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Exploring Community Self-efficacy to Light Pollution Mitigation in A Tourism Destination

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ABSTRACT

Light pollution is an emergent environmental concern, it disrupts the natural patterns of wildlife, contributes to the increase in carbon dioxide in the atmosphere, disrupts human sleep, and obscures the stars in the night sky. However, rural and urban communities often overlook this factor, since it is not seen as a problem, and even if the destination has taken measures to mitigate light pollution, it is still challenging to maintain optimal levels. This study applied a questionnaire ($N = 366$) to examine the community involvement in light pollution mitigation in a Portuguese rural tourism destination in 2023. Results demonstrated that tourism is not a sufficient incentive for participants to take individual measures to mitigate light pollution ($\beta = 0.075$, $p = 0.243$). However, they consider that integrating tourism with light pollution mitigation at the local community level could enhance the tourist experience ($\beta = 0.427$, $p = 0.000$). Tourism destinations should promote environmental education about the effects of light pollution.

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Light pollution; motivation-opportunity-ability (MOA) model; self-Efficacy; community involvement; sustainable tourism; PLS-SEM

Introduction

The interest in the sustainable development of tourism is growing, especially after COVID-19 (Galvani et al., 2020). Tourism activity can result in both positive and negative impacts at an environmental, social, and cultural level. Tourism development can exacerbate the depletion of natural resources and negatively impact local communities when it increases consumption in areas where resources are scarce, leading to the same forms of pollution as any other industry (Gao & Zhang, 2021). United Nations promote the participation of local communities to develop them (Boluk et al., 2019; Zhang et al., 2020). Thus, the purpose of community participation is to bring positive economic and social change through residents' active participation. This theory has been promoted and advocated by the United Nations as a concept of development (Boluk et al., 2019). In tourism, several studies point out the relevant role of the participation of residents in community management education (Dahles et al., 2020), urban planning (Bichler, 2021), tourism development (Liu et al., 2020), ecological protection (Zhang et al., 2020), and other

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fields for the success of tourism destinations. According to Ward et al. (2018), community participation could contribute to the success in the management of cultural heritage (Li et al., 2020), protected areas (Zhang et al., 2020), and water management (Geng et al., 2020).

Diverse studies have focused on specific aspects of pollution, such as air pollution, air quality, carbon footprint (Yuan et al., 2021), noise pollution (Cengiz et al., 2023; Hu et al., 2022), water pollution (Charang et al., 2021; Nitivattananon & Srinonil, 2019), aesthetic pollution (Le et al., 2019; Liu et al., 2016). There are only a few studies that suggest tourism as a solution to light pollution. Most of the studies focus on astrotourism, where light pollution is considered a key element. However, there is a lack of research on this emerging topic as the main subject (e.g. Benfield et al., 2018; Collison & Poe, 2013; Ingle, 2010; Rodrigues & Reis, 2022; Rodrigues et al., 2022; Rodrigues & Loureiro, 2022; Fayos Solá et al., 2014; Soleimani et al., 2018).

Light pollution is defined as every form of artificial light in the wrong place at the wrong time which creates a sky glow, glare, nuisance, and other relevant causes of environmental degradation including some properties of artificial light that emit non-environmentally friendly or inappropriate light (Falchi & Bará, 2023; Lyytimäki, 2015). Light pollution can result from multiple problems such as inefficient, unappealing, or unnecessary use of artificial light (Mander et al., 2023). Specific categories of light pollution include light trespass, over-illumination, glare, light clutter, and sky glow (Rajkhowa, 2014). Light pollution can affect human health and the natural environment and can affect tourism development (Rodrigo-Comino et al., 2023). Many communities conduct diverse economic and recreational activities at night (Dalgleish & Veitch-Michaelis, 2019; Rahayu & Wibowo, 2022). Artificial lighting at night (ALAN) also promotes a greater sense of safety and ensures efficient transportation in communities (Doleac & Sanders, 2015; Falchi et al., 2019; Nadybal et al., 2020). According to Falchi et al. (2023), 80% of the human population lives under night skies that have been artificially brightened. The excessive use of artificial lighting at night has been increasing and has become one of the biggest challenges in terms of environmental pollution today, more than 80 percent of humanity is affected by light pollution (Gaur et al., 2024).

Prior studies attempted to examine the excess of artificial light on human health, and it has been found that this element is actually quite harmful (e.g. Aisling, 2018; Fasciani et al., 2020). Nighttime exposure to artificial light is linked to a circadian system disruption, which has negative consequences on health (Torres-Farfan et al., 2020). The risks for human mental (Tancredi et al., 2022) and physical health (Srivastava et al., 2022) are diverse and include obesity (Rybnikova et al., 2016), diabetes (Opperhuizen et al., 2017) and certain cancers (Gupta & Pushkala, 2021; li et al., 2020) such as Breast (Lai et al., 2020) and prostate (Lamphar et al., 2022).

In contrast, ecologists have long studied the critical role of natural light in regulating species interactions, but in the past century, the extent and intensity of artificial night lighting has increased leading to substantial effects on the biology and ecology of species in the wild (Morgan-Taylor, 2023). Light has two kinds of effects on plants and animals: internal (through physiology) and external (through interactions with the environment and with other species) (Schroer & Hölker, 2016).

In the context of tourism, the increase in activity resulting from tourist activity can increase light pollution levels (Zielinska-Dabkowska & Xavia, 2019); however, the possibility of developing tourist activities based on the observation of starry dark skies, can lead to areas with favorable conditions to apply measures to mitigate light pollution to streamline activities that use the night sky as a tourist attraction, such as astrotourism (Rodrigues & Loureiro, 2022; Rodrigues & Reis, 2022; Soleimani et al., 2018).

The use of artificial light at night (ALAN) and the related brightening of the nightscape increased worldwide in previous decades. Kyba et al. (2023) collected more than 51,000 observations from amateur skywatchers between 2011 and 2022, the study was undertaken in Europe, the United States, Japan, and Australia. They concluded that the average loss of visibility across those regions, due to skyglow, was from 7% to 10% per year. If that trend continues, a sky that has 250 visible stars tonight will have only 100 visible 18 years from now. Light pollution hides the starlight of the night sky for the local community, scientists, and tourists, and like any other form of pollution disrupts ecosystems interring with agriculture, the physiology of plants and animals and causes adverse effects on the health of humans (Rajkhowa, 2014).

Light pollution can be decreased with the more efficient use of lightning (Peña-García & Sędziwy, 2020), which would require changing the habits of much of our society (Rajkhowa, 2014). In this way, community awareness and participation in light pollution mitigation are crucial for the success of the implementation and maintenance of dark sky protection policies. Nowadays, citizens have access to factual information about the negative impact of artificial light at night (ALAN) on their dark skies, and their health and well-being through the internet, school programs, and mass media (Zielińska-Dabkowska et al., 2020).

Motivation is generally known as an energy that drives individuals to achieve their objectives and engage in behavioral activities (Ahmad et al., 2021). It is related to task completion and levels of participation and can affect the intensity and direction of behavior (Jepson & Ryan, 2018). Previous studies analyzed the motivation of communities to engage in the sustainable development of tourism (e.g. Jepson et al., 2014; Kunasekaran et al., 2022; Rasoolimanesh et al., 2017) but none of them addressed the motivation to engage in sustainable behavior at the level of light pollution mitigation at a tourism destination.

The motivation, opportunity, and ability, that is, MOA framework (MacInnis & Jaworski, 1989) was first presented in the context of information processing, and it has been applied in social marketing (Binney et al., 2006), Marketing Management (Guenzi & Nijssen, 2020), consumer behavior (Dong et al., 2022), branding (Song et al., 2024). In tourism, MOA was first applied to explain and determine the level of local participation (Hung et al., 2011).

The framework provides a holistic view of how people are empowered or inhibited to participate in activities and become more active in the tourism development process (Jepson & Ryan, 2018). MOA was also used to analyze community participation in different contexts, namely, heritage tourism (Kunasekaran et al., 2022; Rasoolimanesh et al., 2017), diaspora tourism (Seraphin, 2020), knowledge sharing (Wu et al., 2011), indigenous participation in conservation and tourism development (Latip et al., 2018), factors which facilitate or inhibit inclusive engagement within local community festivals (Jepson et al., 2014).

Previous studies integrating Motivation-Opportunity-Ability (MOA) Model with self-efficacy (S-E) (See Table 1) analyzed the consumer behavior of tourists in cruise tourism (Hung & Petrick, 2012), in the context of a street music festival (Jepson et al., 2014) after the use of augmented reality (AR) in cultural heritage tourism (Lee et al., 2015),

Table 1. Overview of studies integrating the Motivation-Opportunity- Ability (MOA) Model with self-efficacy.

Purpose	Context	Integration of self-efficacy on the MOA model	Source
To explore the role of self-congruity, functional congruity, perceived travel constraints, constraint negotiation, and self-efficacy on travel intentions.	Consumer behavior of tourists in cruise tourism	Ability is measured by self-efficacy	(Hung & Petrick, 2012)
To explore how the Motivation-Opportunity-Ability (MOA) model would benefit from integrating self and group efficacy theory.	Consumer behavior of tourists in a street music festival	Group Efficacy and Self-efficacy as mediators between motivation, Ability, Opportunity, and participation levels	(Jepson et al., 2014)
To explore the Motivation-Opportunity- Ability (MOA) model to assess the predictors of aesthetic experience, moderated by distrust of technology and social influence.	Tourists who used AR in cultural heritage tourism	Ability measured by self-efficacy	(Lee et al., 2015)
To explore how motivation, opportunity, ability (MOA) model and the self-efficacy (S-E) component of the social cognitive theory (SCT), to access how students engage with their program of study.	Engagement of students with their program of study in the area of Event Management.	Group Efficacy and Self-efficacy as mediators between motivation, Ability, Opportunity, and Student participation and student engagement.	(Jepson & Ryan, 2018)
To explore how motivation, opportunity, ability (MOA) model and the self-efficacy (S-E) component of the social cognitive theory (SCT), to access how community can be involved in light pollution mitigation in a tourism destination that implemented actions to protect the night sky.	Community involvement in light pollution mitigation in a tourism destination	Motivation to light pollution mitigation, opportunity and ability as antecedents of self-efficacy and participation and support of tourism as outcomes	Current study

the level of engagement of students with their program of study in the area of event management (Jepson & Ryan, 2018), but there are no previous studies that analyze the community participation in the context of light pollution mitigation in a tourism destination.

Considering the MOA model and the self-efficacy (S-E) component of the social cognitive theory (SCT), this article aims to examine community engagement in light pollution mitigation at a tourist destination that implemented a protected area to preserve the dark night sky.

The study makes a theoretical contribution to the literature on light pollution mitigation in the context of tourism, as it provides an improved understanding of the MOA and self-efficacy in this specific context. The results also give destinations and managers insights into how to engage the local community in the context of light pollution mitigation.

Theoretical framework and hypothesis development

Self-efficacy

According to Bandura (2001), behavioral change is made possible by a personal sense of control. If people believe that they can act to solve a problem instrumentally, they become more inclined to do so and feel more committed to the decision. In social cognitive theory, self-efficacy beliefs act as psychological drivers for inducing behavior alteration outcomes (Gezhi & Xiang, 2022). Self-efficacy is a key connecting link between the environment (social factors) plus cognitive factors and behavior, providing individuals with the capability to influence their cognitive processes and actions and thus alter their environments (Farooq et al., 2022).

Self-efficacy or self-confidence can be regarded as an individual's cognitive judgment of his/her capability to accomplish a task successfully (Bandura, 2001). Past studies on sustainable tourism development promoted using community tourism pointed out that the environmentally responsible behavior of residents is a significant indicator of sustainable tourism development (Cheng et al., 2019). Residents of the local communities with the confidence to actively participate tend to engage in tourism meetings and have a major willingness to manage successful initiatives and development in a tourism destination (Hwang et al., 2012). Therefore, self-efficacy beliefs are an important element in understanding local communities' behavior in organizing, executing, and accomplishing tasks in the tourism industry.

The motivation-opportunity-ability (MOA) model as a driver of self-efficacy

The development of tourism especially in rural destinations not only results in an increase in lodging and tourism businesses but can change the pattern of rural human settlement construction, increase urbanization, and attract more habitants (Yang et al., 2021). One of the main causes of light pollution is the growth of urban areas (Chen & Dong, 2023).

According to Schunk and Benedetto (2020), motivation refers to the processes that instigate and sustain goal-directed activities. In the context of this study, motivation is linked to the perception of the residents about the impacts of light pollution. Yet, self-efficacy is a key personal influence in Bandura's (1997) model of reciprocal interactions that can affect motivational outcomes (Hung & Petrick, 2012; Jepson et al., 2014; Jepson & Ryan, 2018; Lee et al., 2015). Hence, it is hypothesized that (see Figure 1):

H1: Motivation to mitigate light pollution has a positive influence on self-efficacy.

Within the context of tourism, planning opportunities can be defined as circumstances that facilitate public involvement in the public participation process (Hung et al., 2011). Wood and Bandura (1989) assert that individuals possessing a heightened sense of self-efficacy demonstrate a greater facility in envisioning success scenarios, thereby offering positive guidance for performance. Conversely, individuals who perceive themselves as lacking efficacy tend to exhibit a heightened inclination toward envisioning failure scenarios, thereby undermining performance.

Therefore, as the categorization of threats and opportunities involves the evaluation of the probability of gain or loss, a logical connection can be traced between when a probability of loss is predicted and a failure forecast, and, when a probability of winning is predicted, then an opportunity structure develops. Opportunity recognition is an independent, iterative, nonlinear, complex process that is significantly influenced by self-efficacy (Gibbs, 2009). Increasing opportunities lead to the performance of pro-environmental behaviors (Ukenna & Nkamnebe, 2017). Hence, it is hypothesized that:

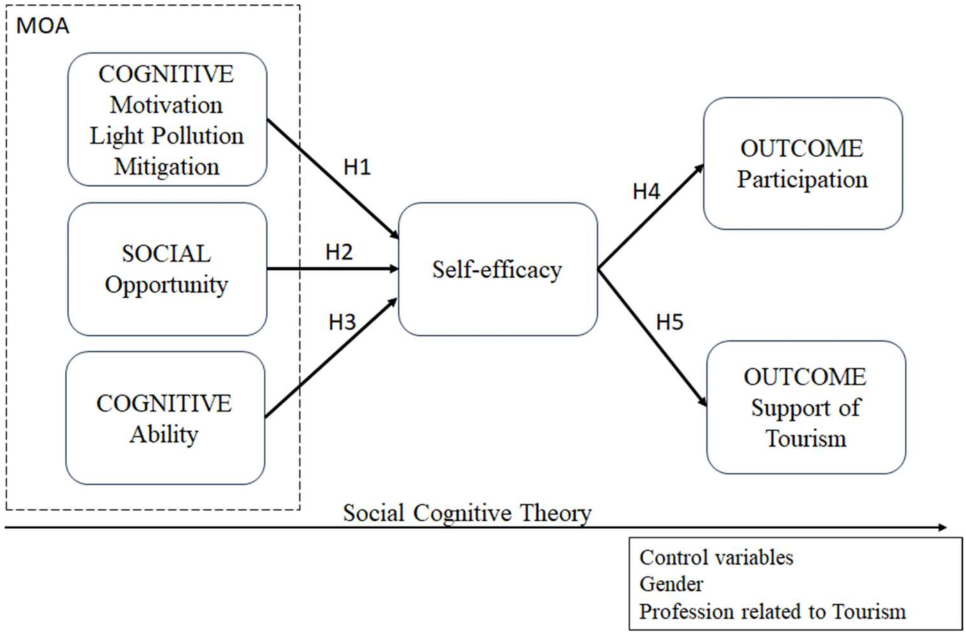

Figure 1. Proposed conceptual framework.

H2: Opportunity has a positive influence on self-efficacy.

The ability concept is supposed to incorporate both a habit and a task knowledge element. Its inclusion in the model draws support from a variety of places, including previous research on light pollution mitigation and its relevance for tourism sustainable development. In contrast, self-efficacy is a fundamental concept of self-confidence. Ability describes a person's belief or confidence in their own ability to complete a given task or solve a problem (Bandura, 2001). Self-efficacy ends up influencing the goals an individual set for himself and the actions and results that individual get in life. If a person's self-efficacy in a certain area is much higher than the skills in that area, he/she will tend to assume goals and expectations that are too high, such increases the probability of failing and giving up on pursuing a certain goal. Yet, if it is much lower, he/she will not feel mobilized for what must be done, and the functioning in that area will likely be below the potential. Hence, it is hypothesized that:

H3: Ability has a positive influence on self-efficacy.

Self-efficacy outcomes

Perceived self-efficacy is related to people's beliefs in their abilities to exercise control over their own functioning and over the events that affect their lives. Self-efficacy beliefs influence thoughts, feelings, self-motivation, and action (Bandura, 1997), and can determine the personal decision regarding the initiation of coping behavior, its duration, and the amount of time and effort expended on such behavior. Self-efficacy expectations are an integral part of the process for individuals to act for change at the level of support of tourism and pro-environmental behaviors, (Fun et al., 2014; Kunasekaran et al., 2022; Latip et al., 2018; Yang et al., 2022). Hence, it is hypothesized that:

H4: Self-efficacy has a positive influence on participation.

H5: Self-efficacy has a positive influence on the support of tourism.

Control variables

Two control variables were considered, gender and profession related to tourism. The reason lies in previous studies such as those by (Alananzeh et al., 2022; Hu et al., 2019; Pham, 2020; Xu & Hu, 2021) it was found that gender and profession had an influence on the participation of local communities in mitigating the impacts of tourism.

Method

Study context

The target of the study is the region of Dark Sky Alqueva in Portugal. This region has the largest artificial lake in Europe, lake Alqueva, which was created in 2002. The lake resulted from the construction of a dam; it is 83 km long, distributed along the Portuguese municipalities of Moura, Mourão, Portel, Barrancos, Reguengos de Monsaraz, and Alandroal, and extends further to Spain, occupying an area of 250 km^2 (Rodrigues & Reis, 2022). The Alqueva region experienced a significant landscape change as a result of this lake, drawing the attention of investors who wanted to develop tourism here – especially involving nautical activities – and create thousands of hotel beds. Initially, this initiative appeared in 2007 as a degrowth tool for this massive intention of construction in this rural area. But in 2008 that plan was abandoned, due to a severe economic crisis in Portugal. The intention to mitigate light pollution continued and in 2011 this region was certified by the Starlight Foundation as a "Starlight Tourism Destination". In 2007 with the "Declaration in Defense of the Night Sky and the Right to Starlight" (2007), representatives of Instituto de Astrofísica de Canarias (IAC), United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations World Tourism Organization (UNWTO), International Astronomical Union (IAU), United Nations Environment Programme – Convention on the Conservation of Migratory Species of Wild Animals (UNEP-CMS), European Commission (CE), Secretariat on the Convention on Biological Diversity (SCBD), Council of Europe (COE), UNESCO's Man and Biosphere Program (MAB), and Ramsar-Convention launched an international movement in defense of the sky through the Starlight Foundation, promoting the dissemination of astronomy and sustainable, high-quality tourism in those places where the night sky has cared (Starlight Foundation, 2023). The main goals of the Foundation are (i) cultural dissemination of astronomy; (ii) through outreach, and promotion of astro-tourism to enable people to appreciate the starry night sky in dark sky places; (iii) adoption of intelligent lighting and innovation, and the consequent saving of energy. Starlight Foundation has certified destinations in Argentina, Chile, Portugal, Spain, Sweden, Italy, México, Morocco, Canada, and Colombia.

Starlight tourism destinations are places that have very low light pollution associated with other necessary conditions that make it possible for visitors to enjoy viewing the night sky (Starlight Foundation, 2023) since light pollution mitigation is not the only feature that makes a destination adequate to offer astrotourism.

Another entity certifies territories, Dark Sky International, which was founded in 1988 with the mission to preserve public or private land to preserve and protect the nighttime environment and our heritage of dark skies through quality outdoor lighting in 2023 there were 201 certified Dark Sky Places globally (Dark Sky, 2023).

These reserves from both entities, namely, Starlight Foundation and Dark Sky International are specifically conserved for their scientific, natural, educational, cultural, heritage, and public enjoyment. Having two specific entities for certification of territories is positive as it allows for a diversity of options for each community to choose the program that best suits their characteristics, interests, and/or needs. In this case, as this destination brings together several perfect characteristics for the development of astrotourism, the most suitable program was the certification as a "Tourism Destination" of the Starlight Foundation.

This territory (see Figure 2) has a large area of approximately 10.200 Km^2 and integrates 11 municipalities in Portugal, namely, Alandroal, Barrancos, Évora, Mértola, Moura, Mourão, Portel, Redondo, Reguengos de Monsaraz, Estremoz and Serpa, in Spain it integrates 13 municipalities. In Portugal, at the moment there are no national or regional policies regarding light pollution but on the Spanish side, there is a Municipal ordinance regulating exterior lighting for the protection of the night sky of Extremadura.

Preliminary study

Before the application of the questionnaire, it was done a preliminary study based on a qualitative approach, to analyze the underlying issues, and these findings were used to develop the survey instrument. Thus, a semi-structured focus group with open-ended questions was carried out to obtain qualitative information about the subject of study due to the lack of studies about light pollution and tourism development. All nine participants of the focus group were from the community where the questionnaire was applied (see Table 2), and one of the researchers asked for consent to take notes.

The focus group started with a small lecture about light pollution, namely what it is, its main problems and how to help individually to solve the problem and then all the participants were asked to discuss the link between light pollution and tourism development in the territory using three main topics (open questions) namely, (1) "What does it mean now and what importance do you give to light pollution before and after listening to an explanation on this topic?"; (2)"Which consequence of light pollution is most relevant to you?" and (3) "As a community what can we do locally to mitigate light pollution?". The focus group ended when no new substantive information emerged.

From the analysis of the focus group, the impacts of light pollution that concerned more were, and what can motivate more to act was the possibility of energy saving, and the development of astrotourism, to mitigate impacts on human health and in nature. The results also highlighted that self-efficacy is relevant for the participation of citizens in pollution mitigation actions "Tourism is important for our region, I can develop actions for this purpose if I know that I am able to accomplish certain things and work in tune with my

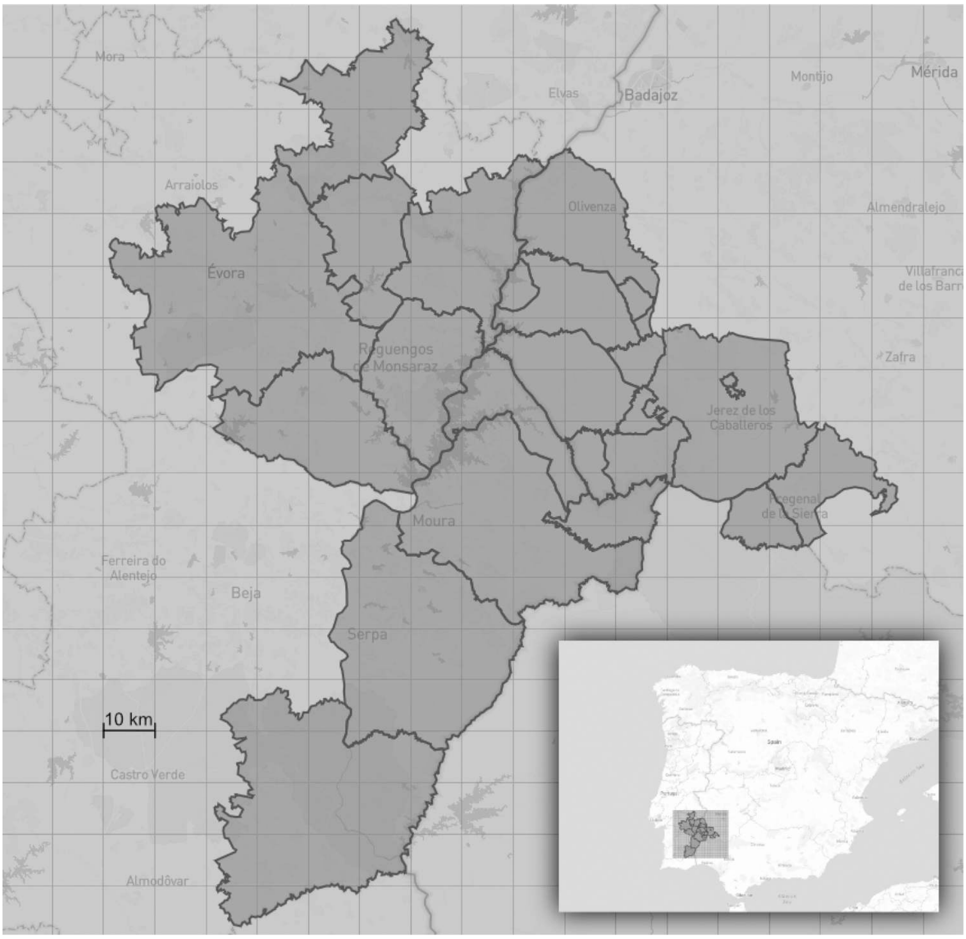

Figure 2. Map of the Starlight Tourism Destination Dark Sky Alqueva.

Table 2. Profile of the focus group participants.

Gender	Age	Profession	Number
Female	56	Teacher	R1
Female	50	Tourism Professional	R2
Male	60	Owner of a local business establishment	R3
Male	45	Artist	R4
Female	32	Owner of a local business establishment	R5
Female	50	Owner of a local business establishment	R6
Female	34	Tourism Professional	R7
Male	44	Owner of a local business establishment	R8
Male	39	Public worker	R9

desires, values and skills, I believe that is what allows me to go far in life" (R6). Opportunity "when authorities develop new plans we are able to participate" (R1), ability "I think it is so important to protect all the natural resources including the night sky as develop tourism" (R8), participation "if each of one in the region takes a small action, like change the night illumination at home, it will improve conservation" (R3), and support of tourism tourism in our region should support all forms of sustainable development including light pollution mitigation (R2) were also found to be relevant at the level of light pollution mitigation amongst the focus group participants. Taken all together, the results of this phase provided the necessary information to develop the relevant items for motivation and elaborate the model that was studied in the research survey.

Measures

The research survey consisted of two parts. The first part assessed community Motivation-Opportunity-Ability (MOA) and self-efficacy at the level of pollution mitigation in a tourism destination and the second part covered sociodemographic variables, including gender, age, level of education, employment status, and place of residence. All the scales were sourced from the existing literature and have been validated in prior research except Motivation (for light pollution mitigation) with were developed based on the results of study one.

This research used a closed-ended structured questionnaire to collect data. The items measuring the constructs of self-efficacy, motivation, opportunity, ability participation, and support of tourism were adapted from prior studies (see Table 4) and formulated using a seven-point Likert scale. Previous studies (Joshi et al., 2015; Wakamita et al., 2012) examined the advantages of using either a five-point or seven-point scale, concluding that a seven-point scale achieves the best fit. The questionnaire was prepared to reduce common method bias, by considering participants' randomized items, reverse questions, and attention questions (Liao et al., 2021).

Sampling procedure and data collection

Data were collected in different locations of Dark Sky Alqueva, between January and March 2023 at the Dark Sky Alqueva territory to residents over 18 years old of the different areas of the territory (see Figure 2). The questionnaire was administered by two field researchers, who first outlined the research purpose and invited the local population to participate in the survey. Following their consent, a self-administered questionnaire was provided to those who preferred to complete it themselves, or the field researchers helped others to complete it. Of the 398 questionnaires distributed by the two field researchers, only 366 questionnaires were filled out and used in this study, giving a response rate of 92%.

Profile of respondents

The sample is composed of 51.1% of females and 48.9% of males. Of these, 42.0% were between the ages of 36 and 55. The majority of respondents attended high school (58%), had a full-time job (64.2%), or were students (27.6%), and their profession was not related to tourism (65.6%) (see Table 3).

Results

Partial least squares (SmartPLS4) method was used to tread data due to the exploratory and predictive nature of the proposed conceptual framework. Factor loadings were all

Table 3. Socio demographic characteristics.

Characteristics	Frequency	Percentage
Gender		
Female	180	51.1
Male	172	48.9
Age		
18–35	120	34.1
36–55	148	42.0
>55	84	23.9
Education		
Elementary School	12	3.4
High School	204	58.0
College-University	136	38.6
Employment status		
Full-time employee	226	64.2
Freelance Professional/businessman	16	4.5
Student	97	27.6
Pensioner	7	2.0
Unemployed	6	1.7
Profession related to tourism		
Yes	121	34.3
No	231	65.6

above 0.7 the reliability scores were higher than 0.7, and the average variance extracted (AVE) was above 0.6 indicating convergent validity (see Table 4). The discriminant validity was accessed through the Fornell-Larcker criterion and the Heterotrait-monotrait ratio (HTMT). Both criteria were met (see Table 5). Regarding the inner VIF (variance inflation factor) values, all of them are below 3.33, revealing no collinearity problems (Diamantopoulos & Siguaw, 2006).

All hypotheses were supported, except H1 ($\beta = 0.075$, $p = 0.243$) (see Table 6). We used a bootstrapping procedure with 5,000 subsamples to get the t-values and the confidence interval of 95% for the values of beta. The fit of the model was good (SRMR = 0.066, d_ULS = 1.307, d_G = 0.429, $\chi^2 = 912.053$, and NFI = 0.814) (Hair et al., 2019). All the values of Q^2 are positive. The model is able to explain 27.1% of the variance in self-efficacy, 13.7% in participation, and 18.2% in support.

Regarding the two control variables, gender, and profession related to tourism, an MGA analysis was performed. The MGA allowed testing of the moderator effect of gender and profession related to tourism between the different relationships in the proposed model. The first step was to assess the MICOM (measurement invariance of composite models) (Henseler et al., 2015), considering (1) configural invariance (identical number of indicators, data, and algorithm settings), (2) compositional invariance (performing 5000 permutations with correlations close to 1 and permutation *p*-values non-significant), and (3) scalar invariance that does not pose any issue. The MGA results reveal that there are not any significant multi-group differences (see Table 7).

Discussion

This study demonstrated the influence of MOA on self-efficacy. From the three concepts, only motivation does not exercise a statistically significant effect ($\beta = 0.075$, $p = 0.243$). Although motivation represents concerns with eliminating light pollution to save electricity, benefit nature and animals, and contribute to tourism development, it is the ability

Table 4. Measurement model.

Construct	FL	M	SD
Motivation (Light Pollution Mitigation) (Based on the review of the literature and focus group)			
CA = 0.832, CR (rho_a) = 0.842, CR (rho_c)= 0.887, AVE = 0.664			
Ending light pollution saves resources (electricity)	0.801	5.6	1.52
Ending light pollution has positive health effects (e.g. prevents insomnia)	0.809	5.3	1.64
Ending light pollution allows nature to be preserved (plants and animals in the region)	0.860	5.4	1.60
Ending light pollution enables tourism development (dark sky observation. astrotourism)	0.786	5.3	1.74
Opportunity (Latip et al., 2018; Rasoolimanesh et al., 2017)			
CA = 0.898, CR (rho_a) = 0.902, CR (rho_c)= 0.924, AVE = 0.710			
The local authorities are in touch with the local community	0.808	4.3	1.64
The local community is consulted or informed of new management decisions	0.857	3.8	1.75
Community interest in natural resource use is incorporated in reviewing management plans	0.867	4.0	1.72
Local people are involved in protecting the night sky	0.826	3.7	1.79
Local people are involved in the planning of training and capacity building program	0.854	3.7	1.77
Ability (Latip et al., 2018)			
CA = 0.839, CR (rho_a) = 0.843, CR (rho_c)= 0.893, AVE = 0.676			
Tourism should be integrated with light pollution mitigation (protection of the night sky)	0.865	5.2	1.60
Economic gains of tourism are as important as the protection of the night sky	0.769	5.0	1.71
The night sky together with the landscape needs greater protection	0.835	5.7	1.42
Increasing tourism will not harm the night sky protection	a		
There should be more light pollution policies for conservation and tourism development	0.817	5.4	1.56
Self-efficacy (Wang & Xu, 2015)			
CA = 0.880, CR (rho_a) = 0.882, CR (rho_c)= 0.926, AVE = 0.806			
More tourism development in Alentejo makes me feel more confident in changing occupations if I'm not satisfied with my current one	0.898	4.8	1.79
More tourism development in Alentejo makes me feel more confident in finding my ideal job in Alentejo	0.921	4.8	1.82
Tourism development in Alentejo makes me feel more confident in enjoying the lifestyle of my own	0.874	5.1	1.74
Participation (Latip et al., 2018)			
CA = 0.782, CR (rho_a) = 0.783, CR (rho_c)= 0.873, AVE = 0.696			
Direct involvement of local people will improve the conservation of the night sky	0.836	5.2	1.57
Local people involved in tourism management will improve the experiences of tourists	0.804	5.9	1.22
Local residents can better protect the night sky	0.862	5.1	1.58
Support of Tourism (Wang & Xu, 2015)			
CA = 0.852, CR (rho_a) = 0.858, CR (rho_c)= 0.894, AVE = 0.629			
I'd like Alentejo to attract more tourists	0.817	5.8	1.45
I'd like Alentejo to add more nature-based attractions	0.805	6.4	1.08
Alentejo should invest more in developing tourism	0.829	6.1	1.26
Local taxes should be used to support Alentejo tourism development	0.764	5.6	1.61
The region should think of all types of sustainable tourism development	0.746	6.3	1.12

Note: FL = Factor Loading; M = Mean; SD = Standard Deviation; CA = Cronbach's Alpha; CR = Composite Reliability; a = deleted; AVE-Average Variance Extracted.

(β = 0.254, *p* = 0.000) and above all the opportunity (β = 0.325, *p* = 0.000) that drives participants to self-efficacy. Thus, aligned with Latip et al. (2018), participants need to believe that the community should integrate tourism and light pollution mitigation and that more light pollution policies – with the participation of the local community (Rasoolimanesh et al., 2017) – should emerge for conservation and tourism protection.

Table 5. Discriminant validity.

	1	2	3	4	5	6
1.Ability	0.822	**0.435**	**0.790**	**0.487**	**0.518**	**0.703**
2.Opportunity	0.377	0.843	**0.381**	**0.487**	**0.257**	**0.229**
3.Participation	0.639	0.322	0.835	**0.445**	**0.419**	**0.771**
4.Self-efficacy	0.421	0.436	0.370	0.898	**0.488**	**0.335**
5.Support	0.437	0.233	0.338	0.427	0.793	**0.304**
6.Motivation	0.592	0.201	0.623	0.290	0.253	0.815

Note: Bottom-left Fornell Lacker criterion; top-right in bold Heterotrait–Monotrait Ratio (HTMT) criterion.

Table 6. Structural results.

Direct Effect	Beta	STDEV	t-value	*p* values	Confidence Interval 2.5%	97.5%	f^2	VIF	Hypothesis
Motivation→Self-efficacy	0.075	0.064	1.167 ns	0.243	−0.038	0.214	0.005	1.540	H1:not supported
Opportunity→Self-efficacy	0.325	0.054	6.005***	0.000	0.218	0.433	0.124	1.167	H2:supported
Ability→Self-efficacy	0.254	0.072	3.532***	0.000	0.110	0.390	0.051	1.723	H3:supported
Self-efficacy→Participation	0.370	0.056	6.594***	0.000	0.259	0.482	0.158	1.000	H4:supported
Self-efficacy→Support	0.427	0.048	8.979***	0.000	0.336	0.523	0.223	1.000	H5:supported
Specific Indirect effect	Beta	STDEV	t-value	*p* values	2.5%	97.5%			
Ability→Self-efficacy→Support	0.109	0.036	2.987	0.003	0.044	0.184			
Opportunity→Self-efficacy→Support	0.139	0.028	4.893	0.000	0.088	0.201			
Motivation→Self-efficacy→Support	0.032	0.027	1.165	0.244	−0.017	0.091			
Motivation → Self-efficacy →Participation	0.028	0.026	1.076	0.282	−0.014	0.089			
Opportunity→Self-efficacy→ Participation	0.120	0.025	4.885	0.000	0.076	0.173			
Ability→Self-efficacy→Participation	0.094	0.034	2.742	0.006	0.036	0.167			
R^2 Self-efficacy	0.271	Q^2 Self-efficacy		0.216					
R^2 Participation	0.137	Q^2 Participation		0.117					
R^2 Support	0.182	Q^2 Support		0.163					

Note: STDEV- Standard deviation; ***$p < 0.001$; ns Not Significant; VIF-Variance Inflation Factor; f^2-effect size.

Table 7. MGA results for moderation.

Moderating effect	MGA β Difference (Female - Male)	2-tailed (Female vs Male) *p* value	MGA β Difference (yes − no)	2-tailed (yes vs no) *p* value
Ability→Self-efficacy	0.240	0.087	0.168	0.230
Opportunity→Self-efficacy	−0.118	0.269	−0.162	0.123
Self-efficacy→Participation	0.205	0.054	0.171	0.100
Self-efficacy→Support	0.000	0.999	0.081	0.368
Motivation→Self-efficacy	−0.051	0.679	0.152	0.247

The involvement of both the population and tourists in the planning and conservation creates a better vision of the tourism development in the destination. Self-efficacy can influence participation ($\beta = 0.370$, $p = 0.000$) and support of tourism ($\beta = 0.427$, $p = 0.000$). Therefore, when individuals feel more confident in changing occupations or finding a new job and enjoying their lifestyle are also more open to participating in the well-being of the community, for instance, the conservation of the night sky and improving the experience of tourists. Individuals are also more interested in promoting the destination and encouraging tourists to come to the destination.

Implications and future research

Theoretical implications

This research contributes to the theory of self-efficacy by integrating MOA with the Social Cognitive Theory (SGT). MOA delivers how individuals process information and beliefs based on their motivations, opportunities, and abilities. These three aspects can be regarded as social and cognitive drivers of self-ability and there it is possible to integrate SGT. SGT precisely suggests that social and environmental factors can lead to change behaviors, here regarded as participation and support of tourism. In this vein, MOA and SGT are combined to explain the community involvement in light pollution mitigation in a tourism destination.

Managerial implications

In recent decades, the expansion of tourism and the concurrent rise in energy efficiency – coupled with the reduced costs of lighting technology – have resulted in a substantial escalation of light pollution in numerous tourist destinations. While artificial light has undeniably contributed to human comfort and progress, numerous studies underscore the detrimental effects of excessive artificial light, both indoors and outdoors, on humans, fauna, and flora.

Despite being a significant form of pollution, excessive artificial light at night has largely been neglected on an international scale. There exists a notable deficiency in awareness about this issue among local authorities and the general population alike. A crucial aspect of addressing this problem involves recognizing the dangers associated with excessive artificial light, both indoors and outdoors. The challenge lies in overcoming the common perception that light is inherently linked to purity and progress, making it difficult for individuals to associate it with potential harm. The lack of public familiarity with energy technologies and their associated problems compounds this challenge. This observation aligns with the findings of extensive public opinion research spanning decades, revealing that the general public often lacks well-informed perspectives on specific policy issues.

Notably, one of the outcomes of this research indicates that individuals, upon gaining awareness of the impacts of light pollution on humans and the natural environment, acknowledge the necessity of contributing to the mitigation of this problem.

One of the paramount measures that a tourist destination can endorse is, foremost, the dissemination of information and environmental education about the impacts of light pollution and the preservation of an uncontaminated night sky.

The region under study adhered to the guidelines set forth by the Starlight Foundation for the mitigation of light pollution. Nevertheless, the principal challenge faced by this destination, as well as any other aspiring to uphold or achieve commendable levels of light pollution mitigation, lies in effectively managing and restraining pollution levels. This arduous task arises due to the persistent introduction of new sources of light pollution within the community regularly. Such control is attainable only through the concerted efforts of both local authorities, engaged in continuous endeavors, and the collaborative participation of the local population.

The issue at hand is not confined to a specific territory; numerous locations contend with similar challenges. For instance, in September 2023, Hehuan Mountain in Taiwan faced the prospect of being removed from the International Dark Sky Park registry due to a newly identified source of pollution emanating from the numerous LED signs along the mountain paths. Although these signs served the purpose of guiding visitors during nighttime, their luminosity posed difficulties in meeting the Dark Sky Park requirements. Prompt action was taken upon informing the local authorities, resulting in the resolution of the issue (Radio Taiwan INTL, 2023).

Similarly, in July 2023, New Zealand's inaugural internationally endorsed Wai-iti Dark Sky Park confronted the risk of losing its dark sky designation in the coming years owing to a 150% surge in light pollution (Stuff, 2023). The continuation of this alarming increase threatened the park's esteemed Dark Sky status.

The recent surge in media coverage has the potential to catalyze the establishment of urban lighting governance, emphasizing the imperative for sustainable management of artificial light during nighttime. Public communication initiatives and the heightened awareness of light pollution and its ecological repercussions are key components of this endeavor. A notable example is the action taken by the Chilean government in October 2023, wherein a new standard was introduced to safeguard the nation's unique dark skies. This standard incorporates local biodiversity as a focal point of protection, facilitating the recovery of endangered species threatened by light pollution. As part of this initiative, public lighting in Chile will undergo adjustments to prioritize amber tones and restrict the usage of blue light. Moreover, advertising and sports lighting will be subjected to schedule controls, promoting increased rest for populations residing in proximity to promotional displays. Strengthened preventive measures will be implemented to ensure compliance with these guidelines in products or projects. Addressing the multifaceted issue of light pollution requires collaborative efforts from both public and private sector entities engaged in planning, promotion, education, advocacy, or stakeholder training related to light pollution mitigation.

A viable means of enhancing the knowledge and engagement of local citizens is through the implementation of citizen science initiatives. Citizen science encompasses activities that involve the public in scientific research, thereby serving as a conduit to integrate science, policymakers, and society comprehensively. An illustrative example is the Globe at Night Program, an international citizen-science campaign designed to augment public awareness regarding the detrimental effects of light pollution. This initiative encourages citizen scientists to measure the brightness of their night sky and submit observations through a dedicated website, accessible from computers or smartphones. Notably, over the course of the past 15 years, more than 211,000 measurements have been contributed by individuals from 180 countries during year-round campaigns, rendering Globe at Night a highly successful and impactful light pollution awareness initiative.

While light pollution predominantly manifests in urban areas, its impact is increasingly felt in rural spaces, particularly in regions experiencing a surge in tourist activity. Although not all destinations possess favorable atmospheric conditions for tourist activities associated with stargazing (astrotourism), the mitigation of light pollution holds fundamental importance in any locale. This is essential for the well-being of the local population and environmental preservation. Moreover, it could be strategically employed as a degrowth tool, especially in destinations grappling with an excess of night tourism. Additionally, its integration could be coordinated with measures aimed at noise reduction. In the context of rural destinations, the preservation of a bucolic nighttime landscape is crucial, as excessive lighting has the potential to diminish the nostalgic charm that tourists deeply appreciate in locales reminiscent of a bygone era.

Limitations and future research

Even though the current study has numerous theoretical and practical implications, it also identifies certain limitations that allow for future research. First, the model was analyzed with the results of just one destination, but light pollution is a global problem that affects or could affect all destinations globally, therefore this model should be applied in other contexts, such as different types of urban and cultural destinations. Future studies should also study the cultural aspects related to light and dark to ascertain the differences between communities regarding this issue to ascertain the optimal levels of light/ dark that could be accepted mutually by the community and tourists. Future studies should also delve deeper into the emotions that a light/dark environment can induce in both tourists and the local community to find ways to motivate active participation by both tourists and the local community in mitigating light pollution.

Conclusion

In the context of the MOA model and the self-efficacy (S-E) component of the social cognitive theory (SCT), this article investigates community engagement in the mitigation of light pollution within a Portuguese tourist destination that has implemented a protected area to preserve the dark night sky. In alignment with prior research, exemplified by studies conducted by Latip et al. (2018) and Rasoolimanesh et al. (2017), adherence to the MOA model suggests that participants must hold the conviction that the community should integrate tourism and actively engage in light pollution mitigation. Furthermore, there is a need for the formulation of additional light pollution policies, wherein the local community actively participates, aimed at conservation and the protection of tourism interests.

Based on this outcome, it is evident that the successful implementation of strategies to address this emerging issue is facilitated when the community perceives associated benefits, particularly in the context of tourist activity development, like astrotourism. This underscores the imperative for heightened awareness among the general public regarding the gravity of this form of pollution, akin to the significance attributed to water, noise, and air pollution.

The involvement of both the local population and tourists in the planning and conservation efforts contributes to a more comprehensive vision of tourism development in the destination. Recognizing the unique characteristics and requirements of each destination, local communities should play a pivotal role in light pollution mitigation through awareness campaigns elucidating the nature of light pollution, its resolution, and the underlying motivations, whether for the local well-being, tourism development, or even in the context of degrowth, considering its integration with other mitigation policies such as noise reduction. Future studies should delve deeper into understanding how different tourism communities culturally perceive light and darkness, determining acceptable levels of light pollution mitigation for each community, and exploring varied approaches to mitigating light pollution in diverse tourism destinations, including urban areas.

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