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ELICITING VISIT INTENTIONS TO MUSEUMS THROUGH VIRTUAL REALITY: THE ROLE OF VIVIDNESS, PRESENCE, AND SERIOUS LEISURE

David Alexandre Amaro Rato

Dissertation submitted as partial requirement for the conferral of Master in Marketing,

Supervisor: Prof. Doutora Sandra Maria Correia Loureiro

Professora associada com agregação do Instituto Universitário de Lisboa, ISCTE Business School, Departamento de Marketing, Operações e Gestão Geral

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BUSINESS
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Abstract

Museums are more than a place to preserve and showcase culturally important collections of art and artefacts. They offer serious leisure activities that can be increased by using Virtual Reality (VR) tools.

This study aims to better understand the effect of virtual atmospheric cues on serious leisure in a virtual museum environment, as well as the impact of serious leisure on the desire to visit the physical location of a museum. For this purpose, a conceptual framework was created and tested. It is based on the S-O-R framework (Mehrabian & Russell, 1974) and includes: Museum Atmospheric Cues as the stimulus element; Presence, Vividness and Serious Leisure as the organism components, and, lastly, the Intention to Visit as the behavioural response.

To test the model, data was collected through a questionnaire that was shared after participants (N=219) enjoyed a brief virtual tour of Lisbon's National Coach Museum. This research allowed to conclude that there are positive relationships between the five constructs of the conceptual model, meaning all six hypotheses are supported. Results demonstrated that virtual atmospheric cues exercise a significant effect on the perception of vividness and presence. Both vividness and presence influence serious leisure and this, in turn, affects the serious leisure in a virtual museum environment. Furthermore, they also revealed a good understanding of serious leisure as a driver of the intention to visit the physical museum. Thus, from this study, several managerial implications and suggestions for further research can be identified.

Keywords: virtual reality, museum experiences, serious leisure, vividness, presence, atmospheric cues.

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Resumo

Os museus são mais do que um lugar destinado a preservar e exibir coleções de arte e artefactos considerados culturalmente importantes. Estas instituições oferecem atividades de lazer sério que podem ser incrementadas usando ferramentas de Realidade Virtual.

Este estudo visa compreender o efeito das pistas atmosféricas virtuais no lazer sério num museu virtual, bem como o impacto do lazer sério no desejo de visitar o espaço físico do museu. Para isto, um modelo conceitual foi criado e testado. Baseia-se na modelo S-O-R (Mehrabian & Russell, 1974) e inclui: Pistas Atmosféricas do museu como elemento de estímulo; Presença, Vivacidade e Lazer Sério como componentes de organismo, e a Intenção de Visitar como resposta comportamental.

Para testar o modelo, os dados foram recolhidos através de um questionário que foi distribuído após os participantes (N= 219) terem realizado uma breve visita virtual ao Museu Nacional dos Coches. Esta pesquisa permitiu concluir que existem relações positivas entre os cinco construtos do modelo conceitual, significando que todas as hipóteses são suportadas. Os resultados demonstraram que as pistas atmosféricas do ambiente virtual exercem um efeito significativo na perceção de vivacidade e presença. Tanto a vivacidade como a presença influenciam o lazer sério e este, por sua vez, influencia a experiência num contexto de museu virtual. Além disso, os resultados também revelaram um bom entendimento de lazer sério como impulsionador da intenção de visitar o museu fisicamente. Assim, a partir deste estudo, várias implicações práticas e sugestões para novas investigações podem ser especificadas.

Palavras-chave: realidade virtual, experiência no museu, lazer sério, vivacidade, presença, pistas atmosféricas.

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Chapter 1 – Introduction

1.1 The relevance of the topic

First and foremost, museums are tourist attractions that exist to preserve, to research, to educate, and to promote cultural, historical, and natural heritage (Ruiz-Alba et al., 2019; Antón et al., 2019). Museums have always been considered important heritage destinations, as well as primary tourist attractions due to their educational and entertainment sides. However, a museum visit may not be considered simply a visit, but as a lively process, accounting for, not only the visiting act itself but also the 'pre' and the 'post' visit (Sheng & Chen, 2012).

Thus, museums are considered as experience-centred places that provide emotional, affective, and cognitive stimuli to visitors (Antón et al., 2019; Loureiro & Blanco, 2021). They are more than mere places that not only showcase their collections to the public, but they are also educational, entertainment and engaging locations (Lee et al., 2020). As visitor-oriented places, they should be able to confer a pleasant experience to visitors while enhancing their knowledge about a certain topic without professional motivation (serious leisure activities) (Barbieri & Sotomayor, 2013; Stebbins, 1992; Gould et al., 2008).

As stated by Ruiz-Alba et al. (2019), the act of visiting a museum is something that can be anticipated by managers, being crucial to consider several preparatory activities in which potential visitors can engage with the heritage sites (for inspiration and planning) before the actual visiting experience takes place. Those activities can be brochures, websites, apps, online virtual experiences, testimonies, as well as previous experiences (Ruiz-Alba et al., 2019; Sheng & Chen, 2012).

Immersive technologies, such as Augmented Reality (AR) and Virtual Reality (VR), can boost the process of anticipation of an experience, by offering unexpected opportunities for co-creation (Jung & tom Dieck, 2017). According to Loureiro (2020), Virtual Reality has been extensively applied in the hospitality and tourism sectors (e.g., museums, art galleries, hotels and restaurants) to promote their experiences. Also, this immersive technology has been successfully used by other industry sectors, namely healthcare, education, and retail.

Within the museum context, VR may enable visitors to perceive the virtual environment in detail and obtain information about the museum exhibition (Loureiro, 2020). It can be considered a powerful tool to elicit in potential visitors a desire to view the actual museum collections (Loureiro, 2020). Although a few studies have analysed the role of VR in museums (e.g., Jung et al., 2016; Lee, et al., 2020), no studies have yet investigated antecedents of serious leisure in the VR context.

1.2 Contextualization

According to UNESCO (2020: 7)*, "Museums are vital public spaces that should address all of society and can therefore play an important role in the development of social ties and cohesion, building citizenship, and reflecting on collective identities"*. In 2021, Portugal received 7,496,851 visitors to museums, of which 2,891,412 were foreign visitors (INE, 2022). However, these results were highly influenced by the COVID-19 pandemic and the travel restrictions imposed. For comparison, in 2019, Portuguese museums received 19,777,691 visitors, being 10,342,761 from foreign countries (INE, 2020). INE (2022) also accounted for the existence of 419 museums in the Portuguese national territory, indicating the relevance of this sector not only for employment and income but also as a cultural attraction for both locals and foreigners.

The emergence of the COVID-19 pandemic came to challenge museums' missions and operations, forcing many of them to reinvent and quickly adapt themselves. As stated by The Guardian (2020): "*Since the emergence of Covid-19 and resulting self-quarantine, thousands of museums, cultural institutions, festivals and global happenings have temporarily shuttered operations, leaving behind empty streets and a restless public. In a sector that thrives on in-person connection, the loss of an audience is disastrous, yet resilient performers, institutions, galleries, even entire art fairs, are moving to the digital arena, using streaming services and virtual reality, manifesting live concerts, organizing dance parties and launching online-only spaces".*

Several museum institutions revised new ways to keep in contact with their audience, taking advantage of new technologies (e.g., VR and Social Networks) and their growing role in everyday life. Moreover, museums made use of their previously digitalized resources, increased activity on Social Media, performed already-planned activities in a digital manner, and created special activities for the general public and for professional and scientific publics (UNESCO, 2020).

The unprecedented digital and cultural transformation that rapidly evolved since the start of the COVID-19 crisis, lead museums to realign their missions, responding with a new sense of purpose and connection, increasing social engagement, teaching, learning, as well as reaching out to more diverse audiences (Giannini & Bowen, 2022).

Besides this, museum managers and curators have also been dealing with two major concerns that have emerged during the last years: authenticity and new museology. Museums should be seen as authentic places where visitors can explore and appreciate, moving beyond time, space, and language barriers (tom Dieck et al., 2018). Additionally, heritage sites must offer enriching and engaging experiences, in order to attract a wider public. This may be achieved by promoting edutainment (education + entertainment) experiences (Addis, 2005).

To address those concerns, museums have been developing new strategies, and performing several changes and shifts. They are also progressively adopting technological innovations into their virtual and physical spaces, namely Virtual Reality. This immersive technology has been actively adopted in cultural tourism as it has been considered an impactful marketing tool, that can be used to promote a destination or site and provide new and completely challenging immersive experiences to visitors, as well as to provide accessible tourism (Guttentag, 2010).

According to Lee et al. (2020) and considering the importance of edutainment experiences as part of museum visits, Virtual Reality technology is seen as an authentic and pleasurable way of obtaining information about the museum's collections.

1.3 Research Questions and Objectives Definition

The dissertation's main purpose is to understand the relevance of the usage of Virtual Reality by museum managers and curators (in a pre-visit stage) as a tool to cultivate the desire to visit the physical location of a museum. Having as an example the case of the selected Portuguese museum, the National Coach Museum, the study will focus on whether this type of museum experiences can be seen as useful tools to engage, produce positive emotions, and consequently leverage the number of visitors.

At the same time, this study provides a first understanding of the mechanism by which atmospheric cues of a virtual environment led to serious leisure and, consequently, the intention to visit the actual museum. It seeks to analyse the effect that VR museum's atmospheric cues have on the recognition of the representational richness of the mediated environment, as well as the feeling of presence and the perception of being active in such environment. It aims to investigate if the sense of presence and the perception of vividness enhance the sensation of satisfaction, gratification, enjoyment and enrichment (serious leisure), and to examine if those feelings, considered as serious leisure, influence the willingness to visit the physical location of the museum in the future.

Therefore, the research in this dissertation will create value, by being able to connect and understand the relationship between all the previously mentioned concepts, in order to answer the following research questions:

1. What is the role of vividness and presence as a link between atmospheric cues and serious leisure?
2. Can serious leisure in a VR environment influence visitors' intention to visit the physical location of the museum?

1.4 Structure of the Dissertation

This dissertation is divided into five chapters. The first chapter corresponds to the Introduction, where the research topic is firstly presented, and where its relevance, context and importance are highlighted. This is followed by the presentation of the research questions and objectives for the research. In the second chapter, relevant literature for the topic under analysis is reviewed, being the main concepts of the research: Experience Marketing, Museum Experience, Virtual Reality in Museums, Atmospheric Cues, Vividness, Presence, Serious Leisure and Intention to Visit. Then, the conceptual framework and the developed hypotheses are introduced and justified. In the third chapter, the methodology, i.e., the research methods employed to address the hypothesis, the procedures for the data collection, and the measurement scales are presented. The results of the conducted study are analysed in the fourth chapter, resulting in a discussion, in theoretical contributions and managerial implications. In the final chapter, the main conclusions, the limitations and future research recommendations are reported.

Chapter 2 - Literature review

2.1 Experience

2.1.1. Experience Marketing

Attention to the importance of the concept of Experience in the Marketing field has been drawn more than 20 years ago. Schmitt (1999) was one of the first authors to highlight this new approach to Marketing, denoting the necessity to shift from the features-and-benefits approach to customer experiences approach. The author also stated that managers can design experiences for their customers through five strategic experimental modules (SEM), which are the sensory experiences (sense), the affective experiences (feel), the cognitive experiences (think), the physical experiences, behaviours, and lifestyles (act) and the social-identity experiences resulting from relating to a reference group or culture (relate).

Pine and Gilmore (1999) emphasized that companies should not offer goods and services alone, but as an experience to be enjoyed, which they defined as a series of memorable events staged by a company to engage with its customers in a personal and unique way, either in an emotional, intellectual, physical, or spiritual level. Furthermore, the authors emphasized the importance of guest participation and environmental relationship as dimensions of the experiences. Guest participation spectrum ranges from passive participation, where customers don't directly affect or influence the performance, acting as an observer or listener, to active participation, in which customers personally affect it. The environmental relationship varies from absorption, described as the state in which a person's attention is fully occupied with the experience, to the state of immersion, in which the person is physically or virtually part of what is being experienced. The authors also provided a classification of experiences into four types/realms: aesthetic, entertainment, educational, and escapist.

Since the preliminary and inescapable work developed by Schmitt (1999) and Pine and Gilmore (1999), other scholars have been dedicated to the study of the concept of Experience, which has emerged as a topic of extreme relevance in the Marketing field. In the case of this literature review, it is of special relevance to look into the concept of Experience within museum and tourism environments. The tourism sector is seen as an experience-intensive one, where consumers seek and pursue experiences above everything else (Ruiz-Alba et al., 2019).

One of the major tourism motivations lies in the fact that people seek to get away from their daily life and experience different things. Larsen (2007) demonstrates that the tourist experience is not only the feeling during the trip but an accumulated psychological phenomenon that also considers the pre-visiting or planning and the after visit. The author also

identifies a circular pattern, as tourists' memories and past experiences will influence expectations for future visits.

2.1.2. Museum Experience and Immersive Technologies

2.1.2.1 Museum Experience

Museums and cultural heritage sites are primary tourist attractions in any travel destination. Chan (2009) considers museums as experience-centred places that provide emotional, affective, and cognitive stimuli. Museums offer a complex combination of factors that structures the attitude and feelings of visitors towards their visit. According to McIntosh (1999), a visit to a museum can produce feelings of fun, enjoyment, escape from routine, learning or pleasant time shared with family or friends.

Sheng and Chen (2012) research propose five types of visitor experience: easiness and fun, cultural entertainment, personal identification, historical reminiscence, and escapism. Museums are sites of experiential consumption that offer a stage for social, cognitive, and environmental education, as well as for leisure and recreation activities, and that represents a space for social interaction (Chan, 2009; Kim et al., 2010). Moreover, Sheng and Chen (2012) specify that museum's visitor experience is a lively process that includes experiences before, during and after each visit. Indeed, visitors create expectations based on interactions between other tourists and previous experiences, as well as the search for information in advance and the pursuit of virtual experiences on the Internet. Thus, it is crucial that museums analyse visitor expectations, and consider them as something than can be anticipated, considering the preparatory activities in which they can engage, such as websites or apps (Buhalis & Foerste, 2015).

Consequently, tourists can no longer be seen as mere passive observers, but as co-creators of their own visiting experience, and this should be perceived as part of the experience itself and not only as an anticipative action or a preparation (Ramaswamy & Ozcan, 2018). Research developed by Ruiz-Alba, et al. (2019) revealed that the increase of internet use in the recent years led visitors to develop high levels of expertise in the process of anticipation of an experience. This process is enhanced by the existing and the emerging technologies that offer opportunities for tourists to co-create the visiting experience (tom Dieck & Jung, 2017). These co-creation actions have a relevant influence on the relationship between emotions, satisfaction, and loyalty (Bigné et al., 2001; Ruiz-Alba et al., 2019). Moreover, Ruiz-Alba et al. (2019) specify two segments of visitors: rational and emotional. Therefore, rational visitors tend to get more involved in the co-creation of their visiting experience, developing higher expectations.

2.1.2.1 Virtual Reality in Museums

A Virtual Reality (VR) environment is a synthetic world that may or may not mimic the real world and in which the participants feel immersed (Milgram et al., 1995). By using VR devices, a user can experience the virtual environment as if he or she was part of it (Tussyadiah et al., 2018; Loureiro et al., 2020). The virtual environment modifies in real time as the device recognizes the user's reactions and motions, allowing the identification of a vivid mental representation of the environment, and producing the illusion of interaction and immersion (Wirth et al., 2007). Moreover, VR provides users with educational, entertaining, escapist, and aesthetic experiences (Jung & tom Dieck, 2017; Loureiro et al., 2021).

Regarding the tourism sector, VR has been considered an impactful marketing tool, as destinations, attractions, and hotels can use it to promote a destination or site and provide new and completely challenging immersive experiences to their clients, as well as to provide accessible tourism for all (Guttentag, 2010). Additionally, it has been regarded as an interesting instrument in tourism that reduces the barrier of distance between potential tourists and a destination, due to its capacity to produce vivid mental images that visitors can use to forecast their future experiences, pre-conceiving how their possible destination will be (Skard et al., 2021; Loureiro et al., 2021). Tom Dieck and Jung (2017) stated that this tool has the potential to shape how consumer experiences are designed and consumed, having the capacity to influence them at different touchpoints throughout the customer journey.

Virtual Reality has been progressively adopted in cultural tourism since it has been seen as a highly effective technology device that enables people to perceive enjoyable and immersive information about museums and their collections (Lee et al., 2020). Also, these immersive technologies offer the possibility for museums to bring unanimated objects back to life or to explore hidden sites, enabling visitors to access physically inaccessible places or objects (tom Dieck & Jung, 2019).

2.2 Atmospheric Cues, Vividness and Presence

2.2.1 Atmospheric Cues

Within the retail context, Kotler (1974: 50) defines atmospherics as *"the conscious designing of space to create certain buyer effects, specifically, the designing of buying environments to produce specific emotional effects in the buyer that enhance purchase probability".* Later, Baker et al. (1994) considered atmospheric cues as the smell, design, sound, and lighting, as well as social factors (i.e., employees and customers). Eroglu et al. (2003), when referring to web atmospheric, used on websites and social media, considered design, layout, colours, and sounds. Literature has demonstrated a diversity of factors to consider on atmospheric cues,

whether it is online, offline, or virtual (Crespo et al., 2019). Yet, in accordance with Loureiro, (2015), those factors are highly dependent on the inserted context and should not be generalized.

Despite the apparent differences, particularly concerning the purpose and definitions of success, Forrest (2013) applied the atmospheric model to the museum context, in order to draw conclusions regarding the role that the exhibition environment, namely ambience and design, have on the visitor's perceptions and overall experience. Signalling that the main objective for retailers is to maximize sales, while museums seek to create surroundings where visitors feel comfortable and in control, having the possibility to learn, the author found ample overlaps that led him to consider the adaptation of retail atmospherics to the museum context. Moreover, atmospheric cues should regard external and general internal aspects, as well as layout and design, point of purchase and decoration, and human variables (Forrest, 2013).

Identifying that literature lacks the presuppose of a concrete number of factors for evaluating atmospheric cues on a museum environment, Loureiro's (2019) framework defines four main factors: design, lighting, learning, and staff. Thus, the design represents the colour scheme, facilities, museum décor and the museum's permanent display. Lighting means the pleasure and adequacy of lighting (Loureiro & Blanco, 2021). Learning refers to the pleasure of having an experience that makes the visitor more knowledgeable, and staff represents the museum's working force and how they present themselves and communicate with visitors (Loureiro, 2019).

Atmospheric cues have a strong effect on the visitors' perception of authenticity (Loureiro, 2019). They represent a stimulus that is perceived by visitors and are interpreted and interiorized throughout the museum visit (Loureiro 2015). These stimuli will activate the memory-based associative and cognitive process of the information leading to positive or negative attitudes and behaviours towards the experience (Loureiro & Blanco, 2020). In a Virtual Reality context, the atmospheric cues are also seen as stimuli perceived by the participant of the virtual visit. The flow state (Csikszentmihalyi & LeFevre, 1989) in museum visitors through the VR atmospheric cues lead to sensations of vividness and telepresence.

2.2.2 Vividness

Steuer (1992) defines vividness as the way an environment confers information to the senses, that is the representational richness set out by its formal features prevailing in the environment. The concept correlates sensory breadth and sensory depth. The former corresponds to the number of sensory dimensions that are simultaneously presented, whereas the latter refers to the quality of the sensory information available.

Regarding Virtual Reality, vividness is associated with the quality of the representations. It is a necessary dimension that highly contributes to customers' sense of presence (Steuer, 1992). Moreover, a richer portrayal of the environment with a superior image quality promotes a higher perception of vividness and contributes to customers' immersion in the virtual scenario (Yim et al., 2017). Additionally, sensory and motor engagement enabled by VR allows users to perceive vivid mental representations of the mediated spaces, enhancing the feeling of embodiment (Wirth et al., 2007). Thus, within the tourism and hospitality context, vividness is highlighted as having an important role in the decision-making process of selecting a future destination or site to visit, offering customers realistic destination feelings. Therefore, if the imagery is clear, vivid, and sharp, portraying a potential destination in a rich manner, it will make visitors develop positive attitudes towards it (Lee et al., 2020).

2.2.3 Presence

According to Steuer (1992: 81), presence is *"the extent to which one feels present in the mediated environment, rather than in the immediate physical environment (presence)".* To Kim and Biocca (1997), it represents the feeling of embodiment in the virtual scenario that is developed by technological methods. The sense of presence in the VR scenario generates positive outcomes in attitude, belief and intention. It presents two dimensions: arrival - meaning the feeling of being present in the mediated environment - and departure - the feeling of separation from the physical environment**.**

Lee (2004) understands presence as a state in which the virtuality of the experience stays unnoticed. The author also establishes three types of presence: physical presence, social presence, and self-presence. Physical presence occurs when users experience the mediated objects or environments as actual physical in a sensory or non-sensory way. Thus, the para-authenticity or the artificiality of the objects or environment stays unnoticed. Social presence occurs when technology users don't notice either the artificiality or para-authenticity of other humans or nonhuman intelligences in the VR environment. Additionally, self-presence occurs when VR user doesn't notice the virtuality of their own para-authentic representation or the artificially constructed alter-selves inside virtual environments

Wirth et al. (2007) define two dimensions of spatial presence: self-location, meaning the feeling of being located in mediated environments, and, possible actions, as the perceived action possibilities in the virtual environments. Feelings of telepresence *"can boost immersion, thereby enhancing the persuasiveness of brand messages and brand-related consumer responses",* as cited by Cowan and Ketron (2019). In the tourism sector, a destination's image is vital in marketing, as it critically influences the choosing process of a travel destination. It is

an important tool for differentiation among competitors. As VR was conceived to aid consumers into immersion in the mediated environment, the sense of presence mediates online information into cognitive responses, leading to greater engagement, and positively influencing consumer behaviour (Hyun & O'Keefe, 2012). A stronger sense of spatial presence is effective in leading to stronger interest and liking toward a destination, contributing to positive attitude change (Tussyadiah et al., 2018).

2.3 Serious Leisure

Stebbins (1992: 3) defines serious leisure as *"the systematic pursuit of an amateur, hobbyist, or volunteer activity that is sufficiently substantial and interesting for a participant to find a career there in the acquisition and expression of its special skills and knowledge"*. Hence, monetary remuneration is not a necessary requirement for someone to pursue serious leisure activities, as it generates distinct types of benefits (Stebbins, 1992). This concept comprehends an array of leisure activities in which career doesn't necessarily translate into a professional motivation, instead expressing inducement to be involved in something that one finds interesting, educational and fulfilling (Loureiro & Ferreira, 2018). Visiting a museum, the interest in learning history or a particular artist can be included in the activities called serious leisure (Barbieri & Sotomayor, 2013; Gould et al., 2008; Stebbins, 1992).

Stebbins (1992) postulates six distinguished qualities or characteristics of serious leisure: perseverance, leisure career, significant effort, durable outcomes (either individual or group outcomes), unique ethos, and identification with pursuits.

SL provides the opportunity to learn about and to participate in one's field of interest. While visiting a museum, a visitor can experience a sense of progressive improvement or fulfilment of their learning and positive intrinsic rewards due to the entertainment of admiring the collections and the use of new or improved tools and facilities (Stebbins, 2001; Stebbins, 2004). In addition, the motivational process of serious leisure, the enriching experience of visiting a museum, and self-identification generate positive emotions (Loureiro & Sarmento, 2019).

Thus, three dimensions can mirror serious leisure in the museum context: personal enrichment, self-gratification-satisfaction, and self-gratification-enjoyment. Personal enrichment represents the process to enhance the visitor's intellectual resources, the accumulation of admired and valued experiences as the result of serious participations (Stebbins, 1992), as the experience within the VR museum can be considered. Self-gratification-satisfaction means the satisfaction, sensation of fun, fulfilment, and gratification of the visitors for visiting the museum (Stebbins, 2001). Lastly, self-gratification-enjoyment is

connected to the sensation of enjoyment produced by a casual leisure activity, such as the VR experience (Stebbins, 1982).

Loureiro and Sarmento (2019) research identified that serious leisure strongly enhances pleasant arousal, engagement, and positive word-of-mouth, caused by the sense of cognitive enjoyment and educational information. Serious Leisure also positively influences engagement. Consequently, the authors argue that museums should provide refreshing and enriching experiences, and to do so, heritage sites must be prepared with equipment and devices that allow visitors to interact and improve learning.

2.4 Visit Intention

Ajzen (1991) defines behavioural intentions as the readiness and/or the likelihood of an individual revealing a specific behaviour. Intentions are an effective method for predicting an individual's actual behaviour due to the strong existing correlation (Loureiro, 2015). Thus, visit intention represents the combination of interest and the likelihood of visiting a place. Motivation, expectations, and positive past experiences have a positive effect on behavioural intentions to visit places (Luo & Ye, 2020). Within the tourism sector, it has been identified that the role of experience, satisfaction, perceived quality, and involvement also have a critical relevance in explaining behavioural intentions (Chen et al., 2011).

To what concerns museums, prior research from Luo and Ye (2020) expose that eventual visitors develop a proactive behaviour concerning searching for information about a museum they are looking forward to visiting, thereby leading to the development of strong museum visit expectations. This evaluation of a prospective museum experience is often carried out online. Moreover, it has been found that positive technology experiences led to eliciting visit intentions (Jung et al., 2016; Tussyadiah et al., 2018). Consequently, museums have been using Virtual Reality as an entertainment and educational (edutainment) way to advertise and provide information about a museum in different locations, so that potential visitors may generate visit intentions (Lee et al., 2020). According to the same authors, museums should emphasize the educational and entertainment (edutainment) factors of VR, providing exact and plentiful information in a creative and captivating way. This will facilitate the immersion feeling in the VR environment, enhancing the experience, and influencing the intention to visit the physical museum (Lee et al., 2020).

2.5 Conceptual Framework and Hypotheses development

The present sub-chapter concerns the presentation of the conceptual framework and the hypotheses developed for the study, aiming to achieve results and draw conclusions. Both the model and the hypotheses were obtained through theory-based assumptions, the result of the analysis of previous research, previously presented in the Literature Review. This study follows a positivistic approach, arguing that there is a positive association among the constructs.

The conceptual framework was developed having as a base the stimulus-organism-response (SOR) model (Mehrabian & Russell, 1974). These authors state that an external stimulus affects organism (either cognitively or emotionally) and produces a certain behavioural response. Usually, the stimuli lead to an affective reaction, which can be pleasure, arousal or dominance (PAD dimensions). As shown in Figure 2.1, the present study considers one stimulus component, three organism components, and one response component.

It was considered as stimulus component, the Museum's Atmospheric Cues observed through Virtual Reality. Then, Vividness, Presence and Serious Leisure compose the organism element, as emotional and cognitive benefits resulted from the attribute perception. Lastly, the Intention to Visit is the regarded behavioural response to the organism.

Moving forward, the developed hypothesis will be tested, through the methodology explained in the following chapter. It will clarify the role of the museum's atmospheric cues in the perceptions of presence and vividness, as well as serious leisure, considered as an emotional and cognitive state, and, in turn, the influence that these three constructs produce in the intention to visit the physical space of the museum. This research will reveal the consequences of using VR by museums in a pre-visit stage and how these initiatives will affect potential visitors and their willingness to visit the physical space of the museum. Thus, reinforcing the role of VR as an effective tool for museums to create awareness, to elicit positive emotions and to drive the number of visitors.

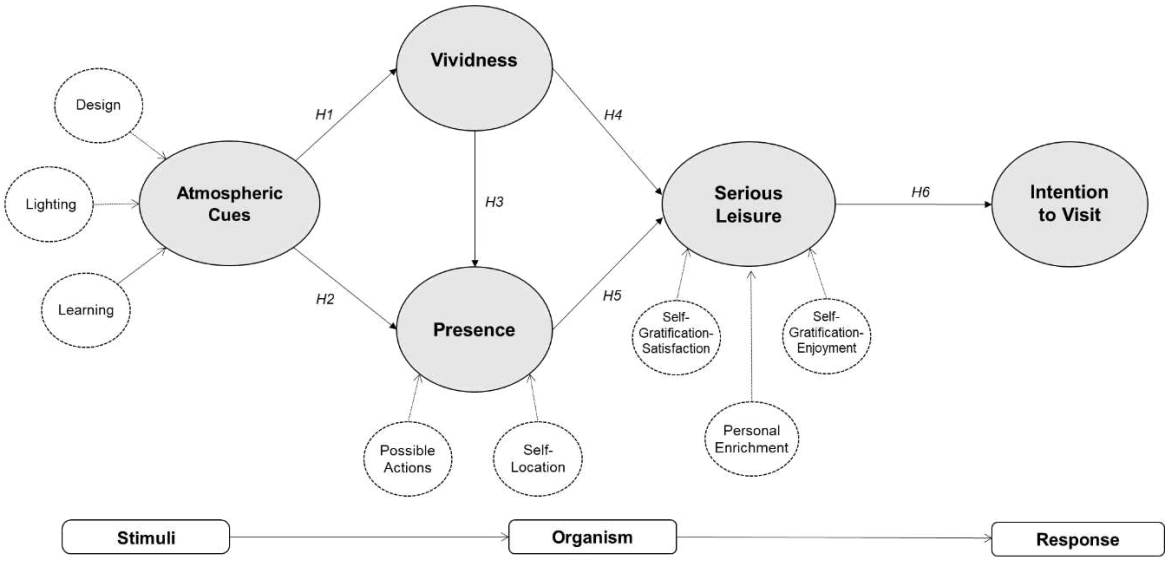

Figure 2.1 *– Proposed Conceptual Model.*

Source: Author's own elaboration.

2.5.1 Vividness as dependent variable

The atmospheric cues of a museum seen through VR can be considered as the stimuli that led the visitor's brain to perceive the richness of the representation of the mediated environment. Vividness may express the visitor's internal motivation to be in the VR environment (Loureiro, et al., 2021; Todd et al., 2012;). Therefore, when a museum visitor experiences the stimuli provided by the atmospheric cues of the VR museum, he will be more immersed in such mediated environment and will recognize its representational richness. Given this argumentation, the following hypothesis was formulated:

H1: Atmospheric Cues are positively associated with Vividness

2.5.2 Presence as the dependent variable

By experiencing a sense of presence in the mediated environment, the participant will likely form a favourable attitude towards it. In the present example, it may create in the visitor a certain desire to visit the physical location of the museum (Tussyadiah et al., 2018; Vorderer et al., 2004; Wirth et al., 2007).

Wirth et al.'s (2007) conception of spatial presence aggregates the feeling of being located in the VR environment, the perception of being active, and the possibility to move around the objects in VR. Moreover, the sensation of being in a VR museum is induced by the atmospheric cues of the virtual scenario, contributing to create a flow state in visitors (Csikszentmihalyi & LeFevre, 1989).

The immersion in the VR museum, experienced while enjoying the mediated environment and moving around, produces in the visitor the sensation of actually being there (Crespo et al., 2019; Mikropoulos, 2006; Willems et al., 2019). Thus, it is suggested that the design, lighting, and learning cues in the virtual museum contribute to the feeling of presence and the perception of being active in such virtual museum. Therefore, the following hypothesis was created:

H2: Atmospheric Cues are positively associated with Presence

The richness of the representativeness of a virtual environment has been demonstrated to be effective in creating a sensation of actually being in the mediated environment. Also, it has proved to be relevant in creating the perception of being active around the objects displayed in the VR (Fortin & Dholakia, 2005; Jiang & Benbasat, 2007; Schuemie et al., 2001). As in a VR store, a VR museum can display diverse cues through the lighting, colours, design, or information that visitors experience and interiorize. When the VR provides a sensation of rich representativeness of the different cues of the museum, then the sense of presence will tend to increase, to be more real and intense (Kim et al., 2021). Hereby, the following hypothesis is suggested:

H3: Vividness is positively associated with Presence

2.5.3 Serious Leisure as dependent variable

Likewise, a rich environment with adequate image quality provided by the VR can enhance the perception of personal enrichment and fun, as well as eliciting a sensation of fulfilment in the visitor's mind. In the same way, it is expected that the feeling of presence in VR can boost the immersion in the virtual experience of the museum, developing a sensation of satisfaction and enjoyment and even personal enrichment due to the knowledge acquired during the experience.

Therefore, serious leisure can be regarded as an organism because it represents emotional and cognitive states. The flow state (Csikszentmihalyi & LeFevre, 1989) created during the VR experience through the rich representation of the environment and the sensation of being there is expected to enhance the feeling of enjoyment, fulfilment, and personal enrichment (serious leisure). Taken all together the following hypotheses are suggested:

H4: Vividness is positively associated with Serious Leisure

H5: Presence is positively associated with Serious Leisure

2.5.4 Serious Leisure outcomes

A pleasant overall VR experience should be able to boost immersion creating a flow state (Csikszentmihalyi & LeFevre, 1989). Therefore, the sensation of satisfaction, fulfilment and even personal enrichment developed through the VR experience of the museum is expected to favourably influence the virtual visitors to actually intend to visit the physical museum. Hence, the following hypothesis is suggested:

> H6: Serious Leisure is positively associated with Intention to Visit the Physical Space of the Museum

Chapter 3 - Methodology

The present chapter concerns the research methods employed to address the hypotheses previously developed, aiming to provide answers for the identified gap in the literature. Its purpose is to better understand the effectiveness of the usage of Virtual Reality by museums as a way of inducing the desire to visit their physical space, and how this action is influenced by the impact of the museum's atmospheric cues on the feeling of presence, vividness and serious leisure in a virtual museum environment.

In order to do so, quantitative research in the form of a questionnaire was the chosen approach. As a way of ensuring a significant sample for the study, the aim was to survey more than 200 participants. The questionnaire (Appendix A and Appendix B) was developed based on the literature review and was elaborated using measurement scales that had been previously tested and were chosen from articles considered relevant to each construct. Those were carefully adjusted according to the purpose and context of the present study. The data for the current research was collected after the participants explored Lisbon's National Coach Museum through Virtual Reality.

3.1. Construct Measurement

The questionnaire was developed with a multiple-item scale composed of five constructs that constitute the conceptual framework: Atmospheric Cues, Vividness, Presence, Serious Leisure, and Intention to Visit (see Table 3.1).

As a way of understanding the experience the visitor had in the museum, the Atmospheric Cues construct was applied. The measures adapted to the museum context by Loureiro (2019) from Kottasz (2006) and Forrest (2013) were considered for this study. The construct is composed of four dimensions: staff; design; lighting, and learning. However, since the present study refers to the environment of a virtual museum, staff was not considered. Design comprises 4 items, lighting is composed of 2 items and learning is comprised of 4 items.

The construct Vividness, which refers to the quality of the representations in the context of VR, was measured by using a pre-developed scale used by Lee et al. (2020), based on Babin and Burns (1998). This construct includes 6 items.

In order to analyse the feeling of embodiment in the virtual scenario, the construct Presence was applied. To measure Presence, the MEC Spatial Presence Questionnaire developed by Vorderer et al. (2004) was adapted. This construct is composed of two dimensions: Self-Location and Possible Actions, each one measured with four items.

Serious Leisure is predicted by Personal Enrichment, Self-Gratification-Satisfaction and Self-Gratification-Enjoyment. Those were measured with a scale adapted from Gould et al. (2017), based on previous research (Gould et al., 2008). The three dimensions are measured with three items each. These measures allowed the author to comprehend the emotions aroused by the virtual visit and its significance for the visitor.

For the author to understand the behavioural intention to visit the real site of the museum in the future, a pre-developed 3-item scale, from Tussyadiah et al. (2018), based on prior research from Kozak and Rimmington (2000), was used.

Additionally, in order to analyse the common method variance (CMV), a construct with 4 items concerning the respondent's attitude towards the colour blue was included in the questionnaire (Chin et al., 2013; Simmering et al., 2015).

All constructs, except Vividness, were measured in the questionnaire using a 7-point Likert scale of agreement, where participants answered from 1, meaning strongly disagree, to 7, meaning strongly agree, to all the items that constitute each variable under analysis. Vividness was measured using a 7-point Semantic differential scale.

Table 3.1 *– Measurement Scales.*

Construct	Dimensions	Type of Scale	Source
Atmospheric Cues	Design; Lighting; Learning	7-Point Likert scale of agreement (1- Strongly Disagree to 7- Strongly Agree)	Loureiro (2019); Kottasz (2006); Forrest (2013)
Presence	Self-Location; Possible Actions	7-Point Likert scale of agreement (1- Strongly Disagree to 7- Strongly Agree)	Vorderer et al. (2004)
Vividness		7-point Semantic differential scale	Lee et al. (2020); Babin and Burns (1998)
Serious Leisure	Personal Enrichment; Self-Gratification-Satisfaction; Self-Gratification-Enjoy	7-Point Likert scale of agreement (1- Strongly Disagree to 7- Strongly Agree)	Gould et al. (2017)
Intention to Visit		7-Point Likert scale of agreement (1- Strongly Disagree to 7- Strongly Agree)	Tussyadiah et al. (2018); Kozak and Rimmington (2000)

Source: Author's own elaboration.

3.2. Questionnaire Design, Adaptation and Translation

The questionnaire was formulated with all the measurement scales mentioned in the previous section, including the original items, plus the sociodemographic variables: gender; age group, education, and nationality. The sociodemographic variables are employed in order to ensure quality and to provide the most accurate description of the sample. Due to its relevance to the study, the level of technology expertise was also included.

The elaboration of the questionnaire took into attention several aspects, namely if the original items were simple and arranged in a concise way, without complex syntax and unfamiliar words. Also, the usage of attention questions and commitment messages was considered.

To share the questionnaire with the participants of the study, an online survey developed in the web-based tool Qualtrics was used. This platform was chosen because of the various benefits it provides, not only to the researchers but also to the respondents. It is undoubtedly very "user-friendly". From the researcher's point of view, it stands out for not having limitations on the number of polls, for allowing the usage of a wide range of scales, for admitting both closed and open questions, for allowing to separate the survey into different sections or themes. Also, a QR code can be generated, allowing fast and easy access to the survey by the participants. In the respondent's scope, it is easy to navigate, and it adapts perfectly to different screens of various devices, namely laptop, mobile phone, and tablet.

Thus, Qualtrics eases the data analysis, by allowing the direct extraction of the survey's results to an Excel spreadsheet, which in turn can be exported to a software for analysing the data, such as SmartPLS and IBM SPSS Statistics.

The questionnaire was structured in five sections. After a brief explanation and contextualization of the research, highlighting the average time spent for its filling and ensuring anonymity and confidentiality of the responses, participants were asked if they have visited the National Coach Museum before, and, if the answer is affirmative, they were further asked when their last visit was. Then, there were three sections concerning the dimensions being tested in the model. The fifth and last section was focused on the sociodemographic variables previously mentioned.

Aiming to be able to reach both Portuguese and foreign participants for the study, the questionnaire was put available in both English and Portuguese languages. Because of that, the original version, in English, had to be translated into Portuguese. Also, as already mentioned, some of the measurement scales had to be adapted to the context of the study.

Before the launching of the virtual reality experience and questionnaire, a pre-test was performed with 10 participants to ensure that the questions were clear and understood. The feedback was positive, the questionnaire revealed to be clear and very few adjustments had to be made. There were some concerns with the translation of some words into Portuguese, as they were not well comprehended as they were in the original version. This issue was rapidly fixed by making the necessary changes. Both the Portuguese and English versions of the Questionnaire can be found in Appendix A and Appendix B, respectively.

3.3. Data Collection

Potential participants for the study were approached personally on the Campus of ISCTE University Institute of Lisbon from the 14th of March until the 28th of April. The author explained the purpose of the study, the amount of time it would take, and asked if they were interested in participating. Those who replied affirmatively were scheduled and taken to ISTAR - Information Sciences and Technologies and Architecture Research Center - Laboratory, Building II room D0.17, to start the experiment that comprises two parts: the Virtual Tour of the National Coach Museum, and the filling of the questionnaire mentioned above.

Once at the VR Laboratory, participants received a brief explanation of the procedure and were alerted to possible dizziness or nausea. Thus, they were advised to interrupt the experience at any time if they did not feel well. Next, participants were instructed on how to observe the Museum through the VR device. Additionally, practical information on how to move and what is the recommendable path to fully explore the available rooms of the Museum were also provided.

Figure 3.1 – *National Coach Museum's Virtual Visit.*

Source: museudoscoches.gov.pt/

The VR equipment used for the Virtual Tour of the Museum was an Oculus Quest 2, headset and controllers, a high immersive HMD. This device was loaned for the duration of the experiment by ISTAR, who also facilitated the usage of their Laboratory, which presents the best conditions for a Virtual Reality experience.

Figure 3. 2 – *Participants in the VR experience.*

Source: Author's own photographs.

As mentioned before, participants were given the opportunity to have a 5-minute Virtual Tour of the National Coach Museum, one of the main Museums of the City of Lisbon (see Figure 3.1), which is a place that preserves one of the most unique collections in the world consisting of vehicles from the XVII, XVIII and XIX centuries including carriages, coaches, berlins, and sedan chairs. The National Coach Museum is located (physically) on the Afonso de Albuquerque Square in Belem, Lisbon. Additionally, the selected Virtual Tour is accessible at the Museum's official website, and was developed by 4D Virtual Lab, a company that provides specialized services in the areas of architecture, archaeology, heritage, planning and engineering, focused on developing immersive content, accessible on an easy, simple and intuitive way.

Once the pre-defined period for the Virtual Tour ended, participants were asked to remove the headset and were then given access to the questionnaire with the items of the constructs used to analyse the proposed model and sociodemographic variables, by scanning a QR code with their smartphones.

3.4 Sample Profile

From a total of 228 answers, 219 of them were considered eligible by having all of the presented questions answered (n=219), meaning that the answers of 9 participants were excluded from the sample. The sample size is similar to the average number used in previous research with VR environments (Serrano et al., 2016; Krasonikolakis et al., 2018). Considering that Cohen's minimum sample size for detecting minimum R square of 0.10, in the case of a maximum number of arrows pointed to a construct of 2, and at a significant level of 5% is 110 (Hair et al., 2021), a sample of 219 is adequate to the study conducted.

Among the 219 respondents, 138 (63%) were female and 81 (37%) were male. The age ranges from 18 to 54 years old, a large part of the sample (81.3%) is composed of participants in the age range of 18 to 24, followed by participants with the age range of 24 to 34 years old (14.5%). Concerning the level of education, roughly half of the sample have a bachelor's degree (52.5%), 21.5% completed high school, 19.6% have a master's degree, and few respondents have professional studies (5%) or a doctorate degree (1.4%). Participants from 21 different nationalities participated in the Virtual Reality experience, being Portuguese the predominant nationality (81.3%), followed by Brazilian (3.7%), German (2.7%), Dutch (2.7%), and French (1.8%).

Regarding the degree of technology expertise of the respondents, about half of them (55.3%) considered themselves average users, 32% were considered experienced, 10% very experienced and 2.7% not experienced. This information can be found in Table 3.2.

Table 3.2 *– Sociodemographic Data.*

	Frequency	Percentage (%)
Gender		
Male	81	37
Female	138	63
Age Group		
18-24	178	81.3
25-34	34	15.5
35-44	6	2.7
45-54	1	0.5
Education Level		
High School	47	21.5
Professional Studies	11	5
Bachelor's Degree	115	52.5
Master's Degree	43	19.6
Doctorate Degree	3	1.4
Technology Expertise		
Very Experienced	22	10
Experienced	70	32
Average User	121	55.3
Not Experienced	6	2.7

Source: Author's own elaboration based on SPSS output.

Chapter 4 – Results and Discussion

The research's outcomes and findings will be presented and discussed in the present chapter. Particularly, a comprehensive analysis of the data gathered from the questionnaire will be provided and explained. This will be followed by the discussion of the results, and the presentation of the theoretical contributions and managerial implications, a consequence of the combination of theoretical knowledge and the research's main findings. As already mentioned, it will provide conclusions about the process of eliciting the desire to visit a museum institution, as a result of a VR experience.

4.1 Data Analysis

After performing the VR experiment for around one and a half months, it was possible to collect the necessary data for the current study. 228 participants were surveyed, however, by default, some of the answers of 9 participants were missing from Qualtrics reports. Thus, a sample of 219 respondents remained for the analysis. After downloading the responses from Qualtrics, data was exported to an Excel file, to facilitate the import in the chosen statistical program, Smart PLS 3.0. However, due to the existence of a Portuguese and an English version of the questionnaire, they were both merged into an Excel sheet, being the data in Portuguese translated into English.

The collected data was treated using Smart PLS 3.0 and followed the repeated indicators approach for the second-order reflective-formative construct, called atmospheric cues, serious leisure, and presence (Hair et al., 2019). The use of PLS-SEM is due to the nature of the model, which is exploratory in its nature and has a predictive focus, with second-order formative constructs (Hair et al., 2019). From Smart PLS, the final model was created, and all the necessary outputs required to conduct the quantitative data analysis were extracted. First, a descriptive statistical study, assessing the Mean values and Standard Deviation, was pursued. Then, the measurement model is analysed through the reliability of the individual measures, the convergent validity, as well as the discriminant validity of the constructs.

4.1.1 Model Estimation

Through PLS, the following step was the estimation of the model. It is comprised of two first-order constructs (Vividness and Intention to Visit) and three reflective-formative second-order constructs (Atmospheric Cues, Presence and Serious Leisure). Atmospheric Cues presents three first-order dimensions (Lighting, Learning and Design), Presence comprises two first-order dimensions (Self-Location and Possible Actions), and Serious Leisure comprises three first-order dimensions (Self-Gratification-Satisfaction, Self-Gratification-Enjoyment and Personal Enrichment). All these dimensions are significantly distinctive among themselves (in

each second-order construct) and explain and contribute to the perception of the Museum's Atmospheric Cues, sense of Presence and Serious Leisure.

4.1.2 Descriptive Statistics

In the following section, the results of the descriptive analysis of each variable that constitutes the conceptual framework are presented. The values of the respective Means, Standard Deviations, and Loadings were accessed through Smart PLS and SPSS Statistics softwares. Following, an analysis of each variable is presented with tables created with the obtained values.

4.1.2.3 Atmospheric Cues

The first variable under analysis is Atmospheric Cues. It is explained by three dimensions: Design, Lighting, and Learning. This construct comprises 10 items, which are presented in Table 4.1. From the analysis of that table, it is possible to deduct that the item **LE1: It was a very interesting experience** (mean= 6.14) has the highest Average Value, meaning that it has the highest level of agreement in the respondents' answers. In contrast, the lowest level of agreement among the participants corresponds to item **DE4: The décor of the museum was pleasing to me** (mean= 5.40).

Looking at the Standard Deviation, **LE3: The experience has made me more knowledgeable** presents the highest value of 1.428, showing, therefore, higher disparity among the answers. In contrast**, LI2: The lighting was pleasant,** presenting the lowest value of 0.928, expressing a greater similarity among the answers. The construct of Atmospheric Cues has a Mean value of 5.82, indicating a level of agreement close to "Agree" on the 7-point Likert Scale, and a Standard Deviation of 1.128.

Table 4.1 *– Descriptive Statistics: Atmospheric Cues.*

	Mean	SD	Loading
DE1: The colour scheme was pleasing.	5.98	.914	a
DE2: The facilities were attractive.	5.72	1.028	0.824
DE3: The museum permanent display was impressive.	5.71	1.115	0.850
DE4: The décor of the museum was pleasing to me.	5.40	1.239	0.876
LI1: The lighting accentuated the exhibition that was displayed at the museum.	5.96	0.969	0.948
LI2: The lighting was pleasant.	5.92	0.928	0.935
LE1: It was a very interesting experience.	6.14	1.027	0.792

Table 4.1 *– Descriptive Statistics: Atmospheric Cues 2nd Part.*

	Mean	SD	Loading
LE2: I discovered something new.	5.90	1.281	0.740
LE3: The experience has made me more knowledgeable.	5.53	1.428	0.801
LE4: I enjoyed the permanent exhibition.	6.00	1.034	0.778
Construct: Atmospheric Cues	**5.82**	**1.128**	

Source: Author's own elaboration based on SPSS output.

4.1.2.4 Presence

The construct Presence is explained by 8 items, as presented below in Table 4.2. The items **SL3: It was as though my true location had shifted into the VR environment** (mean= 6.01) and **SL2: It seemed as though I actually took part in the action of the VR (sightseeing)** (mean= 6.00) present the highest agreement rates, whereas the item **PA4: It seemed to me that I could do whatever I wanted in the VR environment** (mean= 4.81) presents the lowest value, meaning the lowest concordance among the participants.

Concerning Standard Deviation, **PA1: The objects in VR gave me the feeling that I could do things with them** presents the highest value, 1.472, revealing that respondents answered less similarly regarding this item. On the contrary, **SL1: I felt like I was actually there in the VR environment** shows the lowest value, 0.990, thus less disparity among the responses. As a whole, the construct of Present has a Mean of 5.59 and a Standard Deviation of 1.414. The Mean value represents a value between "Moderately Agree" and "Agree" in the Likert Scale from 1 to 7.

Table 4.2 *– Descriptive Statistics: Presence.*

	Mean	SD	Loading
SL1: I felt like I was actually there in the VR environment.	5.96	0.990	0.824
SL2: It seemed as though I actually took part in the action of the VR (sightseeing).	6.00	1.016	0.809
SL3: It was as though my true location had shifted into the VR environment.	6.01	1.096	0.847
SL4: I felt as though I was physically present in the VR environment.	5.81	1.136	0.829
PA1: The objects in VR gave me the feeling that I could do things with them.	5.16	1.472	0.841
PA2: I had the impression that I could be active in the VR environment.	5.34	1.276	0.872
PA3: I felt like I could move around among the objects in VR.	5.62	1.226	0.792
PA4: It seemed to me that I could do whatever I wanted in the VR environment.	4.81	1.468	0.841
Construct: Presence	**5.59**	**1.414**	

Source: Author's own elaboration based on SPSS output.

4.1.2.5 Vividness

Vividness is constituted by 6 items, presented in Table 4.3. The Mean values reveal that the item **V1: The imagery of this virtual tour was unclear/clear** presents the highest agreement rate of 5.77, demonstrating that the imagery of the virtual tour was perceived as clear. On the contrary, the item **V4: The imagery of this virtual tour was dull/sharp** has the lowest Mean value of 5.16.

Regarding Standard Deviation, **V4: The imagery of this virtual tour was dull/sharp** showcases the highest value, 1.460, revealing that respondents answered less similarly to this item. On the contrary, **V6: The imagery of this virtual tour was poorly defined/ well defined** shows the lowest value, 1.196, thus less disparity among respondents' answers. The construct Vividness has a Mean value of 5.41, indicating a level of agreement between "Moderately Agree" and "Agree", and a Standard Deviation of 1.328.

Table 4.3 *– Descriptive Statistics: Vividiness.*

	Mean	SD	Loading
V1: The imagery of this virtual tour was unclear/clear.	5.77	1.198	0.786
V2: The imagery of this virtual tour was weak/strong.	5.60	1.296	0.833
V3: The imagery of this virtual tour was fuzzy/right.	5.32	1.302	0.874
V4: The imagery of this virtual tour was dull/sharp.	5.16	1.460	0.843
V5: The imagery of this virtual tour was hazy/vivid.	5.27	1.416	0.827
V6: The imagery of this virtual tour was poorly defined/well defined.	5.38	1.196	0.813
Construct: Vividness	**5.41**	**1.328**	

Source: Author's own elaboration based on SPSS output.

4.1.2.6 Serious Leisure

As mentioned before, the variable Serious Leisure is explained by three dimensions: Personal Enrichment, Self-Gratification-Satisfaction, and Self-Gratification-Enjoyment. This construct comprises 9 items, which can be found in Table 4.4. The item with the highest Average Value is **SGE3: I enjoy this virtual visit** (mean= 6.25), which indicates the highest agreement rate in the total of items. On the contrary, **PE2: This visit has added richness to my life** displays the lowest Mean value of 5.16.

Also, item **PE22: This visit has added richness to my life** represents the highest value of Standard Deviation, 1.235, revealing the disparity among the participants' answers.

The item **SGE1: This virtual visit is enjoyable to me** has a Standard Deviation of 0.896, which translates into a lower fluctuation of answers regarding this statement. The construct of Serious Leisure has a Mean value of 5.74, indicating a level of agreement between "Moderately Agree" and "Agree" on the 7-point Likert Scale. Regarding Standard Deviation, the value for this construct is 1.148.

Table 4.4 *– Descriptive Statistics: Serious Leisure.*

	Mean	SD	Loading
PE1: I have been enriched by this virtual visit.	5.66	1.012	0.868
PE2: This visit has added richness to my life	5.16	1.235	0.906
PE3: My experiences have added richness to my life	5.84	1.110	0.712
SGS1: This virtual tour provides me with a profound sense of satisfaction.	5.67	1.033	0.880
SGS2: My visit experiences are deeply gratifying.	5.57	.986	0.858
SGS3: The museum visit is intensely gratifying to me.	5.37	1.143	0.903
SGE1: This virtual visit is enjoyable to me.	6.00	0.896	0.887
SGE2: This virtual visit is fun to me.	6.13	0.915	0.885
SGE3: I enjoy this virtual visit.	6.25	0.920	0.927
Construct: Serious Leisure	**5.74**	1.148	

Source: Author's own elaboration based on SPSS output.

4.1.2.7 Visit Intention

The following variable, Visit Intention, is constituted of 3 items, which are presented in Table 4.5. Regarding the Average Values, **VI3: I can see myself visiting Museu Nacional dos Coches in the future** is the item that presents the highest agreement rate of 5.46. In contrast, **VI2: It is likely that I visit Museu Nacional dos Coches in the future** (mean= 5.30) is the item with the lowest agreement rate. It is also the one with the highest Standard Deviation (SD= 1.600), showing a big level of disparity among the respondents' answers. As a whole, the construct of Visit Intention has a Mean of 5.38 and a Standard Deviation of 1.600. The Mean value represents a value close to "Moderately Agree" on the Likert Scale from 1 to 7.

Table 4.5 *– Descriptive Statistics: Visit Intention.*

	Mean	SD	Loading
VI1: I expect to visit Museu Nacional dos Coches in the future.	5.36	1.533	0.951
VI2: It is likely that I visit Museu Nacional dos Coches in the future.	5.30	1.600	0.978
VI3: I can see myself visiting Museu Nacional dos Coches in the future.	5.46	1.560	0.971
Construct: Visit Intention	**5.38**	**1.600**	

Source: Author's own elaboration based on SPSS output.

4.1.3 Assessment of Measurement Model

This section concerns the analysis of the results of the measurement model of the first-order constructs (Vividness and Intention to Visit), and the components of the second-order constructs (Atmospheric Cues, Presence and Serious Leisure) through the reliability of the individual measures, the convergent validity, as well as the discriminant validity of the constructs.

Primarily, construct reliability and convergent validity were verified. In order to evaluate the adequacy of the model, the reliability is accessed through the examination of the loadings of each construct. One item from Design, DE1, a component of the second-order construct Atmospheric Cues, was eliminated as it presented a loading lower than 0.7. At the first-order construct level, all the remaining factor loadings are above the critical value of 0.7, being considered adequate and reliable (Hair et al., 2019). All loadings can be found in Appendix C. Additionally, as the average variance of manifest variables extracted (AVE) presented values above 0.5, indicating that the constructs include more than 50% of the proportion of the indicators' variance, demonstrating convergent validity (Fornell & Larcker, 1981).

As for the measurement of internal consistency, the values of Rho_A, Cronbach's Alpha and Composite reliability had to be accessed, as shown in Table 4.6. Regarding Rho_A, the values range between 0.793 and 0.965, therefore surpassing the commonly accepted lower limit of 0.7. Referring to Cronbach's Alpha, the values range between 0.776 and 0.965, which means that the minimum agreed value for this coefficient, 0.7, is surpassed by all variables. Lastly, concerning Composite Reliability, it is possible to confirm that all values are higher than the minimum threshold value, 0.6, thus ensuring their reliability.

Table 4.6 *– Construct Reliability and Convergent Validity.*

	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (AVE)
Design	0.808	0.813	0.886	0.723
Learning	0.785	0.793	0.860	0.606
Lighting	0.871	0.878	0.939	0.886
Personal Enrichment	0.776	0.804	0.871	0.694
Possible Actions	0.857	0.860	0.903	0.701
Self-Grat-Enjoy	0.882	0.883	0.927	0.810
Self-Grat-Satisfaction	0.855	0.861	0.912	0.775
Self-Location	0.847	0.848	0.897	0.685
Intention to Visit	0.965	0.965	0.977	0.935
Vividness	0.909	0.917	0.930	0.688

Source: Author's own elaboration based on PLS output.

To access discriminant validity, three approaches were taken into consideration: the Cross-Loadings criterion, the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio criterion**.** Regarding the Cross-loadings, the test system requires that the indicator's outer loading on the associated construct presents a higher value than the remaining cross-loadings regarding other constructs. In the present case, the discriminant validity of the cross-loadings is verified, as all the loadings highlighted in Appendix C represent the higher values in that same line and column.

Considering the Fornell-Larcker criterion, the square root of the average variance extracted (AVE) of each construct must be larger than the correlation with any other construct in the model. As shown in Table 4.7, this criterion is successfully confirmed in the model under analysis. As for the Heterotrait-Monotrait Ratio (HMR) criterion, the average correlations of the indicators across constructs must be lower than 0.9, as correlations close to one indicate a lack of discriminant validity. By interpreting Table 4.8, it is possible to observe that all correlation values are below 0.9, confirming this criterion. As the scores of the Variance Inflation Factor (VIF) are below 3.33, it shows that the construct attachment strength does not possess any inner collinearity issues (Diamantopoulos & Siguaw, 2006), as seen in Table 4.9.

Table 4.7 *Discriminant Validity: Fornell-Larcker Criterion.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Design (1)	**0.850**									
Learning (2)	0.614	**0.778**								
Lighting (3)	0.599	0.449	**0.941**							
Personal Enrichment (4)	0.558	0.713	0.457	**0.833**						
Possible Actions (5)	0.487	0.527	0.337	0.493	**0.837**					
Self-Grat-Enjoy (6)	0.490	0.646	0.441	0.588	0.369	**0.900**				
Self-Grat-Satisfaction (7)	0.610	0.697	0.468	0.680	0.509	0.626	**0.880**			
Self-Location (8)	0.371	0.451	0.368	0.477	0.595	0.366	0.479	**0.828**		
Intention to Visit (9)	0.490	0.466	0.299	0.341	0.258	0.372	0.464	0.202	**0.967**	
Vividness (10)	0.281	0.365	0.287	0.368	0.417	0.283	0.459	0.373	0.324	**0.830**

Source: Author's own elaboration based on PLS output.

Table 4.8 *– Discriminant Validity: HTMT Ratio of Correlations Criterion*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Design (1)										
Learning (2)	0.726									
Lighting (3)	0.715	0.523								
Personal Enrichment (4)	0.690	**0.888**	0.548							
Possible Actions (5)	0.585	0.634	0.392	0.592						
Self-Grat-Enjoyment (6)	0.573	0.761	0.503	0.694	0.423					
Self-Grat-Satisfaction (7)	0.729	0.826	0.539	**0.854**	0.589	0.713				
Self-Location (8)	0.445	0.544	0.428	0.586	0.694	0.424	0.561			
Intention to Visit (9)	0.548	0.518	0.323	0.383	0.282	0.403	0.511	0.224		
Vividness (10)	0.319	0.426	0.313	0.434	0.468	0.314	0.516	0.419	0.343	

Source: Author's own elaboration based on PLS output.

Table 4.9 – Collinearity: *Variance Inflation Factor (VIF) scores.*

	Atmospheric Cues	Serious Leisure	Presence	Intention to Visit	Vividness
Atmospheric Cues		1.554	1.168		1.000
Serious Leisure				1.000	
Presence		1.656			
Intention to Visit					
Vividness		1.280	1.168		

Source: Author's own elaboration based on PLS output.

Regarding the reflective-formative second-order constructs, it was necessary to evaluate if the dimensions (design, lighting and learning in the case of Atmospheric Cues; self-location and possible actions for Presence; self-gratification-satisfaction, self-gratification-enjoyment and personal enrichment in the case of Serious Leisure) are good indicators and explain each of the global constructs. By analysing the following table, Table 4.10, it is possible to verify that all paths are positive, significant ($p < 0.001$), and greater than 0.1 (Chin, 1998). Each first-order construct is relevant to the respective second-order formative index at a significant level of 0.001. In addition, each weight is higher than 0.2, meaning that all first-order constructs have a sufficient level of validity (Roberts & Thatcher, 2009).

Table 4.10 – *Second order constructs: measurement model assessment*

First-order construct	Weight (Beta)	T Statistics	P Values
Atmospheric Cues			
Design	0.399	20.667	0
Lighting	0.282	14.870	0
Learning	0.503	18.613	0
Presence			
Self-Location	0.547	23.910	0
Possible Actions	0.572	25.143	0
Serious Leisure			
Self-Gratification-Enjoyment	0.386	20.383	0
Self-Gratification-Satisfaction	0.410	24.331	0
Personal Enrichment	0.338	19.523	0

Source: Author's own elaboration based on PLS output.

4.1.4 Assessment of Structural Model

In order to study the relationships between the latent variables and to test the validity of the aforementioned hypothesis, the structural model was assessed. Also known as the inner model, it is the result of the PLS algorithm calculation. It provides conclusions about the path coefficients, indicating the strength of the relationships between those variables. This was assessed through a non-parametric approach, Bootstrap (5000 resampling).

The conceptual model, presented in Figure 4.1, comprises two types of variables: an exogenous latent variable - atmospheric cues - which have no structural path relationships, and the endogenous variables - vividness, presence, serious leisure and intention to visit - which are predicted by the model and analysed through structural model relationships with other constructs (Hair et al., 2011)

All the hypotheses previously presented are supported by the results, as all paths are positive, greater than 0.1 (Chin, 1998) and all p-values lower than 0.05, as shown in Table 4.11.

H1 hypothesizes that atmospheric cues positively influence vividness. By analysing the results, ($\beta = 0.379$; p-value < 0.001), it is possible to observe that when museum visitors experience the stimuli caused by the atmospheric cues of the Museum, which in the current study is visited in a Virtual form, they will tend to form a positive opinion towards the representational richness of the environment. Concerning **H2**, it posits that the atmospheric cues have a positive effect on the sense of presence. The results ($\beta = 0.483$; p-value < 0.001) show that the design, lighting, and learning cues in the virtual Museum enhance the feeling of embodiment in the virtual scenario. **H3** evaluates if vividness is positively associated with presence. The hypothesis is supported by the results ($\beta = 0.260$; p-value < 0.001), showing that when the VR provides a sensation of rich representativeness of the different cues of the museum, the feeling of embodiment increases. **H4** proposes that vividness positively influences serious leisure and **H5** inspects if presence has a positive effect on serious leisure. Both hypotheses are supported by the results ($\beta = 0.110$; p-value < 0.05 and $\beta = 0.133$; p-value < 0.01, respectively). This means that the representational richness of the environment that can be seen through the VR can enhance the perception of personal enrichment and provide sensations of fulfilment, enjoyment and satisfaction in the visitor's mind. In the same way, the feeling of embodiment felt during the virtual visit may arouse the same perception and sensations mentioned immediately above. **H6** proposes that serious leisure positively influences the intention to visit the physical museum. The results support this hypothesis ($\beta = 0.450$; p-value < 0.001). Therefore, the sensation of satisfaction, fulfilment, and personal enrichment, developed throughout the virtual visit to the museum, favourably influence the

creation of a real intention to visit the physical site of the museum. All these direct effects can be found in Table 4.11.

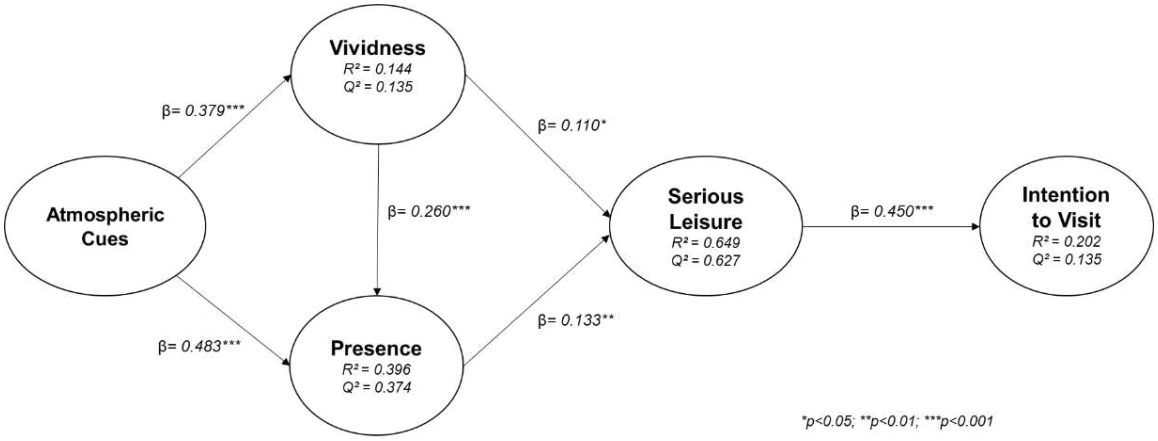

Figure 4.1 – *PLS Results.*

Source: Author's own elaboration based on PLS outputs.

Table 4.11 *– Direct Effects.*

	Beta	Std Deviation	T Statistics	P Values	Test Results
Atmospheric Cues → Vividness	0.379	0.063	6.056	0.000	H1: Supported
Atmospheric Cues → Presence	0.483	0.059	8.256	0.000	H2: Supported
Vividness → Presence	0.260	0.066	3.949	0.000	H3: Supported
Vividness → Serious Leisure	0.110	0.050	2.210	0.028	H4: Supported
Presence →Serious Leisure	0.133	0.051	2.606	0.009	H5: Supported
Serious Leisure → Intention to Visit	0.450	0.069	6.489	0.000	H6: Supported

Source: Author's own elaboration based on PLS output.

Concerning the effects of the control variables, age, gender, education level and technology expertise, on the Intention to Visit the museum, only age and gender proved to have a significant effect on the intention to visit the physical museum, being significant in a 0.01 and 0.001 level, respectively (Chin, 1998). The older the participants are, the more interest they have shown in visiting the physical location of the museum. Moreover, female participants proved to be more willing to visit the physical location of the museum in the future, when compared to male participants The results also revealed that technology expertise, as

well as education level, do not exercise a significant effect on the intention to visit the physical museum (see Table 4.12).

Table 4.12 *– Control Variables.*

	Original Sample	Std. Deviation	T Statistics	P Values	2.5%	97.5%
Age → Intention to Visit	0.133	0.052	2.577	0.010	0.023	0.226
Education → Intention to Visit	-0.077	0.060	1.288	0.198	-0.190	0.046
Technology Expertise → Intention to Visit	-0.029	0.057	0.514	0.608	-0.132	0.074
Gender → Intention to Visit	-0.161	0.050	3.235	0.001	-0.257	-0.062

Source: Author's own elaboration based on PLS output.

Table 4.13 presents the values of R square, Q square, and the Model fit. An endogenous variable's variation that is explained by one or more independent variables in the model is expressed statistically as R square. Moreover, its values aid in accessing the predictive accuracy of the model. The values range from 0 to 1, and higher values indicate a higher level of predicted accuracy. In the present study, the values of R square range between 0.144 and 0.649, demonstrating a satisfactory level of predictive power. The predictive validity is also ensured by the positive values of Q square, calculated through the blindfolding procedure of the Stone-Geisser test.

In the present case, it can be verified that Atmospheric Cues explain 14.4% (R^2= 0.144) of the variance in Vividness and it is relevant for this variable (Q^2=0.135). Atmospheric Cues and Vividness explain 39.6% (R^2= 0.396) of the variance in Presence with predictive relevance (Q^2=0.374). In turn, Vividness and Presence explain 64.9% of the variance in Serious Leisure (R^2= 0.649), presenting relevance (Q^2=0.627). Finally, Serious Leisure explains 20.2% (R^2= 0.202) of the variance of Visit Intention and it is relevant for this variable (Q^2= 0.135).

Regarding Cohen (1988), in order to analyse the effect size, values of 0.02, 0.15, and 0.35 represent the small, medium, and large effects of exogenous latent constructs on an endogenous latent construct. Only the relationships Vividness → Presence, Vividness → Serious Leisure and Presence → Serious Leisure have a small effect size. The Total Effects and the Specific Direct Effects can be accessed on Appendix D and Appendix E, respectively.

In this study, a marker was used in order to analyse common method variance (CMV). The marker was the attitude towards the colour blue. Following Chin et al. (2013), the marker variable model (see Table 4.14) was performed by adding the marker as an exogenous

construct that has a regression path to each endogenous construct. All parameter estimates that were significant in the model are equal or slightly smaller in the marker variable model and the paths do not decrease in significance. Thus, the model does not pose issues concerning CMV.

Lastly, regarding the model fit, and as a way of avoiding model misspecification, the standardized root mean square residual (SRMR) was accessed. This is determined by the difference between the observed correlations and the expected model-implied correlations matrix. A commonly accepted good fit corresponds to a value lower than 0.08, being a perfect fit the value 0. In the present study, an SRMS of 0.054 was obtained, indicating a well-fitting model, as the value is lower than the considered threshold.

Table 4.13 – *R-Square, Q-Square, and Model Fit.*

	R Square	Q Square
Vividness	0.144	0.135
Presence	0.396	0.374
Serious Leisure	0.649	0.627
Visit Intention	0.202	0.135
		Model Fit
SRMR		0.054

Source: Author's own elaboration based on PLS output.

Table 4.14 – *Direct effects: without and with Marker*

	Beta	Std. Deviation	T Statistics	P Values	2.5%	97.5%	Beta	Std Deviation	T Statistics	P Values	2.5%	97.5%
	Without Marker						With Marker					
AC→SL	0.669	0.047	14.174	0.000	0.561	0.745	0.669	0.048	13.894	0.000	0.570	0.755
AC→P	0.483	0.059	8.256	0.000	0.372	0.594	0.478	0.063	7.620	0.000	0.347	0.585
AC→ V	0.379	0.063	6.056	0.000	0.262	0.498	0.367	0.064	5.746	0.000	0.245	0.487
V→SL	0.110	0.050	2.210	0.028	0.022	0.211	0.110	0.044	2.477	0.014	0.026	0.200
V→P	0.260	0.066	3.949	0.000	0.124	0.399	0.260	0.070	3.731	0.000	0.127	0.406
P→SL	0.133	0.051	2.606	0.009	0.036	0.239	0.133	0.048	2.756	0.006	0.040	0.227
SL→VI	0.450	0.069	6.489	0.000	0.308	0.576	0.450	0.069	6.529	0.000	0.311	0.585

Source: Author's own elaboration based on PLS output.

4.2 Discussion

The present study was developed to determine the effect that the atmospheric cues of a Museum, visualized through VR, produce in the perceptions of vividness and presence and, subsequently, the effect they have on serious leisure, and how this may impact the arouse of the intention to visit the physical site of the Museum. The study's diverse sample (N=219) made it possible to accomplish the goals outlined in the conceptual model (Image 2.1), which will be detailed in this section.

Concerning the Descriptive Statistics, the main conclusions to draw concern the constructs with the highest and lowest agreement rate on a 7-point Likert and Semantic Differential Scale. Therefore, the construct with the highest Mean is Atmospheric Cues, with a value of 5.82. This construct has a Standard Deviation value of 1.128, the lowest among all the constructs. These two results show that visitors give the museum's atmospheric cues a strong emphasis, and the answers to these items were the most similar among respondents. On the contrary, the Visit Intention construct has the lowest agreement rate of 5.38 and the highest Standard Deviation of 1.600, revealing the highest disparity of responses.

Regarding the second-order constructs, Atmospheric Cues, Presence and Serious Leisure, it is important to understand which of the dimensions retain the highest rate of agreement among respondents. For Atmospheric Cues, Lighting is the dimension that appears to be the most valued, with a mean of 5.94, closely followed by Learning (5.89). Concerning Presence, the dimension with the highest mean is Self-Location, with a value of 5.95. For the Serious Leisure construct, Self-Gratification-Enjoyment is the dimension with the highest importance, with a mean of 6.12. Also, Lightning, Self-Location and Self-Gratification-Enjoyment are the dimensions with the lowest Standard Deviation values in each corresponding construct, meaning that they comprise the lowest disparity of responses regarding the items included.

All the developed hypotheses are supported by the model, as made clear in the measurement model section. The link between the variables under research will be fully explored in the following paragraphs.

By analysing if the Museum Atmospheric Cues – experienced through Virtual Reality - positively influence the sense of Vividness (H1) and the sense of Presence (H2) perceived by the participants, it was possible to conclude that all three dimensions of the construct Atmospheric Cues, which are Design, Lighting, and Learning, have an influence in those perceptions. Moreover, the analysis indicates that the variable with the highest effect on the perceptions is Learning (β=0.503), whereas Lighting (β=0.338) is the least influential. These conclusions reveal to be consistent with the results presented by Loureiro (2019) for a physical

visit to a museum, where learning emerges as the most relevant component of atmospheric cues. The Atmospheric Cues of the Museum accomplish an important role as stimuli to enhance the feelings of presence and vividness. Results show that there is a positive relationship between Atmospheric Cues and Vividness (β=0.379), and Atmospheric Cues and Presence (β=0.483), supporting H1 and H2, respectively.

Possible Actions and Self-Location, the two factors that aggregate to form Presence, present very similar weights (β= 0.572 and β= 0.547, respectively), which means that both contribute to the perception of presence in the same proportion. These findings are in accordance with the results presented by Tussyadiah et al. (2018). The Virtual Reality experience demonstrates its effectiveness in simulating the sense of being in a physical space. Also, the results reveal a positive influence between Presence and Vividness (β=0.260), and, thus supporting hypothesis H3. Prior research from Lee et al. (2020) highlights a similar relation. According to the same authors, within the tourism and hospitality scope, both vividness and presence – in the VR context - play important roles, as they provide a genuine sense of place and realistic destination feelings.

As for the relationship between Vividness and Serious Leisure, the results show that there is a positive relationship between the two (β= 0.110), supporting hypothesis H4. The present study also reveals a positive influence between Presence and Serious Leisure (β= 0.133), therefore supporting hypothesis H5. However, although both Vividness and Presence exercise a significant effect on Serious Leisure, it is mainly the combination of the effect of Vividness on Presence (β=0.260) that influences Serious Leisure (Lee et al., 2020). The research of Loureiro et al. (2021) confirms that both vividness and presence are direct consequences of cognitive and emotional states within a VR environment. The richness of the virtual environment and the sense of presence lead to positive outcomes, as VR users will feel more immersed and willing to be active in the virtual environment. An interactive and vivid atmosphere is a key factor for arousing favourable user emotions with effective results in the aftermath (Yim et al., 2017; Lee, 2004). As a consequence, visitors will feel like they have participated in an interesting activity that also involves an educational component (Barbieri & Sotomayor, 2013).

The results proved that there is a positive relationship between Serious Leisure and its three determinants, Personal Enrichment (β= 0.338), Self-Gratification-Satisfaction (β= 0.410) and Self-Gratification-Enjoyment (β= 0.386). Self-gratification-satisfaction appears to be the component with the highest weight value, meaning that it is the one that produces a highest influence on the perception of serious leisure. Finally, the results revealed a positive relationship between Serious Leisure and the Intention to Visit the physical Museum (β=

0.450), supporting H6. The perception of satisfaction, enrichment and enjoyment felt during the activity of visiting an educational place (Barbieri & Sotomayor, 2013) – as is the case of a VR museum – is critical in leading an individual to decide to visit the physical museum. Thus, the VR museum environment can be a relevant tool to encourage virtual visitors to visit the physical museum (Loureiro et al., 2020). Although prior studies have endeavoured to show the relevance of VR in tourism, this attempts to establish the effect of the stimuli that create a flow leading to gratification and to the intention to visit the physical site. This result is in accordance with Lee et al. (2020), which state that an immersive VR environment improves the experience as a whole and, consequently, induces the desire to visit a museum's physical site. By providing exact and plentiful information in a novel and captivating way, visitors will feel immersed in a VR environment, having an enhanced experience and overpassing possible limitations of real sites, which ultimately influences their intention to visit the actual place.

This way, Virtual Reality can be seen as a powerful tool to elicit in potential visitors the desire to explore the physical location of Museums or Cultural Heritage sites. The design, lighting, and learning cues experienced and appreciated in the virtual environment contribute to the feeling of presence and the perception of being active. Visitors will feel more immersed, recognizing the representational richness of the scenario, producing the sensation of actually being there. The feeling of presence in VR, as well as the perception of rich representativeness of the different cues provided by the VR, can boost the immersion in the experience, enhancing the perception of personal enrichment and fun, as well as eliciting a sensation of fulfilment in the visitor's mind. The flow state created during the VR experience through the rich environment and the sensation of being there is expected to enhance the sensation of enjoyment, fulfilment, and personal enrichment. Therefore, those feelings are expected to positively influence the virtual visitors to actually intend to visit the physical museum.

4.3 Theoretic Contribution

From a theoretical perspective, the present study provided several contributions to the research of Virtual Reality within the Marketing field. Immersive technologies, such as augmented and virtual reality, have been a subject of plentiful studies in the past decades. These technologies have been considered impactful marketing tools, being regarded as a way of providing new and challenging experiences. Nevertheless, a considerable number of studies have tried to propose VR as a substitute for travel and for certain products in the tourism industry (Guttentag, 2010). Instead, this study reinforces the position of the usage of virtual reality in tourism not as a replacement for the cultural site, but as a contributor to the inducement of the intention to visit, as well as a tool that enhances the overall experience.

Firstly, this study introduces a new use of the Stimulus-Organism-Response (S-O-R) framework (Meharabian and Russel, 1974), by exploring new relationships between variables, and by incorporating new ones. Atmospheric cues were considered as direct antecedent of the perceptions of vividness and presence, being the stimuli that affect the organism. Vividness, presence and serious leisure were considered as organism in the S-O-R framework. Generally, this framework regards organism as emotional and cognitive states, that are usually represented by constructs such as pleasure, arousal, or dominance (Roschk et al., 2017). In this case, vividness and presence represent feelings and sensations, as a consequence of the interiorization of the stimuli experienced during the virtual visit to the museum. Serious leisure was also considered as part of the organism, as it embodies emotional and cognitive states, expressed by the personal enrichment, self-gratification-satisfaction, and self-gratification-enjoyment dimensions.

In addition, the three constructs that constitute organism in the S-O-R framework are sorted considering serious leisure as a function of vividness and presence. Serious leisure, meaning satisfaction, enjoyment, and personal enrichment, felt while experiencing a leisure activity, as the VR tour of the museum can be considered, is a consequence of the immersion in VR translated by vividness and presence.

Thus, for the first time, serious leisure is represented as having a direct effect not in the intention to revisit the museum, but in the intention to visit the physical site of the museum. Although other factors may also contribute to lead virtual visitors to the physical facilities of a museum, serious leisure demonstrates to be an effective driver of the behavioural response.

4.4 Managerial Implications

The present study discloses significant implications that should be taken into consideration by museums and heritage sites managers, as well as other interested parties within the tourism and hospitality sector.

Managers should consider Virtual Reality as an effective tool to persuade individuals to visit the physical site of a museum. The investment in this kind of immersive technologies can be critical for promotion purposes, generating interest in the museum's collections from potential visitors. VR can also be used to deliver alternative museum experiences, highlighting details that are difficult to regard and appreciate on the museum site, allowing users to "be" in places that are inaccessible in the physical museum or accessing reconstitutions of locations that don't exist anymore. In addition, when the location of a particular site may seem problematic for some tourists, either because of the distance, the financial costs involved, or

mobility problems, these virtual solutions may help overcome those issues, allowing users to keep pursuing their cultural interests.

The design of the VR museum environment affects visitor evaluation and consequent behaviour. In the specific case of museums, visitors may expect that the virtual environment replicates the physical one. In a virtual setting, museum visitors want to have the pleasure of a knowledgeable experience with a pleasant environment design. Therefore, to encourage visitors to continue the VR experience and even to elicit in them the desire to visit the physical location of the museum, managers should provide an exhibition layout, colour scheme and décor that highlights the elements of the exhibition, and at the same time imparts knowledge.

Museum visitors expect to feel knowledgeably enriched when experiencing the visit to the museum through VR. Thus, the design of the environment must facilitate access to information, not only by offering a perfect visualization of the different elements of the exhibitions, in a 360º setting, but as well as by exhibiting information on the history of the object (e.g., carriage, painting, sculpture), and all kinds of relationships with the history of the destination.

A visitor only experiences a sense of improvement in their knowledge and positive intrinsic rewards when the atmosphere of the environment, together with its representational richness and the feeling of embodiment in the virtual setting, emerges during the VR visit. This sensation of improvement due to the knowledge acquired through the VR experience is the key factor to lead the visitor to visit the physical museum.

Chapter 5 – Conclusions and Recommendations

The results from the present study show that Virtual Reality can be considered an impactful tool for museum institutions to elicit the desire to visit their physical locations. This is highly influenced by the learning, satisfaction, gratification, and enjoyment feelings that VR users felt during their experience in the mediated environment, as a consequence of the representational richness of the design, learning and lighting cues displayed, as well as the sense of presence and embodiment. As it was proved, Serious Leisure is positively correlated with Intention to Visit, meaning that those VR initiatives promote edutainment and produce strong feelings and positive emotions, such as personal enrichment, satisfaction, gratification and enjoyment. This allows Museums to engage with potential visitors on an enhanced level, forwarding them to their physical location.

5.1 Limitations and Further Research suggestions

From the first until the last stage, the present study was designed and conducted with caution. Yet, as is the case of any research, during its elaboration several restraints were faced. Those limitations deserve to be expressed as they can also be considered as opportunities for future theoretical research.

First, although the sample was considered suitable for research purposes, 81% of the participants represent people between 18 and 24 years old. Due to the conditions on how the research had to be carried out, there were no respondents from older generations (more than 55 years old). Therefore, it would be interesting to compare the results of this young group of people with the ones of older respondents. Regarding nationality, Portuguese participants constitute 81% of the sample. Consequently, for future research, the same study about the same museum could be extended to a more culturally diverse group, with different nationalities, in order to understand if there would be different behaviours and reactions.

Second, for comparative studies, different VR tours of different Museums, either Portuguese or from other countries, should be conducted. By selecting different museums and their respective VR tours, the experience and the findings may differ. Thus, more comprehensive and applicable conclusions might be drawn. Also, future studies might want to consider different senses other than visual, namely auditory.

Third, other studies might manipulate individually each factor of the VR atmospheric cues (design, lighting and learning) and go further in understanding specific elements of a virtual museum that affect serious leisure. Also, as a way of considering staff (the fourth atmospheric cue that was not considered in the present research) on a VR museum visit, the usage of an Artificial Intelligence Virtual Assistant could also be further studied.

Lastly, other drivers of serious leisure should be considered for future studies. For instance, enjoyability and inspiration. The former measures the agreeability of undergoing the VR experience, and the latter as an impulse in the internal process of engaging in the experience and the desire to continue in the future. Positive emotional states can eventually increase interest in visiting the physical location of the museum.

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Appendixes

Appendix A – Questionnaire English Version

ISCTE Instituto Universitário de Lisboa

Welcome dear participant!

I am a Master's student in Marketing at ISCTE Business School. I am currently working on my final dissertation, which aims to understand the impact that a Virtual Reality visit to a museum has on a person and on their intention to visit the place physically.

This questinaire will take you more or less 4 minutes to complete and all responses are kept anonymous and confidential.

Your participation is extremely important and valued.
Thank you very much for your cooperation and for your time.

Have you ever visited the Museu Nacional dos Coches in Lisbon?

- ○ No
- ○ Yes

If yes, when was the last time? (year)

On a scale from 1 (Strongly Disagree) to 7 (Strongly agree) please indicate your agreement with the following sentences:

	Strongly Disagree	Disagree	Moderately Disagree	Nor Agree nor Disagree	Moderately Agree	Agree	Strongly Agree
I felt like I was actually there in the VR environment.	○	○	○	○	○	○	○
It seemed as though I actually took part in the action of the VR (sightseeing).	○	○	○	○	○	○	○
It was as though my true location had shifted into the VR environment.	○	○	○	○	○	○	○
I felt as though I was physically present in the VR environment.	○	○	○	○	○	○	○
The objects in VR gave me the feeling that I could do things with them.	○	○	○	○	○	○	○
I had the impression that I could be active in the VR environment.	○	○	○	○	○	○	○
I felt like I could move around among the objects in VR	○	○	○	○	○	○	○
It seemed to me that I could do whatever I wanted in the VR environment.	○	○	○	○	○	○	○

Regarding the imagery of this virtual visit, rate the following statements on a scale of 1 to 7:

Unclear	○ ○ ○ ○ ○ ○ ○	Clear
Weak	○ ○ ○ ○ ○ ○ ○	Strong
Fuzzy	○ ○ ○ ○ ○ ○ ○	Right
Dull	○ ○ ○ ○ ○ ○ ○	Sharp
Hazy	○ ○ ○ ○ ○ ○ ○	Vivid
Poorly-defined	○ ○ ○ ○ ○ ○ ○	Well-defined

On a scale from 1 (Strongly Disagree) to 7 (Strongly agree) please indicate your agreement with the following sentences:

	Strongly Disagree	Disagree	Moderately Disagree	Nor Agree nor Disagree	Moderately Agree	Agree	Strongly Agree
The colour scheme was pleasing.	○	○	○	○	○	○	○
The facilities were attractive.	○	○	○	○	○	○	○
The museum permanent display was impressive.	○	○	○	○	○	○	○
The décor of the museum was pleasing to me.	○	○	○	○	○	○	○
The lighting accentuated the exhibition that was displayed at the museum.	○	○	○	○	○	○	○
The lighting was pleasant.	○	○	○	○	○	○	○
I discovered something new.	○	○	○	○	○	○	○
The experience has made me more knowledgeable.	○	○	○	○	○	○	○
I enjoyed the permanent exhibition.	○	○	○	○	○	○	○
It was a very interesting experience	○	○	○	○	○	○	○

On a scale from 1 (Strongly Disagree) to 7 (Strongly agree), please indicate your agreement with the following sentences:

	Strongly Disagree	Disagree	Moderately Disagree	Nor Agree nor Disagree	Moderately Agree	Agree	Strongly Agree
I have been enriched by this virtual visit.	○	○	○	○	○	○	○
This visit has added richness to my life.	○	○	○	○	○	○	○
My experiences have added richness to my life	○	○	○	○	○	○	○
This virtual tour provides me with a profound sense of satisfaction.	○	○	○	○	○	○	○
My visit experiences are deeply gratifying.	○	○	○	○	○	○	○
The museum virtual visit is intensely gratifying to me.	○	○	○	○	○	○	○
This virtual visit is enjoyable to me.	○	○	○	○	○	○	○
This virtual visit is fun to me.	○	○	○	○	○	○	○
I enjoy this virtual visit.	○	○	○	○	○	○	○

On a scale from 1 (Strongly Disagree) to 7 (Strongly agree), please indicate your agreement with the following sentences:

	Strongly Disagree	Disagree	Moderately Disagree	Nor Agree nor Disagree	Moderately Agree	Agree	Strongly Agree
I expect to visit Museu Nacional dos Coches in the future.	○	○	○	○	○	○	○
It is likely that I visit Museu Nacional dos Coches in the future.	○	○	○	○	○	○	○
I can see myself visiting Museu Nacional dos Coches in the future.	○	○	○	○	○	○	○

On a scale from 1 (Strongly Disagree) to 7 (Strongly agree), please indicate your agreement with the following sentences:

	Strongly Disagree	Disagree	Moderately Disagree	Nor Agree nor Disagree	Moderately Agree	Agree	Strongly Agree
I like the blue colour.	○	○	○	○	○	○	○
The blue colour is nice.	○	○	○	○	○	○	○
I love the blue colour.	○	○	○	○	○	○	○
I hope to buy a car in blue colour.	○	○	○	○	○	○	○

Gender

- ○ Male
- ○ Female
- ○ Other

Age

- ○ 18 - 24
- ○ 25 - 34
- ○ 35 - 44
- ○ 45 - 54
- ○ 55 - 64
- ○ > 65

Education

- ○ Elementary School
- ○ High School
- ○ Professional Course
- ○ Bachelor's Degree
- ○ Master's Degree
- ○ Doctorate Degree

Nationality

Technology Expertise

- ○ Very Experienced
- ○ Experienced
- ○ Average User
- ○ Not Experienced

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix B – Questionnaire Portuguese Version

Bem-vindo caro participante!

Sou estudante de mestrado em Marketing na ISCTE Business School. Neste momento estou a trabalhar na minha dissertação final, que visa compreender o impacto que uma visita virtual a um museu tem numa pessoa e na sua intenção de visitar o mesmo fisicamente.

O questionário tem a duração cerca de 4 minutos e todas as respostas são mantidas anonimas e confidenciais.

A sua participação é extremamente importante e valorizada.
Muito obrigado pela colaboração e pelo tempo dispensado.

Alguma vez visitou o Museu Nacional dos Coches em Lisboa?

- ○ Sim
- ○ Não

Se sim, em que ano realizou a sua última visita?

Numa escala de 1 (Discordo totalmente) a 7 (Concordo totalmente), indique o quão de acordo está com as seguintes afirmações:

	Discordo Totalmente	Discordo	Discordo Parcialmente	Não Concordo Nem Discordo	Concordo Parcialmente	Concordo	Concordo Totalmente
Senti que estava realmente no ambiente virtual	○	○	○	○	○	○	○
Pareceu que realmente participei na ação no ambiente virtual	○	○	○	○	○	○	○
Foi como se a minha localização tivesse mudado para o ambiente virtual	○	○	○	○	○	○	○
Senti-me como se estivesse fisicamente no ambiente virtual	○	○	○	○	○	○	○
Tive a impressão de que poderia realizar ações com os objetos no ambiente virtual	○	○	○	○	○	○	○
Tive a impressão de que podia estar ativo no ambiente virtual	○	○	○	○	○	○	○
Senti que podia mover-me entre os objetos no ambiente virtual	○	○	○	○	○	○	○
Senti que podia fazer o que quisesse no ambiente virtual	○	○	○	○	○	○	○

Relativamente à qualidade da imagem desta visita virtual, classifique numa escala de 1 a 7 as seguintes afirmações:

Nada clara	○	○	○	○	○	○	○	Bastante Clara
Fraca	○	○	○	○	○	○	○	Forte
Difusa	○	○	○	○	○	○	○	Concisa
Fosca	○	○	○	○	○	○	○	Nítida
Turva	○	○	○	○	○	○	○	Limpa
Nada definida	○	○	○	○	○	○	○	Muito definida

Numa escala de 1 (Discordo totalmente) a 7 (Concordo totalmente), indique o quão de acordo está com as seguintes afirmações:

	Discordo Totalmente	Discordo	Discordo Parcialmente	Não Concordo Nem Discordo	Concordo Parcialmente	Concordo	Concordo Totalmente
O esquema de cores era agradável	○	○	○	○	○	○	○
As instalações eram atraentes	○	○	○	○	○	○	○
A exposição permanente do museu impressionou-me	○	○	○	○	○	○	○
A decoração do museu agradou-me	○	○	○	○	○	○	○
A iluminação realçou a exposição	○	○	○	○	○	○	○
A iluminação era agradável	○	○	○	○	○	○	○
Foi uma experiência bastante interessante	○	○	○	○	○	○	○
Descobri algo novo	○	○	○	○	○	○	○
Esta experiência tornou-me mais informado	○	○	○	○	○	○	○
Gostei da exposição permanente	○	○	○	○	○	○	○

Numa escala de 1 (Discordo totalmente) a 7 (Concordo totalmente), indique o quão de acordo está com as seguintes afirmações:

	Discordo Totalmente	Discordo	Discordo Parcialmente	Não Concordo Nem Discordo	Concordo Parcialmente	Concordo	Concordo Totalmente
A visita virtual enriqueceu-me	○	○	○	○	○	○	○
A visita acrescentou riqueza à minha vida	○	○	○	○	○	○	○
As minhas experiências acrescentam riqueza à minha vida	○	○	○	○	○	○	○
A visita virtual proporcionou-me uma sensação de satisfação.	○	○	○	○	○	○	○
As visitas que realizo são profundamente gratificantes	○	○	○	○	○	○	○
A visita virtual ao museu foi bastante gratificante para mim	○	○	○	○	○	○	○
A visita virtual foi agradável	○	○	○	○	○	○	○
A visita virtual foi divertida	○	○	○	○	○	○	○
Eu gostei desta visita virtual	○	○	○	○	○	○	○

Numa escala de 1 (Discordo totalmente) a 7 (Concordo totalmente), indique o quão de acordo está com as seguintes afirmações:

	Discordo Totalmente	Discordo	Discordo Parcialmente	Não Concordo Nem Discordo	Concordo Parcialmente	Concordo	Concordo Totalmente
Espero visitar o Museu Nacional dos Coches no futuro	○	○	○	○	○	○	○
É provável que visite o Museu Nacional dos Coches no futuro	○	○	○	○	○	○	○
Vejo-me a visitar o Museu Nacional dos Coches no futuro	○	○	○	○	○	○	○

Numa escala de 1 (Discordo totalmente) a 7 (Concordo totalmente), indique o quão de acordo está com as seguintes afirmações:

	Discordo Totalmente	Discordo	Discordo Parcialmente	Não Concordo Nem Discordo	Concordo Parcialmente	Concordo	Concordo Totalmente
Eu gosto da cor azul	○	○	○	○	○	○	○
A cor azul é linda	○	○	○	○	○	○	○
Eu amo a cor azul	○	○	○	○	○	○	○
Eu espero comprar um carro azul	○	○	○	○	○	○	○

Género

- ○ Masculino
- ○ Feminino
- ○ Outro

Idade

- ○ 18 - 24
- ○ 25 - 34
- ○ 35 - 44
- ○ 45 - 54
- ○ 55 - 64
- ○ > 65

Nível de Escolaridade

- ○ Ensino Básico
- ○ Ensino Secundário
- ○ Curso Profissional
- ○ Licenciatura
- ○ Mestrado
- ○ Doutoramento

Nacionalidade

Utilização de Tecnologia

- ◯ Muito Experiente
- ◯ Experiente
- ◯ Utilizador Comun
- ◯ Nada Experiente

We thank you for your time spent taking this survey.
Your response has been recorded.

Appendix C – Cross Loadings

	DE	LE	LI	SL	PA	PE	SGE	SGS	V	VI
DE2	**0.824**	0.404	0.528	0.334	0.435	0.455	0.353	0.493	0.215	0.342
DE3	**0.850**	0.676	0.459	0.381	0.476	0.546	0.525	0.583	0.299	0.514
DE4	**0.876**	0.460	0.547	0.225	0.325	0.414	0.357	0.471	0.196	0.379
LE1	0.507	**0.792**	0.453	0.475	0.483	0.603	0.516	0.575	0.366	0.325
LE2	0.290	**0.740**	0.249	0.312	0.327	0.443	0.388	0.382	0.196	0.243
LE3	0.346	**0.801**	0.261	0.274	0.413	0.583	0.474	0.557	0.341	0.326
LE4	0.691	**0.778**	0.396	0.324	0.400	0.569	0.599	0.618	0.228	0.514
LI1	0.588	0.470	**0.948**	0.351	0.325	0.481	0.426	0.480	0.296	0.330
LI2	0.537	0.370	**0.935**	0.342	0.308	0.375	0.403	0.398	0.241	0.228
SL1	0.278	0.340	0.283	**0.824**	0.402	0.323	0.313	0.315	0.272	0.171
SL2	0.365	0.386	0.309	**0.809**	0.491	0.409	0.323	0.426	0.305	0.207
SL3	0.312	0.438	0.327	**0.847**	0.535	0.433	0.263	0.430	0.322	0.164
SL4	0.271	0.325	0.299	**0.829**	0.533	0.406	0.315	0.407	0.332	0.130
PA1	0.343	0.431	0.198	0.543	**0.841**	0.452	0.297	0.444	0.312	0.221
PA2	0.391	0.444	0.295	0.530	**0.872**	0.393	0.344	0.456	0.355	0.228
PA3	0.409	0.397	0.304	0.454	**0.792**	0.344	0.272	0.311	0.341	0.142
PA4	0.493	0.491	0.337	0.461	**0.841**	0.459	0.321	0.487	0.391	0.268
PE1	0.515	0.661	0.434	0.390	0.450	**0.868**	0.621	0.670	0.325	0.355
PE2	0.524	0.668	0.397	0.442	0.483	**0.906**	0.496	0.711	0.314	0.305
PE3	0.331	0.419	0.299	0.358	0.272	**0.712**	0.314	0.560	0.280	0.167
SGE1	0.469	0.570	0.421	0.364	0.391	0.551	**0.887**	0.570	0.272	0.303
SGE2	0.413	0.550	0.397	0.306	0.265	0.507	**0.885**	0.554	0.237	0.309
SGE3	0.441	0.623	0.373	0.317	0.339	0.528	**0.927**	0.566	0.256	0.392
SGS1	0.513	0.651	0.402	0.438	0.414	0.667	0.589	**0.880**	0.388	0.398
SGS2	0.521	0.487	0.396	0.422	0.402	0.643	0.417	**0.858**	0.392	0.418
SGS3	0.574	0.688	0.437	0.407	0.521	0.745	0.631	**0.903**	0.431	0.411
V1	0.256	0.278	0.237	0.326	0.310	0.250	0.245	0.346	**0.786**	0.268
V2	0.243	0.322	0.252	0.276	0.334	0.318	0.239	0.388	**0.833**	0.188
V3	0.295	0.341	0.339	0.384	0.426	0.369	0.273	0.440	**0.874**	0.331
V4	0.179	0.258	0.189	0.263	0.298	0.275	0.200	0.389	**0.843**	0.264
V5	0.168	0.300	0.180	0.275	0.318	0.260	0.242	0.317	**0.827**	0.223
V6	0.234	0.307	0.198	0.311	0.365	0.337	0.203	0.388	**0.813**	0.322
VI1	0.508	0.467	0.300	0.192	0.259	0.327	0.342	0.461	0.305	**0.951**
VI2	0.461	0.446	0.277	0.218	0.258	0.336	0.354	0.461	0.326	**0.978**

VI3	0.453	0.438	0.290	0.176	0.230	0.327	0.383	0.422	0.309	**0.971**

Source: Own elaboration based on PLS outputs.

Appendix D – Total effects

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	2.5%	97.5%
Atmospheric Cues → Serious Leisure	0.788	0.030	26.177	0.000	0.722	0.835
Atmospheric Cues → Presence	0.582	0.050	11.654	0.000	0.476	0.676
Atmospheric cues → Visit Intention	0.354	0.064	5.572	0.000	0.232	0.477
Atmospheric Cues → Vividness	0.379	0.063	6.056	0.000	0.262	0.498
Serious Leisure → Visit Intention	0.450	0.069	6.489	0.000	0.308	0.576
Presence → Serious Leisure	0.133	0.051	2.606	0.009	0.036	0.239
Presence → Visit Intention	0.060	0.024	2.474	0.014	0.014	0.108
Vividness → Serious Leisure	0.144	0.048	3.023	0.003	0.059	0.242
Vividness → presence	0.260	0.066	3.949	0.000	0.124	0.399
Vividness → Visit Intention	0.065	0.025	2.638	0.009	0.024	0.118

Source: Own elaboration based on PLS outputs.

Appendix E – Specific Indirect effects

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	2.5%	97.5%
ACues → SLeisure → VInt	0.301	0.058	5.168	0.000	0.187	0.419
ACues → Pres → SLeisure	0.064	0.027	2.372	0.018	0.015	0.121
Pres → SLeisure → VInt	0.060	0.024	2.474	0.014	0.014	0.108
ACues → Viv → SLeisure → VInt	0.019	0.010	1.881	0.061	0.003	0.041
Viv→ Pres → SLeisure → VInt	0.016	0.007	2.119	0.035	0.003	0.032
Viv → Pres → SLeisure	0.034	0.015	2.227	0.026	0.007	0.068
Viv → SLeisure → VInt	0.049	0.025	2.002	0.046	0.010	0.105
ACues → Viv → SLeisure	0.042	0.020	2.082	0.038	0.007	0.084
ACues → Viv → Pres	0.099	0.032	3.051	0.002	0.045	0.167
ACues → Viv → Pres → SLeisure → VInt	0.006	0.003	1.873	0.062	0.001	0.013
ACues → Viv → Pres → SLeisure	0.013	0.007	1.978	0.048	0.002	0.027
ACues → Pres → SLeisure → VInt	0.029	0.013	2.271	0.024	0.006	0.055

Source: Own elaboration based on PLS outputs.