

Research

Adoption of environmental technologies in the hotel industry: development of sustainable intelligence and pro-environmental behavior

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Abstract

Innovative environmental technologies such as solar energy, hydroelectricity, waste-to-energy, and rainwater reuse sources have the potential to completely transform the modern world to reduce climate change and dependency on fossil fuels. This study aims to investigate the role of environmental innovative technologies on customers' experiences of hotels with a mediating role of sustainable intelligence. The study theorizes that environmental innovative technologies enhance customers' experience and attitude towards hotels. The innovation diffusion theory is utilized as a main theoretical framework to address the research problem. The data was collected from tourists/visitors at top hotels with a usable sample size of 222 respondents. Survey results reveal that innovative technologies in the context of *Environmental Responsibility* and *Economic Responsibility* have a significant influence on *Pro-Environmental Behaviour* with the full mediating role of *Sustainable Intelligence*. These findings have important implications when implementing innovative technologies in the tourism industry to (1) improve customer satisfaction, experience, and attitude towards the hotels and destinations; (2) provide guidelines in tourism development policy and marketing; (3) help government agencies to effectively use pro-environmental technologies to change consumer attitude. After the investigation, some intriguing theoretical and practical conclusions have been made.

Keywords Tourism · Sustainability · Environmental innovative technologies · Destinations marketing · Destination social responsibility · Environmental behaviour

1 Introduction

The recent decade marks an extraordinary determination from the tourism industry to raise awareness about environmental concerns and their sensitivity [1, 2]. Different stakeholders are held accountable like the public, administrative authorities, and residents for environmental degradation or not caring for it [3–5]. Countries and climate action institutions that truly care about the environment experience a personal cost while protecting it [6, 7]. The hotel industry is one of the major contributors to the consumption of resources like food, water, energy, and non-reusable products which is why this industry has been criticized by environmentalists and economic activists [8, 9]. The criticism has led the hotel industry to reform its business strategies to minimize environmental strains [10, 11], and reforms are restricted to developed nations only.

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Usually, environmental activists blame hotel owners, management, and staff for anti-environmental practices [12]. Without the participation of tourists in the process of eco-innovation, the efforts would not be successful [13, 14]. Hotels taking such initiatives will have a direct impact on the pro-environmental behavior and destination social responsibility of the customers [15]. Societies that care about their environment usually impact the pro-environmental behavior in their residents due to the values they hold, even if the individuals are not intrinsically motivated [16]. Same way if hotels can adopt such technologies to halt the environmental risk, it can influence tourists as well [17]. After all, hotels are a major part of social life [18, 19]. Despite the hotel's adoption of eco-innovation, it is to be discovered the influence it has on the tourists.

World Tourism Organization (UNWTO) 2023, has been working towards different tourism sustainability Development Goals (SGDs) such as biodiversity, climate action, and hotel energy solutions. The priority action by the G20 survey was set to green tourism and SGD:12 is the goal which states responsible consumption and production [20]. Nearly Zero Energy Hotels (NZEH) by UNWTO, states the accommodations account for nearly 21% of CO₂ tourism carbon emissions which is 2% of the 5% global CO₂ emissions. NZEH provides technical support, training, and information to small and medium hotel businesses by bringing knowledge from successful hotels from developed nations [21]. Usually, hotels face barriers like a lack of green knowledge, poor financial conditions, and environmental feasibility [22, 23]. For hotels to be environmentally smart, it is essential to implement innovative technologies.

Environmental degradation decreases the visits from tourists. The degradation decreases the value of a certain destination as compared to well-preserved environments [24, 25]. For Pakistan, environmental degradation can decrease tourism value by 33.7% in the coming years [26]. Innovation can save costs and put a minimum risk to the environment [27]. To maintain the value of tourist places, it is imperative to preserve the environment and surroundings which would be possible if hotels adopt technologies that save precious environmental resources like luxury hotels are implementing [23, 28]. Solar panels, saving rainwater for use, and charging batteries through water, are some practices that are a part of eco-friendly accommodations.

The readiness of all stakeholders in the implementation of technologically innovative technologies to save resources is a key aspect [29, 30]. Customer satisfaction levels tend to be higher for technological and innovative hotels with environmental concerns as compared to the normal ones [31, 32]. The use of robots and environmental concerns are pleasing to the customers, and help hotels to save cost and time. This adaption has become a cultural and competitive portent in developed nations [33, 34]. It seems necessary for hotel businesses in developing nations to jump on the bandwagon of being mindful of the surroundings and trends adopted by successful hotels. Environmentally aware hotels can attract a specific kind of tourists that have a sense of Destination Social Responsibility which is a relatively alien concept [35, 36]. Sustainable Intelligence is the knowledge and experience of the tourists to have sustainable tourism without the harm of natural resources [37, 38]. All these factors contribute to building pro-environmental behavior in tourists.

The indispensable role of hotels in the adoption of innovation and technologies to preserve resources and how it impacts visitors has not been paid attention to in previous literature. By identifying and responding to the issues, the study attempts to investigate (1) Does the hotel's adoption of environmental technologies evoke the destination's social responsibility and sustainable intelligence in tourists? (2) Having more environmentally friendly experiences at hotels makes tourists intellectually informed about environmental protection, and (3) Does the use of innovation and technology to preserve the resources evoke pro-environmental behavior in tourists?

2 Literature review

2.1 Innovative environmental technologies and destination social responsibility

United Nations's (UN) Climate Technology Center & Network (CTCN) provides technical assistance globally such as wastewater to bio-gas potential, development of green buildings, the technical feasibility of solar and rainwater storage on public buildings, energy-efficient systems for households and industries for countries with less natural resources [39]. This assistance has been provided to Pakistan in many fields by CTCN and business owners are gradually learning to implement the projects to store rainwater, implement energy systems, and install hydro solutions [40]. Hospitality is revolutionizing in Pakistan with hotel owners becoming mindful of the environment but change is gradual [41, 42]. Without green knowledge, abundance is wasted while hotels try to make visitors happy due to hotels being purely business-centric settings [43, 44]. Environmental technologies like renewable energy solar or wind, greywater recycling,

energy-efficient lighting, and biodegradable decomposition are a part of modern hoteling which has evolved its name from hotel to Ecotel [45]. Technological Innovation can improve operational and managerial business activities systematically to use energy and other environmental resources efficiently [46]. Incorporation of technologies into current business practices requires intelligently redesigning the processes [47]. Making small gestures of recycling and biodegradable packaging and smart use of amenities to save water waste can create a lasting influence on tourists [48, 49]. If tourists visit such hotels, they feel a deep sense of connection with nature and its preservation. Most hospitality sectors are not in a position to comply with pricey and novel approaches to carbon emission mitigation [50].

Remarkably, in Pakistan, a few destinations are implementing novel technologies to minimize the risk of environmental degradation and to save resources. Some of the observations on waste audit assessment made by IMARAT Institute of Policy Studies [51] of zero-waste hotels in Pakistan are as follows: Energy efficiency: Use of solar panels, and hydropower are used by a few hotels in the north, and solar is used mostly all around the country however biomass and geothermal projects are still underway. Thermal is used in the south but again due to the cost involved the implementation is not outspread. Water Conservation: some hotels have implemented rainwater harvesting however greywater recycling is still not adopted. Reduce, reuse, and recycle: These strategies include upcycling and refurbishing to work on aesthetic aspects of the hotels' furniture, amenities, and buildings. Organic waste management is done with the collaboration of agriculture to increase the circular economy which also reduces landfills. Collaboration with local suppliers poses a minimum risk to the environment by saving fuel, and transportation costs and a close-knit relationship for environment-friendly packaging [51].

Consumers can be mindful if hotels make certain efforts like digital awareness while bookings, interactive screens to educate guests, and certain discounts/rewards for consumers who prefer sustainable living. Guided/digital tour invitations to practice sustainability like towel reuse, saving water, and other strategies to create a shared sense of responsibility. Local partnerships are emphasized as a chunk of the hotel's story even for international chains [52]. Contemporary tourism practices value sustainability. The term destination social responsibility refers to the customer's perception of sustainability [53]. As per attribution theory, people tend to learn from a specific event, if the destination host cares about the environment, they too show destination social responsibility [35, 54] it is assumed if stakeholders protect the destination economically, culturally, and environmentally, it creates destination loyalty from the tourists as well [55]. Destination social responsibility is the measure that tourists have set to evaluate the activities that are performed at the destination and contribute to them [37, 56]. Social, cultural, and environmental values to protect the destination vary from country to country, the concept of destination social responsibility is what makes the tourists behave responsibly.

2.2 Economic responsibility

Economic responsibility is a key factor of destination social responsibility since it contributes to economic development, profitability, a stronger tax base, and the cost-effectiveness of projects [57]. Sustainable economic development improves the life quality of families of a destination, employees working for it, and local communities [58]. Innovative environmental technologies can be beneficial for economic, social, and environmental aspects [59]. Smart technologies can save the operating costs of a setup which ends up in economic prosperity for the destination and its residents and plenty of resources saved [37]. Implementation of sustainable practices and innovation provides win-win outcomes for economic conditions and the environment [60]. An innovative environment caters to all the sustainability requirements of a destination, at the same time it has certain economic benefits for all the stakeholders including tourists.

2.3 Environmental responsibility

The biggest contributing factor to environmental deterioration has been careless human behavior [61]. Responsible behavior about the environment has started to reflect as the usability of technology has been accepted widely [62]. Awareness spread through social media platforms has also compelled destination hosts to adopt the innovation to attract certain kinds of tourists [63]. When tourists have prior acquaintance with sustainable destination practices it has a profound impact on future destination choices [64]. The hotel's consideration to include the environmental concern in plans would not hamper the tourist capability to be in line with that agenda [65] The reciprocal effect can be observed in the innovation of tourist and destination stakeholders.

2.4 Socio-cultural responsibility

It is generally observed that tourists' responsible behavior is greatly influenced by environmental responsibility factors. Socio-cultural responsibility consists of three features. The decision-making impacts the local livelihood, dispersal of responsibilities and benefits equally among the involved groups, and finally cultural sustainability [66, 67]. Destinations and hotels provide a livelihood to local communities in the form of employment [68], management of the equitable distribution of gains and obligations is challenging because one group considers environmental exploitation as advantageous while others may oppose the idea [69] and lastly culture in form of building, architect and local values should not be disturbed by tourism activities (71). Businesses that pay attention to sociocultural aspects of tourism become influential and impact the tourist visit intention as well.

2.5 Sustainable intelligence

The sense that initiates the desire to preserve the environment in which one exists or surrounds itself is usually known as sustainable intelligence [70]. In the past decade, many terminologies have been applied to environmentally conscious tourists' behavior and attitudes, of course, not all of these have been acknowledged and accepted. Classifications by studies of tourist behavior and attitude are ecological tourist, green tourist, sustainable tourist, and nature-based tourist [71–74]. These taxonomies have been made based on activities performed while on an excursion [75]. Despite all these terms, a discrepancy has been observed in previous studies in professed values and practical behavior of consumers [76, 77]. It is believed that tourists with a higher sense of environmental concern tend to select hotels and destinations that take environmental protection initiatives to serve the customers [78]. The prevailing rhetoric in the tourist industry around sustainability (theory, viewed as an idea) and responsibility (practice, interpreted as sustainable behavior) necessitates a thorough comprehension of the steps involved in the implementation of the sustainability agenda of the host [79], which this paper attempts to deliver. To fill this gap, we have confidence that if the destination or hotel provides an atmosphere where tourists are bound to adhere to rules implemented by the host of the destination, it is more likely for the tourist to reflect sustainable intelligence.

2.6 Pro-environmental behavior

Pro-environmental behavior has been an emphasis of consumer psychology researchers to investigate behavioral aspects like environmentally friendly product purchase decision process [80], the altruistic value of environmental products [81], and green behavioral intention [82]. Different reasons have been presented behind people choosing environmentally friendly options for accommodations that reflect pro-environmental behavior [83]. Altruistic values are guiding principles of individuals that stimulate them to take steps for the well-being of others [84]. Whereas, egoistic altruism which means the good that is done for others also pays off in self-benefit [85]. Altruistic values and egoistic altruism are both triggers to adopt environment protection behavior [86, 87]. Altruistic values and awareness about environmental protection knowledge can lead to pro-environment behavior [88]. For the development of pro-environmental behavior in tourists, tourists must possess prior knowledge of sustainable intelligence and destination social responsibility.

2.7 Innovation diffusion theory

The theory of innovation diffusion was first published in a book in 1962 by Everett Rogers [89]. The theory aims to comprehend how, when, and why novel ideas have been propagated throughout society [90]. As per Fig. 1 when hotels adopt environmentally innovative technologies such as solar energy, hydroelectricity, waste-to-energy, and rainwater reuse is adopted by hotels, it is like a novel idea for Pakistani society since the usage of these energies is rare and expensive. The success of these environmental technologies depends on how anticipative the guests are, The process of spread goes through five stages in a social setting (1) early adopters known as trendsetters or technology enthusiasts (2) next in line are the visionaries, organizations that are risk takers also come into this category (3) the next adopters are pragmatists that consists of a majority of the population who adopt new idea based on its realistic approach (4) majority of the population that adopts new idea late are the ones who see an economic necessity or are bound to do so due to peer pressure (5) lastly, the people who have been a skeptic of the idea all the way also join into the acceptance process [91–93]. The rationale for using this theory in this study is that in a society that is getting to know the idea of sustainability

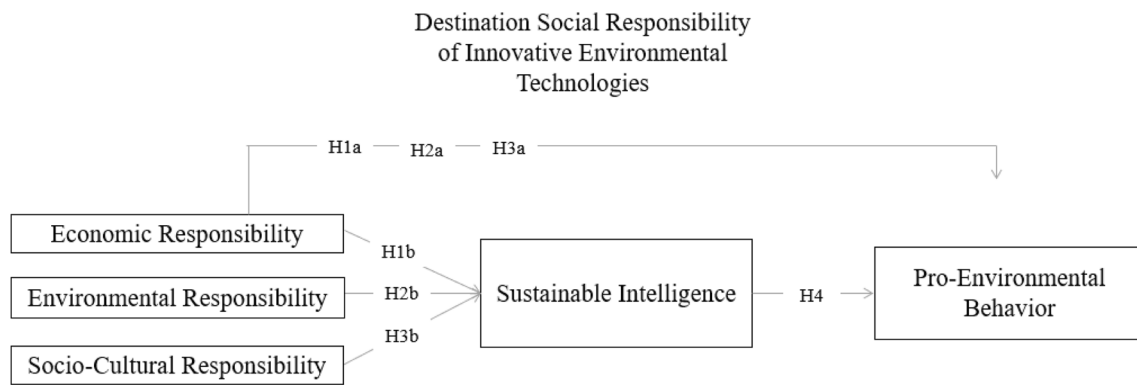


Fig. 1 Conceptual framework

and destination social responsibility, all categories of adopters are found. We need to observe at what pace these ideas are proliferated among the masses.

3 Hypotheses development

3.1 Economic responsibility

Destination social responsibility requires the active participation of all stakeholders such as residents, businesses, and tourists which means all should be involved in economic responsibility [94]. The economic prosperity of a destination depends on the best competitive strategies that the destination adopts in terms of technology, price, and atmosphere [95]. Therefore, whenever technological innovation happens in companies, there are potential financial benefits that help fulfill the economic responsibility of businesses [96]. Moreover, economic well-being helps to prosper the whole society of a destination resulting in a more welcoming attitude toward tourists [97]. On the contrary, a destination's negative reputation adds to customer's discontent and does not support environmentally responsible behavior [98–100]. Resource conservation, increased income sharing, and effective taxation are all benefits of economic responsibility that make the destination prosperous [37, 92]. An investigation is required for the existence of the reciprocal influence of economic responsibility and its support in building pro-environmental behavior [100]. Hence, in this study, we assume that innovation generates economic rewards that lead to specific sustainable behaviors; tourists tend to emulate these sustainable behaviors when they witness this stability. Based on the discussion above, we posit:

H1a: Economic Responsibility has a significant impact on Pro-Environmental Behavior.

H1b: Economic Responsibility will have a significant impact on Sustainable Intelligence.

3.2 Environmental responsibility

Comparing an individual who has been a part of responsible environmental actions with a person who has not, results in later having a stronger bond with nature [101–103]. The destination host has a big responsibility in terms of creating a sense of environmental responsibility through sincerity in actions. In return, genuine social interaction can lead to sustainable intelligence and pro-environmental behavior [104]. On a big scale, tourism activities degenerate the environment. The destinations that show environmental concern are a source of creating positive change in consumer attitudes. The innovation related to mitigating carbon emissions is usually expensive and is not complied with by most destinations. Sometimes there is extreme pressure from leadership to adopt sustainable practices [50]. If destinations comply with the regulation, they attract exceptional responses from involved stakeholders [105]. Moreover, when hotels practice sustainability, it is highly likely to spread awareness among tourists (81,84, 85). It is like a social imitation behavior and this legacy is taken to other tourist spots internationally. However, there could be a discrepancy between the declared values of tourists and their practical implementation of this behavior. This inconsistency may occur due to higher prices and extra effort to be a sustainable tourist (78, 79, 107). To test this discrepancy, it is unclear if the destination host reflects environmental responsibility through innovation adoption, could it increase sustainable intelligence and create pro-environmental behavior? Therefore, we posit:

H2a: Environmental Responsibility has a significant impact on Pro-Environmental Behavior.

H2b: Environmental Responsibility will have a significant impact on Sustainable intelligence.

3.3 Socio-cultural responsibility

Tourism without environmental concerns becomes merely an industrial activity is a lifelong criticism of this business [106]. The discussion around sustainable tourism is fragmented, inconsistent, and frequently rife with fallacious claims and reasoning [107]. The components of sociocultural responsibility are three. The decision-making process affects the local economy, the equitable distribution of advantages and obligations among the participating groups, and, ultimately, the sustainability of the culture [66, 67, 108]. New developments in this field are considering the socio-cultural aspects that value local culture, architecture, history, livelihoods, and values attached to the destination [109, 110]. Stakeholders contemplate the value of working towards shared benefits and losses [69]. Tourists may feel profoundly connected with a destination when it practices socio-cultural responsibility since it reflects the conduct they receive at the hands of employees and locals [67]. Management decision-making on the environment's preservation and upkeep is influenced by the comprehension of sociocultural relevance [111]. However, sociocultural responsibility is reflected in the satisfaction of employees and locals which is obviously a result of management decisions but empirically has not been proven for tourists [112], thus we feel a gap between knowledge and industry practices. To cover this gap, we postulate:

H3a: Socio-Cultural Responsibility will have a significant impact on Pro-Environmental Behavior.

H3b: Socio-Cultural Responsibility has a significant impact on Sustainable Intelligence.

3.4 Sustainable intelligence and pro-environmental behavior

Pro-environmental behavior reduces the detrimental effects on the environment [113]. Human actions are responsible for the degradation of the environment however some socially intelligent beings try not to harm the environment [114]. Some internal and external factors are responsible for the development of this behavior [115]. Internal factors are knowledge, values, attitude, and motivation whereas, external factors consist of the culture, economic and social atmosphere [116]. Sustainable intelligence is one of the internal factors that entails prior awareness of green encounters [64]. For tourists, destinations function as external social, cultural, and economic forces [69, 108]. Here we emphasize that the actions taken by socially and emotionally intelligent entities work as a drive to sustainable intelligence [114], however, sustainable intelligence can lead to pro-environmental behavior. Cognitive resources support the behavior, on the contrary, sometimes a pro-environmental attitude does not lead to a permanent behavior [117]. We support the idea that when hotels spread awareness through virtual guides, advertisements, and smart boards, it is highly likely for the tourist to use these cognitive resources as a guide to transforming temporary knowledge into permanent behavior. We hypothesize the following based on these ideas:

H4: Sustainable Intelligence has a significant impact on Pro-Environmental Behavior.

4 Methodology

The aforementioned literature indicates that a hotel's implementation of sustainable practices has specific results on the hotel's economy, ecology, and sociocultural aspects. We empirically investigated this phenomenon. Climate Technology Center & Network (CTCN) has provided support to many small businesses in Pakistan [39] and as a result, the country has been able to devise environmentally innovative technologies to preserve the resources. Previously, tourism studies selected tourists as participants to collect the data [112, 118–120]. Moreover, tourists are considered to be more suitable units to collect data for studies that involve tourism-related areas [119]. Furthermore, data gathered directly from tourists provides researchers with insights into the impact that sustainable practices have on tourists' perceptions, satisfaction, and future intentions [121], therefore data has been gathered from male and female tourists who directly experienced it. According to Hair et al. [120], multiply the number of items used to collect the data by 10. Sixteen items were used to collect the data. Thus, the study sample size is $16 \times 10 = 160$ male tourists who experienced it. Mellahi and Harris [122] reported a response rate of 52.68% for business and management research conducted in the Pakistan/India region. Therefore, considering Mellahi and Harris's [122] findings that 50% of respondents returned the questionnaires in previous research, the number of questionnaires is doubled to 320. As we targeted only the tourists who have experienced the

sustainable practices of hotel locations. After addressing the response rate issues, a usable sample size of 222 respondents was gathered for the analysis.

4.1 Survey desing

Carefully chosen pre-defined metrics from prior research were used to carry out an online survey. The responses were collected only from tourists who have experienced sustainable innovative technologies at a hotel with a prior investigative technique. Google Forms were used to gather the data which is a commonly used software to gather information from specific audiences. Google Forms are considered to be user-friendly, accessible, and reliable tools for gathering data [123].

4.2 Measurements

All of the measures utilized in this investigation were taken from reputable studies that were published in respectable journals. Four items of economic responsibility have been adopted [109, 124]. Four items for environmental responsibility have been taken from [37, 109, 124]. Four items of sociocultural responsibility have been implemented [37, 109, 118, 124]. Four items of sustainable intelligence have been taken from [69, 125]. Four items of pro-environmental behavior have been adopted [37, 109]. PLS-SEM has been used to perform the analysis.

5 Results

5.1 Measurement model assessment

Two staged methods have been applied for measuring and testing, with the first step being the removal of construct items that do not converge with the model depending upon confirmatory factor analysis (CFA) [126]. CFA is a statistical technique that is most appropriate for measuring constructs with fewer contacts for the analysis to characterize the measurement of a construct, PLS route modeling, which combines principal component analysis and ordinary least square regression, forms the foundation for these constrictive assumptions as compared to other analytical software [127–129]. Previous research demonstrates that, in comparison to covariance-based structural equation modeling, or CB-SEM, partial least squares SEM (PLS-SEM) is more commonly utilized [130]. In CFA, we only look for factor loadings relevant to discriminant and convergent validity. Figure 2 is a graphical representation of the model and constructs.

Table 1 reflects the factors of construct reliability and validity which are Cronbach's Alpha, composite reliability (Rho-A), composite reliability (Rho-C), and finally average variance extracted (AVE) with a satisfactory range of 0.7. Table 1 reflects that Rho_A and Rho_c are all higher than 0.7 which means that construct items have converged well with the measurement model [128].

Composite reliability indicates satisfactory reliability of the constructs which is suggested within the range of 0.7 and 0.9 [129]. Variance of the items shows the level of convergence is usually estimated by the Average Variance Extract (AVE). AVE in the range of 0.60 explains the 60% variance of an item within a construct. The acceptable range for AVE is 0.50. However, in this case, the AVE was indicated to be exceptionally good [130].

Discriminant validity has been analyzed by the criterion defined by Fornell and Larcker [131]. The ascending values given in Table 2 are simply the square root of AVE. According to Fornell and Larcker, the squared inter-construct correlates between a given and every other reflectively assessed construct in the model have to be evaluated to determine the AVE of each construct [132]. It means that the lower values (correlation constructs) of the top values (Square root of AVE) should be less to satisfy this criterion (Table 3).

The concept of the Heterotrait-Monotrait Ratio (HTMT) was proposed by Hensler [133], it reflects the mean value of the item correlation of each item. The adequate value HTMT as it is reflected in Table 3 should be less than 0.90 for theoretically alike constructs and 0.85 for hypothetically distant constructs [133]. The diagonal values in bold in Tables 2 and 3 represent the comparison of correlation with the other constructs, these values are the square root of AVE.

The values that have been given in the table in descending order are the square root of AVE which are greater than the lower numbers given below under every descending value. Correlation among the construct has been presented in the Table 4.

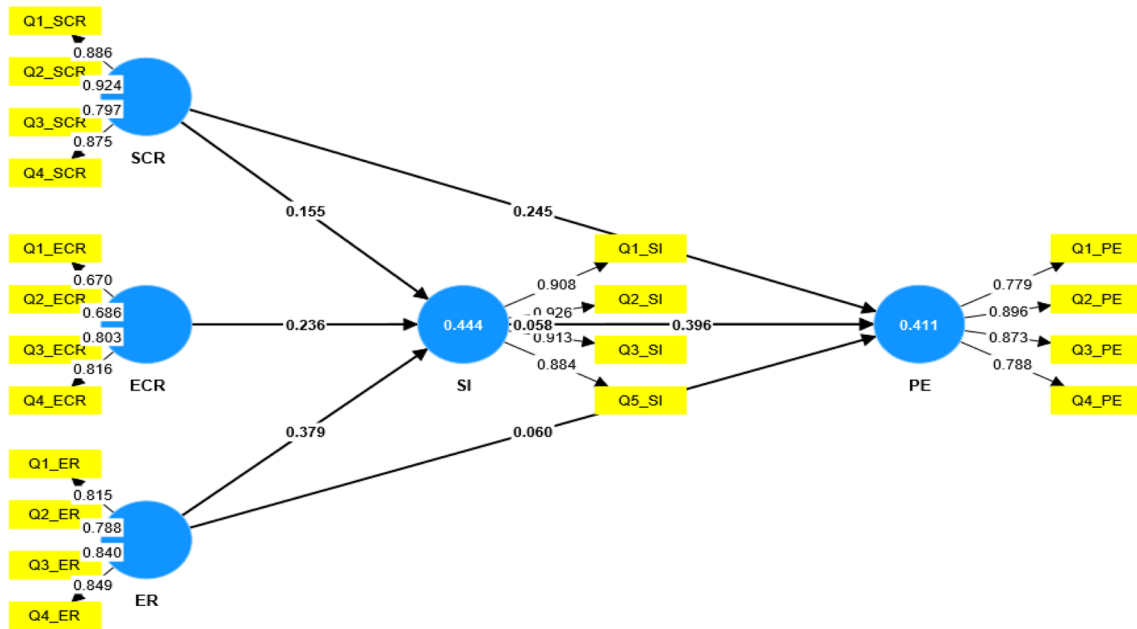


Fig. 2 Confirmatory Factor Analysis- CFA-PLS SEM

Table 1 Construct reliability and validities

Constructs	Cronbach's alpha	Composite reliability (Rho_A)	Composite reliability (Rho_C)	Average variance extracted (AVE)
ECR	0.814	0.84	0.876	0.639
ER	0.787	0.808	0.86	0.606
PE	0.86	0.939	0.851	0.594
SCR	0.839	0.855	0.892	0.674
SI	0.798	0.805	0.868	0.622

Table 2 Fornell and Larcker criteria for discriminant validity

	ECR	ER	PE	SCR	SI
ECR	0.8				
ER	0.39	0.779			
PE	0.198	0.156	0.771		
SCR	0.47	0.536	0.183	0.821	
SI	0.548	0.555	0.159	0.65	0.789

Table 3 Heterotrait-Monotrait Ratio

	ECR	ER	PE	SCR	SI
ECR					
ER	0.471				
PE	0.156	0.143			
SCR	0.557	0.649	0.134		
SI	0.649	0.678	0.139	0.781	

Table 4 Correlations among construct

	ECR	ER	PE	SCR	SI	VIF
ECR	1					1.376
ER	0.39	1				1.376
PE	0.198	0.156	1			1.460
SCR	0.47	0.536	0.183	1		1.787
SI	0.548	0.555	0.159	0.65	1	1.689

The results signify that the model is well-suited for discriminant validity. Finally, the Variance of Inflation Factor (VIF) represents the multicollinearity, which means that values are lower than 3. It is a good fit and there is no multicollinearity.

5.2 Structural model assessment

5.2.1 Mediation analysis

The mediation model is used to represent the direct and indirect effects of the constructs. The details of the mediation are reflected in Fig. 3. Direct effect is indicated by a single arrow between two constructs whereas the indirect effect is measured through one superseding construct between 2 constructs. The indirect effect also indicates the mediation examination of the relationship strength when another variable intervenes. The mediation analysis is performed as well and the direct relationship is evaluated. If the mediated relationship is stronger than the direct relationship it boils down to full mediation whereas, the stronger direct relationship indicates partial mediation. In the same way, if the indirect relationship between the constructs is weak and the direct relationship is stronger it means it is only a direct relationship.

Table 5 represents the specific indirect effect, mean values, T values, and P values. According to the table, the specific indirect effects of Independent Variables (IV) on Mediator and Mediator to Dependent Variables (DVs) have been significant. It reflects a significant relationship of Mediators between IVs and DVs, it is a confirmation of the establishment of mediation.

Total Indirect effect according to Table 6 is the complete calculation of the Mediator’s significance between IVs and DVs. Essentially, the total indirect effect is the total of all the individual indirect effects. In simple words, it is the

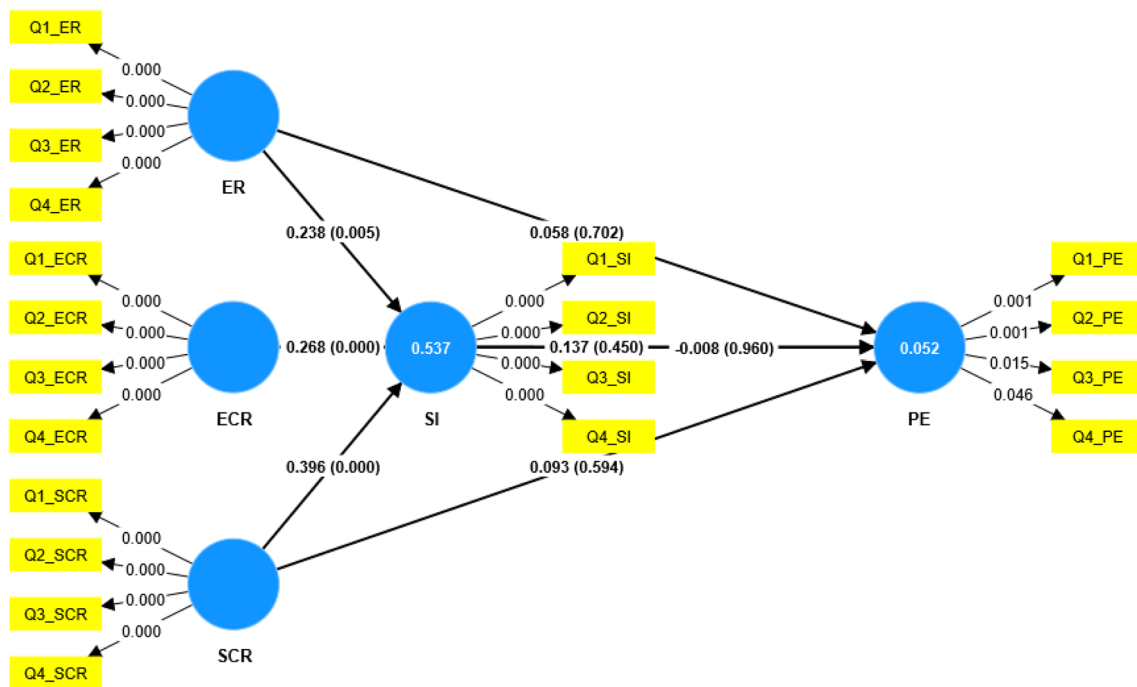


Fig. 3 Structural model with mediation effects

Table 5 Specific indirect effects-Means, STDEV, T values, and P values

Mediation	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
SCR→SI→PE	- 0.003	0.002	0.068	0.049	0.961
ECR→SI→PE	- 0.002	0	0.046	0.049	0.961
ER→SI→PE	- 0.002	0.004	0.044	0.046	0.964

Table 6 Total Indirect Effect, Mean, STDEV, T values, and P Values

Constructs	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
ECR→PE	0.094	0.094	0.036	2.566	0.01
ER→PE	0.15	0.149	0.038	3.945	0
SCR→PE	0.061	0.062	0.029	2.136	0.033

Table 7 Total Effects, Mean, STDEV, T values, and P Values

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values
ECR→PE	0.135	0.11	0.164	0.823	0.411
ECR→SI	0.268	0.271	0.073	3.654	0
ER→PE	0.056	0.042	0.141	0.399	0.69
ER→SI	0.238	0.249	0.086	2.78	0.005
SCR→PE	0.089	0.107	0.148	0.603	0.546
SCR→SI	0.396	0.399	0.075	5.291	0
SI→PE	- 0.008	0.003	0.167	0.05	0.96

sum of all indirect effects. Another way to explain it is the total direct effect between IVs and DVs minus the direct effect between IVs and DVs. The indicator of the total indirect effect is the p-value, which is ($p < 0.05$) which indicates that in this case, the Mediator is significant in the relationship between IVs and DVs. The results provide sufficient evidence that there is a significant linear relationship between IVs and DVs because the correlation coefficient is significantly different from zero.

When specific and total indirect effects are measured, the results can be incomplete without mentioning the total effect of the mediation. As per Table 7, the total effect is significant and its indicator is the p-value which is ($p < 0.05$) which means correlation coefficient is significant, and t-statistics which is (> 1.96) whereas, only one path is insignificant which is ECR→PE and again the indicators are p-value and t-statistics which are less than 0.5 and 1.96 respectively.

Table 8 is the summary of the hypothesis acceptance and rejection. As for all the hypotheses, a specific summary has been provided.

H1a: The mediation analysis results reveal that ECR non-significant direct effect on PE ($B = 0.135$, $t = 0.823$, $p = 0.411$). Hence, H1 was not supported as the path ECR- > PE is non-significant.

H1b: The findings show that ECR has a significant impact on SI. ($B = - 0.268$, $t = 3.654$, $p < 0.01$). Hence hypothesis H1b was supported as the path ECR- > SI shows a significant relationship.

H2a: The mediation results show that ER direct effect on PE is non-significant ($B = 0.056$, $t = 0.399$, $p = 0.699$). Hence, H1 was not supported as the path ER- > PE is non-significant.

H2b: The findings show that ER has a significant effect on SI ($B = - 0.238$, $t = 2.78$, $p < 0.01$). Hence hypothesis H2b was supported as the path ER- > SI has a significant relationship.

H3a: The results indicate that SCR direct effect on PE is non-significant ($B = 0.089$, $t = 0.603$, $p = 0.546$). Hence, H1 was not supported as the path SCR- > PE is non-significant.

H3b: The mediation analysis shows that SCR has a significant effect on SI ($B = - 0.369$, $t = 5.291$, $p < 0.01$). Hence hypothesis H3b was supported as the path SCR- > SI has a significant relationship.

H4: The mediation results show that the mediator SI has a non-significant effect on the dependent variable PE ($B = - 0.008$, $t = 0.5$, $p = 0.96$). Hence, H1 was not supported as the path SI- > PE is non-significant.

Table 8 Summary of Hypotheses Acceptance/Rejection

Type of effect	Effect	Path coefficient	T-stat	Remarks
Total effect	ECR→PE	0.135	0.816	Non-significant total effect
	ECR→SI	0.268	3.608**	Significant total effect
	ER→PE	0.056	0.393	Non-significant total effect
	ER→SI	0.238	2.770**	Significant total effect
	SCR→PE	0.089	0.611	Non-significant total effect
	SCR→SI	0.396	5.368**	Significant total effect
	SI→PI	-0.008	0.051	Non-significant total effect
Indirect effect	SCR→SI→PE	-0.003	0.049	Non-sig indirect effect
	ECR→SI→PE	-0.002	0.049	Non-significant indirect effect
	ER→SI→PE	-0.002	0.045	Non-significant indirect effect
Direct effect (path coefficient)	ECR→-PE	0.137	0.748	Non-Significant Direct Effect
	ECR→SI	0.268	3.608**	Significant direct effect
	ER→PE	0.058	0.378	Non-Significant Direct Effect
	ER→SI	0.238	2.77**	Signiant direct effect
	SCR→PE	0.093	0.543	
	SCR→SI	0.396	5.368**	Significant direct effect
	SI→PI	-0.008	0.051	
VAF (variance accounted for)	EI/TE(SCR→SI→PE)/SCR→PE	-3%		
	ECR→SI→PE/ECR→PE	-1.48%		
	ER→SI→PE/ER→PE	-4%		

* $p < .05$, ** $p < .01$

6 Discussion and conclusion

This study has applied Innovation Diffusion Theory to develop a framework of research to analyze the impact of Destination Social Responsibility on tourists when innovative environmental technologies are adopted by hotels. However, the characteristics of new technologies such as perceived usability, compatibility with the processes, complexity, and tribality determine the adoption of any new idea or technology. "Hit and Trial" could be appropriate for large hotel chains [9], but is too challenging for average businesses. Sustainable intelligence and Pro-environmental behaviors have been a part of previous studies but the technological aspect has been overlooked in all those studies [134, 135]. The edge that this study had was the impact of smart technologies on destination social responsibility and pro-environmental behavior.

Destination Social Responsibility when it is established by the host of a destination, requires the participation of all the stakeholders. As a result of this institutionalization, a collective formation of economic, environmental, and sociocultural responsibility is devised. Destination Social Responsibility is the result of this economic, environmental, and sociocultural responsibility reflected by the actions of the stakeholders which include the community residents, employees, and business owners who share some set rules to perform responsibilities and share the benefits and fatalities [1, 4, 16, 58]. Destination Social Responsibility not only provides social and economic well-being but also preserves the natural environment of the destination proven by the observation in the following study. As a result, it has a superior influence on the tourists.

Hosts at the destination can have a great responsibility for the environmental, social, and economic concerns through environmental technological adoption. Despite all the caution, the adoption of these practices still needs to be approved and adopted by the visitors since prices and processes may vary from a regular hotel [57, 136], whether they are willing to participate in this process by acting in a pro-environmental way. In Pakistan, sustainability is becoming eminent among hotel businesses because of the support provided by UNWTO institutions to be mindful of operating in zero energy consumption, effective waste management systems, hydro projects on small scales, solar energy conservation and finally saving rainwater [20].

This study has used Sustainable intelligence as a mediator to understand the relationship between Destination Social Responsibility institutions and adoption of the tourists by this relationship. Sustainable Intelligence refers to an individual's capability to engage in environmentally responsible behaviors based on experience and previous knowledge of sustainability [37, 125]. We employed sustainable intelligence as a mediator between economic responsibility, environmental responsibility, and sociocultural responsibility for pro-environmental behavior. The mediation effect in results for total effect shows that the sustainable intelligence of tourists acts as a strong mediator for environmental responsibility and socio-cultural responsibility whereas, a weak predictor for economic responsibility. This means that sustainable intelligence mediates the process of tourists' development of pro-environmental behavior for socio-cultural and environmental aspects.

The tendency of visitors to be sustainably intelligent outperforms in two facets, one is environmental and the other is socio-cultural. The framework as implied by innovation diffusion theory, explores the environmental technologies that are adopted by tourists in the development of pro-environmental behavior [79]. advised by the researcher. The results revealed that a hotel's implementation of innovation and technologies has a reciprocal effect on the tourists which makes them act in a certain way. Moreover, sustainable intelligence is a strong mediator to acting visitors in this way.

Furthermore, the tourists must experience or have knowledge of green practices prior to such a visit can help the pro-environmental to be accepted. Sustainable Intelligence can be accommodating when it comes to all the stakeholders and institutions of Destination Social Responsibility. Therefore, previous work has overlooked all three responsibilities (Economic, Environmental, and socio-cultural) concerning technological innovation by hotels. This study has filled that gap by examining this relationship with the mediation of sustainable intelligence. The results reveal that pro-environmental behavior is greatly impacted by Destination Social responsibility clusters through the path of sustainable intelligence. For the industry and academia, it is essential to consider sustainable intelligence for the implementation of technologies and innovation.

7 Theoretical implications

This study has contributed to the current knowledge of innovative technologies used by hotels by applying the Innovation Diffusion theory to predict the pro-environmental behavior of hotel visitors who possess a respectable knowledge of sustainability. Destination Social Responsibility clusters (Economic, Environmental & Sociocultural) support innovation diffusion by making tourists aware of the effects that are made on the overall environment by the stakeholders. According to the theory of innovation diffusion, the process of adoption of Innovation has to go through certain steps to be completely absorbed by the tourists. As mentioned earlier visitors who are technology enthusiasts are the first to visit such hotels these tourists are the ones who already possess sustainable intelligence. Society as a whole gets inspired when Destination Social Responsibility becomes a norm, as more and more establishments take a chance to abandon conventional hotel layouts, known as visionaries.

The next step in the process is the majority of the population who are usually tourists or service users. They see the usability of the idea as economically, environmentally, and socio-culturally these communities start to flourish due to the realist approach of the Destination Responsibility cluster [137]. Moreover, through this study, we predict that sustainable intelligence is transformed through this diffusion process would lead innovation to become a future necessity to bring prosperity to the destination. Despite the skepticism of the people who think technology adoption does not make any difference would be forced to admit its usability. Destination Social Responsibility clusters have never been investigated concerning Innovation diffusion is a unique aspect and a major contribution of this study. The results of the study statistically reveal the difference between the direct impact of Economic, environmental, and Sociocultural on Pro-environmental and its indirect effect through sustainable intelligence and are also consistent with the study done by Chan [22] and Lee [37]. It signifies the relevance of the strong effects of Destination Social Responsibility clusters through sustainable Intelligence on pro-environmental behavior.

This investigation also contributes to the green marketing knowledge of the research as consumers in any type of purchasing are making careful choices. It has also been studied under the umbrella of the Theory of Planned Behavior (TPB) when consumers purchase consciously with environmental concern [138]. Although this concept has not been brought to attention as of yet from the hotel industry perspective, this study is going to be the first one that contributes to the knowledge of green marketing strategies of hotels. Along with the process of being a responsible host the hotel owners are using green advertising, and eco-labels on the hotel amenities, saving energy innovatively to educate the tourists on the environmentally friendly choices they make. These green

marketing strategies edify the consumers about sustainability knowledge. This concept is known as sustainable intelligence. In such scenarios, when a tourist makes the intention to book such hotels/destinations that are mindful of sustainability the interplay of sustainable intelligence is already there.

There is extensive literature available on when Western consumers practice pro-environmental behavior however this has not been a part of the literature for the Eastern world. Apart from sustainability being economically and environmentally beneficial, it also contributes to the marketing strategies used in Eastern countries. Consumers not being aware of the green and sustainable knowledge often make choices not eco-friendly whereas hotels in our study are at least trying to educate the masses on environmental preservation through green marketing strategies. This creates a win-win situation as whatever environmental degradation activities happen in the East have an indirect effect on the Western environment due to the global impact of the environment. This study is a little effort to add to the present literature and can have a global impact. In this regard, the education videos, green branding, eco-labels, and sustainability advertisement strategies are all a continuity effort to add to the sustainability knowledge of future hoteliers.

8 Practical implications

The findings of the study provide the hotel industry with certain practical implications. Firstly, in terms of market segmentation, hotels can attract certain kinds of tourists with high sustainable intelligence through marketing techniques of sustainability campaigns. For the campaigns to promote their sustainable and innovative practices they need to make promotional efforts specifically highlighting their steps to promote the processes. This can especially be portrayed by making monthly reports public for the advertisement of the zero energy, effective waste management power generation projects. This can be particularly useful for a strong brand image as visitors are more likely to have a positive image of the hotels that demonstrate a deep concern for the environment. Customers will develop a deep sense of commitment and loyalty in addition to the practice the environmental concern with the destination.

For all the above-mentioned recommendations, there needs a proper marketing strategy design from the hotels since it is going to be different from a regular product purchased as mentioned for the TPB. It is sort of a luxury investment for the consumers and usually, consumers treat themselves lavishly without realizing the environmental strain it will create. Green marketing in the hotel industry can create awareness. These strategies may include making informative videos, and advertisements comparing the consequences of compromising environmental concerns, highlighting the eco-friendly practices of the hotel, and making prominent the eco-labels on amenities. The same education can be provided to the community of the destination through marketing training programs to create maximum awareness so that they can become a part of the marketing plan. It contributes to the marketing efforts positively as the community becomes an advocate of the business.

Secondly, practicing Destination Social Responsibility along with its economic, environmental, and socio-cultural clusters would create an atmosphere of social concern, mindful use of resources, and a sense of community. The role of innovation diffusion is not limited to the users rather it has serious implications for all the stakeholders. Local residents, suppliers, employees, and even competitors are equally involved in this process which creates a win-win situation for everyone with healthy competition. Innovative technological applications can save cost on energy, water usage, and operational costs. Operational costs can bring overall prosperity to the community when they share the benefits without environmental degradation. The socio-cultural responsibility will be reflected in the language, values, livelihood, and architectural conservations.

Thirdly, hotels can comply with environmental regulations by implementing innovative technologies. It can improve the social standing of the tourism industry since UNWTO has already indicated that accommodations account for nearly 21% of CO₂ tourism carbon emissions which is 2% of the 5% of global CO₂ emissions. Destination Social Responsibility can ensure to attraction of sustainably intelligent tourists which can ensure the long-term viability of this industry. Last but not least, this study has empirically tested that innovative sustainable practices at destination can attract tourists who believe that preservation of the environment is an important factor. All the stakeholders (economic, environmental, and socio-cultural) play an imperative part in strengthening the relationship between Destination Social Responsibility and Pro-environmental behavior.

9 Limitations and future research suggestions

The limitation of this study also opens new avenues of research as this study is limited to only Pakistani hotels that have implemented innovative environmental technologies, whereas the scope of the study can be enhanced in other locations as well. Future researchers can conduct this research in different socio-cultural environments to generalize the results of current research. Although this study has used a quantitative method, however, future studies can apply in-depth interviews can produce more profound results.

Author contributions Author A: Idea Generation/Literature Review/Manuscript Writing/Data Collection Author B: Problem Identification/Overall Supervision/Theoretical Framework Author C: Data Analysis/Software Creation Author D: Interpretation/Proofreading All authors reviewed the manuscript and took responsibility for full involvement in all stages of the research.

Data availability We hereby confirm that all participants/subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of UCP Business School at the University of Central Punjab, Lahore, Pakistan (Project No. UCP/FOMS/25/2024). Data available in a repository with restricted access: <https://www.openicpsr.org/openicpsr/project/199249/version/V1/view>.

Declarations

Competing interests The authors declare no competing interests.

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References

1. Li T, Liu F, Soutar GN. Connecting tourism experience and environmental learning. *Curr Issue Tour*. 2021;24(13):1792–7.
2. Canosa A, Graham A, Wilson E. Growing up in a tourist destination: developing an environmental sensitivity. *Environ Educ Res*. 2020;26(7):1027–42.
3. Han W, McCabe S, Wang Y, Chong AYL. Evaluating user-generated content in social media: an effective approach to encourage greater pro-environmental behavior in tourism? *J Sustain Tour*. 2018;26(4):600–14.
4. Cheng TM, Wu HC, Wang JTM, Wu MR. Community Participation as a mediating factor on residents' attitudes towards sustainable tourism development and their personal environmentally responsible behaviour. *Curr Issue Tour*. 2019;22(14):1764–82.
5. Muler Gonzalez V, Coromina L, Gali N. Overtourism: residents' perceptions of tourism impact as an indicator of resident social carrying capacity-case study of a Spanish heritage town. *Tourism review*. 2018;73(3):277–96.
6. Steg L, Bolderdijk JW, Keizer K, Perlaviciute G. An integrated framework for encouraging pro-environmental behaviour: the role of values, situational factors and goals. *J Environ Psychol*. 2014;38:104–15.
7. Becken S, Whittlesea E, Loehr J, Scott D. Tourism and climate change: evaluating the extent of policy integration. *J Sustain Tour*. 2020;28(10):1603–24.
8. Bohdanowicz P, Zientara P, Novotna E. International hotel chains and environmental protection: an analysis of Hilton's we care! programme (Europe, 2006–2008). *J Sustain Tour*. 2011;19(7):797–816.
9. Salehi M, Filimonau V, Ghaderi Z, Hamzehzadeh J. Energy conservation in large-sized hotels: insights from a developing country. *Int J Hosp Manag*. 2021;99: 103061.
10. Wang Y, Font X, Liu J. Antecedents, mediation effects and outcomes of hotel eco-innovation practice. *Int J Hosp Manag*. 2020;85: 102345.
11. Preziosi M, Acampora A, Lucchetti MC, Merli R. Delighting hotel guests with sustainability: revamping importance-performance analysis in the light of the three-factor theory of customer satisfaction. *Sustainability*. 2022;14(6):3575.
12. Cadarso MÁ, Gomez N, López LA, Tobarra MÁ. Calculating tourism's carbon footprint: measuring the impact of investments. *J Clean Prod*. 2016;111:529–37.
13. Cai W, Li G. The drivers of eco-innovation and its impact on performance: Evidence from China. *J Clean Prod*. 2018;176:110–8.
14. Demirel P, Kesidou E. Sustainability-oriented capabilities for eco-innovation: Meeting the regulatory, technology, and market demands. *Bus Strateg Environ*. 2019;28(5):847–57.
15. Chakraborty A. Can tourism contribute to environmentally sustainable development? Arguments from an ecological limits perspective. *Environ Dev Sustain*. 2021;23(6):8130–46.
16. Choi HC, Sirakaya E. Sustainability indicators for managing community tourism. *Tour Manage*. 2006;27(6):1274–89.
17. Buhalis D, Leung R. Smart hospitality—interconnectivity and interoperability towards an ecosystem. *Int J Hosp Manag*. 2018;71:41–50.

18. Honkanen P, Verplanken B. Understanding attitudes towards genetically modified food: The role of values and attitude strength. *J Consum Policy*. 2004;27(4):401–20.
19. Pourfakhimi S, Duncan T, Coetzee W. A critique of the progress of eTourism technology acceptance research: time for a hike? *J Hosp Tour Technol*. 2019;10(4):689–746.
20. G-20 Priority Issues Survey-Retrieved August 7, 2023: www.tourism.sdg.org/priority G-20 India report: <https://tourism4sdgs.org/g20india/>.
21. Nearly Zero Energy hotels- Retrieved August 8, 2023: www.tourism.sdg.org/initiatives-nearly-zero-energy-hotels: <https://tourism4sdgs.org/initiatives/nearly-zero-energy-hotels-nezeh/>.
22. Chan ES, Okumus F, Chan W. Barriers to environmental technology adoption in hotels. *J Hospital Tourism Res*. 2018;42(5):829–52.
23. Pereira V, Silva GM, Dias Á. Sustainability practices in hospitality: case study of a luxury hotel in Arrábida Natural Park. *Sustainability*. 2021;13(6):3164.
24. Zhang Y, Khan SAR, Kumar A, Golpīra H, Sharif A. Is tourism really affected by logistical operations and environmental degradation? An empirical study from the perspective of Thailand. *J Clean Prod*. 2019;227:158–66.
25. Leitão NC, Balsalobre-Lorente D. The effects of tourism, economic growth and renewable energy on carbon dioxide emissions. *Strategies in sustainable tourism, economic growth and clean energy*, 2021; 67–87.
26. Amir M, Siddique M, Ali K, Bukhari AAA, Kausar N. Asymmetric relationship of environmental degradation and economic growth with tourism demand in Pakistan: evidence from non-linear ARDL and causality estimation. *Environ Sci Pollut Res*. 2022;29(4):5891–901.
27. Aman S, Hassan NM, Khattak MN, Moustafa MA, Fakhri M, Ahmad Z. Impact of tourist's environmental awareness on pro-environmental behavior with the mediating effect of tourist's environmental concern and moderating effect of tourist's environmental attachment. *Sustainable*. 2021;13(23):12998.
28. Bharwani S, Mathews D. Sustainable luxury: from an oxymoron to a tautology—the case of the Indian luxury hospitality industry. *Worldwide Hospital Tourism Themes*. 2023;15(3):231–48.
29. Pizam A, Ozturk AB, Balderas-Cejudo A, Buhalis D, Fuchs G, Hara T, Chaulagain S. Factors affecting hotel managers' intentions to adopt robotic technologies: a global study. *Int J Hospital Manag*. 2022;102:103139.
30. Wang J. Building competitive advantage for hospitality companies: the roles of green innovation strategic orientation and green intellectual capital. *Int J Hosp Manag*. 2022;102: 103161.
31. Zhu D, T. Effects of robot restaurants' food quality, service quality and high-tech atmosphere perception on customers' behavioral intentions. *J Hospital Tourism Technol*. 2022. <https://doi.org/10.1108/JHTT-01-2021-0022>.
32. Luu TT. Fostering green service innovation perceptions through green entrepreneurial orientation: the roles of employee green creativity and customer involvement. *Int J Contemp Hosp Manag*. 2022;34(7):2640–63.
33. Choi Y, Choi M, Oh M, Kim S. Service robots in hotels: understanding the service quality perceptions of human-robot interaction. *J Hosp Market Manag*. 2020;29(6):613–35.
34. Maté-Sánchez-Val M, Teruel-Gutierrez R. Evaluating the effects of hotel location on the adoption of green management strategies and hotel performance. *J Sustain Tour*. 2022;30(8):2029–52.
35. Kim H-R, Yoon S-Y. How to help crowded destinations: tourist anger vs. sympathy and role of destination social responsibility. *Sustainability*. 2020;12(6):2358.
36. Demir M, Rjoub H, Yesiltas M. Environmental awareness and guests' intention to visit green hotels: the mediation role of consumption values. *PLoS ONE*. 2021;16(5): e0248815.
37. Lee CK, Olya H, Ahmad MS, Kim KH, Oh MJ. Sustainable intelligence, destination social responsibility, and pro-environmental behaviour of visitors: evidence from an eco-tourism site. *J Hosp Tour Manag*. 2021;47:365–76.
38. Siddiqui S, Bano N, Hamid S. An evaluation of tourists' intention towards the sustainable conservation of cultural heritage destinations: the role of place identity, destination image & sustainable intelligence. *J Tourism Sustain Well-being*. 2023;11(2):81–99.
39. Climate Technology Center & Network (CTCN) Retrieved on: September 4 2023 from <https://www.ctc-n.org/>.
40. United Nations Climate Change (UNCC) Retrieved on: September 7, 2023 <https://unfccc.int/documents>.
41. Haldorai K, Kim WG, Garcia RF. Top management green commitment and green intellectual capital as enablers of hotel environmental performance: The mediating role of green human resource management. *Tour Manage*. 2022;88: 104431.
42. Raza SA, Khan KA. Impact of green human resource practices on hotel environmental performance: the moderating effect of environmental knowledge and individual green values. *Int J Contemp Hosp Manag*. 2022;34(6):2154–75.
43. Unsola VO, Saydam MB, Arasli H, Sulu D. Guest service experience in eco-centric hotels: a content analysis. *International Hospitality Review*, (ahead-of-print). 2022.
44. Yeşiltaş M, Gürlek M, Kenar G. Organizational green culture and green employee behavior: Differences between green and non-green hotels. *J Clean Prod*. 2022;343: 131051.
45. Dani R, Tiwari K, Negi P. Ecological approach towards sustainability in hotel industry. *Materials Today*. 2021;46:10439–42.
46. Wang M, Li Y, Li J, Wang Z. Green process innovation, green product innovation and its economic performance improvement paths: a survey and structural model. *J Environ Manage*. 2021;297: 113282.
47. Blöcher K, Alt R. AI and robotics in the European restaurant sector: assessing potentials for process innovation in a high-contact service industry. *Electron Mark*. 2021;31:529–51.
48. Bhat DAR, Sharma V. Enabling service innovation and firm performance: the role of co-creation and technological innovation in the hospitality industry. *Technol Anal Strat Manag*. 2022;34(7):774–86.
49. Serafim GH, Cristovao Verissimo JM. The relationship between strategic orientation, service innovation, and performance in hotels in Angola. *Sustainability*. 2021;13(11):6256.
50. Ahmed W, Ahmed W, Najmi A. Developing and analyzing framework for understanding the effects of GSCM on green and economic performance: perspective of a developing country. *Manag Environ Quality*. 2018;29(4):740–58.
51. IMARAT Institute of Policy Studies: Resource taken on 27–02–2024: <https://iips.com.pk/strategies-for-zero-waste-hotel-in-pakistan/>.
52. Climate Trade Reference taken on 01/03/2024: <https://climatetrade.com/5-effective-strategies-for-sustainable-hotels-to-attract-eco-conscious-travelers-and-promote-responsible-tourism/>.

53. Su L, Yang X, Swanson SR. The influence of motive attributions for destination social responsibility on residents' empowerment and quality of life. *Journal of Travel Research*, 2022; 00472875221138790.
54. Su L, Lian Q, Huang Y. How do tourists' attribution of destination social responsibility motives impact trust and intention to visit? The moderating role of destination reputation. *Tour Manage.* 2020;77: 103970.
55. Font X, Garay L, Jones S. Sustainability motivations and practices in small tourism enterprises in European protected areas. *J Clean Prod.* 2016;137:1439–48.
56. Buhalis D, Harwood T, Bogicevic V, Viglia G, Beldona S, Hofacker C. Technological disruptions in services: lessons from tourism and hospitality. *J Serv Manag.* 2019;30(4):484–506.
57. Su L, Swanson SR, He X. A scale to measure residents perceptions of destination social responsibility. *J Sustain Tour.* 2020;28(6):873–97.
58. Gursoy D, Boğan E, Dedeoğlu BB, Çalıřkan C. Residents' perceptions of hotels' corporate social responsibility initiatives and its impact on residents' sentiments to community and support for additional tourism development. *J Hosp Tour Manag.* 2019;39:117–28.
59. Mathew PV, Sreejesh S. Impact of responsible tourism on destination sustainability and quality of life of community in tourism destinations. *J Hosp Tour Manag.* 2017;31:83–9.
60. Horng JS, Hsu H, Tsai CY. An assessment model of corporate social responsibility practice in the tourism industry. *J Sustain Tour.* 2018;26(7):1085–104.
61. Kiatkawsin K, Sutherland I, Lee SK. Determinants of smart tourist environmentally responsible behavior using an extended norm-activation model. *Sustainability.* 2020;12(12):4934.
62. Sadiq M, Adil M. Ecotourism related search for information over the internet: A technology acceptance model perspective. *J Ecotour.* 2021;20(1):70–88.
63. Phaosathianphan N, Leelasantitham A. An intelligent travel technology assessment model for destination impacts of tourist adoption. *Tourism Manage Perspect.* 2021;40: 100882.
64. Samuel G, Lucivero F, Somavilla L. The environmental sustainability of digital technologies: stakeholder practices and perspectives. *Sustainability.* 2022;14(7):3791.
65. Kasim A. Towards a wider adoption of environmental responsibility in the hotel sector. *Int J Hosp Tour Adm.* 2007;8(2):25–49.
66. Rannikko P. Combining social and ecological sustainability in the Nordic forest periphery. *Sociol Rural.* 1999;39(3):394–410.
67. Puhakka R, Sarkki S, Cottrell SP, Siikamäki P. Local discourses and international initiatives: sociocultural sustainability of tourism in Oulanka National Park. *Fin J Sustai Tourism.* 2009;17(5):529–49.
68. Scheyvens R. Local involvement in managing tourism. In: *Tourism in destination communities.* Wallingford UK: CABI Publishing; 2003. p. 229–52.
69. Li Y, Hunter C. Community involvement for sustainable heritage tourism: a conceptual model. *J Cult Herit Manage Sustain Dev.* 2015;5(3):248–62.
70. Lee CK, Olya H, Park YN, Kwon YJ, Kim MJ. Sustainable intelligence and cultural worldview as triggers to preserve heritage tourism resources. *Tour Geogr.* 2023;25(2–3):899–918.
71. Swarbrooke J, Horner S. *Consumer behaviour in tourism.* London: Routledge; 2007.
72. Budeanu A. Sustainable tourist behaviour—a discussion of opportunities for change. *Int J Consum Stud.* 2007;31(5):499–508.
73. Bergin-Seers S, Mair J. Emerging green tourists in Australia: their behaviours and attitudes. *Tour Hosp Res.* 2009;9(2):109–19.
74. Juvan E, Dolnicar S. Green tourists: Insights from prompted and unprompted recall research. In: *CAUTHE 2014: tourism and hospitality in the contemporary world: trends, changes and complexity: trends, changes and complexity.* Brisbane: School of Tourism, The University of Queensland; 2014. p. 924–7.
75. Mehmetoglu M. Typologising nature-based tourists by activity—theoretical and practical implications. *Tour Manage.* 2007;28(3):651–60.
76. McKercher B, Prideaux B, Cheung C, Law R. Achieving voluntary reductions in the carbon footprint of tourism and climate change. *J Sustain Tour.* 2010;18(3):297–317.
77. Weaver DB. Organic, incremental and induced paths to sustainable mass tourism convergence. *Tour Manage.* 2012;33(5):1030–7.
78. Perez Guilarte Y, Barreiro Quintans D. Using big data to measure tourist sustainability: myth or reality? *Sustainability.* 2019;11(20):5641.
79. Mihalic T. Sustainable-responsible tourism discourse—towards 'responsustainable' tourism. *J Clean Prod.* 2016;111:461–70.
80. Sen S, Du S, Bhattacharya CB. Corporate social responsibility: a consumer psychology perspective. *Curr Opin Psychol.* 2016;10:70–5.
81. Gao J, Zhao J, Wang J, Wang J. The influence mechanism of environmental anxiety on pro-environmental behaviour: the role of self-discrepancy. *Int J Consum Stud.* 2021;45(1):54–64.
82. Loureiro SMC, Guerreiro J, Han H. Past, present, and future of pro-environmental behavior in tourism and hospitality: a text-mining approach. *J Sustain Tour.* 2022;30(1):258–78.
83. Han H. Travelers' pro-environmental behavior in a green lodging context: converging value-belief-norm theory and the theory of planned behavior. *Tour Manage.* 2015;47:164–77.
84. Schwartz SH, Howard JA. Internalized values as motivators of altruism. In: *Development and maintenance of prosocial behavior: international perspectives on positive morality.* Boston, MA: Springer, US; 1984. p. 229–55.
85. Batson CD, O'Quin K, Fultz J, Vanderplas M, Isen AM. Influence of self-reported distress and empathy on egoistic versus altruistic motivation to help. *J Pers Soc Psychol.* 1983;45(3):706.
86. Wang S, Wang J, Li J, Yang F. Do motivations contribute to local residents' engagement in pro-environmental behaviors? Resident-destination relationship and pro-environmental climate perspective. *J Sustain Tour.* 2020;28(6):834–52.
87. Wang L, Wong PPW, Narayanan Alagas E. Antecedents of green purchase behaviour: an examination of altruism and environmental knowledge. *Int J Cult Tourism Hospital Res.* 2020;14(1):63–82.
88. Kim MS, Stepchenkova S. Altruistic values and environmental knowledge as triggers of pro-environmental behavior among tourists. *Curr Issue Tour.* 2020;23(13):1575–80.
89. Rogers EM, Shoemaker FF. *Communication of innovations; a cross-cultural approach.* 1971.
90. Kim MJ, Lee CK, Preis MW. The impact of innovation and gratification on authentic experience, subjective well-being, and behavioral intention in tourism virtual reality: the moderating role of technology readiness. *Telematics Inform.* 2020;49: 101349.
91. Rogers EM. New product adoption and diffusion. *J consum Res.* 1976;2(4):290–301.

92. Baptista R. The diffusion of process innovations: a selective review. *Int J Econ Bus.* 1999;6(1):107–29.
93. Kaminski J. Diffusion of innovation theory. *Can J Nursing Inform.* 2011;6(2):1–6.
94. Byrd ET, Gustke LD. Identifying tourism stakeholder groups based on support for sustainable tourism development and participation in tourism activities. *WIT Transactions on Ecology and the Environment.* 2004; 76.
95. Dimoska T, Trimcev B. Competitiveness strategies for supporting economic development of the touristic destination. *Procedia Soc Behav Sci.* 2012;44:279–88.
96. Cegarra-Navarro JG, Reverte C, Gómez-Melero E, Wensley AK. Linking social and economic responsibilities with financial performance: the role of innovation. *Eur Manag J.* 2016;34(5):530–9.
97. Mata J (2019). Intelligence and innovation for city tourism sustainability. *The future of tourism: innovation and sustainability*, 2019; 213–232.
98. Su L, Hsu MK, Boostrom RE Jr. From recreation to responsibility: Increasing environmentally responsible behavior in tourism. *J Bus Res.* 2020;109:557–73.
99. Zhu L, Zhan L, Li S. Is sustainable development reasonable for tourism destinations? An empirical study of the relationship between environmental competitiveness and tourism growth. *Sustain Dev.* 2021;29(1):66–78.
100. Chirieleison C, Montrone A, Scrucca L. Event sustainability and sustainable transportation: a positive reciprocal influence. *J Sustain Tour.* 2020;28(2):240–62.
101. Palmberg IE, Kuru J. Outdoor activities as a basis for environmental responsibility. *J Environ Educ.* 2000;31(4):32–6.
102. Cheng TM, Wu HC. How do environmental knowledge, environmental sensitivity, and place attachment affect environmentally responsible behavior? An integrated approach for sustainable island tourism. *J Sustain Tour.* 2015;23(4):557–76.
103. Yang R, Wong CW, Miao X. Analysis of the trend in the knowledge of environmental responsibility research. *J Clean Prod.* 2021;278: 123402.
104. Li S, Liu M, Wei M. Host sincerity and tourist environmentally responsible behavior: the mediating role of tourists' emotional solidarity with hosts. *J Destin Mark Manag.* 2021;19: 100548.
105. Sun Y, Duru OA, Razaq A, Dinca MS. The asymmetric effect eco-innovation and tourism towards carbon neutrality target in Turkey. *J Environ Manage.* 2021;299: 113653.
106. McKercher B. Some fundamental truths about tourism: understanding tourism's social and environmental impacts. *J Sustain Tour.* 1993;1(1):6–16.
107. Liu Z. Sustainable tourism development: a critique. *J Sustain Tour.* 2003;11(6):459–75.
108. Heikkinen HI, Lakomäki S, Baldrige J. The dimensions of sustainability and the neo-entrepreneurial adaptation strategies in reindeer herding in Finland. *J Ecol Anthropol.* 2007;11(1):25–42.
109. Su L, Huang SS, Pearce J. How does destination social responsibility contribute to environmentally responsible behaviour? A destination resident perspective. *J Bus Res.* 2018;86:179–89.
110. Stojanović T, Trišić I, Brđanin E, Štetić S, Nechita F, Candrea AN. Natural and sociocultural values of a tourism destination in the function of sustainable tourism development—an example of a protected area. *Sustainability.* 2024;16(2):759.
111. Popov EA, Kolesnikova ON, Zamjatina ON. (2021, February). Environment as a socio-cultural phenomenon. In *IOP Conference Series: Earth and Environmental Science* (Vol. 670, No. 1, p. 012026). IOP Publishing.
112. Throsby D. Tourism, heritage and cultural sustainability: Three 'golden rules'. In: *Cultural tourism and sustainable local development.* Routledge. 2016; 31–48
113. Barbaro N, Pickett SM. Mindfully green: examining the effect of connectedness to nature on the relationship between mindfulness and engagement in pro-environmental behavior. *Personality Individ Differ.* 2016;93:137–42.
114. Lisboa PV, Gómez-Román C, Guntín L, Monteiro AP. Pro-environmental behavior, personality and emotional intelligence in adolescents: a systematic review. *Front Psychol.* 2024;15:1323098.
115. Kollmuss A, Agyeman J. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environ Educ Res.* 2002;8(3):239–60.
116. Gronhoj A, Thøgersen J. Action speaks louder than words: the effect of personal attitudes and family norms on adolescents' pro-environmental behaviour. *J Econ Psychol.* 2012;33(1):292–302.
117. Langenbach BP, Berger S, Baumgartner T, Knoch D. Cognitive resources moderate the relationship between pro-environmental attitudes and green behavior. *Environ Behav.* 2020;52(9):979–95.
118. Kang M, Moscardo G. Exploring cross-cultural differences in attitudes towards responsible tourist behaviour: a comparison of Korean, British and Australian tourists. *Asia Pac J Tourism Res.* 2006;11(4):303–20.
119. Ritchie BW, Burns PM, Palmer CA. *Tourism research methods: integrating theory with practice.* UK: Cabi; 2005.
120. Hair JF Jr, Sarstedt M, Hopkins L, Kuppelwieser VG. Partial least squares structural equation modeling (PLS-SEM): an emerging tool in business research. *Eur Bus Rev.* 2014;26(2):106–21.
121. Andereck KL, Valentine KM, Knopf RC, Vogt CA. Residents' perceptions of community tourism impacts. *Ann Tour Res.* 2005;32(4):1056–76.
122. Mellahi K, Harris LC. Response rates in business and management research: an overview of current practice and suggestions for future direction. *Br J Manag.* 2016;27(2):426–37.
123. Tojiyeva MMQ, Abdullayev AAU. The use of modern technologies in statistical data collection. *Asian J Multidimensional Res.* 2021;10(12):752–7.
124. Fatma M, Rahman Z, Khan I. Measuring consumer perception of CSR in tourism industry: scale development and validation. *J Hosp Tour Manag.* 2016;27:39–48.
125. López-Sánchez Y, Pulido-Fernández JI. In search of the pro-sustainable tourist: a segmentation based on the tourist "sustainable intelligence." *Tourism Manage Perspect.* 2016;17:59–71.
126. Anderson JC, Gerbing DW. Structural equation modeling in practice: a review and recommended two-step approach. *Psychol Bull.* 1988;103(3):411.
127. Mateos-Aparicio G. Partial least squares (PLS) methods: origins, evolution, and applications to social sciences. *Commun Stat Theory Methods.* 2011;40(13):2305–17.

128. Hair JF Jr, Howard MC, Nitzl C. Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *J Bus Res.* 2020;109:101–10.
129. Jöreskog KG. Simultaneous factor analysis in several populations. *Psychometrika.* 1971;36(4):409–26.
130. Hair JF Jr, Matthews LM, Matthews RL, Sarstedt M. PLS-SEM or CB-SEM: updated guidelines on which method to use. *Int J Multivariate Data Anal.* 2017;1(2):107–23.
131. Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. *J Mark Res.* 1981;18(1):39–50.
132. Hair JF, Ringle CM, Sarstedt M. PLS-SEM: indeed a silver bullet. *Journal of Marketing theory and Practice.* 2011;19(2):139–52.
133. Henseler J, Ringle CM, Sarstedt M. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *J Acad Mark Sci.* 2015;43:115–35.
134. Han H, Olya HG, Cho SB, Kim W. Understanding museum vacationers' eco-friendly decision-making process: strengthening the VBN framework. *J Sustain Tour.* 2018;26(6):855–72.
135. Park E, Lee S, Lee CK, Kim JS, Kim NJ. An integrated model of travelers' pro-environmental decision-making process: the role of the new environmental paradigm. *Asia Pacific J Tourism Res.* 2018;23(10):935–48.
136. Feng X, Tao Z, Zhang L, Shi R. Addressing challenges of an ageing population by rationally forecasting travel behaviours of the elderly: a case study in China. *Environ Dev Sustain.* 2022. <https://doi.org/10.1007/s10668-022-02692-x>.
137. Smerecnik KR, Andersen PA. The diffusion of environmental sustainability innovations in North American hotels and ski resorts. *J Sustain Tour.* 2011;19(2):171–96.
138. Szabo S, Webster J. Perceived greenwashing: the effects of green marketing on environmental and product perceptions. *J Bus Ethics.* 2021;171:719–39.

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