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Unveiling astrotourists' profiles. Activities, motivations, economic and social benefits and experiences

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ABSTRACT

This research aims to determine the variations that occur in the socio-demographic profile (gender, age, educational level and income) of the visitor interested in astrotourism based on some questions about the activities they carry out related to astronomy, motivations, economic and social benefits and the assessment of experiences about astrotourism through data gathered by a questionnaire. An artificial neural network is developed to generate potential "identikits" or estimated profiles of astrotourists based on the replies incorporated into the model and easily customisable by the researcher, which is especially useful in developing products and services adapted to astrotourism.

KEYWORDS

Astrotourism; Astronomical Tourism; Astrotourist; Stars; Artificial Neural Networks; Multilayer Perceptron.

RESUMEN

Esta investigación pretende determinar las variaciones que se producen en el perfil sociodemográfico (sexo, edad, nivel de estudios y renta) del visitante interesado en el astroturismo a partir de algunas preguntas sobre las actividades que realiza relacionadas con la astronomía, motivaciones, beneficios económicos y sociales y la valoración de experiencias sobre el astroturismo a través de los datos recogidos mediante un cuestionario. Se desarrolla una red neuronal artificial para generar potenciales «identikits» o perfiles estimados de astroturistas a partir de las respuestas incorporadas al modelo y fácilmente personalizables por el investigador, lo que resulta especialmente útil en el desarrollo de productos y servicios adaptados al astroturismo.

PALABRAS CLAVE

Astroturismo; Turismo astronómico; Astroturista; Estrellas; Redes neuronales artificiales; Perceptrón multicapa.

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INTRODUCTION

Humanity has always been attracted by the sky and the stars as a source of fascination and inspiration, finding a reason for experience and memory (Rodrigues et al. 2023) and for what the light of stars and other celestial bodies represents for humanity (Escario-Sierra et al., 2022). In this sense, space measures the year's seasons and determines the time of different activities, such as agriculture (Collison & Poe, 2013). The stars have served (and currently do) to inspire novels and to create myths and legends. Likewise, the sky represents culture and science. It is a crucial element in education (Tapada et al., 2021) in the scientific vocations of young people, especially women.

In recent years, the development of astrotourism has been promoted, which consists of contemplating the skies and the stars in places with low pollution and far from areas with light pollution. Astrotourism is cultural, natural and scientific tourism (Charlier & Bourgeois, 2013). It is a typology of tourism of a multidimensional nature with different types of interactions (Tapada et al., 2021) since it allows connecting the sky, nature and tourism in certain rural places, promoting their economy and sustainability, and reinforcing historical aspects, social, scientific, symbolic and cultural (Rodrigues & Loureiro, 2022; Wassenaar & Coetzee, 2024).

Astrotourism has its reference in the Starlight Foundation (fundacionstarlight.org). The Starlight Foundation was created in 1982 by the Astrophysics Institute of the Canary Islands, Spain. Currently, the Starlight Foundation is a project within UNESCO and is supported by the International Astronomical Union and the World Tourism Organization (UNWTO). Consequently, and supported by these international organisations, the Starlight Foundation and the UNWTO are promoting scientific tourism through astrotourism.

In the same way that UNESCO has created a system of inscriptions of places as World Heritage Sites (WHS) or elements as Intangible Heritage of Humanity, which, in addition to preserving these places and/or elements for future generations, also supposes an attraction for tourist flows, the Starlight Foundation has created a certification system for specific locations. This certification system approves spaces that have excellent quality for the contemplation of the starry sky and, therefore, these areas need special protection and conservation by public authorities and private companies, being at the same time a claim for attracting people interested in contemplating the stars. The Starlight Certification combines science and tourism, taking advantage of astronomy and the vision of the firmament as an instrument for a new form of sustainable tourism (Foundation Starlight, 2022a).

For this reason, it is necessary to approach the study of astrotourism as an example of sustainable tourism in rural areas since it will allow the local community to obtain economic and social benefits and will also help them fight against the depopulation of these destinations (Jacobs et al., 2020; Sawada et al., 2024) or develop other eco-recreational activities (Batinoluho, 2024; Kement et al., 2023). This type of tourism positively impacts the cultural, scientific and environmental heritage of the locations recognised by the Foundation Starlight (2022b). It would benefit the local economy and the country by attracting more visitors from within and abroad to learn more about astronomy and astro-tourism.

Furthermore, it reinforces the area's biodiversity by providing a sustainable and meaningful tourism experience aligned with the conservation of natural resources and cultural

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heritage in situ (Mushy, 2024). Wassenaar and Coetzee (2024) highlighted that parks and reserves represent optimal locations for providing premium astrotourism experiences with minimal environmental impact.

Moreover, due to the reduced infrastructure requirements, astrotourism can be implemented at a minimal cost. Stargazing can be undertaken without using optical instruments at no cost or with inexpensive binoculars (Mitchell & Gallaway, 2019; Mushy, 2024). Furthermore, it offers prospects for scientific education, the dissemination of indigenous knowledge and active involvement, enhancing the experience of tourists and the local host community (Mushy, 2024). This is why astrotourism contributes to the achievement of several United Nations Sustainable Development Goals (United Nations, 2015).

On the other hand, this type of tourism can contribute to awakening the scientific vocations of young people, especially by promoting the participation of women and girls and seeking their scientific vocation. It is even possible to promote astronomy among the youngest through educational centres.

Many researchers agree that rural areas are heterogeneous and present different characteristics (Jacobs et al., 2020; Pizarro & Verelst, 2023). Despite this, there are distinctive characteristics common to all: visitors to rural areas generate authentic interaction with the natural environment and primarily participate actively in the activities, traditions and lifestyles of local communities (Huimina & Ryan, 2012; Okech et al., 2012). Tourists seek this different and "unique-identity" experience (Álvarez-García et al., 2019). Understanding the motivational factors that affect their decision-making is essential in developing a tourism destination (Jacobs et al., 2020; Rodrigues et al., 2022).

Tapada et al. (2021) point out that the scientific literature must reinforce the definition and delimitation of astrotourism, considering its activities' typologies. It is also necessary to analyse the sensations and experiences of astrotourists (Tapada et al., 2021; Rodrigues et al., 2023) to develop and promote different tourist activities that complement each other to provide visitors with more complete, innovative and attractive offers.

Thus, this research aims to determine the variations that occur in the socio-demographic profile (gender, age, educational level and income) of the visitor interested in astrotourism based on some questions about the activities they carry out related to astronomy, motivations, economic and social benefits and the assessment of experiences about astrotourism through the development of an artificial neural network (ANN). Following this method, the generation of potential "identikits" or estimated profiles of astrotourists based on the replies incorporated into the ANN and easily customisable by the researcher is intended, especially useful in developing the products and services adapted to astrotourism. Although this methodology has been used successfully on flamenco shows profiles' attendees (García-García et al., 2023), gastronomic tourists (Moral-Cuadra et al., 2022), or visitors to WHS (Valverde-Roda et al., 2023), no studies of this type applied to astronomical tourism were found. This work aims to pioneer this line, covering the gap detected.

This study's innovation focuses on analysing the astrotourism experience approaching sensations and motivations concerning the socio-demographic profile. Although the scientific literature has begun to explore motivation (Pásková et al., 2021; Rodrigues et al., 2022; Rodrigues et al., 2023), the impact of

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astrotourism on destination image (Soleimani et al., 2019), the interaction with other tourist resources (Van Wyk-Jacobs, 2018) or a destination for photography fans (Rodrigues et al., 2020), aspects regarding the identification of the socio-demographic profile of astrotourists, as well as the study of their motivations remain, they are still little researched.

1. LITERATURE REVIEW

1.1) What is astroturism

Astrotourism is currently shaped as a key element in the sustainable development of certain rural territories, which makes it possible to adequately combine social, economic and environmental resources (Álvarez-García et al., 2019; Jacobs et al., 2020; Violin et al., 2024). Likewise, this type of tourism allows the reinforcement of science and is crucial for developing the scientific vocation of young people. At the same time, it is an inclusive and accessible tourism that allows people of all ages to contemplate the fascinating spectacle of the stars. Astrotourism is related to archaeotourism and ethnotourism (Tapada et al., 2021). It represents the importance of studying and contemplating the sky for humanity and all the mythologies that have developed around it.

Astrotourism has three different dimensions: first, the scientific dimension that is based on protecting the quality of the starry sky; second, the cultural dimension that focuses on promoting astronomy as part of the scientific, cultural and environmental heritage; and third, the economic dimension that seeks the income generation by the tourist flux, particularly in the local community. Astrotourism is committed to historical, social, scientific, symbolic and cultural concepts (Tapada et al., 2021). Thus, astrotourism combines cultural, natural, and scientific tourism (Charlier & Bourgeois, 2013).

Astrotourism is tourism that seeks new experiences in different places by creating dark-sky reserves and starlight parks (Tapada et al., 2021; Escario-Sierra et al. 2022). Currently, astrotourism is highly developed in various parts of the world, highlighting the Canary Islands (Spain), Portugal, Chile and the United States

1.2) Astrotourism destinations

The tourist destination's determination must have unique characteristics for astrotourism. In this sense, Fayos-Solá et al. (2014) point out that they must have the following features: first, the professional approach to the scientific aspects of the place; second, the creation of adequate tourist products; and third, the consolidation of an acceptable tourism policy. In these astrotourism destinations, it is necessary to combine reducing light pollution without restricting services to society that allow artificial light in the absence of sunlight (Escario-Sierra et al., 2022).

The sky by itself is not enough to cause the arrival of visitors. Still, the promotion and use of a series of measures are required to ease the development of tourist products related to the dissemination of astronomy (Escario-Sierra et al., 2022). Therefore, it would be necessary to reinforce the following aspects in the destination: first, investment in infrastructure; second, training of specialised personnel (tourism and astronomy); third, protection of the unpolluted night sky; and fourth, preserve the environment's natural state (Escario-Sierra et al., 2022).

The certifications are obtained after an audit process where environmental requirements, lighting strategies, infrastructures and available resources are analysed. The Starlight Reserves and the Starlight Tourist Destinations stand out among these certifications. The Starlight Reserves are protected natural spaces where both an exceptional quality of

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the night sky and access to contemplate the light of the stars are sought. There are currently 17 Starlight Reserves worldwide. For their part, the Starlight Tourist Destinations are places that can be visited, which enjoy excellent qualities for contemplating the starry skies and which, being protected from light pollution, are especially suitable for developing tourist activities based on this natural resource in these places. There are 54 Starlight Tourist Destinations worldwide (Foundation Starlight, 2022b).

1.3) Motivations

Motivation influences the choice because it is one of the tourist's primary impulses when planning their trip. The reasons why an individual chooses a destination and travels to it can be diverse. Delving into the scientific literature on the motivations for which a person demands a particular product or service, it is observed that it is a variable subject to both environmental changes and societal behavioural variations. In this sense, motivation is a dynamic process since the consumer modifies it based on his experience or the evolution of his status and age (Pearce, 1982).

Tourists decide to travel because they have different motivations and culture is one of the main reasons for this (Correia et al., 2013). Astrotourism is cultural tourism, and some previous studies have evaluated the main motivations for carrying out this type of tourism (Amorim et al., 2019; Carreira et al., 2021; Joseph et al., 2022; Rodrigues & Loureiro, 2022; Rodrigues et al., 2022; Rodrigues et al., 2023; Solano-Sánchez et al., 2022). At the same time, the destination must be explicitly analysed since there is a great diversity of places and also of variables that affect each one of them as there is intense competition between destinations to attract tourists, especially those from abroad (Kim et al., 2014; Thong et al., 2024), presenting different types of resources. Following Abuamoud et al. (2014), the demand for these destinations is influenced both by the services provided by public managers and private companies and by the collaboration of the local community in promoting tourism in those areas. In astrotourism the synergies between the different public administrations and private companies are essential.

Identifying tourists' motivations, satisfaction level, assessment, and loyalty are crucial to carrying out the correct sustainable management of destinations. Thus, it is necessary to define the strategies for public managers and private companies. In addition, it is essential to interpret the sky and the stars correctly in these destinations. Consequently, this would imply, on the part of public managers and private companies in that place, making a correct interpretation of the cross-cultural context of this destination (Saipradist & Staiff, 2007). For this reason, public managers must reinforce the visitor's understanding of astronomy in these places.

2. METHODLOGY

2.1) Data collection

The methodology consists of conducting fieldwork by surveying people interested in astrotourism. The purpose is to develop a segmentation of people interested in astrotourism based on their activities at the destination and their socio-demographic profile. The characteristics of the population present difficulties in the sample design of a quantitative study through a survey. In the present research, and in line with what has been indicated in certain field studies by the scientific literature (Callegaro et al., 2015), no sampling framework identifies the entire population. Likewise, the composition of the population to build quotas is not known either (Díaz de Rada Igúzquiza et al., 2019). On the other hand, it has not been possible to carry out fieldwork in

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astrotourism destinations either, since these are varied, dispersed, and, to a large extent, unknown, since astrotourism can be carried out practically anywhere with little light pollution and it is not necessary for is certified by the Starlight Foundation.

For these reasons, it has been decided to carry out a web survey of a self-selected sample (Callegaro et al., 2015) or a volunteer sample (Couper, 2000), supported by advertisements on social networks aimed at people interested in astronomy, to try to reduce possible voluntariness bias. This type of sample is adapted to the present research aim since it allows the creation of typologies of tourists according to the activities they carry out without the need to know the composition of the population. This way of developing fieldwork has several advantages, such as the cost/effectiveness ratio, the ease of covering a larger population and sample selection, the rapid collection of the questionnaires and the minimisation of errors in the tabulation process (Evans & Mathur, 2005).

On the other hand, this fieldwork provides great geographical and temporal flexibility, something essential in this type of research. At the same time, the biases associated with the interviewer are not present, such as the social desirability bias (Díaz de Rada Igúzquiza et al., 2019). Additionally, this type of fieldwork tends to give fewer extreme answers (Frippiat & Marquis, 2010), which is especially interesting for studies that focus on analysing the satisfaction and motivations of tourists. This type of data collection is widely accepted in tourism research (Otto et al., 2020) and, broadly, in the social sciences (Frippiat & Marquis, 2010). The fieldwork for this research was carried out between December 2021 and April 2022, using convenience sampling and collecting 493 responses, of which 328 were valid.

2.2) Survey design

The survey design has been based on previous scientific literature (Rodrigues et al., 2015; Jacobs et al., 2020; Tapada et al., 2021; Rodrigues et al., 2023). Different tourist managers and university professors pretested the initial questionnaire. This pretest allowed a more detailed survey to be checked by a pilot study of 30 people interested in astrotourism. Once the pretest and the pilot study were completed, the final version of the questionnaire was designed. The final version of the survey pursues the greater clarity of the questions, the more significant adjustment of the responses to achieve the research aim and the greatest possible precision to not excessively prolong the interview with the person surveyed. The questionnaire was set between five and seven minutes, an optimal duration for self-administered web questionnaires (Revilla & Ochoa, 2017).

The questionnaire is completely anonymous and is divided into two parts. The first part includes questions related to the motivations for travelling to contemplate the sky and the stars, the economic and social benefits of astrotourism, and an assessment of related experiences. The second part analyses the socio-demographic characteristics of the people surveyed, including gender, age, academic training and monthly household income. The questions included in the first part of the questionnaire were formulated through a seven-point Likert scale, where 1 referred to “little” and 7 “a lot”. On the other hand, the questions collected in the second part of the questionnaire were closed-ended type.

2.3) Data analysis

Rumelhart and McClelland (1986) define an artificial neural network (ANN) as a network composed of several process elements (PE) or nodes with a small amount of storage capacity. These units are composed of a vector of inputs (x_1, x_2, …, x_n), with synaptic weights (w_1, w_2, …, w_n) that are applied to

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these input vectors using a propagation rule (based on the corresponding linear combination). Applying an activation function to that propagation rule provides the output value of these nodes. The nodes are grouped into several layers: input, output, and intermediate or hidden layers (one or more).

Using SPSS Statistics software v.23, an ANN of the multilayer perceptron (MLP) type is developed, in which the input values correspond to the responses obtained in the survey, and the output values correspond to the estimates that the network makes on the different socio-demographic characteristics of the astrotourist's profile. Considering automatic/default configuration regarding hidden layers/neurons and activation function, various networks are tested, preserving the one that presents a higher degree of adjustment in terms of coefficient of determination (R^2) and mean absolute percentage error (MAPE).

3. RESULTS

3.1) Socio-demographic tourist's profile and question collection

The socio-demographic profile obtained from the sample is presented in Table 1. Almost two out of three respondents are men. It stands out as medium and medium-high purchasing power since two-thirds of the sample exceeds €1,500 monthly household income. A high academic level is also detected since two out of three respondents have university studies or higher. Regarding age, 9 out of 10 participants are over 29 years old, and 7 out of 10 are over 41. The average profile corresponds to a man of medium/high income, with university studies and between 30 and 50 years.

Gender (GEN)		**Academic training (ATR)**	
Male	64.63%	Primary education	1.83%
Female	35.37%	Secondary education	11.58%
		Vocational education/ Professional Course	20.43%
Monthly household income (INC)		University graduate	31.71%
Less than 700€	4.88%	Masters/PhD	34.45%
701€ to 1,000€	6.40%	**Age (AGE)**	
1,001€ to 1,500€	23.78%	18–29 years old	10.37%
1,501€ to 2,500€	31.40%	30–41 years old	20.12%
2,501€ to 3,500€	17.38%	42–53 years old	40.55%
More than 3,501€	16.16%	54–65 years old	23.78%
		More than 65 years old	5.18%

Table 1. Socio-demographic profile of the respondents. Source: Own elaboration.

The questions presented in the survey on a seven-point Likert scale are shown in Table 2. These are grouped into activities that promote astrotourism (Q01-Q06), motivations (Q07-Q18), economic and social benefits (Q19-Q23) and experiences' assessment (Q24, Q25). The items (Table 2) that generated the most agreement among the people surveyed refer to the willingness to return to practising astrotourism (Q25), the awakening of scientific vocations (Q20), obtaining a unique experience (Q11) or the perception of the astrotourism as a sustainable activity (Q19). On the contrary, the questions that generated the most disagreement include the motivation of indulging (Q15), meeting new people (Q12), feeling renewed (Q14) or escaping from the daily routine (Q16).

Code	**Question**	**Mean**	**SD**
	Activities that encourage you to do astrotourism		
Q01	Visit an astronomical science park	5.61	1.65
Q02	Visit an astronomical observatory	6.11	1.37
Q03	Participate in a guided night walking tour	5.71	1.59

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Q04	Participate in an activity of interpretation and night observation in astronomical viewpoints	6.01	1.32
Q05	Photography activities	5.45	1.73
Q06	Visit a destination related to astronomy	6.18	1.17
	Motivations for astrotourism		
Q07	Increase my knowledge about the skies	6.02	1.35
Q08	Satisfy my curiosity	6.13	1.26
Q09	Use my imagination	5.30	1.61
Q10	To discover new things	6.09	1.24
Q11	Get a unique experience	6.27	1.15
Q12	Meet new people	4.62	1.85
Q13	Spend my free time	5.64	1.52
Q14	To feel renewed	4.98	1.78
Q15	To indulge me	4.55	1.94
Q16	To escape from the daily routine	5.07	1.88
Q17	To get away from the crowds (people, traffic)	5.36	1.87
Q18	To have cultural experiences different from my daily life	5.66	1.59
	Economic and social benefits of astrotourism		
Q19	Astrotourism is sustainable tourism	6.20	1.24
Q20	Astrotourism awakens scientific vocations	6.29	1.11
Q21	Astrotourism makes it possible to deseasonalise trips	5.86	1.38
Q22	Astrotourism is an instrument to fight against depopulation	5.66	1.58
Q23	Astrotourism helps to develop certain areas socially and economically	6.05	1.26
	Assessment of astrotourism experience		
Q24	I made the right decision choosing astrotourism	6.13	1.15
Q25	After my experience, I think I will do astrotourism again	6.48	1.01

Table 2. Astrotourism question set. Source: Own elaboration.

3.2) Artificial neural network performance

The reached ANN structure is shown in Table 3 and Figure 1. The input values correspond to all the answers obtained in each one of the questions, the latter being the nodes that form the input layer. These values are later standardised and multiplied by their synaptic weights (Figure 1), obtaining the values of the hidden layer. These are transformed by the hyperbolic tangent as an activation function and multiplied by their respective synaptic weights (Figure 1), thus obtaining the output values, which correspond to the estimates of the different items of the socio-demographic profile. These last values invert their standardisation to obtain numerical values in the range shown in Table 1 (dependent variables).

	Bias	Value=1
Input Layer	Covariates	Q01 Q02 Q03 Q04 Q05 Q06 Q07 Q08 Q09 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25
	Number of Units (excluding bias)	25
Hidden Layer	Rescaling Method for Covariates	Standardised
	Number of Hidden Layers	1

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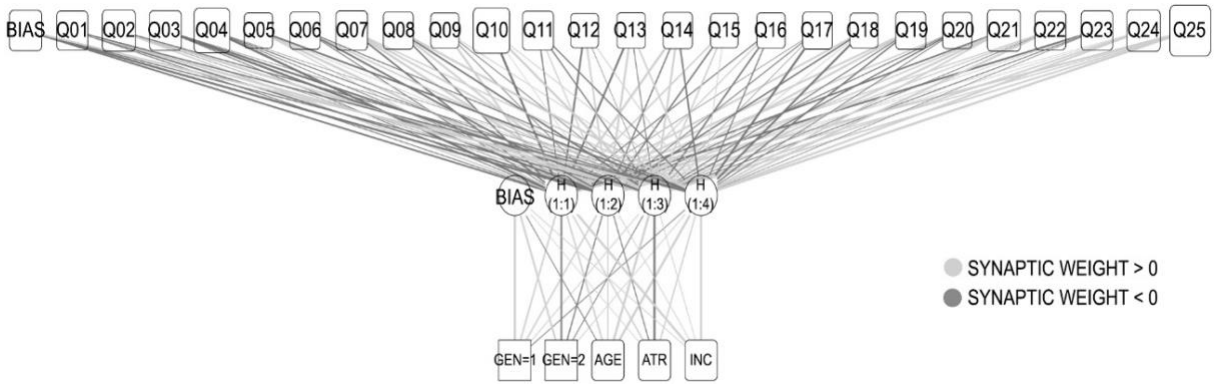

Figure 1. ANN's graphic representation. Source: Own elaboration.

	Number of Units in Hidden Layer (excluding bias)	4
	Activation Function	Hyperbolic tangent
Output Layer	Dependent Variables	GEN=1 (male) GEN=2 (female) AGE (from 18 to 75) ATR (from 1 to 5) INC (from 1 to 6)
	Number of Units	5
	Rescaling Method for Scale Dependents	Standardised
	Activation Function	Identity
	Error Function	Sum of Squares

Table 3. ANN's structure. Source: Own elaboration.

The data obtained during the ANN development process are shown in Table 4. First, the sample is divided with an approximate weighting of 70%–30% between the training and testing groups. The training group continuously generates different synaptic weights, while the test group checks the errors made by the network using synaptic weights. When the testing group detects that it is no longer possible to continue reducing the error committed by the ANN (that is, the difference between the real and estimated values), the training group stops (stopping rule, Table 4), and the network is finished. Thus, Table 4 shows the errors made by both groups according to the different nodes of the output layer, the stopping rule and the time obtained to generate the ANN.

Training (N=230; 70.12%)	Sum of Squares Error		312.552
	Average Overall Relative Error		0.791
	Percent Incorrect Predictions for Categorical Dependents	GEN	30.43%
	Relative Error for Scale Dependents	AGE	0.781
		ATR	0.739
		INC	0.820
	Stopping Rule Used		1 consecutive step(s) with no decrease in error (based on the testing sample)
	Training Time		0:00:00.18
Testing (N=98; 29.88%)	Sum of Squares Error		164.960
	Average Overall Relative Error		0.916
	Percent Incorrect Predictions for Categorical Dependents	GEN	33.67%
	Relative Error for Scale Dependents	AGE	0.848
		ATR	0.967
		INC	0.899

Table 4. ANN's development summary. Source: Own elaboration.

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The goodness of fit obtained in the network output values consistent with the different items of the socio-demographic profile is shown in Table 5. First, the mean absolute percentage error (MAPE) indicates the percentage difference between real and estimated values. Second, the coefficient of determination (R^2) is the percentage of variance variability the estimate can achieve. The MAPE obtained present values that oscillate around 25%, and the R^2 indicates that, on average, the model obtained explains approximately 45% of the variability of the variance.

	GEN	AGE	ATR	INC	Overall
MAPE	22.56 %	20.66 %	25.85 %	33.97 %	25.76%
R²	94.93 %	25.21 %	36.12 %	22.49 %	44.69%

Table 4. ANN's goodness of fit. Source: Own elaboration.

The methodology also allows to know the degree of importance that each input node contributes to the ANN (Figure 2). Thus, issues such as the willingness to return to do astrotourism (Q25), discover new things (Q10) and participate in an interpretation and observation from an astronomical viewpoint (Q04) stand out among the more critical items in the network conformation. On the contrary, meeting new people (Q12), indulging yourself (Q15) or having cultural experiences different from those of daily life (Q18) stand out among those that added less importance to the model.

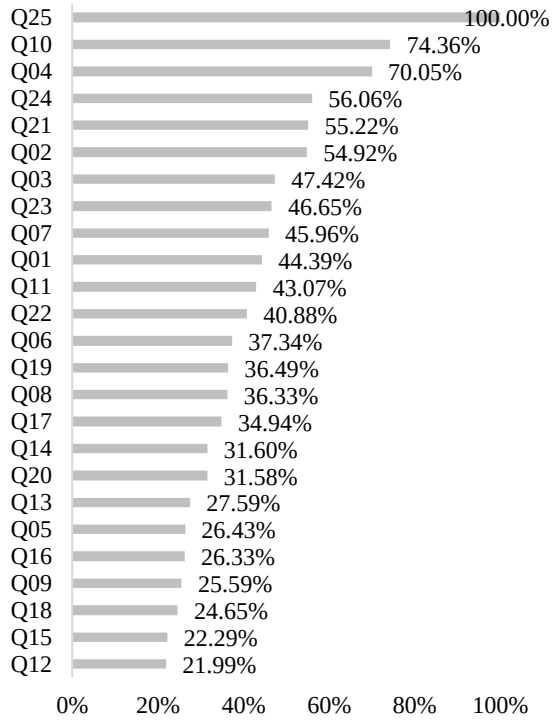

Figure 2. ANN exogenous variables' relevance. Source: Own elaboration.

Additionally, it is also possible to know the degree of influence that each input node has on each of the output ones. To do this, all the output data is collected, while question by question is put in its minimum (1) and maximum (7) value, remaining the rest of the questions that are not analysed at their mean. Once the results have been obtained, and in terms of ease info display, the ten questions that had the most significant influence on both the increase (Table 6) and the decrease (Table 7) of the different output items corresponding to the socio-demographic profile are shown.

Thus, Table 6 shows how the willingness to repeat astrotourism activities (Q25) and the perception of it as an instrument to fight depopulation (Q22) grows according to the age and income of the respondent. On the other hand, as the academic level is higher, the interest in a night route increases (Q03), and the perception that astrotourism awakens scientific vocations (Q20) or the motivation to satisfy

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curiosity increases (Q08). On the other hand, the older profiles also show a perception of making the right decision when choosing to do astrotourism (Q24) and that it helps to adjust the trips seasonally (Q21).

	Question	Socdem. items	Var.
Q25	After my experience, I think I will do astrotourism again	AGE	30.33%
Q25	After my experience, I think I will do astrotourism again	INC	24.83%
Q24	I made the right decision choosing astrotourism	AGE	23.22%
Q03	Participate in a guided night walking tour	ATR	17.12%
Q21	Astrotourism makes it possible to deseasonalise trips	AGE	16.58%
Q22	Astrotourism is an instrument to fight against depopulation	INC	15.73%
Q22	Astrotourism is an instrument to fight against depopulation	AGE	14.07%
Q20	Astrotourism awakens scientific vocations	ATR	13.51%
Q08	Satisfy my curiosity	ATR	13.16%
Q09	Use my imagination	INC	12.54%

Table 6. Questions with the most direct influence on profiles' socio-demographic items. Source: Own elaboration.

Table 7 presents a growing interest in the interpretation and in night observation from different astronomical viewpoints (Q04), as well as in the search for a unique experience (Q11) as the age and income of the respondents decrease. Related to the above, an inverse relationship is also found between an interest in discovering new things (Q10) and income level. For their part, older profiles show a decreasing interest in walking routes (Q03). As the level of academic training increases, the motivation of astrotourism to discover new things decreases (Q10), the conception that this type of tourism allows seasonal adjustment of trips (Q21) and a decreasing interest in visiting an astronomical science park (Q01).

	Question	Socdem. items	Var.
Q04	Participate in an activity of interpretation and night observation in astronomical viewpoints	INC	-22.21%
Q10	To discover new things	ATR	-19.06%
Q23	Astrotourism helps to develop certain areas socially and economically	INC	-18.29%
Q11	Get a unique experience	AGE	-18.01%
Q10	To discover new things	INC	-16.61%
Q03	Participate in a guided night walking tour	AGE	-16.51%
Q11	Get a unique experience	INC	-16.09%
Q01	Visit an astronomical science park	ATR	-15.32%
Q21	Astrotourism makes it possible to deseasonalise trips	ATR	-14.50%
Q04	Participate in an activity of interpretation and night observation in astronomical viewpoints	AGE	-14.16%

Table 7. Questions with the most inverse influence on profiles' socio-demographic items. Source: Own elaboration.

4. DISCUSSION

It is revealed how age and income seem to be correlated in tastes and preferences –in line with Moral-Cuadra et al. (2022) and Valverde-Roda et al. (2023)–, since they show a greater interest in repeating the practice of astrotourism and an awareness of it as an instrument to fight against depopulation. They also show less interest in interpreting astronomical viewpoints, looking for silent contemplation, and searching for a "unique" experience, perhaps because they are prone to repeating the experience and do not perceive it as something unique and/or unusual. Additionally, and

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related to the latter, there is less interest in discovering new things as income increases, which slightly contradicts Rodrigues and Loureiro (2022), who determined that novelty positively influenced loyalty, that is, the intention to repeat.

Academic training influences the respondent's preferences differently, forming another type of profile, as happens in Moral-Cuadra et al. (2022). Thus, a higher educational level affects aspects such as awakening scientific vocations, satisfying curiosity or the interest in night walks. On the other hand, lower academic training is related to less motivation to discover new things and/or visit an astronomical science park, which is associated with the above. Finally, gender was not shown to be a determining factor in any case, in the line of García-García et al. (2023).

5. CONCLUSIONS

Astrotourism is configured as a new type of tourism in which travellers seek rural destinations that allow the contemplation of the stars and the sky. The model achieved in this research allows to properly determine the relationships between the activities, motivations, economic and social benefits and experiences of astrotourism regarding the socio-demographic profile (gender, age, academic training and income) of the astrotourist, being a pioneer in this line.

Following the contributions made in the present research, the most interesting profile for having a higher level of income, and therefore the development of astrotourism in the area has a more significant economic impact, corresponds to an older person who seeks an astrotourism of "classic" or "traditional" type, avoiding guides and rejecting walking routes and/or looking for something "new" or "unique". Additionally, it is essential to consider that it seems to be a tourist profile prone to repeating this type of activity and be aware that it is a helpful type of tourism in the fight against depopulation. Consequently, attracting an older and high-income-level astrotourist can help transform rural areas into sustainable tourism hubs committed to keeping the population in their place of origin. However, paradoxically, the higher income profiles do not believe that astrotourism is helpful for the economic and social development of the areas involved. This research also presents two other important theoretical contributions. The first is to present a literature review on astrotourism that could be interesting for future research. The second theoretical contribution of this research focuses on designing a methodology on ANN that can be replicated in another research.

The practical application of this work resides in obtaining a model capable of making adjusted estimates of profiles or "identikits" of astrotourists based on their activities, motivations, opinions and experiences. In this way, a collection of these responses, easily customisable by the researcher as input values, will give rise to a precise estimate of a specific profile of tourists interested in astronomical observation. Consequently, private companies and public agencies dedicated to astrotourism can adapt their offer more accurately to their potential client, optimising the development of their activities. Likewise, identifying the profile of potential visitors to a destination would help companies that work in that destination be able to design specific products for them, reinforcing the economic contribution of this type of tourism. For example, night tours with activities may be aimed at people with a higher level of education and younger age, and the development of viewpoints and contemplation activities, which do not require long walking trips, may attract people of higher age and income. However, it would also be necessary to orientate these destinations for the reception of tourists. In this sense, it is essential to

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adapt the infrastructure of the geographical area to the demands of visitors and to reinforce the specialisation of private companies to offer a quality tourism product.

The main limitation of the paper derives from the time it was carried out since it would be convenient to extend the study covering the entire year. Another limitation of the study is that it is based solely on demand. As a line of future research, it is proposed that the scope of the study be strengthened by including the offer of specific destinations specialised in astrotourism.

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