调节作用。

原创性/价值：本研究通过结合 *TAM* 和 *AIDA* 与个人创新性来研究消费者的 *VR* 旅游意图过程，填补了现有文献中的空白。本研究强调了对旅游业从业者和学术研究人员的重大管理见解，这些见解可以帮助决策者推动 *VR* 旅游的发展。

实践意义：从理论上讲，本研究开创了一个结合 *AIDA*、*TAM* 和个人创新性的框架，以提升对 *VR* 旅游采用动态的理解，并丰富旅游研究。从管理角度来看，它提供了有价值的指南，帮助定位通信和技术，以增加 *VR* 旅游参与度，并为行业从业者提供了发展路线图。

关键词 *VR* 旅游，*AIDA* 模型，*TAM*，个人创新性，多群组分析
文章类型 研究型论文

Turismo de realidad virtual: Intención de uso mediado por la utilidad percibida, la actitud y el deseo

Resumen

Objetivo: *El COVID-19 detuvo el turismo global, lo que indujo a las partes implicadas a utilizar el turismo de realidad virtual para mantener el nivel de interés. Debido a los avances tecnológicos y al acceso más amplio a Internet a nivel mundial, el turismo de realidad virtual se ha vuelto cada vez más común. Basándose en el modelo de Atención-Interés-Deseo-Acción (AIDA) y en el modelo de aceptación tecnológica (TAM), y con la inclusión de la innovación personal, este estudio tiene como objetivo comprender las intenciones de los consumidores hacia el compromiso con el turismo de realidad virtual investigando factores como la innovación personal, el interés, la utilidad percibida, la facilidad de uso percibida, la actitud y el deseo.*

Diseño/metodología/enfoque: *Se recopilaron datos de 252 participantes utilizando un enfoque transversal, y se utilizó la modelización de ecuaciones estructurales de mínimos cuadrados parciales para evaluar el modelo de investigación.*

Resultados: *Los resultados indican que la innovación personal de los consumidores influye fuertemente en la intención de turismo de realidad virtual mediada por la utilidad percibida, la actitud y el deseo. La intención de turismo de realidad virtual también se ve significativamente afectada por el interés en el turismo de realidad virtual y está mediada por la utilidad percibida y la facilidad de uso percibida, la actitud y el deseo. La facilidad de uso percibida y la utilidad percibida están significativamente relacionadas con el interés y determinan la actitud. La actitud influye tanto directa como indirectamente de manera significativa en la intención de turismo de realidad virtual a través del deseo de los usuarios, que media en la relación. A través del análisis de múltiples grupos, se encontró que la edad, la educación y el estado civil moderan la relación entre el deseo y la intención.*

Implicaciones: *Desde el punto de vista teórico, este estudio es pionero en la creación de un marco que aúna AIDA, TAM e innovación personal para avanzar en la comprensión de la dinámica de adopción del turismo de realidad virtual y enriquecer la investigación turística. Desde el punto de vista de la gestión, ofrece una valiosa orientación sobre cómo orientar las comunicaciones y la tecnología para aumentar la participación del turismo de realidad virtual y presenta una hoja de ruta para los profesionales del sector.*

Originalidad/valor: *Esta investigación aborda las lagunas identificadas en la literatura existente mediante la integración de TAM y AIDA con la innovación personal para analizar el proceso de la intención de los consumidores de turismo de realidad virtual, provocada por la innovación personal de los consumidores y el interés en el turismo de realidad virtual. El estudio pone de relieve importantes perspectivas de gestión tanto para los profesionales del sector turístico como para los investigadores académicos, que pueden ayudar en la toma de decisiones para promover el desarrollo del turismo de realidad virtual.*

Palabras clave *Turismo de realidad virtual, modelo AIDA, TAM, Innovación personal, Análisis de múltiples grupos*
Tipo de papel *Trabajo de investigación*

1. Introduction

Postpandemic, technology is essential to facilitate online tourist destination visits through web-mediated virtual information. Virtual reality (VR) visits provide alternative tourism experiences that evoke curiosity and affirmative emotional responses toward travel destinations (Le *et al.*, 2024). VR tourism offers experiences via technology-driven 3D visual simulations of real tourist landscapes created using computers (Kim *et al.*, 2020), allowing tourists to experience destinations virtually to gain an impression prior to an actual visit or enhance previous experiences (Atzeni *et al.*, 2022). VR provides immersive, realistic and authentic sensory participation for travelers and offers experiences to individuals with

budget constraints, time limitations and/or physical or mental health constraints (Loureiro *et al.*, 2020).

Hospitality and tourism are experiencing an increase in VR tourism use and adoption and use it to effectively market and advertise services and products (Zeng *et al.*, 2020). The global VR tourism market is expected to reach 12.3 billion by 2023 (Future Market Insights, 2023) and is estimated to grow to approximately 26.0 billion in 2033. As concern over the impact of tourism on the environment grows, demand for VR in the tourism industry increases, leading to fierce competition among VR providers. Thus, effective marketing and communication are vital to promote VR products. To deliver the most appropriate and effectual message, marketers should recognize the decision-making procedure of potential customers (Puccinelli *et al.*, 2009). The attention-interest-desire-action (AIDA) model is often used to explain consumer behavior in response to marketing communications, which has proved effective at explaining how media exposure leads to product or service purchases (Strong, 1925). AIDA assumes consumers move through a sequence of cognitive, affective and behavioral stages, which assists marketers in comprehending how target audiences evolve (Song *et al.*, 2021). As VR facilitates accelerated decision-making processes, this study uses AIDA to assess how tourists' behavioral intentions and decision-making processes change as a result of VR.

Due to the complexity of technology-based products or services, it is harder to predict which consumer interest processes, triggered by advertising communications, resulting in purchases. Understanding this complexity can clarify consumer adoption, as although advertising communications generate interest in new technologies, consumers must move through the stages toward adoption (Kim *et al.*, 2010). In studies on technology adoption, especially those on tourism, the technology acceptance model (TAM) is frequently used (Özekici and Küçükergin, 2023). The conceptual structure of TAM can be customized to match the unique context of VR tourism to identify the factors influencing technology adoption (Oncioiu and Priescu, 2022). TAM proposes attitude is a crucial factor in predicting consumers' intention to use new technological innovations. It also identifies perceived usefulness (PU) and perceived ease of use (PEOU) as determinants of attitude.

Although AIDA and TAM are proven in multiple sectors, integrating them can elicit valuable insights for the tourism industry and help management develop effective strategies to remain competitive as VR tourism grows. This integrated approach addresses each model's limitations and aligns with recent research emphasizing the importance of combining technological assessments with psychological consumer journeys to comprehensively understand VR tourism adoption (Geng *et al.*, 2022; Zhang and Hwang, 2023).

TAM has limitations when predicting technology adoption in context-specific situations (Park *et al.*, 2014) and requires adjustment and enhancement to align with the intricate dimensions of VR (Lim *et al.*, 2024). TAM's explanatory power can be improved by incorporating it with another theory that predicts VR tourism adoption (Vishwakarma *et al.*, 2020). Consumers' personal innovativeness is an alternative construct to explain VR technology adoption, as it represents consumers' general propensity toward it (Parasuraman, 2000). Literature on new product adoption highlights the importance of personal innovativeness and argues it is the key factor influencing consumers' adoption of innovative products (Si *et al.*, 2024). To explain VR tourism adoption, it is necessary to integrate the TAM model with personal innovativeness (Senali *et al.*, 2023; Karami *et al.*, 2024).

Chan *et al.* (2023) support AIDA's sequential pathway from capturing attention, generating interest, fostering desire and culminating in action; however, other studies do not fully support this theory (Weng *et al.*, 2021) and criticize the traditional AIDA's effectiveness in altering consumer actions (Song *et al.*, 2021).

As Lee *et al.* (2022) suggest applying diverse statistical techniques to an integrated hypothesis framework, particularly the mediation-moderation methods for analyzing

behavior intentions to investigate consumers' changeable behavior, this research focuses on the moderating impact of age, education and marital status via multiple group analysis and examines the nexus between attitude and VR tourism behavior intention, particularly the mediating effect.

Understanding motivations to engage in VR tourism assists marketers and VR creators to develop more appealing and tourist-friendly products that enhance experience engagement and develop long-term relationships with tourists. As such, the following research questions (RQs) are addressed:

RQ1. Can VR increase visitors' interest in participating in VR tourism?

RQ2. How do tourists' PEOU and PU of VR technologies in tourism affect attitude and VR tourism intention?

RQ3. What kind of model addresses VR tourism acceptance, taking into account limitations and features?

RQ4. Which factors in the proposed model are most significant in determining whether to engage in VR tourism, and do these factors have a positive impact on intention?

Given VR's vast potential and the relative novelty for many users, it is crucial to comprehend the factors impacting tourists' VR tourism acceptance. To examine the factors influencing VR tourism adoption, this study integrates the combined AIDA–TAM model with personal innovativeness, complementing each model's strengths and explores the factors influencing consumers' VR tourism behavior intention, as well as the roles of attitude and desire in this process. This study provides valuable insights for both tourism researchers and industry professionals.

2. Literature review

2.1 Virtual reality tourism

VR tourism combines VR and tourism through modern information and communication technologies, enabling individuals to visit and experience tourist sites without physical travel. VR tourism is a direct and impactful virtual technology application that elevates travel experiences by offering innovative destination marketing tools and attractions to reshape consumer experiences, which is proving to be an effective customer engagement tool (de Lurdes Calisto and Sarkar, 2024).

Previous research investigates different aspects of VR tourism experiences, such as travel, attitude, enjoyment and subjective well-being (Tussyadiah *et al.*, 2018). Studies on the effects of VR tourism emphasize the crucial role of the perception of low manipulative intent VR marketing communication creates (Spielmann and Orth, 2021). Some studies focus on factors such as immersion, presence and flow (Atzeni *et al.*, 2022), whereas others emphasize the links between VR attachment and experiential satisfaction, loyalty and intention to visit and recommend destinations (Wu *et al.*, 2020a; Geng *et al.*, 2024). Kim *et al.* (2020) confirm VR has a positive effect on cognition and discuss how the affective responses improve viewers' experience and visit and revisit intentions.

Prior VR tourism studies focus on pandemic periods; however, this research investigates individuals' awareness of VR travel options and how they perceive them postpandemic. The conceptual model contributes to the knowledge of sensory destinations by uncovering the underlying mechanism among how individuals' personal innovativeness and PU affect VR tourism intention.

This research offers significant contributions to practitioners, suggesting VR is an effective tourism marketing tool due to its ability to enhance tourists' *in-situ* experience. In this study, a broad VR tourism concept is adopted by conducting surveys on potential tourists using nonimmersive viewing of 360-degree videos.

2.2 Technology acceptance model and attention-interest-desire-action

To effectively forecast the enduring popularity of VR tourism in the present and future market, it is imperative to establish a relevant model that amalgamates critical psychological and technology adoption factors linked to consumers' VR technology use and travel intentions.

According to TAM, the primary motivators determining users' attitude toward new technology are PEOU and PU (Song *et al.*, 2021). When individuals view a technology as effective and easy to use, it cultivates a positive attitude that increases adoption intention. TAM has gained considerable prominence in clarifying tourists' VR technology adoption, as it explains variance in behavioral use intention and actual technology use (Guo *et al.*, 2024) and, due to its simplicity in structural equation modeling frameworks, effectively predicts tourists' VR technology adoption (Vishwakarma *et al.*, 2020; Özekici and Küçükergin, 2023; Zhang and Hwang, 2023; Guo *et al.*, 2024).

The AIDA framework, renowned in advertising and communication, charts consumers' path through awareness, interest, desire and action. AIDA identifies consumers' purchasing behavior from initial product awareness to a final purchase decision (Song *et al.*, 2021; Weng *et al.*, 2021; Geng *et al.*, 2022; Zhang and Hwang, 2023). Studies applying AIDA to tourism destination marketing demonstrate its effectiveness in assessing the sensory marketing impact on potential visitors' intentions (Weng *et al.*, 2021). Zhang and Hwang (2023) advocate applying a refined AIDA in sensory marketing for VR tourism destinations and propose leveraging perceived destination VR sensory stimulation as a measure of consumer attention and interest, specifically in response to the sensory aspects of destination advertising.

This research applies AIDA to sensory marketing for tourism destinations using VR to evoke sensory reactions, focusing on attracting consumer interest, desire and intention toward VR destination advertisements. As this research focuses on the effect of a 360-degree nonimmersive VR video on consumer behaviors, participants are exposed to information about one sightseeing spot (Northern Lights in Norway) only and, presumably, devote their full attention to it. Therefore, the initial stage of attracting attention is irrelevant and not included.

TAM is criticized for its limited ability to predict technology acceptance (Park *et al.*, 2014) and requires refinement and enhancement to be suitable for complex VR dimensions (Lim *et al.*, 2024). Similarly to TAM, AIDA struggles to assess its target audience's actual behaviors (Song *et al.*, 2021; Zhang and Hwang, 2023). To address TAM and AIDA's limitations and gain insight into travelers' purchasing decision-making process, this study integrates essential components of both models. Merging TAM and AIDA's fundamental elements improves capacity to predict behavioral intentions, providing greater insight into the complex dynamics of technology adoption (Song *et al.*, 2021). As consumers with higher levels of personal innovativeness are generally more optimistic about trying and adopting new technology, this research model also incorporates personal innovativeness.

2.3 Personal innovativeness

Innovation adoption is often domain-specific, with individuals choosing to adopt certain innovations while neglecting others (Goldsmith and Hofacker, 1991). Personal innovativeness is widely used in new information technology adoption research, often in conjunction with technology adoption theories such as TAM.

Personal innovativeness refers to *the willingness of an individual to try out any new information technology* (Agarwal and Prasad, 1998). Current literature indicates personal innovativeness is a significant predictor of consumer adoption intention (Karami *et al.*, 2024; Si *et al.*, 2024). A recent meta-analysis study by Ciftci *et al.* (2021) found personal

innovativeness has a medium positive effect on technology use intention in the hospitality and tourism industry. Individuals with high levels of personal innovativeness tend to adopt technological innovations, irrespective of encountering negative or inadequate details (Ciftci *et al.*, 2021).

Hapsari *et al.* (2023) posit personal innovativeness should be considered in determining consumer acceptance, whereas PEOU and PU are significant variables in consumers' willingness to adopt technology. There is evidence to suggest consumers with high personal innovativeness have a positive perception toward ease of use and usefulness of new applications (Senali *et al.*, 2023; Karami *et al.*, 2024). Those with greater personal innovativeness are prone to overlook system complexity and accessibility to resources when embracing new technologies. Individuals embracing novelties and challenges perceive the technology as friendly and easy to use. As a result, the following hypotheses are proposed:

H1. Personal innovativeness has a positive impact on the PEOU of VR tourism.

H2. Personal innovativeness has a positive impact on the PU of VR tourism.

2.4 Interest, desire, perceived ease of use and perceived usefulness

A challenging marketing objective is generating interest in new products or services. There is a higher probability of consumers engaging with new products when promotional material emphasizes aspects most relevant to potential customers (Zhang and Hwang, 2023). Although TAM is confirmed as a valid model, Davis *et al.* (1989) evidence external factors, such as interest, can also affect PU and PEOU. Song *et al.* (2021) states when promotional material or advertisements generate interest, it can impact the PU and PEOU of a new technology.

In tourism marketing, consumers' strong interest in VR tourism has a positive impact on PEOU, as increased interest may increase ease of navigating and using a particular system (Zhang and Hwang, 2023). Geng *et al.* (2022) and Zhang and Hwang (2023) also state interest toward VR tourism positively affect PU and PEOU.

Based on AIDA, Kim (2024) investigates the dual nature of consumer confusion and its implications on the purchasing journey, in the context of hotel brands, and found interest has a positive effect on desire, which consequently promotes action.

As such, the following hypotheses are proposed:

H3. Interest has a positive impact on the PEOU of VR tourism.

H4. Interest has a positive impact on the PU of VR tourism.

H5. Interest positively impacts desire toward VR tourism.

2.5 Perceived ease of use, perceived usefulness and attitude

According to TAM, an individual's PEOU and PU are the primary factors determining their attitude towards a technological innovation, which in turn influences use intention. If an individual perceives a particular technology will simplify and enhance a specific task and it is easy to use, they are more likely to have a positive attitude toward it, leading to intention to use it and ultimately determining the adoption of the technology.

Wu *et al.* (2020b) reveal PEOU greatly enhances PU within hospitality; however, the impact of PEOU on PU in a VR context is inconsistent. Özekici and Küçükergin (2023) and Zhao and Huang (2022) evidence the significant positive impact of PEOU on PU; however, Israel *et al.* (2019) found no significant connection.

Attitude is the assessment of individuals' preference for using VR tourism (Geng *et al.*, 2022). When individuals perceive less effort is required to use a specific technology, the more likely their attitude toward its use will be positive (Venkatesh *et al.*, 2003). PEOU and PU significantly influence attitude formation and are primary motivators of consumers' technology use intention (Song *et al.*, 2021). Özekici and Küçükergin (2023) also demonstrate the substantial positive impact of PEOU and PU on attitude toward VR tourism. Thus, this study hypothesizes:

H6. PEOU positively impacts VR tourism's PU.

H7. PEOU positively impacts attitude toward VR tourism.

H8. PU positively impacts attitude toward VR tourism.

2.6 Attitude toward virtual reality tourism

AIDA proposes interest invokes a desire phase. Once interest is generated, consumers desire to engage with the new product or service (Wijaya, 2012). Geng *et al.* (2022) evidence during the transformation of initial interest to desire and subsequently culminating in behavioral intention, it is crucial to sustain the potential user's enthusiasm and positive attitude. Based on TAM and AIDA, Song *et al.* (2021) evidence attitude toward food delivery apps significantly affect desire to use them.

In a VR context, attitude positively affects VR tourism intention (Geng *et al.*, 2022; Zhao and Huang, 2022; Özekici and Küçükergin, 2023) and a positive attitude typically leads to intention to use VR tourism (Zhao and Huang, 2022). When consumers have positive attitudes toward VR tourism, they will be more inclined to desire using it. Thus, this study hypothesizes:

H9. Positive attitudes toward VR tourism increases individuals' desire to use it.

H10. Attitude positively impacts VR tourism intention.

2.7 Desire and virtual reality tourism intention

Desire is defined as the *action's end state*. In hospitality sector technology-based products and services, desire positively effects behavior intention (Song *et al.*, 2021; Kim, 2024). Geng *et al.* (2022) confirm desire positively affects intention to use VR tourism. Therefore, the 11th hypothesis is:

H11. Desire has a positive influence on intention to use VR tourism.

The proposed research model for the study is illustrated in Figure 1.

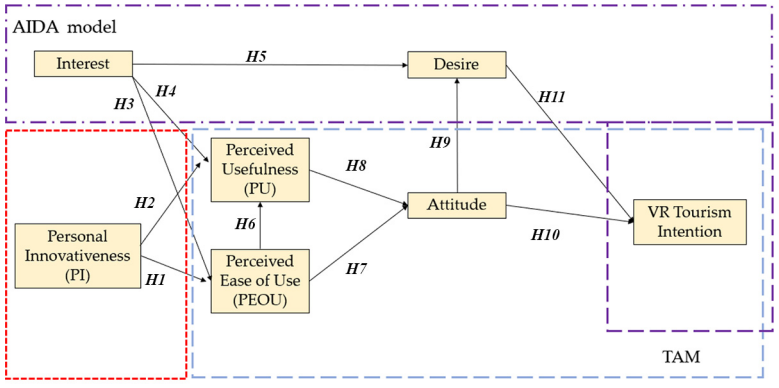
3. Methodology

3.1 Sample and processes

The snowball sampling method was used to recruit participants from northern Taiwan who expressed an interest in experiencing 360-degree VR landscape videos and had never visited Norway. The initial respondents were asked to recommend other individuals who they believed would be interested in VR. This approach is consistent with the existing literature on the adoption of various technologies in different contexts (Maqbool *et al.*, 2023; Sinha *et al.*, 2024).

To collect contact information, Google forms were available online from March 1 to March 31, 2023 for participants to complete. Participants were asked to complete two verification questions: never traveled to Norway in the past three years and can identify the Northern Lights in Norway as the featured scenic spot. A total of 300 participants accessed the questionnaire; however, 48 were disqualified based on screening questions. The remaining 252 sample participants, 43.3% male and 56.7% female, were instructed to view a 2-min,

Figure 1 Research model



Source: Authors own creation

12-s long 360-degree VR video of the Northern Lights in Norway, provided by AirPano (www.youtube.com/watch?v=fNsYzXDJg_8&t=27s), on a mobile device. Table 1 presents the respondents' characteristics.

3.2 Measurement

All measurement variables used were sourced from prior research to ensure validity and reliability. This questionnaire employs Likert-type scales with five points, from (1) strongly disagree to (5) strongly agree. Based on theoretical assumptions, this research measures seven constructs, personal innovativeness, PEOU, PU, attitude, interest, desire and VR tourism intention. To guarantee the questionnaire's comprehensibility, the back-translation method was used to translate it from English to Chinese. All research construct questionnaire items and resources are outlined in the Supplementary Materials (S1).

3.3 Data analysis

The data analysis was conducted using SPSS 26 and SmartPLS 4.0. SmartPLS clarifies the relationships among variables and indicators by using path models, which streamlines the

Table 1 Demographic analysis

Demographic characteristics	*Frequency*	*%*
Gender		
Male	109	43.3
Female	143	56.7
Age		
Baby Boomer Generation	21	8.4
Generation X	103	40.9
Generation Y	111	44.0
Generation Z	17	6.7
Education		
Associate degree	70	27.8
Bachelor and above	182	72.2
Marital status		
Single	80	31.7
Married	172	68.3

Source: Authors' own creation

specification of relationships and the model's complexity. Furthermore, SmartPLS operates without necessitating assumptions about data distribution, thus enhancing the flexibility of data utilization (Hair *et al.*, 2012).

4. Results

4.1 Common method bias

Within partial least squares-structural equation modeling (PLS-SEM), the full collinearity examination strategy is implemented to detect common method bias (Kock, 2015). To ensure data reliability, Hair *et al.* (2011) and Kock (2015) recommend variance inflation factor (VIF) values under 3.3. Multicollinearity is evaluated by examining the VIF, with the results indicating all VIF values are under 3.3 (Kock and Lynn, 2012), thus there is no common method bias issue (Table 2).

4.2 Measurement model

After the initial model assessment, one attitude item (AT1) was excluded due to a factor loading below the recommended minimum value of 0.70 (Hair *et al.*, 2019). All composite reliability values, Cronbach's α and Dijkstra Henseler's (rho_A) are above the 0.70 threshold, confirming the data has adequate reliability (Table 2) (Loh *et al.*, 2021).

Average variance extracted (AVE) and factor loading are used to evaluate convergent validity (CV). All factor loadings, except for AT1, exceed the threshold value of 0.70 (Loh *et al.*, 2021). The AVE values range from 0.708 to 0.862, exceeding the minimum threshold of 0.50 (Fornell and Larcker, 1981). These criteria indicate the measurement model has good CV.

To affirm discriminant validity, this study applies the Fornell and Larcker (1981) guideline, mandating the square root of each construct's AVE exceed the corresponding correlation coefficients with other constructs (Hew and Kadir, 2017). The heterotrait–monotrait (HTMT) analysis results demonstrate excellent discriminant validity, indicating the distinctiveness of each variable in comparison to the others (Henseler *et al.*, 2015). All HTMT values are below

Table 2 Confirmatory factor analysis for model building

Constructs	*Indicators*	*Factor loading*	*VIF*	*Cronbach's α*	*rho_A*	*CR*	*AVE*
PI	PI1	0.839	1.633	0.794	0.799	0.879	0.708
	PI2	0.868	1.824				
	PI3	0.817	1.642				
INT	INT1	0.931	2.108	0.841	0.841	0.926	0.862
	INT2	0.926	2.108				
DES	DES1	0.890	2.379	0.892	0.892	0.933	0.822
	DES2	0.908	2.686				
	DES3	0.922	3.072				
PEOU	PEOU1	0.867	2.183	0.844	0.847	0.906	0.762
	PEOU2	0.901	2.409				
	PEOU3	0.850	1.759				
PU	PU1	0.840	1.795	0.834	0.843	0.900	0.750
	PU2	0.873	2.089				
	PU3	0.886	1.986				
AT	AT2	0.896	1.622	0.765	0.766	0.895	0.810
	AT3	0.904	1.622				
VRTI	VRTI1	0.908	2.452	0.888	0.893	0.930	0.816
	VRTI2	0.896	2.599				
	VRTI3	0.906	2.640				

Source: Authors' own creation

0.9 and meet Henseler *et al.* (2015) HTMT (<0.9) conditions, indicating less correlation among constructs (Table 3). Thus, the measurement model exhibits satisfactory reliability, as well as discriminant and CV.

4.3 Structural model test

The structural model hypotheses were tested using a bias-corrected, accelerated bootstrap process with 5,000 subsamples, as recommended by Hair *et al.* (2011), with all hypotheses being supported (Table 4). Personal innovativeness significantly impacts PEOU (beta = 0.181, $p < 0.01$) and PU (beta = 0.266, $p < 0.01$), supporting *H1* and *H2*. Interest positively affects PEOU (beta = 0.505, $p < 0.01$), PU (beta = 0.298, $p < 0.01$) and desire (beta = 0.344, $p < 0.01$), indicating *H3*, *H4* and *H5* are supported. PEOU significantly impacts PU (beta = 0.265, $p < 0.01$) and attitude (beta = 0.163, $p < 0.01$), supporting both *H6* and *H7*. PU positively affects attitude (beta = 0.615, $p < 0.01$), which supports *H8*. Attitude positively impacts desire (beta = 0.526, $p < 0.01$) and VR tourism intention (beta = 0.271, $p < 0.01$), meaning *H9* and *H10* are supported. Finally, desire positively impacts VR tourism intention (beta = 0.312, $p < 0.01$), confirming *H11*. The model effectively explains 29.2% of the VR tourism intention variance, 51.1% of the changes in attitude, 59.8% in desire, 35.5% in PEOU and 43% in PU.

To improve internal validity and minimize the influence of confounding and extraneous factors, the control variables, gender, age, marital status and education, are considered in the equations, with no significant relationship found between them and VR tourism intention. This implies the aforementioned factors have no substantial effect on tourists' VR tourism intention.

Table 3 Discriminant validity

Variables	*AT*	*DES*	*INT*	*PEOU*	*PU*	*PI*	*VRTI*
AT	*0.900*	0.870	0.697	0.606	0.872	0.563	0.598
DES	0.719	*0.907*	0.738	0.609	0.746	0.509	0.565
INT	0.561	0.639	*0.929*	0.679	0.645	0.446	0.534
PEOU	0.490	0.529	0.571	*0.873*	0.630	0.444	0.542
PU	0.702	0.649	0.547	0.532	*0.866*	0.581	0.670
PI	0.442	0.43	0.365	0.365	0.472	*0.842*	0.451
VRTI	0.495	0.506	0.46	0.471	0.577	0.380	*0.903*

Source: Authors' own creation

Table 4 Structural model assessment

Hypothesis and relationship	*β*	t-*value*	*Bias corrected confidence intervals* 5%	95%	*Results supported?*
H1. PI→PEOU	0.181**	3.195	0.088	0.272	Yes
H2. PI→PU	0.266***	4.218	0.161	0.369	Yes
H3. INT→PEOU	0.505***	8.667	0.401	0.596	Yes
H4. INT→PU	0.298***	4.672	0.191	0.402	Yes
H5. INT→DES	0.344***	6.654	0.261	0.432	Yes
H6. PEOU→PU	0.265***	4.224	0.166	0.372	Yes
H7. PEOU→AT	0.163**	2.890	0.070	0.254	Yes
H8. PU→AT	0.615***	12.401	0.526	0.691	Yes
H9. AT→DES	0.526***	9.462	0.433	0.616	Yes
H10. AT→VRTI	0.271**	3.230	0.129	0.404	Yes
H11. DES→VRTI	0.312***	4.035	0.183	0.435	Yes

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source: Authors' own creation

The effect size of each hypothesis was analyzed. Attitude has a large effect size on desire and PU has a large effect size on VR tourism intention, exceeding the large size threshold value (0.35). Interest has a moderate effect size on desire and PEOU, exceeding the size threshold value (0.15) (Cohen, 2013). Other paths are observed as having only minor effects (Table 6).

The goodness of fit (GoF) value is 0.588, exceeding the high GoF threshold (0.36) (Tenenhaus *et al.*, 2005), which indicates a satisfactory model fit. In addition, the Q^2 prediction for VR tourism intention is greater than zero (Table 5), indicating PLS-SEM-based predictions are superior to the most basic benchmark (Evermann and Tate, 2016). The mean absolute error (MAE) of PLS-SEM is lower than the MAE of the linear model benchmark (Table 7), indicating it has the highest predictive power in the model.

4.4 Mediating effect analysis

The serial mediation model undergoes analysis via SmartPLS 4.0, a tool designed specifically for assessing intricate models, with a bootstrap sampling size of 5,000 to mirror the randomness of sampling effectively. To evaluate indirect effects, a bias-corrected bootstrapping method is applied. The significance of a mediation effect is decided by whether the 95% bias-corrected confidence interval (BCCI) excludes 0.

The bootstrap results for the indirect effects show interest indirectly influences attitude through PEOU and PU (beta = 0.348, $p < 0.001$, 95% BCCI = [0.277, 0.424]) (Table 8).

Table 5 Predictive relevance (Q^2) and R^2

Endogenous construct	Q^2	R^2
Attitude	0.352	0.511
Desire	0.429	0.598
Perceived ease of use	0.34	0.355
Perceived usefulness	0.37	0.430
VR tourism intention	0.213	0.292

Source: Authors' own creation

Table 6 Effect size (f^2)

Predictors/dependent constructs	*Attitude*	*Desire*	*Interest*	*Perceived usefulness*	*VR tourism intention*
Attitude		0.472			0.05
Desire					0.066
Interest		0.202	0.343	0.101	
Perceived ease of use	0.039			0.079	
Perceived usefulness					0.554
Personal innovativeness			0.044	0.103	

Source: Authors' own creation

Table 7 PLS-predict result

	PLS-SEM			*Linear model benchmark*	
Construct	*RMSE*	*MAE*	*Q^2-predict*	*RMSE*	*MAE*
VR tourism intention	0.653	0.485	0.213	0.648	0.500

Notes: MAE = mean absolute error; RMSE = root mean squared error
Source: Authors' own creation

Table 8 Mediating results

Relationship	β	t-value	Bias-corrected confidence intervals 5%	95%
Total indirect effects				
PI→AT	0.222***	4.921	0.151	0.299
PI→VRTI	0.097***	3.607	0.002	0.059
INT→AT	0.348***	7.673	0.277	0.424
INT→VRTI	0.259***	6.609	0.198	0.328
AT→VRTI	0.164***	3.714	0.094	0.240
Specific indirect effects				
PI→PU→AT→VRTI	0.044*	2.338	0.019	0.081
PI→PU→AT→DES→VRTI	0.027*	2.488	0.013	0.049
INT→PEOU→AT→DES→VRTI	0.014*	2.184	0.006	0.027
INT→PEOU→PU→AT→VRTI	0.022*	2.283	0.010	0.043
INT→PEOU→PU→AT→DES→VRTI	0.013**	2.661	0.007	0.025
INT→PU→AT→VRTI	0.050**	2.633	0.024	0.085
INT→PU→AT→DES→VRTI	0.030**	2.771	0.015	0.051
INT→DES→VRTI	0.107**	3.309	0.057	0.163
AT→DES→VRTI	0.164***	3.714	0.097	0.244

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
Source: Authors' own creation

Given the substantial indirect influence of attitude on desire, leading to VR tourism intention (beta = 0.164, $p < 0.001$, 95% BCCI = [0.094, 0.240]), desire is verified as this relationship's mediating factor. The serial mediating impact of interest on VR tourism intention is significant (beta = 0.259, $p < 0.001$, 95% BCCI = [0.198, 0.328]) and present in PEOU and PU, and attitude and desire are simultaneous and nonsimultaneous, respectively. The serial mediating effect of personal innovativeness on attitude and VR tourism intention also produces the same results.

4.5 Multiple-group analysis

To ensure a comprehensive analysis and interpretation, the model is evaluated using multiple-group analysis (MGA). PLS-MGA is an effective method to analyze moderation among a wide spectrum of interconnected relationships, as it focuses on subgroup heterogeneity (Hair *et al.*, 2017).

Prior to completing MGA, this study uses the measurement invariance of a composite model (MICOM) process within the PLS-SEM approach to evaluate measurement invariance (Henseler *et al.*, 2016). MICOM focuses on assessing three areas:

1. configural invariance;
2. compositional invariance; and
3. equal means and variances.

An overview of the MICOM process is listed in Supplementary Materials (Tables S2, S3, and S4).

To identify significant differentiations between the two groups, MGA is evaluated using the PLS-MGA bootstrapping method. For each group, the path coefficients and significance levels are elicited by comparing direct group-specific bootstrap estimates simultaneously.

The PLS-MGA results identify an insignificant difference between male and female participants for all hypotheses (Table 9). With regard to variations among generations, the path coefficients reveal personal innovativeness has a stronger effect on PEOU among

Table 9 MGA Results

Relationship	*Path coefficients diff (Male–Female)*	*Welch-Satterthwaite test* p-*value*	*Path coefficients diff (BX–YZ Generation)*	*Welch-Satterthwaite test* p-*value*	*Path coefficients diff (Low–High Education)*	*Welch-Satterthwaite test p-value*	*Path coefficients diff (Single–Married)*	*Welch-Satterthwaite test* p-*value*
H1. PI→PEOU	0.054	0.629	−0.264*	0.016	−0.066	0.602	0.09	0.476
H2. PI→PU	0.145	0.274	−0.035	0.778	0.049	0.693	−0.301	0.053
H3. INT→PEOU	0.001	0.992	0.226*	0.046	0.283**	0.005	−0.159	0.208
H4. INT→PU	−0.018	0.885	0.011	0.933	−0.25	0.134	0.217	0.077
H5. INT→DES	0.024	0.823	0.191	0.085	−0.074	0.566	0.087	0.473
H6. PEOU→PU	−0.087	0.488	0.028	0.836	0.326*	0.036	0.056	0.680
H7. PEOU→AT	0.075	0.541	−0.058	0.625	−0.135	0.338	0.11	0.360
H8. PU→AT	−0.157	0.146	0.028	0.782	0.147	0.206	−0.137	0.200
H9. AT→DES	−0.02	0.866	−0.153	0.195	−0.047	0.730	−0.16	0.208
H10. AT→VRTI	−0.032	0.852	−0.200	0.231	−0.051	0.746	0.189	0.274
H11. DES→VRTI	−0.074	0.632	0.314*	0.037	0.282*	0.037	−0.342*	0.037

Notes: PI = personal innovativeness; INT = interest; DES = desire; PEOU = perceived ease of use; PU = perceived usefulness; AT = attitude; VRTI = VR tourism intention. *$p < 0.05$; **$p < 0.01$

Source: Authors' own creation

Generations Y and Z than on Baby Boomers and Generation X. However, the impact of interest on PEOU and desire on VR tourism intention is stronger for Baby Boomers and Generation X than for Generations Y and Z.

The variations between lower (associate degree) and higher (bachelor and above) education level respondents are also assessed. Only the effects of interest on PEOU, PEOU on PU and desire on VR tourism intention are significant. Interest has a stronger effect on PEOU among lower education level respondents. Similarly, the impact of PEOU on PU and desire on VR tourism intention is stronger for lower education level respondents than for higher (bachelor and above).

With regard to the variations among marital status, the differences in path coefficients reveal the effect of desire on VR tourism intention is much higher for married respondents than single.

5. Conclusions

Tourism and destination marketing increasingly uses VR to offer immersive destination experiences. This study focuses on the influence of interest and desire on VR tourism intention, which, thus far, has received limited research attention (Geng *et al.*, 2022; Zhang and Hwang, 2023). Recognizing the significance of consumers' acceptance of VR tourism and increasing interest in engaging with VR tourism, this study combines AIDA and TAM with personal innovativeness to introduce an integrated model to comprehensively assess consumers VR tourism intention. This research demonstrates a satisfactory model fit and all hypotheses are supported.

Regarding AIDA, the results indicate consumer interest leads to increased PEOU and PU of VR tourism. As consumers become more interested in VR tourism, they tend to consider it user-friendly and beneficial, suggesting an inclination to believe VR tourism delivers on the promised benefits advertised through marketing. This implies a strong relationship among interest, PEOU and PU in TAM, which aligns with prior studies evidencing marketing communication as a significant external element in new innovation adoption (Geng *et al.*, 2022; Zhao and Huang, 2022; Özekici and Küçükergin, 2023; Zhang and Hwang, 2023).

Within TAM, the results reveal both PEOU and PU are significant antecedents of attitude; however, PU has a greater impact on attitude than PEOU. This aligns with similar findings in various research areas related to technology adoption and VR application (Özekici and Küçükergin, 2023; Wu *et al.*, 2020b; Zhao and Huang, 2022).

VR tourism embodies technology-driven products and services, where PEOU and PU play pivotal roles in shaping individuals' attitudes. Attitude toward VR tourism is vital in cultivating consumers' adoption desire. AIDA suggests marketing communication can generate interest in a product or service, which leads to the desire to acquire it. Combining the AIDA and TAM theories confirms attitude, a determinant of PEOU and PU, forms prior to desire, making it a crucial mediator between the technical cognitive factors (PEOU and PU) and the emotional motivation factor (desire).

Desire is found to significantly impact tourists' VR tourism intention, meaning desire is a motivator for establishing behavior intention during the psychological processing stages. Geng *et al.* (2022) states to transform interest into desire, and subsequently into behavior intention, it is crucial to sustain the potential user's enthusiasm and positive attitude.

This paper also investigates how gender, age, education and marital status moderate the relationship between selected constructs to explain the endogenous variables of VR tourism intention. As age increases, desire has a stronger influence on VR tourism intention, whereas the impact of desire on VR tourism intention is stronger for lower education level respondents than for higher (bachelor and above). Desire also has a stronger effect on VR tourism intention among married respondents than single.

5.1 Theoretical contribution

The research results elicit multiple significant theoretical contributions. This study sought to supplement the deficiencies of TAM and AIDA, creating significant academic value, as integrating the two models mitigates their limitations and maximizes the advantages of each, whereas proposing an overarching framework for decision-making in the context of VR tourism.

Within the context of VR tourism adoption, the application and expansion of personal innovativeness, TAM and AIDA demonstrates their adaptability and applicability in clarifying the adoption of technology and engagement behaviors across various sectors (Geng *et al.*, 2022; Zhang and Hwang, 2023). Integrating these theories can provide a useful framework to examine emerging technology adoption and resultant loyalty across different contexts (Lim, 2018).

Introducing and examining personal innovativeness as an extension of TAM highlights the importance of investigating other factors when researching novel technology adoption, such as VR. This theoretical implication suggests future studies should investigate the potential relevance of constructs, and the relationships between them, to gain a deeper understanding of the distinctive aspects of VR adoption in different contexts (Wei, 2019).

The findings extend current knowledge by clarifying desire as a critical mediator between attitude and intention in VR tourism, supporting prior studies examining desire's influence in hospitality contexts, e.g. food delivery apps (Song *et al.*, 2021) and hotel brands (Kim, 2024). This result parallels prior research validating the mediating effect of individuals' desire in the emerging VR tourism context (Geng *et al.*, 2022).

This study pioneers the exploration of how interest, an integral AIDA component, influences PEOU and PU from TAM's perspective. The significant impact of interest on these technology acceptance factors aligns with Song *et al.* (2021), who verify external variables can shape PEOU and PU. Integrating AIDA's motivational premise with TAM's technological assessments deepens insights into the interplay between VR destination advertising stimuli and user evaluations of new technologies. The results verify extrinsic perception and intrinsic motivation are paramount considerations when developing technology innovations.

By incorporating personal innovativeness as a precursor to PEOU and PU, the research results enhance understanding of how personal innovativeness predisposes consumers toward perceiving a new technology as useful and easy to use and extends prior research focused on personal innovativeness' role in technology adoption in a VR tourism context (Si *et al.*, 2024).

This study seamlessly integrates AIDA, TAM and the concept of personal innovativeness to offer a comprehensive framework for assessing VR tourism intention, which not only provides a robust structure for future research endeavors but also offers valuable new insights into this emerging field.

5.2 Managerial implications

The findings elicit several managerial implications. Similar to Song *et al.* (2021) results, interest significantly affects PEOU, PU and desire, offering industry practitioners insight to develop strategies to attract and acquire tourists. Collaborating with VR developers and content creators to increase consumer interest in VR can help create high-quality VR content. The travel industry can partner with platform providers, media companies or telecoms to develop novel, engaging and content-rich audio-visual materials and innovative services. Through creating and offering high-quality, vivid and seamless VR experiences featuring immersive and nonimmersive content, VR's potential can be leveraged to evoke curiosity and favorable attitudes toward destinations. Social media promotions, VR

experience events and collaborations with influencers can also boost exposure and interest. The relationship between interest toward VR tourism and potentially successful marketing practices can be better understood by examining the moderating effects of characteristics such as age, gender, education and marital status.

Tourists' attitude and VR tourism intention are significantly influenced by PU and PEOU, according to this study's findings. Therefore, destination marketers, travel agents and VR providers should prioritize designing appealing, user-friendly VR applications that adhere to tourists' preferences and desires, as well as investigating diverse platforms to effectively raise awareness and communicate VR advantages. Clear communication highlighting how VR tourism complements and enriches physical travel, through previsit planning, postvisit reminiscing and expanding access to remote destinations, can increase PU.

VR tourism operators or marketers should analyze consumer needs from the perspective of usefulness, including the desired destinations, sights and experiences. Frequent updates to VR tourism content will also improve practicality. To enhance the accessibility and inclusiveness of VR tourism and expand its scope to individuals with economical or physical constraints enabling them to only explore global destinations virtually, it is essential to leverage advanced internet technology. For instance, VR tourism providers can increase usability of VR devices for older consumers by incorporating voice activation tools, live customer service, bold fonts and larger text sizes (Cham *et al.*, 2024), thereby enhancing the accessibility of virtual destinations. VR tourism operators or marketers could also use appropriate music to create the desired ambience for different virtual scenes (Yang *et al.*, 2023).

Desire significantly influences tourists' preferences toward engaging in VR tourism. Recognizing desire is subjective and the effect it has on tangible tourist actions could be restricted under certain circumstances. Marketers should focus on increasing VR tourism's authenticity, immersion, sense of presence and interactivity (Tsai, 2022), as this can help maintain consumers' desire and encourage consideration of physical tourism (Geng *et al.*, 2022). In addition, creating VR content with hedonic elements that foster connections and inspire a desire to visit the destinations presented in VR tourism is encouraged (Morrison *et al.*, 2024).

Postpandemic, the use of social media platforms, such as Facebook, YouTube and Line, is essential to encourage and inspire consumers, thereby stimulating interest in VR tourism. The elder demographic, typically consisting of Baby Boomers and Generation X, represent a significant portion of retirees and salaried workers. Their interest and willingness to engage in VR tourism could be increased through effective promotional campaigns, such as group purchases, bundled sales and discounts.

Comprehending individuals' specific motivations to participate in VR tourism assists VR providers with developing more captivating and tailored experiences, which can promote enduring tourist relationships, resulting in increased customer loyalty. Travel agents and VR providers can contribute to the tourism industry's growth by using VR technology in marketing and operation strategies, helping to attract a wider range of tourists and differentiate themselves from other competitors.

This study emphasizes the importance for destination marketers, travel agents and VR providers to consider the factors influencing tourists' engagement in VR tourism. This knowledge can be used to improve marketing strategies, product offerings and customer engagement initiatives, leading to greater business success and sustainability in an evolving tourism industry.

5.3 Limitations and future research

This research has several limitations. The snowball sampling method used to recruit respondents can cause biases and misrepresent the overall population. Sampling issues could be improved by conducting a simple random sampling.

Although 360-degree virtual content is classified as VR, it does not offer users the complete range of movement and interaction (Rahimizhian *et al.*, 2020). Future research could explore fully immersive VR applications to investigate significant psychological, social and cultural predictors and examine the impact on behavioral outcomes, such as intention. Furthermore, this study only provided a single 360-degree destination video of Norway, which limits the generalizability of the findings. Future investigations could expand experimental research by using multiple 360-degree videos of different tourism destinations to examine consumer responses more comprehensively.

Finally, surveys were conducted using nonimmersive 360-degree video viewing on mobile devices. Some researchers argue the impact of users' perception of VR technology depends on the type of VR device used (Kim and Ko, 2019). Future research could explore the moderating effect of media (VR device) type on the relationship between participants' perceptions and attitudes.

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Supplementary materials

The supplementary material for this article can be found online.

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