

Emotional and cognitive responses to cultural heritage: a neuromarketing experiment using virtual reality in the tourist destination image model context

Alexis-Raúl Garzón-Paredes¹, Marcelo Royo-Vela^{2*}

¹*Facultad de Ciencias Administrativas, Universidad UTE, Quito, Ecuador; alexisr.garzon@ute.edu.ec.
Departamento de Comercialización e Investigación de Mercados, Universitat de Valencia, Valencia, España;
araulgar@alumni.uv.es*

*Facultad De Jurisprudencia, Ciencias Políticas y Económicas; Universidad Indoamérica, Quito, Ecuador;
agarzon6@indoamerica.edu.ec*

²*Departamento de Comercialización e Investigación de Mercados, Universitat de Valencia, Valencia, España;
Marcelo.Royo@uv.es*

Corvinus University of Budapest, Corvinus Institute for Advanced Studies, Budapest, Hungary

**Correspondence: Marcelo Royo Vela; Marcelo.Royo@uv.es*

Abstract:

The research is driven to identify and measure, through electroencephalography the impact of cultural and architectural heritage emulated by virtual reality on the mind of a tourist, in the form of cognitive and emotional responses measured as brain waves, identifies, through electroencephalogram, the cognitive and the emotional responses by subjects immersed in cultural tourist destination virtual reality, takes as conceptual framework the tourist destination image model and focus on tourist destinations characterised by historical, cultural, and architectural heritage. A neuromarketing experiment is carried out in which the cognitive and affective responses can be observed and measured using alpha α and beta β brain bioelectric waves, the data obtained directly from the human brain is used to carry out an analysis using the partial least squares regression algorithm PLS. The results show that the cognitive and emotional response caused by the tourist destination cultural heritage through virtual reality in individuals, is positive.

Keywords: Neuromarketing; virtual reality; cultural tourism, heritage; tourist destination image model; cognitive response, emotional response.

1. Introduction

Indeed, the tourism industry worldwide has experienced a major hiatus as a result of the COVID-19 pandemic (Buckley & Cooper, 2021). However, the vision of tourists play an important role in tourism development (Jangra et al., 2021; Serano-Arcos et al., 2021) and tourists can have unique tourist experiences with a destination's multimedia through content such as images, text, videos and audios (Lupu et al., 2021) With the recent explosion of virtual tours (Njerekai, 2019),

virtual platforms are becoming increasingly important as entertainment tools. Together to this, consumption of multimedia content is increasing globally and systematically generates new research questions in the tourism marketing and destination management fields (Palazzo et al., 2021)

The tourist destination image - hereinafter TDI - means a strategic effort for all tourism actors and has been researched intensively during the last decades. However, regarding its measurement, it is problematic when travellers subjectively assess it by means of surveys (Wullur & Sutapa, 2019).

For this reason, this research that uses electroencephalography to obtain metric data directly from the subject's brain has to be understood as a methodological proposal, to reduce this subjective bias.

The TDI is a multidimensional construct consisting of cognitive and affective dimensions (Beerli-Palacio & Martín-Santana, 2017; Elliot & Papadopoulos, 2016; Hernández et al., 2016; Huete Alcocer & López Ruiz, 2019; Kani et al., 2017; M. Y. Lai et al., 2020; Marine-Roig & Anton Clavé, 2016) that has been developed under the prism of different definitions and formation models, and therefore allowing more than one interpretation (Garzón-Paredes & Royo-Vela, 2021). The findings suggest that greater conceptual work is required (Duignan, 2021) and the same can be said regarding TDI measurement methodologies and scales which shows to the researcher, perhaps because of the destination diversity, a wide set of methods and tools (Garzón-Paredes & Royo-Vela, 2021). In this sense, research on the TDI framework that use simultaneously virtual reality, multivariate analysis and neuroscience to investigate urban or rural cultural destinations, in which heritage is present, is scarce. According to (Kim et al., 2017), to understand relationship and effects between culture and tourism is an interesting and necessary research topic, however it has been little studied so far.

Since an important part of the tourist product can be culture, cultural tourism plays a fundamental role both in the attractiveness of destinations and its image (Huete-Alcocer et al., 2019). Thus, the contribution of cognitive and affective images to the image of a destination can be related to its local heritage. Intangible culture as well as the tangible culture such as historical and architectural heritage can increase the cognitive and emotional response to a destination and consequently, its image, its attractiveness and its competitiveness (Folgado-Fernández et al., 2017; George, 2017), it can be said that the cognitive and emotional components of the TDI can be studied through the historical, architectural, and cultural heritage of cities (Royo-Vela, 2009).

Therefore, the research is driven to identify and measure, through electroencephalography (Yulita et al., 2020), the impact of cultural and architectural heritage emulated by virtual reality on the

mind of a tourist in the form of cognitive and emotional responses (Barrile et al., 2020) measured as brain waves (Rawnaque et al., 2020). Data obtained from a neuromarketing experiment and directly from the human brain is used to carry out an analysis using the partial least squares regression algorithm PLS, applying structural equation models; thus evaluating, the effects of the cultural and architectural heritage on the TDI. It is the general hypothesis of this research that the emotional and cognitive impact that architectural and cultural heritage has on the minds of tourists is intense and generates a positive image of the destination.

1.1. Literature review and hypotheses setting

Use of virtual reality to investigate heritage

The starting point of the presented research is the theory of destination marketing, in which the concept of destination branding is the key element that elements of nature and historical heritage are strongly present (Adamus-matuszyńska et al., 2021) a traveller has a mental image of a destination that could have unique characteristics, but there is also a common and public mental image of a destination (Obenour et al., 2005).- For this reason, the application of neuroscience and virtual reality constitutes a significant leap forward in the investigation of the destination image and the impact of heritage. According to Park and D. Njite (Park & Njite, 2010), also (Gholitabar et al., 2018), by linking tourism with virtual reality (Y. Li et al., 2021), heritage has a crucial socio-psychological dimension connected with national identity through experience attributes. There is a psychological mechanism influencing behaviour; its effects are significant due to the modality and navigability in the emotional and cognitive dimensions of virtual travel experience.

It is possible to group target image data, using hybrid techniques of artificial intelligence and evolutionary arithmetic algorithms. However, only with a broader understanding of relationships between virtual reality and the image of the destination, tourism opportunities will be better utilized. Virtual reality offers a variety of promising applications (Dogan & Kan, 2020; W. J. Lee & Kim, 2021; Lo & Cheng, 2020; Schott & Marshall, 2021; van Nuenen & Scarles, 2021) in areas ranging from administration to entertainment. It allows

people to have virtual experiences similar to reality and perform various tasks by achieving predetermined objectives using simulated scenes (Hyun & O'Keefe, 2012; Streimikiene & Korneeva, 2020). The findings on the use of virtual reality allow improving the motor, functional, and cognitive performance of a person (Aminov et al., 2018; Gui, 2021). Using virtual reality can be exciting, fun, and increases motivation (de Rooij et al., 2016)

When the product is a destination, the creation of images is critical since the tourist cannot test the product before acquiring it. Virtual reality allows eliminating this restriction. Furthermore, virtual reality offers the ability to create alternative experiences that can be useful for heritage preservation (Mongelli et al., 2021) its use will continue to increase potentially, both in applications and importance; Researchers and professionals have an excellent opportunity to exploit virtual reality in this field (Guttentag, 2010).

It's interesting to investigate the behaviour of the tourist through stimuli that emulate a possible visit to a destination endowed with cultural heritage and thus evaluate the conceptions in the human mind. (Sirgy & Su, 2000) For this, it is possible to use the navigability advantages in a virtual travel experience. It is known from previous studies that virtual reality significantly influences the emotional and cognitive dimensions of the experience (Briciu et al., 2020; Choi et al., 2018) which facilitates the investigation of the concept. Due to technological advances, distance has lost its traditional role as a cognitive filter between the subject and the site, resulting in tourist cultural spaces becoming filled with images and icons. Tourist destinations are becoming compelled to overcome new challenges offered by virtual reality media.

The tourist Destination Image

Positive images of the destination after visits can satisfy important factors. (Andersson et al., 2021). Tourism is a multifaceted field and in order to understand its complexity (Chia et al., 2021) the tourist expectation has a positive and significant effect on destination attractiveness (Trimurti & Utama, 2021) the TDI construct, definition and formation has been widely (Sun et al., 2021) researched for more than 50 years (Gómez et al.,

2018) regarding the formation model, also there is a large amount of scientific literature that has identified and measured antecedents, factors, constructs and consequences from various approaches, places, scales, constructs, structures and statistical techniques, mainly with the modelling of structural equations. See (Baloglu & McCleary, 1999; Baloglu & McCleary, 1999; Asunción Beerli & Martín, 2004; Asunción Beerli & Martín, 2004; Bigné Alcañiz et al., 2009; Echtner & Ritchie, 1993; Esper & Rateike, 2010; Gallarza et al., 2001; Gartner, 1994; Govers et al., 2007; C.-K. Lee et al., 2005; Royo-Vela, 2005, 2009; Royo & Serarols, 2005; Tasci et al., 2007)

The literature is extensive, and it is still going; however, the TDI is consensually defined as mental impressions and perceptions that tourists have of a place (K. Lai & Li, 2016) as well as is an emotional response. According to Royo-Vela (2005), the TDI are cognitive and emotional responses towards a destination based on a cognitive-affective structure formed along the time by the individual. (Royo-Vela, 2005)

The image represents a simplification of many associations and pieces of information and emotion connected to the site (Domínguez-Azcue et al., 2021; Shi et al., 2021; Zaman & Aktan, 2021) they are the product of the mind trying to integrate cognition and emotion about a place, places which, by the way, are far from being similar. For this reason, the conceptualization and measurement of the destination image needs to fit the touristic destination (Royo-Vela, 2009).

According to (Garzón-Paredes & Royo-Vela, 2021; Royo-Vela, 2009) the destination image is of paramount importance for tourist destination management since it motivates the interest of tourists, their satisfaction, loyalty, or intention to behave. There are obvious differences in tourists' emotional response, knowledge and perception in terms of overall perception, tourist resources, environment perception, recreational status and tourism attraction management (Lin & Zhao, 2021). It is an ever-changing construct that can be classified according to the conscious control that a person has over a place, is a mental representation of knowledge, thoughts, emotions and general impression about a destination that consists of three components: cognitive image, affective image,

and general image of the destination. (Fu & Timothy, 2021; Lindblom et al., 2018; Rosa et al., 2018; Skavronskaya et al., 2017; Stylidis et al., 2017; Sultan et al., 2021; Yap et al., 2018)

The image become part of the economy of self-representations online (Baumann, 2021) previous studies indicate that there is a hierarchical influence of the cognitive component on the image straight on and through the affective component as well as an effect of the affective component on the image. (Chiu et al., 2016) (Echtner & Ritchie, 1993) (Gartner, 1994) (Baloglu & McCleary, 1999) (Royo-Vela, 2005). That is, cognition is hierarchical above affect; therefore, from these results found in previous investigations, we can establish the first hypothesis:

H1: The virtual cognitive image (cognitive response) influences the virtual affective image (emotional response)

Before an image can influence behaviour, it is essential to understand how an image affects the viewer since a person's beliefs influence the attitude (Stylidis et al., 2021) towards the site. In this regard, previous causal links indicate that cognitive and emotional skills serve to attribute values and feelings to images (Ryan & Cave, 2005). Therefore, a key factor to consider is the emotional content as an expression of affective states. The emotional content of an image is linked to experience (T. T. Li et al., 2021) in situ and previous expectations, whereas cognitive assessment is related to visual effects. The perception of landscape elements is crucial to understand the role of visual elements. The cognitive image is a combination of information resources as well as capabilities and previous experiences, and the affective image is based on expectations, evaluations and experience in situ (Zhou, 2014) Accordingly, cognition and emotion are positively related to the image of a destination (Lindblom et al., 2018). In other words, environments and places produce cognitive and emotional responses on the traveller (Baloglu & McCleary, 1999) Thus, the TDI is generated by tourists based on their cognitive and affective responses (Shafiee et al., 2016). Based on these research, hypotheses two and three are presented below:

H2: The virtual cognitive image (cognitive response) positively influences the image of the destination.

H3: The virtual emotional image (emotional response) positively influences the image of the destination.

2. Materials and Methods

Participants

Neuromarketing is the execution of techniques that belong to neurosciences applied in the field of marketing (Aguiló-Lemoine et al., 2020; Garczarek-Bąk et al., 2021; Juárez-Varón et al., 2020; Mañas-Viniegra et al., 2021; Mansor & Isa, 2020; Nilashi et al., 2020), identifying responses to stimuli designed with specific objectives. These techniques are used to obtain accurate data on consumer reactions, optimising the management of market resources, and improving products and services. The primary function of the collection of responses to these stimuli is to investigate the behaviour and decision-making process of tourists.

The current investigation uses electroencephalography experimentation to collect brain wave data as responses to the stimulation of virtual reality in a sample of 25 people residing in Ecuador randomly selected between the ages of 21 and 60 years. Before the experiment, each participant has given written consent to sign, and they are informed that participation is optional and that they reserve the right to withdraw at any time (Gholami Dobarjeh et al., 2018) tourists' perceived destination image positively enhances their behavioural, (Tavitiyaman et al., 2021) it's important to mention that tourists did not previously know any of the evaluated destinations heritage.

Materials and procedure

The data collection procedure is performed in a physiology laboratory equipped with an electroencephalogram EEG (Aldayel et al., 2020); virtual reality (VR) goggles; a projector; headphones, and an iPhone 6 smartphone (see figures 1, 2 and 3). The phone is inserted into virtual reality device to

project videos of tourist sites containing architectural heritage; additionally, a computer records all the data.



Figure 1. Electrode placement and Electroencephalogram placement.



Figure 2. Smartphone in VR glasses and VR glasses.



Figure 3. Physiology laboratory, getting the waves.

Method-brain electromagnetic waves studied

The information generated by the electroencephalogram (EEG) is complex (González-Morales et al., 2020); therefore, it should be organized in a way that facilitates visual analysis. The EEG has a series of oscillations that, given specific characteristics, are called rhythms. Its generation is due to a complex set of cellular and synaptic mechanisms

that occur in the brain. The EEG is the graphic registry of rhythmic cerebral activity arranged in several timelines known as channels representing the areas of the brain where they were obtained. In other words, using electroencephalography equipment provides a record of rhythmic brain activity.

The oscillations produced on paper or digital registry are the results from the sum of the excitatory

and inhibitory postsynaptic potentials. These signals are of low amplitude but can be analysed using a series of differential amplifiers.

Rhythmic activity is obtained through electrodes placed on the scalp and is electronically amplified. It generates a registry that enables visualization and analysis. A typical EEG record consists of several strokes arranged in horizontal lines. Each of these corresponds to a channel and the oscillations per unit of time (one second), to different rhythms or brain waves. Conventionally, the same method is used to place electrodes on human skulls; this system is known as the international

10-20 electrode placement system. Through this system, we ensure that the electrodes are placed on the same areas of the head.

The nomenclature uses uppercase letters and numerical subscripts. The frontal, central, temporal, parietal and occipital electrodes recognized with the characters: F, C, T, P and O respectively (see figure 4). The even subscript indicates the right hemisphere while the odd one the left hemisphere. For example, F3 refers to the left frontal electrode while T4 to the right temporal. Lastly, the channels are identified according to the electrodes that feed it.

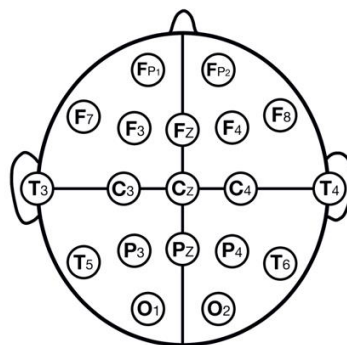


Figure 4. International system 10-20

To approve the hypotheses, wave amplitude must be high; that is, a stronger stimulus will produce a steeper wave.

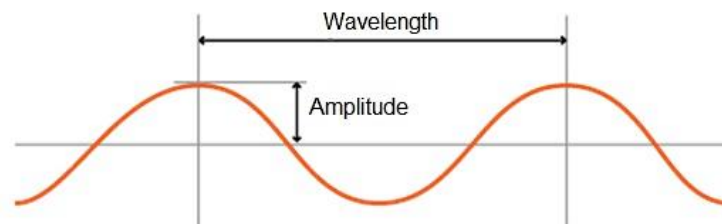


Figure 5. Wave example.

This experiment focuses on the investigation of alpha and beta waves, an important characteristic inherent to the behaviour of alpha activity, is the variation that is usually visible in its amplitude. The

amplitude is variable with an increase and decrease of the amplitude measured peak to peak or from maximum positivity to maximum negativity

(see figure 5). The term used to describe this phenomenon in literature is that of ‘waxing and waning’ or modulation. The alpha rhythm is the most critical finding to declare a subject as alert or awake. Alpha α waves are electromagnetic oscillations in the frequency range of 8-12 Hz.

Beta waves are in the frequency range of 12 to 30 Hz as a result of strong neuronal activity. These waves represent more complex brain activity related to states of awareness and focus. Frequency is the first step to identify a cerebral rhythm and classically; they are represented in characters of

the Greek alphabet and expressed in cycles per second or Hertz (Hz). The electric brain waves: delta, theta, alpha, beta and gamma, coexist in the brain and vary in frequency according to the amount of electricity generated by a stimulus (see figure 6 and table 1). This makes it possible to break down the waves into high, medium or low frequencies; the more significant the impact achieved by the stimulus in a human, the more electricity will be generated in the brain and the higher the frequency recorded by the electroencephalography equipment.

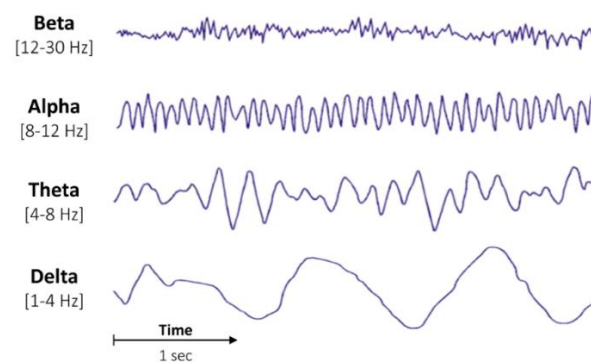


Figure 6. Beta, alpha, theta and delta waves.

Table 1. Types of brain wave frequencies captured by the electroencephalogram and their interpretation.

Name of the band	Frequency range [Hz]	Detail
δ (delta)	1 – 4	Deep sleep
θ_1 (theta low)	4 – 6	Relaxed
θ_2 (theta high)	6 – 8	Imaginative relaxed
α_1 (low alpha)	8 – 10	Break, but not sleep,
α_2 (high alpha)	10 – 12	Relaxing, emotionally pleasant
β_1 (low beta)	12 – 18	Relaxed, lax, even depressive.

$\beta 2$ (medium beta)	18 – 22	An optimal level of cognition these waves helps us to be much more receptive
$\beta 3$ (high beta)	22 – 30	Intense
γ (gamma)	30 – 40	Challenging to grasp it in electroencephalograms, high cognitive processing, tension, stress, happiness, euphoria.

Obtaining the metric data

Brain areas and frequency distribution are fundamental in identifying different brain rhythms correctly. The former implies that brain activity has a specific placement in different areas of the brain, and the latter displays rhythmic brain activity

adopting various frequency bands. The electroencephalogram shows this information in timelines called channels. The combination of several channels and their respective sources create a register known as assembly, which averages the ranges of each type of wave to manage data and straightforwardly (see figure 7).

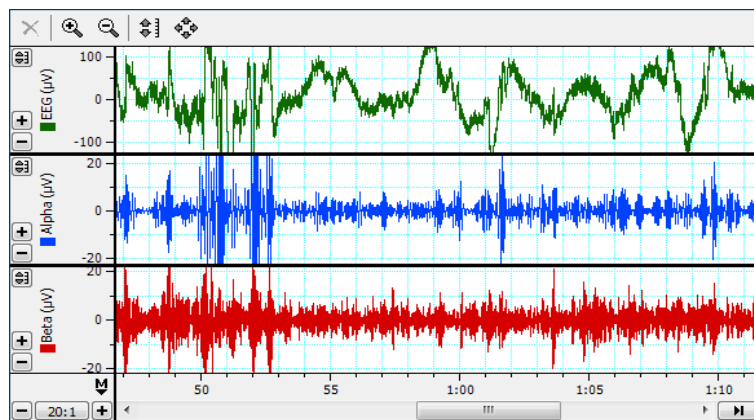


Figure 7. Image of the frequency waves taken from one of the participants in the experiment. A 29-year-old man.

It is important to work with the frequency distribution information to obtain the quantitative data and achieve the analysis in the structural equation model. Primarily the combinations of all channels are taken, alpha from 8Hz to 12Hz and beta from 12Hz to 30Hz (see table 3). Subsequently, two

wave points from each range (alpha and beta) are randomly taken from the combined waveforms. Information is gathered in this manner to analyse the variables in the system of structural equations. These data are measured in Hertz (Hz symbol).

Table 2. Measures the brain waves for each construct.

Construct	Name of the band	Frequency range [Hz]	Detail
	$\alpha 1$ (low alpha)	8 – 10	Break, but not sleep,

Affective imagen	α_2 (high alpha)	10 – 12	Relaxing, emotionally pleasant
(Cognitive image) Cognitive imagen	β_1 (low beta)	12 – 18	Relaxed, lax, even depressive.
	β_2 (medium beta)	18 – 22	An optimal level of cognition these waves helps us to be much more receptive
	β_3 (high beta)	22 – 30	Intense

The structural model is composed of cognition (cognitive image), emotion (affective image) and image (global image), the beta points are associated with cognition, the alpha points, with emotion

and, the general image is the result of a compound of cognition plus one of emotion; the construct is created with the sum of the average of the alpha and beta waves (see figure 8).

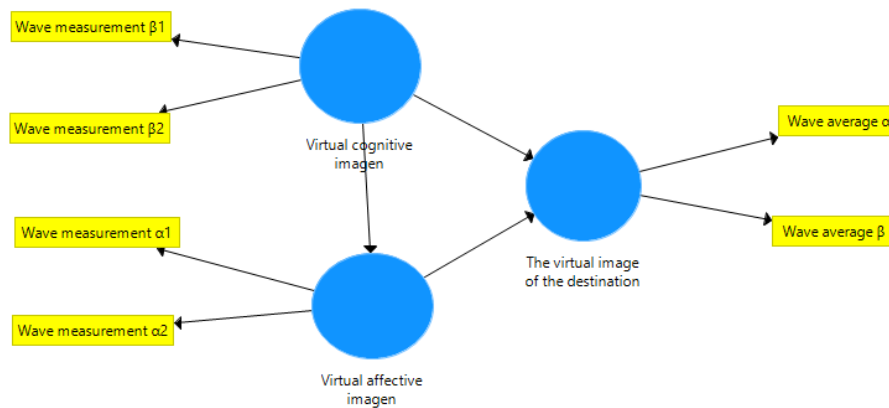


Figure 8. Structural model.

Variables α =Emotion

Variables β =Cognition

$$\bar{X} \alpha + \bar{X} \beta = \frac{\sum_{i=1}^N \alpha}{N} + \frac{\sum_{i=1}^N \beta}{N} = image$$

In other words, the metric data of the observable variables in the structural model are taken directly from the participants’ brains. They are associated with the constructs depending on what they represent for the human mind, and the general image is measured with the summation of the metric variables cognition plus emotion. $\alpha + \beta$.

The virtual reality multimedia stimulus

The images perceived by visitors are fast, efficient, and convenient, (Zhang et al., 2021) we live

in a multisensory world, our experiences are constructed by the stimulation of all our senses. Nevertheless, digital interactions are mainly based on audio-visual elements, while other sensory stimuli have been less explored. Virtual reality (VR) is a sensory-enabling technology that facilitates the integration of sensory inputs to enhance multisensory digital experiences (Flavián et al., 2021; Samah et al., 2021; Yuce et al., 2020) Technology may be important in customer satisfaction and must be explored and used to create a superior experience (Lakshmi & Ganesan, 2010). Brain activity and visual stimulation provided by virtual reality can be quantitatively studied to identify the impact of architectural and cultural heritage (AS-SAS, 2020; Deng et al., 2020; Jung et al., 2020)

The tourist virtual destinations that were assessed in this experiment are detailed in table 3 with the

respective projection times in the VR devices. All are in Spain.

Table 3. Virtual destinations evaluated in the experiment.

No.	Accumulated time		Destination
	Start	End	
1	00:00	00:37	Plaza de la Santa Cruz
2	00:37	01:39	Plaza Mayor of Madrid
3	01:39	02:00	Arco de Cuchilleros
4	02:00	02:30	Doors of the market of San Miguel
5	02:30	03:01	Street Mayor and church del Sacramento
6	03:01	03:33	Plaza de la Villa
7	03:33	04:02	Viaduct of Segovia
8	04:02	04:33	Temple of the Employer Madrileña
9	04:33	04:59	Plaza de la Armería
10	04:59	05:23	Solar of the Plaza de la Armería
11	05:23	05:54	Royal Palace of Madrid
12	05:54	06:19	Centre of the Plaza de East
13	06:19	06:50	Monastery of the Incarnation
14	06:50	07:21	Plaza de Ramales
15	07:21	07:48	Plazuela de Santiago
16	07:48	08:15	Castle of the Adrada
17	08:15	09:15	León
18	09:15	10:15	Casa Botín
19	10:15	11:11	Basilica of San Isidro
20	11:11	12:08	Cathedral of León
21	12:08	13:06	Plaza de la Paja

Structural equation modelling. PLS procedure, confirmatory path analysis, and data adequacy.

In accordance with (Chin, 1998) The PLS procedure is designed to explain the variance - R^2 - of the dependent construct, this procedure is robust in small and medium samples. In terms of the data, an initial concern is related to the sample size, depending on the number of relationships to be evaluated, the widely used empirical rule states that the total sample size is 10 times the greater of two possibilities 1) The block that has the largest number of indicators or 2) the dependent variable that is affected by the largest number of independent variables. In the present model, the first possibility is equal to 2 since the latent variables have two observable variables each, both the α variables and the β variables, and in the second possibility it is also equal to two, since the number of hypotheses that arrive at the dependent variable image is equal to 2. (Chin, 1998)

That means that the minimum size of the sample in this investigation is $2 \times 10 = 20$, however the sample under analysis contains 25 cases.

To implement the PLS technique, it is necessary to verify the adequacy of the data as well as the test power for the dependent variable - R^2 -; For this, it is necessary (to evaluate the reflective model, the reliability of the indicator, the reliability of internal consistency, the convergent validity as well as the discriminant validity), It is also necessary to consider the formative evaluation of the internal model (endogenous constructs, the variance, the size of the effect, the relative predictive relevance of the indirect and total path as well as the coefficient of effect and significance) -. (Hair et al., 2012)

The processing data software is SMART-PLS. (Ávila & Moreno, 2007) the modelling of structural equations with partial least squares PLS-SEM is a method of multivariate analysis of the second generation that currently has a significant

acceptance in the scientific community, mainly in the areas of social sciences and economics. Being a robust and flexible alternative, it allows working with estimates of simultaneous equations through multiple regressions. It aims to increase the explanatory capacity of the empirical verification of the theory, the development of computer programs has also contributed to its use.

In the configuration, a full Bootstrapping used with 5000 subsamples applied, in the bootstrap confidence interval method with correction of bias and acceleration (BCA). The type of two-tailed test, the significance level of 0.05, the schism of route weights (route), 5000 maximum interactions and the stop criterion $(10^{-X}) = 7$.

The latent variables evaluated are cognition, emotion and image. The investigated model proposes that cognition is hierarchical to emotion and, in turn, these two constructions hierarchically influence the image of the destination.

According to the classification shown in table 2, the α waves, associated with emotion, are between 10Hz and 12Hz and the β waves, associated with cognition are between 22Hz and 30Hz. Outside this range, the impact is passive or very stressful. In other words, cognitive and emotional components structure the image of destination measured from brain waves, by the use of the electroencephalogram, four random metric data are taken as observable variables. Two points are for alpha emotion (α) and Two points for beta cognition (β). For the structural analysis in the smartPLS software, observable variables (points taken from brain waves) are associated with each latent variable.

Then the database is normalized with the following variables and equations (see table 4).

Table 4. Equation variables.

Variable	Signified
α =	Alpha wave value
$\alpha_{normalized}$ =	Normalized alpha value
α_{min} =	The minimum value of alpha waves recorded by the EEG
α_{max} =	The maximum value of alpha waves recorded by the EEG
β =	Beta wave value
$\beta_{normalized}$ =	Normalized Beta value
B_{min} =	The minimum value of beta waves recorded by the EEG
B_{max} =	The maximum value of beta waves recorded by the EEG
X =	The minimum value of the normalized scale
Y =	The maximum value of the normalized scale

$$\alpha_{normalized} = \left(\left(\frac{\alpha - \alpha_{min}}{\alpha_{max} - \alpha_{min}} \right) \times X \right) \div Y$$

$$\beta_{normalized} = \left(\left(\frac{\beta - \beta_{min}}{\beta_{max} - \beta_{min}} \right) \times X \right) \div Y$$

with data obtained from brain electrical waves by applying neuroscience techniques to measure a stimulus, this fact has been proven. On the Pearson correlation coefficient (R2), a measure of linear relationship between two quantitative random variables, it can be said that the adjusted (R2), for the endogenous variable virtual image of the destination, the variable is 0.687, which means that 68% of the variance of this variable is explained by the model. (See figure 8)

6. Results

The implicit objective of this research is to demonstrate that an analysis PLS-SEM can be carried out

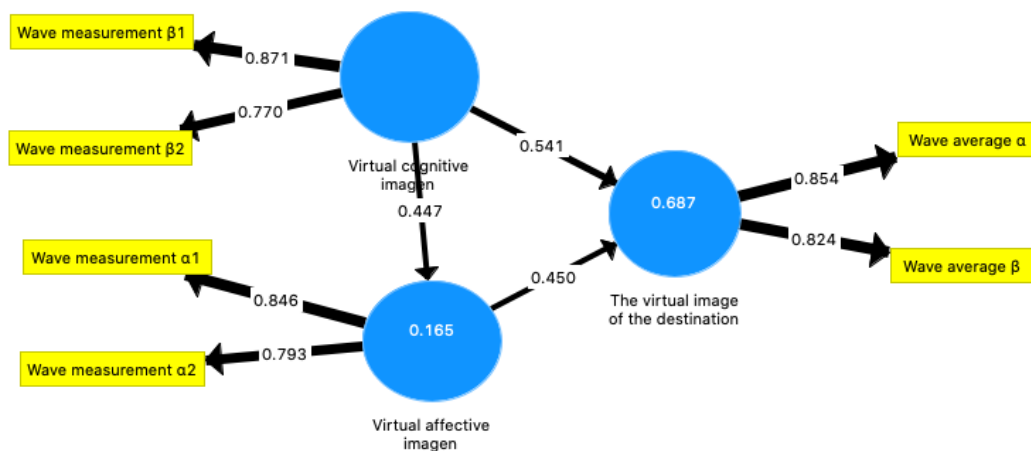


Figure 8. Structural model, the constructs show adjusted (R2).

The study shows that the emotional and cognitive impact of destinations endowed with historical architectural, cultural heritage, emulated with virtual reality, positively influence the image of the virtual destination.

Since the observable variables respond to completely interchangeable and correlated indicators, since they are taken from the same frequency waves of the brain, the model is reflective.

The structural model is composed of cognition (cognitive image), emotion (affective image) and

image (global image), the beta points are associated with cognition, the alpha points, with emotion and, the general image is the result of a compound of cognition plus one of emotion; the construct is created with the sum of the average of the alpha and beta waves (see figure 9). The results of the discriminant or divergent validity analysis verified that the constructions determined in the model measure their concept and not the rest of the constructions. Below is a graph with the complete results of Bootstrapping.

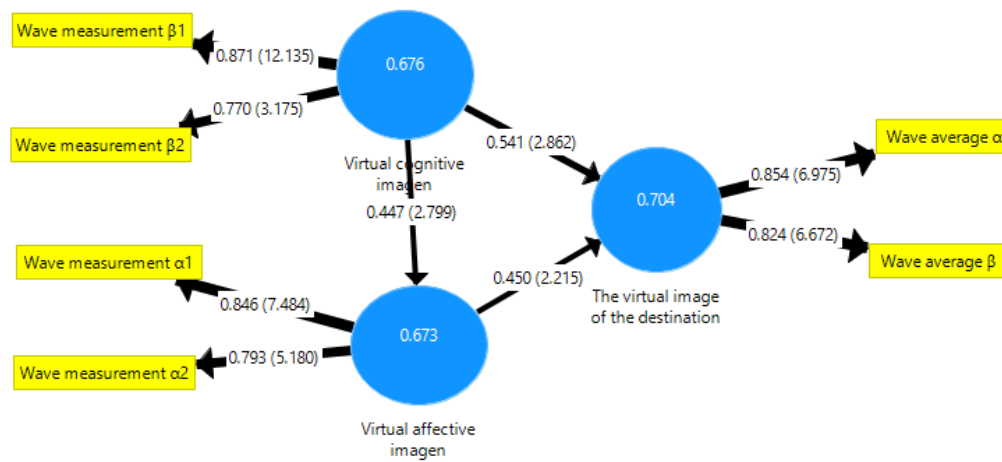


Figure 9. Structural model results.

The variance between the same constructs shows that they correlate more significantly with their same indicators than the others. The convergent

reliability and validity analysis shows that the average extracted variance is > 0.5, which indicates that the construction explains more than half of its variation than the other composing indicators.

Table 5. Discriminant validity of the model.

		F1	F2	F3
F1.	Virtual affective imagen	0,820	N/A	N/A
F2.	Virtual cognitive imagen	0,447	0,822	N/A
F3.	The virtual image of the destination	0,692	0,742	0,839

Table 6. Convergent reliability and validity of the measuring instrument used by the model.

Factor	Indicator	Load	Weight	P-Value	Value t	CR	AVE
F1. Virtual affective imagen	α_1		0,846	0,000	7,484		
	α_2		0,793	0,000	5,180	0,804	0,673
F2. Virtual cognitive imagen	β_1		0,871	0,000	12,135	0,806	0,676
	β_2		0,770	0,002	3,175		
F3. The virtual image of the destination	$\bar{X}\alpha$	0,854		0,000	6,975	0,826	0,704
	$\bar{X}\beta$	0,824		0,000	6,672		
Note: CR = Compound Reliability; AVE = Average extracted variance							

In composite reliability (CR), the indicator of all constructions is > 0.8 , so they are acceptable. The values of t also are significant since having a

value > 1.96 ; the average extracted variance is substantial > 0.67 in all factors. The loads are significantly higher than 0.82, and the standardized factor weights are significantly greater than 0.77.

Table 7. Convergent reliability and validity of the measuring instrument used by the model.

Hypothesis	Beta Standardized	P-Value	Value t (bootstrap)
H1: Virtual cognitive imagen --> Virtual affective imagen	0,447	0,005	2,799
H2: Virtual cognitive imagen --> Virtual image of destination	0,541	0,004	2,862
H3: Virtual affective imagen --> Virtual image of destination	0,450	0,027	2,215

All hypotheses are favourable the t value is > 1.96 . and P-values less than 0.05 The study shows that emotional and cognitive impact of a destination characterized by the heritage and emulated with virtual reality positively influences the image of the virtual destination. The positive emotional and

cognitive impact of heritage on the virtual tourist is confirmed.

Regarding hypothesis number 1. H1: The virtual cognitive image (cognitive response) influences the virtual affective image (emotional response) the t value is 2,799 the P-Value is 0,005 and the

beta standardized is 0,447; the values are favourable, for this reason, hypothesis No.1 is approved

About hypothesis number 2. H2: The virtual cognitive image (cognitive response) positively influences the image of the destination. the t value is 2,215 the P-Value is 0,027 and the beta standardized is 0,450; the values are also favourable; hypothesis No.2 is approved.

Regarding hypothesis number 3. H3: The virtual emotional image (emotional response) positively influences the image of the destination. the t value is 2,862 the P-Value is 0,004 and the beta standardized is 0,541; likewise, the values are also favourable and hypothesis No.3 is approved.

The model ratifies all quality indicators and approve the three hypotheses.

7. Conclusions

The findings suggest greater conceptual work, in this sense, research on the TDI framework that use simultaneously virtual reality, multivariate analysis and neuroscience to investigate urban or rural cultural destinations, in which heritage is present, is innovative.

Intangible culture, as well as, the tangible culture such as historical and architectural heritage can increase the cognitive and emotional response to a destination and consequently, its image, its attractiveness and its competitiveness, it can be stated through this study that that the cognitive and emotional components can be studied through the historical, architectural, and cultural heritage.

This research shows that it is possible to measure, the impact of the cultural and architectural heritage emulated with virtual reality, on the mind of a tourist, in the form of cognitive and emotional responses through brain bio-electric waves with the help of electroencephalography. Therefore, this article has sought to open a debate as a means to significantly evaluate several important developments in modern tourism communication.

The positive emotional and cognitive impact of heritage on the virtual tourist has been confirmed, as well as, that the model is possible, it was also discovered that brain waves can vary according to

the stimulus design, which significantly affects the results in the multivariate analysis. In other words, the brain's bioelectric waves can vary according to the importance that the subject gives to the stimulus, the stimuli can have specific objectives and their impact can be measured with the EEG.

It has been demonstrated that it is possible to measure TDI with neuroscience tools and techniques, since audio-visual stimuli can be analysed psych-physiologically by the impact they cause on brain bioelectric waves, thanks to this technique it was identified that virtual trips generate a favourable TDI in the virtual tourist.

8. Limitations

The limitations of the research can be focused on the design of stimulus and the data collection tools.

One factor that would improve the stimulus is to include manual interaction in the virtual reality stimulus through joysticks.

For data collection electroencephalogram tool can be improved, with state-of-the-art EEG equipment, even more specific information about the human brain's reactions to virtual reality stimuli can be identified, with this improvement, data can be accurately identified for studying the synchronization of electroencephalography equipment with virtual reality and determine at which moments in the video the stimulus increase, as well as the specific area of the brain that is activated. This idea can be combined with the design of specific stimuli, enhancing possible lines of research in the future.

8. Future lines of research

Deconstruction of the model is proposed analysing hypotheses from other perspectives, for example, when the virtual emotional image is hierarchical to the virtual cognitive image and the virtual destination image. Another possibility is to analyse the virtual cognitive image and the virtual emotional image, influencing in parallel the image of the virtual destination.

Familiarity is another topic that can also be investigated in the future using two samples to compare brain waves as well as structural equation models; one sample may be familiar with the location and the other not.

In this study virtual reality videos are used considering that the main attraction is heritage and not multimedia production, the videos principally show heritage infrastructures without any other specific objective in stimulation design, therefore, a potential line of future research is the design and analysis of virtual reality videos with more specific communication and stimulation objectives. A hypothesis to be investigated in the future is that brain waves increase if the stimulus is better, leading to favourable results in the modelling of structural equations.

References

- [1] Adamus-matuszyńska, A., Dzik, P., Michnik, J., & Polok, G. (2021). Visual component of destination brands as a tool for communicating sustainable tourism offers. *Sustainability (Switzerland)*, 13(2), 1–18. <https://doi.org/10.3390/su13020731>
- [2] Aguiló-Lemoine, À. E., Rejón-Guardia, F., & García-Sastre, M. A. (2020). Congruence effects on the effectiveness of sponsorship of sport event websites: An experimental approach. *Sustainability (Switzerland)*, 12(19). <https://doi.org/10.3390/su12198173>
- [3] Aldayel, M., Ykhlef, M., & Al-Nafjan, A. (2020). Deep learning for EEG-based preference classification in neuromarketing. *Applied Sciences (Switzerland)*, 10(4), 1–23. <https://doi.org/10.3390/app10041525>
- [4] Aminov, A., Rogers, J. M., Middleton, S., Caeyenberghs, K., & Wilson, P. H. (2018). What do randomized controlled trials say about virtual rehabilitation in stroke? A systematic literature review and meta-analysis of upper-limb and cognitive outcomes. *Journal of NeuroEngineering and Rehabilitation*, 15(1), 1–24. <https://doi.org/10.1186/s12984-018-0370-2>
- [5] Andersson, S., Bengtsson, L., & Svensson, Å. (2021). Mega-sport football events' influence on destination images: A study of the of 2016 UEFA European Football Championship in France, the 2018 FIFA World Cup in Russia, and the 2022 FIFA World Cup in Qatar. *Journal of Destination Marketing and Management*, 19(October 2020). <https://doi.org/10.1016/j.jdmm.2020.100536>
- [6] ASSAS, R. I. (2020). Losing and Finding Reality in the Virtual World: Media Representation of Saudi Culture – the Case of the Ministry of Culture. *Islamic Heritage Architecture and Art III*, 1, 201–210. <https://doi.org/10.2495/iha200171>
- [7] Ávila, M., & Moreno, F. (2007). Aplicación de la técnica PLS-SEM en la gestión del conocimiento: un enfoque técnico práctico (Vol. 8). <https://doi.org/10.23913/ride.v8i16.336>
- [8] Baloglu, S., & McCleary, K. W. (1999). U.S. international pleasure travelers' images of four Mediterranean destinations: A comparison of visitors and nonvisitors. *Journal of Travel Research*, 38(2), 144–152. <https://doi.org/10.1177/004728759903800207>
- [9] Baloglu, S., & McCleary, K. W. (1999). A model of destination image formation. *Annals of Tourism Research*, 26(4), 868–897. [https://doi.org/10.1016/S0160-7383\(99\)00030-4](https://doi.org/10.1016/S0160-7383(99)00030-4)
- [10] Barrile, V., Fotia, A., Bernardo, E., & Candela, G. (2020). Geomatics techniques for submerged heritage: A mobile app for tourism. *WSEAS Transactions on Environment and Development*, 16, 586–597. <https://doi.org/10.37394/232015.2020.16.60>
- [11] Baumann, U. (2021). “Past Future Concrete” revisited: Ex-Yugoslav monuments shaped as destinations via online image practices. *Cesky Lid*, 107(4), 469–492. <https://doi.org/10.21104/CL.2020.4.03>
- [12] Beerli-Palacio, A., & Martín-Santana, J. D. (2017). How does confirmation of motivations influence on the pre- and post-visit change of image of a destination? *European Journal of Management and Business Economics*, 26(2), 238–251. <https://doi.org/10.1108/EJMBE-07-2017-014>
- [13] Beerli, Asunción, & Martín, J. D. (2004). Tourists' characteristics and the perceived image of tourist destinations: A quantitative

- analysis - A case study of Lanzarote, Spain. *Tourism Management*, 25(5), 623–636. <https://doi.org/10.1016/j.tourman.2003.06.004>
- [14] Beerli, Asunción, & Martín, J. D. (2004). Factors influencing destination image. *Annals of Tourism Research*, 31(3), 657–681. <https://doi.org/10.1016/j.annals.2004.01.010>
- [15] Bigné Alcañiz, E., Sánchez García, I., & Sanz Blas, S. (2009). The functional-psychological continuum in the cognitive image of a destination: A confirmatory analysis. *Tourism Management*, 30(5), 715–723. <https://doi.org/10.1016/j.tourman.2008.10.020>
- [16] Briciu, A., Briciu, V. A., & Kavoura, A. (2020). Evaluating how “smart” Brasov, Romania can be virtually via a mobile application for cultural tourism. *Sustainability (Switzerland)*, 12(13). <https://doi.org/10.3390/su12135324>
- [17] Buckley, R., & Cooper, M. A. (2021). Assortative matching of tourists and destinations: Agents or algorithms? *Sustainability (Switzerland)*, 13(4), 1–10. <https://doi.org/10.3390/su13041987>
- [18] Chia, S. K. S., Lo, M. C., Razak, Z. Bin, Wang, Y. C., & Mohamad, A. A. (2021). Impact of destination image on tourist satisfaction: The moderating effect of information technology (It). *Geojournal of Tourism and Geosites*, 34(1), 88–93. <https://doi.org/10.30892/gtg.34112-623>
- [19] Chin, W. W. (1998). The partial least squares approach for structural equation modeling. *Modern Methods for Business Research*, January 1998, 295–336.
- [20] Chiu, W., Zeng, S., & Cheng, P. S.-T. (2016). The influence of destination image and tourist satisfaction on tourist loyalty: a case study of Chinese tourists in Korea. *International Journal of Culture, Tourism and Hospitality Research*, 10(2), 223–234. <https://doi.org/10.1108/IJCTHR-07-2015-0080>
- [21] Choi, Y., Hickerson, B., & Kerstetter, D. (2018). Understanding the Sources of Online Travel Information. *Journal of Travel Research*, 57(1), 116–128. <https://doi.org/10.1177/0047287516683833>
- [22] de Rooij, I. J. M., van de Port, I. G. L., & Meijer, J.-W. G. (2016). Effect of Virtual Reality Training on Balance and Gait Ability in Patients With Stroke: Systematic Review and Meta-Analysis. *Physical Therapy*, 96(12), 1905–1918. <https://doi.org/10.2522/ptj.20160054>
- [23] Deng, Y., Han, S. Y., Li, J., Rong, J., Fan, W., & Sun, T. (2020). The design of tourism product CAD threedimensional modeling system using VR technology. *PLoS ONE*, 15(12 December). <https://doi.org/10.1371/journal.pone.0244205>
- [24] Dogan, E., & Kan, M. H. (2020). Bringing Heritage Sites to Life for Visitors: Towards A Conceptual Framework for Immersive Experience. *Advances in Hospitality and Tourism Research (AHTR)*, 9100, 76–99. <https://doi.org/10.30519/ahtr.630783>
- [25] Domínguez-Azcue, J., Almeida-García, F., Pérez-Tapia, G., & Cestino-González, E. (2021). Films and destinations—towards a film destination: A review. *Information (Switzerland)*, 12(1), 1–20. <https://doi.org/10.3390/info12010039>
- [26] Duignan, D. M. B. (2021). Leveraging Tokyo 2020 to re-image Japan and the Olympic city, post-Fukushima. *Journal of Destination Marketing and Management*, 19(February 2020), 100486. <https://doi.org/10.1016/j.jdmm.2020.100486>
- [27] Echtner, C. M., & Ritchie, J. R. B. (1993). The measurement of destination image: An empirical assessment. *Journal of Travel Research*, 31(4), 3–13.
- [28] Elliot, S., & Papadopoulos, N. (2016). Of products and tourism destinations: An integrative, cross-national study of place image. *Journal of Business Research*, 69(3), 1157–1165. <https://doi.org/10.1016/j.jbusres.2015.08.031>
- [29] Esper, F. S., & Rateike, J. Á. (2010). Tourism destination image and motivations: The spanish perspective of Mexico. *Journal of Travel and Tourism Marketing*, 27(4), 349–360. <https://doi.org/10.1080/10548408.2010.481567>

- [30] Flavián, C., Ibáñez-Sánchez, S., & Orús, C. (2021). The influence of scent on virtual reality experiences: The role of aroma-content congruence. *Journal of Business Research*, 123(October 2020), 289–301. <https://doi.org/10.1016/j.jbusres.2020.09.036>
- [31] Folgado-Fernández, J. A., Hernández-Mogollón, J. M., & Duarte, P. (2017). Destination image and loyalty development: the impact of tourists' food experiences at gastronomic events. *Scandinavian Journal of Hospitality and Tourism*, 17(1), 92–110. <https://doi.org/10.1080/15022250.2016.1221181>
- [32] Fu, Y., & Timothy, D. J. (2021). Social media constraints and destination images: The potential of barrier-free internet access for foreign tourists in an internet-restricted destination. *Tourism Management Perspectives*, 37(December 2020). <https://doi.org/10.1016/j.tmp.2020.100771>
- [33] Gallarza, M., Saura, I. G. I. L., & Calderón, H. (2001). Mesurer l' image d' une destination - une approche par les attributs perçus. 56(1), 13–22.
- [34] Garczarek-Bąk, U., Szymkowiak, A., Gaczek, P., & Disterheft, A. (2021). A comparative analysis of neuromarketing methods for brand purchasing predictions among young adults. *Journal of Brand Management*, 28(2), 171–185. <https://doi.org/10.1057/s41262-020-00221-7>
- [35] Gartner, W. C. (1994). Image Formation Process. *Journal of Travel & Tourism Marketing*, 2(2–3), 191–216. https://doi.org/10.1300/J073v02n02_12
- [36] Garzón-Paredes, A. R., & Royo-Vela, M. (2021). Experimenting Through Neuromarketing to Measure the Impact of Spanish Cultural Heritage. *Smart Innovation, Systems and Technologies*, 209, 380–400. https://doi.org/10.1007/978-981-33-4260-6_34
- [37] George, R. (2017). Responsible tourism as a strategic marketing tool for improving the negative image of South Africa. *Worldwide Hospitality and Tourism Themes*, 9(5), 543–554. <https://doi.org/10.1108/WHATT-07-2017-0031>
- [38] Gholami Dobarjeh, Z., Dobarjeh, M. G., & Kasabov, N. (2018). Attentional Bias Pattern Recognition in Spiking Neural Networks from Spatio-Temporal EEG Data. *Cognitive Computation*, 10(1), 35–48. <https://doi.org/10.1007/s12559-017-9517-x>
- [39] Gholitabar, S., Alipour, H., & Manuel, C. (2018). An Empirical Investigation of Architectural Heritage Management Implications for Tourism: The Case of Portugal. <https://doi.org/10.3390/su10010093>
- [40] Gómez, M., Imhoff, B., Martín-Consuegra, D., Molina, A., & Santos-Vijande, M. L. (2018). Language tourism: The drivers that determine destination choice intention among U.S. students. *Tourism Management Perspectives*, 27(May), 125–135. <https://doi.org/10.1016/j.tmp.2018.06.001>
- [41] González-Morales, A., Mitrovic, J., & Garcia, R. C. (2020). Ecological consumer neuroscience for competitive advantage and business or organizational differentiation. *European Research on Management and Business Economics*, 26(3), 174–180. <https://doi.org/10.1016/j.iedeen.2020.05.001>
- [42] Govers, R., Go, F. M., & Kumar, K. (2007). Virtual destination image a new measurement approach. *Annals of Tourism Research*, 34(4), 977–997. <https://doi.org/10.1016/j.annals.2007.06.001>
- [43] Gui, X. (2021). Tourism Management System Based on mobile Internet. <https://doi.org/10.1088/1742-6596/1881/4/042089>
- [44] Guttentag, D. A. (2010). Virtual reality: Applications and implications for tourism. *Tourism Management*, 31(5), 637–651. <https://doi.org/10.1016/j.tourman.2009.07.003>
- [45] Hair, J. F., Sarstedt, M., Pieper, T. M., & Ringle, C. M. (2012). The use of partial least squares structural equation modeling in strategic management research: a review of past practices and recommendations for future applications. *Long Range Planning*, 45(5–6), 320–340.
- [46] Hernández, J. M., Duarte, P. A., & Folgado, J. A. (2016). The contribution of cultural events to the formation of the cognitive and affective images of a tourist destination.

- Journal of Destination Marketing and Management, July 2016, 1–9. <https://doi.org/10.1016/j.jdmm.2017.03.004>
- [47] Huete-Alcocer, N., López-Ruiz, V. R., & Grigorescu, A. (2019). Measurement of satisfaction in sustainable tourism: A cultural heritage site in Spain. *Sustainability (Switzerland)*, 11(23), 1–15. <https://doi.org/10.3390/su11236774>
- [48] Huete Alcocer, N., & López Ruiz, V. R. (2019). The role of destination image in tourist satisfaction: the case of a heritage site. *Economic Research-Ekonomska Istrazivanja*, 0(0), 1–18. <https://doi.org/10.1080/1331677X.2019.1654399>
- [49] Hyun, M. Y., & O’Keefe, R. M. (2012). Virtual destination image: Testing a telepresence model. *Journal of Business Research*, 65(1), 29–35. <https://doi.org/10.1016/j.jbusres.2011.07.011>
- [50] Jangra, R., Kaushik, S. P., & Saini, S. S. (2021). An analysis of tourist’s perceptions toward tourism development: Study of cold desert destination, India. *Geography and Sustainability*, 2(1), 48–58. <https://doi.org/10.1016/j.geosus.2021.02.004>
- [51] Juárez-Varón, D., Tur-Viñes, V., Rabasa-Dolado, A., & Polotskaya, K. (2020). An adaptive machine learning methodology applied to neuromarketing analysis: Prediction of consumer behaviour regarding the key elements of the packaging design of an educational toy. *Social Sciences*, 9(9). <https://doi.org/10.3390/SOCSCI9090162>
- [52] Jung, K., Nguyen, V. T., Piscarac, D., & Yoo, S. C. (2020). Meet the virtual jeju dol harubang—The mixed VR/Ar application for cultural immersion in Korea’s main heritage. *ISPRS International Journal of Geo-Information*, 9(6). <https://doi.org/10.3390/ijgi9060367>
- [53] Kani, Y., Aziz, Y. A., Sambasivan, M., & Bojei, J. (2017). Antecedents and outcomes of destination image of Malaysia. *Journal of Hospitality and Tourism Management*, 32, 89–98. <https://doi.org/10.1016/j.jhtm.2017.05.001>
- [54] Kim, W. H., Malek, K., Kim, N. J., & Kim, S. H. (2017). Destination personality, destination image, and intent to recommend: The role of gender, age, cultural background, and prior experiences. *Sustainability (Switzerland)*, 10(1). <https://doi.org/10.3390/su10010087>
- [55] Lai, K., & Li, X. (Robert). (2016). Tourism Destination Image: Conceptual Problems and Definitional Solutions. *Journal of Travel Research*, 55(8), 1065–1080. <https://doi.org/10.1177/0047287515619693>
- [56] Lai, M. Y., Wang, Y., & Khoo-Lattimore, C. (2020). Do Food Image and Food Neophobia Affect Tourist Intention to Visit a Destination? The Case of Australia. *Journal of Travel Research*, 59(5), 928–949. <https://doi.org/10.1177/0047287519867144>
- [57] Lakshmi, R., & Ganesan, P. (2010). Does self-service technology impact destination image and customer delight? *Worldwide Hospitality and Tourism Themes*, 2(5), 520–538. <https://doi.org/10.1108/17554211011090139>
- [58] Lee, C.-K., Taylor, T., Lee, Y.-K., & Lee, B. (2005). The impact of a Sport Mega-Event on Destination Image. *International Journal of Hospitality & Tourism Administration*, 6(November), 65–88. <https://doi.org/10.1300/J149v06n03>
- [59] Lee, W. J., & Kim, Y. H. (2021). Does VR tourism enhance users’ experience? *Sustainability (Switzerland)*, 13(2), 1–15. <https://doi.org/10.3390/su13020806>
- [60] Li, T. T., Liu, F., & Soutar, G. N. (2021). Experiences, post-trip destination image, satisfaction and loyalty: A study in an ecotourism context. *Journal of Destination Marketing and Management*, 19(January), 100547. <https://doi.org/10.1016/j.jdmm.2020.100547>
- [61] Li, Y., Song, H., & Guo, R. (2021). A study on the causal process of virtual reality tourism and its attributes in terms of their effects on subjective well-being during COVID-19. *International Journal of Environmental Research and Public Health*, 18(3), 1–16. <https://doi.org/10.3390/ijerph18031019>
- [62] Lin, S. R., & Zhao, H. X. (2021). Research on the tourism destination image and sustainable development of off-season ecotourism

- based on tourists' perception - A case study of Daoxiang Lake in Beijing. *E3S Web of Conferences*, 251. <https://doi.org/10.1051/e3sconf/202125102074>
- [63] Lindblom, A., Lindblom, T., Lehtonen, M. J., & Wechtler, H. (2018). A study on country images, destination beliefs, and travel intentions: A structural equation model approach. *International Journal of Tourism Research*, 20(1), 1–10. <https://doi.org/10.1002/jtr.2148>
- [64] Lo, W. H., & Cheng, K. L. B. (2020). Does virtual reality attract visitors? The mediating effect of presence on consumer response in virtual reality tourism advertising. *Information Technology and Tourism*, 22(4), 537–562. <https://doi.org/10.1007/s40558-020-00190-2>
- [65] Lupu, C., Rodrigues, A. I., Stoleriu, O. M., & Gallarza, M. G. (2021). A textual and visual analysis of the intrinsic value dimensions of romania: Towards a sustainable destination brand. *Sustainability (Switzerland)*, 13(1), 1–23. <https://doi.org/10.3390/su13010067>
- [66] Mañas-Viniegra, L., Santos-Silva, D., & Liberal-Ormaechea, S. (2021). The visual-digital identity of corporate brands: A study of neuromarketing in young people from Spain and Portugal. *Tripodos*, 48(48), 135–151. <https://doi.org/10.51698/tripodos.2020.48p135-151>
- [67] Mansor, A. A., & Isa, S. M. (2020). Fundamentals of neuromarketing: What is it all about? *Neuroscience Research Notes*, 3(4), 22–28. <https://doi.org/10.31117/neuroscirn.v3i4.58>
- [68] Marine-Roig, E., & Anton Clavé, S. (2016). A detailed method for destination image analysis using user-generated content. *Information Technology & Tourism*, 15(4), 341–364. <https://doi.org/10.1007/s40558-015-0040-1>
- [69] Mongelli, M., Chellini, G., Migliori, S., Pezzello, A., Pierattini, S., Puccini, M., & Cosma, A. (2021). Comparison and integration of techniques for the study and valorisation of the Corsini Throne in Corsini Gallery in Roma. *Acta Imeko*, 10(1), 40. https://doi.org/10.21014/acta_imeko.v10i1.816
- [70] Nilashi, M., Yadegaridehkordi, E., Samad, S., Mardani, A., Ahani, A., Aljojo, N., Razali, N. S., & Tajuddin, T. (2020). Decision to adopt neuromarketing techniques for sustainable product marketing: A fuzzy decision-making approach. *Symmetry*, 12(2). <https://doi.org/10.3390/sym12020305>
- [71] Njerekai, C. (2019). An application of the virtual reality 360° concept to the Great Zimbabwe monument. *Journal of Heritage Tourism*, 0(0), 1–13. <https://doi.org/10.1080/1743873X.2019.1696808>
- [72] Obenour, W., Lengfelder, J., & Groves, D. (2005). The development of a destination through the image assessment of six geographic markets. *Journal of Vacation Marketing*, 11(2), 107–119. <https://doi.org/10.1177/1356766705052569>
- [73] Palazzo, M., Vollero, A., Vitale, P., & Siano, A. (2021). Urban and rural destinations on Instagram: Exploring the influencers' role in #sustainabletourism. *Land Use Policy*, 100(December 2019), 104915. <https://doi.org/10.1016/j.landusepol.2020.104915>
- [74] Park, Y., & Njite, D. (2010). Relationship between destination image and tourists' future behavior: Observations from Jeju Island, Korea. *Asia Pacific Journal of Tourism Research*, 15(1), 1–20. <https://doi.org/10.1080/10941660903510024>
- [75] Rawnaque, F. S., Rahman, K. M., Anwar, S. F., Vaidyanathan, R., Chau, T., Sarker, F., & Mamun, K. A. Al. (2020). Technological advancements and opportunities in Neuromarketing: a systematic review. *Brain Informatics*, 7(1). <https://doi.org/10.1186/s40708-020-00109-x>
- [76] Rosa, P., Carvalhinho, L., & Soares, J. (2018). Developing a destination image through the perceptions of stakeholders: A case study. *International Journal of Tourism Research*, 20(1), 60–71. <https://doi.org/10.1002/jtr.2153>
- [77] Royo-Vela, M. (2005). Emotional and informational content of commercials: Visual and auditory circumplex spaces, product information and their effects on audience evaluation. *Journal of Current Issues and Research*

- in Advertising, 27(2), 13–38. <https://doi.org/10.1080/10641734.2005.10505179>
- [78] Royo-Vela, M. (2009). Rural-cultural excursion conceptualization: A local tourism marketing management model based on tourist destination image measurement. *Tourism Management*, 30(3), 419–428. <https://doi.org/10.1016/j.tourman.2008.07.013>
- [79] Royo, M., & Serarols, C. (2005). EL TURISMO RURAL-CULTURAL: UN MODELO DE GESTIÓN DEL MARKETING TURÍSTICO A NIVEL DESTINO. 16, 197–222.
- [80] Ryan, C., & Cave, J. (2005). Structuring destination image: A qualitative approach. *Journal of Travel Research*, 44(2), 143–150. <https://doi.org/10.1177/0047287505278991>
- [81] Samah, K. A. F. A., Nasaruddin, N. I. S., Afandi, M. A. R., Rahim, N. Z. A., Rum, S. F. M., & Saman, F. I. (2021). Non-immersive virtual reality for malay and islamic world museum melaka: Effects from COVID-19 pandemic. *International Journal of Advanced Technology and Engineering Exploration*, 8(74), 91–101. <https://doi.org/10.19101/IJATEE.2020.S1762118>
- [82] Schott, C., & Marshall, S. (2021). Full-immersion virtual reality for experiential education: An exploratory user experience analysis. *Australasian Journal of Educational Technology*, 37(1), 96–110. <https://doi.org/10.14742/ajet.5166>
- [83] Serrano-Arcos, M. D. M., Sánchez-Fernández, R., & Pérez-Mesa, J. C. (2021). Analysis of product-country image from consumer's perspective: The impact of subjective knowledge, perceived risk and media influence. *Sustainability (Switzerland)*, 13(4), 1–25. <https://doi.org/10.3390/su13042194>
- [84] Shafiee, M. M., Tabaeian, R. A., & Tavakoli, H. (2016). The effect of destination image on tourist satisfaction, intention to revisit and WOM: An empirical research in Foursquare social media. 10th International Conference on E-Commerce in Developing Countries: With Focus on e-Tourism, ECDC 2016, 1–8. <https://doi.org/10.1109/ECDC.2016.7492964>
- [85] Shi, Y., Bettache, K., Zhang, N., & Xue, L. (2021). Constructing nostalgia in tourism: A comparison analysis of genuine and artificial approaches. *Journal of Destination Marketing and Management*, 19(August 2020), 100488. <https://doi.org/10.1016/j.jdmm.2020.100488>
- [86] Sirgy, M. J., & Su, S. (2000). Destination Image, Self-Congruity, and Travel Behavior: Toward an Integrative Model. *Journal of Travel Research*, Vol. 38, May 2000, 340–352. *Journal of Travel Research*, 38(MAY), 340–352. <http://jtr.sagepub.com.ezproxy.memphis.edu/content/38/4/340.full.pdf+html>
- [87] Skavronskaya, L., Scott, N., Moyle, B., Le, D., Hadinejad, A., Zhang, R., Gardiner, S., Coghlan, A., & Shakeela, A. (2017). Cognitive psychology and tourism research: state of the art. *Tourism Review*, 72(2), 221–237. <https://doi.org/10.1108/TR-03-2017-0041>
- [88] Streimikiene, D., & Korneeva, E. (2020). Economic impacts of innovations in tourism marketing. *Terra Economicus*, 18(3), 182–193. <https://doi.org/10.18522/2073-6606-2020-18-3-182-193>
- [89] Styliadis, D., Cherifi, B., & Melewar, T. C. (2021). Exploring Czechs' and Greeks' mental associations of London: A tourist destination or a place to live in? *Journal of Destination Marketing and Management*, 19(December 2020), 100530. <https://doi.org/10.1016/j.jdmm.2020.100530>
- [90] Styliadis, D., Shani, A., & Belhassen, Y. (2017). Testing an integrated destination image model across residents and tourists. *Tourism Management*, 58, 184–195. <https://doi.org/10.1016/j.tourman.2016.10.014>
- [91] Sultan, M. T., Sharmin, F., Badulescu, A., Gavrilut, D., & Xue, K. (2021). Social Media-Based Content towards Image Formation: A New Approach to the Selection of Sustainable Destinations. *Sustainability*, 13(8), 4241. <https://doi.org/10.3390/su13084241>
- [92] Sun, W., Tang, S., & Liu, F. (2021). Examining perceived and projected destination im-

- age: A social media content analysis. *Sustainability (Switzerland)*, 13(6). <https://doi.org/10.3390/su13063354>
- [93] Tasci, A. D. A., Gartner, W. C., & Tamer Cavusgil, S. (2007). Conceptualization and Operationalization of Destination Image. *Journal of Hospitality and Tourism Research*, 31(2), 194–223. <https://doi.org/10.1177/1096348006297290>
- [94] Tavitiyaman, P., Qu, H., Tsang, W. sze L., & Lam, C. wah R. (2021). The influence of smart tourism applications on perceived destination image and behavioral intention: The moderating role of information search behavior. *Journal of Hospitality and Tourism Management*, 46(June 2020), 476–487. <https://doi.org/10.1016/j.jhtm.2021.02.003>
- [95] Trimurti, C. P., & Utama, I. G. B. R. (2021). Bali tourism destination structural loyalty model from consumer behavior perspective. *Turkish Journal of Computer and Mathematics Education*, 12(4), 494–505. <https://doi.org/10.17762/turcomat.v12i4.531>
- [96] van Nuenen, T., & Scarles, C. (2021). Advancements in technology and digital media in tourism. *Tourist Studies*, 21(1), 119–132. <https://doi.org/10.1177/1468797621990410>
- [97] Wullur, M., & Sutapa, I. N. (2019). Measuring the tourist destination images based on service quality using fuzzy inference system. *IOP Conference Series: Materials Science and Engineering*, 567(1). <https://doi.org/10.1088/1757-899X/567/1/012007>
- [98] Yap, C. S., Ahmad, R., & Zhu, P. (2018). International tourist satisfaction in Malaysia: antecedents and consequences. *Anatolia*, 29(1), 1–17. <https://doi.org/10.1080/13032917.2017.1422769>
- [99] Yuce, A., Arasli, H., Ozturen, A., & Daskin, M. (2020). Feeling the service product closer: Triggering visit intention via virtual reality. *Sustainability (Switzerland)*, 12(16), 1–17. <https://doi.org/10.3390/su12166632>
- [100] Yulita, I. N., Sholahuddin, A., Emilliano, & Novita, D. (2020). PAMELA-CL: Partition Membership Based on Lazy Classifier for Neuromarketing. *Journal of Physics: Conference Series*, 1577(1). <https://doi.org/10.1088/1742-6596/1577/1/012050>
- [101] Zaman, U., & Aktan, M. (2021). Examining residents' cultural intelligence, place image and foreign tourist attractiveness: A mediated-moderation model of support for tourism development in Cappadocia (Turkey). *Journal of Hospitality and Tourism Management*, 46(January), 393–404. <https://doi.org/10.1016/j.jhtm.2021.01.017>
- [102] Zhang, D., Qi, H., & Qi, N. (2021). Transportation image: Place-based vehicles for destination branding. *Journal of Destination Marketing and Management*, 19(January), 100541. <https://doi.org/10.1016/j.jdmm.2020.100541>
- [103] Zhou, L. (2014). Online rural destination images: Tourism and rurality. *Journal of Destination Marketing and Management*, 3(4), 227–240. <https://doi.org/10.1016/j.jdmm.2014.03.002>