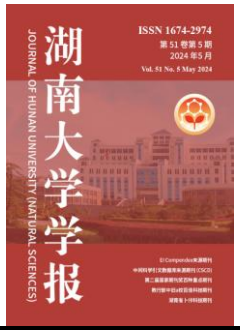

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Perceived Quality of Virtual Reality and Augmented Reality Technology Influences Travel Intention: The Case of Vietnam

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Abstract: In today's digital landscape, virtual reality (VR) and augmented reality (AR) technology plays a crucial role in providing users with experiences before making a purchase or selecting a destination. However, the impact of this technology mainly depends on its quality. A review of the literature related to this field shows that few studies have explored the quality of VR and AR and its impact on consumers' behavioral intentions. While a significant amount of research is dedicated to the technical applications of AR and VR, there remains a gap in understanding users' perceptions and impacts of both tangible and intangible products when these technologies are combined. In response to this research gap, the authors developed a model that quantifies the user experience of VR/AR technology through their perception of its quality. This study aims to measure how information quality, system quality, security, usefulness, and ease of use of VR and AR influence user satisfaction and promote travel intention, especially in Vietnam tourism. The proposed model is based on the information system success (ISS) model, technology acceptance model (TAM), and stimulus-organism-response (SOR) model. This study conducts an empirical analysis on users interested in traveling to Ho Chi Minh City and Da Nang City, Vietnam. The research model was executed through the administration of an online questionnaire and face-to-face interviews, resulting in 408 valid samples. Results analyzed using linear structural modeling (SEM) methods show that consumer perceptions of information quality, system quality, security, usefulness, and ease of use have a positive impact on the perceived quality of VR/AR, thereby influencing tourists' travel intention through the mediating role of satisfaction. In the research model, the impact of VR/AR perceived quality on satisfaction and the impact of satisfaction on travel intention have the most substantial weight, which shows that the quality of the VR/AR technology plays a vital role in enhancing tourists' travel intentions.

Keywords: augmented reality, virtual reality, satisfaction, travel intention.

虚拟现实和增强现实技术的感知质量影响旅游意愿：以越南为例

摘要:

在当今的数字环境中，虚拟现实(虚拟现实)和增强现实(应收账款)技术在为用户提供购买或选择目的地之前的体验方面发挥着至关重要的作用。然而，这项技术的影响主要取决于其质量。回顾与该领域相关的文献，发现很少有研究探讨虚拟现实和应收账款的质量及其对消费者行为意图的影响。虽然大量研究致力于应收账款和虚拟现实的技术应用，但在理解用户对这

些技术结合时对有形和无形产品的感知和影响方面仍然存在差距。为了弥补这一研究空白，作者开发了一个模型，通过用户对虚拟现实/增强现实技术质量的感知来量化用户体验。本研究旨在衡量虚拟现实和应收账款的信息质量、系统质量、安全性、实用性和易用性如何影响用户满意度并促进旅行意愿，尤其是在越南旅游业。提出的模型基于信息系统成功(国际空间站)模型、技术接受模型(谭)和刺激-生物-
反应(索尔)模型。本研究针对有意向前往越南胡志明市和岘港市旅游的用户进行了实证分析。研究模型通过在线问卷和面对面访谈的方式实施，共收回408份有效样本。采用线性结构模型（扫描电子显微镜）方法分析的结果表明，消费者对信息质量、系统质量、安全性、实用性和易用性的感知对虚拟现实/增强现实的感知质量有正向影响，从而通过满意度的中介作用影响游客的出行意愿。在研究模型中，虚拟现实/增强现实感知质量对满意度的影响以及满意度对出行意愿的影响具有最大的权重，说明虚拟现实/增强现实技术的质量对提升游客的出行意愿起着至关重要的作用。

关键词: 增强现实、虚拟现实、满意度、旅游意向。

1. Introduction

The tourism industry is considered one of the critical industries of many countries; it is considered a smokeless industry, and it has contributed significantly to the economy of many countries. However, the COVID-19 pandemic has dramatically affected the global economy, along with the impact on many industries, and the tourism industry has also suffered huge losses. In 2021, Vietnam's tourism sector experienced a more significant decline than in 2020, attributed to the effects of the pandemic. Although Vietnam opened tourism early after the pandemic, According to the Vietnam National Administration of Tourism, the number of international visitors to Vietnam has yet to increase to meet expectations. In 2022, international tourists to Vietnam will reach 3.6 million people, 23.3 times more than in 2021. The number of domestic tourists reached 101 million, an increase of more than 1.5 times compared with the set target. According to the Vietnam General Statistics Office, total revenue from tourism is estimated to reach 495 trillion VND, exceeding 23% of the 2022 plan and reaching 66% compared to 2019. To attract tourists, businesses must have specific strategies that effectively combine many solutions and policies. With the vigorous development of information technology today, applying VR/AR to develop the tourism industry in the post-COVID-19 context is an inevitable trend.

Numerous studies have investigated the influence of VR/AR technology on user behavior toward tourist destinations [1, 2]. Linaza et al. assessed several mobile AR applications for tourist sites, focusing mainly on how customers perceived the apps' utility and opportunities for future development [3]. The relationship between the presence of VR, the cognitive experience value, emotional state, and the behavior of tourists toward the destination [4]. The results show that the perceived presence of VR positively influences users' cognition and emotions. In addition, experiential value significantly affects visitors' behavioral intentions after using VR. However, a limitation of this study is that the survey subjects were mainly students and office workers. The model only measures VR but has yet to combine it with AR to fully evaluate user intentions, so this research fills the above limitation.

The relationship between perceived value and social influence, effort expectancy, enjoyment, informativeness, accessibility, personalization, etc, is measured by [5]; the results indicate that these factors impact user perception. This study focused on investigating the use of AR technology in tourism behavior without considering its combination with VR. Furthermore, the model did not explore the relationship between perceived AR value and consumer travel intentions. The model did not address security issues, an essential factor influencing user perception of quality.

They explored the impact of VR quality on tourists' intentions based on the ISS model [6]. The results show that content quality, system quality, and vividness positively affect users' attitudes toward the destination. However, the study fails to address the impact of AR quality on tourist behavior. It aims to measure the factors that influence user satisfaction and behavioral intentions and examine how smart technology attributes can enhance travel experiences at the Liangzhu Museum in China. The results indicate that accessibility and interaction significantly influence the enhanced experience. Tourists' perception of intelligent

technology was significantly related to their satisfaction [7].

The purpose of this study on the perceived quality of VR/AR technology in virtual tourism is to improve the understanding of the effectiveness of experiences with VR and AR technology in influencing the intention to visit a destination. Investigating consumer behavior using AR and VR technology in tourism can provide insights for businesses to effectively leverage these technologies in destination marketing and help businesses VR/AR technology content developers focus on creating authentic experiences that lead to cognitive and emotional responses that influence the intention to visit tourist destinations. This has three specific goals: (1) examining the attributes of VR/AR that influence users' perceptions of quality; (2) measuring the relationship between perceived VR/AR quality and tourist satisfaction; (3) investigating the relationship between satisfaction and tourists' behavioral intentions toward the destination; additionally, this research provides valuable management recommendations to assist businesses in attracting tourists.

2. Literature Review and the Research Model

2.1. Information System Success (ISS) Model

DeLone and McLean proposed an ISS model and identified six factors attributed to ISS: system quality, information quality, use, user satisfaction, individual impact, and organizational impact. They then developed an updated model, including service quality [8]. The ISS model elucidates the reasons behind users' adoption of various information systems and has been widely applied in various scenarios. Some studies on consumer behavioral intentions in tourism have applied the ISS model.

2.2. Technology Acceptance Model (TAM)

The TAM [9] has been widely applied in the tourism industry to understand and predict tourists' acceptance and usage of various technologies. TAM has been extended and applied in various contexts within tourism to explore different aspects of tourism, including social media marketing, digital content marketing, outbound leisure travel, and intelligent tourism technology.

2.3. Stimulus–Organism–Response (SOR) Model

The SOR model states that people's perceptions of their surroundings (stimulus) and experiences (process) shape their behavioral reactions [10]. Numerous researchers have used the SOR model to examine consumer behavior, including [2]. User behavior when using online services, communications, and information technology, such as user auction behavior on mobile devices, has been studied using the SOR model [11]. In addition, in the context of tourism, the SOR model is used to describe the behavioral responses of consumers.

2.4. VR/AR Technology in Tourism

VR/AR is applied in different types of tourism, such as heritage tourism, health tourism, and ecotourism. These technologies have been explored for various applications, including enhancing visitor experiences in cultural tourism, museums and art galleries, heritage tourism, and ecotourism [2, 12]. Research has delved into the intersection of VR and AR in tourism, exploring methodologies, contexts, and impacts on user experiences. These technologies have influenced both the supply side of tourism and tourists, presenting new engagement and immersion opportunities [13]. While VR/AR technology is crucial in the tourism industry, there is still a need for research to enhance its attributes, including security, information systems, and user emotions, particularly in the context of tourism in Vietnam. This study aims to utilize the ISS, TAM, and SOR models to delve deeper into how the perceived quality of VR/AR impacts visitors' travel intentions.

2.5. Relationship between Attributes and Perceived Quality of VR/AR

The information quality and system quality of VR/AR technology is specifically the quality of content, including that system's image and sound quality. ISS research [8] stressed the significance and applicability of content quality. Travel destination descriptions comprise the information found in VR tourist content. Dieck et al. stated that the information quality factor will make users curious and intend to use AR [2, 12]. Information technology systems are crucial tools that integrate data to assist users in utilizing and interacting. The effectiveness and user experience of VR/AR technologies are significantly influenced by system quality.

Security is paramount for VR/AR users as it directly impacts the protection of users' personal information when utilizing technology. It is a critical concern that system users prioritize and are vigilant about [14]. Prior studies have also assessed and quantified the level of personal information security when utilizing smart technology during travel [15]. Users will not use it if they feel unsafe. Conversely, people will feel more at ease using technology if it increases their sense of security.

Dieck et al. [12] explored the relationship between ease of use, usefulness, and perceived quality of VR and AR in the tourism industry. Users' experiences and happiness with VR tourist activities are positively impacted by the perceived simplicity of the use of VR technology, which influences users' inclination to engage in VR tourism [16].

In the tourism industry, the adoption of and interaction with technology have a significant impact

on user experience. Studies have shown that the acceptance of information technology is closely linked to the perceived usefulness and ease of use [9]. In adopting virtual tourism technology, perceived ease of use positively impacts perceived usefulness, highlighting their interplay in shaping users' intentions to adopt new technologies in the tourism sector [17]. Based on the above arguments, the following hypothesis is proposed:

H1a: Information has a positive impact on the perceived quality of VR/AR.

H1b: The system has a positive impact on the perceived quality of VR/AR.

H1c: Security has a positive impact on the perceived quality of VR/AR.

H1d: Usefulness has a positive impact on the perceived quality of VR/AR.

H1e: Ease of use has a positive impact on the perceived quality of VR/AR.

H1f: Ease of use has a positive impact on usefulness.

2.6. Relationship between Perceived Quality of VR/AR and Experiencer Satisfaction

Many studies have explored how the quality of VR/AR affects satisfaction. Diet has measured the relationship between AR quality and user satisfaction in the context of Korean tourism [2]. A study on the perceived quality of intelligent tourism technology and its impact on tourist satisfaction in Macau revealed that the quality of such technology has a positive influence on customer satisfaction, subsequently increasing their likelihood of returning to the destination [15]. Based on the above arguments, the following hypothesis is proposed:

H2: Perceived quality of AR/VR positively affects user satisfaction.

2.7. Relationship between Satisfaction and Travel Intention

Tourist satisfaction in the realm of tourism refers to an individual's psychological state when evaluating their experiences with tourism activities, encompassing the quality of services and the appeal of destinations [18]. The overall evaluation of utilizing AR technology during travel is referred to as AR satisfaction [1]. The correlation between destination attitude, behavioral intention, and AR satisfaction was studied in [19]. Based on the above arguments, the following hypothesis is proposed:

H3: Satisfaction affects the intention to visit the destination.

Drawing upon the TAM, ISS, and SOR foundation theories and incorporating relevant previous research, the authors developed a research model (Fig. 1).

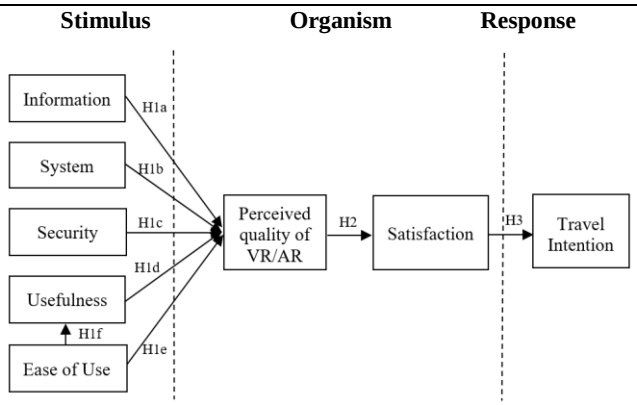

Fig. 1 Proposed research model (The authors)

3. Research Methodology

3.1. Instrument Development

After a review of research pertaining to the topic, the authors compiled and synthesized various scales. Subsequently, they proceeded with data analysis and testing of research hypotheses. Table 1 shows the measurement scales inherited from previous studies.

Table 1 Research instruments (The authors' summary from previous studies)

Variable	Instruments	References
Information (INF)	INF1: Timeliness of information INF2: Relevance of information INF3: Attractiveness of information INF4: Provides accurate information INF5: Provides complete information	[12, 20]
System (SYS)	SYS1: VR can be used to find information on travel destinations SYS2: Accuracy of system SYS3: Navigation quality SYS4: Personalization according to interests SYS5: Has fast response to my requests	[12, 20]
Security (SEC)	SEC1: Smart tourism technologies protect my personal and sensitive information SEC2: Smart tourism technologies respect my privacy and the safety of my transactions. SEC3: Smart tourism technologies are trustworthy and reliable SEC4: Smart tourism technologies adequate security to protect my personal information	[21, 22]
Usefulness (PU)	PU1: Alternative to traditional visit PU2: Convenience of gathering information PU3: Using Mobile AR apps while traveling enables me to find the travel product easily PU4: Product information on Mobile AR apps while traveling is clear and understandable.	[12, 23]
Ease of use (PEU)	PEU1: Costs of effort PEU2: Instructions needed to	[12, 23]

	facilitate handling PEU3: Learning to use Mobile AR apps would be easy for me PEU4: It would be easy for me to become skillful at using Mobile AR apps PEU5: I find the Mobile AR apps easy to use	
Perceived quality of VR/AR (PEQ)	PEQ1: Manufacturer X provides us with high quality products PEQ2: Manufacturer X always satisfies our quality standards PEQ3: Manufacturer X's products are very reliable PEQ4: Appropriateness to intent of use	[24-26]
Satisfaction (SAT)	SAT1: I am satisfied with the quality of information provided by the AR SAT2: I am satisfied with the visual interface design (such as graphic) of the AR SAT3: The AR service makes my tourist experience more interesting SAT4: Using VR will help me choose my destination in a better and more comfortable way SAT5: I am satisfied with the system stability and speed of the AR	[18, 19]
Travel Intention (INT)	INT1: I am planning to visit a destination that I have observed in a virtual reality tourist environment INT2: I plan to visit the destination I viewed in a virtual reality travel environment in the near future INT3: I am willing to visit the destination I observed in a virtual reality tourism environment as soon as possible INT4: I plan to save money and time to visit a destination I've seen in a virtual reality travel environment INT5: I want to know more about new travel destinations	[1, 16, 27]

3.2. Data Collection

The surveyed participants consist of individuals aged 18 to 55 who are currently residing in Ho Chi Minh City and Da Nang City and interested in travel. Data was collected through direct and online survey methods using a convenient sampling approach. The number of survey samples sent was 600, of which 500 were online surveys, 100 were face-to-face surveys, and 425 were received. After cleaning and eliminating 17 invalid response samples, the remaining survey samples included in the official study were 408.

3.3. Data Analysis

In this study, structural equation modeling (SEM) is used to test the proposed research model. The tool used to perform the analysis is AMOS 20 software, which uses a maximum likelihood estimation method. SPSS 20 was used for exploratory factor analysis (EFA). The research diagram and hypothesis will be analyzed based on the main data collected. Confirmatory factor analysis (CFA) and average variance extracted (AVE) were used to evaluate the measurement model.

4. Research Results

4.1. Profile of the Sample

Table 2 provides an overview of the demographic characteristics of the research sample. Within this sample, the female demographic constituted 63.5%, while the male demographic represented 36.5%. Regarding age distribution, individuals aged 18 to 30 comprised 36.8%, those aged 31 to 40 constituted 42.9%, and individuals aged 41 to 55 accounted for 20.3%. Notably, the latter age group exhibited a pronounced interest in travel-related activities. For the question *Have you ever used VR/AR?*, the number of people who answered Yes is 349, accounting for 85.5%, and the number of people answering No is 59, accounting for 14.5%; this proves this technology is trendy among tourists. For the question *Are you satisfied with VR/AR technology after using it?*, the number of people who answered *Yes* is 318, accounting for 77.9%, and the number of people answering *No* is 31, accounting for 7.6%.

Table 2 Research sample size and structure (The authors' elaboration)

Characteristics	Frequency	Percentage
Gender		
Male	149	36.5
Female	259	63.5
Age		
18-30 years old	150	36.8
31-40 years old	175	42.9
41-55 years old	83	20.3
Education		
High school	44	10.8
Bachelor	220	53.9
Postgraduate	104	25.5
Others	40	9.8
Occupation		
Private Employee	109	26.7
Student	130	31.9
Entrepreneur	82	20.1
Others	87	21.3
Have you ever used VR/AR?		
Yes	349	85.5
No	59	14.5
Are you satisfied with VR/AR technology after using it?		
Yes	318	77.9
No	31	7.6

4.2. Measurement Model

The analysis is performed in two steps. Step one is to analyze each independent factor to identify the contents that must be considered in testing scale reliability more clearly. Step two uses the oblique rotation method to test the convergent and discriminant validity of all variables in the model. Using the oblique

rotation method, EFA results of all variables show that the research model concepts achieve convergent and discriminant validity. The results of the variance analysis extracted using EFA for the scales are presented in combination in Table 3.

Table 3 Reliability and validity measures (The authors' elaboration)

Factors	Cronbach's Alpha (CA)	Extracted Variance (EFA) (%)	Composite reliability (CR)	Average Variance Explained (AVE) %
INF	0.67	62.4	0.804	50.9
SYS	0.71	63.5	0.811	51.9
SEC	0.82	65.3	0.824	53.8
PU	0.83	67.3	0.839	56.5
PEU	0.75	55.3	0.851	58.8
PEQ	0.81	65.4	0.826	54.4
SAT	0.63	55.3	0.732	40.6
INT	0.78	54.4	0.793	43.9

After analyzing the EFA by rotating the matrix according to the extraction method, the factor loading coefficient of the variable PEU5 is less than 0.5, so this variable should be removed before entering the CFA analysis. The results of the CFA analysis presented show that the critical model is suitable because the general goodness-of-fit indexes are chi-square/df = 1.744 (<3), GFI = 0.894 is smaller than the standard of 0.9 and within the acceptable limits, CFI = 0.939 (>0.9), TLI = 0.931 (>0.9), and RMSEA = 0.043 (<0.08) meets the requirement. Table 4 presents the results of Variance Extracted, CR, and AVE. The results show that the corresponding parameters of the analysis methods all meet technical requirements (Fig. 2).

Table 4 Discriminant validity test (The authors' elaboration)

Item	INF	SYS	SEC	PU	PEU	PEQ	SAT	INT
INF	7.1							
SYS	0.6	7.2						
SEC	0.6	0.6	7.3					
PU	0.4	0.4	0.5	7.5				
PEU	0.5	0.4	0.5	0.5	7.6			
PEQ	0.5	0.5	0.5	0.4	0.5	7.3		
SAT	0.3	0.4	0.4	0.4	0.4	0.4	6.3	
INT	0.2	0.2	0.3	0.2	0.3	0.3	0.6	6.6

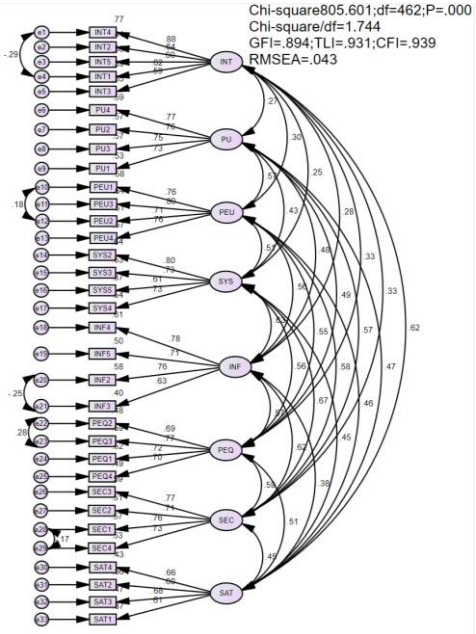

Fig. 2 CFA model (The authors' elaboration)

The results of the discriminant validity test are presented in Table 4; the square root of AVE is larger than the correlation value in the rows and columns. Therefore, according to the Fornell-Larcker criteria [28], the theoretical model's research concepts meet the discriminant validity requirement.

4.3. Structural Model and Hypothesis Test

Linear structural models represent cause-and-effect relationships between independent and dependent constructs [29]. The overall fit values of the model all meet technical requirements: GFI = 0.879 (smaller than the standard of 0.9 and within the acceptable limits), TLI = 0.913 (>0.9), CFI = 0.921 (>0.9), and RMSEA = 0.067 (<0.08) meets the requirements (Fig. 3).

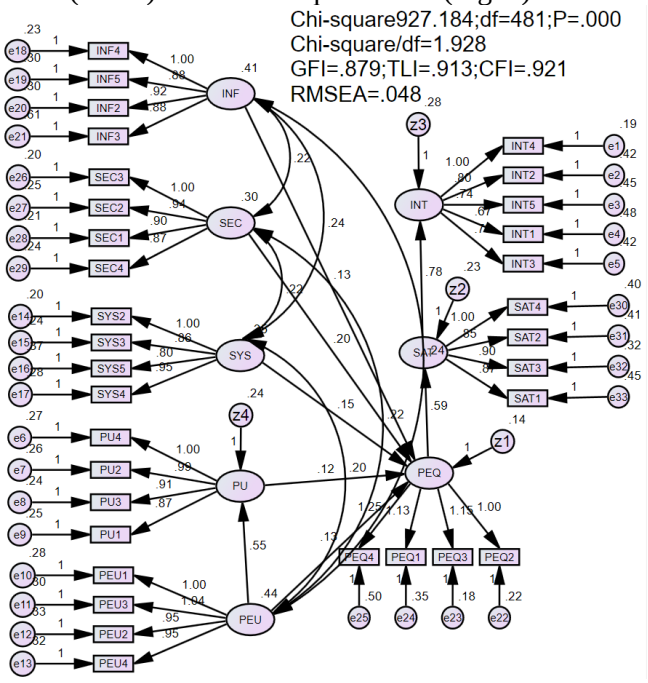

Fig. 3 Research hypothesis test using SEM (The authors' elaboration)

Research results show that the factors of information, system, security, usefulness, and ease of use have a positive impact on the perceived quality of VR/AR, perceived quality of VR has a positive impact on satisfaction, and satisfaction has a positive impact

on the travel intention (Table 5).

Table 5 Standardized regression weights of theoretical relationships (The authors' elaboration)

Relationship		Weight	S.E	C.R	p	Conclusion
H1a	INF → PEQ	0.163	0.036	3.963	***	Supported
H1b	SYS → PEQ	0.175	0.039	3.914	***	Supported
H1c	SEC → PEQ	0.218	0.044	4.541	***	Supported
H1d	PU → PEQ	0.146	0.048	2.323	0.016	Supported
H1e	PEU → PEQ	0.165	0.046	3.134	0.002	Supported
H1f	PEU → PU	0.600	0.059	9.048	***	Supported
H2	PEQ → SAT	0.534	0.111	6.347	***	Supported
H3	SAT → INT	0.642	0.091	8.607	***	Supported

5. Discussion

The results show that the attributes that affect VR/AR perceived quality are in the same direction as information, system, security, usefulness, and ease of use. This pivotal test supports previous studies [2, 12, 30-32], which shows the importance of VR/AR technology information system quality on user perception in pre-trip experience.

The perceived quality of VR/AR is a significant determinant of satisfaction, with a value of 0.534. This critical test supports previous studies [16, 33, 34], affirming that users will be satisfied if the system has good quality. This reiterates that product quality, particularly in the context of VR/AR, plays a pivotal role in user satisfaction.

Satisfaction with the VR/AR experience is crucial, as it positively influences travel intention with a value of 0.642. This underscores the mediating role of satisfaction in shaping travel intention. This pivotal trial supports previous studies [1, 35]. The study emphasizes that tourists' satisfaction using VR/AR significantly impacts their behavioral intentions toward the destination.

This study not only reinforces the impact of VR/AR on tourism but also identifies key factors that influence travel intention. Importantly, it empirically confirms the effectiveness of using VR/AR in tourism. The findings of this study reveal a significant positive impact between VR/AR quality and both satisfaction and travel intention. The research indicators further elucidate that VR/AR attributes effectively provide information about the travel destination, satisfying the user's knowledge needs and fostering positive feelings and intentions about the destination.

6. Conclusion

The quality of VR/AR technology significantly positively impacts consumer intention about the destination. Our research findings highlight the critical attributes of VR/AR, such as information, system, security, usefulness, and ease of use, that influence the quality of VR/AR. The quality of VR/AR affects user satisfaction, which plays a crucial mediating role in the relationship between the quality of VR/AR and travel intention, with the most vigorous intensity standardized regression weights being 0.534 and 0.642, respectively. These results underscore the pivotal role of perceived VR/AR quality and satisfaction in enhancing destination intention, especially in Vietnam's current tourism context, thereby motivating users to plan their travels.

This study uses experimental setups where participants are exposed to VR or AR experiences of travel destinations. The effectiveness of this approach depends on the realism and immersive quality of the VR/AR system used. Higher quality systems provide more compelling experiences that can more effectively influence travel intentions. Post-experience surveys and questionnaires are often used to measure participants' perceptions of quality and their travel intentions. This approach is effective for gathering subjective data directly from users. However, the results can be influenced by the user's mood, previous experiences, and expectations. Investigating how different designs affect user experience and satisfaction can inform improvements in VR/AR technologies. This approach effectively tailors experiences to user preferences and needs, potentially increasing the desire to visit the actual location.

This study offers practical insights for tourism destination managers and manufacturers. It serves as a roadmap for effectively promoting the destination, harnessing the unique benefits of VR/AR innovative tourism technology that traditional technology lacks. By enhancing the quality of VR/AR products, manufacturers can elevate user experiences, thereby boosting travel intentions. This study also enriches the theoretical understanding of consumer behavior towards intelligent technology products in tourism, providing actionable management implications for manufacturers.

Although it reaches some results, this study has several limitations. First, the survey sample is small, so representativeness is low. Furthermore, the study only surveyed users between the ages of 18 and 55 in Ho Chi Minh City and Da Nang, so the results only reached a certain level of reliability. Therefore, the following research direction will expand the survey scope nationwide instead of only surveying users in Ho Chi Minh City and Da Nang. Expand the demographic scope, such as a more diverse survey age group, instead of limiting the age range from 18 to 55. Second, the research expands the investigation of factors affecting the decision to choose a destination instead of just investigating the factors that influence travel intention as currently. Finally, this study only considered technical factors and emotional states that affect intention. As technology develops, there will be other factors that affect user intention.

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