



Faculty of Applied and Creative Arts

**Virtual Reality Technology and Tourist Behavior Intention of National
Museums in Guangdong**

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Virtual Reality Technology and Tourist Behavior Intention of National Museums in
Guangdong

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DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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ABSTRACT

This study investigates the integration of virtual reality (VR) in museum exhibitions, focusing on its current development in museums within China's Guangdong region. It examines museum visitors' behavioural intentions towards VR, considering generational differences, and draws on the UTAUT2 model to formulate a conceptual framework. The research employs a specifically designed questionnaire for quantitative analysis in two phases. Initially, the PLS-SEM method identifies the primary factors influencing visitors' intentions. Subsequently, one-way ANOVA examines generational differences in these factors. The study finds performance expectancy, effort expectancy, social influence, design quality, hedonic motivation, and previous experience positively affect behavioural intentions, while perceived risk negatively influences them. Notably, generational differences are observed in effort expectancy, design quality, hedonic motivation, and perceived risk. Based on these insights, the study proposes targeted measures to improve VR acceptance among museum visitors in Guangdong, offering valuable references for similar research in the museum field.

Keywords: Behavioral intention, museum VR, UTAUT2; generational differences

Teknologi Realiti Maya dan Tingkah Laku Pelancongan Niat Muzium Negara di Guangdong

ABSTRAK

Kajian ini menyelidiki integrasi realiti maya (VR) dalam pameran muzium, dengan fokus pada perkembangan semasa di muzium dalam wilayah Guangdong, China. Ia meneliti niat tingkah laku pengunjung muzium terhadap VR, dengan mengambil kira perbezaan generasi, dan menggunakan model UTAUT2 untuk merumuskan rangka kerja konseptual. Penyelidikan ini menggunakan soal selidik yang direka khas untuk analisis kuantitatif dalam dua fasa. Pada mulanya, kaedah PLS-SEM mengenal pasti faktor utama yang mempengaruhi niat pengunjung. Seterusnya, ANOVA sehala meneliti perbezaan generasi dalam faktor-faktor ini. Kajian mendapati jangkaan prestasi, jangkaan usaha, pengaruh sosial, kualiti reka bentuk, motivasi hedonik, dan pengalaman terdahulu memberi kesan positif kepada niat tingkah laku, manakala risiko yang dirasakan memberi kesan negatif. Perbezaan generasi ketara diperhatikan dalam jangkaan usaha, kualiti reka bentuk, motivasi hedonik, dan risiko yang dirasakan. Berdasarkan wawasan ini, kajian mencadangkan langkah-langkah yang disasarkan untuk meningkatkan penerimaan VR dalam kalangan pengunjung muzium di Guangdong, menawarkan rujukan berharga untuk penyelidikan serupa dalam bidang muzium.

Kata kunci: *Niat tingkah laku, muzium VR, UTAUT2; perbezaan generasi*

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LIST OF ABBREVIATIONS

BI	Behavioral Intention
DQ	Design Quality
EE	Effort Expectation
Gen	Generations
HM	Hedonic Motivation
IDT	Innovation Diffusion Theory
IQ	Information quality
MM	Motivational Model
PE	Performance Expectation
PE _x	Past Experience
PR	Perceived Risk
SCT	Social Cognitive Theory
SI	Social Influence
S-O-R	Stimulus-Organism-Response Theory
TAM	Technology Acceptance Model
TAM2	Technology Acceptance Model 2
TAM3	Technology Acceptance Model 3
TPB	Theory of Planned Behaviour

TPA	Rational Action Theory
UB	Usage Behavior
UTAUT	Unified Theory of Acceptance and Use of Technology
UTAUT2	Unified Theory of Acceptance and Use of Technology 2
VR	Virtual Reality

CHAPTER 1

INTRODUCTION

1.1 Study Background

Museums are the public areas of every country and region, serving as crucial venues for storing and disseminating human history, art, science, and cultural heritage. In August 2022, at its 26th conference in Prague, the International Council of Museums (ICOM) adopted a new definition of museums, affirming them as non-profit permanent institutions serving society. These institutions are responsible for the research, collection, protection, interpretation, and display of tangible and intangible cultural heritage (China Museum Association, 2022). Emphasising accessibility, inclusivity, and promoting diversity and sustainability, museums are open to the public and play a crucial role in preserving our shared human legacy.

Museum origin and historical development are rich and complex, based on five important stages. The first phase traces back to ancient times, with the earliest physical museums dating back to the late Eastern Han dynasty in China and Ancient Egypt and Greece around the 3rd century B.C. (Zhang & Courty, 2021). In Ancient Greece, a museum was initially conceived as a “temple of culture”, aimed at safeguarding and studying culture. Meanwhile, the aristocracy often collected and preserved various artworks and precious items in ancient China as symbols of wealth, power, and cultural achievement (Keightley, 2022). During this era, museums were typically exclusive and not open to the public, resembling what could be described as “private warehouses” in ancient China (Tythacott, 2022).

The second stage was during the Middle Ages and Renaissance, with the Church assuming a central role in protecting artworks and historical artefacts. This reflected the Church's dual role as a religious and political institution, possessing considerable power, land, and wealth. Consequently, churches became repositories of relics and artefacts open to believers (Chen, 2017). The Renaissance era witnessed European nobles collecting various natural and artificial products, establishing "cabinets of curiosities" that left a lasting impact on subsequent science and art (Von, 2021).

The third stage spanned the 18th to 19th centuries, when public education and scientific research gained popularity, leading to the birth of modern public museums (Prottas, 2019). The British Museum officially opened in 1784 and became the world's first permanent public museum. Subsequently, public museums were established in European and American countries, symbolising a crucial stage that granted every citizen access to cultural institutions.

The fourth stage, from the 20th to the 21st century, witnessed a significant increase in the number and types of museums. During this period, museums expanded their functions, adding educational roles to their traditional roles in collection, preservation, and research, evolving into vital spaces for education and community participation (Giannini & Bowen, 2022). Finally, the fifth stage, from the 21st century to the present, saw modern museums increasingly prioritise diversity and inclusiveness, adopting more participatory and interactive approaches (Mitxhell & Yoshida, 2019).

Museums are crucial in social education, driven by substantial public demand and anticipation (Mas & Monfort., 2021). This demand centres on knowledge acquisition and benefits through museum exhibits and educational activities, which has persisted since ancient

times (Alrashid, 2021). The future development of museums is anticipated to evolve alongside technological and economic advancements, focusing on digitalisation and the integration of virtual technologies (Schiele, 2021). Concurrently, museums must engage deeply in social issues and public dialogues. For instance, museums will pay more attention to important issues such as environmental protection and racial discrimination, striving to promote social change through exhibitions and projects guiding the public towards the right values (Bhavnagri & Muhsin., 2023; Wen, 2021; Manikowska, 2020). From a historical perspective on museums' origin and development, the core functions of collection, display, research, and education remain paramount.

The global trend of museums takes various forms, with each country or region museum landscape influenced by factors such as history, culture, social environment, policy, and economy (Harvey & Mahard, 2020). Overall, the number and type of museums are steadily increasing, contributing to enhanced cultural exchange, promoting the tourism industry, and promoting economic development (Qizi, 2021). In 2022, the number of museums in China reached 6565, showing a positive upward trend and reflecting the nation's commitment to planning and constructing museums (Zhang & Yu, 2023). Governments worldwide actively support museums through various policies, including regular operation and development funding. Legislative measures protect museums, and promotional platforms raise their profile and influence. For example, the U.S. National Science Foundation funds annual museum science education projects (Zheng & Lu, 2016), while museums in the U.K. and France are government-funded and tasked with managing and developing museums (Carter, 2023). Canada employs tax incentives and reward policies to encourage public participation in museum

donations and volunteer services (Mason & Sayner, 2019). These examples reflect governments' recognition of the value and role of museums, emphasising their crucial status.

Museums are increasingly recognised for their role in social education, which is vital in promoting individual and social learning and development (Loureiro et al., 2020). Responding to public demand for cultural education (Elisafenko et al., 2020). Museums cater to a broad audience across different age groups (Chynoweth, 2020). For students and young people, museums offer insights into human culture and knowledge, while for adults, they serve as quality social and leisure venues (Serravalle et al., 2019). Given their immense importance, the development and innovation of museums are key concerns for every country or region, garnering policy support and protection (Sandahl, 2019).

China's definition of museums aligns with that of the International Council of Museums, viewing museums as important venues for preserving and inheriting human civilisation (Kong, 2021). The establishment and development of museums are highly valued and supported by the government and the people. By the end of 2022, China had 6,565 museums, ranking among the top in the world. Through the continuous improvement of the policy of free museum admission, over 90% of museums in China are free to the public. The National Cultural Heritage Administration began classifying museums in 2010, evaluating them based on comprehensive management and infrastructure, collection management and scientific research, exhibitions, and social services. Museums are categorised into first, second, and third levels, with national first-level museums considered the highest in museum grading, boasting extensive collections, diverse types of precious cultural relics, and high historical, cultural, scientific, and artistic values (Liu, 2020).

While museums worldwide retain the four core functions of collection, display, research, and education, differences exist between museums in China and those in other countries. This current study notes that the emphasis on public participation is somewhat different, especially compared to Western countries. In Western countries, museums prioritise public participation, encouraging audience interaction and participation, and actively integrating audiences into exhibitions or cultural education activities (Robinson, 2020). Although these trends are gradually gaining ground in China, Chinese museums still predominantly focus on passive observation and learning (Bollo et al., 2017). Recognising the positive development trend of public participation, Chinese museums continue to emphasise this aspect in both academic and practical research (Wang, 2022).

Guangdong Province, China's largest economic province, holds a very important position in the country. Compared with museums in other regions of China, museums in Guangdong Province have a rich historical and cultural heritage, housing many cultural relics and historical materials, and can be divided into Cantonese culture, Hakka culture, and Chaozhou culture. The most unique and important aspect is the prevalence of various local languages in Guangdong Province, with the Cantonese being the mainstream. This is different from museums in other provinces across China. In Guangdong region's , voice prompts and mobile navigation are available in Cantonese, Mandarin, and English. The traditional folk culture displayed by museums in the Guangdong region often needs to be dubbed in Cantonese, allowing tourists to better understand the Guangdong region's local culture and folk rituals. This, to some extent, poses additional curatorial challenges for museum in the Guangdong region.

However, the local government provides great policy protection and financial support, encouraging museums' digital exploration and development in local museums.

There are 377 museums in Guangdong Province, ranking second in China, including 79 national museums and ten national first-class museums (Guang, 2023). Guangdong places significant attention on museum planning and development, offering multi-faceted financial support, policy guidance and attracting top-tier talent. This reflects the positive attitude and policies of the Guangdong provincial government towards museums, highlighting its dedication to cultural heritage protection, commitment to social services and public education, and the increasing importance of museum research.

The continuous development of museums provides staff and researchers with opportunities to explore innovative paths. Beyond prioritising public participation, museums increasingly seek collaborations with advanced digital technology to enhance exhibition forms and participation methods (Fleming, 2019). In the era of rapid digital advancement, national governments and museum professionals are keen on integrating traditional culture with cutting-edge VR technology. For example, the Finnish National Museum in Helsinki uses VR technology to immerse visitors in the virtual world of the 1863 painting "Alexander II Opens the Diet." Visitors can walk through the virtual exhibition hall, interact with the characters in the painting, and experience the traditional cultural customs and living environment of 19th-century Finland (Jim, 2024). The Natural History Museum in London, in collaboration with Sky Broadcasting, developed the "Hold the World" VR experience, allowing visitors to interact face-to-face with Sir David Attenborough, learn about rare specimens, and even virtually handle

these specimens (Jim, 2024). These examples combine VR technology with traditional culture and scientific knowledge, providing innovative visiting experiences for museum exhibitions.

In the 2010s, VR technology entered its fourth stage, marked by its widespread applications. Many countries and regions now incorporate VR technology into their policies and development strategies (Alnagrat et al., 2022). VR technology, a novel and practical development of the 20th century, utilises advancements in high-tech fields such as 3D graphics, multimedia, orientation, and display to create virtual environments. Through electronic sensors, users can interact and communicate within these generated virtual environments, offering a profound sense of immersion (Abich et al., 2021).

The evolution of VR technology can be divided into four stages despite its relatively short total duration. The concept of VR can be traced back to the 1960s when Ivan Sutherland and his student Bob Sproull designed the earliest VR system known as the ‘Sword of Damocles’ in 1968 (Sutherland, 1968). The second stage occurred in the 1990s when preliminary VR products emerged. For instance, the British company Virtuality Group conducted VR research and development, launching the ‘Virtuality System’ product in 1991. It became the world’s first mass-produced VR game machine, operating through a head-mounted display (HMD) and data gloves. Although it faced technical limitations and high-cost equipment, this device played a significant role in promoting the development and popularization of VR technology (Song, 2021).

The third stage, spanning the 2000s, witnessed a slowdown in the development of VR technology. The negative impacts from the preceding stage prompted many teams and investors to approach this technology with greater caution. It was not until the fourth stage, emerging after the 2010s, that VR regained attention. With the maturation and advancement of technology, VR

experienced a resurgence. In 2012, Oculus VR played a pivotal role by introducing the Oculus Rift, a consumer-oriented VR headset (Fang & Harrison, 2021). Subsequently, many companies seized the trend and opportunity, launching their own VR devices. As of 2022, VR technology has matured significantly, expanding its applications from gaming to other fields, including education and healthcare. The widespread adoption of VR has instilled new hopes and ideas for development across many industries and sectors (Lohre et al., 2020).

VR technology has been extensively researched and applied nationwide (Hamda & Jia, 2022). However, due to the differences in technical and economic development levels, VR technology's status and research state differ in different countries (Raja & Priya, 2021).

The United States stands out as a major global leader in VR technology, boasting robust technological strength and substantial investment and research and development (R&D) resources (Wohlgenannt et al., 2020). Large tech giants like Facebook (now Meta), Google, and Microsoft are at the forefront of VR technology research and development.

In addition to the U.S., Europe demonstrates active development in VR technology. This can be attributed to the economic strength of Western countries and the rapid acceptance of high technology and new innovations by Western citizens (Fanea-Ivanovici & Pană, 2020). The European Union has shown significant attention and support for VR technology development in terms of policy and economy (Kreslins et al., 2022). Currently, European and American countries are actively researching the deployment of VR technology in public education and public initiatives, with a growing focus on applying VR in preserving cultural heritage, public museums, and various other fields (Kamińska, 2019).

In contrast to Western countries, Asian countries started their development in VR technology later, with Japan and South Korea emerging as key players in this domain (Keane et al., 2020). Their leading positions in electronic technology and the entertainment industry have provided a solid foundation for VR technology development. For instance, companies such as Japan's Sony and South Korea's Samsung have also launched VR gaming equipment, closely following the footsteps made by their Western counterparts (Bai, 2019). This global development of VR technology reflects its significance as a focal point in future technological advancements, highly valued by each country.

In Asia, the influence of European and American countries on VR technology development is evident, and since the 21st century, the focus has shifted toward serving the public with an emphasis on integrating VR technology with traditional cultural dissemination sites, leading to widespread use in science and technology museums and traditional museums (SER, 2019).

China initiated the study of VR technology in the late 1990s, as indicated by Xiong (2020). Currently, China has achieved or is closely approaching a global advanced level in various aspects of VR technology, particularly in market size, application scenario development, and hardware manufacturing. Despite these accomplishments, certain deficiencies persist in China's VR industry development compared to international standards. For example, there are gaps in core technology research and development when measured against advanced technologies in Europe and the U.S. A critical challenge lies in the shortage of high-quality content (Zhang et al., 2022).

While China's VR application scenarios are rich compared to international standards, there are still shortcomings in content information quality and high-quality interface design (Han, 2020). These deficiencies may impact the user experience and hinder the market development of China's VR products, prompting focused research by technicians to address these issues. The rapid development of VR technology in China has prompted the government to introduce a series of policies supporting collaboration between VR technology and the cultural and museum industry. Leveraging the speed and high-tech nature of VR technology, these initiatives aim to enhance visitors' knowledge and benefits (Gan, 2023).

Public service cultural venues such as museums must align with national and local policy deployments, making VR technology an increasingly common and innovative approach to enhance visitor participation and experience (Pei et al., 2019). VR technology offers substantial benefits to museums, enabling the virtual restoration of precious cultural relics and vanished items, including ancient buildings and creatures (Handoko & Nugroho, 2023). Furthermore, employing VR to restore cultural relics creates a virtual environment for visitors, providing immersive visual, auditory, and tactile experiences related to these artefacts or cultures (Li & Huang, 2022). This greatly enriches the visitor's participatory experience and facilitates a deeper understanding of cultural knowledge.

Chinese museums actively embrace VR technology to provide richer and more vivid exhibition experiences. In December 2022, the relevant departments of the Chinese government released the "Action Plan for the Integration of VR and Industry Application Development (2022-2026)", recognising China's VR industry as undergoing explosive growth. The government has invested significant manpower and resources in applying VR technology to

cultural tourism, urging museums and cultural exhibition halls to develop VR digital experience products. This initiative allows excellent cultural content to innovate with VR technology, providing visitors with innovative ways to engage (Zhao et al., 2019).

As one of the most important cities for economic development in China, Guangdong has consistently ranked among the top three in China's GDP. It leads other provinces in various aspects such as economy, culture, tourism, and population. In terms of the introduction and application of VR technology, Guangdong first implemented VR technology in profit-oriented industries. Subsequently, the Guangdong regional government applied VR technology in cultural and tourism development. Museums, being a crucial part of cultural and tourism development, are actively exploring the feasibility of VR exhibitions, VR experiences, or VR services.

While VR technology presents numerous possibilities for Chinese museums, it poses various difficulties and challenges. For example, issues such as technological adaptability and equipment comfort must be considered when applying VR technology in cultural exhibitions in museums. It emphasizes innovative content design while preserving cultural authenticity and also considers the comprehensibility of the content to visitors. In Guangdong, some traditional folk cultures typically use distinctive dialects. How to present these through VR technology while considering the user experience of visitors is undoubtedly a significant challenge. Therefore, although curators in Guangdong's museums are enthusiastic and have many ideas about VR exhibitions, they are still in the initial stages of development.

In the case of museums in Guangdong Province introducing VR technology, despite national policies and local incentives supporting the use of VR exhibition plans, many museum

staff express concerns about the technology (Ch'ng et al., 2019). Based on early telephone interviews and field research results (see Table 1.1.1), only three national-level museums feature long-term fixed VR exhibitions. Other museums occasionally host mobile VR exhibitions but face stability issues. Additionally, when asked about the consideration of setting up long-term fixed VR exhibitions, staff from seven other museums stated that they were in the preparation stage, engaging in repeated discussions and research but were yet to finalize their plans. Due to challenges related to technology equipment usage and user experience, museum VR exhibition plans need careful consideration of visitor behaviour intentions and thorough feasibility testing before implementation.

Table 1.1: Overview of the use of VR technology in national first-level museums in Guangdong Province

Name of museum	Long-term VR Exhibition	Short-term VR Exhibition	Remarks
Guangzhou Museum			The team is discussing VR options.
Guangdong Maritime Silk Museum	√		It is the first VR exhibition in Guangdong Province and is still in use.
Dongguan Opium War Museum			The team is discussing VR options.
Guangdong Chinese Hakka Museum	√		Need to upgrade, and there is not much usage.
Guangdong Provincial Museum		√	The team is testing the feasibility of a VR exhibit.
Shenzhen Museum		√	The team has been incorporated into the future plans.
Museum of the King of Southern Vietnam		√	The team has been incorporated into the future plans.

Table 1.1 continued

Guangdong Folk Craft Museum		The team is testing the feasibility of a VR exhibit.
Guangzhou Art Museum	√	It is now closed and under software upgrade.
Memorial Hall of Sun Yat-sen's former residence		The team is discussing VR options.

As China's leading economic province, Guangdong enjoys abundant financial support and is a major hub for advanced technology research in the country. Despite these advantages, the overall progress of VR exhibition schemes in museums in Guangdong has been slow (Lo et al., 2019). The current state of VR technology development in these museums can be categorised into three stages.

Firstly, there are museums in the early planning stages where teams are still deliberating over VR exhibition schemes. Discussions involve decisions on the type of VR technology to be introduced, placement, display methods, and other logistical aspects. However, reaching a final consensus can be time-consuming, leading to delays in the implementation of VR exhibition schemes. For instance, the Guangzhou Museum staff mentioned ongoing debates on the type of VR technology to introduce, with differing views among museum staff and VR technology researchers. The Sun Yat-sen Memorial Hall staff highlighted difficulties in determining the suitability of VR exhibition interfaces for the museum's specific exhibition themes, requiring repeated revisions and confirmations.

Secondly, museums are in the mid-term testing phase, conducting feasibility tests for VR exhibitions. Testing primarily involves museum teams and VR technology R&D personnel,

with limited involvement of simulated testing with visitors. VR exhibition feasibility testing focuses primarily on hardware operation and interface presentation effects (Pu & Tong, 2022). For example, during the testing phase, the Guangdong Provincial Museum staff are concerned with whether the interface presentation effects meet the museum team's expectations and accurately represent the collections or culture.

Thirdly, there are museums in the late operational phase, with varying performances of VR exhibitions. Short-term VR exhibitions serve as the basis for long-term, but some face challenges. For example, the Shenzhen Museum and the Museum of the Nanyue King attempted short-term VR exhibitions but faced low utilization and return visit rates due to operational difficulties and dissatisfaction with content. Some long-term VR exhibitions also faced issues, such as the closure and adjustment of the VR exhibition at the Guangzhou Art Museum due to its long duration and high operational difficulty. Similarly, the long-term VR exhibition at the Guangdong Hakka Museum(Figure 1.1) was closed due to feedback about dull content, with visitors expressing a preference for exhibits showcasing the folk activities or unique customs of ethnic minorities (Huang, 2023).The Maritime Silk Road Museum in China also has VR devices(Figure 1.2), but due to the relatively difficult operation of the equipment, it takes longer to use. Similar VR devices are not uncommon in China, but they can also encounter such issues(Zhang & Francis, 2024).



Figure 1.1: VR exhibition of China Hakka Museum in Guangdong



Figure 1.2: VR exhibition of Maritime Silk Museum

The overall progress of VR exhibitions in Guangdong's national-level museums is slow, with various issues appearing in the early planning, mid-term testing, and late operational stages.

This also affects the attitude and planning of other non-national level museums towards VR exhibitions, thus affecting the development and application of VR technology in most museums in Guangdong. At the root of these problems is that the museum teams did not respect the users' feelings and could not meet their needs (Nasta & Pirolo, 2020). The heavy self-conception of the museum teams resulted in the overall slow progress of VR exhibitions (Patrick & Hollenbeck, 2021).

Therefore, based on this research background and current status, this study analyses the characteristics and needs of museum visitors to identify the main factors affecting their intentions to use VR technology and propose improvement methods. Using the results of this study as a theoretical reference, museums can more specifically design the product type and form of VR technology for visitors, ultimately improving visitor intentions to use museum VR technology products and allowing museum VR technology products to achieve maximum usage value.

1.2 Problem Statement

The slow progress of the VR exhibition in national-level museums in the Guangdong region is mainly attributed to two issues. Firstly, there is a lack of focus on the group differences of museum visitors (Bozzelli et al., 2019). This includes two aspects: firstly, the characteristics of the museum visitors are not clearly defined, and secondly, there is an unclear understanding of the needs and objectives of museum visitors. The second issue is the unclear factors influencing museum visitors' behaviour towards VR technology and a lack of systematic research on museum visitors' behavioural intentions towards VR technology. These issues result

in VR exhibitions by museum staff and curators not being designed with a user-centered approach, which directly affects visitors' usage of VR and their satisfaction.

1.2.1 Inability to properly understand user needs

The important consideration for museum staff when designing VR technology solutions is meeting the audience's needs, especially visitors of different ages. The slow progress of museum VR exhibits is greatly related to user behaviour intention and user needs(Mao, 2020). Most museum staff in the Guangdong region are not paying enough attention to this key issue, resulting in many digitisation technologies and VR exhibition methods in museums not liked by visitors (Li, 2021; Luo, 2022).

As public spaces, museums must cater to the diversified needs of tourists (Liu, 2021). The exhibition function requires the museum to present the collections to the public through various exhibitions or displays (Trunfio et al., 2020). The museum's display and educational functions are directly oriented towards visitors, with exhibitions aiming to present collections and help visitors understand the significance and value of cultural relics through interpretation (Mohd et al., 2018). The educational function focuses on meeting tourists' learning needs, aiming to provide knowledge and stimulate thinking for the public (Ma, 2019). In fulfilling these functions, museums must fully consider tourists' diverse needs and characteristics and plan accordingly (Komarac et al., 2019).

Considering age and demand perspectives, museum visitors span from children to the elderly, each with different cultural knowledge, interests, acceptance abilities, and thinking levels (Walhimer, 2021). Visitors under 18 years old, often learners, view museums as extensions of classrooms, seeking knowledge and understanding of cultural history (Feliu-

Torruella et al., 2021). Young and middle-aged visitors, the primary force among museum-goers, view the museum as a high-quality social place for learning and leisure (Batat, 2020). They prefer to enjoy leisure and entertainment and kill time in the museum (Amanatidis et al., 2020). Elderly visitors, usually visiting with families or children, come for family outings and to pass the time (Abram et al., 2021). For example, the VR exhibition at the Nanyue King Museum was once held as a short-term exhibition, but it did not continue in the long run. According to the curator, the issue was the audience appeal of the VR content; the interface design was too child-oriented, attracting only young children. However, these children did not show much patience, often stopping after randomly clicking a few pages and buttons. Despite this, the museum staff still believe in the feasibility of VR exhibitions and have included them in future plans. They believe that more research and analysis on the target audience for museum VR are needed.

The National Museum of China reported that in 2022, 94.14% of its visitors were under 60 years old, emphasising the age characteristics and preferences of museum-goers, particularly those aged 18-60 (National Museum of China, 2023).

The failure to clarify visitor characteristics and purposes and the lack of differentiation between visitor groups directly contribute to museum visitors' low behaviour intention and usage rates towards VR technology products (Luo & Ye, 2020). Additionally, the museum teams in the Guangdong region of China lack long-term observation in practical research on user behaviour intention, hindering their ability to capture changes and developments in user behaviour intention (Li et al., 2023). Therefore, it is imperative for museum teams first to clarify the needs, behaviour, intentions, and characteristics of tourists. The age characteristics of museum visitors must be combined with theoretical analysis, recognising that older and younger

visitors have different operation methods, habits, and perceptions. Subsequent research and demonstration efforts are essential to address these complexities.

1.2.2 The Factors Influencing Museum Visitors' Behavior Towards VR Technology Are Not Clear

As museum VR technology products become more prevalent, some museum teams in China are beginning to recognise the significance of focusing on visitor behaviour intentions and needs (Xu et al., 2019). Concurrently, certain museum teams actively seek academic articles and museum cases for study and research. However, there exists a gap in both academic and practical research. Firstly, regarding academic research, there is a scarcity of articles in China that specifically address museums using VR technology, especially in studying visitor behaviour intentions (Zhang et al., 2022). Most articles in the China Knowledge Network database regarding museum VR technology emphasise the importance and sustainable development of VR technology for museums (Luo & Ye, 2020). Others primarily list cases and technological updates related to VR, with a limited focus on museum visitor behaviour intentions (Han & Cui, 2021). Many scholars believe that the better the VR technology, the more it can attract visitors' attention. Although VR technology can indeed capture visitors' interest initially, there is a lack of research on visitors' in-depth usage or willingness to use it. Additionally, Chinese researchers focus more on updating VR technology for museums rather than on users' needs. This can result in museum VR experiences not achieving effective and sustainable development. Therefore, there are few articles by Chinese scholars on VR technology in museums and visitors' behavioral intentions, and the research conclusions are superficial and not in-depth.

Museum teams in China face a significant misconception when collecting user data. Although many museums implement questionnaires and feedback mechanisms, such as using paper feedback forms or encouraging visitors to leave messages on the official museum website in the Guangdong region, this data is often one-sided and non-targeted (Zhuang et al., 2021). It fails to fully capture the behaviour and intentions of visitors, particularly their inclinations toward VR technology. For example, the curation team at the Guangdong Hakka Museum is discussing VR plans and upgrading the existing VR equipment because their current VR equipment has low usage rates. When formulating optimization plans, they collect visitor feedback mainly through non-standardized interviews or distributing questionnaires. However, the questionnaire questions are not systematically formulated and contain many objective questions. As a result, the data they collect is often incomplete or fragmented, and curators can only vaguely understand that factors such as the applicability, safety, and comprehensibility of the VR equipment might influence its usage rate among visitors.

Due to the absence of an effective user feedback information management and analysis system, museum teams and researchers struggle to integrate and analyse the collected data (Xu et al., 2019). These data are crucial as they provide comprehensive feedback on user needs and help understand the key factors that affect museum visitors' behavioral intentions towards VR technology.

Furthermore, museum staff lack an effective theoretical framework and model for interpreting visitor behaviour intentions. Models like TAM and UTAUT, which are instrumental in studying tourists' behaviour intentions toward new technology (Nizar et al., 2018), need adjustments based on the VR products offered by different types of museums in various regions

(Cheng et al., 2023; Dwivedi et al., 2019). However, Chinese museum researchers often lack the knowledge and proficiency to apply these models (Luo & Ye, 2020), resulting in minimal utilisation of similar models for analysis. Due to the limited research results by Chinese scholars on VR technology in museums and visitor behavioral intentions, there are fewer references to psychological theoretical models in this context. Chinese museum researchers are exploring the possibility of using similar models for their studies and are striving to find a theoretical framework suitable for studying visitor behavioral intentions towards VR technology within the context of Chinese museums.

The number of articles published by Chinese researchers on user behaviour intention research is relatively small. While researchers often refer to articles published by international researchers, China's different national policies and cultural backgrounds may lead to errors in drawing conclusions from these references. China has undergone thousands of years of development, resulting in distinct cultural characteristics and living habits in each region. Cultural and language differences may cause the conclusions of international research to be not entirely applicable in China. For example, Guangdong has its own unique dialect, which differs from international common languages and even has some pronunciation differences from the standard Chinese language. Therefore, the conclusions of international researchers can only serve as a reference and need to be studied based on the characteristics of local museums. In practical testing, researchers in Guangdong museums have struggled to accurately reflect the real behaviour intentions of all users during the implementation of practical research on user behaviour intentions (Zhuang et al., 2021). This emphasise a crucial gap in both research theory and research methods within this field of study.

1.3 Research Gap

This study highlights the knowledge gap in international research, particularly regarding the Guangdong region of China. It investigates the behavioral intentions of visitors to museums in Guangdong Province towards virtual reality technology. The study includes the theoretical models used, data collection methods, and data analysis methods. This will enable relevant researchers and museum staff to systematically and effectively obtain user feedback data and identify the factors influencing museum visitors' willingness to use VR technology in the Guangdong region through theoretical models. Related studies, such as those conducted by Li et al. (2020), have employed the Theory of Planned Behaviour (TPB) model to investigate visitor behavioural intentions at the Macao Science Center, excluding considerations for VR technology. Similarly, other studies, such as Zhuang et al. (2021), employed the TAM model to examine AR technology and visitor behavioural intentions. While these studies offer some reference value, they lack an in-depth exploration of VR technology, and currently, no scholars have conducted any research on the behavioral intentions of museum visitors towards VR technology in the Guangdong region. Consequently, a research gap persists in studying visitors' behavioral intentions towards VR technology in the Guangdong region, and this study aims to fill that gap.

Moreover, this study reveals data gaps in examining museum visitors' behavioural intentions. Researchers studying visitor behavioural intentions must focus on key visitor attributes, such as age and visiting needs, conducting in-depth research based on these user needs (Trunfio et al., 2022). Given the diverse age groups and varying visiting needs of museum visitors, understanding the significant changes in visiting needs across different age groups is

crucial (Elgammal et al., 2020). As public service spaces, museums cater to a broad age range, from children to the elderly, using VR devices (Shehade & Stylianou-Lambert, 2020). Consequently, it is important to explore intergenerational differences among museum visitors. While some researchers have noted the lower enthusiasm of elderly museum visitors in using interactive technology compared to younger visitors (Lee et al., 2020; Vareiro et al., 2021), comprehensive data analysis from different age groups remains scarce. Particularly, there is a dearth of research examining the intergenerational differences influencing museum visitors' behavioural intentions towards VR technology. There may be significant differences in attitudes, values, behavior patterns, lifestyles, and technology usage habits between different generations. For researching museum visitors' behavioral intentions towards VR technology, this study needs to pay attention to the differences between generations. Understanding generational differences helps better meet the needs of different generations and assists museum curators in more effectively optimizing VR service plans.

1.4 Research Objectives

The main purpose of this research is to survey visitors to national museums in Guangdong, China, studying the museum visiting behaviour intentions of Gen X, Y, and Z, identifying influencing factors and proposing improvement methods. The specific goals are as follows:

RO1: Investigate the main factors influencing the behavioral intentions of museum visitors towards VR technology in Guangdong.

RO2: To explore whether there are generational differences in the factors influencing museum visitors' behavioural intentions.

RO3: Proposing methods and strategies to improve museum visitors' behavioural intentions towards VR technology.

1.5 Research Questions

RQ1: What were the main factors influencing the intention of museum tourists in the Guangdong region to use VR technology?

RQ2: Were there generational differences in the main factors influencing tourists' behavioural intentions?

RQ3: How might the behavioural intention of museum tourists towards VR technology be bolstered?

In this study, the researcher will analyse data from museum visitors (Gen X, Y and Z) to identify key factors influencing visitors' behavioural intentions and consider age as a moderating factor for its positive or negative impact to achieve RQ1.

Furthermore, in this study, based on the age characteristics of museum visitors, respondents are divided into three groups: Gen X, Y, and Z. For survey purposes, and by comparing the mean data of the three groups, the researcher will analyse the behavioural differences among different generational museum visitors in using VR technology to answer RQ2.

Based on the research results, methods to enhance visitors' visiting experience and behavioural intentions are proposed, providing theoretical references for national museums in Guangdong on how to formulate VR technology schemes more effectively, and realised RQ3.

1.6 Significance of the Research

Firstly, in terms of research theory, it addresses the existing research gap in utilising VR technology by museum visitors in the Guangdong region. Specifically, the study categorises museum visitors and explores generational differences influencing their behavioural intentions. By examining the technology needs of visitors across different age groups, this research contributes to the specificity and depth of theoretical investigations. It significantly fills the academic research gap concerning the behavioural intentions of generational museum users in China. The study expands on the selected user behavioural intention model, enriches the theoretical system, and enhances research methods in museum user behavioural intention research. Additionally, it serves as a theoretical reference for other types of museums or cultural exhibition halls.

Secondly, on a practical level, the study aims to identify the primary factors influencing the behavioural intentions of museum visitors from different generations towards VR technology through data analysis and empirical evidence. It intends to propose methods to enhance museum visitors' behavioural intentions towards VR technology, assisting museum staff in developing more visitor-centric VR exhibition programs. This approach not only helps test the feasibility of VR exhibitions but also contributes to making VR technology more efficient, thereby improving the quality of museum services and visitor experiences. Moreover, on a societal level, promoting this research conclusion can help enhance public acceptance and

understanding of emerging technologies. It provides innovative pathways for museum education and can potentially drive development in various fields, such as culture, tourism, and education. By promoting these research findings, the study aims to foster positive societal impacts and contribute to the advancement of technology integration in cultural institutions.

1.7 Structure of the Paper

This study will be divided into six chapters. The first chapter elaborates on the current research status, problem statement, research questions, and objectives. The second chapter is a literature review, which selects search databases and keywords based on the first chapter's research status, problem statement, and research questions. By reviewing and analysing relevant domestic and international literature, the goal is to understand and outline the current state of VR technology in museums, review the literature in this field, and understand the theories and research methods cited by researchers. A suitable theoretical and conceptual framework for this study will be determined through the literature review. The third chapter is on research methods, focusing on research design. This chapter explains how this study chooses appropriate research methods, data collection methods, and data analysis tools, as well as the process of data collection and the steps for data analysis. This chapter is based on the extended UTAUT2 model, proposes research hypotheses, design questionnaire scales, and collects responses on the behavioural intentions of museum visitors towards VR technology. In addition, a pre-test will be conducted before the official distribution of the questionnaire to test its reliability and validity, and adjustments will be made according to the pre-test results. This study has obtained Research Ethics Approval for Non-Medical Research on Humans from Universiti Malaysia Sarawak (Refer to appendix A).

Chapters four and five will be dedicated to data analysis and the interpretation of data conclusions. The study will conduct data analysis in two stages, addressing the respective research questions. Descriptive statistics, PLS-SEM structural equation, one-way ANOVA, and other statistical methods will be employed, utilizing SmartPLS and SPSS software tools for data analysis. The fifth chapter will interpret and discuss the results in light of the literature review and the data analysis conclusions, uncovering deeper insights. This stage will specifically address the third research question — proposing methods to enhance museum visitors' behavioural intentions towards VR technology.

The final chapter, the sixth, will serve as a conclusion, summarizing the study and emphasising its significance.

1.8 Scope of the Research

The scope of this study is the national-level museums in Guangdong province that have VR technology. According to preliminary phone interviews and on-site research conducted by the author on these ten national museums in Guangdong, only three have long-term VR exhibitions: Guangdong Maritime Silk Road Museum, Guangdong Hakka Museum, and Guangdong Folk Art Museum. However, for various reasons, the VR exhibitions in the last two museums are suspended and require further upgrades and repairs. Therefore, the main target of this survey is visitors to the Guangdong Maritime Silk Road Museum, with a small portion of sample data provided by visitors to other national-level museums in Guangdong. The respondents of this study are divided into three groups, Generation X, Generation Y, and Generation Z, with at least 150 valid questionnaires needed from each group to accurately analyse the behavioural differences of visitors across generations when using VR technology.

1.9 Definition of Terms

To maintain the clarity and consistency of terms and concepts in this study, the following are definitions of some key terms used in the context of this research.

VR Technology (Product) - A device or system that uses computer technology to create a simulated environment (Anthes, 2016). In this study, the 'VR Technology (Product)' is used in museum exhibitions, referring to the technology (product) that visitors operate through VR head-mounted display devices, and the VR technology (product) of the museum is a PC-connected VR head-mounted display or standalone VR head-mounted display.

Museum - A public or private facility that collects, protects, researches, and exhibits areas related to nature, historical culture, art, etc. (Holman, 2022). In this study, a museum refers to a non-profit comprehensive museum that serves society and its development. Its collection and display of artefacts or traditional culture allows audiences to understand, appreciate, and learn.

Behavioural Intention - Defined as a person's expectancy, plan, or intention to perform a certain behaviour (Hu et al., 2019). In this study, behavioural intention refers to the expectation or plan of museum visitors to use, accept, or continue to use VR technology.

Cross-generational visitors - Generally used to describe tourist groups of different ages or stages of the life cycle (Christopher & Garza, 2021). In this study, cross-generation divides visitors into Generation X, Y, and Z. Generation X refers to visitors born between 1965 and 1979; Generation Y refers to visitors born between 1980 and 1994; Generation Z refers to

visitors born between 1995 and 2004 (the respondents of this study are adults, and in China, those under 18 are considered minors).

Extended UTAUT2 Model - In this study, multiple variables are added to the basic UTAUT2 model to construct an extended UTAUT2 model applicable to the study of the behavioural intention of museum visitors towards VR technology. The Extended UTAUT2 Model mentioned in this article only applies to this study.

1.10 Research Limitations

Due to COVID-19 and local policies, China temporarily closed most of its comprehensive museums in 2021 and 2022 to reduce cross-infection among visitors, which limited the progress of my research and the collection of questionnaires. The data collected in this study is limited to museums in Guangdong province in China, and due to this geographical limitation, the study's results may primarily reflect the actual situation of museums in this specific region. The applicability of the study's conclusions may be limited for museums in other regions, especially those with significant differences in cultural background, economic development, and technical conditions compared to Guangdong province. Secondly, there are also theoretical limitations. This study is based on current research status and basic user behavioural intention models to design expanded models and employs quantitative research methods. Due to individual differences among users, this model may not cover all factors affecting museum visitors' behavioural intentions, and some insignificant potential factors may not have been considered in this study. In addition, due to the rapid changes in VR technology and the social environment, some content and conclusions of this study may need to be updated and revised.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This literature review focuses on the current integration status between museums and VR technology, specifically examining the behavioural intention of museum visitors to use VR technology products within this context. The review is organised into five sections. The first section delves into the international perspective, analysing the existing status and research progress of the VR technology implementation in museums. The goal is to develop strategies for integrating VR technology in museums in the Guangdong region. By leveraging the insights gained from this literature analysis, the review seeks to speculate on museum VR technology's future development trends and identify existing research limitations.

The second section analyses the present landscape of VR technology products. It aims to categorise and understand the common types of museum VR products and their advantages and disadvantages. This exploration aids in understanding whether the type of VR products can affect the interactions and experiences of museum visitors.

The third section examines the theoretical foundations and research perspectives researchers have drawn upon in the selected literature. It compiles the theories and research models referenced by previous studies, assesses their strengths and weaknesses, and contemplates the construction of a theoretical framework that can be effectively applied to this research.

The fourth section explores the primary factors influencing users' behavioural intention to engage with VR technology. This phase involves compiling and analysing outcomes from previous research to determine whether the data and conclusions from these studies can help inform the identification of appropriate independent variables and assumptions for this research.

Furthermore, it entails a comparative analysis and discussion of previous research conclusions alongside the present study's findings. This comparative approach aids in refining the research plan and achieving more precise data results.

The fifth section offers a comprehensive summary of the literature review, highlighting existing gaps and problems within this research domain, particularly those related to data. Additionally, it underscores the importance of addressing the needs and behavioural intentions of visitors across different generations while respecting the diverse nature of museum attendees.

Concluding this review, this research's theoretical and conceptual framework is formulated, drawing upon insights from prior studies. This framework is intended to provide a robust theoretical underpinning for the research methodologies outlined in the subsequent chapters. The literature search for the initial two sections of this review involved the formulation of keywords such as "VR" , "museum", and "VR product". Given the extensive volume of literature across databases like Google Scholar and Scopus, emphasis was placed on articles with high citation rates and relevance. Moreover, this phase concentrated on systematic literature reviews focused on museum VR (including AR and XR) technology. Such comprehensive reviews employ rigorous search strategies and criteria, bolstering the credibility of the results.

For the subsequent sections (three and four) of this literature review, a broader keyword scope encompassing “museum”, “VR”, “behavioural intention”, and “visitor” was employed. This expanded scope acknowledges the relatively smaller literature volume in this research domain. Major databases were consulted, including Google Scholar, Scopus, Web of Science, ACM Digital Library, and the China National Knowledge Infrastructure (CNKI). Additionally, publication years were restricted to 2010 through 2023 to emphasise the latest developments. The selection of articles from 2010 onwards aligns with VR technology’s post-2010s stage of development, facilitating a meticulous exploration of the latest research outcomes. This 15-year span enables the synthesis of contemporary theories and findings, furnishing innovative and robust theoretical backing for the study’s conceptual framework. Furthermore, the selection scope for research theory-related literature will be suitably expanded.

2.2.1 Past, Present, and Future

VR technology was initially developed and applied in developed countries across Europe and America, finding its early roots in the United States military sector. As technology gained popularity, VR became famous in the gaming and entertainment industry (Wohlgenannt et al., 2001). VR technology is extensively employed across various domains, with museums as a significant application arena. Within museums, VR technology offers immersive experiences distinct from conventional exhibition methods (Lee et al., 2020). Diverging from traditional presentation approaches, VR enables visitors to traverse time and space using VR devices, immersing themselves in historical artefacts’ cultural and contextual significance (Trunfio et al., 2022). This innovative exhibition form is undeniably transformative and more impactful. The evolution of the merger between museums and VR technology can be understood through three

stages. The initial phase, dating back to the early 21st century, marks an experimental stage wherein museums initiated trials with VR technology. These early applications were often project-specific, utilising large and technically complex VR equipment. The subsequent stage, occurring predominantly during the 2010s, represents the era of mainstream adoption. Corresponding with the maturation of VR technology, costs decreased, rendering VR more accessible, leading to its mainstream incorporation within museums. Finally, the third phase signifies full integration, as recent years witnessed a profound collaboration between VR technology and museums, ushering in new visitor experiences.

In foreseeing even deeper integration, future developments will necessitate VR technology to shoulder increased responsibilities while aligning with the multifaceted functions of museums (Janes, 2023). This progression prompts museum researchers to shift their focus from technology design and hardware enhancements toward technology adaptability and alignment with users' behavioural intentions.

Turning to specific case studies showcasing the symbiosis between museums and VR technology, it is evident that European and American museums led the way. The Paris Museum of Science and Industry in France pioneered VR technology during its early experimental phase, introducing the immersive “CyberDome” exhibition. This interactive project gave visitors a fully immersive environment, exploring themes like the ocean, geology, and the universe. Aligned with the museum's mission to promote scientific and technological knowledge, the museum demonstrated high technological insight and vision. The Paris Museum of Science and Industry (French name: “Cité des Sciences et de l'Industrie”) is Europe's largest science and technology museum (Levin et al., 2010). Similar instances abound across Europe and America,

exemplified by the British Museum's "Ancient Life VR Experience", launched in 2015, offering a glimpse into life during the Bronze Age through VR devices (Kennedy, 2015). Likewise, the Natural History Museum in London introduced the "David Attenborough's Great Barrier Reef Dive VR" experience (Natural History Museum, 2015). More recently, in 2021, the Louvre in France unveiled the "Mona Lisa: Beyond the Glass" VR experience, allowing visitors to delve into the profound meaning of the iconic Mona Lisa painting (McGivern, 2019).

Museums in Western countries are leading the way in embracing collaboration with VR technology. This trend also extends its influence to museums in non-Western countries, where a growing emphasis on collaboration and integration with VR technology is emerging. A notable illustration of this trend comes from the Edo Museum in Tokyo. In 2017, the museum initiated a project leveraging VR technology to recreate the historical Edo period (1603-1863). Through this initiative, visitors are afforded the unique opportunity to navigate through a virtual cityscape, immersing themselves in the experiences of that era and gaining profound insights into life during that historical epoch (Soga et al., 2018). The ArtScience Museum in Singapore unveiled the captivating "Into the Wild" VR experience In 2017, aimed at reviving the Southeast Asian rainforest ecosystem, offering visitors an opportunity to explore and interact in the virtual environment (Kim & Chung, 2020).

Recently, Chinese museums have also grown interested in intensive collaboration and VR technology research. For instance, the Palace Museum in China harnessed VR technology to meticulously recreate the luxury of royal banquets during the Ming and Qing dynasties (1368-1912). This innovative endeavour immersed visitors into the lives of ancient royalty and nobility (Li & Huang, 2022). Similarly, institutions like the China Science and Technology Museum,

the Shanghai Science and Technology Museum, and the Nanjing Massacre Memorial Hall have all leveraged VR technology to construct immersive virtual environments. These environments facilitate visitors' engagement with historical narratives and educational content.

Numerous countries exhibit a positive stance towards the synergy between museums and VR technology. In 2018, the UK's Department of Culture initiated the "Museum Digitalisation" program, promoting the integration of new technologies within museum spaces. This program offers financial support and expertise, guiding museums in innovating their exhibitions and digital initiatives through VR technology. In the U.S., the National Foundation and National Science Foundation extend funding and incentive programs to empower museums to preserve cultural heritage and educational endeavours via VR technology. Australia's "Digital Culture Fund", administered by the Australia Council for the Arts (2021), allocates financial resources to museums and cultural institutions for digitisation and VR-related undertakings. These actions highlight governments' recognition of VR technology's role in advancing the digital economy and creative sectors. With this motivation, more museums are expected to embrace VR technology to cultivate enhanced exhibition experiences, unlocking the considerable potential of VR applications in museums. Chinese museums, too, benefit from substantial governmental backing, which encompasses increased funding for museum digitisation and the establishment of standards and norms for digital infrastructure within museums (Dong et al., 2011). While the horizon for VR technology in museums appears promising, it also underscores a challenge for museum researchers: they must optimise the advantages of VR technology. This necessitates focusing on users' acceptance and behavioural intentions towards VR products. Only through

enhancing visitors' experiences and intentions can VR products within museums be deemed both practical and meaningful (Han et al., 2019).

Moreover, investigating the content of the cooperative cases between museums and VR technology across diverse nations, it is evident that most VR technology initiatives for museums are grounded in the museum's overarching theme or specific exhibition themes. These initiatives often involve crafting scripts and narratives that revolve around restoring historical scenes and traditional activities. Bekele and Champion (2010) further elucidate that museum VR installations are particularly tailored for cultural heritage and historical contexts. This is due to the challenges of eliciting visitor empathy through images or one-way video outputs alone, particularly when dealing with historical architecture and generational contexts.

Providing a "real" environment through VR technology augments the visitor experience. VR products offer a distinct learning mode within a virtual milieu (Jung et al., 2016). The authenticity of historical scenes and traditional activities is a primary concern for visitors, underscoring the significance of accurate restoration (Margetis et al., 2020). Consequently, this study evaluates the impact of immersion and information quality on tourist behavioural intentions. It posits that for maximum effectiveness in depicting historical scenes and traditional activities, the employment of mature technology must be coupled with a heightened emphasis on aesthetic design. An exquisite interface design quality can potentially intensify visitors' immersion and enhance the overall quality of their museum experience.

2.2.2 Types of VR Products

The most prevalent VR technology products accessible to the general public encompass VR head-mounted displays (HMD), commonly known as VR helmets, accompanying

controllers, sensors, and other components. The VR HMD is important within this array of devices, serving as the analogous control centre, much like the human brain orchestrates other concurrent devices (Luong et al., 2015). This display epitomises an augmented display with sensory capability and operational functionality. It can compute data and transmit images, granting users access to immersive virtual panoramas engrossing them in a simulated world.

VR HMD can be broadly categorised into four types:

1. PC-Connected VR HMD: This type necessitates connection to a high-performance computer via a cable to render image and audio output. The defining feature is the tethering of the VR HMD to a PC, which mandates relatively high requirements for PC performance, size, and quality (Pranith et al., 2011). This configuration enables high-definition image quality, supporting high-resolution, high-frame-rate imagery. The PC boasts an exceptional technical response speed, affording users a top-tier VR experience (Narula, 2022). Nevertheless, this category poses certain drawbacks: the cost is elevated, a seamless operation necessitates a high-performance computer, and the setup process entails installation and testing time. A data cable connection also limits user mobility (Wang et al., 2016; Rosen et al., 2020; Saredakis et al., 2020).

2. Standalone VR HMD: A standalone VR HMD operates autonomously, eliminating the need for connections to computers or mobile phones. It incorporates all necessary hardware components, including processors, displays, sensors, and other requisites. In contrast to PC-connected VR HMD, this version liberates users from activity range constraints, allowing unhindered movement free from cable limitations. However, owing to inherent hardware

limitations, the imagery quality and hardware response speed are less advanced than their PC-connected counterparts (Mehrfard et al., 2019; Shu et al., 2019; Yun et al., 2020).

3. Mobile Device VR HMD: This variant leverages a mobile device as its screen, typically requiring specific VR glasses to secure the phone. Similar to the experience of watching a 3D movie, VR glasses serve as intermediaries for visualisation, with the mobile device as the projection screen. In contrast to the preceding two VR HMDs, this option is economically viable, user-friendly, and broad-reaching, as users can operate their familiar smartphones. However, its shortcomings include compromised experience quality, subpar image quality, restricted functionalities, and continuous power consumption (Chen et al., 2021; Gugenheimer et al., 2019).

4. Mixed Reality (MR) HMD: This display combines virtual content with the real world, enabling users to interact and engage with virtual elements within an authentic environment. MR is a fusion of VR and AR technologies (Ko & Rogers, 2008). MR technology concentrates on harmoniously blending virtual objects with actual surroundings. It requires stringent imaging technology requisites, accentuating the immersive experience of seamlessly interacting with virtual components amid the real world. Hardware prerequisites for this display surpass those of the preceding three VR head-mounted display categories, culminating in the highest manufacturing and acquisition costs. However, the application scope of MR HMD remains confined, with relatively limited deployments due to ongoing technological development and testing (Rokhsaritalemi et al., 2020; Speicher et al., 2019; Chen et al., 2017).

The content within museum VR products predominantly revolves around virtual exhibitions and interactive experiences, allowing visitors to immerse themselves in dynamic

environments. Virtual exhibitions create immersive environments where museum-goers can engage, often reconstructing important historical scenes and cultural activities. For instance, Ahn and Wohn (2015) designed a virtual 3D “cave” that enables visitors to partake in ancient rituals and marvel at timeless art pieces. The Bruges History Museum in Belgium employed VR technology to resurrect historical scenes from 15th-century Bruges, allowing visitors to delve into the lives and events of that era. Tennent et al. (2020) took visitors on a journey through the world’s inaugural photography exhibition, providing a virtual platform to appreciate the works of the master photographer.

Furthermore, VR technology empowers visitors to interact with objects on the interface, “manipulating” virtual tools for tasks like restoring cultural artefacts or crafting handicrafts. Across various museum explorations of VR technology, virtual exhibitions and interactive experiences have emerged as pioneering presentation strategies (Sooai et al., 2017). These require attention to product performance, hardware quality, and stringent quality standards. The two most recommended options for museums seeking an ideal VR HMD are high-performance and high-quality devices: PC-connected VR HMDs and standalone VR HMDs. Numerous brands and models are available in the context of PC-connected VR HMD, such as HTC Vive (Figure 2.1) and Valve Index. Meanwhile, standalone VR HMD products like Oculus Quest (Figure 2.2) and Oculus Quest 2, endorsed by Mehrfard et al. (2019), offer an immersive experience with impressive capabilities.



Figure 2.1: HTC Vive product diagram (Vive official website, 2023)



Figure 2.2: Oculus Quest product diagram (Meta official website, 2023)

Museums often opt against mobile device VR headsets and MR headsets for two primary reasons. Firstly, museums place a premium on upholding the authenticity of historical culture, necessitating a high level of image fidelity, which mobile device VR HMD may struggle to provide. Secondly, the mobile device VR HMDs require visitors to use their mobile devices (phones, tablets, etc.), introducing challenges related to product compatibility and software installation (Kyriakou & Hermon, 2019). This process can be cumbersome for visitors, limiting their seamless engagement with VR products. Similarly, the cost and technological maturity of MR HMDs often deter museums from adopting them. Due to their high cost and relatively mature technology, these options tend to be less favoured by museums. Nonetheless, as MR technology continues to evolve, museums may increasingly explore profound collaborations with this technology in the future.

It is important to acknowledge that the selection of museum VR HMD products is linked to the museum's environment and the characteristics of its visitors. Museums often face spatial limitations and high visitor footfall, making it challenging to deploy VR HMDs that do not require PC connection via cables. The absence of cables can lead to safety concerns as visitors could become disoriented in the physical environment while engrossed in the virtual space. Additionally, when VR HMDs are used independently, museum staff might find it difficult to manage and provide guidance, thus raising concerns about device operation and visitor safety. Consequently, the choice of VR products can also influence visitor behavioural intentions.

2.2.3 Limitations of VR Products

This study contends that effective VR equipment can significantly enhance visitors' museum experiences, particularly through high-performance devices that offer high-quality

image output. This leads to an immersive visual sensation that heightens visitors' sense of enjoyment. However, certain articles have raised concerns about these devices.

Puig et al. (2020) utilised 3D reconstruction and VR technology to showcase the Neolithic settlement scene of La Draga, selecting the HTC Vive VR HMD. While acknowledging the positive impacts of VR technology on museums, the researchers also highlighted its associated dilemmas, underscoring the drawbacks and limitations of VR HMDs (Puig et al., 2020). The article pointed out that users often encounter difficulties during use and require additional guidance or training. Similarly, Tennent et al. (2020) employed the HTC Vive product, which supports multi-user experiences (up to 6 individuals). However, since VR HMDs can obstruct the line of sight, they can lead to collisions among users sharing the same space, posing safety concerns. Furthermore, the requirement for a room-size experience space coupled with cable connections mandates users to carry backpack-type computers, adding a physical burden. In museums in the Guangdong region, VR technology also faces some limitations. For example, in the VR exhibition at the Guangdong Maritime Silk Road Museum, the museum provides a surrounding sofa for visitors to sit on and offers HTC Vive VR headsets. Curators believe that the surrounding sofa can place visitors in a safe area to prevent them from moving around and bumping into things. However, according to my observations, visitors tend to move their bodies unconsciously after entering the VR world, causing them to bump into the sofa. Therefore, there are certain limitations in the experience and safety issues.

The scenarios above can be interpreted as issues related to VR products' usability, interface design, and safety concerns associated with their usage. Examining these concerns from cognitive and behavioural psychology perspectives, product usability and safety are the

main factors influencing user experience and satisfaction. A product boasting excellent usability and interface design empowers users to grasp operational methods rapidly, cultivating a favourable inclination towards usage (Reimann et al., 2010). Product safety encompasses whether users can ensure their personal and information security while utilising the product or whether they evaluate the potential risks associated with its use (Tran, 2020). If users perceive a product as lacking in safety, it can erode their trust (Hassan & Ahmed, 2023). Consequently, the study underscores the importance of considering user behaviour and developing high-quality VR technology solutions for museums. The research will delve further into the potential impacts of product usability, interface design, safety, and perceived risk on visitors' behavioural intentions to utilise VR technology, building upon the insights provided by the studies above.

2.2.4 Summary

This study has comprehensively analysed the current state of museums incorporating VR technology, the categories of VR head-mounted displays selected by museums, and the challenges arising from utilising VR products, as elucidated in the literature review of this section. Using insights from the literature, the study will focus on four key limitations: product usability, interface design, safety, and user perception. It will investigate whether these limitations impact the behavioural intentions of museum visitors to engage with VR technology in subsequent phases of in-depth research.

By exploring these limitations, the study aims to uncover how these factors influence user interactions and experiences with VR technology within museum environments. This focused inquiry seeks to deepen our understanding of how usability, interface design, safety considerations, and user perceptions collectively shape the propensity of museum visitors to

embrace and interact with VR technology. Ultimately, this research endeavour aspires to yield valuable insights for refining the efficacy of VR technology implementation in museums and enhancing the overall quality of the visitor experience.

2.3 Related Theories and Models

This section analyses the theoretical framework employed by researchers in the same domain on the behavioural intentions of museum visitors towards utilising VR technology. It scrutinises and extends the theories most frequently used, aiming to categorise and understand the applied theories within published works. The objective is to analyse this study's focus and research subjects, identify theories pertinent to this investigation, and develop a fitting theoretical framework. Given the relatively limited literature in this domain, this phase also considers digital technologies associated with VR technology, including Augmented Reality and Mixed Reality.

Typically, researchers examine the behavioural intentions of museum visitors towards digital technology by directly employing psychological theories or theoretical models. However, a subset of researchers expands research based on psychological theories in conjunction with theories from other disciplines. Psychological theories or models researchers utilise predominantly stem from three branches of psychology: social psychology, behavioural psychology, and cognitive psychology. Educational psychology also contributes to the discourse by addressing individual differences, developmental aspects, learning motivation, and other factors relevant to the learning and teaching process.

Social psychology scrutinises how the social environment influences an individual's psychological processes (Lin et al., 2023), analysing how the surrounding context shapes users'

cognition, emotions, and behaviours (Rogers, 2019). Behavioural psychology focuses on human behaviour, particularly the user's responses to stimuli (Fisher, 2022). Cognitive psychology explores human mental processes, encompassing perception, memory, attention, decision-making, and the comprehension of information (Fleming, 2019). Educational psychology examines individual dissimilarities, learning motivation, and developmental aspects within the learning-teaching context (Vygotsky, 2020).

Considering these branches of psychology and the research objectives in this article, it is reasonable to infer that various psychological theories will find applicability in this study. Given that this research seeks to examine factors influencing the behavioural intentions of museum visitors towards VR technology, it will concentrate on visitor-specific elements such as cognitive perceptions of technology, psychological states, and decision-making processes. External factors like the social context, usage environment, and peer advice will also impact these elements. Consequently, this study aspires to integrate theoretical models from other researchers to construct a robust theoretical framework apt for this investigation.

2.3.1 Technology Acceptance Model and Extension

2.3.1.1 Theory of Technology Acceptance Model

This model is among the most frequently discussed and applied in this research domain. The Technology Acceptance Model (TAM), devised by American researcher David Davis in 1989, is grounded in the Rational Action Theory (TRA) underpinnings. Its purpose is to elucidate and forecast users' embracement of information technology (Davis, 1989). At its core, this model comprises two main variables: perceived ease of use and perceived usefulness.

Perceived ease of use pertains to the user's conviction that the new technology is straightforward to navigate and demands minimal effort and time to attain proficiency (Silva, 2015).

In contrast, perceived usefulness embodies the user's perception that the technology holds the potential to enhance work efficiency or offer personal benefits (Natasia et al., 2022). This theory posits that these core variables influence users' responses to novel technology. When users perceive the technology as useful and user-friendly, they will embrace it. This study contends that the TAM model encompasses certain concepts from cognitive psychology, specifically perceived usefulness and perceived ease of use, which are related to individual cognitive processes (Marangunić & Granić, 2015; Ammenwerth, 2019; Harsanto et al., 2023).

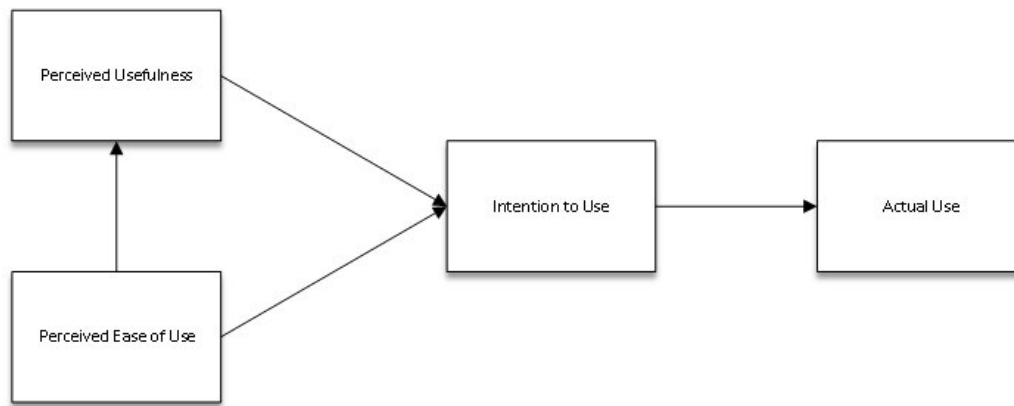


Figure 2.3: TAM Model (Davis, 1989)

Wu (2022) extended the Technology Acceptance Model (TAM) by introducing information quality and information richness as system features, creating a research model that yielded promising results through experimental investigation, See Figure 2.3 for the TAM model diagram. Hammady (2021) consistently referenced the TAM model as a foundational

extension framework. In their extended model, three interrelated constructs emerged: perceived usefulness, perceived ease of use, and usage intention. Moreover, perceived enjoyment and the guidance function were integrated. Researchers scrutinised the guidance function's influence on other variables and its impact on visitors' utilisation intentions.

Rhee (2019) augmented the TAM model by incorporating immersion and fatigue as mediators, with a specific focus on evaluating the acceptance of Virtual Reality (VR) technology among museum users.

Similarly, Gharibi (2022) adapted the modified TAM model to explore the behavioural intentions of disabled visitors toward Extended Reality (XR) digital technology. This adaptation included variables like perceived trust, perceived efficiency, and perceived enjoyment, resulting in a comprehensive study.

Furthermore, some articles diverge slightly from the core variables of the TAM model in their hypothetical models, yet they acknowledge the impact of the TAM model. For instance, one article features a hypothetical model with main variables like interaction quality, information quality, and perceived playfulness, which are expanded upon by incorporating the perceived ease of use variable from the TAM model (Jiang et al., 2022). Other articles blend the principles of the TAM model with environmental information visualisation concepts (Hammady et al., 2020). Another researcher builds a model involving the TAM model and theory of mind. The model extends the variables of the TAM model, such as flow state, perceived enjoyment, and perceived efficiency as intermediary variables for research (Wu, 2021).

All the researchers mentioned above acknowledge the TAM model. Hammady (2021), Rhee (2019), and Gharibi (2022) expand the basic TAM model according to their research

content and objectives to obtain effective research results. It is clear that using the TAM model to study users' attitudes towards technology acceptance is beneficial, and they believe that the TAM model can effectively assist in conducting research and analysis. According to the information, the TAM model was first proposed in 1989 (Malatji et al., 2020). Following this model, there have been further in-depth studies that have extended and modified the TAM model. Therefore, understanding the origin and development of the TAM model is crucial for this research. This study hopes to be inspired by the evolutionary development process of the TAM model. Through initial Google searches, the research will identify the chronological development and model names of the TAM model (as shown in Figure 2.4), and the authors will list and analyse relevant models in this study.

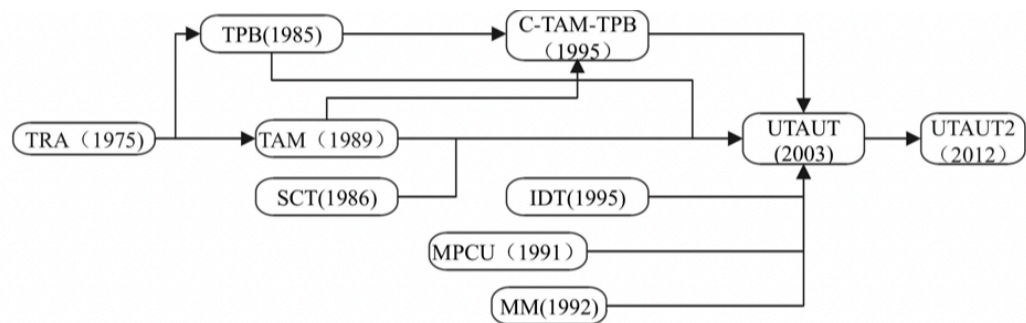


Figure 2.4: Evolution of the Technology Acceptance Model (Mi, 2022)

2.3.1.2 Overview of Theory of Reasoned Action

The TAM model is based on the Theory of Reasoned Action (TRA) model. The TRA model was first proposed by Fishbein and Ajzen in 1975. The TRA model is a psychological framework to predict individual behaviour and explain the relationship between attitudes and

actions in human activities (Al-Nuaimi & Al-Emran, 2021). In essence, it refers to an individual's inclination to undertake a specific behaviour based on their anticipated outcomes from that behaviour (Rastini & Respati, 2021). The TRA model encompasses three key components: Attitude, Subjective Norm, and Behavioural Intention (Montano & Kasprzyk, 2015).

Attitude denotes an individual's evaluation of the behaviour at hand, while Subjective Norm involves an individual's cognitive perceptions of the expectations of significant individuals concerning a particular behaviour. For instance, this might happen as a user believes their family expects them to prioritise their health by getting enough sleep. Additionally, the Subjective Norm encompasses a compliance aspect, signifying an individual's willingness to conform to the expectations of influential individuals (Obrenovic et al., 2022). This aspect incorporates the individual's compliance with these expectations and their motivation to do so, thereby highlighting the influence of external factors on attitudes. When individuals hold a positive view of a particular thing or behaviour and perceive it as significant to those close to them, they are more likely to engage in that behaviour.

According to the TRA model, Behavioural Intention is the most immediate predictor of behaviour. Both Attitude and Subjective Norm, operating as independent variables, exert an impact on an individual's Behavioural Intention, which in turn directly shapes their behaviour (Wiguna & Dellyana, 2023; Obaid, 2021; Madden et al., 1992).

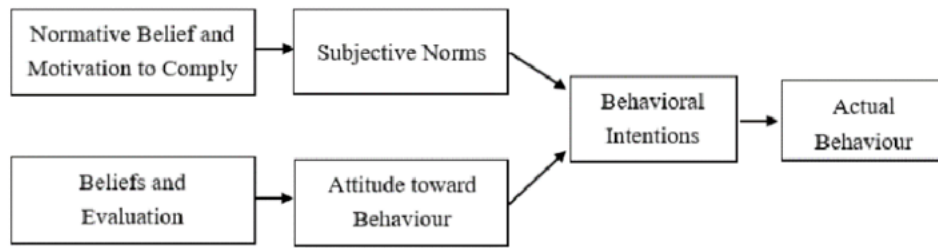


Figure 2.5: TRA model framework (Madden et al., 1992)

2.3.1.3 Overview of Theory of Planned Behaviour

The TRA model lacks accuracy in examining behaviours not entirely governed by human rational intentions, as objective factors frequently influence human behavioural intentions. To enhance the predictive accuracy of the TRA, Ajzen introduced the Theory of Planned Behaviour (TPB) in 1985, building upon the foundations of the former (Ajzen, 1991). The TPB posits that behavioural intention influences the actual execution of behaviour; a stronger intention enhances the likelihood of behaviour occurrence (Conner & Armitage, 1998). TPB contends that, apart from subjective awareness, various external factors exert an influence that might impede individuals from acting according to their intentions (Wang et al., 2021). The actual control over behaviour by individuals depends on their capacity to surmount these obstacles. Additionally, the model acknowledges facilitating factors such as experience and assistance from others (Troise et al., 2021). Consequently, external factors exhibit positive and negative effects, influencing user behavioural intentions and requiring consideration.

The TPB model asserts that three primary facets impact behavioural intention: personal attitudes towards behaviour, subjective norms surrounding behaviour, and perceived control

over behaviour. It posits that favourable attitudes and subjective norms motivate behaviour, yet users will only develop specific intentions for action when they feel they possess sufficient control over the behaviour (Wilson, 2022).

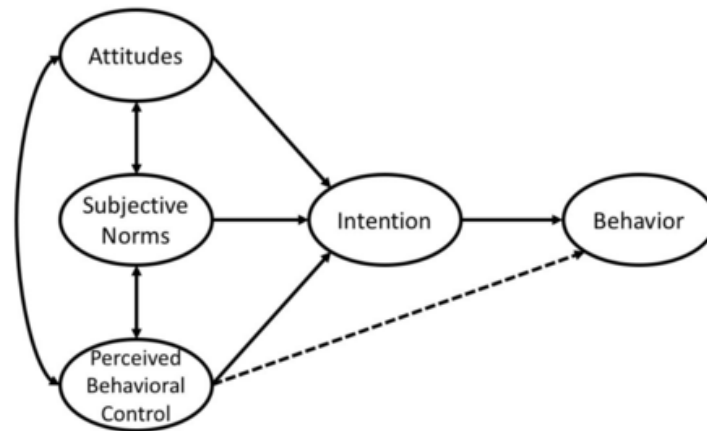


Figure 2.6: TPB model framework (Fishbein & Ajzen, 1975)

The TRA and the TPB predate the TAM, and the latter was developed based on the former. The initial two theories are based on studying user behaviour, whereas the TAM emphasises investigating user behaviour towards technology. The TAM concentrates more on the context of technology acceptance (Nistor et al., 2019). While these three models possess a certain historical and theoretical interrelation, they each maintain distinct characteristics and find application in different domains.

As time has progressed, researchers, including Venkatesh (year), have identified certain limitations within the Technology Acceptance Model (TAM). These limitations have highlighted the challenges of achieving accurate predictive results when applying the TAM

directly. Consequently, researchers have been contemplating ways to enhance and evolve the TAM model in the future to make it a more robust and reliable framework.

2.3.1.4 Overview of Technology Acceptance Model 2 and Technology Acceptance Model 3

Technology Acceptance Model 2 (TAM2), proposed by Venkatesh et al. in 2000, extends the original TAM. It was primarily designed to address some of the limitations in the original technology acceptance model (Venkatesh et al., 2000), evolving into a more detailed and comprehensive theoretical framework for technology acceptance (Chuttur, 2009). The TAM2 model also explains and predicts user behaviour in accepting and using new technologies. In addition to the original perceived usefulness factors and perceived ease of use, the TAM2 model introduces new factors. Subjective norms, image, job relevance, output quality, and result demonstrability are considered to influence individuals' perceived usefulness (Purnama et al., 2019). Subjective norms, similar to the variable in the TRA model, refer to users' cognition of themselves and the influence of the environment on user behaviour. Image refers to whether using this technology can enhance an individual's status and personal influence in social groups. They are more likely to accept and use this technology if it improves their social image. Job relevance refers to an individual's cognition of technology. If this technology can help them complete their work, they are more likely to accept it (Salloum et al., 2019). Output quality refers to the quality of the output or the result of this technology; if approved by users, they are more likely to accept and use it. Result demonstrability refers to whether users think the results of a certain technology are clear and intuitive; if so, they are more inclined to use it. Perceived ease of use is influenced by two new variables, experience and volition. Experience refers to an individual's experience with technology, and past experiences can influence individual

behaviour. Volition refers to the degree to which an individual voluntarily uses a certain technology. If users voluntarily use technology, it can be considered that their perceived ease of use of the technology is likely high (Wingo et al., 2017).

The TAM2 model is more complex than the TAM model, indicating that researchers are aware of the deficiencies of the TAM model and that there is still unexplored territory in the study of users' behavioural intentions towards technology, requiring continuous in-depth research. Comparing the TAM and TAM2 models, researchers have adjusted the definitions and measurement methods of perceived usefulness and perceived ease of use to enhance the accuracy of results, aiding researchers in gaining a more profound understanding and improved predictive capability for users' technology acceptance behaviour.

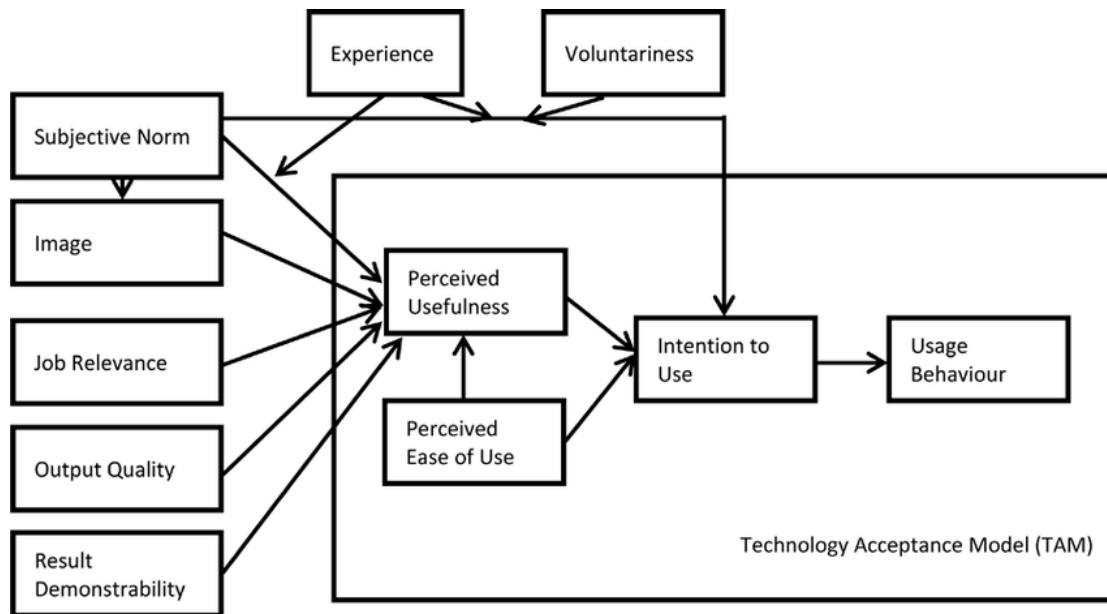


Figure 2.7: Technology Acceptance Model 2 (Venkatesh et al., 2000)

The Technology Acceptance Model 3 (TAM3) was proposed by Venkatesh and Bala in 2008. The TAM3 model builds upon the foundation of TAM and TAM2, introducing more variables and offering a detailed analysis of the factors influencing perceived ease of use (Venkatesh et al., 2008). Like TAM and TAM2, it retains perceived usefulness and perceived ease of use while adding a series of new variables to facilitate research, aiming to achieve accuracy and comprehensive data results (Lai, 2017). TAM3 introduces three main variables: Anchoring, Adjustments, and System Characteristics (Lala, 2014). TAM3 presents a more comprehensive and detailed theoretical framework to assist researchers in better understanding and predicting user behaviour in accepting and using new technologies. The primary distinction between TAM and TAM3 lies in the number and complexity of variables (Rondan-Cataluña et al., 2015). The 22-year interval between the introduction of TAM3 and the original TAM model illustrates the increasing attention researchers are giving to the technology acceptance model and its application across various fields.

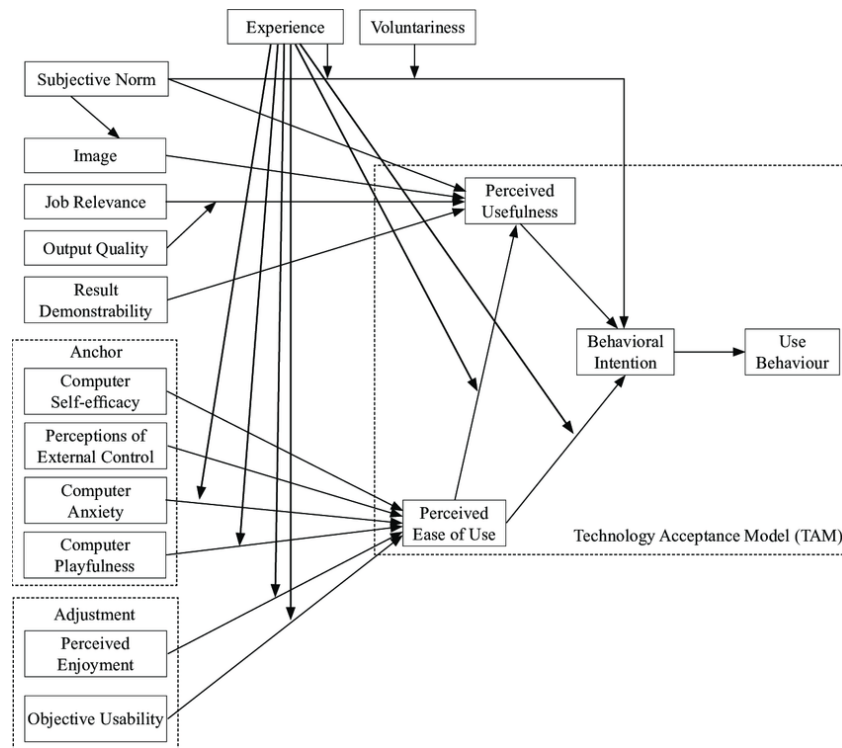


Figure 2.8: Technology Acceptance Model 3 (Venkatesh et al., 2008)

2.3.1.5 Overview of Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) is an integrated model proposed by Venkatesh et al. in 2003. Being one of the original researchers of the TAM model, Venkatesh integrated the variable concepts of the TAM model into the UTAUT model. Consequently, in understanding the development and evolution of the TAM model, the UTAUT model is also considered an essential improvement and extension of the TAM model. The UTAUT model merges the TRA, TPB, Motivational Model (MM), Combined TAM and TPB (C-TAM-TPB), Innovation Diffusion Theory (IDT), and Social Cognitive Theory (SCT). The UTAUT model explores the factors that influence user cognition (Venkatesh et al., 2003).

Integrating the propositions of eight models, the UTAUT model condenses them into four key dimensions: performance expectancy, effort expectancy, social influence, and facilitating conditions, along with four moderating variables: gender, age, experience, and voluntariness (Botha, 2023).

Performance expectancy refers to an individual’s perception of the benefits of using this technology for their work or personal growth, akin to the perceived usefulness in the TAM model. Effort expectancy pertains to the extent of effort an individual believes is required to use this technology, similar to perceived ease of use in the TAM model (Abbad, 2021). Social influence encompasses subjective norms, social factors, and public image. Facilitating conditions encompass the assistance or guidance an individual receives when using technology.

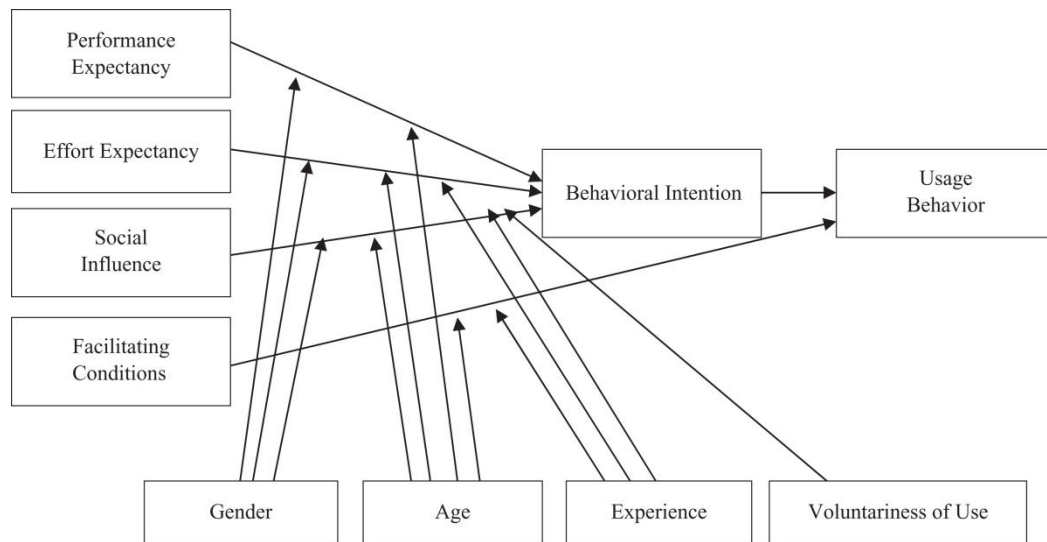


Figure 2.9: Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003)

The UTAUT2 model, an extension of the UTAUT model, was proposed by Venkatesh et al. in 2012. Its primary focus is to explain and predict user adoption and usage of novel technologies (Venkatesh et al., 2012). While retaining the four principal variables of the

UTAUT model, the UTAUT2 model introduces three novel variables: hedonic motivation, price value, and habit (Tamilmani et al., 2021). Hedonic motivation pertains to the pleasure users experience from using technology, serving as a positive driving force. Price value implies that users consider the cost and benefits of technology use, determining whether the advantages outweigh the costs. Habit is the simplest to understand, signifying whether users are already accustomed to using a particular technology (Nikolopoulou et al., 2020).

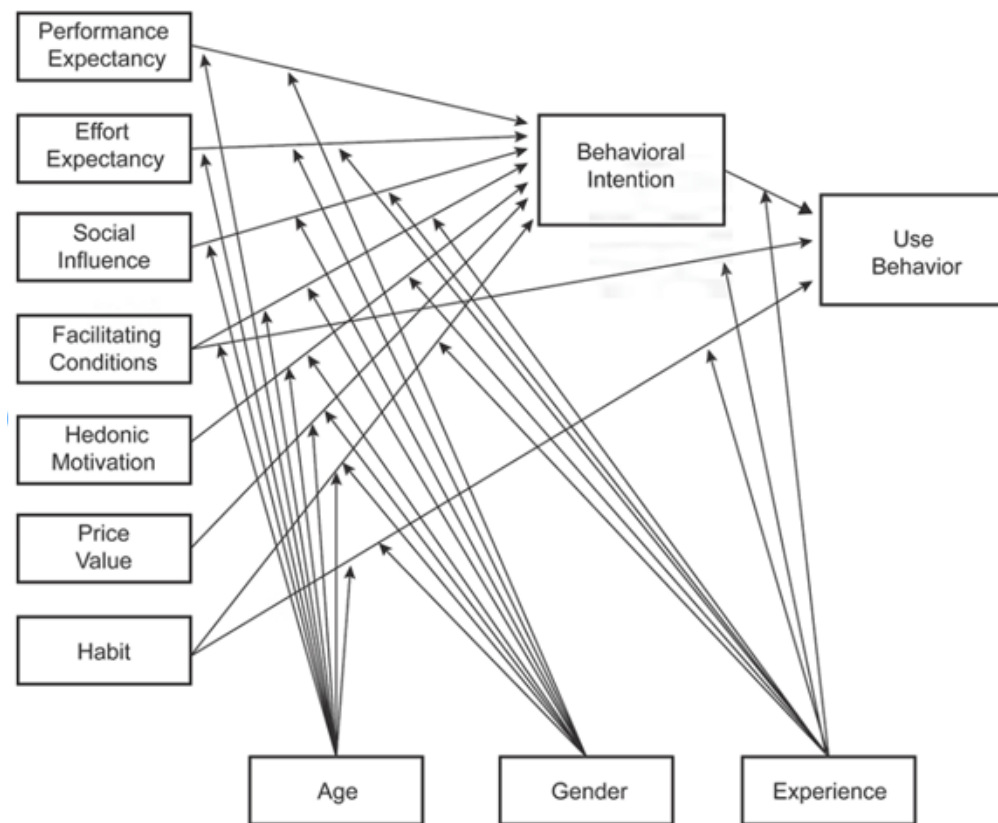


Figure 2.10: Unified Theory of Acceptance and Use of Technology2 (Venkatesh et al., 2012)

The UTAUT2 model is an extension of the UTAUT model and is particularly well-suited for examining user intentions to accept and adopt new technologies. Compared to the UTAUT

model, the UTAUT2 model boasts enhanced predictive capabilities and has received empirical support (Eneizan et al., 2019). Empirical findings demonstrate that the UTAUT2 model's explanatory capacity for usage behaviour surpasses 70%, surpassing the effectiveness of any known model.

Although the UTAUT2 model has been widely applied in explaining and predicting technology acceptance behavior, it still has some limitations and drawbacks. For example, the complexity of the model: the UTAUT2 model includes multiple variables such as performance expectancy, effort expectancy, social influence, etc., which increases the complexity of data collection and analysis. This means that if this study adopts the UTAUT2 model, it must ensure a sufficient quantity of data samples collected. There are also issues with theoretical comprehensiveness. Venkatesh et al. (2012) used samples from multiple countries in their original study, demonstrating the model's application in different cultural contexts. The UTAUT2 model integrates multiple theoretical frameworks, enhancing its explanatory power and showing a certain universality and applicability across various cultural backgrounds. However, it also requires strategic adjustments based on the specific research content and the characteristics of the target culture. Different studies may need to adjust or simplify the model to fit specific research goals and environments.

This study has deeply understood the TAM model through its evolutionary analysis. Furthermore, by comprehending and studying other models, this study posits that the UTAUT2 model, an extension of the TAM model and integrating multiple models, exhibits robust predictive capabilities and comprehensive attributes. Consequently, this study will feature the

UTAUT2 model in its theoretical framework, opt for the most suitable theoretical structure following a comparison with other theories, and subsequently extend and apply it further.

2.3.2 Field Theory

Field Theory was introduced by the social psychologist Kurt Lewin in the 1940s. He emphasised that human behaviour is shaped by the complex interaction between the individual and the environment, which forms a life space or field (Lewin, 1942).

The essence of Field Theory suggests that an individual's life space contains a multitude of forces that can propel them to transition from one state to another (Hammer et al., 2020). These forces can emanate from environmental elements (social norms, the influence of others' behaviour) and individual factors (desires, needs) (Raimbault & Joly, 2021). Field Theory has also been important in human-computer interaction and user experience design. For instance, researchers employ Field Theory to comprehend user needs, motivations, and the interactive environment where the user and technology intersect to grasp user behaviour (Bufacchi & Iannetti, 2018; Hewstone & Stroebe, 2021).

Deng et al. (2023) provide their explanation and understanding of human behaviour and experience in two theories, one of which is Field Theory. The researchers believe that museum visitors engaging with VR technology are inevitably influenced by environmental factors from the museum's exhibition space, the interactive device's setting, and the impact of companions. Field Theory can assist researchers and has produced noteworthy research outcomes.

Despite some criticism, Field Theory provides an important framework and guidance for understanding and studying individual behaviour. It has provided theoretical direction for

numerous researchers in their subsequent research endeavours, and its ongoing development has influenced the formulation of numerous other theories. Examples include the Human-Task-Technology-Environment Model and the Person-Environment-Behaviour Model. Many researchers investigating user behaviour have acknowledged the relationship between their established variables and Field Theory.

This study aligns with Field Theory and, similarly to Deng et al. (2023), contends that diverse factors will impact museum visitors employing VR technology. Within the ambit of environmental factors, visitors' choices may be influenced by the location of the museum exhibition hall, the surroundings of the VR device, encouragement from companions, and the atmosphere. This study asserts that museum visitors use VR technology devices when environmental stressors are minimised or when companions actively motivate engagement. The influence of environmental factors warrants serious consideration from researchers.

2.3.3 Cognitive-Emotional-Behavioural Theory

Cognitive-emotional-behavioural theory provides a framework for understanding individual behaviour, highlighting the interaction between cognition, emotion, and behaviour. (Allen & Lewis, 2020). The Cognitive-Emotional-Behavioural Theory argues that these three components are interconnected. The cognitive aspect can influence the emotional state, and the emotional response can impact user behaviour. Conversely, an individual's behaviour can also affect their emotions and cognitive processes. This theory emphasises the dynamics and evolution of individual factors (Rina et al., 2021; Faghani et al., 2020).

Alongside Field Theory, Deng et al. (2023) integrated another theory into their research: the Cognitive-Emotional-Behavioural Theory. The researchers contend that a visitor's

fundamental cognition and emotional evaluation influence behavioural intentions, tendencies, and preferences. Individuals initially formulate a perception of the technology, and these perceptions subsequently lead to shifts in attitudes and emotions towards the technology, ultimately driving action guided by cognition and emotion (Rodrigues & Ferreira, 2018). Furthermore, some researchers have constructed a cognitive-emotional-behavioural structural equation model based on this theory to explore the impact of visitors' cognitive and emotional assessment of poetry culture on their behavioural intentions (Luo et al., 2021).

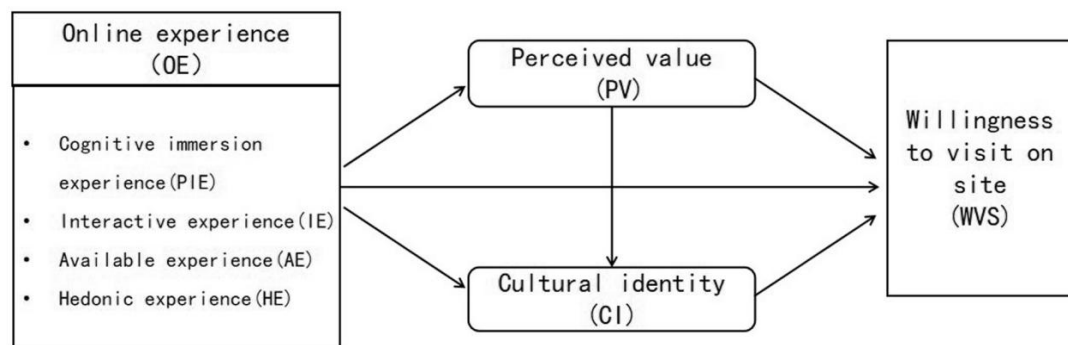


Figure 2.11: Deng et al.'s model (Deng et al., 2021)

To date, no existing research specifically explores the application of the Cognitive-Emotional-Behavioural Theory in examining the behavioural intentions of museum visitors toward VR technology. While this theory offers a conceptual framework for understanding and addressing various mental health issues, it has certain limitations within this research field. Notably, this theory places excessive emphasis on individual psychological cognition and emotional shifts, often disregarding the impact of external environmental factors on individuals. Consequently, it becomes evident that researchers like Deng et al. (2023) have fully addressed

this concern by incorporating Field Theory to consider external environmental influences while simultaneously integrating the Cognitive-Emotional-Behavioural Theory to encompass individual factors related to tourists. This fusion of theories offers a more comprehensive approach to elucidating the behavioural intentions of museum visitors towards digital technology. In this study, it becomes imperative to precisely define the research objectives and assess whether the chosen theory ensures the breadth and precision required for the investigation. Furthermore, the study will delve into the necessity of potentially employing two or more theories in a complementary manner to facilitate a cross-disciplinary analysis.

2.3.4 Stimulus-Organism-Response Theory

The Stimulus-Organism-Response Theory was originally proposed by the Russian physiologist Ivan Pavlov (Le & Chau, 2023). This theory provides insights into user behaviour and underscores the relationship between external environmental stimuli, an individual's internal cognitive processes, and resultant behavioural responses (Wu et al., 2021). Stimulus refers to any element encountered by an individual within their environment, encompassing natural physical factors (e.g., sound, light, visual colour) and social human influences. These factors exert an impact on an individual's sensory perceptions and experiences. Organism refers to the internal perceptual processes within an individual, which constitute the internal representation of stimuli. This element functions as a connection between the individual and the eventual response. The term response denotes the behavioural manifestation an individual displays following exposure to stimuli. This manifestation may encompass motor actions (such as touch, movement, and conversation) or internal reactions (alterations in emotions and thoughts) (Karedza & Sikwila, 2017). The S-O-R model predominantly finds application in the

realm of consumer behaviour analysis. This model posits that consumers, upon encountering stimulation (e.g., marketing strategies, product appearance, pricing), generate an organismic response (such as a desire to purchase, curiosity, or aversion), leading to actions such as making a purchase, investigating deeper into product understanding, or choosing not to purchase (Kumar et al., 2023; Dua, 2023; Kim & Lennon, 2013).

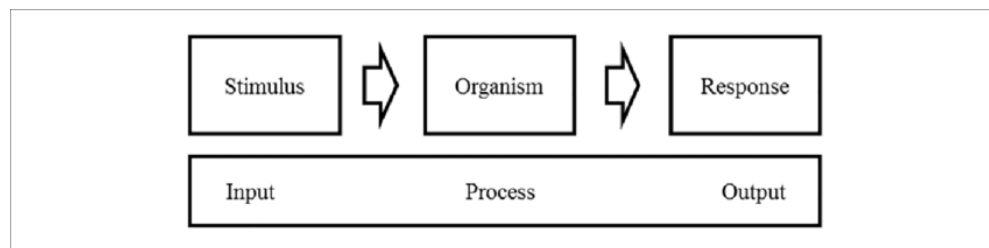


Figure 2.12: S-O-R model (Jacoby, 2002)

A few researchers have employed the Stimulus-Organism-Response Theory to explore the intentions behind museum visitor behaviour. For instance, Wang (2023) combined the S-O-R theory with the mind theory, giving rise to the Hedonic Motivation System Adoption Model (HMSAM), featuring four variables (flow experience, display method, proficiency, and behavioural intention). This study utilised renowned artworks such as *Starry Night* and *Water Lilies* in VR scenarios, employing the model to scrutinise the behavioural intentions of museum visitors towards such VR designs.

A focal point was the psychological response elicited by the VR product's display method and its consequent impact on behavioural intentions. Bird et al. (2022) harnessed the S-O-R model to delve into the user experience of museum visitors engaging with AR technology. The researchers posited that immersive technology could evoke positive or negative reactions,

directly influencing visitors' experiences with digital technology. Negative responses often result from cognitive overload, as digital experiences commonly require visitors to acquire new skills. The research conclusions underscored the interconnectedness of cognitive and emotional states with behavioural responses. Kim et al. (2020) deployed the S-O-R theory to validate cognitive and emotional shifts in tourists' VR-based tourism experiences. The findings validated that emotional responses significantly influence tourists' behavioural intentions towards VR technology.

The above exposition underscores the S-O-R's emphasis on dissecting users' cognitive and emotional transformations, highlighting the driving force of emotional shifts in guiding their actions. This underscores the critical import of the emotional nature, whether positive or negative. In this study, the museum visitors' emotional changes can either propel their acceptance and utilisation of VR technology or pose barriers to their behavioural intentions. By reflecting on the abovementioned three articles, this study must consider the impact of tourists' cognition and emotions on their behavioural intentions. Attending to positive emotions (such as delight, curiosity, and joy) and negative emotions (like complexity, fear, and perceived risk) is imperative.

2.3.5 Information Quality Model

The aforementioned theoretical models originated from psychology, except for the Information Quality Model, which originated from information science and information systems (Torres & Sidorova, 2019; Behl et al., 2023). It serves as a theoretical framework for assessing and enhancing information quality. This theory contends that information quality (IQ) is measured across various dimensions, with quality indicators encompassing aspects like

authority, verifiability, coverage, composition and organisation, objectivity, ethics, comprehensiveness, effectiveness, uniqueness, timeliness, and reproducibility (Lukyanenko et al., 2020). This model is dedicated to evaluating the quality of technology or products, such as evaluating an information system (such as a website or interface information). By assessing the information, issues can be identified, and appropriate measures can be taken for improvement. Furthermore, the information quality assessment outcomes can guide redesign decisions to ensure optimal information quality (Ghasemaghaei, M., & Hassanein, 2019).

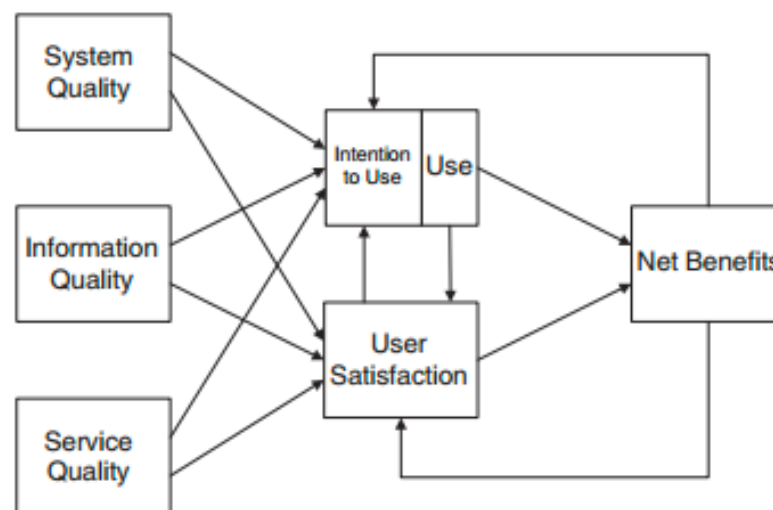


Figure 2.13: Information quality model (Gorla et al., 2010)

Not many researchers in this research field use the Information Quality Model. Su et al. (2023) used this theory to analyse whether VR interactive devices can be used to develop cultural tourism experience systems. They explore users' acceptance satisfaction and subsequently explore and analyse the relationship between information quality, system quality, learning effects, and behavioural intentions. The researchers believe good system quality

(system design) and information quality will make users feel they can get higher value, improving user satisfaction. Zhang et al. (2022) used the Information Quality Theory model and drew inspiration from the Flow Theory. Their study investigated the impact of technical level, information quality, and system quality on the loyalty and satisfaction of millennial intelligent museum visitors. They introduced the flow experience concept as a mediating role in the IS success model. This perspective demonstrates that this researcher pays attention to the impact of system quality and information quality on users, considers users' psychological changes, and believes these three factors are interconnected.

It can be summarised that system quality and information quality can be identified as the performance of the technology or product, which differs from external environmental and individual internal factors. Nonetheless, this study believes that system quality and information quality are key factors that will affect the behavioural intentions of museum visitors towards VR technology, so these two factors will be considered.

2.3.6 Undefined Theory

In addition to the theories mentioned in the previous sections, some articles referenced theories that are not clear. However, the perspectives presented in these articles are intriguing and worth reflecting on. McPhetres (2019) conducted research with Awe as the keyword, positing that Awe is a cognitive emotion of users, which drives people's desire for knowledge and is a positive attitude that affects user behaviour. It can be understood that when museum visitors have the emotion of awe, this emotion will drive visitors to use digital technology. Some articles are based on cases conducted by museum staff or professionals, primarily qualitative

research revolving around the museum user experience (Durmus, 2023; Deng et al., 2023; Bird et al., 2022).

This study augments its comprehension of the research within this domain by summarising the theories or models embraced within published articles. These summaries provide profound inspiration and theoretical guidance, proving invaluable for formulating this study's theoretical and conceptual framework.

2.4 Findings of Tourists' Behavioral Intentions in Using VR Technology

This section summarises the research findings on tourists' behavioural intentions regarding the use of VR technology within this field. By reviewing existing literature, we gain insights into the conclusions drawn by researchers in the same research domain. The researcher explores the primary factors influencing tourists' behavioural intentions towards VR technology and considers whether to add or remove any factors in developing an extended model in subsequent sections. Furthermore, we pay attention to the research conclusions in these articles, which we will later compare and discuss with the empirical results of this study to provide more comprehensive and accurate research findings. Based on previous research literature, the most commonly mentioned factors affecting tourists' behavioural intentions towards VR technology are perceived usefulness, perceived ease of use, social influence, information quality, and system quality.

2.4.1 Perceived Usefulness and Perceived Ease of Use

Perceived usefulness can be understood as how museum visitors assess the practical value and functionality of VR technology or VR systems. It refers to users perceiving the

benefits and value they receive when using VR technology. Researchers in this field believe that when tourists have a positive perceived usefulness, i.e., they believe that using VR technology is beneficial, they are more likely to lean toward this digital technology (Maziriri et al., 2023). The concept of perceived usefulness finds broad application and interpretation in various information systems and technology acceptance theories or models. For instance, in the Technology Acceptance Model (TAM), perceived usefulness is a core component, directly affecting users' attitudes and intentions (Li et al., 2019). The TAM model suggests that when users believe a new technology can improve their work efficiency, they are more willing to accept and use it. In the Unified Theory of Acceptance and Use of Technology (UTAUT), perceived usefulness is incorporated into a more comprehensive and complex framework (Dwivedi et al., 2019). UTAUT regards perceived usefulness as performance expectancy, involving users' expectations of the benefits and improvements when using a particular technology, which is one of the key factors affecting user acceptance and usage (Ammenwerth, 2019). In the Information Systems Success Model, perceived usefulness is a factor that, along with other factors like system quality and information quality, influences users' overall evaluation of the system and its acceptance. Perceived usefulness is, therefore, applicable in the study of museum visitors' behavioural intentions regarding VR technology and plays a significant role in this context.

Perceived ease of use refers to users' belief that using a certain technology or system does not require much effort or time. Like perceived usefulness, perceived ease of use finds wide application in many models and theories. For instance, in the Technology Acceptance Model, perceived ease of use is a critical factor, apart from perceived usefulness, which directly

influences users' acceptance and usage intentions (Tahar et al, 2020). Similar to the TAM model, UTAUT, the Information Systems Success Model, and the Theory of Planned Behavior also incorporate perceived ease of use as a key factor influencing user acceptance and behavioural intentions. It relates to performance expectancy in the UTAUT model and the concept of perceived behavioural control in the Theory of Planned Behavior (Huang, 2023). In the Diffusion of Innovation theory context, perceived ease of use can be seen as an important factor affecting the speed of innovation adoption (Al-Rahmi et al., 2019). If new technology is easy to use, it is more likely to be adopted and diffused rapidly.

The previous research findings show that perceived usefulness is the most frequently mentioned factor. Most researchers name this variable directly when constructing their models (e.g., Wu, 2022; Parra, 2019; Errichiello et al., 2019; Bachiller et al., 2023; Wu, 2021). Some articles, while not naming the variable as perceived usefulness or perceived utility, tend to describe it in terms of perceived usefulness (e.g., Jonathon & Mcphetres, 2019; Cheng, 2021).

Perceived ease of use is also frequently mentioned, and nearly all articles emphasise the importance of both perceived ease of use and perceived usefulness as core variables. Some articles mention technological ease of use or technical quality, which are inspired by the concept of perceived usefulness and adapt it to fit their specific research (e.g., Shehade, 2020; Parra, 2019; Jiang et al., 2022). Perceived ease of use pertains to how tourists perceive the ease of understanding and operating digital technology. Researchers believe that when tourists have a positive perceived ease of use, meaning they feel they can easily master and understand digital technology, they are more likely to accept and use it.

The researchers mentioned above consider perceived usefulness and perceived ease of use to be critical factors influencing tourists' behavioural intentions towards VR technology. These concepts are more inclined to tourists' cognitive psychology and cognitive feedback, which can be understood as internal individual factors. Some authors also focus on the influence of psychological cognition. Psychological cognition is understood as an internal factor in tourists, but different authors have slightly different interpretations of this concept. They primarily focus on whether tourists generate psychological cognition before using digital technology or during the usage process and how their post-usage psychology may influence whether they use the technology repeatedly or continuously. Rhee (2019) and Jonathon & Mcphetres (2019) mention concepts such as curiosity, awe, and pleasure motivation occurring before tourists use digital technology, which drives tourists to use the technology actively. Some researchers consider presence as a feeling tourists experience when they feel like they have entered a high-quality virtual environment. The feeling of being present in the virtual environment promotes positive experiences and comfort during usage, thereby enhancing tourists' behavioural intentions (Durmus, 2023; An et al., 2021). With positive psychological cognition, there are also negative forms. Gongbo (2022) explains it as perceived risk and hypothesises that perceived risk negatively affects tourists' use of AR technology. The hypothesis is supported by data analysis. In other words, if museum tourists perceive that VR technology carries risks and develop negative psychological cognition, it hinders their behavioural intentions to use VR technology.

Therefore, this study needs to consider the influence of both positive and negative psychological cognition on tourists' behavioural intentions towards VR technology and

incorporate these concepts into the extended theoretical model. It is also necessary to make preliminary assumptions about the impact of perceived usefulness, perceived ease of use, and positive and negative psychological cognition on tourists' behavioural intentions regarding the use of VR technology in museums

2.4.2 Social Influence and Peer Influence

According to past research, tourists' behavioural intentions at museums are influenced not only by personal cognitive factors but also by social influence and peer influence (Elgammal et al., 2020; Wang et al., 2019). Social influence and peer influence involve how individuals are affected by social factors and the behaviour of others (Hu et al., 2019). These factors may include social structures (such as digital economic conditions and digital economic development), social relationships (the influence of family, friends, and colleagues visiting together), and the environmental context (museum exhibition environments and ambience), among others.

Regarding these influencing factors, especially in articles referencing Field Theory theory, researchers emphasise the significance of environmental factors. For example, Deng et al. (2023) focused on the impact of environmental factors on museum tourists' behavioural intentions to use VR technology. They concluded that environmental factors influence museum tourists to use virtual display technology.

2.4.3 Information Quality and System Quality

Information quality and system quality are frequently mentioned. In this study, information quality is understood as whether virtual reality products possess information

accuracy and richness, interface quality, and information guidance. This covers the quality requirements of both hardware and software of virtual reality technology products and the design of interface guidance. Shehade (2020) believes that if the aesthetics and image quality of VR interface design are low and the interface guidance design is poor, tourists may develop negative emotions, affecting their perceived usefulness and perceived ease of use, ultimately leading to negative impacts on behavioural intentions. Additionally, Hammady et al. (2021) and Parra (2019) argue that when the interface design is not aesthetically pleasing or is complex, interface guidance serves as a tour guide to instruct older and novice tourists, calming tourists' psychological state. Furthermore, in an article by Sundar et al. (2016), navigability is mentioned, which can also be understood as a component of information quality. This issue can have a negative impact on museum tourists' use of VR technology.

From the perspective of design psychology, high-quality information design or system hardware support can provide tourists with accurate, aesthetically pleasing, and easily understandable information (Bodker, 2021), enabling them to grasp and understand quickly and maintain a positive emotional state during use (Johnson, 2020). This factor has strong correlations with other factors, which providing a framework and theoretical reference for this study.

2.4.4 Conclusion

This study acknowledges the importance of tourists' internal factors in using virtual reality technology and believes that the factors mentioned above, such as perceived usefulness, perceived ease of use, and psychological cognition, should all be considered in the UTAUT2

extended theoretical model developed in this study, with replacements, additions, or deletions made based on the UTAUT2 model.

This study believes that social influence and peer influence should also be considered. The relevance of these two influencing factors to the meaning of social influence in the UTAUT2 model needs to be explored better to modify the UTAUT2 extended model applicable to this study. Meanwhile, information quality and system quality, closely related to museum interactive devices, are also crucial. This study believes that when information quality and system quality have a positive impact, they drive tourists' behavioural intentions towards VR technology. Therefore, these factors mentioned above, including perceived usefulness, perceived ease of use, social influence and peer influence, information quality, and system quality, will be further integrated with the UTAUT2 model to determine the independent variables suitable for the extended model developed in this study.

2.5 Research on Behavioral Intentions of Visitors of Different Age Groups

In this relevant field of research, researchers have predominantly focused on young people, especially those with higher levels of education. For instance, Jia and colleagues (2022) used 112 college students as their research subjects, emphasising that the availability of interaction positively impacts the behavioural intentions of these young visitors. In this context, interaction availability refers to visitors gaining skill or emotional value through interaction with new media devices. Jonathon and Mcphetres (2019) researched young groups, investigating whether awe, a cognitive emotion, drives visitors' behavioural intentions towards interactive technology. They concluded that awe is a positive emotion for young visitors, motivating them to use technology by stimulating their curiosity for knowledge. However, the author also

suggests that these influences are not statistically significant while they exist. Rhee (2019) conducted research based on the TAM model with feedback from 50 college students, and the conclusion of the article shows that perceived usefulness and perceived ease of use are important influencing factors for visitors' behavioural intentions, and technological suitability did not receive positive feedback.

Most researchers choose young people as research subjects primarily because they believe that VR technology is an emerging technology and is more likely to be accepted by young people due to their living and learning environments surrounded by new media technologies. Furthermore, young people are often more technologically proficient and adaptable than other age groups, displaying a positive attitude toward VR technology.

However, using young visitors as research subjects has limitations. This study believes that museum VR technology should be designed for visitors of all age groups. Nevertheless, the aforementioned researchers (Rhee, 2019; Jia et al., 2022; Jonathon & Mcphetres, 2019) only chose young visitors as their research subjects, which may compromise the accuracy of their analytical results. Therefore, this study suggests that research subjects should encompass visitors of different age groups to analyse their differences.

Some authors have also recognised this point, with some studies having a broader age range for their research subjects, considering both young and older populations. For instance, Parra (2019) had a study with 50% young and 50% older participants. The conclusions show they are influenced by perceived usefulness, ease of use, and information quality. However, despite similar performance, the author found that increasing age has a negative impact on performance in simulation tasks. Older individuals rely on more cognitive resources and often

experience confusion because advanced technology hinders their navigation abilities. Hammady and colleagues (2020) extended their research subjects to ages 18-25, 26-40, and 41-60. They studied the differences in the “Museum Eye” MR technology for users in each age group. The study found that perceived usefulness, ease of use, and information quality impact users of all age groups.

Furthermore, the authors also discovered that information guidance provides the application's usefulness, influencing visitors' future usage intentions. More importantly, as people age, they require more guidance or assistance in their operations. Sundar and colleagues (2015) described the importance of technological navigability as a critical factor influencing visitors' behavioural intentions, especially for older visitors.

From the studies mentioned above, it is evident that perceived usefulness, ease of use, and information quality significantly influence the behavioural intentions of visitors across various age groups. Information navigation is an influential factor, which can be understood as a tool in VR that helps visitors with location, exploration, and operation. This study considers information navigation an important aspect of information quality. It can be optimised through technological hardware and information interface design to make it easier for visitors, particularly older ones, to understand information and technical operations. Once this issue of information navigation is addressed, it can indirectly enhance the ease of use for older visitors and reduce the gap in technology adaptation between older and younger visitors.

Hence, it is clear that differences exist in the behavioural intentions of visitors of different age groups, and these variances relate to the different growth environments, levels of familiarity with VR technology, and emotional cognition across age groups. In general,

perceived usefulness, ease of use, social influence, and information quality affect visitors' behavioural intentions. However, specific differences in how these influencing factors affect visitors of different age groups require further attention. For instance, there are generational differences in information navigation. Therefore, this study will consider expanding the age range of research subjects and examining the differences in the behavioural intentions of visitors from different generations.

2.6 Previous Literature Gap

2.6.1 Lack of Theoretical Development

This section provides an overview of the theories most commonly employed by researchers in this field. Among these, literature grounded in the TAM predominates, followed by the S-O-R and the Information Quality Model. However, theories like the Cognitive-Emotional-Behavioural Theory and Field Theory exhibit certain limitations. When investigating the behavioural intentions of museum visitors towards VR technology, it becomes evident that these models may not encompass an adequate range of aspects or dimensions, lacking comprehensive coverage. Naturally, some researchers acknowledge this limitation and integrate other theories into their research designs to validate their findings, including multiple theories within their studies.

Nonetheless, this study also recognises certain limitations within the TAM theoretical model. While the TAM model boasts widespread and highly applied application, it predominantly centres on the two important variables of perceived usefulness and perceived ease of use, which tend to focus more on individual internal factors or perceptions. However, addressing individual internal factors fails to provide a comprehensive perspective. The TAM

model has not fully encompassed all important factors and variables, a limitation also noted by numerous researchers (Malatji et al., 2020). Reflecting on prior research, it becomes evident that individual internal factors represent only a portion of the elements influencing the behavioural intentions of museum visitors. Additional factors exist, such as environmental external factors and information quality and system quality. Consequently, researchers often supplement the TAM model with multiple variables, expanding the traditional two-variable TAM model to encompass four, five, or even six variables, enhancing its complexity while augmenting its comprehensiveness.

In response to this theoretical limitation, the current study is contemplating whether to expand the TAM model following the methodologies of prior researchers or to identify a theoretical framework similar to the TAM model but possessing greater comprehensiveness. This study aims to identify relevant variables by analysing preceding literature, aligning them with the research theme, questions, and objectives, and selecting appropriate research methodologies and analytical tools.

2.6.2 Data Gap

Based on the research findings from previous literature, there is a lack of cross-generational studies, with no known studies having undertaken cross-generational research. Most researchers primarily survey college students or young individuals, resulting in a dearth of research concerning elderly tourist groups. Since museums serve as public service venues, the range of ages among groups visiting for educational and leisure purposes is extensive. Only a small fraction of researchers have mentioned that the utilisation behaviour of older adults to VR technology is less proficient. Parra (2019) conducted an experiment involving 22 young and

22 older adults performing multiple tasks. The conclusion was that older adults exhibited inferior usage behaviour compared to their younger counterparts and relied more heavily on cognitive resources. Several other researchers have also indicated that the mobility and comprehension abilities of the elderly lag behind those of the younger population, suggesting that their needs and behavioural traits should be considered during design (Iancu & Iancu, 2020; Mannheim et al., 2019). A commonly held perception among researchers is that middle-aged and older museum visitors find it more challenging to embrace digital technology than their younger counterparts. However, existing literature fails to provide definitive evidence of uniformity in every influencing factor. There is a gap in past literature when contemplating cross-generational tourists' behavioural characteristics and discrepancies.

Age is a significant demographic variable within psychological research (Stone et al., 2020), and it is highly plausible that it impacts the behavioural intentions of museum visitors concerning VR technology. To address this research void, the present study seeks to investigate the influence of age-related attributes on the behavioural intentions of museum visitors. This aspect constitutes one of the primary research focuses. The study will incorporate visitors' age as a moderating variable to explore the disparities in influencing factors across generations of tourists. This approach aims to enable the researcher to attain a more comprehensive and accurate understanding of cross-generational tourists' behavioural intentions towards VR technology and formulate more precise recommendations for improvement.

2.7 Frameworks of the Study

2.7.1 Theoretical Framework

The most frequently cited influencing factors within this field of research are the internal factors of the tourist individual, external environmental factors, and information quality and system quality. The researcher has thoroughly analysed these factors. The initial hypothesis of this study posits that the use of VR technology by museum visitors will predominantly be influenced by individual factors, external factors, equipment quality, and usage experience. The alignment between the three primary influencing factors identified in previous literature, namely the internal factors of the tourist individual, external environmental factors, and information quality and system quality, and the initial hypothesis of this study validates its correctness. This also signifies a positive trajectory in this study's research approach and progression.

The insights obtained from previous literature have been highly advantageous to this study. The data, conclusions, and findings served as motivation. Firstly, these insights aid in refining and expanding the model. The study will concentrate on the most frequently mentioned influencing factors highlighted by researchers and investigate how to incorporate them into the extended model. Secondly, when addressing the first research question (What were the main factors influencing the intention of museum tourists in the Guangdong region to use VR technology?), this study will draw on the conclusions of these previous research while integrating them with its findings to address this inquiry. Lastly, in subsequent chapters, this study will compare the findings with previous studies, heightening the accuracy and comprehensiveness of the conclusions.

This theoretical framework integrates insights from previous literature with the study's overarching theme, research questions, and objectives. The UTAUT2 model is adopted as the foundational theoretical framework. By integrating additional literature, the study adjusts the

independent and mediating variables of the UTAUT2 model to create a theoretical framework tailored to this study's context. The following three reasons substantiate the choice of the UTAUT2 model:

The UTAUT2 model closely aligns with the trajectory of this study. Evolved from the TAM model, TAM2 model, TAM3 model, and UTAUT model, UTAUT2 seamlessly integrates eight diverse models and theories (TAM, DOI, TPB, SCT, MPCU, MM, EMPT, and SIT models) to predict and elucidate individuals' technology adoption. This model is ideally suited for investigating museum visitors' behavioural intentions towards VR technology. It validates this study's hypotheses and facilitates the comprehension of user behaviour intentions. This model is valuable with its robust predictive capacity and comprehensive coverage of various factors.

The UTAUT2 model encompasses an all-encompassing perspective and variables. The foundational variables of the UTAUT2 model encapsulate the three focal factors of individual factors, external factors, and usage experience central to this study. Compared to other theories, the UTAUT2 model's variables encompass user perceptions, environmental influences, information quality, and more. This aligns with other literature's conclusions and findings and underscores the model's comprehensive and explanatory standpoint (Fithriya et al., 2019). The UTAUT2 model's adaptability is noteworthy; this study will adapt and extend it to suit its specific research questions and objectives.

This study utilises the moderating variables within the UTAUT2 model for research purposes. The moderating variable age in the UTAUT2 model aids this study in addressing the second research question (Were there generational differences in the main factors influencing

tourists' behavioural intentions?). During subsequent data collection, age groups will be deliberately formed to furnish important data for ensuing data analysis.

Thus, the UTAUT2 model is selected as the foundational theoretical framework. The study further customises the model to align with its content, research questions, and objectives (Figure 2.14). Detailed explanations of the model variables will follow in subsequent sections.

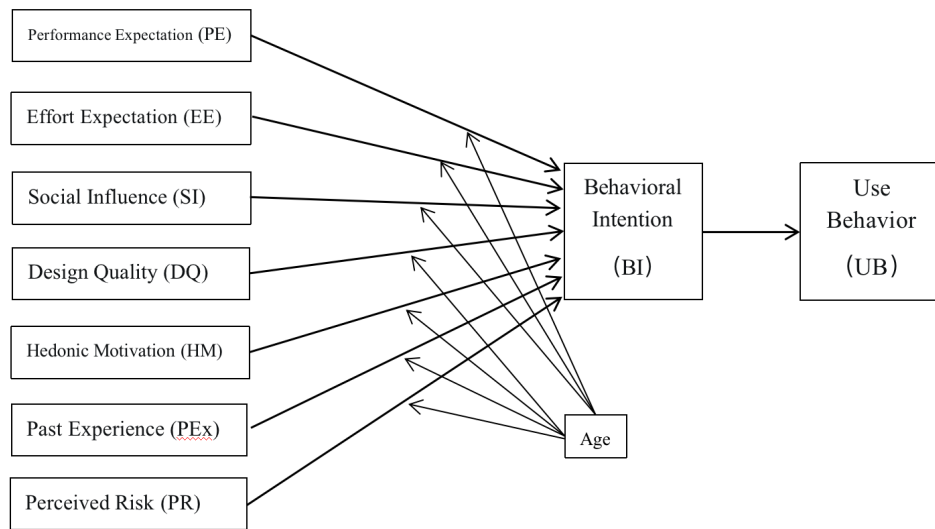


Figure 2.14: Extended model of museum visitors' intention to use VR technology

2.7.2 Conceptual Framework

After conducting a comprehensive review of key literature and empirical studies by numerous researchers, this study has discerned that the core variables of the UTAUT2 model offer valuable insights into user usage intentions. Derived from the original UTAUT model, the UTAUT2 model introduces three novel influencing factors, yielding a set of core variables encompassing Performance Expectancy, Effort Expectancy, Social Influence, Facilitating

Conditions, Hedonic Motivation, Habit, and Price Value. The extended model developed herein is designed to address three principal research questions. Firstly, the study investigates key independent variables' significant impact on behavioural intention. Subsequently, it dissects cross-generational museum visitors into distinct age groups to investigate mean differences in key influencing factors. Finally, the study undertakes a comparative analysis between the conclusions drawn from the two stages of data collection, thereby furnishing objective and precise answers to the third research question.

This study tailored the traditional UTAUT2 model by modifying independent and moderator variables. The core variables retained include Performance Expectancy, Effort Expectancy, Social Influence, and Hedonic Motivation. These variables are key in scrutinising museum visitors' behavioural intentions towards VR technology and have been emphasised by most previous studies. The recurring terms system quality and information quality in the related literature are also important, similar to Facilitating Conditions. The integration of information quality and Facilitating Conditions results in the variable Design Quality, which encompasses device environment, hardware support, product interface, and script content.

The extended model incorporates Perceived Risk as a core variable due to literature indicating that it could significantly impact user behavioural intentions. The variable Past Experience supersedes Habit, encompassing the influence of the user's VR education level on behavioural intention. This affects not formal education but the extent of VR technology training or education exposure. Moreover, the variable Price Value is deemed inapplicable to this study. As the technology under examination involves museum VR products accessible to the public,

users' considerations regarding equipment cost and value are relatively marginal, warranting its exclusion.

The conventional set of gender, age, experience, and voluntariness is revised, with age as the singular moderator variable. Firstly, gender is omitted as it does not provide moderator influence on museum visitors' usage of VR technology. The gender ratio and identity hold no bearing on the behavioural intentions of visitors. Secondly, voluntariness refers to the freedom of choice in adopting a technology. Given that this study does not enforce the usage of VR technology, visitors are free to choose whether to experience it or not, rendering voluntariness a factor of marginal influence. Thirdly, experience parallels past experience, introducing redundancy and consequently is excluded from this extended model.

The extended model ultimately encompasses seven variables: Performance Expectancy, Effort Expectancy, Social Influence, Hedonic Motivation, Design Quality, Past Experience, and Perceived Risk. The sole moderator variable is age. These seven variables comprehensively cover individual internal factors, external factors, device quality, and usage experience. This study contends that these variables collectively explain museum visitors' behavioural intentions towards VR technology. The subsequent chapter will define research methodologies and analytical tools based on the extended model's attributes, research questions, and objectives.

2.8 Summary of the Chapter

This chapter primarily presents the current landscape of VR technology's implementation within museums and analyses the relevant literature related to the behavioural intentions of museum visitors towards VR technology. The chapter explores the theories or theoretical models researchers employ in this domain and examines their respective conclusions

and findings. Drawing from a combination of theories and insights from previous literature, a well-suited theoretical framework is subsequently delineated, and a corresponding conceptual framework is formulated.

Throughout this chapter's literature review, an exhaustive process of comparison and assimilation has culminated in selecting the UTAUT2 model as the foundational theoretical framework. This model serves as the cornerstone for further expansion in alignment with the objectives of this study and its research questions. Notable adjustments have been made to the independent and moderator variables to make them more suitable for this study's data collection and analysis requirements.

CHAPTER 3

METHODOLOGY

3.1 Overview

This chapter was based on the theoretical framework and research objectives discussed in the previous chapter, formulating an appropriate research method for this study. This study adopts an explanatory research method based on its research objectives. It aims to explore the main factors influencing the willingness of museum visitors in the Guangdong region to use VR technology and to analyze the differences in behavioral intentions among different generations (Generations X, Y, and Z) and the reasons for these differences. Initially, the study considered using structured questionnaires and statistical analysis methods for testing. The final decision on data collection and analysis methods will be made by referencing the research content of scholars in the same field and based on the theme of this study. The research was divided into two stages according to the objectives, allowing for data analysis. The results of each stage addressed different research questions. In subsequent discussion chapters, this study discussed the empirical results of these two stages and, combined with previous literature findings, proposed methods and strategies to improve tourist behavioural intentions.

After the research methods were determined, this study further elaborated on the steps for data collection, detailing the manipulation of variables, formulation of hypotheses, methods of data collection, participants, and survey timing, among other relevant information. Additionally, before the formal data collection, this chapter conducted a preliminary survey of the respondents. Reliability and validity analyses were performed on a small sample dataset

during this preliminary research phase. Based on the preliminary research results, the questionnaire was purified or modified to ensure that the questionnaire used in the formal survey phase, discussed in the fourth chapter, was valid and accurate for this study.

3.2 Research Design

3.2.1 Research Method

The research method is determined based on this study's topic, purpose, and research questions. Quantitative analysis, a prevalent research approach, employs mathematical and statistical tools to gather and evaluate quantifiable data. It utilises structured and predefined methods to obtain results (Humble, 2020). Quantitative analysis requires establishing hypotheses and using collected data from large samples to determine causal relationships (Mohajan, 2020). Finally, the collected data is quantitatively assessed to reach conclusions.

Qualitative research delves deeply into human behaviour, experiences, opinions, or social phenomena (Keith et al., 2022). This approach leans towards exploratory research, with data often comprising textual content, such as verbal accounts from respondents, interview transcripts, documentation, etc. Data collection techniques include interviews, focus groups, case studies, and document analysis (Merriam, 2015). Finally, the collected data is coded and organised to deduce data conclusions (Lester et al., 2020).

The primary distinction between quantitative and qualitative research is the type of data they yield (Morgan, 2022). While qualitative research produces non-numerical data, quantitative research yields numerical data analysed through statistical methods (Chai et al., 2021). Their data collection techniques, analysis tools, and sample sizes also differ, with quantitative research

typically demanding larger samples (Chalmers & Cowdell, 2021). Although distinct, some studies use a mixed-methods approach, integrating qualitative and quantitative methodologies. However, in this research domain, the mixed-method approach is relatively rare.

Reviewing past literature, most studies in this field employ quantitative analysis, with only a few opting for qualitative assessment. For instance, researcher Shehade (2020) engaged in dialogues with museum staff through interviews, understanding their perceptions of museum users' experiences with VR technology and gathering insights about user demands and the challenges they encounter. Conversely, Durmus (2023) executed case studies on five museum research teams, examining the types, presentation styles, and user perceptions and needs of museum VR technologies. Differences in research methodologies arise due to varying research subjects, contents, and the nature of the collected data.

Revisiting the research objectives of this study: First, it aims to explore the primary factors affecting the behavioural intentions of museum tourists in the Guangdong region. Second, it intends to investigate the intergenerational differences in these influencing factors. Lastly, it proposes methods to enhance visitor behavioural intentions. This study is divided into two stages: the first requires quantifiable data for significant statistical analysis, while the second requires comparing mean values of three quantified datasets. Additionally, this research is grounded in the extended UTAUT2 model, requiring quantifiable data for analysis. Given these circumstances, this study opts for quantitative research analysis to fulfil its design.

3.2.2 Data Collection Methods

Having chosen the quantitative research method, this phase designed data collection methods by the quantitative research approach. The questionnaire survey was a widely used

research method, primarily aimed at collecting vast amounts of standardised data. This data was then encoded and subjected to statistical analysis (Krosnick, 2018). Questionnaire surveys typically involve distributing pre-established questions to a set of respondents. These questions need to be standardised; altering questions or options midway was prohibited. Therefore, there were high standards for the questionnaire formulation, which, viewed from another perspective, implied the high quality of the collected questionnaire responses (Siraj-Blatchford, 2020). Another feature of the questionnaire was that it required a large sample of data. If researchers intended to apply statistical knowledge to data analysis, such as examining significant influences, it was vital to emphasise the quantity of the data sample (Adam, 2020).

From the previous literature, all articles that chose quantitative research methods used questionnaire surveys as their data collection method. These previous studies used questionnaire surveys mainly because they used psychological theoretical models for research. These models need to formulate hypotheses and verify them through data analysis. Some researchers such as Cheng (2021), Jiang et al. (2022), Wu (2022), and Gharibi et al. (2022) all extended the TAM model as the basis for their models, adding multiple variables to verify whether these variable factors had a significant impact on user behaviour. Because the extended model had multiple independent variables and many research hypotheses, if these hypotheses were independent of each other or need to be tested separately, then the researchers need a larger sample size to support statistical analysis. For example, Wu (2022) proposed 11 research hypotheses and collected 265 valid questionnaires, which, compared to interviews, required a large sample size. Also, Zhang et al. (2022) used psychological theory and the Information Systems (IS) success model to collect feedback from 519 Chinese millennials. Yang et al. (2022) aimed to study the

application of intelligent tourism technology in museum experiences and evaluate visitor intentions. They used a questionnaire survey method, and the data were collected from four different museums in four countries, with a total of 365 museum visitor data collected for validating the structural model.

The research theme, purpose, and questions determined the data collection method. As for this study, the research subjects were museum tourists, and it emphasised the age characteristics of cross-generational (Gen X, Y, and Z). The number of samples affected the statistical power, that is, the ability to detect actual effects (differences or correlations), which placed high requirements on the quantity of data samples collected. At the same time, this study was based on the UTAUT2 model for data analysis. This extended model had seven independent variables and 1 moderating variable. The data need to prove the model's validity and accuracy also required a certain quantity of data samples. A sufficient number of samples could provide more accurate results. From this point of view, this study need a large amount of data samples for analysis, and the questionnaire survey data collection method was the most suitable.

A structured questionnaire survey collects data through a series of standardized pre-designed questions. The order and format of the questions remain consistent throughout the survey to ensure that all respondents answer the same questions. This study will design the questionnaire questions based on the research questions, hypotheses, and model variables. Paper questionnaires will be distributed to museum visitors in the Guangdong region, and the data will subsequently be entered into Excel spreadsheets. Finally, the data will be tested using Pls-Smart and SPSS software tools.

3.2.3 Data Analysis Methods and Tools

The methods and tools for data analysis were developed based on the research questions of this study. The research questions are:

RQ1: What were the main factors influencing the intention of museum tourists in the Guangdong region to use VR technology?

RQ2: Were there generational differences in the main factors influencing tourists' behavioural intentions?

RQ3: How might the behavioural intention of museum tourists towards virtual reality technology be bolstered?

This study was divided into two stages for data collection and analysis based on the first and second research questions. Each stage used different data analysis methods and tools based on the guidance of the research question. Considering the first research question, this study proposed hypotheses based on the constructed UTAUT2 extended model, such as the Performance Expectation significantly positively impacting the Usage Intention of museum tourists using VR technology. The purpose of the first stage is threefold: (1) To prove the model's validity, including the relationships between multiple variables; (2) To verify whether the hypothesis held; and (3) To analyse whether the independent variable data had significance on the dependent variable.

The data analysis methods applicable to the first stage mainly included hypothesis testing, regression analysis, and structural equation modelling (SEM). Hypothesis testing is a process of testing research hypotheses through statistical inference (Ong & Puteh, 2017), such as the T-test, which provides a quantitative way to describe the statistical significance of results.

Regression analysis is a prediction model used to study the relationship between two or more variables and to predict the changes driven by one or more variables. SEM is a multivariate statistical analysis method that could simultaneously evaluate multiple regression equations and consider the impact of measurement errors (Lowry & Gaskin, 2014).

In the past literature, researchers used the TAM extension model or S-O-R extension model preferred SEM for data analysis. For example, Gharibi et al. (2022) used a quantitative method and Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyse data when studying the behavioural intention of disabled tourists to accept XR technology. Cheng (2022) used PLS-SEM to analyse the perceived spatial relationship of users to online virtual museum navigation after constructing a research model for validation. Also, Yang & Zhang (2022) used the PLS-SEM and SmartPLS (version 3.3.3) analysis tool, and Su et al. (2023) used the PLS Multi-Group Structural Model for their research.

Coming back to this study, the first stage of this study, like many researchers mentioned above, chose Structural Equation Modeling for data analysis and determined the data analysis method of the first stage as PLS-SEM. The reasons were as follows: First, PLS-SEM could handle multiple variables with complex relationships and explore multiple influencing factors and their relationships, so this feature of PLS-SEM was suitable for this study (Rigdon et al., 2017). Secondly, PLS-SEM was suitable for predicting models, which aligned with the research purpose of this stage. Finally, PLS-SEM had both predictability and interpretability (Shmueli et al., 2019), which predicted and explained which key factors influenced the willingness of museum tourists to use VR technology, which could answer the first research question.

Regarding choosing analysis tools, in referring to the tools used in past literature, the main focus was on SmartPLS analysis software. SmartPLS software has an intuitive graphical user interface and can easily establish and revise models (Sarstedt & Cheah, 2019). This software's features matched this study's needs, so this study chose the SmartPLS data analysis tool for the first stage. The research framework for the first stage (Figure 3.1) was as follows:

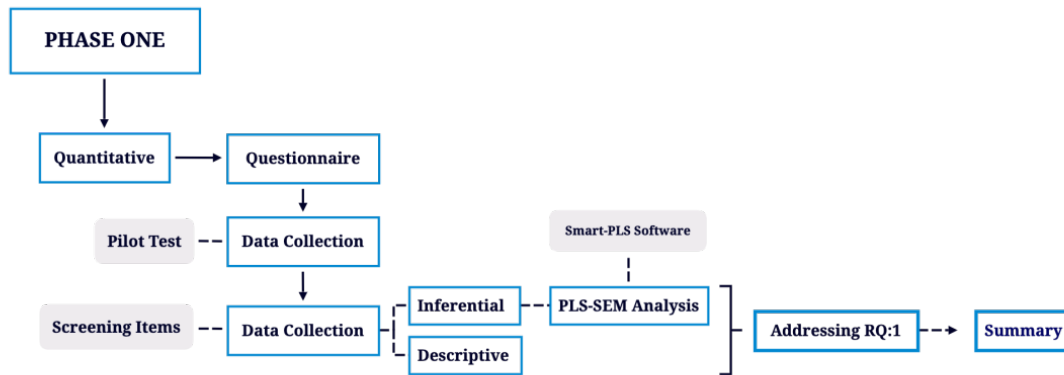


Figure 3.1: Phase I: Research framework diagram

The second stage was to analyse the differences in the willingness of cross-generational tourists to use VR technology. In previous literature research, no studies mentioned or paid attention to this issue, creating a research gap. The author chose one-way ANOVA as the data analysis method based on the data type and research purposes. This statistical method was suitable for detecting whether there were significant differences in the means of three or more independent sample groups (Şahin & Aybek, 2019). This “one-way” can be understood as a classification factor or an independent variable (Mishra et al., 2019). This statistical method could compare the differences in the means of X, Y, and Z generation independent sample

groups for this research stage. Common software included SPSS, Python, etc. This study chose to use SPSS software for analysis. SPSS software, one of the most commonly used statistical analysis software in academia, has powerful functions (George & Mallery, 2019). The interface was straightforward, and the operation was convenient (Amershi et al., 2019). Another reason was that the pre-survey stage of this chapter also used SPSS software to test the reliability and validity of the questionnaire. The research framework for the first stage (Figure 3.2) was as follows:

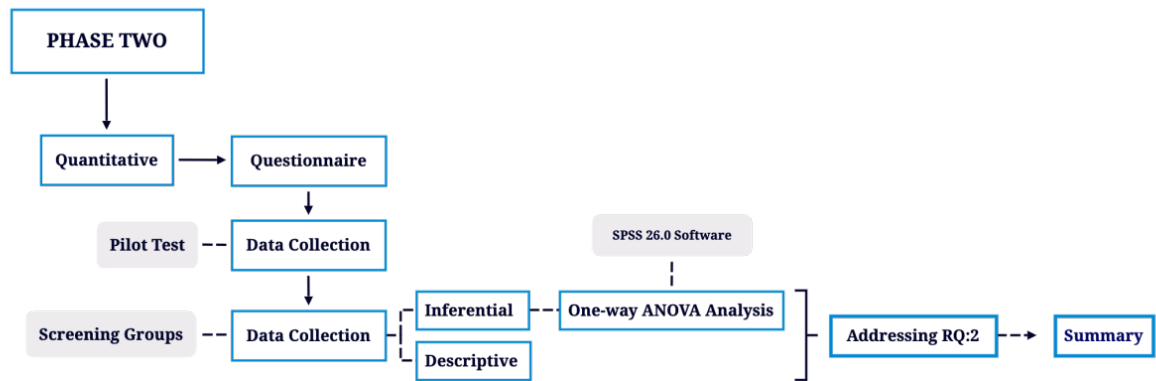


Figure 3.2: Phase II: Research framework diagram

3.3 Location of the Study

The location of this study was the national first-class museums in Guangdong, China, which had VR technology available for visitors. The primary focus was on the Guangdong Maritime Silk Road Museum, a museum with VR technology equipment accessible to tourists for an extended period. Additionally, a small portion of the research was conducted at other national first-class museums in Guangdong that provided VR technology equipment to visitors

during the research period. These museums were designated as national first-class museums by relevant departments in China. They were known for their high visitor traffic and diverse exhibitions, making them attractive to many tourists. Furthermore, compared to other specialised theme museums like art museums or science and technology museums, comprehensive museums appeal to tourists of all ages. This characteristic allowed the study to collect feedback from respondents of varying ages more easily during the questionnaire surveys.

3.4 Population and Sample

This study targeted museum visitors who had experienced VR technology in Guangdong museums. Researchers observed visitors using VR technology and then invited them to fill out paper questionnaires. Before visitors completed the questionnaire, researchers provided basic information about the survey and emphasized the importance of completing it independently to avoid peer influence and ensure data validity. These visitors were categorized by age for questionnaire distribution. Since museum tourists often travel in pairs or groups, the questionnaires were typically completed by groups of visitors. Researchers prioritized targeting group visitors. For example, a family visiting the museum could be divided into three groups for questionnaire completion, each representing the X, Y, and Z generations. This group-style approach also provided more accurate responses to questions about the social impact variable, ensuring the representativeness of demographic data across different generations.

Considering the broad age range of respondents (excluding minors who require adult guidance when using VR technology), participants in this study ranged from 18 to 58 years old. In addition, paper questionnaires were distributed to visitors in Guangdong museums equipped

with VR technology to ensure questionnaire accuracy, especially considering that Gen X visitors might not find online questionnaires convenient.

Since this study was based on the UTAUT2 model and required a comparison of means among three independent sample groups, it required a substantial number of data samples. To ensure data validity, the study aimed to collect at least 150 valid questionnaires from each independent sample group, totalling 450 valid questionnaires. Consequently, the study distributed 200 questionnaires to each independent sample group, amounting to 600 questionnaires to guarantee sufficient valid responses.

In the process of data collection, there may be potential biases, mainly focusing on sampling bias and questionnaire design bias. This study addresses these potential biases with corresponding strategies. For instance, stratified sampling will be used, sampling according to specific strata (Generations X, Y, and Z) to ensure the representativeness of the sample. Structured questionnaires may have issues with poorly designed questions leading to respondent misunderstanding or incorrect answers. This study will conduct a small-scale pre-test of the questionnaire before the formal survey, performing reliability and validity tests. This will help identify and correct any issues. Additionally, clear and concise language will be used to ensure respondents accurately understand the questions, ensuring the validity and reliability of the research results.

3.5 Instruments of the Study

3.5.1 Research Basis

This study extended the foundational UTAUT2 model and introduced a modified model tailored to its investigation into the willingness of museum tourists to adopt VR technology. The study developed hypotheses derived from its research objectives and theoretical framework, with the questionnaire content designed to align with these hypotheses. The expanded model is illustrated in Figure 3.3, and an in-depth analysis of the model variables follows.

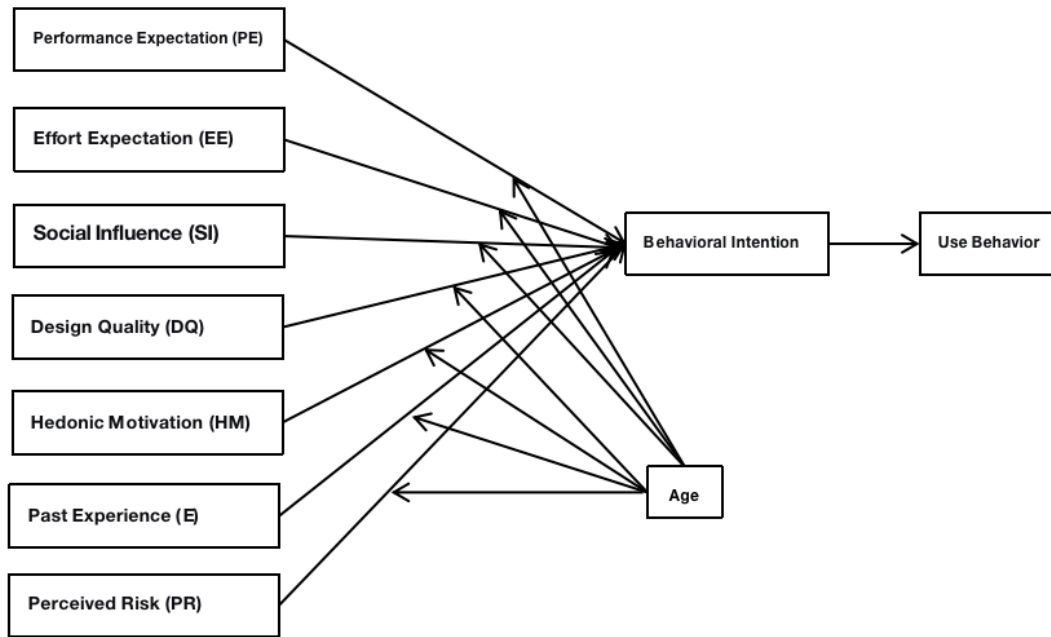


Figure 3.3: Extended model of museum visit intention to use VR technology

The extended model formulated in this study encompasses seven-dimensional variables:

1. Performance Expectancy: This dimension gauges users' beliefs about the technology's ability to enhance their understanding of exhibitions or cultural relics. If museum visitors perceive VR technology as beneficial for deepening their comprehension, they are likelier to use it. Conversely, a negative perception can deter usage.

2. Effort Expectancy: Effort expectancy in this study reflects museum visitors' expectations regarding the ease of learning VR technology. If tourists find VR devices easy to learn and master, they are more inclined to accept and learn this technology. Conversely, resistance is likely if visitors perceive VR devices as difficult to learn.

3. Social Influence: Social influence captures how others and the current environment impact visitors' decisions to adopt technology. For instance, encouragement from friends, family, or the social context can motivate tourists to engage with VR technology.

4. Design Quality: Design quality evaluates whether the design aspects of VR technology meet visitors' expectations. This dimension encompasses hardware compatibility, network performance, interface aesthetics, navigation design, and interactive narratives. An excellent design can positively influence museum tourists' experiences and willingness to use VR technology.

5. Hedonic Motivation: Hedonic motivation taps into users' intrinsic drive for pleasure, satisfaction, and enjoyment. When VR technology offers enjoyable experiences, visitors are likelier to use it due to hedonic motivation.

6. Past Experience: Past experience refers to the accumulated experiences that influence current and future behaviours, perceptions, emotions, and psychological processes. Previous encounters with similar VR products shape visitors' attitudes and intentions regarding museum VR technology.

7. Perceived Risk: Perceived risk represents the subjective expectation of potential loss before using a technology or product. For museum visitors in Guangdong, the concept of museum VR technology is relatively new. Hence, they may assess potential negative

consequences, such as discomfort or anxiety, which can increase perceived risk. Reducing this perceived risk is essential to enhance tourists' intention to use VR technology.

3.5.2 Research Hypothesis

In the first stage of this study, sixteen hypotheses were formulated according to the extended model, and PLS-SEM analysis was performed.

H01: Performance Expectation significantly positively affects the Behavioural Intention of VR technology by museum visitors.

Ha1: Age negatively moderates the impact of Performance Expectation on Behavioural Intention.

This study defines performance expectation as the extent to which museum VR technology enhances visitors' understanding of exhibits and cultural relics. Higher performance expectations are believed to lead to a stronger intention to use VR technology. The influence of performance expectation on usage intention is moderated by age, with the impact diminishing as age increases.

H02: Effort Expectancy significantly positively affects the Behavioural Intention of VR technology by museum visitors.

Ha2: Age negatively moderates the influence of Effort Expectancy on Behavioural Intention.

In this study, effort expectancy reflects how easily museum visitors perceive it when using VR technology. Higher effort expectancy is expected to lead to a stronger intention to use

VR technology. The moderation effect of Age suggests that as age increases, the impact of effort expectancy on usage intention weakens.

Ho3: Social Influence significantly positively affects the Behavioural Intention of VR technology by museum visitors.

Ha3: Age negatively moderates the influence of Social Influence on Behavioural Intention.

Social influence in this study relates to visitors' intentions influenced by peers, friends, or the surrounding environment. The more encouragement and use of VR technology by others in the social context, the stronger the intention to use VR technology is expected to be. However, age moderates this effect, with the impact decreasing as age rises.

Ho4: Design Quality significantly positively affects the Behavioural Intention of VR technology by museum visitors.

Ha4: Age negatively moderates the influence of Design Quality on Behavioural Intention.

Design quality encompasses various aspects of VR technology, such as hardware compatibility, aesthetics, and interface design. Higher design quality will result in a stronger intention to use VR technology. However, age moderates this relationship, diminishing the impact as age increases.

Ho5: Hedonic Motivation significantly positively affects the Behavioural Intention of VR technology by museum visitors.

Ha5: Age negatively moderates the influence of Hedonic Motivation on Behavioural Intention.

Hedonic motivation is linked to the pleasure, satisfaction, and enjoyment museum visitors derive from VR technology. When VR technology is perceived as fun and enjoyable, it is expected to lead to a stronger intention to use it. However, age moderates this relationship, diminishing the impact as age increases.

Ho6: Past Experience significantly positively affects the Behavioural Intention of VR technology by museum visitors.

Ha6: Age negatively moderates the influence of Past Experience on Behavioural Intention.

Past experience refers to how previous experiences and perceptions influence museum visitors' intentions. Positive past experiences with VR products are expected to result in a stronger intention to use VR technology. However, age moderates this relationship, decreasing the impact as age rises.

Ho7: Perceived Risk significantly negatively affects the Behavioural Intention of VR technology by museum visitors.

Ha7: Age positively moderates the influence of Perceived Risk on Behavioural Intention.

Perceived risk relates to negative emotions experienced by museum visitors while using VR technology, such as panic or worry about physical and mental health. When visitors have these negative emotions, their intention to use VR technology is expected to decrease. However, age moderates this relationship, with the impact increasing as age rises.

Ho8: Behavioural Intention significantly positively impacts the Use Behavior of museum visitors.

Ho9: Behavioural Intention mediates the relationships among Performance Expectancy, Effort Expectancy, Social Influence, Design Quality, Hedonic Motivation, Past Experience, Perceived Risk, and Usage Behavior.

In the second stage of this study, based on the extended model, null hypothesis H0 and alternative hypothesis H1 were established for the seven independent variables, and a one-way analysis of variance was conducted.

Null Hypothesis (H0): There is no significant difference in the overall mean of Performance Expectancy among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a significant difference in the overall mean of Performance Expectancy among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no significant difference in the overall mean of Effort Expectancy among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a significant difference in the overall mean of Effort Expectancy among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no significant difference in the overall mean of Social Influence among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a significant difference in the overall mean of Social Influence among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no statistically significant difference in the overall mean of Facilitating Conditions among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a statistically significant difference in the overall means of Facilitating Conditions among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no statistically significant difference in the overall mean of Hedonic Motivation among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a statistically significant difference in the overall mean of Hedonic Motivation among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): No statistically significant difference exists in the overall mean of Prior Experience among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): A statistically significant difference exists in the overall means of Prior Experience among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no statistically significant difference in the overall mean of Perceived Risk among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a statistically significant difference in the overall mean of Perceived Risk among at least two generational groups (X, Y, Z).

3.5.3 Questionnaire Structure

The questionnaire content in this study is designed according to the UTAUT2 extended model of this study and the purpose of the research, ensuring the validity and accuracy of the questionnaire questions for this study and facilitating subsequent data analysis. The title of this research questionnaire is “Questionnaire on Behavioural Intentions of Museum visitors about

VR Technology Utilization”. In the introductory section of the questionnaire, the purpose of this study and the researcher’s identity are briefly introduced, and the scoring method for the questionnaire is also explained. Before the questionnaire is scored, the person distributing the questionnaire needs to verbally explain and elaborate on the content of this study to the participants. Participants receive the informed consent form for this study. After reading and agreeing to it, they can fill out the survey questionnaire.

The questionnaire is divided into two sections. The first part pertains to the general statistical information of the respondents, collecting details about their age, gender, and the duration of VR technology usage. Age serves as an important moderating variable in the extended model of this study. Special attention is paid to the age question in this study, and the feedback from this question is used to categorise different age groups. If the respondent’s age is not within the range of options provided or fails to answer this question, their responses cannot be used as a basis for data analysis. Such questionnaires will be directly discarded and not included in the data analysis.

The second part is the main axis of the entire survey questionnaire, based on the different dimensions of the extended model and scales validated by domestic and foreign literature. It is mainly divided into eight sets of questions for questioning. Each set of questions corresponds to a variable (this study has seven independent variables and 1 moderating variable). All questions use the Likert five-point scale for measurement (Taherdoost, 2019), encouraging interviewees to make differentiated choices. The answer options are strongly disagree, disagree, neutral, agree, strongly agree, and are recorded as 1; 2; 3; 4; 5 respectively. As a measurement standard, strongly agree represents the highest degree of agreement with the question description, scoring

5 points; strongly disagree represents the lowest degree of agreement with the question description, scoring 1 point. If the respondent does not complete the entire questionnaire or omits parts of this section, their responses are considered invalid. Such questionnaires will also be directly discarded, as they might lead to inaccurate results in the data analysis.

3.5.4 Scale Design

To ensure the reliability and validity of the scale, the questionnaire items in this survey were drawn from established scales used in previous literature (Zu, 2020; Xie, 2012; Mi, 2022). Additionally, considering the specific characteristics of museum visitors using VR technology, the questionnaire items were adapted and modified to make them more contextually appropriate for the research topic.

In the questionnaire, the following key aspects are covered:

1. Performance Expectancy and Effort Expectancy: The questionnaire starts by asking respondents about their expectations regarding the outcomes of using VR technology and the perceived effort required to use it. These questions align with the performance expectancy and effort expectancy variables in the UTAUT2 model.

2. Social Influence: Respondents are asked whether social influence, such as the encouragement or influence of others, affects their use of VR technology.

3. Design Quality: The questionnaire assesses respondents' perceptions of the quality of VR technology from the perspective of museum tourists. This aspect considers hardware, interface design, and overall user experience.

4. Hedonic Motivation: Questions delve into the positive attitudes and emotions that users may experience while using VR technology, focusing on the hedonic motivation variable.

Past Experience: Respondents are asked about their previous experiences with VR technology and how these experiences may influence their current attitudes and intentions regarding its use.

5. Perceived Risk: The questionnaire explores respondents' levels of perceived risk and uncertainty while using VR technology, including any negative emotions they may encounter during its use.

6. Usage Intention: Finally, respondents are questioned about their likelihood of using VR technology in the future. This corresponds to the dependent variable, usage intention, and helps gauge the motivation of museum tourists to use or reuse VR technology.

By addressing these aspects, the questionnaire (Table 3.1) aims to comprehensively capture the factors influencing the behavioural intentions of museum visitors regarding VR technology utilisation while ensuring that the items are contextually relevant to the research topic.

Table 3.1: Questionnaire question scale correspondence

Variables	Number	Items of the scale
Performance Expectancy	PE1	When visiting a museum, I believe using VR technology can effectively enhance my museum experience.
	PE2	Using VR technology can help me better understand the exhibition content.
	PE3	Using VR technology can provide me with more information and knowledge at the museum.
Effort Expectancy	EE1	I believe that with effort, I can learn VR technology.
	EE2	I believe that using VR products only requires learning simple operating methods.
	EE3	I am confident that I can quickly master VR skills.

Table 3.1 continued

Social Influence	SI1	The people around me all support using VR products, and I would consider using them.
	SI2	I think using VR products is a trend, and I will follow the trend to try it.
	SI3	If the people I am with and the people in my environment are using VR products, I would also consider using them.
Design Quality	DQ1	I hope that the information content of VR products is accurate and rich.
	DQ2	I believe that the high-quality graphics and information provided by VR technology make my usage experience more enjoyable.
	DQ3	I believe that the high-quality interface design of VR products makes my usage experience more enjoyable.
	DQ4	I believe the interface guide design of VR products can guide me to operate efficiently.
Hedonic Motivation	HM1	I find using VR products an interesting thing.
	HM2	It makes me feel very happy during the use.
	HM3	Using VR products brings me a sense of curiosity and excitement.
Past Experience	HB1	Using VR products has become a habit for me.
	HB2	Even without others' suggestions, I would choose to use VR products to visit the museum.
	HB3	Past experience can help me use VR technology.
Perceived Risk	PR1	I think there are health risks in using VR products, such as physical discomfort, equipment not being disinfected, etc.
	PR2	I have some worries and fears when using VR products.
	PR3	I always feel that VR products have safety risks, such as losing direction in the real world after wearing VR glasses.
Behavioural intention	BI1	I plan to continue using museum VR products in the future.
	BI2	I am willing to try more museum VR products.
	BI3	I would recommend more people to use it.

Table 3.1 continued

Usage behaviour	UB1	I prefer to go to museums with VR technology.
	UB2	I will continue to use VR products and encourage those with me to use them.
	UB3	I will encourage others to use VR products.

3.6 Pilot Study

3.6.1 Pre-data Collection

Before conducting a formal large-scale data collection, this study conducted a preliminary study to assess the reliability and validity of the survey questionnaire. The aim was to make any necessary adjustments to ensure the effectiveness and accuracy of the subsequent research. The preliminary study initially involved testing the questionnaire, which was designed based on the measurement scale, on a small-scale sample. Statistical analysis tools were used to analyse the data collected from this small-scale study, and further revisions to the questionnaire were made based on the results of exploratory factors.

The participants in the preliminary study were consistent with those in the formal study, targeting museum tourists who had experience using VR technology. Additionally, the study ensured that respondents covered a range of ages, including Gen X, Y, and Z, to maintain the validity of the data. In total, 78 questionnaires were collected during the preliminary study.

The collected data from the preliminary study underwent a descriptive statistical analysis, which is presented in Table 3.2. This analysis likely included measures such as means, standard deviations, and frequency distributions to provide an overview of the responses and initial insights into the variables and their relationships.

Table 3.2: Results of Descriptive Statistics for Small Sample

Sample statistical characteristics	Classification	Frequency	Percentage
Gen	X (1965-1979)	26	33.3
	Y (1980-1994)	28	35.9
	Z (1995-2004)	24	30.8
Gender	Male	43	55.1
	Female	35	44.9
VR takes time	1-5 minutes	32	41
	5-10 minutes	29	37.2
	More than 10 minutes	17	21.8

Based on the data presented in Table 3.2, the sample for the preliminary study is characterised as follows:

1. Age Distribution: Twenty-six participants were born between 1965 and 1979, constituting 33.3% of the sample. Twenty-eight participants were born between 1980 and 1994, representing 35.9% of the sample. Twenty-four participants were born between 1995 and 2004, accounting for 30.8% of the sample. This distribution indicates a balanced representation of three different age groups within the sample.

2. Gender Distribution: There were 43 male participants, making up 55.1% of the sample. There were 35 female participants, accounting for 44.9% of the sample. The gender distribution shows a slight majority of male participants.

3. Time Spent Using VR: Thirty-two participants reported spending 1-5 minutes using VR, constituting 41% of the sample. 29 participants reported spending 5-10 minutes using VR, making up 37.2% of the sample. Seventeen participants reported spending more than 10 minutes

using VR, accounting for 21.8% of the sample. This distribution reflects the varying durations of VR usage among participants, with the majority spending 1-10 minutes.

The preliminary study's demographic composition appears to represent a diverse sample of age and gender, which can be important for subsequent analyses and the generalizability of findings. Additionally, the distribution of time spent using VR provides insights into participants' engagement levels with the technology.

3.6.2 Validity and Reliability of Instruments

In order to ensure the accuracy and effectiveness of the survey, it is crucial to conduct a reliability and validity test on the questionnaire before conducting a formal large-scale data collection. Reliability refers to the consistency and stability of measurement results. The higher the reliability of the questionnaire, the lower the interference from human or other factors on the data, and the more accurate the analysis results presented by the collected data.

In this study, a common measure known as Cronbach's Alpha coefficient is used to measure the internal consistency of the questionnaire and individual questions. The Cronbach's Alpha coefficient, proposed by the American psychologist Lee (1951), is also known as the reliability coefficient, internal consistency coefficient, or a coefficient. The coefficient ranges between 0 and 1. 0 indicates no consistency at all, and 1 indicates full consistency. In social science research, researchers generally set Cronbach's Alpha coefficient standard to 0.7 or higher, indicating acceptable reliability. However, if the coefficient is between 0.5 and 0.7, there may be some problems with the measured items. If the Cronbach's Alpha coefficient is below 0.5, it is necessary to consider revising the scale again.

Furthermore, the Corrected-Item Total Correlation (CITC) is utilised to analyse the correlation between each item and purify and filter the items to avoid multi-dimensionality. The items will be removed if the coefficient value after the item is deleted is higher than Cronbach's Alpha coefficient value of the dimension.

In this study, based on previous research, the Cronbach's Alpha coefficient and the Corrected-Item Total Correlation are used to evaluate the reliability of the questionnaire. It is generally believed that the higher the values of the above two indicators, the better the internal structure consistency of the measured variables. Specifically, when the Cronbach's Alpha coefficient is higher than 0.7 and the Corrected-Item Total Correlation is higher than 0.4, it can be explained that the questionnaire has good reliability.

The reliability test results of the small sample in the pre-survey phase according to the standards of Cronbach's Alpha coefficient and the Corrected-Item Total Correlation are shown in Table 3.3.

Table 3.3: Summary Table of Reliability Analysis for the Small Sample Scale Questionnaire

	CITC value	Alpha if Item Deleted	Cronbach's Alpha
PE1	0.771	0.866	0.894
PE2	0.799	0.844	
PE3	0.809	0.835	
EE1	0.771	0.819	0.877

Table 3.3 continued

EE2	0.776	0.814	
EE3	0.742	0.845	
DQ1	0.673	0.394	
DQ2	0.55	0.480	
DQ3	0.657	0.405	0.641
DQ4	-0.003	0.866	
SI1	0.816	0.835	
SI2	0.759	0.886	0.895
SI3	0.814	0.834	
HM1	0.795	0.843	
HM2	0.766	0.869	0.893
HM3	0.81	0.831	
PEx1	0.796	0.842	
PEx2	0.796	0.830	0.889
PEx3	0.776	0.854	
PR1	0.848	0.794	
PR2	0.758	0.880	0.893
PR3	0.777	0.864	
BI1	0.802	0.797	
BI2	0.731	0.865	0.88
BI3	0.776	0.826	
UB1	0.53	0.183	0.543

Table 3.3 continued

UB2	0.589	0.050
UB3	0.069	0.905

Table 3.4 illustrates the reliability coefficient value of items DQ1 to DQ4 is 0.641 (<0.7), indicating that the reliability of the research data is poor. According to the “item-deleted alpha coefficient”, the reliability coefficient significantly increases after item DQ4 is deleted, indicating that this item should be removed. Furthermore, based on the CITC value, the CITC value corresponding to DQ4 is less than 0.2, indicating that the relationship between this item and the remaining analysis items is weak and requires deletion.

Table 3.4: DQ1-DQ4 Cronbach reliability analysis

	CITC value	Alpha if Item Deleted	Cronbach's Alpha
DQ1	0.673	0.394	0.641
DQ2	0.55	0.480	
DQ3	0.657	0.405	
DQ4	-0.003	0.866	

Additionally, as can be seen from Table 3.5, the reliability coefficient value of items UB1 to UB3 is 0.543 (<0.7), indicating that the quality of the reliability of the research data is poor. According to the “item-deleted alpha coefficient”, the reliability coefficient significantly increases after this item is deleted. Also, according to the CITC value, the CITC value corresponding to item UB3 is less than 0.2, indicating that the relationship between this item and other analysis items is weak. In summary, this item should be deleted.

Table 3.5: UB1-UB3 Cronbach reliability analysis

	CITC value	Alpha if Item Deleted	Cronbach's Alpha
UB1	0.530	0.183	0.543
UB2	0.589	0.050	
UB3	0.069	0.905	

After deleting items DQ4 and UB3, this study again conducted a reliability analysis on the revised questionnaire, as shown in Table 3.6.

Table 3.6: Summary Table of Reliability Analysis for the Revised Questionnaire

	Correction term Total correlation (CITC)	Alpha if Item Deleted	Cronbach's Alpha
PE1	0.771	0.866	0.894
PE2	0.799	0.844	
PE3	0.809	0.835	
EE1	0.771	0.819	0.877
EE2	0.776	0.814	
EE3	0.742	0.845	
DQ1	0.755	0.802	0.866
DQ2	0.697	0.856	
DQ3	0.784	0.775	
SI1	0.816	0.835	0.895
SI2	0.759	0.886	
SI3	0.814	0.834	

Table 3.6 continued

HM1	0.795	0.843	
HM2	0.766	0.869	0.893
HM3	0.81	0.831	
PEx1	0.796	0.842	
PEx2	0.796	0.83	0.889
PEx3	0.776	0.854	
PR1	0.848	0.794	0.893
PR2	0.758	0.88	
PR3	0.777	0.864	
BI1	0.802	0.797	
BI2	0.731	0.865	0.880
BI3	0.776	0.826	
UB1	0.828	.	0.905
UB2	0.828	.	

As seen from Table 3.6, after removing items DQ4 and UB3, all variables' Cronbach's Alpha coefficient are above 0.8, indicating the high quality of data reliability in this study. Regarding the "Cronbach's Alpha if Item Deleted", no significant increase in the reliability coefficient is observed after the deletion of any items. Thus, these items should not be removed. Additionally, the CITC value of all related variable items is above 0.4, suggesting a good correlation among these items and indicating a high-reliability level.

Validity measures the degree to which a measurement tool, such as a questionnaire can accurately measure the concept or characteristics of a scale. Exploratory Factor Analysis (EFA)

is widely used to measure structural validity. It can evaluate multiple measurement results and determine whether they have a stable structure or valid analysis method. EFA and validity are closely related concepts, and EFA is often used to determine the construct validity of a measurement tool, such as a questionnaire.

First, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity should be conducted to determine whether the sample is suitable for subsequent exploratory factor analysis. The KMO value mainly compares the simple correlation with the partial correlation coefficient among items, judging the suitability for factor analysis. KMO values range from 0 to 1. The closer the value is to 1, the greater the suitability for factor analysis. Generally speaking, factor analysis can be performed if the KMO value exceeds 0.6.

Conversely, if the KMO value is less than 0.5, factor analysis may not be suitable for this dataset. Bartlett's test is also a basic indicator used to determine the suitability for EFA. It mainly verifies whether the correlation coefficient between items is significant. The criterion for judging Bartlett's test is to see if the corresponding P-value is less than 0.05 ($P < 0.05$ is significant), indicating suitability for EFA.

The KMO and Bartlett's test of the preliminary research small sample data are presented in Table 3.7. According to the information in the table, the KMO value for the preliminary research questionnaire is 0.720. This value exceeds 0.6, meeting the prerequisite for factor analysis, suggesting that the data is suitable for this purpose. Additionally, the P-value of Bartlett's test for this dataset is less than 0.05, indicating the data's suitability for factor analysis.

Table 3.7: KMO and Bartlett's Test of Pre-survey

KMO and Bartlett's test		
KMO value		0.720
Approximate chi-square		1413.64
Bartlett's test for sphericity	df	325
	p-value	0.000

This study conducts a comprehensive variance explanation after passing the KMO and Bartlett's test. Total variance explanation refers to the percentage of the original data variance explained by all the factors or components extracted in the factor analysis. It helps gauge the explanatory power of the factors within the model for the data. The closer the total variance explanation rate is to 100%, the better the model can align with the data and capture more data information. The total variance explanation rate for the preliminary survey is presented in Table 3.8.

Table 3.8: Variance Explanation Rate Table

Variance explanation rate table									
Eigenvalue			Pre-rotation variance explanation rate			Post-rotation variance explanation rate			
Charac teristic root	Variance explai -ned rate %	Cu mul ative %	Charac teristic s root	Varia nce explai ned rate %	Cumul ative %	Char acteri stics root	Varian ce explain ed rate %	Cumul ative %	
1	6.34	24.385	6.34	24.385	24.385	2.593	9.973	9.973	
2	3.797	38.987	3.797	14.602	38.987	2.578	9.917	19.89	

Table 3.8 continued

3	2.548	9.798	48.786	2.548	9.798	48.786	2.578	9.913	29.803
4	2.176	8.371	57.157	2.176	8.371	57.157	2.569	9.882	39.685
5	1.963	7.549	64.706	1.963	7.549	64.706	2.529	9.728	49.414
6	1.638	6.299	71.004	1.638	6.299	71.004	2.518	9.683	59.096
7	1.314	5.053	76.058	1.314	5.053	76.058	2.458	9.456	68.552
8	1.256	4.83	80.887	1.256	4.83	80.887	2.417	9.297	77.849
9	1.076	4.14	85.027	1.076	4.14	85.027	1.866	7.177	85.027
1 0	0.476	1.829	86.856						
1 1	0.423	1.627	88.482						
1 2	0.36	1.386	89.869						
1 3	0.343	1.321	91.189						
1 4	0.315	1.21	92.399						
1 5	0.297	1.141	93.54						
1 6	0.261	1.002	94.542						
1 7	0.25	0.962	95.504						
1 8	0.19	0.73	96.234						
1 9	0.167	0.641	96.875						
2 0	0.161	0.62	97.495						
2 1	0.147	0.566	98.061						
2 2	0.132	0.509	98.571						

Table 3.8 continued

$\frac{2}{3}$	0.117	0.45	99.021
$\frac{2}{4}$	0.099	0.382	99.403
$\frac{2}{5}$	0.079	0.305	99.708
$\frac{2}{6}$	0.076	0.292	100

Table 3.8 analyses factor extraction and the amount of information extracted by these factors. The table reveals that nine factors were extracted during the factor analysis, with all eigenvalues exceeding 1. After rotation, the variance explanation rates for these nine factors are as follows: 9.973%, 9.917%, 9.913%, 9.882%, 9.728%, 9.683%, 9.456%, 9.297%, and 7.177%. The cumulative variance explanation rate after rotation amounts to 85.027%. This signifies that the factor analysis model effectively explains 85.027% of the variance in the observed data, demonstrating its efficacy. It also underscores that the revised UTAUT2 model is well-suited for this study and possesses robust explanatory capabilities.

Furthermore, guided by the KMO and Bartlett's test outcomes, this study conducted an exploratory factor analysis. Principal component analysis was the primary method employed, and the factors were subjected to rotation using the maximum variance rotation technique. After six iterations, factor rotation was accomplished. Specific results of the rotation matrix can be found in Table 3.9.

Table 3.9: Exploratory Factor Analysis Rotated Matrix Results

Rotated Component Matrix a									
Name	Component								
	1	2	3	4	5	6	7	8	9
PE1	0.866								
PE2	0.877								
PE3	0.857								
EE1							0.826		
EE2							0.849		
EE3							0.862		
DQ1								0.873	
DQ2								0.821	
DQ3								0.911	
SI1						0.882			
SI2						0.835			
SI3						0.907			
HM1					0.854				
HM2					0.838				
HM3					0.841				
HB1		0.88							
HB2		0.898							
HB3		0.87							
PR1				0.891					
PR2				0.82					
PR3				0.842					
BI1			0.925						
BI2			0.844						
BI3			0.859						
UB1									0.89
UB2									0.876

Table 3.9 continued

Extraction Method: Principal Component Analysis.

Rotation Method: Kaiser Normalization Maximum Variance Method.

a The rotation converged after 6 iterations.

3.6.3 Finding

The questionnaire has yielded favourable results in terms of both reliability and validity. A detailed analysis of the pre-survey data revealed that two items within the scale displayed CITC values below 0.4 in the initial reliability assessment. Hence, these problematic items were removed to address this, resulting in a refined dataset. Upon conducting a second reliability analysis on this cleaned dataset, the results demonstrated a Cronbach's Alpha coefficient exceeding 0.8, signifying strong internal consistency of the questionnaire. Moreover, all analytical items exhibited CITC values surpassing the standard threshold of 0.4, confirming the questionnaire's robust reliability.

Furthermore, from a validity standpoint, the factor analysis model elucidated 72% of the total variance, indicating its effective explanation of the primary patterns and structure within the data. Additionally, the convergence of factors following six iterations of rotation suggested improved interpretability of the factors post-rotation. All commonalities corresponding to the research exceeded 0.5, indicating the capacity of these factors to extract valid information.

Overall, the model demonstrates commendable reliability and validity. In this study, further consideration will be given to the theoretical interpretation of these factors, and the model will be subjected to additional verification and measurement. Based on the data analysis conducted, after reliability and exploratory factor analyses and removing non-standard items

DQ4 and UB3, a questionnaire comprising 26 scale items has been finalised as the core content for the forthcoming large-scale data collection. Subsequently, data analysis and interpretation will be carried out

3.7 Ethical Concerns

All processes and methodologies employed in this research have received approval from the Human Research Ethics (Non-medical) Committee of Sarawak University in Malaysia (Approval No: HREC(NM)/2023(1)/35). Before participating in this research, all participants were comprehensively briefed regarding the research's objectives and procedures and their prerogative to discontinue their involvement in the questionnaire at any point. Furthermore, preceding the distribution of the questionnaire, the researchers furnished each respondent with a Consent Form and Participant Information Sheet for their perusal and endorsement. It was explicitly emphasised that this research is solely for academic purposes and devoid of any commercial interests to allay any concerns of the respondents and bolster their engagement and candour in responding. To safeguard the privacy and personal information of the participants, all data gathered in this study have been anonymised. For details, please refer to Appendix A.

3.8 Summary of the Chapter

This chapter outlines the research methods, data collection procedures, and data analysis tools employed, all of which align with this study's research theme, objectives, and methodologies. Quantitative analysis was selected per the study's conceptual framework in conjunction with a questionnaire as the primary data collection instrument.

The data analysis in this study unfolds in two distinct stages, each characterised by specific research objectives, thus necessitating different analysis methods and tools. The initial research stage seeks to delve into the key determinants influencing the behavioural intentions of museum tourists in the Guangdong region. To achieve this, the study utilises PLS-SEM to validate the model and evaluate the significant impact of various variables on behavioural intentions. Consequently, the SmartPLS analysis tool was chosen to facilitate data analysis, aligning with the requirements of this stage.

The subsequent research stage aims to explore disparities in the willingness of cross-generational tourists to adopt VR technology, particularly emphasising the comparative analysis of seven independent variables. Given the research objectives of this phase, the study has opted for the SPSS analysis tool to conduct a one-way analysis of variance (ANOVA). Furthermore, post hoc test analysis will be carried out based on the outcomes of the variance analysis.

After establishing the research methodology, this study further detailed the interpretation of variables, assumptions, and the construction of the questionnaire. A pilot study was also conducted based on the finalised questionnaire to perform reliability and validity analyses on the data from a small sample. During the reliability analysis phase of the pilot study, two items with CITC values below 0.4 were removed. As a result, a questionnaire consisting of 26 scale items was formed for the formal research. The preliminary research in this chapter laid the foundation for subsequent large-scale sample collection and data analysis.

CHAPTER 4

DATA ANALYSIS

4.1 Overview

This chapter delves deeply into data analysis and comprehension. The analysis is designed to uncover the primary factors that influence the behavioural intentions of museum visitors in the Guangdong province while also discerning distinctions among these influencing factors across Gen X, Y, and Z.

The collected data undergoes an initial filtration process before being subjected to descriptive analyses. The data analysis is divided into two stages. In the first stage, the Partial Least Squares Structural Equation Modeling (PLS-SEM) multivariate analysis method is adopted, employing the SmartPLS data analysis tool to validate the extended UTAUT2 model and its underlying hypotheses. Within this context, examining the relationship between independent variables and behavioural intentions occurs, leading to conclusions and the research question [RQ1] being addressed. The second stage employs the One-Way Analysis of Variance (ANOVA) statistical method. For this, the SPSS data analysis tool is employed to conduct a mean difference analysis, allowing the exploration of generational differences among museum visitors influenced by independent variables. Ultimately, conclusions are drawn, and the research question [RQ2] is addressed.

4.2 Questionnaire Sample Analysis

4.2.1 Sample Data Acquisition and Processing

Before officially commencing data collection, this study carried out a preliminary survey in the previous chapter, which involved the analysis of 78 valid questionnaire responses. The initial version of the questionnaire's reliability and validity were analysed in this phase. After refining the questionnaire items, a reliable and valid questionnaire was finalised. Subsequently, 600 paper questionnaires were distributed based on the refined questionnaire. The decision to employ paper questionnaires was driven by the study's emphasis on visitors from Gen X, Y and Z. Acknowledging that older visitors might experience difficulties or unease when using online questionnaires, the choice to opt for paper-based questionnaires was made.

Furthermore, the objective was to capture groups of visitors travelling together to museums, ensuring more impactful feedback on the social influence (items SI1-SI3). Consequently, paper questionnaires were chosen to gather insights on VR technology from museum visitors. The survey locations primarily encompassed museums in the Guangdong area that embraced long-term VR technology for exhibitions and other museums featuring short-term VR technology for exhibitions.

The questionnaire is divided into two parts. The first part captures basic information about the respondent, including gender, age range, and time spent on VR technology in museums. Building upon the refined scale items, the second part comprises 26 questions aligned with measurable variables. All questions use a five-point Likert scale, a widely used questionnaire format recognised for effectively collecting data (Lantz, 2013), allowing museum visitors to express their perceptions across five levels.

Owing to the utilisation of paper distribution, the data collection process spanned from February to June 2023, predominantly concentrating on weekends. A total of six hundred questionnaires were disseminated, with two hundred allocated for Gen X, Y, and Z, respectively. After sorting and analysis, questionnaires that indicated option 1 (indicating no prior use of VR products in museums) or exhibited incomplete or missing responses were omitted. A total of 524 valid questionnaires were acquired, culminating in a noteworthy response rate of 87.3%.

4.2.2 Demographic Analysis of the Sample

This study performs a descriptive statistical analysis of the demographic information gathered from the survey data, focusing specifically on gender, age range, specific age, and time spent. The demographic findings are presented in Table 4.1.

Table 4.1: Demographic Findings of the Survey Participants

Sample statistical characteristics	Classification	Frequency	Percentage
Gen	X (1965-1979)	187	35.7
	Y (1980-1995)	186	35.5
	Z (1996-2004)	151	28.8
Gender	Male	287	54.8
	Female	237	45.2
VR takes time	1-5 minutes	223	42.6
	5-10 minutes	212	40.4
	More than 10 minutes	89	17

Overall, as evidenced by Table 4.1, the personal information of the participants in this study is representative. Moreover, the distribution of questionnaire samples appears to be

reasonably balanced, indicating the overall feasibility of this survey. Firstly, considering the number of participants across three generations, Gen X comprises 187 participants, Gen Y comprises 186 participants, and 151 participants represent Gen Z. The structured questionnaire format may be a potential limitation of the data collection method, as paper questionnaires, unlike online questionnaires, cannot be set to require all questions to be answered before submission. Paper questionnaires are more open. The smaller number of Gen Z respondents is primarily attributed to omissions when these participants completed the questionnaire. This may be related to their shorter time to complete the task, as Gen Z participants generally spend less time than the other two generations. This haste may cause some questions to be missed. Although this limitation may slightly decrease the participation of Gen Z respondents, it will not affect the subsequent research. In the data collection planning stage, the study considered the need to compare the means of three independent sample groups. To ensure data validity, each generation's sample size will not be less than 150. Therefore, the number of Gen Z samples meets the required sample size for the study.

Nevertheless, although the number of Gen Z participants is slightly below 33%, the difference in numbers across the three generations is not significant. The distribution remains relatively uniform, fulfilling this study's intended sample size. The gender breakdown indicates a slightly higher proportion of males than females, yet the distribution remains balanced. A notable divergence in the data is observed concerning the time spent utilising VR technology within the museum context. Specifically, 42.6% of museum visitors allocated 1-5 minutes, 40.4% spent 5-10 minutes, and 17% engaged for over 10 minutes. These findings suggest a plausible correlation between the availability of VR products in the museum and visitor engagement. For

instance, where numerous visitors converge with limited equipment or devices, it can reduce the time tourists spend on VR products, influenced by factors like waiting lines and other limitations. Consequently, this study should also address the enhancement of visitors' behavioural intentions within a condensed timeframe.

4.3 Phase One Data Analysis

4.3.1 Reliability and Validity of the Measurement Model

During this stage, the 524 collected paper questionnaires were digitised into Excel to facilitate seamless integration into the analysis software. The study used Partial Least Squares Structural Equation Modeling (PLS-SEM) as its chosen multivariate analysis method. PLS-SEM employs the partial least squares method to estimate interconnected linear regression equations, enabling the exploration of relationships among multiple latent variables (Hair et al., 2011). Through applying PLS-SEM, each variable in the extended UTAUT2 model formulated in this study can be expressed as a series of specific indicators quantified via corresponding questionnaire items. Subsequently, the model's reliability and validity are assessed by utilising appropriate algorithms.

The PLS-SEM methodology comprises two main components, each involving an iterative algorithm. The initial phase evaluates the measurement model, encompassing reflective and formative indicators assessments. This evaluation examines diverse aspects and their associated latent variables to ascertain their reliability, convergent validity, and discriminant validity. The second part assesses the causal relationships among latent variables, involving estimating path coefficients, significance levels and more. This study adopted the standards

evaluation indicators criteria outlined by Hair et al. (2021). The specific measurement parameters and evaluation standards are summarised in Table 4.2.

Table 4.2: Measurement Parameters and Evaluation Standards (Hair et al., 2021)

Reliability/Validity		Name	Evaluation criteria
Reflective indicator	Component reliability	CA	≥ 0.708 (0.7~0.9)
	Component reliability	CR	> 0.7 (0.7~0.9strong)
	Component reliability	Rho_A	> 0.70
Reflective indicator	Convergent validity	Indicator loadings	> 0.50 ; > 0.7 is good
	Convergent validity	AVE	≥ 0.50
	Discriminant validity	HTMT	Same < 0.90 ; not the same < 0.85
	Discriminant validity	Fornell-Larcker criterion	· AVE is greater than the square of the correlation coefficient between the construct and other constructs
	Discriminant validity	Cross loadings	· The loads of the indicators in the relevant constructs should be greater than all the loads in the other constructs
Formative indicator	Validity	Indicator weights	> 0.05 weak; > 0.10 moderate; > 0.20 strong
	validity	VIF	> 0.2 and < 5 ; < 3 is good

Table 4.2 continued

Structural model	Model validity	R^2	>0.75strong; >0.5mderate; >0.25weak
	Model validity	f^2	>0.35strong; >0.15mderate; >0.02weak
	Model validity	Q^2	>0.5strong; >0.25mderate; >0weak
	Model validity	T	>1.96;>2.57strong

This study imported the data from the 524 questionnaires into the SmartPLS (version 4.0.9.5) software to execute PLS_SEM path modelling, as shown in Figure 4.1.

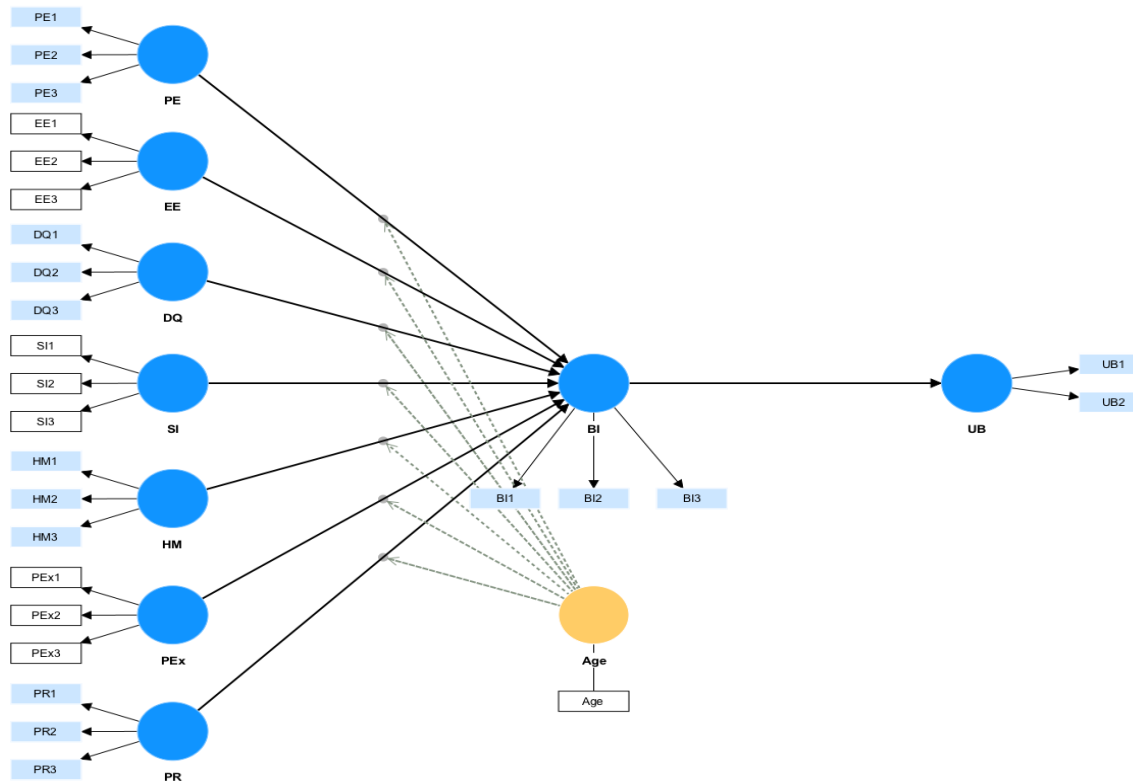


Figure 4.1: Structural Equation Model based on PLS-SEM

The assessment of reflective indicators involves two main aspects: reliability and validity. Reliability refers to the consistency of measurement results. A high level of reliability for a latent variable indicates stable and dependable measurement outcomes. On the other hand, validity refers to measurement accuracy and the extent to which test items accurately depict participants' characteristics. A valid model produces valuable and effective analysed results (Hair et al., 2019).

Furthermore, validity can be subdivided into convergent validity and discriminant validity. Convergent validity measures the correlation between multiple variables or indicators within the same facet. A substantial correlation between indicators of the same facet is expected for specific research. On the other hand, discriminant validity measures the relationship between each latent variable and its corresponding facet (Shmueli et al., 2019). The correlation degree between various facet variables should be low enough to distinguish different facets effectively (Fitzener, 2007).

The evaluation of reflective indicator reliability involves the simultaneous examination of three parameters: Cronbach's alpha (CA), Composite reliability (ρ_a), and Composite reliability (ρ_c). Cronbach's alpha is a statistic used to measure internal consistency and is a crucial measure of measurement reliability (Kalkbrenner, 2023). A CA value exceeding 0.7 is considered acceptable internal consistency. According to Hair et al. (2021), a CA greater than 0.708 is considered to have acceptable internal consistency. Composite reliability, like CA, is another statistical indicator used to measure the internal consistency of a latent variable's measurement model. Generally, a Composite reliability value above 0.7 is considered a good

result. The reliability examination of the reflection within this study's data model is presented in Table 4.3.

Table 4.3: Reflective Indicator Reliability Test Table

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
BI	0.881	0.882	0.927
DQ	0.890	0.892	0.932
EE	0.876	0.876	0.924
HM	0.885	0.899	0.929
PE	0.896	0.898	0.935
PE _x	0.885	0.887	0.929
PR	0.905	0.906	0.941
SI	0.899	0.910	0.936
UB	0.751	0.753	0.889

Table 4.3 shows that the reliability of each latent variable in this study surpasses 0.7, with all latent variables except UB exceeding 0.8. These values indicate a high level of internal consistency and reliability between the observed indicators of each construct. Moreover, the composite reliability of each latent variable is also above 0.7, providing additional evidence for the internal consistency within the observed variables.

Convergent validity measures the degree of correlation between different observed variables of the same latent construct. The assessment of convergent validity for reflective indicators necessitates the simultaneous evaluation of two parameters: Outer Loadings and

Average Variance Extracted (AVE). Typically, Outer Loading should reach at least 0.5 or higher to ensure a satisfactory correlation between the observed and latent variables. AVE is an indicator to measure the shared variance among latent variables. It is utilised to evaluate the quality and reliability of latent variables (Hair et al., 2019). An AVE below 0.5 may indicate potential issues with the convergent validity of the measurement model. Robust Outer Loadings coupled with adequate AVE values collectively signify strong convergent validity. The analysis tables for convergent validity in this study are illustrated in Tables 4.4 and 4.5.

Table 4.4: Outer Loading

	BI	DQ	EE	HM	PE	PE_x	PR	SI	UB
BI1	0.901								
BI2	0.900								
BI3	0.895								
DQ1		0.919							
DQ2		0.898							
DQ3		0.899							
EE1			0.904						
EE2			0.891						
EE3			0.890						
HM1				0.913					
HM2				0.913					
HM3				0.877					
PE1					0.906				
PE2					0.908				

Table 4.4 continued

PE3	0.916	
PEx1	0.907	
PEx2	0.911	
PEx3	0.887	
PR1	0.923	
PR2	0.919	
PR3	0.910	
SI1		0.925
SI2		0.899
SI3		0.910
UB1		0.887
UB2		0.902

Table 4.5: Average variance extracted (AVE)

	BI	DQ	EE	HM	PE	PEx	PR	SI	UB
AVE	0.808	0.820	0.801	0.812	0.828	0.814	0.841	0.831	0.800

Tables 4.4 and 4.5 show that all factor loadings exceed 0.6, and the AVE values of each latent variable surpass 0.5. This observation indicates a strong correlation between each observed variable and its corresponding latent variable. The robust convergent validity is thus established, indicating the model's good aggregation validity.

Discriminant validity is the process of determining if different latent variables can be effectively differentiated. This involves assessing whether indicators of the same construct exhibit notably high correlations while indicators of distinct constructs demonstrate relatively weak correlations (Franke, & Sarstedt, 2019). Consequently, the evaluation of discriminant validity seeks to ensure the strongest correlation between reflective constructs and indicators within the PLS path model. Examining discriminant validity involves concurrent assessment of three key parameters: the Fornell-Larcker criterion, Cross loadings, and the Heterotrait-monotrait ratio (HTMT).

The Fornell-Larcker criterion, a widely used method for evaluating discriminant validity, primarily examines whether the square root of the AVE extraction of each variable (the value on the diagonal) surpasses the correlation of that specific observed variable with other observed variables (Henseler et al., 2015). Cross loadings compare the outer loadings of observed variables with their corresponding latent constructs and other observed variables (related latent constructs). This evaluation seeks to determine if the outer loading of an observed variable with its corresponding latent construct is significantly higher than those associated with other latent constructs. The HTMT compares the average cross-correlation coefficient between different indicators of different constructs with the average correlation coefficient among indicators of the same indicators. Generally, an HTMT value below 0.85 indicates good discriminant validity (Ab Hamid et al., 2017).

The assessment results for the Fornell-Larcker criterion, Cross loadings, and HTMT in this study are illustrated in Tables 4.6, 4.7, and 4.8, respectively.

Table 4.6: Discriminant Validity: Fornell-Larcker criterion

	BI	DQ	EE	HM	PE	PE _x	PR	SI	UB
Age									
BI	0.899								
DQ	0.479	0.905							
EE	0.520	0.197	0.895						
HM	0.413	0.243	0.249	0.901					
PE	0.482	0.219	0.318	0.188	0.910				
PE _x	0.392	0.111	0.220	0.232	0.158	0.902			
PR	-0.418	-0.355	-0.250	-0.258	-0.292	0.160	0.917		
SI	0.428	0.189	0.210	0.240	0.274	0.154	-0.165	0.911	
UB	0.634	0.360	0.444	0.350	0.419	0.381	-0.389	0.375	0.895

Table 4.7: Discriminant Validity: Cross loadings

	BI	DQ	EE	PE _x	HM	PE	PR	SI	UB
BI1	0.901	0.448	0.505	0.370	0.364	0.439	-0.400	0.356	0.585
BI2	0.900	0.435	0.439	0.336	0.374	0.424	-0.344	0.435	0.580
BI3	0.895	0.408	0.457	0.350	0.380	0.436	-0.384	0.363	0.543
DQ1	0.442	0.919	0.172	0.106	0.204	0.220	-0.372	0.136	0.345
DQ2	0.411	0.898	0.198	0.093	0.196	0.183	-0.279	0.185	0.297
DQ3	0.448	0.899	0.167	0.101	0.261	0.191	-0.310	0.192	0.335
EE1	0.466	0.195	0.904	0.220	0.232	0.286	-0.213	0.161	0.409

Table 4.7 continued

EE2	0.474	0.154	0.891	0.180	0.198	0.282	-0.208	0.196	0.392
EE3	0.455	0.179	0.890	0.193	0.240	0.286	-0.252	0.208	0.391
PEx1	0.363	0.099	0.219	0.907	0.210	0.137	-0.133	0.176	0.333
PEx2	0.360	0.099	0.165	0.911	0.200	0.187	-0.168	0.106	0.326
PEx3	0.338	0.102	0.213	0.887	0.221	0.101	-0.133	0.133	0.375
HM1	0.404	0.256	0.254	0.241	0.913	0.187	-0.230	0.197	0.351
HM2	0.391	0.224	0.231	0.210	0.913	0.207	-0.243	0.243	0.340
HM3	0.311	0.168	0.179	0.171	0.877	0.102	-0.225	0.207	0.239
PE1	0.460	0.195	0.309	0.192	0.159	0.906	-0.294	0.258	0.405
PE2	0.411	0.194	0.257	0.116	0.160	0.908	-0.235	0.227	0.348
PE3	0.440	0.210	0.298	0.115	0.198	0.916	-0.265	0.258	0.388
PR1	-0.391	-0.330	-0.245	-0.104	-0.211	-0.275	0.923	-0.164	-0.348
PR2	-0.369	-0.326	-0.216	-0.146	-0.257	-0.239	0.919	-0.152	-0.333
PR3	-0.390	-0.321	-0.227	-0.189	-0.244	-0.287	0.910	-0.136	-0.388
SI1	0.435	0.195	0.159	0.194	0.243	0.293	-0.201	0.925	0.361
SI2	0.348	0.146	0.209	0.102	0.204	0.240	-0.096	0.899	0.308
SI3	0.379	0.169	0.212	0.115	0.205	0.209	-0.144	0.910	0.353
UB1	0.548	0.328	0.378	0.324	0.262	0.372	-0.342	0.346	0.887
UB2	0.585	0.318	0.416	0.359	0.362	0.379	-0.355	0.326	0.902

Tables 4.8: Discriminant Validity: Heterotrait-monotrait ration (HTMT)

BI	DQ	EE	HM	PE	PEx	PR	SI	UB
----	----	----	----	----	-----	----	----	----

Table 4.8 continued

BI								
DQ	0.540							
EE	0.591	0.224						
HM	0.463	0.269	0.279					
PE	0.541	0.245	0.357	0.205				
PE _x	0.443	0.125	0.250	0.259	0.174			
PR	0.468	0.394	0.281	0.288	0.322	0.178		
SI	0.478	0.209	0.239	0.267	0.301	0.168	0.179	
UB	0.778	0.440	0.547	0.420	0.510	0.468	0.471	0.455

Tables 4.6, 4.7, and 4.8: demonstrate that the factor loadings within their respective dimensions surpass those of others. Additionally, the square root of the AVE extraction for each variable (diagonal values) is higher than the correlation of these variables with others, satisfying the test criteria. Moreover, the HTMT values are below 0.85, which also meets the set test criteria. These findings collectively affirm that the reflective indicators of the measurement model fulfil the discriminant validity test, thereby conforming to robust discriminant validity.

Subsequently, this study proceeded to verify the model's Indicator weights. Since the indicator weight values need calculations via Bootstrapping, this study's approach adheres to the standards proposed by Hair et al. (2021). A total of 5,000 resampling iterations were performed to ensure the stability and scientific reliability of the estimated research variables. Indicator weights can be considered indicators of the relative contribution of observed variables in shaping latent variables. A higher weight signifies a greater explanatory role of the observed

variable in relation to the latent variable. It is worth noting that Indicator weights and outer loadings differ in that Indicator weights reflect the relative significance of observed variables during the formation of latent variables (Streukens & Leroi-Werelds, 2016). According to the assessment criteria summarised by Hair et al. (2021), indicator weights should exceed 0.2.

The analysis table depicting the indicator weights of this study's model is presented in Table 4.9.

Table 4.9: Indicator weights

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)
BI1 <- BI	0.901	0.901	0.008	106.415
BI2 <- BI	0.900	0.900	0.007	122.324
BI3 <- BI	0.895	0.895	0.010	94.132
DQ1 <- DQ	0.919	0.919	0.007	130.866
DQ2 <- DQ	0.898	0.898	0.010	94.306
DQ3 <- DQ	0.899	0.899	0.010	86.153
EE1 <- EE	0.904	0.904	0.009	101.492
EE2 <- EE	0.891	0.891	0.012	74.364
EE3 <- EE	0.890	0.889	0.011	79.693
HM1 <- HM	0.913	0.913	0.008	114.713
HM2 <- HM	0.913	0.914	0.007	122.290
HM3 <- HM	0.877	0.876	0.014	61.223
PE1 <- PE	0.906	0.905	0.008	108.341
PE2 <- PE	0.908	0.907	0.009	104.701

Table 4.9 continued

PE3 <- PE	0.916	0.916	0.008	117.751
PEx1 <- PEx	0.907	0.907	0.009	99.596
PEx2 <- PEx	0.911	0.911	0.008	117.781
PEx3 <- PEx	0.887	0.887	0.011	80.800
PR1 <- PR	0.923	0.922	0.007	133.704
PR2 <- PR	0.919	0.918	0.007	129.310
PR3 <- PR	0.910	0.910	0.008	112.291
SI1 <- SI	0.925	0.925	0.006	143.601
SI2 <- SI	0.899	0.898	0.010	89.116
SI3 <- SI	0.910	0.910	0.009	102.577
UB1 <- UB	0.887	0.887	0.011	82.808
UB2 <- UB	0.902	0.902	0.009	97.008

As evidenced in Table 4.9, all indicator weights values are significantly greater than the test standard of 0.2, indicating the validity of each latent variable. Correspondingly, the T value associated with each latent variable surpasses the 2.57 high standard, indicating significant validity for each item.

In the course of this study, consideration must also be given to the issue of multicollinearity. Multicollinearity arises when predictive variables exhibit high linear correlation, indicating substantial intercorrelation among variables. This phenomenon can result in unstable coefficient estimates within the multiple regression model, leading to numerical inaccuracies and instability. The assessment of multicollinearity is essential, and the Collinearity

statistic, particularly the Variance Inflation Factor (VIF), is a widely used tool for diagnosing multicollinearity problems within a multiple regression model (Kim, 2019). The VIF is calculated as the ratio of the variance of the entire model to the variance of a model containing only a single variable. According to the assessment criteria suggested by Hair et al. (2021), the VIF value should exceed 0.2 and be less than 5, with a VIF value ranging from 0.2 to 3 being considered highly favourable.

The collinearity test results for the formative indicators of this measurement model are shown in Table 4.10.

Table 4.10: Collinearity Statistic (VIF)

	BI	DQ	EE	HM	PE	PE _x	PR	SI	UB
BI									1.000
DQ	1.221								
EE	1.313								
HM	1.237								
PE	1.287								
PE _x	1.120								
PR	1.307								
SI	1.185								
UB									
Age	1.060								
Age x PR	1.457								
Age x PE _x	1.103								

Table 4.10 continued

Age x HM	1.325
Age x SI	1.194
Age x DQ	1.292
Age x EE	1.209
Age x PE	1.227

Table 4.10 shows that the VIF values within this study's model fall between 1 and 3, which is a positive outcome, indicating that this measurement model does not have a collinearity problem, thereby ensuring that the estimation of the path coefficients within the structural model will not be negatively affected.

In summary, following comprehensive testing and assessment of the measurement model encompassing discriminant validity, convergent validity, indicator reliability, collinearity testing, and weights significance, the analysed data conclusively affirms the research model's good reliability and validity. It successfully meets the established standards while avoiding collinearity-related issues. At the same time, no anomalies were found during the reliability and validity parameter evaluations, which is related to the reliability and validity assessments conducted in the pre-survey before the formal study. Consequently, the research model's reliability is confirmed, paving the way for evaluations of the structural model to validate hypotheses and explore causal relationships among latent variables.

4.3.2 Path Coefficient Significance Test

In PLS-SEM, the path coefficient test is essential to evaluate the strength and direction of relationships between latent variables. Path coefficients are commonly used to examine the impact of independent variables on dependent variables and to uncover their causal relationships. The significance test of the path coefficient is a crucial step within PLS-SEM, aimed at determining whether the hypothesised causal paths within the model show statistical significance (Matthews, 2017). This phase is central to the study's focus, as it explores the significant impact of each latent variable on museum visitors in Guangdong who engage with VR technology, utilising the path coefficient test.

The criteria for evaluating path coefficients are as follows: A positive path coefficient signifies a positive relationship between the independent and dependent variables. In contrast, a negative coefficient indicates an inverse relationship between the two variables. The magnitude of the path coefficient value indicates the strength of influence exerted by the independent variable on the dependent variable (Kock, 2017). Additionally, the P-value associated with the path coefficient deserves careful consideration. This P-value is usually compared to a predetermined significance level, commonly set at 0.05 or 0.01. If the P-value falls below this threshold, it is considered statistically significant; conversely, if it surpasses the threshold, it is considered non-significant.

For instance, if this study's hypothesis posits that performance expectancy significantly impacts tourists' behavioural intention, and the test outcomes reveal a positive path coefficient from Performance Expectancy (PE) to Behavioural Intention (BI), it can be inferred that Performance Expectancy positively influences tourists' intention to use VR technology. Further scrutiny involves assessing whether the P-value associated with the path coefficient is less than

0.05. If the P-value is below 0.05, it suggests that performance expectancy significantly and positively affects tourists' behavioural intention.

This study adopts 0.05 as the significance level for testing standards based on previous literature for significance levels. If the calculated P-value is less than 0.05, it is deemed to exhibit a significant effect. The analysis comprises separate path coefficient assessments for independent variables, moderating variables, and mediation effects.

Table 4.11: Independent Variable: Path Coefficient Analysis

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
BI -> UB	0.634	0.635	0.034	18.570	0.000
DQ -> BI	0.259	0.259	0.038	6.785	0.000
EE -> BI	0.282	0.28	0.037	7.516	0.000
HM -> BI	0.122	0.121	0.032	3.798	0.000
PE -> BI	0.210	0.210	0.031	6.683	0.000
PEX -> BI	0.196	0.195	0.034	5.732	0.000
PR -> BI	-0.093	-0.092	0.033	2.790	0.005
SI -> BI	0.177	0.177	0.031	5.641	0.000

As shown in Table 4.11, the path coefficient of Behavioral Intention (BI) to Usage Behavior (UB) is 0.634, with a P-value less than 0.05, indicating that the path effect from Behavioral Intention (BI) to Usage Behavior (UB) is significant, implying a significant positive influence. The path coefficients of Design Quality (DQ), Effort Expectancy (EE), Hedonic Motivation (HM), Performance Expectancy (PE), Past Experience (PEX), Perceived Risk (PR),

and Social Influence (SI) to Behavioral Intention (BI) are 0.259, 0.282, 0.122, 0.210, 0.196, -0.093, and 0.177 respectively. All corresponding P-values are less than 0.05.

This data suggests that the path effects of Design Quality (DQ), Effort Expectancy (EE), Hedonic Motivation (HM), Performance Expectancy (PE), Past Experience (PEX), and Social Influence (SI) to Behavioral Intention (BI) are significant, indicating significant positive influences for all except Perceived Risk (PR), which shows a negative influence.

This study tests the moderating variable (Age) to determine if changes in age will have a significant moderating effect on the path from the independent variables to Behavioral Intention (BI). Detailed results can be seen in Table 4.12.

Table 4.12: Moderating Variable: Path Coefficient Analysis

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
Age x SI -> BI	0.017	0.015	0.031	0.547	0.585
Age x PR -> BI	-0.016	-0.018	0.038	0.432	0.666
Age x PEX -> BI	0.013	0.015	0.033	0.393	0.695
Age x DQ -> BI	-0.082	-0.082	0.036	2.271	0.023
Age x EE -> BI	0.033	0.034	0.039	0.847	0.397
Age x HM -> BI	0.023	0.025	0.037	0.631	0.528
Age x PE -> BI	-0.083	-0.083	0.032	2.561	0.010

Analysis in Table 4.12 shows that the interaction terms Age $\times$ Social Influence (SI), Age $\times$ Perceived Risk (PR), Age $\times$ Past Experience (PEX), Age $\times$ Design Quality (DQ), Age $\times$ Effort

Expectancy (EE), Age $\times$ Hedonic Motivation (HM), and Age $\times$ Performance Expectancy (PE) to Behavioral Intention (BI) are 0.017, -0.016, 0.013, -0.082, 0.033, 0.023, and -0.083 respectively. The corresponding P-values are 0.585, 0.666, 0.695, 0.023, 0.397, 0.528, and 0.010. Based on the findings, the interaction term Age $\times$ Performance Expectancy (PE) and Age $\times$ Design Quality (DQ) to Behavioral Intention (BI) are significant, indicating that the moderating variable(Age) has a negative effect on the relationship from Performance Expectancy to Behavioral Intention and from Design Quality to Behavioral Intention.

Within this study, an exploration of mediation effects is undertaken. These effects elucidate how an independent variable influences a dependent variable through one or more mediator variables. Indirect effects analysis helps to understand how relationships between variables are mediated. Moreover, this study also analysed the Total Effects to reflect all possible causal paths. Details can be seen in Tables 4.13 and 4.14.

Table 4.13: Indirect Effect

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
PE -> BI -> UB	0.133	0.133	0.021	6.212	0.000
SI -> BI -> UB	0.112	0.112	0.021	5.329	0.000
EE -> BI -> UB	0.179	0.178	0.025	7.238	0.000
HM -> BI -> UB	0.077	0.077	0.021	3.696	0.000
PR -> BI -> UB	-0.059	-0.059	0.022	2.691	0.007
DQ -> BI -> UB	0.164	0.164	0.025	6.649	0.000
PE _{ex} -> BI -> UB	0.124	0.124	0.023	5.428	0.000

Table 4.14: Total Effects

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
DQ -> UB	0.164	0.164	0.025	6.649	0.000
EE -> UB	0.179	0.178	0.025	7.238	0.000
HM -> UB	0.077	0.077	0.021	3.696	0.000
PE -> UB	0.133	0.133	0.021	6.212	0.000
PE _x -> UB	0.124	0.124	0.023	5.428	0.000
PR -> UB	-0.059	-0.059	0.022	2.691	0.007
SI -> UB	0.112	0.112	0.021	5.329	0.000

Tables 4.13 and 4.14 shows that the indirect effects PE -> BI -> UB, SI -> BI -> UB, EE -> BI -> UB, HM -> BI -> UB, PR -> BI -> UB, DQ -> BI -> UB, PE_x -> BI -> UB and the total effects DQ -> UB, EE -> UB, HM -> UB, PE -> UB, PE_x -> UB, PR -> UB, SI -> UB all show P-values less than 0.05, suggesting that the mediation effects are all valid. These results underscore the pivotal role of the mediator in the relationship between the independent and dependent variables.

Furthermore, this study aims to evaluate the goodness of fit of the measurement model by assessing the size of R^2 (Coefficient of Determination). R^2 gauges the proportion of variability in the dependent variable that is accounted for by the independent variables in the research model. The criterion for the R^2 test necessitates that the R^2 value surpasses the threshold

benchmark of 0.30. A value between 0.50 and 0.70 indicates moderate explanatory power, while a value greater than 0.70 signifies strong explanatory power (Russo & Stol, 2021).

The R^2 value and the adjusted R^2 value of this research model are presented in Table 4.15.

Table 4.15: R Square

	R-square	R-square adjusted
BI	0.630	0.619
UB	0.402	0.401

Table 4.15 offers insight into the R^2 value within this research model. Specifically, the R^2 value attributed to BI (Intention to Use) stands at 0.630, signifying a 63% explanatory power. This value falls within the range of 0.50 to 0.70, indicating a robust degree of explanatory strength. Simultaneously, the R^2 value associated with UB (Usage Behavior) rests at 0.402, corresponding to a 40.2% explanatory power. While slightly below the desired range, this value still exceeds the 0.30 benchmark, implying an acceptable explanatory power level. The research model can collectively elucidate 63% of museum visitors' behavioural intention towards VR technology and 40.2% of their actual usage behaviour. These findings underscore the validity and soundness of the conclusions drawn from the data analysis based on this model.

Upon thorough verification, it is evident that performance expectancy, hedonic motivation, social influence, design quality, hedonic motivation, and past experiences significantly impact the behavioural intention of museum tourists using VR technology. Conversely, perceived risk exerts a negative influence on their behavioural intention.

Additionally, age negatively moderates the impact of performance expectancy on behavioural intention and the effect of design quality on behavioural intention. The research model, after validation through PLS-SEM, is illustrated in Figures 4.2 and 4.3.

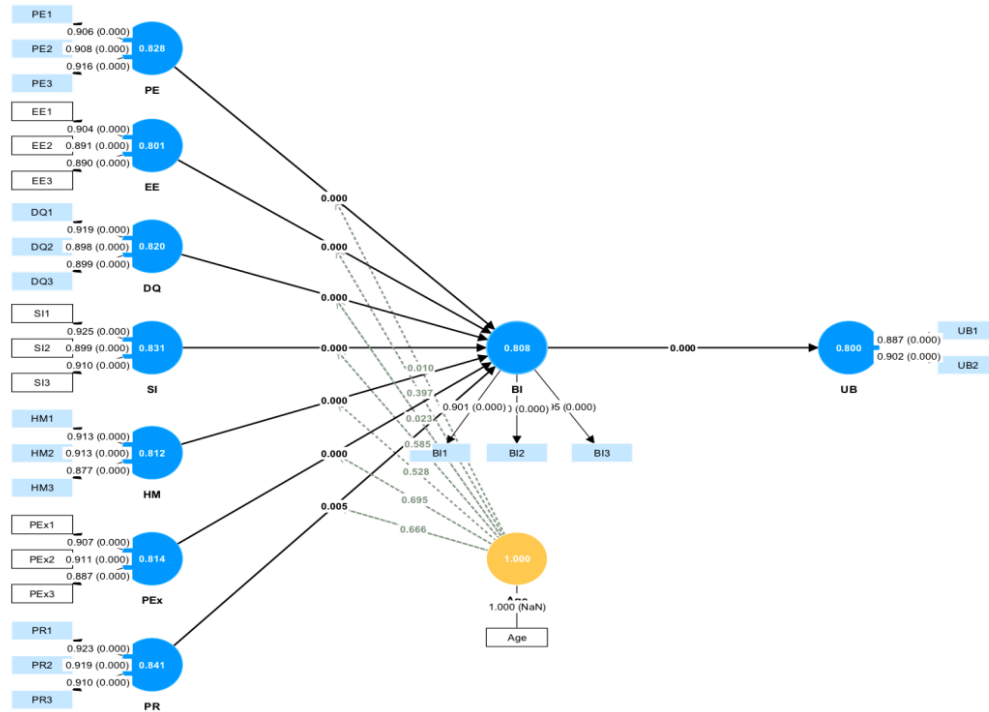


Figure 4.2: PLS-SEM validation results

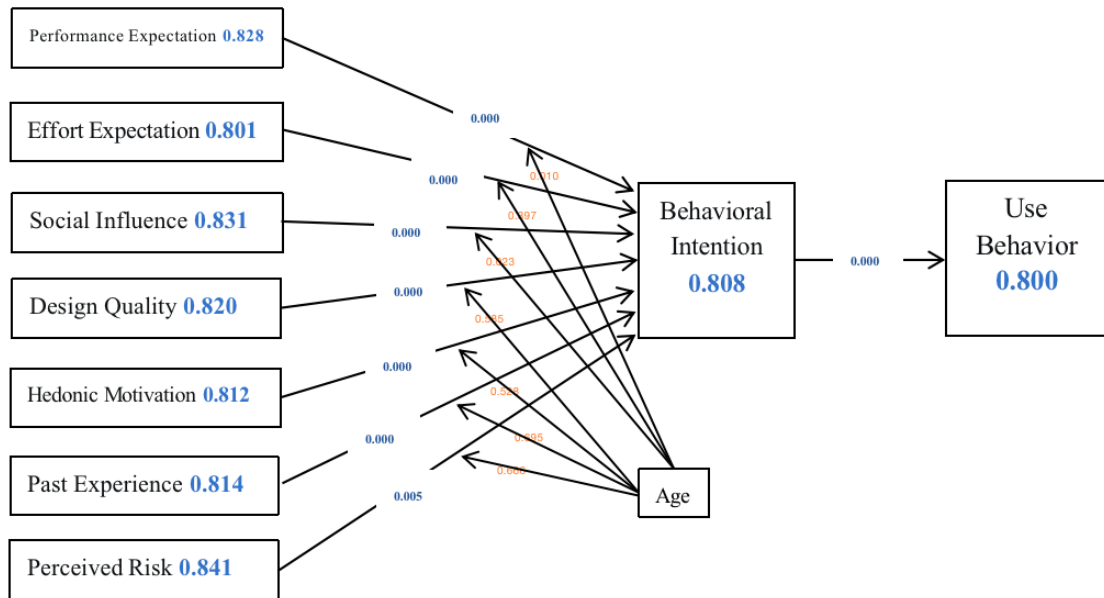


Figure 4.3: Test model validation results

Figures 4.2 and 4.3 are labelled with values for the outer model: Outer weights/Loadings and P values; constructs: Average variance extracted (AVE); and inner model: P values.

4.4 Phase One Data Analysis

Based on the empirical conclusions derived from the first phase, seven primary influencing factors on the behavioural intention of museum visitors towards VR technology. Among these, six factors positively influence museum visitors to use VR technology, while one significantly hinders its use. Based on these findings, this study proceeds to investigate whether there are generational differences among museum visitors within these seven main factors.

To this end, the present phase employs the one-way ANOVA method and uses SPSS version 26. Through the interpretation of empirical outcomes, the objective is to delve into the

generational variances in the principal factors impacting visitors' behavioural intentions. This undertaking seeks to comprehensively grasp the characteristics and requisites of visitors from various generations, facilitating the provision of more effective and comprehensive strategies for the research. Moreover, the empirical results generated in this phase contribute substantively to address the research question [RQ2].

4.4.1 Sample Group Description

The data employed for this study has been extensively presented in sections 4.2 and 4.3.1, accompanied by meticulous questionnaire reliability and validity assessments. Concerning the data analysis techniques and tools applied in this investigation, it becomes imperative to elucidate the method by which the gathered data was categorised to satisfy the prerequisites of the one-way ANOVA analysis. In this phase, the collected samples were stratified based on the moderating variable (age). This categorisation adheres to insights from Mark McCrindle & Wolfinger (2009) while considering classifications by Billy Idol (Katz, 2017).

In this phase, the samples are divided into three groups (Gen X, Y, and Z). The chronological divisions for these groups are as follows: Gen X refers to individuals born between 1965 and 1979, marking them as a cohort that transitioned amidst the advent of digital technology after baby boomers. Gen Y, often called Millennials, encompasses those born between 1980 and 1995, growing up alongside the ascent of the internet and digital technology. In this study, Gen Z encompasses those born between 1996 and 2004. This classification is designed to account for individuals born after 2004 in China as minors, requiring adult supervision or guardians. Such minors are considered vulnerable groups requiring additional ethical reviews and adult protection or intervention.

Operating VR technologies or conducting studies involving minors entails heightened ethical considerations and adult oversight. This amplifies the complexity of data collection. In the pursuit of preserving research ethics and precision, this study focuses on adults within Gen Z. As the first generation to mature in a digitally saturated environment; Gen Z exhibits heightened adaptability and reliance on technology, distinct from other generational cohorts (Dolot, 2018).

For further clarity, the specific dataset corresponding to the three delineated generations is meticulously presented in Table 4.16.

Table 4.16: Sample sizes for the three groups

Sample statistical characteristics	Classification	Frequency	Percentage
Gen	X (1965-1979)	187	35.7
	Y (1980-1995)	186	35.5
	Z (1996-2004)	151	28.8

Table 4.16 summarises the division of 524 people who participated in the survey. The Gen X group comprised 187 people, accounting for 35.7%; Gen Y comprised 186 people, accounting for 35.5%; and Gen Z encompasses 151 people, accounting for 28.8%. These three groups amassed responses exceeding 150, making a substantial and robust sample size. Gen Z had fewer participants than the other two groups is attributed to a higher number of incomplete questionnaires within this generation. However, looking at the proportions, this does not affect the data analysis and empirical results.

This questionnaire's reliability and validity analysis have been elaborated in section 4.3.1. This phase is based on the same questionnaire data set, so it is not detailed here. According to the data description in section 4.3.1, this questionnaire has passed the reliability and validity tests, presenting good data results.

4.4.2 Museum Visitors' Generational Differences Analysis

The one-way ANOVA statistical method is the principal approach to address this phase's research objectives and questions. The one-way ANOVA is designed to detect significant differences between the means of three or more independent sample groups. This method can help the study detect if there is a significant difference in the means of the three generational groups for a particular influencing factor (Yulie et al., 2021).

However, before conducting a one-way ANOVA, it is essential to test the sample data for a normal distribution. The normal distribution is a key for variance analysis. Various methods are available to measure whether the data aligns with the normality assumption. For instance, graphical methods, such as the Normal Q-Q plot, are most common to see if data points fall roughly on a straight line, thus determining if the data approximately follows a normal distribution. Other methods involve calculating skewness and kurtosis values for a quantitative description of data distribution or statistical tests like the Shapiro-Wilk test (Hatem et al., 2022).

This phase's assessment of normal distribution test examined the skewness and kurtosis values of the sample data, reinforced by histograms to explain the data's normal distribution. Table 4.17 displays data on skewness and kurtosis, while Figures 4.4 to 4.7 show histograms of the seven influencing factors.

Table 4.17: Descriptive statistics of skewness and kurtosis.

	N	Mini m-um	Maxi m-um	Mean	Std. Deviation	Skewness	Kurtosis		
	- Statis -tic	Statist -ic	Statisti -c	Statistic	Statistic	Statist -ic	Std. Err or	Statist -ic	Std. Error
PE	524	1.00	5.00	3.0032	1.08810	.014	.107	-.807	.213
EE	524	1.00	5.00	3.1285	1.04296	-.145	.107	-.775	.213
DQ	524	1.00	5.00	3.1088	1.07299	-.018	.107	-.960	.213
SI	524	1.00	5.00	3.2271	1.06190	-.096	.107	-.871	.213
HM	524	1.00	5.00	3.1590	1.05839	-.093	.107	-.846	.213
PEx	524	1.00	5.00	3.2595	1.03398	-.305	.107	-.710	.213
PR	524	1.00	5.00	2.8461	1.11542	.078	.107	-1.045	.213
Valid N (listwise)	524								

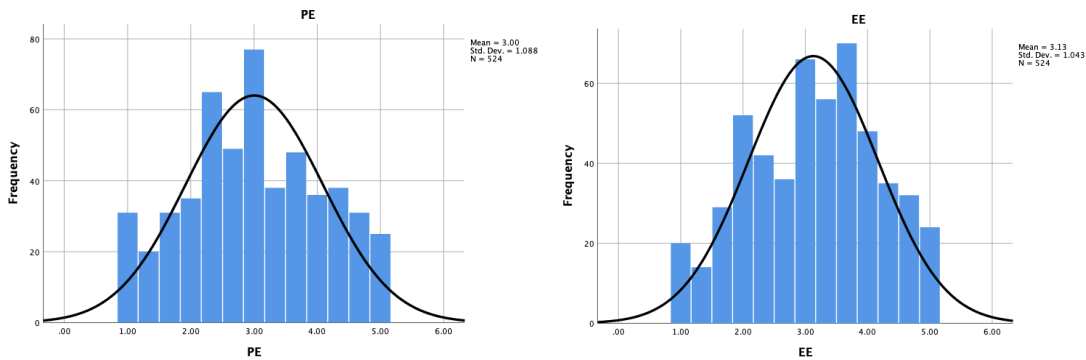


Figure 4.4: PE & EE-Normal distribution histogram

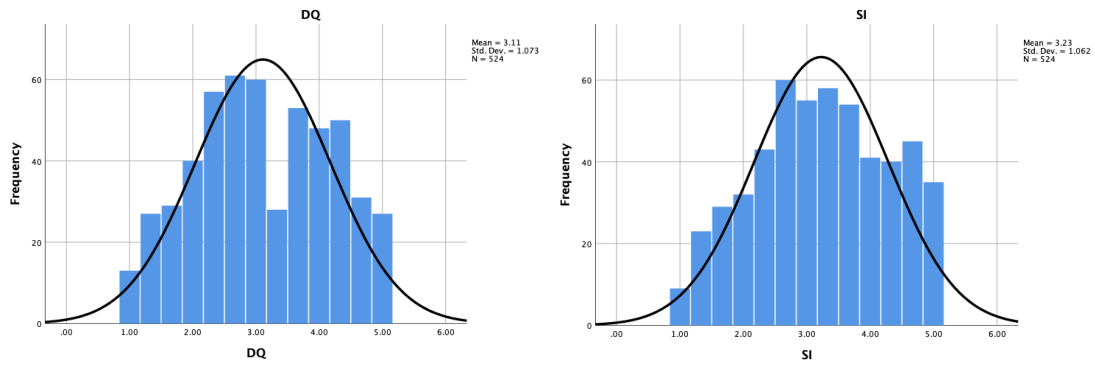


Figure 4.5: DQ & SI-Normal distribution histogram

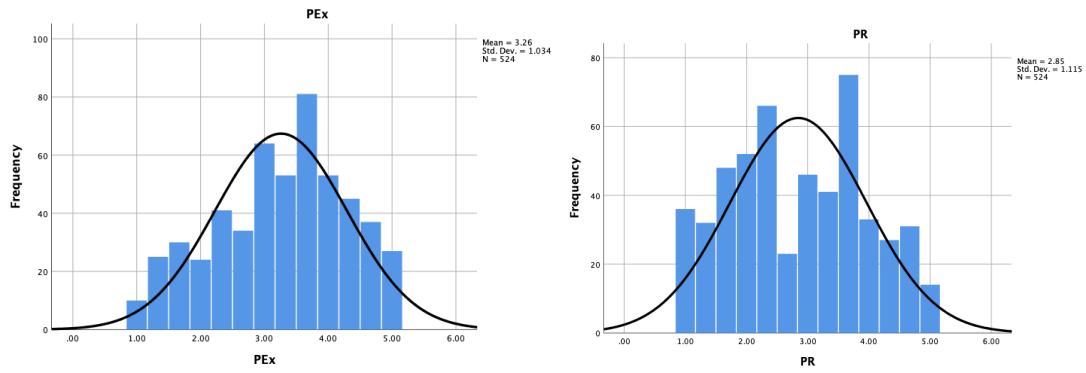


Figure 4.6: PEx & PR-Normal distribution histogram

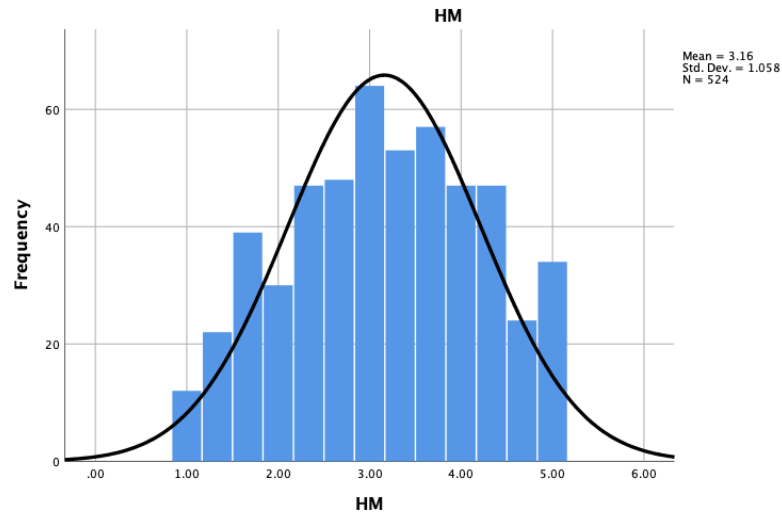


Figure 4.7: HM-Normal distribution histogram

According to Hair (2009), perfectly symmetrical data have a skewness of 0 for normal distribution tests. Generally, absolute skewness values less than 3 satisfy basic normal distribution requirements. Meanwhile, the standard normal distribution's kurtosis is 0 (or 3, depending on the definition). In most cases, absolute kurtosis values under 10 meet the basic normal distribution requirements. The table and histograms (Table 4.17; Figures 4.4, 4.5; 4.6 and 4.7) visually confirm these data distribution characteristics. Therefore, the sample data is determined to meet the basic requirements of a normal distribution, satisfying the variance analysis.

After passing the normality test, the data was analysed using a one-way ANOVA. Based on the conclusions drawn from the initial phase, null hypotheses (H0) and alternative hypotheses (H1) were established for these seven influencing factors.

Null Hypothesis (H0): There is no significant difference in the overall mean of Performance Expectancy among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a significant difference in the overall mean of Performance Expectancy among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no significant difference in the overall mean of Effort Expectancy among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a significant difference in the overall mean of Effort Expectancy among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no significant difference in the overall mean of Social Influence among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a significant difference in the overall mean of Social Influence among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no statistically significant difference in the overall mean of Facilitating Conditions among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a statistically significant difference in the overall means of Facilitating Conditions among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no statistically significant difference in the overall mean of Hedonic Motivation among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): There is a statistically significant difference in the overall mean of Hedonic Motivation among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): No statistically significant difference exists in the overall mean of Prior Experience among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): A statistically significant difference exists in the overall means of Prior Experience among at least two generational groups (X, Y, Z).

Null Hypothesis (H0): There is no statistically significant difference in the overall mean of Perceived Risk among the generational groups of X, Y, and Z.

Alternative Hypothesis (H1): A statistically significant difference exists in the overall mean of Perceived Risk among at least two generational groups (X, Y, Z).

The data was then imported into SPSS version 26.0 for analysis, with the results presented in Table 4.18 and Figure 4.8.

Table 4.18: ANOVA results

	Age(Mean±Std. Deviation)			F□	p□
	X(n=187)	Y(n=186)	Z(n=151)		
PE	2.888±1.123	3.029±1.028	3.115±1.110	1.905	0.15
EE	2.952±1.037	3.167±1.015	3.300±1.057	4.926	0.008**
SI	3.137±1.083	3.269±0.974	3.287±1.136	1.053	0.35
DQ	2.920±1.031	3.174±1.068	3.263±1.103	4.867	0.008**
HM	2.977±1.058	3.152±1.044	3.393±1.038	6.601	0.001**
PEx	3.157±1.068	3.276±0.965	3.366±1.068	1.758	0.173
PR	2.963±1.143	2.927±1.092	2.603±1.078	5.181	0.006**

* p<0.05 ** p<0.01

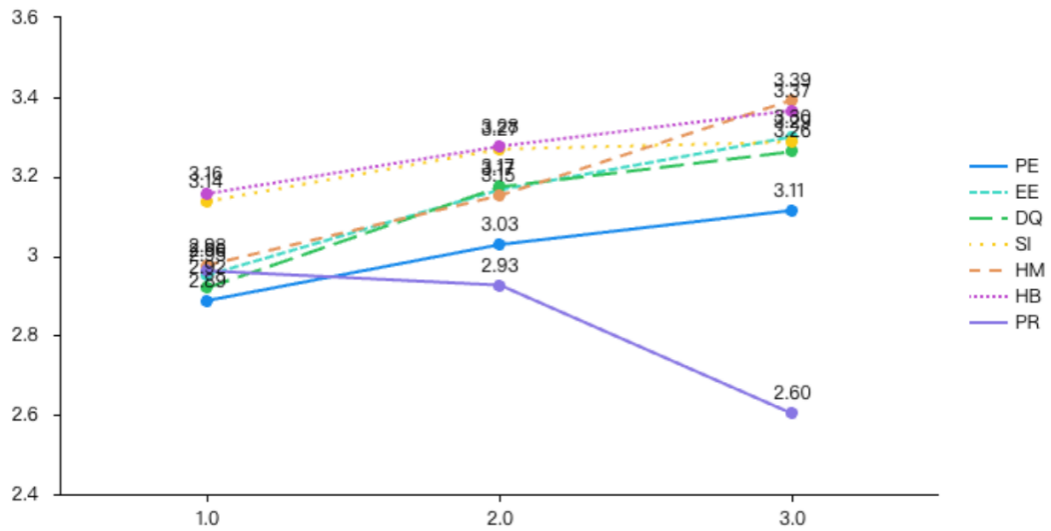


Figure 4.8: Line charts of variance analysis for each factor

The F statistic and P value are typically examined for one-way ANOVA results. A large F statistic indicates that the between-group variance is considerably greater than the within-group variance, suggesting significant mean differences across all groups. The P value indicates the threshold of significance. For this study, the significance level was set at 0.05. The results are considered statistically significant if the P value is less than 0.05 (Ross & Willson, 2017).

As shown in the above data (Table 4.18; Figure 4.8), this phase utilised variance analysis to examine Performance Expectation (PE), Effort Expectation (EE), Social Influence (SI), Design Quality (DQ), Hedonic Motivation (HM), Past Experience (PEX), and Perceived Risk (PR). The empirical results show that for Effort Expectation (EE), Design Quality (DQ), Hedonic Motivation (HM), and Perceived Risk (PR), there were significant differences ($P < 0.05$) among the X, Y, and Z generation tourists. Thus, this study rejects three null hypotheses for these factors and accepts four alternative hypotheses. The details are presented in Table 4.19.

Table 4.19: Analysis results description

Factors	P value	Results	Explanation
PE	0.15	Fail to reject the null hypothesis	No significant difference
EE	0.008**	Reject the null hypothesis	A significant difference in means
SI	0.35	Fail to reject the null hypothesis	No significant difference
DQ	0.008**	Reject the null hypothesis	A significant difference in means

Table 4.19 continued

HM	0.001**	Reject the null hypothesis	A significant difference in means
PE _x	0.173	Fail to reject the null hypothesis	No significant difference
PR	0.006**	Reject the null hypothesis	A significant difference in means

The data from Table 4.19 suggests that tourists from Gen X, Y, and Z exhibit differences in their Effort Expectancy (EE), Design Quality (DQ), Hedonic Motivation (HM), and Perceived Risk (PR). Post hoc multiple comparisons are necessary to determine the differences. One-way ANOVA confirms significant mean differences between the groups. However, it does not specify which groups have these differences. Therefore, this study conducts post hoc multiple comparisons for Effort Expectancy (EE), Design Quality (DQ), Hedonic Motivation (HM), and Perceived Risk (PR).

In contrast, Performance Expectancy (PE), Social Influence (SI), and Past Experience (PE_x) consistently showed no differences and did not require post hoc multiple comparisons, and post hoc tests further elucidate differences between groups. This study uses the Least Significant Difference (LSD) method to determine which groups have significant mean differences (Williams & Abdi, 2010). The results of the post hoc multiple comparisons are shown in Table 4.20.

Table 4.20: Multiple comparisons after the event

	(I)Name	(J)Name	(I)Average	(J)Average	Difference(I-J)	p
EE	X	Y	2.952	3.167	-0.215	0.046*
		Z	2.952	3.3	-0.348	0.002**
	Y	Z	3.167	3.3	-0.134	0.239
DQ	X	Y	2.92	3.174	-0.254	0.022*
		Z	2.92	3.263	-0.343	0.003**
	Y	Z	3.174	3.263	-0.089	0.447
HM	X	Y	2.977	3.152	-0.176	0.106
		Z	2.977	3.393	-0.416	0.000**
	Y	Z	3.152	3.393	-0.241	0.036*
PR	X	Y	2.963	2.927	0.036	0.753
		Z	2.963	2.603	0.36	0.003**
	Y	Z	2.927	2.603	0.324	0.008**

* p<0.05 ** p<0.01

The post hoc multiple comparison results (Table 4.20) show that:

1. Tourists from Gen X, Y, and Z show significant differences in Effort Expectancy (EE) (F=4.926, p=0.008) with notable group mean differences: Y>X and Z>X.
2. They also show significant differences in Design Quality (DQ) (F=4.867, p=0.008) with differences: Y>X and Z>X.
3. For Hedonic Motivation (HM) (F=6.601, p=0.001), the differences are: Z>X and Z>Y.

4. In terms of Perceived Risk (PR) ($F=5.181$, $p=0.006$), the differences are $X>Z$ and $Y>Z$.

This empirical result reveals that Gen X, Y, and Z tourists significantly differ in EE, DQ, HM, and PR. In summary, Gen Y and Z tourists rate Effort Expectancy and Design Quality higher than Gen X. Gen Z rates Hedonic Motivation significantly higher than Gen Y and X. For Perceived Risk, Gen X and Y score significantly higher than GenZ.

4.5 Summary of the Chapter

This chapter will analyse the data from the first and second phases, utilising different data analysis software and methods to derive the results. From the collected data, it can be seen that the questionnaire in this study has good reliability and validity, ensuring the accuracy and effectiveness of the data in this study. This chapter will explain the results from the first and second phases, and in the next chapter, this study will interpret and discuss the data results from both phases.

CHAPTER 5

DISUSSION OF RESULTS

5.1 Overview

This chapter builds upon the empirical findings presented in Chapter Four and addresses the three research questions in this study. Firstly, drawing from the empirical results of the initial phase, this study validates hypotheses and identifies the primary factors that impact the behavioural intentions of museum tourists towards VR technology, thus addressing the research question [RQ1]. Secondly, based on the empirical outcomes of the subsequent phase, this study explores generational differences among tourists from the X, Y, and Z generations concerning these influencing factors, thereby addressing the research question [RQ2]. Finally, by integrating insights from the first and second phases, this chapter proposes methods and strategies to enhance the behavioural intentions of tourists from different generations, ultimately addressing the research question [RQ3].

5.2 Finding of the Phase One

5.2.1 Hypothesis Results Explanation

Based on the research questions and hypotheses, this study, per research question [RQ1], formulated 16 hypotheses during the data analysis phase. Following model validation and rigorous analysis, the empirical results are summarised and presented in Table 5.1.

Table 5.1: Phase One Hypothesis Verification Results

No.	Assumed content	P value s	Validati on results	conclusio n
Ho1	Performance Expectation has a significant positive effect on the Behavioral Intention of VR technology by museum tourists.	0.000	Sig.	Accept the null hypothesis
Ha1	Age has a negative moderation on the impact of Performance Expectation on Behavioral Intention.	0.010	Sig.	Accept the null hypothesis
Ho2	Effort Expectancy has a significant positive effect on the Behavioral Intention of VR technology by museum tourists.	0.000	Sig.	Accept the null hypothesis
Ha2	Age negatively moderates the influence of Effort Expectancy on Behavioral Intention.	0.397	NS.	Reject the null hypothesis
Ho3	Social Influence has a significant positive effect on the Behavioral Intention of VR technology by museum tourists.	0.000	Sig.	Accept the null hypothesis
Ha3	Age negatively moderates the influence of Social Influence on Behavioral Intention.	0.585	NS.	Reject the null hypothesis
Ho4	Design Quality has a significant positive effect on the Behavioral Intention of VR technology by museum tourists.	0.000	Sig.	Accept the null hypothesis
Ha4	Age negatively moderates the influence of Design Quality on Behavioral Intention.	0.023	Sig.	Accept the null hypothesis
Ho5	Hedonic Motivation has a significant positive effect on the Behavioral Intention of VR technology by museum tourists.	0.000	Sig.	Accept the null hypothesis
Ha5	Age negatively moderates the influence of Hedonic Motivation on Behavioral Intention.	0.528	NS.	Reject the null hypothesis
H06	Past Experience has a significant positive effect on the Behavioral Intention of VR technology by museum tourists.	0.000	Sig.	Accept the null hypothesis

Table 5.1 continued

Ha6	Age negatively moderates the influence of Past Experience on Behavioral Intention.	0.695	NS.	Reject the null hypothesis
Ho7	Perceived Risk has a significant negative effect on the Behavioral Intention of VR technology by museum tourists.	0.005	Sig.	Accept the null hypothesis
Ha7	Age positively moderates the influence of Perceived Risk on Behavioral Intention.	0.666	NS.	Reject the null hypothesis
Ho8	Behavioral Intention has a significant positive impact on the Usage Behavior of museum tourists.	0.000	Sig.	Accept the null hypothesis
Ho9	Behavioral Intention has a mediating effect among Performance Expectancy, Effort Expectancy, Social Influence, Design Quality, Hedonic Motivation, Past Experience, Perceived Risk, and Usage Behaviour.	0.000	Sig.	Accept the null hypothesis
		0.000		
		0.000		
		0.000		
		0.000		
		0.007		

Table 5.1 summarises the validation results for the 16 hypotheses established in this stage, with 11 being validated. All hypotheses concerning independent variables were confirmed. This study further examines the outcomes of these 16 hypotheses, specifically:

1. Performance Expectation has a significant positive effect on the Behavioural Intention of VR technology by museum tourists.

2. Age has a negative moderation in the impact of Performance Expectation on Behavioural Intention.

Performance expectation refers to the user's anticipation of benefiting from digital technology (Pramudito et al., 2023), such as helping tourists better understand museum exhibits or acquiring more knowledge through VR products. When museum tourists have such awareness and cognition, it can encourage them to use the technology. The significant positive effect suggests that as tourists' performance expectations for VR technology increase, their willingness to use it will also rise (Setiyani et al., 2023). According to the empirical data, this hypothesis is consistent with research expectations.

As previously discussed, performance expectation significantly impacts tourists' behavioural intentions (Lin & Huang, 2023). This study considered whether there is a negative moderation effect by age, meaning that as age increases, there is a change in the degree to which performance expectation impacts behavioural intention. The data confirms this hypothesis, indicating that as age increases, the positive impact of performance expectation on behavioural intention might weaken. Some researchers also believe that performance expectations change with age. For example, Guttentag & Smith (2017) argue that older individuals expect apps to help them solve problems more quickly and cost-effectively, leading them to prefer using apps. Based on the researchers' careful research on VR technology in museums in Guangdong, most VR products are primarily educational. This is more appealing to younger tourists who have higher expectations for museums. Many students visit museums to learn about history or gain more knowledge (Pavlou & Kadji-Beltran, 2024; Mujtaba et al., 2018). Younger tourists have higher performance expectations for these VR products than older tourists. They believe these new media products are useful, allowing them both to gain knowledge and have a fun experience (Yin et al., 2023). This does not mean that older tourists do not benefit from VR technology, as

the mindset and needs of older tourists differ from those of younger ones. Many older tourists come to the museum to accompany their families, for social purposes, or to pass the time (Falk, 2016). They prefer to benefit from a relaxed, interactive atmosphere. Their demand for knowledge is not as high as younger tourists, but they hope to obtain visual or psychological enjoyment from it (Su & Teng, 2018). In comparison, younger tourists undoubtedly have higher performance expectations for VR products.

Considering these two hypotheses outcomes, although age affects the performance expectations of museum tourists, tourists of all age groups find performance expectations important (Wen et al., 2023). They believe the VR technology in museums is useful, and they would be inclined to use it (Phang & Kong, 2023). The study data reveals that the positive influence of performance expectation on behavioural intention might be weaker as age increases, but the P-value is not high. These findings provide significant insights for this study, suggesting further research on how museums' VR technology strategies can offer more satisfactory experiences for tourists of different ages.

3. Effort Expectancy has a significant positive effect on the Behavioural Intention of VR technology by museum tourists.

4. Age did not have a negative moderating effect on the influence of Effort Expectancy on Behavioural Intention.

The perception of the ease of use of VR technology by museum tourists is one of the key factors determining their willingness to try and use the technology. The data confirms this hypothesis, highlighting the central role of ease of use in technology adoption and satisfaction.

This significant positive effect implies that if museum tourists feel the effort required to use VR technology is low, they would be inclined to use it (Rodrigues et al., 2016).

The hypothesis outcome 4 also suggests that regardless of age, museum tourists believe that using VR technology requires effort and time. This research result is similar to the conclusion of Vishwanath (2023), whose findings also indicate that older users may find it slightly more challenging to learn and use VR technology, although the difference is not significant. This universal notion across ages means that museum tourists of different age groups have similar perceptions regarding how effort expectancy affects the behavioural intention towards VR technology.

5. Social Influence has a significant positive effect on the behavioural intention of VR technology by museum tourists.

6. Age did not have a negative moderating effect on the influence of Social Influence on Behavioural Intention.

This study considers social influence to include the VR product usage environment and peers, indicating that these factors influence museum visitors' behaviour. The establishment of this hypothesis is consistent with the conception of this study. During the research, the researcher found that museum tourists in the Guangdong area prefer to travel in groups, mostly in pairs or with multiple people (Zhao, 2018). Therefore, the personal behaviour of tourists is greatly influenced by social factors (Phang & Kong, 2023). Firstly, encouragement from family or friends who accompany the tourists can influence their perceptions, leading tourists to think, “I might as well try it too”. The herd mentality encourages tourists to use VR products

(Anderson, 2019). Secondly, tourists are also influenced by the ambience of the current environment. For example, the Maritime Silk Road Museum in the Guangdong region has placed VR products in a dedicated VR experience room. This room features mood lighting and music; many tourists are inclined to try VR technology under its ambience (Li, 2019). This needs to consider the VR product's thematic content and consider the museum's display.

The hypothesis outcome 6 shows that the degree of social influence on the behavioural intentions of museum tourists using VR technology is similar across different age groups. Firstly, among museum tourists, there is a high probability of family trips and group outings (Giannini & Bowen, 2019), which the companions will influence. The researcher observed during the research that when young people desire to use VR products and display positive behaviour or encouragement among family tourists, older tourists accompanying them will also be intrigued to try it (Tu, 2018). The phenomena observed on-site by the researcher are consistent with this conclusion.

7. Design Quality significantly positively affects the Behavioural Intention of VR technology by museum tourists.

8. Age negatively moderates the influence of Design Quality on Behavioral Intention.

This study believes that design quality encompasses various aspects of the VR experience, including hardware configuration, technical support, graphic quality, user interface, and overall aesthetic perception. This hypothesis outcome 7 indicates that design quality significantly affects museum tourists' use of VR technology. From another perspective, high-quality hardware supports high-resolution imaging, and a clear and straightforward interface design will better attract users, stimulating their exploration or helping them learn how to

operate the device (Ruiz et al., 2021). This hypothesis outcome 7 indicates that museum tourists highly value hardware choices and display quality, and museum staff and design teams must consider further enhancing design quality.

The hypothesis outcome 8 suggests that as age increases, the positive impact of design quality on behavioural intention might weaken. This means that museum tourists of different ages have varying reactions and evaluations of design quality. Younger users are always attracted by dazzling and exquisite interface designs and prioritise novel, creative design elements (Johnson, 2020). They also have high expectations for the storyline content and transition effects of products and even pay attention to the ambience during use (referring to lighting and sound effects). The current interface design is user-friendly for younger tourists, leaning more towards their taste and aesthetics, so their design quality evaluation is better.

In contrast, older tourists rate design quality lower because they believe the design quality of the VR product does not offer them much assistance. As they age, their physical capabilities decline, and intricate interface designs can hinder their operations, increasing their error rate (Zhou et al., 2022). They may also find VR products daunting. Hence, they would prefer equipment configurations to be simpler and more suited to their abilities.

Based on these findings, future studies must investigate the characteristics and needs of tourists from different generations to strike a design balance. This also provides insights for museum staff and design teams on optimising designs, considering maintaining high-quality design while balancing the needs and experiences of tourists from different age groups.

9. Hedonic Motivation has a significant positive effect on the Behavioural Intention of VR technology by museum tourists.

10. Age did not have a negative moderating effect on the influence of Hedonic Motivation on Behavioural Intention.

The hypothesis outcome 9 indicates that museum tourists, when choosing to use VR technology, are significantly driven by hedonic motives. This suggests that museum tourists are concerned about acquiring knowledge or information and seek joy through VR technology.

From the hypothesis outcome 10, the hedonic motivation driving the behavioural intention of museum tourists to use VR technology is not related to age (Cardoso et al., 2020). Tourists of different ages hope to gain substantial knowledge and seek fun through VR technology. For younger people, exquisite interface designs or some gamified elements can create an immersive atmosphere, enhancing the pleasure and excitement of the VR experience and promoting joyful learning (Pandian et al., 2020). However, entertainment-oriented designs, straightforward interface operations, and comfortable interaction methods for older tourists bring a delightful and joyful experience. This result implies that when promoting VR technology experiences, greater attention can be paid to hedonic learning or interaction-driven experiences.

11. Past Experience significantly positively affects the Behavioural Intention of VR technology by museum tourists.

12. Age did not have a negative moderating effect on the influence of Past Experience on Behavioural Intention.

From the conclusions of the above assumptions, past experience, as a positive factor, can promote the interest and inclination of museum tourists towards VR technology. Moreover, the conclusion suggests that age does not affect the positive influence of past experiences on

current behavioural intentions. This finding highlights the significant role of past experiences in shaping and driving the current behavioural intentions of tourists. Museum tourists rely on their positive past experiences when deciding whether to use VR technology. The study by Loureiro and Ferreira (2020) obtained feedback from over 400 survey responses, affirming that past positive user experiences drive museum visitors to revisit and explore again. Therefore, museum research teams need to objectively analyse and study successful VR cases from the past, ensuring tourists have a pleasant experience and encouraging them to revisit, perhaps multiple times (Lee et al., 2020).

13. Perceived Risk significantly negatively affects the Behavioural Intention of VR technology by museum tourists.

14. Age did not positively moderate the effect of Perceived Risk on Behavioural Intention.

From the results of the H13, the potential risks museum tourists perceive regarding VR technology greatly limit their willingness to interact with such technology. Perceived risk is a negative psychological factor (Nazir & Tat, 2021). When museum tourists perceive that the technology carries safety risks or fear it due to its high-tech nature, this can affect their acceptance of technology (Habibi& Rasoolimanesh, 2021).

From hypothesis outcome 14, individuals across different age groups perceive the relationship between risk and behavioural intention similarly. This means that young and older museum tourists view perceived risk as a negative psychological factor, hindering their acceptance and use of VR technology. No researchers in the field have tested perceived risk for different age groups. However, Sun and Guo (2022) also mentioned that both older and younger

users have certain risk concerns, and these emotions can impact the use of new technological products. This conclusion also indicates that museum research teams must focus on eliminating negative perceptions across all age groups to be more accepting of VR products.

15. Behavioral Intention significantly impacts the Usage Behaviour of museum tourists.

16. Behavioral Intention has a mediating effect among Performance Expectancy, Effort Expectancy, Social Influence, Design Quality, Hedonic Motivation, Past Experience, Perceived Risk, and Usage Behaviour.

The hypothesis outcome 15 suggests that behavioural intention has a significant positive influence on usage behaviour. This conclusion is crucial, as it plays a central role in understanding and predicting the interactions of museum tourists with VR technology. If museum tourists have a strong behavioural intention towards digital technology, the likelihood of their usage will be greater (Chuang & Dong, 2019).

The hypothesis outcome 16 illustrates that behavioural intention mediates these influential factors and Usage Behaviour. From the established assumptions, these factors significantly influence behavioural intention. Apart from perceived risk, which has a significant negative influence, the remaining six factors all drive museum tourists' behavioural intentions, leading to positive tendencies towards usage behaviour and influencing the decision to act. When using the UTAUT2 model as a theoretical framework, most researchers in the same research field also mention factors relevant to this study. For instance, Lin and Huang (2023) discussed five factors in their paper: performance expectancy, effort expectancy, social influence, facilitating conditions, and hedonic motivation, with four of these factors overlapping with the present study. This reveals the complex forces promoting and hindering tourists from

accepting VR technology, allowing for accurately measuring visitor intentions and considering how to translate them into actual behaviour.

To summarise the 16 hypothesis outcomes, the study's first-phase conclusion is that performance expectancy, effort expectancy, social influence, design quality, hedonic motivation, and experience significantly influence museum tourists' behavioural intentions towards using VR technology. The factor perceived risk significantly negatively impacts the behavioural intentions of museum tourists when using VR technology. Furthermore, age negatively moderates the influence of performance expectancy and design quality on visitor behavioural intentions. Also, positive behavioural intentions can significantly impact tourists' usage behaviour.

5.2.2 Discussion of the Phase One

The empirical results of this study reveal significant influences of several factors on the behavioural intention of museum tourists to use VR technology. These significant influencing factors align with the initial assumptions of this study. When formulating the theoretical framework for this research, it was assumed that the use of VR technology by museum tourists is mainly influenced by individual factors, external factors, equipment quality, and usage experience. The seven significant influencing factors identified in this study correspond to the four categories mentioned above. Most researchers in the same research field using the UTAUT2 model as a theoretical framework also mention factors relevant to this study. For example, in the article by Lin and Huang (2023), five factors are mentioned: performance expectancy, effort expectancy, social influence, facilitating conditions, and hedonic motivation. Among these, four factors overlap with this study. The study believes that performance

expectancy, effort expectancy, and hedonic motivation can be understood as positive and proactive perceptions of individual tourists. Perceived risk, however, is a negative perception (Wu et al., 2020). Social influence, as an external environmental factor, design quality, and past experience directly or indirectly affect these individual perceptions.

From the perspective of positive individual perception factors, performance expectancy is synonymous with perceived usefulness in the TAM (Technology Acceptance Model) theory (Ammenwerth, 2019). This necessitates that VR technology should deliver high benefits. The empirical results indicate that performance expectancy significantly influences tourists' behavioural intentions. However, it is important to consider if the high returns from technology vary for tourists of different age groups. As age increases, performance expectancy negatively modulates behaviour intention, indicating that perceptions about high returns from technology differ with age. Younger tourists demand more cultural knowledge from VR technology, showing a stronger thirst for knowledge than older tourists. However, older tourists might not seek knowledge as intensely (Blažič & Blažič, 2020). Elderly users still acknowledge the performance of new media technologies, but they may prioritise enjoyment, which differs from the focus of younger users (Jin et al., 2019). Overall, museum tourists of all ages believe that VR technology offers high returns, and this perception will drive their use of the technology. However, this desire varies with age; as age increases, the perceived benefits from VR technology may decline (Yang et al., 2022).

Regarding effort expectancy, it aligns with the perceived ease of use in TAM. According to the empirical results, museum tourists of all ages acknowledge the importance of this factor in shaping their behavioural intentions. If they find the museum's VR products user-friendly,

they will feel more confident using them (Lin & Huang, 2023). VR technology is more complicated than mobile devices like phones or tablets (Fan et al., 2023). This research found that current museum VR products are mainly PC-connected VR headsets and standalone VR headsets, especially in the Guangdong area (Hou & wang, 2022). These products require tourists to wear VR headsets and sometimes hand sensors, which can be complex for some. Thus, museums should consider VR technology's simplicity and ease of use, which is crucial for all age groups. The study by Shehade and Stylianou-Lambert (2020) mentions that museum visitors encompass a wide age range. Therefore, museum staff must pay attention to the perspectives of visitors of all ages to design VR experiences accordingly. For example, whether it is necessary to provide usage instructions for visitors of different age groups or to assign staff to supervise the equipment. This is similar to the conclusion of this study.

At the same time, this study believes that design quality and effort expectancy are often correlated. High design quality indirectly affects the usability of VR products (Patel et al., 2020). Design quality encompasses hardware, imaging quality, user interaction methods, and interface design, most of which relate closely to usability (Sutcliffe, 2022). If the design quality is high, users find the product easier to use (Sagnieret et al., 2020), enhancing their effort expectancy. Museum researchers should consider optimising current VR hardware and headsets, such as redistributing the weight of the VR headset to reduce user fatigue or simplifying complex wearable sensors to voice recognition or simple gesture control to make the interaction more natural and user-friendly. Furthermore, user interaction methods should cater to different age groups' unique needs and characteristics (Benyou, 2019). The empirical results regarding

design quality and effort expectancy suggest a pressing need to enhance the usability of VR technology hardware and user interaction methods.

Regarding the content of design quality, another important element is interface design quality. A high-quality interface design can greatly influence the overall user experience (Benyou, 2019) and affect other factors directly or indirectly. The interface design quality plays a pivotal role in the experience of tourists using VR technology. Firstly, high-quality interface content allows users to gain more knowledge and content (Bodker, 2021), enhancing the performance expectations of tourists. Secondly, a high-quality interface guide design can help users quickly learn how to operate VR products, increasing tourists' effort expectations.

Furthermore, good interface visual design can enhance the immersion of the tourists, creating a comfortable visual atmosphere for them and serving as a facilitator for enhancing the visitor's hedonic motivation (Farman, 2020). Design quality plays a crucial role in product devices, service experiences, or digital interfaces, all of which involve design quality issues (Lina & Ahluwalia, 2021). Thus, this is also a factor worth paying attention to and researching deeply; many museum tourists recognise it, significantly influencing their behavioural intentions.

Another positive and proactive visitor perception is hedonic motivation. The empirical results of this study show that museum tourists of different age groups believe that hedonic motivation significantly influences their behavioural intentions. Hedonic motivation focuses on an individual's intrinsic needs for pleasure and satisfaction (Al-Azawei & Alowayr, 2020). Hedonic needs emphasise sensory and emotional experiences compared to practical or functional needs (Oluwajana et al., 2019). This involves whether VR products make tourists

happy, comfortable, or satisfied. A good psychological perception of the product motivates tourists to use it. Tourists have expectations for VR technology, which may vary among different age groups. For instance, young tourists may feel delighted by gaining vast knowledge through VR products, and a good atmosphere can also make them happy (Aziz & Friedman, 2019).

In contrast, a straightforward operation or high-quality interface design makes the usage process enjoyable for older tourists. Hence, tourists' hedonic motivations increase, promoting the use of VR technology. This conclusion of our study is similar to the viewpoint of Kim and Hall (2019), who utilised the HMSAM model to investigate the impact of perceived enjoyment on museum visitors. They categorised the survey participants into visitors and non-visitors, and the results indicated that the motivation for enjoyment promoted the interest and behaviour of the survey participants towards new media technologies.

The relationship between design quality and hedonic motivation is also close. National museums in the Guangdong region have unique interface content due to the local linguistic characteristics of Guangdong (Wen, 2017). Thus, the design involves unique dialect dubbing and text explanations. To allow non-local tourists to correctly understand and immerse themselves in the traditional cultural connotations of the Guangdong region, the virtual environment must accurately represent the local culture (Yi & Tao, 20223). Problems arise when tourists cannot understand the content in environments without text standards or text explanations. For instance, when displaying Cantonese opera culture (a major drama in Chinese opera, performed in Cantonese, integrating singing, dancing, martial arts, and dialogue), tourists may virtually arrive at the Cantonese opera stage via VR technology but fail to understand the

meaning of dance movements or dialogues (Feng & Huang, 2023). Consequently, due to the low design quality, tourists' hedonic motivation decreases, affecting their behavioural intentions. On the contrary, if the museum research team provides subtitles and explanations when tourists watch the virtual Cantonese opera performance (Feng & Tang, 2023), it will create a pleasant atmosphere for use and learning, increasing tourists' hedonic motivation and promoting their behavioural intentions.

Past experience represents the accumulation of experiences tourists have had before using the current VR technology. These past experiences influence tourists' present and future behaviours. The empirical results of this phase show that tourists of all age groups believe that past experiences significantly positively affect their behavioural intentions. However, it promotes behavioural intentions only when the past experience is positively evaluated. The premise of positive evaluation is that tourists had a pleasant and rewarding experience when using VR products in the past, leading them to believe that past experiences effectively drive their current decisions (Dedeoglu et al., 2018).

In the initial conception of this study, social influence, as an external environmental factor, would affect the behavioural intentions of museum tourists. According to the empirical results of this phase, the assumption is consistent with the initial conception of the study. Social influence can be understood as influenced by the current environmental atmosphere, societal developments, and others. Furthermore, social influence can also be described as the psychology of conformity, and users are greatly influenced by herd mentality (Ou et al., 2022).

Simply put, there are two forms of conformity behaviour: compliance, where the individual changes their behaviour under external pressure (requests or encouragement) but does

not necessarily change their internal beliefs or attitudes. The other is internalisation, where individuals change their behaviour and internal beliefs or attitudes to align with the group. There are two reasons for conformity: informational social influence and normative social influence (Raafat et al., 2009). Others and the current environment influence museum tourists more. First, they receive encouragement from friends and family. When they actively use it, they intend to use it.

Additionally, when they see the current environment and others actively using it, they are inclined to use VR products. For example, in the VR exhibition of the Guangdong Hakka Museum, some tourists, seeing their peers using VR and being encouraged to do so, will likely try it out. They trust their peers and are willing to accept their recommendations.

Perceived risk differs from the other six significant positive influencing factors as it is a pessimistic perception factor for tourists. Positive psychological cognition drives individual decision-making, while negative cognition inhibits it (Lövdén et al., 2020), general understanding. The factors contributing to perceived risk are multifaceted. Tourists using VR technology are mainly divided into two aspects: first, they will assess the risks of VR products before use, like if there are safety hazards or concerns about hygiene after multiple uses. Secondly, they consider whether they will experience physical discomfort during use, such as dizziness or physical discomfort due to device response delays or instability. Therefore, museums need to consider eliminating the negative perceptions of tourists, for example, by showing how to wear equipment properly or providing instructions. In summary, museum research teams must deeply analyse factors that hinder tourists and find ways to reduce their negative psychology.

This study compared the empirical results of this phase with previous research findings, showing that the empirical results of this phase are consistent with the conclusions of previous literature. The most frequently mentioned significant influencing factors in previous literature are perceived usefulness, perceived ease of use, social influence, and information and system quality (Errichiello et al., 2019; Rhee, 2019). These hypotheses have been reflected in this phase and verified to have a significant positive influence. Some literature also focuses on the significant influence of psychological cognition on tourists' behavioural intentions (Wang, 2023). Some researchers mentioned the importance of pleasure experience, perceived enjoyment, and playfulness to tourists' intentions to use (Wu, 2021; Carvajal-Trujillo et al., 2021). This study's hypotheses also reflect this and are divided into pleasure motivation positive psychology and perceived risk negative psychology, both of which have been verified. The hedonic motivation has a significant positive influence, while perceived risk has a significant negative influence.

The consistency of the empirical results of this phase with previous research indicates the reliability of the findings of this phase. It means the mainstream theories or models in this research field have received further support. At the same time, the extended UTAUT2 model used in this study has also been verified, further strengthening the robustness and reliability of this theoretical framework and can be further studied. It also indicates that this study's research, data collection, and analysis tools are accurate and effective.

5.3 Resolving Research Question [RQ1]

The conclusions drawn in this phase answer the research question [RQ1]: What were the main factors influencing the intention of museum tourists in the Guangdong region to use VR technology?

The results of this phase indicate that the main factors affecting the behavioural intention of museum tourists in the Guangdong region to use VR technology are performance expectations, effort expectations, social influence, design quality, hedonic motivation, past experiences, and perceived risk. According to the empirical results of this phase, the first six influencing factors have a significantly positive impact on the behavioural intentions of museum tourists to use VR technology, while the perceived risk factor has a significantly negative effect.

The results of this research stage are consistent with the findings of most researchers in the same field. From the conclusions of relevant articles using the TAM extension model or the UTAUT extension model, it was found that performance expectancy, effort expectancy, social influence, system information quality, and hedonic motivation are the five most important factors, and they are also the most frequently mentioned significant positive influences by Wu (2022) and Bachiller et al. (2023). Jiang et al. (2022) and Shehade (2020) posited that perceived usefulness and perceived ease of use are the most basic and important two factors. This study also agrees with this view. When museum visitors perceive this VR technology as cost-effective and easy to use, they will certainly be willing to use it.

In addition to social influence, system information quality, and hedonic motivation, some researchers are also very certain about their influence, especially in articles using the Field Theory theory, emphasising the importance of social influence and studying the impact of social influence on visitor behavioural intentions (Deng et al., 2023). As for system information quality,

this factor involves the compatibility of hardware with users and aspects of device interface design, and needs to consider the audience's actions, behaviors, characteristics, and needs (Bodker, 2021).

In addition to significant positive influences, this study, like other previous studies, also focuses on perceived risk as a significant negative influencing factor. Perceived risk hinders users from using new media products. When they believe using these products carries a risk or may cause harm to their bodies, they will develop avoidance psychology and respond negatively (Chao, 2019).

This phase delved into the behavioural intention of museum tourists to use VR technology, revealing the influences and interactions of several crucial factors. The PLS-SEM modelling method was employed, and the SmartPLS analysis tool was used for analysis. The data was rigorously verified and understood, and in-depth interpretations and explanations of the results were provided.

The analysis of each variable shows that these variables influence each other in analysing tourists' intentions and processes of using VR technology. The quality of the device hardware and the interface design (design quality) enhance the ease of use (effort expectation) of VR technology (Shao et al., 2020). If tourists find the VR technology easy to operate (effort expectation) and the interface design simple and comfortable (design quality), it helps them obtain more useful information (performance expectation) and hedonic motivation (Juliana, 2023). Thus, based on a good user experience (past experience), tourists will look forward to the next VR experience (Yue, 2021).

Using the Guangdong Yue Opera Museum as an example, if the museum staff create a VR product themed around a virtual Yue Opera performance stage, the reasons that motivate tourists to use VR technology include positive recommendations from friends and the current environment (social influence), tourists believe that they can learn more about Yue Opera culture through VR (performance expectation), the perception that the technology is easy to use requiring just wearing VR goggles and making simple gestures (effort expectation), and the high-quality equipment and excellent interface design enhance the immersion (design quality). Tourists believe VR can make them happier (hedonic motivation) based on good user experiences (past experiences).

In summary, the interactions among these variables provide a complex and rich perspective to understand the behavioural intentions towards VR technology (Yin et al., 2023). By studying these relationships in-depth, museum staff can enhance tourists' behavioural intentions more effectively.

In addition, this study effectively extended the existing UTAUT2 model by revising it to include multiple variables. From the state of data collection and analysis, the extended model effectively helps researchers study the behavioral intentions of museum visitors in Guangdong towards VR technology and identify the key factors influencing their intentions. This indicates a high level of accuracy in the revised UTAUT2 extended model used in this study. It also suggests that the hypotheses set before the experiment were reasonable, emphasizing the validity of the study's data and reflecting the academic value of this research.

This research also considers whether museum tourists of different age groups exhibit significant differences regarding these significant influencing factors. If significant differences

exist, the museum research team needs to adjust the VR technology plan according to the distinctive features of tourists from different age groups. This is also the focus of the subsequent second phase of the study.

5.4 Discussion of the Phase Two

The findings of this phase reveal that museum tourists do not exhibit age-related differences in their perceptions of Performance Expectancy, Social Influence, and Past Experience. In other words, tourists from all generations acknowledge the benefits of VR technology and find it useful. This consensus boosts the confidence of museum R&D teams.

Regarding Social Influence, results confirm that peers or family influence tourists from all generations. Older tourists might be encouraged by younger ones to overcome their apprehension towards new technology and try it out. Younger tourists might be motivated by positive feedback from other users (Errichiello et al., 2019). Tourists from all generations exhibit behaviours that conform to or benefit from these influences, influencing their decisions (Lee, 2020). This is a common psychological and behavioural trait.

The empirical results indicate that past experiences with VR technology influence the current behavioural intentions of tourists from all generations. This stresses the importance of ensuring that VR experiences are inclusive for all age groups. For instance, the Guangdong Cantonese Opera Museum designed five VR devices based on opera tracks. When tourists try their first VR device, they derive cultural knowledge, pleasure, and relaxation, translating into a good user experience. Such positive past experiences prompt tourists to try other digital technologies (Hsu & Liang, 2022) and may even encourage repeat visits to the museum.

The empirical results indicate that these three key influencing factors are equally important across generations, with little variation. This means tourists from different generations have general performance expectations, universal social influences, and similar past experiences. Based on this finding, this study reflects on the universal appeal of VR technology in museums for tourists of different generations.

Furthermore, at this stage, it was found that there are age differences in the impact of tourists on effort expectancy, design quality, hedonic motivation, and perceived risk. These differences might be due to the different social, cultural, and technological backgrounds faced by tourists from each generation as they grew up. According to the empirical results, more in-depth analysis and research are required to understand the reasons for these differences. By doing so, the needs of museum tourists from different generations regarding VR technology can be better met, providing more effective user experience methods.

China's Gen X differs from Western Gen X, a distinction resulting from the nation's socio-economic development and upbringing environment (Sun & Wang, 2020). The childhood of China's Gen X primarily occurred during the planned economy era. They witnessed the rise of technology and grew alongside the evolution of digital technology (Yang, 2022). It was not until the early 1990s that this generation in China began to engage more extensively with digital products. They were also the first to experience the efficiency and challenges of digitisation in the workplace. By the 21st century, China's Gen X was closely intertwined with digital technology (Yang & Lau, 2015).

In summary, China's Gen X are both observers and participants in the rapid development of digital technology. They acknowledge the vast societal benefits of digital technology, as it

has significantly improved their work and life. Hence, they are actively pondering how to balance the growth of digital technology.

Conversely, there is little difference between China's Gen Y and Z and their Western counterparts. China's Gen Y grew up during China's rapid economic development and was exposed to digital technology, especially the internet and mobile communications, from a young age. They are active online and on social media (Yang et al., 2020). Their attitude towards digital technology is receptive and friendly, and they consider how to generate value in the digital world. China's Gen Z was born into a highly digitalised environment (Tseng et al., 2021) and relies heavily on digital technology and social media. They habitually seek knowledge or emotional value from technology (Liu, 2021). By analysing China's Gen X, Y, and Z, these characteristics and descriptions help this study understand the generational differences regarding specific influencing factors and draw conclusions based on their unique traits.

Gen Y and Z tourists rate higher effort expectancy than Gen X tourists. This might reflect the younger generations technical acceptance, product adaptability, or learning ability towards VR technology products compared to Gen X. Specifically, compared to Gen X, Gen Y and Z had earlier and more frequent contact with digital technology during their growth (Calvo-Porrall & Pesqueira-Sanchez, 2020). Gen Y tourists began exposure during childhood, while Gen Z has been immersed in digital technology since infancy. As a result, their adoption and mastery of new technologies are swift. Influenced by their upbringing, Gen Y and Z tourists are accustomed to constant learning and adaptability, and their product adaptability and learning ability are strong (Luger et al., 2022). VR products differ from typical digital products (like phones and tablets) in that they often present greater operational challenges and require more learning time.

Thus, while Gen X tourists acknowledge the influence of effort expectancy and are willing to invest time and energy to learn VR technology, they need to expend more effort and time than Gen Y and Z tourists. Hence, there is a generational difference. In conclusion, Gen Y and Z tourists rated higher in effort expectancy than Gen X tourists, resulting from their living environment, growth experience, and familiarity with VR technology.

Tourists from Gen Y and Gen Z rated the design quality higher than tourists from Gen X. This empirical result indicates that tourists from Gen Y and Gen Z have a higher appreciation for design quality. In contrast, the design quality evaluation is significantly lower for Gen X tourists. Firstly, Gen Y and Gen Z tourists have a higher acceptance of the hardware support for VR products because their familiarity with VR technology products and their grasp of the hardware support is better than that of Gen X tourists (Li et al., 2019). If the hardware support is difficult to operate for Gen X tourists, it will reduce their design quality evaluation. This is one reason for the generational differences.

Secondly, regarding the interface design of VR products, a good interface design quality can positively drive tourists' behavioural intentions (Braham et al., 2021). It can be seen from this that Gen Y and Gen Z tourists are relatively satisfied with the product's interface design. However, Gen X tourists have stricter requirements for interface design. They prefer a simple and clean interface design and reject flamboyant design elements. For example, conventional ICON buttons have been designed with graphic or font deformations, which increases their operating difficulty(Wikström, 2022). The Guangdong Maritime Silk Road Museum's VR product interface design uses small fonts, making the author wonder if this could cause visual discomfort for older tourists. Many interface designs do not consider elderly tourists, and for

them, a complex menu structure or redundant functions can impede their operations (Alsswey & AI-Samarraie, 2020), or excessive animations, ICON effects, and transition animations can confuse them and cause visual fatigue (Saari & Hynninen, 2021). All these issues affect the elderly tourists' evaluation of design quality and also influence their behavioural intentions and user experience with VR technology.

Lastly, an important issue to focus on for Gen X tourists is guide design. Gen Y and Gen Z tourists, who are familiar with digital technology, can handle more complex operating procedures or steps (De Cicco et al., 2020). However, for older tourists, the importance of guide design lies in hardware operation guides and interface guide design. Hardware operation guides can help Gen X tourists learn to operate devices, improving their design quality evaluation and effort expectancy (Li & Luximon, 2020). On the other hand, the interface guide design is important as older tourists are unfamiliar with VR technology and have doubts and misunderstandings about the functions and operation instructions of the interactive interface (Neves & Vetere, 2019). Older tourists have a higher interface operation error rate when using VR products, affecting their design quality evaluation. Moreover, it also affects their hedonic motivation.

From the above content, it is clear that the generational differences in effort expectancy and design quality mainly arise from differences in the familiarity and sensitivity of different generations to VR technology. Gen Y and Gen Z tourists are more in control of and adaptable to digital technology than Gen X tourists (Labovitz & Hubbard, 2020). Thus, the museum research team needs to focus on how to solve the learning and mastering issues of Gen X tourists

with VR technology, to help them quickly grasp the operating methods of VR technology, and to pay attention to the impact of interface design on Gen X tourists.

The generational differences in hedonic motivation show that Gen Z tourists are significantly higher than Gen X and Gen Y tourists in terms of hedonic motivation, with no significant difference between Gen X and Gen Y tourists. This study believes this relates to the tourists' living environment, educational background, and visitation needs. Firstly, compared to the other two generations, Gen Z tourists have become accustomed to obtaining knowledge and information from digital products and rely on digital products to a certain extent (Hernandez-de-Menendez et al., 2020). They are more likely to adapt to and enjoy the rewards brought by VR technology. Some Gen Z tourists have different visitation purposes than the other two generations and visit museums to gain knowledge. They expect VR technology and look forward to gaining knowledge from VR products. When they acquire knowledge and useful information from them, they feel satisfied and happy (Buhalis & Karatay, (2022). Other generational tourists, although they do not rate hedonic motivation as highly as Gen Z tourists, recognise its importance, and they also expect to obtain high returns from VR technology, especially to feel relaxed or happy. Thus, the VR products of the museum cater to the needs of tourists from different generations, which brings them more pleasure and promotes their behavioural intentions.

According to the empirical results, there are generational differences in perceived risk, with Gen X and Gen Y tourists significantly higher than Gen Z tourists. There are two main reasons: the difference in growth backgrounds. For Gen X and Gen Y tourists, their understanding of VR technology is unfamiliar, so their first reaction is to resist and fear it. Gen

Z tourists do not have as strong fear and resistance to new technology as Gen X and Gen Y tourists (Childers & Boatwright, 2021).

Another reason is the difference in family roles. Gen X and Gen Y tourists initially exhibit a cautious attitude towards new technologies, assessing the unknown risks stemming from their life experience and cultural understanding (Errichiello et al., 2019). The family roles of Gen X and Gen Y tourists differ from those of Gen Z tourists. Many Gen X and Gen Y tourists play the role of parents or even grandparents. One of their purposes for visiting museums is to accompany the family or educate their children. This study believes that these differences in family roles will affect their psychological perceptions of VR technology, that is, the risk assessment of VR technology. The risk assessment involves multiple factors, such as health risks. Gen X and Gen Y tourists worry about the potential health threats of VR technology to themselves and their families (Calvo-Porrall & Pesqueira-Sanchez, 2020), such as whether wearing VR headsets will harm adolescents' eyesight or accidents will occur during physical movements or transitions. Moreover (Li et al., 2022), some older tourists are concerned about the hygiene and disinfection of devices (Skoog, 2020), wondering if shared VR equipment harbours bacteria that could cause health problems for themselves and their families.

Compared with previous literature, only a few researchers have focused on the distinctive characteristics of museum tourists. Most researchers give a general overview of museum tourists, and their research subjects are mainly younger groups. For example, Anand et al. (2023), Jonathon and Mcphetres (2019), and Kim et al. (2020) have focused their research on young individuals. Furthermore, some researchers have targeted young tourists and focused on those with higher education levels (Hammady et al., 2020; Jiang et al., 2022). However, there

are indeed differences among museum visitor groups. Therefore, focusing this study on generational differences is meaningful. At the same time, this study also agrees with this limited literature. In previously published literature, Parra (2019) realised the technical difficulties older museum tourists faced, feeling that older individuals struggle in virtual spaces. They rely on more resources for auxiliary operations, and their emotions decline continuously during the process, suggesting that the test tasks pose a significant challenge to older tourists.

Moreover, Hammady et al. (2021) segmented their study group (18-25 years, 26-40 years, and 41-60 years). They had them simulate the operation of a mixed reality device called “Museum Eyes” to observe their operational performance and behavioural intentions. The test results showed that the younger tourists had the highest acceptance, and as age increased, their behavioural intention and operational level exhibited a stepwise decline. Palau-Saumell and others (2016) stated that the functionality of digital products hinders older users. Still, this problem can be alleviated by upgrading the technology and optimising the interface.

The conclusions of these previous studies are consistent with the empirical conclusions of this study, which confirms the validity of the findings in this research. In summary, the generational differences between Gen X, Gen Y, and Gen Z tourists are primarily due to Gen X’s unfamiliarity with VR technology and their inferior tech-learning capability. Moreover, this study needs to focus on the impact of interface design quality on Gen X tourists. Additionally, this research found that older tourists are influenced by perceived risk, so there is a need to pay particular attention to the risk perceptions of Gen X and Gen Y tourists regarding VR technology.

5.5 Resolving Research Question [RQ2]

The conclusions of this stage address the research question [RQ2]: Were there generational differences in the main factors influencing tourists' behavioural intentions? Specifically, there are generational differences among museum tourists in terms of effort expectancy, design quality, hedonic motivation, and perceived risk.

Through the analysis of sample data, it was found that there are no generational differences among tourists concerning performance expectancy, social influence, and past experiences. This suggests that museum tourists from different generations recognise the benefits of VR (VR) technology. This could be related to the general impression the public has of museums. VR technology in museums is believed to help people acquire new knowledge and understand history and culture (Man & Gao, 2023). This positive product perception also alleviates concerns about VR products, greatly reducing one of their perceived risks, namely the notion that the content might not be suitable for viewing or learning. As for the factors of social influence and past experiences, it makes sense that there is no significant generational difference. Social influence affects behavioural intentions across generations since peers, older or younger generations, can influence individuals. Past experiences emphasise that a good user experience encourages tourists from all generations to revisit or use VR technology multiple times.

It was also found that there are generational differences among tourists regarding effort expectancy, design quality, hedonic motivation, and perceived risk. The main reasons for the generational differences in effort expectancy and design quality are due to the differing growing environments and usage habits between Gen X tourists and those from Gen Y and Z, especially when comparing Gen X with Gen Z. The operational and learning difficulties of museum VR technology are relatively higher compared to other digital technologies, especially for Gen X

tourists. Increased operational difficulty burdens Gen X tourists psychologically, making them feel that “even if I try hard to learn, I might not master it”. Therefore, there is a need to adjust the operational difficulty of VR technology. The design quality is closely related to effort expectancy. One aspect of design quality involves hardware support, which is especially important for Gen X tourists, affecting their design quality evaluation. Differences in design quality also arise from interface designs that have not considered the age characteristics and operational habits of Gen X tourists. Issues like small fonts, overly flashy interfaces, numerous animated transitions, and a lack of user-friendly guides can negatively influence the behavioural intentions of Gen X tourists. Ultimately, the generational differences in effort expectancy and design quality stem from the museum team not considering older tourists’ operational habits and needs.

Additionally, this stage identified a generational difference in hedonic motivation. All generation of tourists believe they can derive pleasure and satisfaction from VR technology. However, Gen Z tourists are more likely to derive joy and satisfaction from these tech products and desire a fun atmosphere for learning new knowledge (Hyun & Kim, 2018). Thus, they have a stronger curiosity and explorative desire for such VR products.

Lastly, a generational difference was discovered in perceived risk. Among the three generations, Gen X and Gen Y tourists are more cautious and concerned about VR technology compared to Gen Z. They tend to evaluate the risks of using VR technology, considering potential threats. Interestingly, evidence from the first and second stages showed that tourists of all ages recognise the benefits of VR technology, implying that their risk assessments see the content or value delivery of the product as positive. This can reduce the influence of perceived

risks. However, attention must be given to dispelling the negative perceptions and impressions of VR technology held by Gen X and Gen Y tourists.

In the second phase of this study, the generational differences in the behavioral intentions of museum visitors in Guangdong towards VR technology were investigated. The study used an extended UTAUT2 model with "age" as a mediating variable, and it was determined that generational differences indeed exist. The presence of these generational differences partially fills the research gap and provides directions for future research. Based on the results of the second phase, the extended UTAUT2 model used in this study can effectively conduct research and explain the behavioral intentions of visitors across different age groups. Therefore, the extended UTAUT2 model demonstrates high explanatory power and validity.

Through the findings of this stage, this research investigates the user needs and behavioural intentions of tourists across generations. It was identified that current VR technology does not cater enough to Gen X tourists, highlighting the need to focus on the requirements of this group. Emphasis should be placed on assisting tourists in quickly learning to operate VR technology and dispelling their negative impressions of it. Based on the discoveries of this phase, subsequent steps will propose methods to improve the behavioural intentions of museum tourists and address the research question [RQ3].

5.6 Discussion and Resolving Research Question [RQ3]

This study has completed data analysis for both the first and second phases, drawing conclusions that fulfil the objectives of each research phase and addressing research questions [RQ1] and [RQ2]. In this section, this study discusses the combined conclusions of the first and second phases, considering methods to enhance effort expectancy, design quality, and perceived

risk among Gen X tourists. It also suggests methods and recommendations to improve the behavioural intentions of museum tourists across all age groups, thereby addressing the research question [RQ3].

From the conclusions of these two stages, it is evident that the behavioural intentions of museum tourists towards VR technology are influenced by seven main factors: performance expectancy, effort expectancy, social influence, design quality, enjoyment motivation, past experience, and perceived risk. Moreover, tourists exhibit generational differences in the four major influencing factors: effort expectancy, design quality, enjoyment motivation, and perceived risk. The analysis and conclusions about significant influencing factors in this study align with the views of most researchers. Most researchers have stated that an effective way to enhance the behavioural intentions of museum tourists is to improve their evaluations of these influencing factors (Xu et al., 2019; Wu & Li, 2015; Nizar et al., 2018). The study also presents improvements and design strategies based on these factors. For instance, Nizar et al. (2018) believe that VR technology should be simplified to meet tourists' usage requirements, making it easier for them to operate. Li et al. (2020), emphasise the need for more comprehensive promotional guidance and training, while Forrest (2013) suggests a good museum atmosphere can attract tourists.

While these strategies can indeed enhance tourists' intentions, there are limitations. The second stage's empirical results show generational differences among museum tourists regarding these influencing factors. Only a few studies have focused on the needs of tourists from different age groups. Such studies provide targeted recommendations, such as Parra (2019) who suggests designers should consider the elderly's physical capabilities, while Chitima and

Mmakola (2023) believe that the primary target audience for VR digital products is the youth, implying content should be more engaging and interface design more vibrant to attract them.

From the empirical conclusions of the two phases, the seven key influencing factors among X, Y, and Z generation visitors are interrelated and closely connected. Therefore, when formulating strategies, multiple key influencing factors can be considered. For example, regarding effort expectancy and design quality, improving interface visual optimization and interface guide design can enhance their willingness to use. Alternatively, for performance expectancy and hedonic motivation, designing various VR usage modes can allow visitors of different age groups to find a suitable VR mode for their experience, thereby increasing their hedonic motivation as they perceive the VR mode as suitable for them. Consequently, the strategies formulated should be inclusive and comprehensive, promoting the adoption and acceptance of VR technology by visitors of different age groups.

This research proposes that while improving the evaluations of the six influencing factors and reducing the perceived risks is vital, different age groups' unique characteristics and behaviours need further consideration. For instance, simplifying the interface for older users might make it uninteresting for younger ones. The strategies need to strike a balance. As a solution, the study suggests offering multiple modes within a product, including a general interface and an elderly-friendly interface, catering to different age groups. This multi-modal functionality can address the generational differences in enjoyment motivation by offering diverse content modules to meet the requirements of different generations.

This study aims to benefit museum tourists of all ages, addressing their specific needs. It also provides specific solutions tailored to the conditions of museums in the Guangdong

region of China and the characteristics of tourists in that region, ultimately enhancing their behavioural intentions towards VR technology.

Based on the aforementioned research conclusions and the characteristics of museums in the Guangdong region, this study proposes five methods to enhance the behavioural intentions of museum tourists to use VR technology.

1. Increase education and training: Museum research teams can introduce educational and training courses to help tourists learn about VR technology. The form of these courses can vary. Firstly, printed operation procedures or illustrative advertisements can be distributed or posted, especially near where the devices are stored. When tourists pick up the VR equipment, they can refer to these illustrations, assisting them in wearing and adjusting the device. Additionally, animated guides can be created to avoid preachy or overly formal presentations since older Gen X or senior Gen Y tourists might resist strict instructional formats (Cavalcanti et al., 2021). Instead, museum teams should think of gentler ways to remind tourists of operating standards, such as using animated museum mascots or engaging, light-hearted text for guidance. A relaxed atmosphere can make older tourists more receptive to this new technology, fostering a higher effort expectancy and ensuring a pleasurable experience (Kim & Ko, 2019).

It is essential to avoid lengthy and complicated instructional procedures and durations. Displaying device operating methods through illustrative ads or animations is effective (Unsworth, 2020). The content of illustrative advertisements should pay attention to the writing style, while animations should not be too long. This ensures tourists learn to operate VR technology quickly, enhancing their confidence and enjoyment. Illustrations or animations are

more engaging than textual explanations, especially for Gen X tourists. This approach also alleviates technological apprehension or fear, reducing their perceived risk.

2. Optimise Interface Design: Interface design is extremely important for museum tourists. An intuitive and user-friendly interface can greatly enhance the visitor's experience and satisfaction (Kačerová et al., 2022). Particularly for Gen X tourists, a good interface design can improve their evaluations of effort expectancy, design quality, and enjoyment motivation. There are various ways to optimise the interface design. First, you can integrate interface elements and reduce complicated ICONS and auxiliary graphics. This step requires testing for different generations of tourists to understand their interface operation habits and requirements. Special attention needs to be given to the requirements of Gen X tourists, as they are sensitive to colours, fonts, and lighting with age (Cheng & Sabran, 2021). For instance, the conventional default font size might be less recognisable for Gen X tourists, but enlarging all fonts might affect the overall interface composition, colour, and visual combination. This research believes that the interface of museum VR products can add optional models, such as an elder-care mode. Nowadays, more and more elder-care modes are applied to digital products. Its main function is to adjust the font, interface colour, or light to meet the needs of the elderly (Kobayashi & Yamamoto, 2019).

Moreover, for Gen X tourists, museums can add a guide feature when optimising the VR product interface. For example, when going to the next page operation, “pop-up” prompts for the next step can assist tourists. At the same time, a “virtual guide” function can be added, primarily designing a virtual figure as the guide to interact with tourists (Hammady et al., 2020). On the one hand, it can guide tourists to make correct choices or commands. On the other hand, it can enhance the fun during use and improve their experience (Sun et al., 2019).

Many exhibitions and cultural contents of museums in the Guangdong region of China are displayed based on the Cantonese language. This unique language feature of the museums in the Guangdong region is one of the reasons they are popular, and its Cantonese culture is well-received by tourists (Cai, 2022). Therefore, the dubbing or copywriting of VR product content displayed in museums in Guangdong always contains a lot of Cantonese dialects. For example, the Guangzhou Cantonese Opera Museum and the Guangdong Foshan Museum are mainly based on Cantonese opera culture and Foshan kung fu, with Cantonese used in opera lyrics and kung fu slogans. Cantonese is essential if VR products are to be created for these traditional cultures (Men et al., 2020). Therefore, museums must balance Cantonese dubbing and museum tourists' experience, ensuring that retaining Cantonese dubbing, music, or copywriting does not affect tourists' operation and viewing experience. Also, some museum tourists in the Guangdong region come from Guangdong, meaning they are familiar with Cantonese, especially Gen X tourists. Their daily language is mostly Cantonese. Given this visitor characteristic, the museum research team might consider adding options in the elder-care mode, such as voice reminders or virtual guides to switch to Cantonese mode. This can make Gen X tourists feel more at home, thus cooperating more with the VR products, enhancing user experience, and thus improving their effort expectancy, performance expectancy, and enjoyment motivation.

3. Design Diverse Content Modes: The museum research team can optimise the content of VR products, introducing learning and enjoyment modes. The learning mode is specifically aimed at museum tourists who visit primarily for learning, emphasising cultural popularisation and knowledge imparting. Though it might seem somewhat dull compared to the enjoyment

mode, the museum research team must closely integrate content with the interface, allowing tourists to learn pleasantly in a good interface design and usage environment (Lee, 2022). This feature is mainly set up for Gen Z tourists, whose primary visiting requirement is learning and secondary is enjoyment. Concurrently, the enjoyment mode can serve other generations of tourists or those whose main goal is enjoyment and whose secondary is learning. This multi-faceted content mode can cater to different generations or visiting requirements, satisfying more tourists' needs. For example, for the Guangdong Hakka Culture Museum, the learning mode can display the cultural history and development theory of Guangdong Hakka, interspersed with a few fun animations to assist tourists in learning (Huang, 2023). The enjoyment mode can showcase the folk scenes of Guangdong Hakka culture, watch traditional dance scenes or instruments, and gain pleasure and satisfaction through the VR product.

4. Increase Protection Measures: According to the empirical results, Gen X and Gen Y tourists have a negative impression of VR products. That is, their evaluation of perceived risk is high, negatively affecting their behavioural intentions. One reason for perceived risk is that Gen X and Gen Y tourists are concerned about potential health threats from VR products (Herz & Rauschnabel, 2019). For example, VR headsets might disorient them in the real world. While making limb movements or body shifts, they might collide with objects, resulting in bodily harm (Bond et al., 2021). Thus, this study suggests museums can provide knee protectors to safeguard vulnerable body joints. At the same time, any obstacles or sharp exposed objects in the operating area can be cleared or covered, and operation zones can be restricted, barring other tourists from entering. These protective measures can effectively lower tourists' potential health threats,

offering them a conducive operating environment and removing psychological barriers (Omon et al., 2019).

5. Regularly Clean and Disinfect Equipment: Museum tourists perceive risk because they believe many people have used these VR products and have not been disinfected by staff for a long time. Thus, they worry about the health and hygiene of the equipment (Ortet et al., 2022), especially Gen X and Gen Y tourists. This study suggests that museum staff regularly disinfect VR products and display cleaning status labels. They can also provide tourists with hand sanitisers or liquid soap to alleviate concerns.

This study offers five improvement methods for museum tourists using VR technology: enhancing education and training, optimising interface design, designing diverse content modes, increasing protection measures, and regularly cleaning and disinfecting equipment. These methods can effectively enhance museum tourists' performance expectancy, effort expectancy, social influence, design quality, enjoyment motivation, and experience. Moreover, they resolve tourists' intergenerational differences in effort expectancy, design quality, and enjoyment motivation. Furthermore, these methods can decrease the perceived risk, a negative psychological perception, especially among Gen X and Y tourists. In summary, the five methods proposed in this study can effectively increase tourists' behavioural intentions towards VR technology.

With the rapid development of technology and the continuous change in visitor preferences, the factors influencing museum visitors' behavioral intentions towards VR technology and their interrelationships may also evolve. For example, as VR technology continues to advance, the usability and quality of the experience will significantly improve. This

may encourage more visitors to try and use VR technology, reducing concerns about technological complexity and the learning curve, thereby decreasing generational differences in effort expectancy. Museums need to closely monitor these changes and adjust their strategies in a timely manner to meet the ever-changing needs and expectations of visitors. By optimizing technology, enhancing experiences, adapting to cultural changes, and providing personalized services, museums can maximize the potential of VR technology, attract more visitors, and enhance their visiting experience.

CHAPTER 6

CONCLUSION

6.1 Overview

This study is conducted in the context of integrating VR technology with museum exhibitions, set against the backdrop of the current state of VR technology development in museums in China's Guangdong region. After analysing the current landscape, an observable pattern emerged: the progression of VR technology exhibitions in national museums within Guangdong has been relatively sluggish. This phenomenon can be attributed to two primary reasons: the uncertain behavioural intentions of museum visitors towards VR technology and the lack of systematic research and theoretical literature to offer guidance in this domain. This study addresses these knowledge gaps and data deficiencies within the field, highlighting the dearth of research focusing on museum visitors' engagement with VR technology in China. Additionally, it underscores the absence of well-defined theories or theoretical models capable of explaining or predicting museum visitors' behavioural intentions, specifically in the Guangdong region. Moreover, a notable dearth of data related to the behavioural intentions of older visitors underscores the lack of insights into cross-generational differences.

By assessing past literature and considering the current developmental status of VR technology in museums, this study has formulated three key research questions: [RQ1]: What were the main factors influencing the intention of museum tourists in the Guangdong region to use VR technology? [RQ2]: Were there generational differences in the main factors influencing tourists' behavioural intentions? [RQ3]: How might the behavioural intention of museum tourists towards VR technology be bolstered?

Each research question carries its own set of objectives. The initial objective entails examining the behavioural intentions of museum visitors towards VR technology, with age serving as a moderating factor. The subsequent goal is to examine the potential generational variances in factors influencing these behavioural intentions. Finally, grounded in empirical conclusions and existing literature, this study offers methodologies and strategies to enhance museum visitors' behavioural intentions towards VR technology.

To embark on this inquiry, relevant literature was collated, and the theoretical models employed by previous researchers were subjected to thorough analysis. A fitting theoretical framework was synthesised from these insights and gaps identified. This model was expanded, and the independent and moderating variables were adjusted to align with the research objectives and questions.

A quantitative analytical approach was chosen, underpinned by formulating a questionnaire rooted in the theoretical framework. The data analysis unfolded in two distinct stages. The first used the Partial Least Squares Structural Equation Modeling (PLS-SEM) methodology, facilitated by SmartPLS analysis software, to validate the model's validity and signify the significance of path coefficients—an undertaking to address the research question [RQ1]. Subsequently, the second stage employed one-way ANOVA in conjunction with SPSS software, unmasking generational disparities in influencing factors and serving to answer the research question [RQ2]. Ultimately, synthesising findings from both stages, a comprehensive analysis ensued, unveiling methods to understand behavioural intentions, capably addressing the research question [RQ3].

Methodologies and procedural steps for data analysis in this study closely adhered to established procedures, safeguarding data accuracy and empirical result validity. These empirical findings effectively addressed the three stipulated research questions, attaining the envisaged research objectives and enriching the author's comprehension of the field. Moreover, these findings are valuable theoretical references and foundations that guide future research endeavours.

6.2 Key Findings

This study has yielded two significant findings. Firstly, the extended UTAUT2 model identified seven primary factors that influence the behavioural intentions of museum visitors towards VR technology. Among these, performance expectancy, effort expectancy, social influence, design quality, hedonic motivation, and previous experience significantly and positively impact visitors' behavioural intentions. However, perceived risk has a significant negative impact. This discovery underscores the potential for museums to strategise and enhance visitors' behavioural intentions by tailoring initiatives around these six influential factors.

Furthermore, this study found interconnectedness among these factors, illustrating their capacity to directly or indirectly affect each other. Meanwhile, museums should pay particular attention to the negative effect of perceived risk. This suggests that visitors evaluate the risk associated with the technology before engaging with VR. Elevated perceived risks have the potential to dampen visitors' intentions to embrace the technology. Hence, this study proposes various improvement methods to address visitors' psychological concerns, reducing perceived risk and negatively impacting their behavioural intentions.

The second significant finding is the existence of generational differences in the factors that shape the behavioural intentions of museum visitors. The empirical results spotlighted generational differences in effort expectancy, design quality, hedonic motivation, and perceived risk. Gen Y and Z visitors rated effort expectancy and design quality more favourably than Gen X. Moreover, the empirical outcomes revealed that Gen Z visitors exhibited significantly higher scores in hedonic motivation relative to Gen X and Y. Additionally, this study's insights discovered that the adverse effect of perceived risk also varies across generations, with Gen X and Y visitors reporting higher perceived risk ratings compared to Gen Z visitors.

6.3 Implication of the Study

Theoretical Implications: This research provides valuable insights for developing theories in related fields by thoroughly analysing the influencing factors of museum visitors' behavioural intentions towards VR technology. Expanding the existing UTAUT2 model and empirical results establishes a more robust theoretical framework, revealing seven key influencing factors enhancing the model's applicability and effectiveness. Additionally, exploring intergenerational differences enriches theories regarding technology adoption, offering unique insights into the distinct behavioural and preference patterns of different generational groups in adopting VR technology. This also lays a theoretical foundation for future research on intergenerational differences in other fields or digital technologies.

Practical Implications: This research provides practical guidance on effectively enhancing museum visitors' behavioural intentions towards VR technology. These suggestions emphasise the significance of technological design, education, content innovation, and safety in enhancing visitors' VR experiences. Furthermore, considering operational recommendations

tailored to different age groups underscores the importance of intergenerational differentiation strategies.

Managerial Implications: This study offers clear directions for museum management or development personnel on formulating more efficient VR technology strategies and improving museum visitors' VR visiting experiences. The discovery of intergenerational user behaviour differences reveals the digital technology needs and behavioural characteristics of visitors from different generations. Museum curators can use this model or research conclusions to avoid certain limitations and usage obstacles when designing VR exhibitions, thereby enhancing the practical value of VR exhibitions. This can save design costs and testing time to some extent, making VR exhibitions more usable and efficient, and also increasing the return on investment for VR exhibitions. The five methods proposed to enhance visitors' VR technology experiences provide valuable references for museum management and operations.

6.4 Recommendations

This study has devised targeted strategies and solutions from its two primary findings while also considering the distinct regional characteristics of museums in Guangdong, China. The objective is to enhance the behavioural intentions of museum visitors in Guangdong towards VR technology.

Outlined below are five approaches to augmenting museum visitors' behavioural intentions:

1. Enhance Education and Training: This entails distributing printed operational guides, placing diagrammatic instructions near equipment locations, or introducing instructional

animations upon interface initiation. Particularly beneficial for older visitors, this strategy fosters familiarity with VR device operation.

2. Optimise User Interface: Tailor design elements to achieve a streamlined and user-friendly interface. Catering to the preferences of elderly visitors, make adjustments to layout, typography, and illumination. If needed, incorporate guided features to facilitate ease of use.

3. Diversify Content Modes: Develop a range of content modes, optimising product displays to encompass educational and entertainment facets that resonate with varying visitor preferences.

4. Implement Safety Measures: Provide users with safety gear to mitigate potential health concerns, addressing physical safety and psychological well-being.

5. Ensure Equipment Hygiene: Maintain equipment cleanliness through regular disinfection. Label hygiene procedures and offer sanitising products to alleviate visitor apprehensions.

By adopting these recommendations, museums can effectively tailor their offerings to cater to the diverse generational spectra of visitors, ultimately enhancing the visitor experience. Furthermore, these suggestions provide invaluable insights for museum research teams as they continue to innovate and improve the museum environment.

6.5 Limitations and Future Research Directions

This study acknowledges three primary limitations:

1. Technology Evolution: The research is based on the present VR technology landscape within museums in the Guangdong region. Given the rapid pace of technological advancement, future developments could reshape both technological environments and user interactions.

2. Sample Representativeness: There is a potential for the sample not to encompass all possible perspectives, particularly considering potential cultural, regional, or economic disparities that might influence visitors' behavioural intentions.

3. Generational Categorisations: The division into X, Y, and Z generations, while widely recognised, might entail certain ambiguities and variations across studies and regions.

4. Regional Limitations: As one of the economically developed regions in China, Guangdong's advanced economic conditions and technical infrastructure may lead to a higher acceptance of new technology among visitors. However, this economic background might differ from other less economically developed regions.

As VR technology evolves, the museum experience will naturally transform alongside it. Future research could delve deeper into the potential impact of technological advancements on visitor acceptance and experiences, specifically considering the distinct characteristics of the X, Y, and Z generations. Additionally, future research can explore the long-term impacts of using VR technology in museums, which requires a longer period to observe the changes and developments in VR exhibitions. During the long-term observation phase, factors such as energy consumption, hardware production, and electronic waste can also be considered to determine whether they affect the sustainable development of VR exhibitions in museums. Additionally, the study aims to evaluate the practicability of its recommendations and delve into the psychological and behavioural models underpinning visitors' interactions with VR technology.

6.6 Concluding Remarks

This research has thoroughly examined the factors that impact the behavioural intentions of museum visitors towards VR technology, shedding light on the generational differences in

these factors. The study's analysis of intergenerational distinctions fills a gap in prior research, thus providing a valuable theoretical framework for museum research teams. However, despite the valuable insights gained, certain limitations remain. In terms of future research directions, there are opportunities to build upon the conclusions and recommendations presented here, either by delving further into specific aspects or exploring alternative research avenues.

In the context of the rapidly evolving digital landscape and societal shifts, museums, as essential repositories of history, culture, and knowledge, are poised to reshape their interactions with the public. The connection between digital technology and visitors will become increasingly intertwined and influential. Our aspiration is that future research delves even deeper into this domain, offering more effective guidance for museums and creating more enriching and captivating experiences for the public.

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APPENDICES

Appendix A: Ethics Approval for Non-Medical Research on Humans from Universiti Malaysia Sarawak

Deputy Vice Chancellor's Office (Research and Innovation) Human Research Ethics Committee (Non-Medical) Tel: 082 581222/1223 Fax: 082 665115	UNIVERSITI MALAYSIA SARAWAK 94300 Kota Samarahan
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MEMORANDUM

Reference : UNIMAS/TNC(PI)/09 – 65/02 (34)

To : Li Yifei
Faculty of Applied and Creative Arts

From : Chair
Human Research Ethics Committee (Non-Medical)

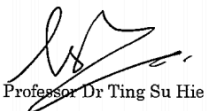
Date : 09 June 2023

Subject : Research Ethics Approval for Non-Medical Research on Humans

With reference to the above, I would like to inform you that your application for research ethics clearance was discussed in the 6th Human Research Ethics Committee (Non-medical) meeting 2/2023 on 24th May 2023. Your application for research ethics has been approved.

Title of project:	Virtual Reality Technology and Tourist Behavior Intention of National Museums in Guangdong
No. Ethics Approval :	HREC(NM)/2023 (1)/35
Principal Investigator :	Li Yifei (Universiti Malaysia Sarawak)
Co-researcher(s):	Associate Professor Dr Mohd Kamal Othman (Universiti Malaysia Sarawak)

Yours sincerely,


Professor Dr Ting Su Hie

c.c : Deputy Vice Chancellor (Research & Innovation)
: Director, UNIMAS Publisher
: Deputy Dean (Research & Commercialisation),
Faculty of Applied and Creative Arts

Figure 1: Ethics Approval for Non-Medical Research on Humans from Universiti Malaysia Sarawak