

A Review of the Stimulus–Organism–Response Paradigm and Environmental Education for Cruise Tourism: A Proposed Framework

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Abstract

With the rapid growth of the global cruise tourism industry and its increasing environmental impact, there is an urgent need to address sustainability challenges in line with the SDGs, especially in Taiwan. Despite the growing research on environmental education, there is a lack of a theoretical framework from the perspective of the stimulus-organism-response (S-O-R) paradigm that examines the relationships between external stimuli, internal organisms, and individual responses to environmental education in the context of cruise tourism. The proposed framework includes attention to environmental issues and awareness of consequences as external stimuli. These stimuli influence affective and cognitive processes, which are internal states of the organism. In turn, the affective and cognitive states drive pro-environmental behavioral responses. Additionally, the proposed framework incorporates two potential moderating factors: cultural differences and environmental education with emerging technologies. Implications for environmental education in cruise tourism are provided.

Keywords: environmental education, sustainable cruise tourism, stimulus–organism–response, external stimulus, internal organism

1. Introduction

This conceptual paper provides a theoretical approach to understanding how the stimulus-organism-response paradigm and environmental education can promote sustainable development in Taiwan's cruise tourism industry. Based on the similarity check report from Turnitin.com, the overall similarity of this paper is 6% with a green label. This result indicates that no serious plagiarism issue is found in this paper.

In recent years, the development of cruise tourism has shown a rapid growth trend and has become an essential part of the global tourism industry [1-3]. According to Statista [4], the global cruise tourism market is expected to exceed \$40 billion by 2029, growing at an average annual rate of approximately 5%. While this rapid growth has brought significant economic benefits, it has also raised widespread concerns about its environmental impact. Studies have shown that cruise tourism exerts significant pressure on the environment and sustainable logistics in terms of carbon emissions, damage to marine ecosystems, and wastewater and waste disposal [5]. According to the European Maritime Transport Environmental Report [6], cruise ships are the largest polluters, emitting about 10 tons of black carbon per ship per year, followed by container ships (3.5 tons per ship), car carriers (2.1 tons per ship), and oil tankers and reefer bulk carriers (1.7 tons per ship each), as shown in Fig. 1.

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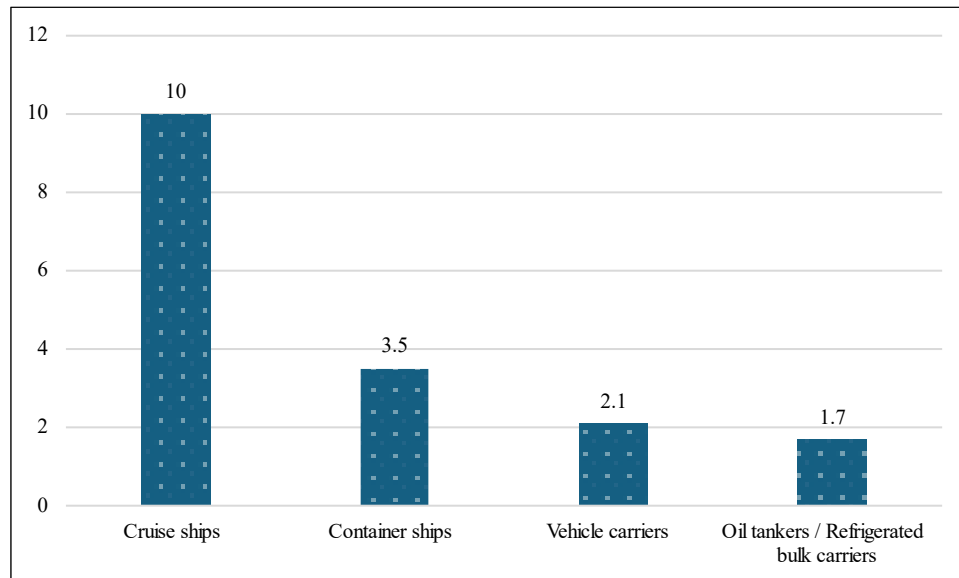


Fig. 1 Annual black carbon emissions per ship (in tons) [6]

Some researchers have proposed an energy efficiency operating index to monitor a ship's energy consumption [7]. Sofiev et al [8] concluded that even if all cruise ships could reduce their sulfur emissions, sulfur marine fuels would still cause 250,000 deaths and 6.4 million cases of childhood asthma each year. In addition, cruise ships recycle 60% more waste per capita than land-based ships. However, managing waste from cruises is a challenge. Fortunately, some cruise lines have already begun to make environmental improvements.

For example, Hurtigruten Cruises, which travels Norway's fjords, coastline, and Arctic, has invested in retrofitting six of its ships with a mix of batteries, liquefied natural gas, and organically liquefied biogas. Viking Ocean Cruises' new cruise ship, Viking Grace, is equipped with rotor wind sails that use wind power generated while underway to power the cruise ship, reducing CO₂ emissions by 900 tons per year. Carnival Cruise Lines is committed to clean energy. The company seeks to control emissions by combining sulfur oxide scrubbers with particulate filters. The Peace Boat, a Japanese cruise line that offers eco-friendly ocean cruises, plans to build a cruise ship powered by wind, solar, and liquefied natural gas.

According to the United Nations Sustainable Development Goals (SDGs), sustainable tourism is identified as a critical target in SDG11 (sustainable cities and communities). In consideration of the accelerated growth of the global cruise tourism industry and its concomitant ecological implications, it is imperative to address sustainability issues in this sector in accordance with the SDGs. In select developed countries, cruise ship ports have witnessed recurrent demonstrations and protests by residents over an extended duration. For instance, in the United States, local citizens can contact the state of Alaska to voice concerns regarding emissions from a visiting cruise ship if they observe or detect a malfunction. This suggests a positive correlation between heightened consumer awareness of environmental protection and companies' increased motivation to enhance their environmental standards. Consequently, governments and international organizations have initiated the formulation of stringent environmental protection policies for cruise ships.

The cruise industry in Taiwan is in its nascent stages of development when compared to the more mature cruise tourism industries in Europe and the United States. Despite the tourism sector in Taiwan undergoing a gradual expansion, marked by an annual increase in the number of travelers, it is imperative to proactively address the potential environmental impacts and promote sustainable practices. From the perspective of academic research, it is essential to conduct a survey in Taiwan regarding cruise tourism and environmental education. This assertion is especially valid when evaluated through the lens of a theoretical framework. Conducting such a survey would facilitate a systematic discussion of the factors that influence tourists' beliefs about sustainable cruise tourism [9]. This presents a unique opportunity to propose the hypothetical relationships among

factors influencing Taiwanese tourists' pro-environmental behaviors in the context of cruise tourism. This would facilitate the development of targeted strategies for environmental education.

Based on search results from a reputable database (Web of Science), existing studies have applied several theoretical models to understand pro-environmental behavior in tourism. These include institutional theory [10], norm activation theory [11], value-belief-norm theory [12], and theories of planned behavior [13]. However, there is a paucity of research exploring the complex interactions between external stimuli, internal organisms, and responses in the context of sustainable cruise tourism. The existing literature utilizes the S-O-R paradigm [14], which emphasizes three constructs in the model.

This study builds on the findings of previous research [15-16] by extending the S-O-R framework from the literature on gaming tourism [15] and the sustainable development of wildlife sanctuaries [16] to include environmental education in cruise tourism. The present study proposes that the S-O-R framework elucidates the role of external stimuli in shaping tourists' perceptions and behaviors toward sustainable practices in the context of cruise tourism. By examining how these stimuli influence cognitive, emotional, and behavioral responses, the proposed framework illuminates how environmental concern and awareness of consequences are translated into action.

This paper poses three key questions: (1) What are the influential external stimuli and internal organisms that influence local tourists' pro-environmental behavior toward cruise tourism? (2) What are the impacts of cultural differences on tourists' pro-environmental behavior toward cruise tourism? (3) Will the implementation of environmental education further strengthen tourists' pro-environmental behavior toward cruise tourism? To address these questions, this study proposes an application of the S-O-R framework in the context of Taiwan's cruise tourism industry. The proposed model comprises two external stimuli (attention to environmental issues and awareness of consequences) and two internal factors (cognitive and affective processes) that influence tourists' intentions to adopt pro-environmental behaviors in cruise tourism. Furthermore, by taking into account the moderating effects of cultural differences and the role of environmental education with emerging technologies, this study aims to provide a theoretical perspective on the promotion of sustainable practices in Taiwan's rapidly developing cruise tourism sector.

2. Literature Review

This section provides a systematic analysis of relevant research to review the intersection of cruise tourism and environmental education. First, it presents the development and current state of cruise tourism in relation to environmental education initiatives. Next, the existing theoretical underpinnings of the S-O-R paradigm from various fields are reviewed. Finally, a proposed research model is introduced in this section.

2.1. Development of cruise tourism and environmental education

In recent years, researchers have pursued a variety of approaches to safeguard significant environmental resources and cultivate public comprehension of the importance of environmental sustainability issues in confronting the environmental challenges posed by cruise tourism. [17]. Among these strategies, environmental education has emerged as a prominent coping mechanism aimed at enhancing environmental awareness, knowledge, and engagement [18-19]. Some cruise lines have initiated the provision of onboard educational courses focusing on environmental subjects, including marine life conservation, the vulnerability of marine ecosystems, and the significance of sustainable tourism behaviors [20].

To cultivate environmentally literate citizens, scholars have proposed that sustainable environmental education should prioritize cultivating a community's capacity to address environmental challenges and promote engagement in environmental protection initiatives [21-22]. For instance, Demir et al. [21] demonstrated that efficacious environmental education can substantially augment tourists' awareness of the impacts of cruise tourism and their propensity to adopt pro-environmental

behaviors. Furthermore, environmental attitudes are defined as the characteristics that individuals develop over time, encompassing values and beliefs concerning the environment, a sustained interest in environmental issues, and actions to protect the environment [22]. Researchers have also indicated that tourists who have participated in these programs exhibit an increased concern for marine conservation and are more inclined to support cruise activities that incorporate environmentally friendly measures [23-24].

Recently, some studies found that emerging technologies are transforming cruise tourism experiences through diverse innovative applications for environmental education. For example, González-Santiago et al. [3] found that smart technologies are being systematically adopted across cruise tourism services, creating new paradigms for guest engagement and operational efficiency. Fan et al. [25] suggested that Augmented Reality (AR) and Virtual Reality (VR) are significantly enhancing tourism experiences by providing interactive and engaging content that enriches passenger journeys. The metaverse represents a particularly promising frontier, where cruise operators can create immersive virtual experiences that complement rather than compete with physical cruise experiences. This hybrid approach allows for holistic customer engagement, where virtual interactions in the metaverse can enhance anticipation and extend the cruise experience beyond the physical voyage [26]. These technological advances are not merely supplementary features but are becoming integral to the cruise industry's evolution, requiring comprehensive educational frameworks to prepare industry professionals for this technological transformation [27].

The convergence of these emerging technologies has far-reaching implications for the traditional maritime hospitality industry. It enables cruise tourism companies to offer personalized, engaging experiences that promote environmental awareness and encourage positive behaviors among tourists. Therefore, this study posits that the integration of immersive technologies, such as virtual reality and interactive media, has the potential to enhance the efficacy of environmental education, thereby facilitating a more profound immersion of tourists' actions in the environment. In the future, as cruise tourism continues to expand, the development and implementation of more effective environmental education strategies will be vital to achieving sustainable development. Utilizing a theoretical framework approach, this conceptual paper underscores the significance of environmental education in the context of cruise tourism.

2.2. Theoretical framework from the S-O-R paradigm

The S-O-R framework, developed from environmental psychology [14], posits that external stimuli (S) influence an individual's internal states or organisms (O), which in turn lead to behavioral responses (R). The S-O-R paradigm posits that S refers to the external stimulus of a situation or event, which is a variable of the external environment, including various marketing and environmental operations. The S-O-R framework is illustrated in Fig. 2.

The O is used to denote the internal organism of an individual, defined as the mechanism of the individual's psychological process, including cognition and affect. The cognitive response is defined as the process through which an individual's mental function interacts with external stimuli, typically characterized as a goal-directed activity [28]. Emotion, in turn, is understood as a subjective, transient psychological trait or state induced by external stimuli.

The R is response behavior, which can be further categorized into two distinct forms: approaching behavior and avoidance behavior. In this theoretical framework, external stimuli are theorized to exert an influence on an individual's internal emotional state. This internal emotional processing process (mechanism) involves an individual's cognitive and affective responses, which in turn lead to specific behavioral outcomes.

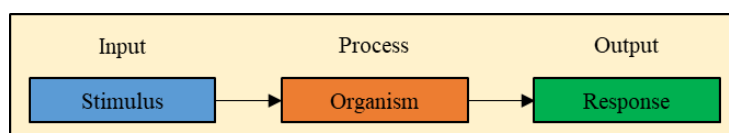


Fig. 2 A conceptual framework of the S-O-R paradigm [14]

2.3. A proposed research model based on the S-O-R paradigm

In the context of cruise tourism, researchers have used the S-O-R paradigm to examine the factors that influence consumers’ pro-environmental behaviors and intentions [29-30]. For example, researchers have examined the relationship between brand name and its perceived value to customers, which in turn influences the image of a business and behavioral intentions [29]. Islam et al [30] conducted a study to determine whether employees’ perceptions of corporate social responsibility have the potential to increase their satisfaction and loyalty. However, there are few studies that have used the S-O-R paradigm to examine the influence of cruise passengers’ environmental concern and awareness on their internal states and pro-environmental behavioral intentions.

The S-O-R paradigm is employed as the foundational framework for this study, which proposes a research model (see Fig. 3) to delineate the relationships between external stimuli, internal organisms, and behavioral responses within the context of cruise tourism. The model incorporates environmental concerns and awareness of consequences as external stimuli, cognitive and affective factors as internal stimuli, and intentions to comply with environmental regulations and willingness to pay for eco-friendly cruise options as behavioral responses. The proposed model incorporates the moderating effects of cultural differences [31-32] and environmental education with emerging technologies [33-34]. The integration of these two moderators enables researchers to examine the moderating effects in the relationship between tourists’ willingness and influencing factors for pro-environmental tourism behavioral intention in different cultures with environmental education.

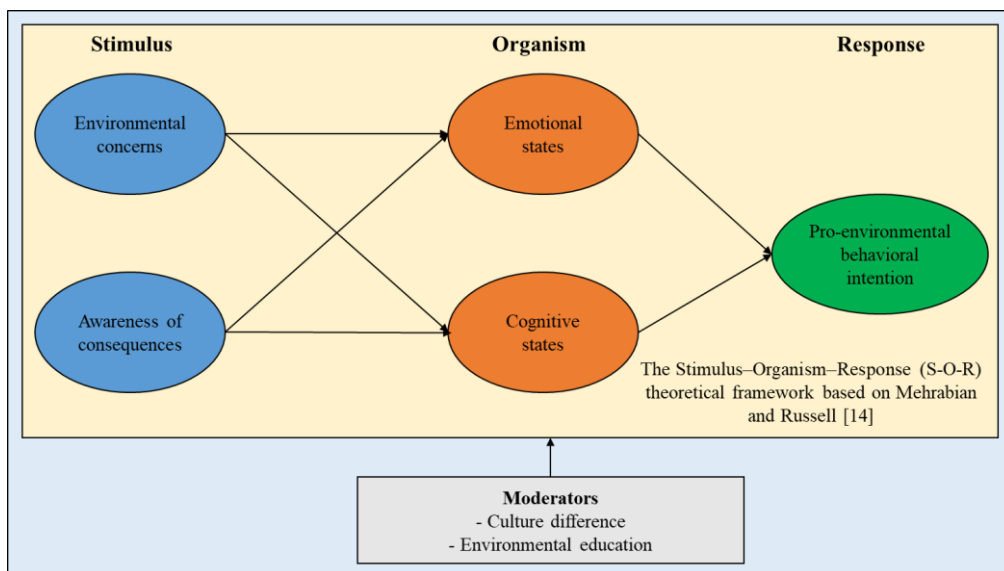


Fig. 3 A proposed research model based on the S-O-R paradigm

The incorporation of moderating variables facilitates researchers’ comprehension of the potential moderating effects between independent variables and behavioral factors. Researchers have posited that cultural differences play a critical role in the context of cruise tourism [31-32]. In cultures where environmental conservation is a deeply held value, tourists are more likely to internalize and act upon pro-environmental norms when they encounter environmental degradation during their cruise experience. In contrast, tourists from collectivist cultures may be more influenced by the behaviors and expectations of their peers, leading to greater engagement in sustainable practices than those from individualistic cultures. A cultural emphasis on nature and sustainability has the potential to heighten tourists’ sensitivity to environmental issues, thereby prompting more decisive pro-environmental actions when confronted with environmental challenges, such as coral reef degradation.

In addition to cultural differences, Saari et al. [35] indicated that environmental concern refers to the perception of many different environmental issues. Among these, an individual’s awareness of consequences refers to the understanding that one’s actions may affect the well-being of others or society [36]. There is a broad consensus that concern for environmental issues

and understanding of the consequences of pollution significantly influence an individual's propensity to engage in environmentally responsible behaviors or decisions [37].

Second, affective factors (affect) are triggered after the evaluation of specific environmental ecologies and behaviors. These affective factors effectively explain individuals' decisions and behaviors in various pro-environmental decisions and behaviors [38]. In addition to affective variables, cognitive variables such as environmental concern and consequence awareness influence individuals' perceived attitudes toward being environmentally friendly [39]. These cognitive variables may also significantly influence an individual's decision to be environmentally friendly and, in turn, their moral obligation to take environmental action. By focusing on the specific components relevant to cruise tourism from an S-O-R perspective, this model provides a systematic understanding of the profile towards the formation of tourists' pro-environmental behavior in cruise tourism.

3. Research Propositions for Environmental Education in Cruise Tourism

Based on the proposed model, three research propositions are provided. First, the S-O-R paradigm serves as the foundational theoretical framework for understanding how external factors (Stimuli) impact individuals' internal psychological states (Organisms), which subsequently drive their behaviors (Responses). In the context of this study, external stimuli encompass factors such as environmental education initiatives, awareness campaigns, and regulatory measures related to cruise tourism. Environmental concerns refer to tourists' awareness and concerns about environmental issues related to cruise tourism, such as carbon emissions and marine ecosystem degradation. Following the literature [38-39], tourists' awareness of consequences involves their understanding of the direct and indirect impacts of cruise tourism on the environment and society.

Next, according to the S-O-R, internal organisms can refer to the psychological processes within tourists. This study includes cognitive (e.g., knowledge and beliefs about environmental issues) and affective states (e.g., emotions like responsibility, guilt, or pride related to environmental stewardship toward cruise tourism). Last, responses in this study are the pro-environmental behaviors exhibited by tourists, such as complying with environmental regulations on cruises or being willing to pay a premium for eco-friendly cruise options.

Based on the literature, the interaction between external stimuli (e.g., environmental concern, awareness of environmental consequences) and internal organisms (e.g., affective and cognitive processes) is crucial for tourists' pro-environmental behavior toward cruise tourism. According to the S-O-R framework, raising awareness of environmental issues and consequences can promote tourists' pro-environmental behavior. In terms of tourists' attention to environmental issues, research has shown that increased awareness of environmental issues increases their willingness to engage in pro-environmental behavior. For example, a study by Salim et al. [40] revealed that increased awareness of the consequences of climate change increased the likelihood of pro-environmental behavior among tourists. Thus, targeted awareness campaigns about the impacts of cruise tourism can motivate local tourists to adopt more sustainable behaviors. The first proposition is provided as follows.

Proposition 1: External stimuli (e.g., environmental concerns and awareness of the consequences of cruise tourism) will positively influence internal organisms, such as cognitive and affective states, which in turn positively affect local tourists' pro-environmental behavior toward cruise tourism.

Operational definition. Environmental concerns are defined as the degree to which tourists are concerned about environmental issues related to cruise tourism, such as carbon emissions and the degradation of marine ecosystems [35]. Awareness of consequences is defined as tourists' understanding of the direct and indirect impacts of cruise tourism on the environment and society [36]. Cognitive states refer to tourists' knowledge, beliefs, and attitudes concerning environmental issues pertinent to cruise tourism [39]. Conversely, affective states encompass the emotional responses exhibited by tourists

(e.g., responsibility, guilt, pride) concerning environmental stewardship in the context of cruise tourism [38]. Finally, pro-environmental behavior constitutes actions undertaken by tourists that serve to mitigate the adverse environmental impacts of cruise tourism. Such actions include adherence to environmental regulations and the selection of eco-friendly cruise options [17].

Second, a crucial moderating role of cultural differences in the proposed S-O-R model is suggested. In tourism literature, some researchers suggested that cultural backgrounds determine how tourists perceive and react to environmental stimuli [31-32]. Cultural differences shape these components by establishing varying social norms and values related to environmental responsibility. In this sense, tourists' cultural differences will have potential moderation in the proposed model. Moreover, according to the theory of planned behavior, social norms regarding environmental responsibility may vary widely across cultures and influence tourist behavior [41]. The theory of planned behavior underpins this proposition by emphasizing that individual behavior is influenced by subjective norms, attitudes, and perceived behavioral control [42], suggesting that individuals often conform to the behavior of those around them.

In the S-O-R paradigm, cultural differences moderate the relationship between external stimuli (e.g., visible environmental degradation, eco-friendly initiatives onboard) and the internal cognitive and emotional responses (organism) that lead to pro-environmental behavior (response). Tourists from collectivist cultures may be more influenced by the behaviors and expectations of their peers, leading to higher engagement in sustainable practices compared to those from individualistic cultures. Tourists who are more influenced by the environmental behavior of their peers are more likely to engage in sustainable behavior than tourists who may not feel the same social pressure or connection to the local environmental context. For example, tourists who witness the degradation of marine environments, such as coral reefs and beaches, are more likely to engage in sustainable behaviors, such as reducing waste and supporting eco-tours.

In cultures where environmental conservation is deeply ingrained, tourists are more likely to engage in pro-environmental behaviors when they witness environmental degradation while traveling. For instance, tourists who observe the deterioration of marine environments, such as coral reefs or beaches, may be inspired to engage in sustainable practices, such as reducing waste and supporting eco-tours. This has prompted cruise lines to develop educational programs that are culturally appropriate and designed to increase environmental awareness and action among tourists. The second proposition is as follows:

Proposition 2: Cultural differences will significantly moderate the relationship between external stimuli and local tourists' pro-environmental behavior toward cruise tourism. An operational definition is provided. Cultural differences are measured by the extent to which values, norms, and beliefs related to environmental responsibility in a certain cruise tourism context differ among different cultural groups [31-32].

Third, based on the literature, this study extended the discussion of environmental education to the context of cruise tourism, proposing that environmental education is important in promoting pro-environmental behavior among tourists. For example, researchers have indicated that environmental education has been shown to increase awareness and understanding of ecological issues, leading to pro-environmental behavior [16, 43]. Studies have also shown that tourists are more likely to participate in actions to reduce environmental impacts when they feel an emotional connection [17]. In this sense, emotional responses are argued to be crucial in influencing behavior. Positive emotional responses induced by environmental education, such as feelings of responsibility, guilt for environmental degradation, or pride in sustainable practices, drive pro-environmental behavior [41].

In this sense, when local tourists feel a strong emotional connection to their natural environment, they may be more inclined to mitigate the negative impacts associated with cruise tourism. Environmental education increases tourists' environmental awareness and stimulates their emotional connection to the natural environment, which in turn strengthens their commitment to environmental action. Therefore, designing targeted environmental education programs can effectively increase local tourists' sense of responsibility for ecotourism and promote sustainable development.

Previous studies have also suggested educational technologies, such as virtual/augmented reality, the Internet of Things, and generative AI. Emerging technologies provide immersive experiences to increase tourists' knowledge about the environmental impacts of their activities, resulting in increased pro-environmental intentions and behaviors [44]. In addition, environmental education programs help build a sense of social responsibility among tourists, allowing them to influence and motivate each other to participate in environmental activities. Therefore, cruise lines should develop targeted educational programs that impart knowledge during the cruise and extend the impact to the end of the trip. These experiences encourage tourists to continue participating in environmental activities and promote a broader awareness of environmental protection.

Research by Lloret et al. [5] shows that informed individuals are more likely to act on their intentions. In the context of cruise tourism, when tourists are educated about the specific negative impacts of their actions (e.g., waste generation, habitat degradation), they are more likely to adopt sustainable behaviors, such as choosing environmentally friendly options or following environmental guidelines during their excursions. In this sense, educational programs incorporating social norms and peer influence mechanisms can significantly affect behavior change [45]. For example, if tourists perceive that their peers are engaging in pro-environmental behaviors (in part due to educational initiatives), they are more likely to adopt similar practices.

Overall, the third proposition emphasizes the pivotal role of environmental education in shaping tourists' pro-environmental behaviors within cruise tourism. Comprehensive environmental education programs are designed to elevate tourists' awareness about environmental issues related to cruising, encourage the adoption of sustainable practices aboard cruise ships, and consider cultural variations that may influence behavior. By integrating these elements, environmental education informs and motivates tourists to engage in actions that are beneficial to the environment, reinforcing their commitment to pro-environmental behavior during their cruise experiences. The third proposition is depicted below.

Proposition 3: Implementing comprehensive environmental education programs will significantly enhance tourists' pro-environmental behavior in the context of cruise tourism by increasing environmental awareness, fostering sustainable practices, and addressing cultural differences.

Operational definition: Comprehensive environmental education programs are defined as the extent to which tourists' knowledge, awareness, and skills related to environmental sustainability in cruise tourism are improved through environmental education programs in cruise tourism [18-19]. Additionally, it is recommended to assess the degree to which related educational technologies are employed in environmental education, such as virtual/augmented reality, immersive technologies, and emerging AI applications, to enhance the delivery and impact of environmental education [2, 33-34].

4. Implications

The findings of this research yield significant insights that can inform strategic approaches across multiple sectors involved in cruise tourism and environmental education. The following implications emerge from our analysis of the internal mechanisms that mediate external stimuli in cruise tourism contexts, offering actionable recommendations for academia, industry practitioners, and government stakeholders. These implications are organized into five key areas that collectively address how to enhance environmental education effectiveness, create more targeted interventions, and foster sustainable tourism practices through improved understanding of tourist behavior and engagement.

- (1) Based on the research propositions, several implications for academia, industry, and government are offered as follows. Using word-of-mouth for cruise tourism's environmental education. By understanding the internal mechanisms that mediate external stimuli, cruise operators can develop more effective educational programs tailored to engage local tourists emotionally and cognitively. Cruise lines can collect personal testimonials and experiences from tourists and incorporate storytelling to make environmental issues more relatable and impactful.

- (2) Targeted awareness campaigns. Cruise lines and environmental educators should be aware that there may be individual differences in tourists' levels of environmental concern. Understanding the characteristics of the environmental concerns of different groups of tourists can help design more targeted environmental education programs. Operators can also create campaigns that highlight the direct impact of cruise tourism on local ecosystems and engage tourists through interactive and visually appealing content. This is consistent with the notion that increased awareness leads to increased pro-environmental action.
- (3) Cultural values and policies for inclusive and friendly community development. Emphasizing local cultural values in environmental education recognizes the unique perspectives of local tourists. Workshops or seminars that incorporate local environmental concerns, traditional ecological knowledge, and participatory activities can increase the relevance of educational content and foster a sense of responsibility among tourists.
- (4) Technology-enhanced cruise tourism and environmental education. The integration of technological solutions such as generative AI or augmented reality can enhance the learning experience. For example, visualizing the environmental impact of cruise tourism on local ecosystems through VR can motivate tourists to adopt pro-environmental behaviors.
- (5) Creating positive social norms and providing action guidelines. By creating positive social norms, cruise lines can reinforce the positive association between tourists' environmental concerns and positive emotional and cognitive responses, such as public recognition of green behavior and awards for environmental excellence. It is also important to provide cruise tourists with clear action guidelines through environmental education. For example, providing tourists with information on how to minimize their environmental impact during a cruise can help them translate their concerns into practical environmental actions.

5. Conclusion

This study reviewed and proposed a theoretical framework based on the S-O-R paradigm to explore how external environmental stimuli and internal cognitive-affective processes influence tourists' pro-environmental behavior in cruise tourism contexts. Based on the S-O-R paradigm, this study successfully conceptualizes the relationship between environmental concern and awareness of consequences as stimuli, cognitive and affective states as organism factors, and pro-environmental behavioral intentions as responses in cruise tourism settings. This study also integrates cultural differences and environmental education as moderators into the proposed framework, providing critical insights for developing targeted environmental education programs that resonate with diverse tourist populations. The result of this study sheds light on how educational approaches can effectively promote sustainable practices among cruise tourists by addressing cultural variations in environmental attitudes and behaviors. Three main contributions are summarized below.

- (1) The development of a theoretical framework. The S-O-R paradigm provides a robust theoretical foundation for understanding environmental education in cruise tourism contexts. Accordingly, this study includes environmental concern and awareness of consequences (external stimuli), cognitive and affective states (internal stimuli), and pro-environmental behavioral intentions (responses) in the proposed framework. The affective and cognitive states serve as critical internal mechanisms that mediate the relationship between environmental stimuli and behavioral responses. This dual-pathway approach recognizes both emotional and rational processing as bridging factors in fostering pro-environmental behaviors among cruise tourists.
- (2) Moderating factors in the framework. This study proposes that contextual considerations of cultural differences and environmental education with emerging technologies are significant moderating variables in the framework. Two moderators can better explain the S-O-R relationships in sustainable cruise tourism. Understanding these moderating factors is crucial for tailoring environmental education programs to diverse tourist populations.

- (3) Practical applications for sustainable cruise tourism. The framework offers actionable implications for cruise industry stakeholders, environmental educators, and policymakers. It also supports the design of culturally sensitive and technology-enhanced educational programs that can effectively promote sustainable behaviors among cruise tourists. These contributions broaden the scope of SDG achievement and environmental conservation efforts for sustainable cruise tourism.

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Conflicts of Interest

The authors declare no conflict of interest.

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