Research Article

A Two-stage hybrid SEM-ANN approach to assessing the impact of digital marketing platforms in the development of ecotourism behaviour

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ABSTRACT

Purpose: This study investigates the impact of various digital marketing platforms on the development of ecotourism behavior among tourists. Design/Methodology/Approach: A hybrid research approach, integrating Partial Least Squares Structural Equation Modeling (PLS-SEM) and Artificial Neural Network (ANN), was applied to analyze data collected from a random sample of 384 tourists. Findings: Social media was identified as the most influential digital platform shaping tourists' ecotourism behavior. It plays a significant role in fostering environmental education, promoting resource conservation, and contributing to local community development. Search engine optimization (SEO) emerged as a vital tool for raising environmental conservation awareness, while its impact on local community development was less pronounced. Mobile applications and blogging were found to be effective in fostering environmental conservation and enhancing environmental education, respectively. Practical Implications: The findings underscore the pivotal role of social media in influencing ecotourism behavior, emphasizing its potential for ecotourism marketers. Furthermore, the study highlights the importance of leveraging SEO, mobile applications, and blogging to promote environmental awareness and education among tourists. Originality/Value: This research provides valuable insights into the diverse roles of digital marketing platforms in shaping ecotourism behavior, offering practical guidance for ecotourism marketers and destinations seeking to harness the power of digital tools for sustainable tourism development.

Keywords: Environmental education; ecotourism; environmental conservation; social media; blogging; artifical neural network

1. Introduction

Over the last few decades, tourism has been heavily involved in environmental degradation, resulting in tourist locations losing their natural beauty [1]. The primary reason for destroying tourist destinations is the crowded and quick consumption of natural resources [2]. The outcomes of extensive tourism include climate change, greenhouse gas emissions, water, other resource scarcity, and excessive energy use [3]. On the other hand, academics regularly advocate for alternate ways to protect natural tourist locations that safeguard the natural environment and boost tourism growth [4]. According to [5], a highly cohesive alternative approach

emerges in the form of ecotourism, widely regarded as a potent remedy that intertwines economic advancement, ecological preservation, and communal prosperity. An exceptionally impactful avenue to foster ecotourism lies in enlightening visitors about the surrounding natural environment [6]. In addition, ecotourism primarily promotes recycling, energy efficiency, and water conservation to strengthen the local community's cultural integrity [7]. As a result, visitors' environmental interaction may play an essential role in developing environmental education behaviour [8,9]. In addition, according to [10] environmental association refers to the techniques used to enhance public knowledge about environmental conservation and influence people's behaviour to secure long-term sustainability. However, conveying the message of ecotourism behaviour through digital platforms is relatively new, and few academics have previously utilized the idea to disseminate it in the context of ecotourism behaviour [11,12]. According to [13,14], the benefits of employing digital media such as social media, search engine optimisation, blogging, and mobile applications are essential for promoting ecotourism behaviour. In addition, digital marketing technologies, such as online services and social media, have a significant impact on the evolution of tourist destination selection, including social networks, which have completely changed the relationship between the image of a location driven by digital platforms and the image managed and offered to tourists [15,16]. For example, search for a holiday resort, the destination of the stay, and guidance and feedback from digital tools are all critical factors in user behaviour (SEO, mobile applications, blogs and social media) [17,18].

Furthermore, digital marketing tools also significantly influence tourists' intentions toward adopting ecotourism in tourist destinations [19]. To maintain natural tourism attractions for future generations, digital platforms can communicate the message of environmental conservation, community development, and visitor education [20]. Scholars have strongly advocated for blogging, social media, mobile applications, and search engine optimisation tactics as information dissemination channels [21,22]. According to [23], social media, mobile applications, SEO, and blogging are all significant in environmental conservation, education, and community development. While there is literature on the benefits of digital marketing tools in promoting ecotourism behaviour, the question about the specific relationship between these tools and the dimensions of environmental education, community development, and environmental conservation in the context of Pakistan's tourism industry is still unanswered. Few studies have looked at how digital channels like social media, blogging, search engine optimisation, and mobile apps may help spread the message of ecotourism behaviour in this environment. As a result, there is a study vacuum that requires more inquiry to understand how these digital marketing methods impact ecotourism behaviour characteristics in Pakistan's tourist business. The current study aims to investigate the relationship between digital marketing strategies (social media, blogging, search engine optimization, and mobile applications) and ecotourism behavior dimensions (environmental education, community development, and environmental conservation) in the tourism industry of Pakistan. The digital marketing strategies like social media, blogging, search engine optimisation and mobile applications' relationship with ecotourism behaviour dimensions environmental education, community development and environmental conservation investigated.

2. Theoretical foundations and conceptual framework

The current literature provides a theoretical explanation for the causal link between digital platforms and ecotourism behaviour, highlighting the important influence of digital platforms on influencing tourist behaviour in the context of sustainable tourism. Several recent research have found evidence to support this association. According to, [24,25] discovered that social media platforms influence visitors' behaviour and decision-making processes, including their participation in sustainable practices. The study highlighted the importance of social media platforms in spreading information, raising environmental awareness, and

changing tourists' views towards ecotourism. Furthermore [26] found that digital marketing tactics, such as social media and mobile applications, help to increase tourists' knowledge and awareness of ecotourism sites, resulting in beneficial behavioural changes. The relevance of digital platforms in teaching visitors about environmental concerns and supporting sustainable behaviours was emphasised in the study. In addition [27] underlined the relevance of destination websites in giving information on ecotourism attractions, encouraging tourists' environmental attitudes, and influencing their behaviour towards sustainable practises. The study highlighted the importance of digital platforms in altering travellers' beliefs and behaviours about ecotourism. We defined Ecotourism behaviour as "responsible travel to natural sites that safeguard the environment while simultaneously maintaining the well-being of local people" as a multidimensional construct [28]. Accounting for all aspects that must be addressed for ecotourism to be effective is difficult. **Figure 1** depicts the evolution of the ecotourism concept from 1990 to the 2000s, and it is viewed as a means of alleviating poverty and increasing satisfaction with the United Nations Millennium Development Goals [29].
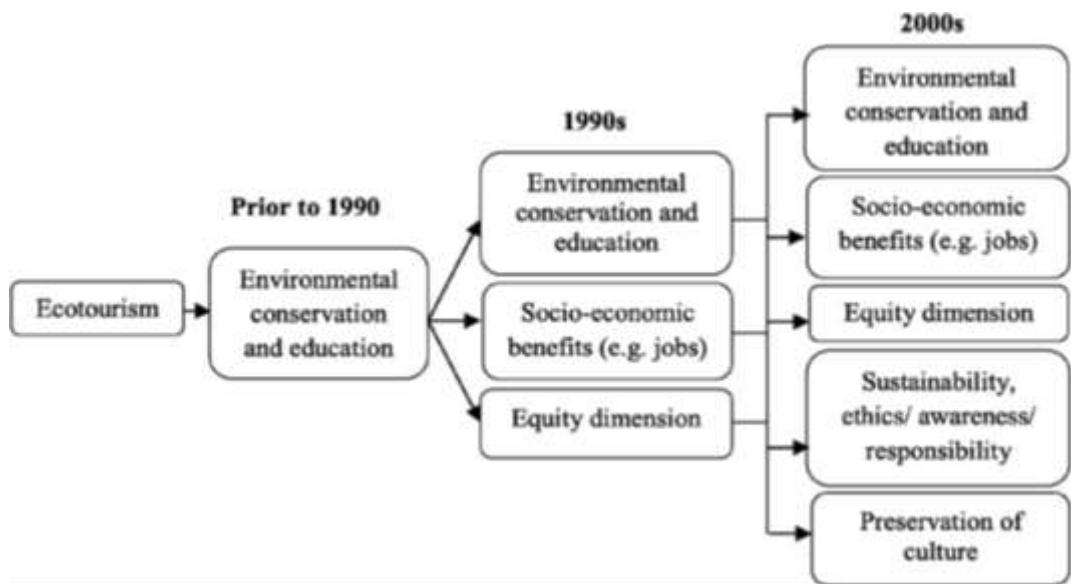

Figure 1. Evolution of the meaning of ecotourism: Figure showing the chronological development of ecotourism concept

Ecotourism is usually associated with cultural and natural resources as a single product [30,31]. Festivals, events, museums, handicrafts, arts and crafts, and local cookery are cultural resources in ecotourism. Ecotourism tourism entails responsible travel to vulnerable and typically protected places to minimise environmental impact [32]. Its goal is to teach tourists about conservation, the supply of funding for local community economic growth, and respect for cultures and human rights [33]. Ecotourism is based on protecting natural resources for future generations, and researchers are keen to use cutting-edge techniques and technology to aid in resource conservation [34]. The wise use of the planet's resources is considered natural resource conservation (Banzhaf, 2019). According to [35] it is in charge of major natural resource management, including forestry, fisheries, soil, grassland, minerals, woodlands, wildlife, parks, desert, and watershed regions. According to the Theory of Reasoned Action (TRA), a person's attitude toward behaviour and beliefs of what constitutes appropriate behaviour influence their motivation to engage in that behaviour [36].in addition, the strongest indicator of future behaviour is the intention or essential nature (the belief that the behaviour will lead to the intended outcome). The Theory of Reasoned Action gave way to the Theory of Planned Behavior, which included freedom and choice [37]. In addition, [38] people believe they can engage in the behaviour whenever they choose and that they have volitional control over it, according to the Theory of Planned Behavior.

Behavioural control is influenced by the combined consequences of two sub-concepts, parallel to attitude and subjective norm. The control beliefs are the predicted chance that a variety of particular conditions will help or impede the implementation of the behaviour. According to (Imran et al., 2021), the significance of digital marketing in behaviour modification and the application of planned behaviour theory towards digital marketing is crucial. In addition, [40] believe that web marketing is critical in influencing tourists' behaviour toward the sites visited during trips.in addition, [41] also agreed that digital marketing has the ability to influence ecotourism behaviour. The use of behavioural theories in tourism is hotly contested in the literature. [42], investigated reference dependency, behavioural biases, decreasing sensitivity to visitor pricing in the context of Spanish tourism, and the acceptability of behavioural theories in the tourism and hospitality industries is recorded. Since 2016, there has been a substantial surge in the use of behavioural theories in tourism and hospitality studies. Researchers [43,44] have acknowledge the role of behavior theories in understanding reference-based tourist behaviour. Thus, the theoretical foundation of our research is based on the theory of planned behaviour in digital marketing and ecotourism beahviour. Also, the TPB incorporates environmental attitude, subjective norms, perceived behaviour control, and behavioural intention to anticipate and explain visitors' ecotourism behaviour. The research includes several digital marketing methods, such as attitude, subjective standards, and perceived behavioural control. The literature does not address tourism pracpractices destination perception. TPB is employed in this study to determine whether environmental beliefs, subjective norms, and perceived behavioural control influence ecotourism behaviour in natural regions.

2.1. Hypothesis development

The internet has benefited ecotourism firms in spreading information about destinations and making trip planning easier [45]. The internet is a valuable e-commerce channel for ecotourism; it is crucial for publicising ecotourism options and organising activities [46]. Internet technology has greatly aided in online marketing of ecotourism locations [43,47]. In prior research, we have very few studies on digital marketing and ecotourism relationship. Mostf ecotourism research has focused only on standard marketing strategies [48]. However, in previous ecotourism research and online marketing, the notion of ecotourism behaviour development among visitors visiting environmental protection sites was communicated. The majority of online internet marketing study overlooks more successful online marketing approaches.

It is critical to focus on nature-based tourism for environmental sustainability to maintain and conserve natural resources and tourist destinations [49,50]. The advanced nations adopted ecotourism to protect the natural environment of tourist destinations [51]. However, countries such as Pakistan are still in the process of implementing ecotourism to preserve tourist attractions. The tourism sector is steadily expanding, and ecotourism is critical to preserving natural areas [52]. Blogging may be an excellent strategy to promote tourism in a certain location. You can help to spread the word about all the amazing things to see and do in the region by writing about local attractions, events, and companies. This can entice more visitors, which can help the local economy.

Promoting ecotourism behaviour through digital marketing strategies is an important development of recent times. Blogs have recently emerged as the fastest-growing source of environmental information [53]. The proliferation of the blog, along with the advent of other social media, has resulted in a drastic increase of the sources and platforms for environmental communication, which is here referred to as the ways people communicate about the environment [54]. Tourists no longer get their news from traditional media outlets such as newspapers and radio. Instead, in principle, any organisation or individual may connect with and interact with members of the public who are significantly different from their close-knit social networks [55]. In addition, new environmental voices can be heard on blogs, Twitter, and Facebook emergence of

ecotourism in the travel sector has been well documented: travel and tourism are among the most popular topics on all sorts of blogs. In addition, blogs significantly impact environmental conservation in most regions of the globe; thus, it is crucial to utilize them to promote environmental conservation (Newsome, 2020). Thus, we hypothesized that

H1: Blogging is positively related to environmental conservation.

The protected area movement used "fortress conservation" [56] or "fence and fines" [57] to conserve natural areas until the late 1970s. On the other hand, this strategy was not long-term viable because it generally neglected rural people's demands for natural resources [56]. Until the late 1970s, the protected area movement adopted "fortress conservation"[56] or "fence and fines" forms of conservation [57] to save natural regions. However, this strategy was not long-term viable, largely due to the system's disregard for rural people's demands for natural resources. As a result, the emphasis on natural resource protection has switched from law enforcement to multi-stakeholder and local community participation in resource management [58]. However, several studies continue to criticise local community conservation involvement, particularly community-based ecotourism efforts, due to the community's complex and diverse features and the different concerns each sector has regarding conservation and development issues [59]. Blogs about travel are platforms that have characteristics in common with more traditional word-of-mouth marketing [60]. Blogs are online diaries that can be shown in various media, including images, text, and vlogs . In contrast to conventional diaries, they frequently offer open access and permit two-way dialogue between blog sharers and browsers [61]. Thousands upon thousands of people have begun to blog about their travels. These blogs provide information on many elements of travelling, such as how to get a visa, book travel arrangements such as housing, transportation, and tickets, navigate local customs, what to do while travelling, and more [62]. Blogs have significantly influenced how travelers find information and make decisions. Blogs can contain more information than other online WOM due to the personal diary-like writing blogs; tourists frequently offer their travel insights and suggestions. In travel blogs, various details of a visitor's experience at a particular location are typically included [63]. According to [64] "Web logs, or "blogs," are fast developing in diverse social and business contexts as influential sources of discourse, knowledge, and community development."(p 40). Blogs have the propensity to promote community development among tourists by cultivating a sense of responsibility through vlogs, text, and open discussions that can highlight the difficulties experienced by the local community [65]. Blogs are spreading the message of community development and protecting the natural environment in these places. However, there is limited evidence that confirms blogging is related to community development. Thus, we proposed hypothesis.

H2: Blogging is positively related to community development.

Blogging has become a great way to share information and education online. Many blogs focus on teaching people about different topics. These blogs can be a great resource for people who want to learn about new things. Many blogs discuss sustainability, green living, and other eco-friendly topics[66]. Blogs are not only important way of learning about tourism destinations in the digital age, but it is also playing equally important role in ecotourism education [67]. Because of the exponential growth in the popularity of blogging, travelers are increasingly considering online opinions while making holiday [53]. Blogs are crucial for tourism education on natural area conservation and boosting visitor behaviour toward safeguarding tourist sites, community development, and local community education. Furthermore, on the other hand, tourist education through digital means considerably reduces environmental concerns [68]. Due to the widespread use of the internet and digital gadgets, digital mediums have become increasingly popular with visitors. Tourism academics have been heavily persuaded to promote the benefits of ecotourism education, praising the ever-

expanding use of technology in primarily positive ways. There is an underlying expectation of visitors and the tourism sector [69]. So, it theoretically, it can be established that blogs are related to environmental education, though, little quantitative results to support the argument, thus we hypothesised that.

H3: Blogging is positively related to environmental education.

Sear Engine optimisation is essential tool for enhance the digital visibility of the tourist site through keyword search marketing [70,71]. SEO can help increase the visibility of tourism-related content and help potential tourists find information about destinations, attractions, and activities [72]. There are a number of ways to optimise website for better search engine ranking related to ecotourism. One way is to use keywords related to ecotourism, such as "ecotourism," "sustainable tourism," "green tourism," etc. Another way is to create content specifically about ecotourism and its many benefits. Finally, backlinking to other websites that are related to ecotourism can also help to improve search engine ranking. Through these strategies environmental conservation message can be propagated and can help in developing pro-environmental behavior among prospective tourists. Search engine marketing has become a flourishing sector in the cyberspace world for destinations to better realize their overseas business and what sort of ecotourism destination they should promote [73]. In order to guide potential tourists to information that encourages pro-environmental behaviour, SEO can play a critical role in spreading the message of environmental conservation [74]. Thus, we hypothesised that

H4: SEO is positively related to environmental conservation.

Search engines have become a vital part for travelers to obtain and filter information, as well as a critical for hospitality and tourism businesses to reach out to potential clients [75]. To give tourists, the most pertinent results depending on their search terms, search engine algorithms are constantly changing. They need to be changed to take user behaviour and technology improvements into account [76]. Search engine optimisation helps travel destination marketers connect data about local communities to travel destination data to help travelers learn about the local community they are visiting and contribute to its development. Though, SEO is a practical tactic for influencing public opinion on environmental protection and community development in tourist areas, there is little information and evidence to support the claim in the literature. So, we developed the hypothesis to provide empirical support for it.

H5: SEO is positively related to community development.

Environmental education is a process that helps people to learn about environmental concerns, acquire critical thinking abilities, and become engaged citizens capable of making educated and responsible decisions [77]. Promoting environmental education is fundamental to ecotourism behaviour. Search engine optimisation can help travel information providers use the right keywords and search text to spread environmental education as widely as possible [78]. SEO is important for education websites because it helps them rank higher in search engine results, which can lead to more website visitors and potential students [79]. SEO can also help education websites to improve their click-through rates and get more people to visit their website. Search engines use various technologies and ranking formulas that are always changing. Small, gradual changes are performed to improve search engine functionality every minute [80]. Google updates its data every minute and its algorithm more than 500 times a year, claim [81], to provide users with up-to-date information and a satisfying search experience. More than 200 variables are used in Google's ranking algorithm, and through these parameters search engine optimization can help in promoting environmental education among tourism [82]. SEO is vital for the education of the tourists and community living around the natural areas, however, the relationship between search engine optimization and environmental education is not confirmed through considerable quantitative studies. Thus, we hypothesised that:

H6: search engine optimisation is positively related to environmental education.

The overlap of digital information on users' immediate environments gives up new prospects in a range of businesses, including enhancing the travel experience [83]. Mobile applications not only provide information on bookings of tourist sites, hotels, and rooms, but they may also play an important part in environmental conservation behaviour. Travelers in the tourism business may now access a variety of services via smartphone apps [84]. Food service, transportation, lodging, travel agency, tours, festivals and events, theme parks, recreational opportunities, and other reservation service activities are examples of tourism-related goods and services that can be purchased [85]. Destination management organisations are developing mobile applications that respond to visitor behaviour in order to set themselves apart from competing destinations and match tourist expectations [86]. According to [87] destination management organisations should purposefully develop value-added mobile services to raise traveler pleasure, improve the travel experience, and encourage destination loyalty. Suppose information about protecting the environment while travelling has been widely disseminated on mobile apps that are well-known among tourists [88]. In that case, this enables mobile apps to be a more prominent part of the tourists' prospective behaviour during their visit and have the ability to shape the environmental conservation behaviour of the tourist significantly. Thus, we hypothesized that

H7: Mobile apps marketing is positively related to environmental conservation.

The lack of local communication has been criticized on the government's political structures and traditions and the strategic role in reserve administration [89]. As a result, the relationship between community-based ecotourism and conservation is hazy and questionable. Nonetheless, some of the objections are mitigated by the economic rewards made by converting biodiversity hotspot places into ecotourism destinations, which aid in conservation and local community development. More recently, the effective use of mobile application marketing to enhance community engagement and development in tourism has been witnesses. Mobile application marketing has recently grown in popularity due to the accessibility of mobile apps and users' desire to spend time using them. Spreading ecotourism information using mobile application marketing is useful way. The sharing idea is becoming more prevalent in the tourism sector thanks to the expansion of businesses like Airbnb, Loft, and Booking.com. The local community benefited from mobile app marketing features that, for instance, established sustainable private transportation for car-sharing to address the issues of traffic congestion, pollution, and housing. The revenues generated by ecotourism operations through community-based tourism using mobile app marketing is a good illustration of community development and shared economic benefits [90]. The ubiquitous usage of cellphones, which has long helped manage visitor experiences, may be traced back to the present popularity and development of mobile applications [91]. In ecotourism, mobile applications are becoming increasingly essential, as they provide visitors with constant access to vital information, particularly throughout their journey.

H8: mobile application marketing is positively related to community development.

The popularity of smartphone apps among travellers is growing, and they may be used for a variety of purposes to save money and time. Mobile app marketing is crucial for marketers to connect with their target audience. Presenting visitors about environmental education while using these apps can be utilised to promote ecotourism behaviour. Environmental education messages may seep into tourists' subconscious minds and affect how they behave. Mobile apps are more complicated to work in global contexts because of time limits, low light, limited internet, and other limitations. User acceptance of mobile applications is heavily influenced by the app's fit for the specific usage scenario 2018 [53]. This can make it harder for them

to spread the word at particular times. Therefore, ongoing mobile app marketing might help advance environmental education. Education related to the behaviour adopted in the tourist's destination can be educated using mobile apps. However, it's hard to conclude the relationship of mobile apps marketing in environmental education. Hence, we formed the hypothesis H9 test the significance of the relationship. to test the significance of the relationship quantitatively.

H9: Mobile applications are positively related to environmental education.

Sustainability is becoming a bigger issue on many levels. According to several assessments, only a very small percentage of visitors actually comprehend the ideas of sustainability and environmentally conscious behaviour[92]. Encourage the creation of initiatives for increased information transmission as one potential strategy for overcoming these barriers to more excellent knowledge. One strategy being investigated at visitors' consumption patterns toward sustainability is marketing for sustainability [93]. Marketing is the processing and distribution of relevant information to visitors (such as the sustainability agenda and stakeholder initiatives. Another research looks at ecotourism via social media methods and approaches. As a new channel of communication, social media has revolutionised many areas of the tourist sector, allowing businesses, and policymakers better to understand the market [94]. According to [95], social media has a tremendous impact on the decision-making processes of modern visitors. In contrast, [54] claim that social media plays a critical role in changing the marketing settings of Destination Marketing and Management Organizations (DMOs) and tour operators by growing their social media accounts to contact, convince, and influence contemporary tourists [96]. Using social media to aid travellers is not a new notion. Since the early twenty-first century, researchers have been seeking to harness the availability of social media data to suggest things to do for visitors. Figure 2 illustrates the conceptual model for the current study derived from the literature.

This work contains restaurant and store recommendations, travel routes, attractions and places of interest, and destination suggestions [96]. They all use social media and user-generated material, such as user locations, so sticking with this theme seems reasonable. Traditional marketing must blend with digital and social media marketing in a new fusion marketing [97]. A combination of marketing tactics and techniques might allow hotels and companies to dynamic exposure in new areas with more potential and growth to current consumers (How Geotagged social media can Inform Mods). Digital marketing strategies have significantly influenced how individuals look for and exchange information and travel decisions in the tourist sector. Because tourism-related products and services are costly and time-consuming, travellers typically gather and analyze a large amount of data before making decisions [95,98]. Environmental conservation using social media is likely to be powerful tool in recent times.

H10: social media is positively related to environmental conservation.

Since it has been determined that tourism marketing is unethical, societal marketing theories and the creation of compelling cases for sustainability must be at the center of these efforts. Research indicates that tourists are increasingly concerned with the environment and the social repercussions of their purchasing decisions [99]. The shopping decisions made by tourists have evolved from being just utilitarian to reflecting their ideas [100]. Travelers are developing progressively more aware of the notion of sustainable consumerism, which takes into account the ethical, environmental, and social implications of purchases (Khanh, 2020; Tabachnick, 2007; Khanh, 2020; Tabachnick, 2007). Social media platforms such as Facebook, Instagram, YouTube, LinkedIn, and Twitter, sometimes known as web 2.0, are among the "mega trends" that have considerably impacted the tourism industry [101,103,104]. It has deeply altered how travellers locate, assess, and cooperate to develop information on tourism service providers and vacation destinations [105–107]. Tourists can

utilise several social media networks in addition to blogs, virtual communities, microblogs, reviews, emails, publications, newsgroups, and discussion boards/forums [61]. Even though social media has emerged as a crucial tool for the travel industry, there are still many questions about the best ways for tourism businesses to market themselves or interact with their customers in this highly dynamic, private, and public conversational context that spreads not only information about ecotourism but also discusses the development of local communities. Thus, we hypothesised that

H11: social media is positively related to community development.
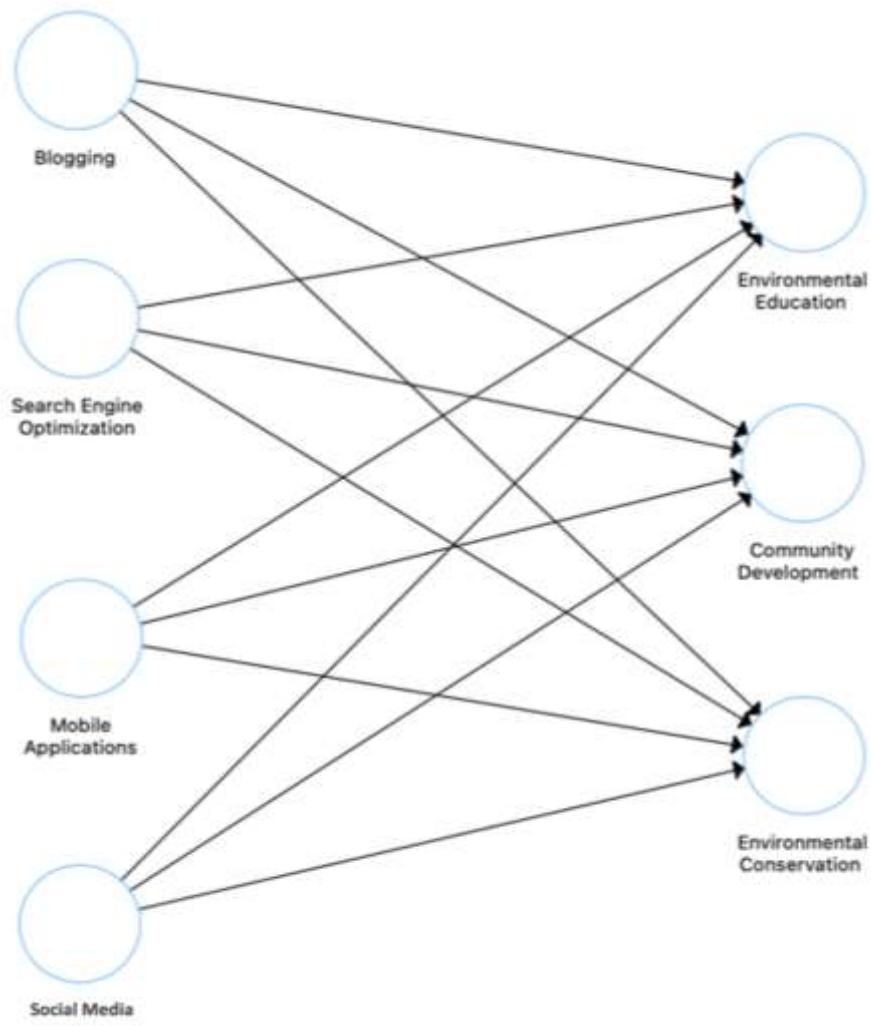
Figure 2. Conceptual model (self-developed)

According to [108], social media are Internet-based channels that allow individuals to connect and select how to portray themselves to both broad and narrow audiences that value user-generated content and the sensation of interaction with others, either in real-time or sequentially. Modern marketing techniques have evolved as a result of how easily information can now be obtained and spread using social media [109]. Popular social media platforms like Facebook, Instagram, YouTube, LinkedIn, and Twitter are used by the majority of people, giving tourism management organisations a chance to inform potential tourists about the environment and encourage ecological behaviour [110]. These various social media platforms can be utilized to raise awareness of environmental issues among tourists and people in touristy locations [111]. Environmental Education is encouraging more sustainable ecotourism practices. It is a force that promotes

conservation; it ensures that those who must bear the social and environmental costs of tourism development profit; (ii) fosters environmental consciousness among visitors and locals; and (iii) benefits communities and the economy. Thus, to develop ecotourism behavior its important to spend more on social media marketing campaigns that fosters environmental education. Hence, we proposed the hypothesis:

H12: social media is positively related to environmental education.

3. Research methodology

3.1. Measurement

There is a sizable amount of literature on ecotourism behaviour that emphasises the components of environmental education, community development, and environmental conservation. These qualities have been acknowledged as essential elements of ecotourism behaviour by numerous research. For example, fully comprehend the precise processes by which environmental education, community growth, and environmental protection affect visitors' real behaviour in ecotourism situations. A major aspect of ecotourism behaviour that has also been recognised is community development, which involves creating positive interactions between visitors and local communities as well as helping their economic development and cultural heritage preservation. Last but not least, ecotourism behaviour emphasises environmental conservation, placing a focus on the prudent use of natural resources and the preservation of biodiversity.

We employed a well-known, trustworthy, and independently validated self-administered questionnaire to gather data. We used scales from previous studies to achieve this purpose. To collect data, the study instrument used a 5-point Likert scale. Furthermore, the ecotourism idea used in this study contained three components: conservation, community development, and education. In a prior study, scales were used to analyse ecotourism behaviour; measuring indicators were chosen since the researchers had previously used them to assess ecotourism behaviour [112,113]. The International Ecotourism Society (TIES) defined ecotourism in 1990 as "responsible travel to natural areas that conserves the environment and improves the well-being of local people[114]. The International Ecotourism Society (TIES) defined ecotourism in 1990 as "responsible travel to natural areas that conserves the environment and improves the well-being of local people" (.Since its conception, TPB has been used by tourism researchers with varying degrees of effectiveness to predict ecotourism behaviour in a range of situations. For this study, the definition of ecotourism will be "responsible travel to natural areas that conserves the environment and improves the well-being of local people and educate them about the sustainable environment." Social media are Internet-based channels that enable individuals to connect and choose self-present with both wide and restricted audiences that gain value from user-generated material and the sense of contact with others, either in real-time or asynchronously. Items for Social media scales are adopted from [115,116]. According to Mobile applications, referred to as software systems operating on mobile devices, are evolving rapidly, making ubiquitous information access at anytime and anywhere a true reality. Mobile application scales are adopted from [117]. A blog as an online log or weblog, a word used by Barger in 1997. In its most basic form, it is a website containing dated entries that are presented in reverse chronological order and published on the Internet. Blogs are described as an alternative to a personal web page; however, this comparison simplifies both the content and the communication technique through blogging. Scale for Blogging was adopted from [118] and [109]. According to the Search Engine Marketers Professional Organization, the main American-based organization that represents practitioners in the field Search engine optimization (SEO) is defined as "the act of altering a website's content and code to increase exposure inside one or more search engines." and items for Search engine optimization scales are adapted from [11].

3.2. Sampling and data collection

Purposeive sampling was utilized initially to identify travelers who had employed digital strategies for promoting travel. Three key regions in Northern Pakistan were chosen due to their significant tourist activity in 2018, with a total of 7.7 million tourists recorded during that period. Using the guidelines of the Morgen Table, 384 tourists were randomly selected from various tourism destinations. To reach this sample size, 800 questionnaires were distributed, and more than half were effectively responded to, facilitating the collection of data from 384 individuals across three different locations. Data collection was conducted through Google forms, targeting hotel guests, local tourists exploring popular sites, and adventure enthusiasts camping in these areas. The research sourced data from the most renowned tourist spots in Pakistan, including Gilgit-Baltistan, Naran, Kaghan, Muree, and Galyat, specifically chosen due to their popularity.

Sample Characteristics

The demographic details of the participants were crucial in the ongoing research. Aspects such as the digital marketing platforms used, geographical area, gender, and age were key features. The study aimed to acquire information from visitors exploring three distinct regions of Pakistan. The proportion of visitors utilizing various digital marketing channels was delineated, including Facebook (153%), YouTube (74%), Instagram (44%), Twitter (32%), Blogging (22%), Mobile Applications (25%), and Search Engine Optimization (SEO) (34%). Specifically, the Naran & Kaghan region hosted 157 tourists (40%), the Gilgit Baltistan region received 154 tourists (40%), and the Galyat region received 76 tourists (20%). Moreover, male visitors accounted for 287 (72.8%) of the total, whereas female visitors constituted 97 (27.2%). In terms of age distribution, tourists aged 18-24 made up 243 (62.3%) of the sample, those aged 25-29 accounted for 43 (11.6%), those aged 30-35 constituted 44 (11.9%), and those aged 36 and above accounted for 54 (13.3%). The study targeted visitors who employed digital marketing techniques for traveling in the northern regions of Pakistan, as evidenced by the data above.

4. Results

4.1. Assessment and goodness of measurement model

All elements were assessed in the measurement model to check if they added significantly to the model shown in this study. The study investigates internal consistency, reliability, and discriminant validity due to the use of reflective indicators. The measuring model is displayed in **Figure 3**.
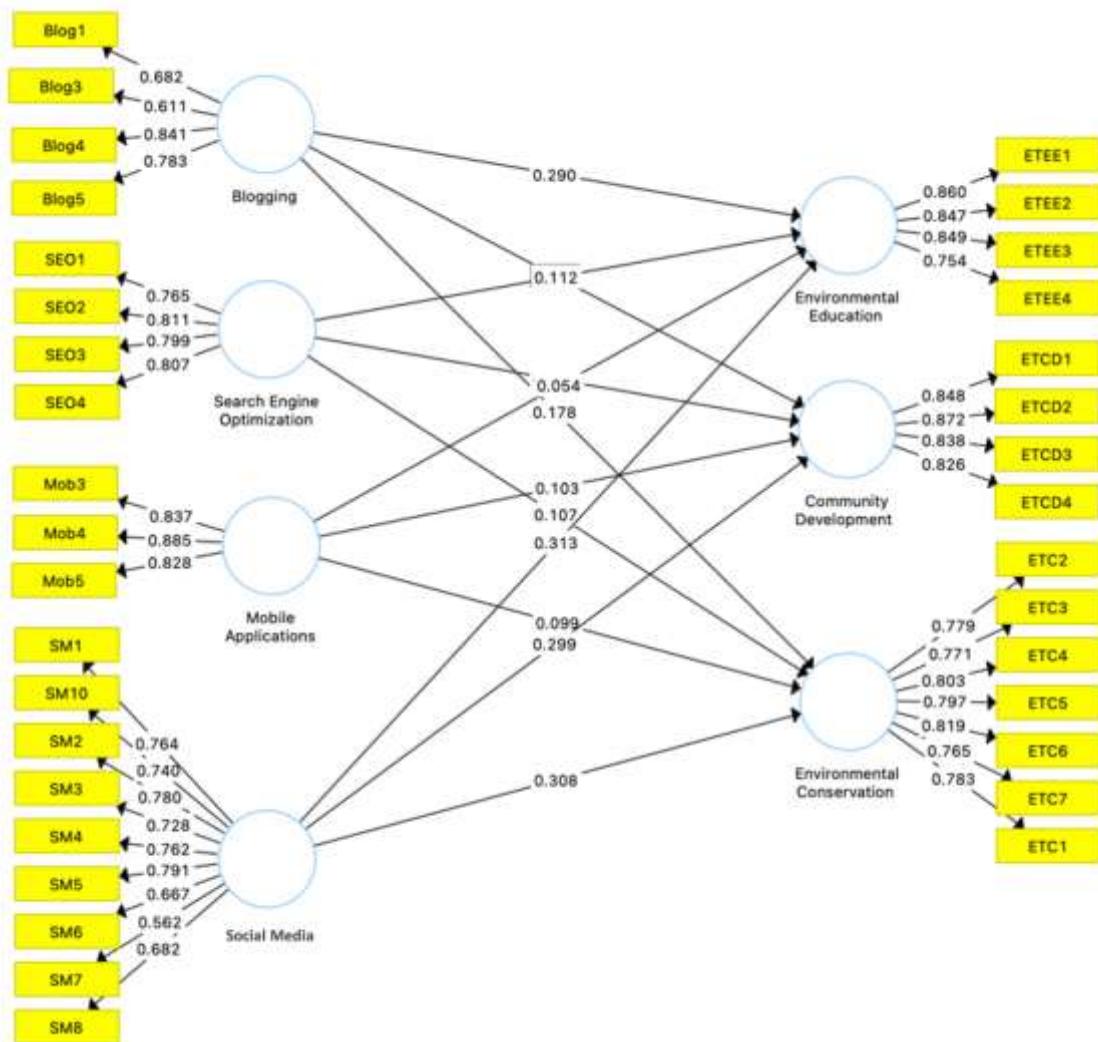
Figure 3. Measurement model: figure showing factor loadings of the latent constructs

4.1.1. Construct reliability and validity

The construct reliabilities and validity are shown in **Table 1**. Convergent validity is defined by [119] as the correlation between measurements of the similar idea and is involved with structure loadings and Average Variance Extracted (AVE). Higher outer loading on a structure shows that the linked markers or things used to assess the same idea are quite comparable (Hair et al., 2019). Because it shows how severely all of the construction elements are loaded, the outside loading (standardised) indicator should be 0.700 or higher. It is recommended that any outside loading with a value less than 0.7 be removed. The items, on the other hand, can be kept if the construct's Average variance extraction value is more than 0.50. The average variance extracted (AVE) for the construct should be 0.5 or above, indicating that the constructs describe more than the proportion of variation in their indicators. The measurement items are more likely to include more unobserved variance if the AVE is less than 0.5. Table 1 displays the outside loadings of the measures, as well as the build reliability and AVE. At initial stage a few items illustrated low factor loading and AVE, these items were Blog2, ETCD5, ETCD6, ETCD7, ETEE5, ETEE6, Mob1 and Mob2. These items were removed from further analysis.

The composite reliability for all concepts is better than 0.70, with an average variance extract larger than 0.50. The first outcome of the current analysis revealed a low average variance extraction result. However,

by deleting the items that had low factor loading, the constructs' average variance extraction met the required criteria of 0.50. The construct composite reliabilities range from 0.823 to 0.943, as shown in **Table 1**. Ecotourism had a composite reliability of 0.943, blogging had a reliability of 0.823, social media had a reliability of 0.907, and search engine optimisation had a reliability of 0.874. This shows that fair composite reliability values result in convergent validity.

Table 1. Measurement model

Constructs	Items	Factor Loadings	Composite Reliability	Average Variance Extracted (AVE)
Blogging	Blog1	0.682	0.822	0.54
	Blog3	0.611		
	Blog4	0.841		
	Blog5	0.783		
Enviromental Conservation	ETC1	0.783	0.92	0.622
	ETC2	0.779		
	ETC3	0.771		
	ETC4	0.803		
	ETC5	0.797		
	ETC6	0.819		
	ETC7	0.765		
Community Development	ETCD1	0.848	0.91	0.716
	ETCD2	0.872		
	ETCD3	0.838		
	ETCD4	0.826		
Environmental Education	ETEE1	0.86	0.897	0.687
	ETEE2	0.847		
	ETEE3	0.849		
	ETEE4	0.754		
Mobile Apps	Mob3	0.837	0.887	0.723
	Mob4	0.885		
	Mob5	0.828		
SEO	SEO1	0.765	0.874	0.634
	SEO2	0.811		
	SEO3	0.799		
	SEO4	0.807		
Social Media Marketing	SM1	0.764	0.907	0.523
	SM2	0.78		
	SM3	0.728		
	SM4	0.762		
	SM5	0.791		
	SM6	0.667		
	SM7	0.562		
	SM8	0.682		
	SM10	0.74		

4.1.2. Discriminant validity

Discriminant validity refers to the degree to which a tool has a really different idea from all others [119]. The degree to which related concepts have distinct values is referred to as discriminant validity. It denotes

that a construct is unique and that its logic is reflected in the model. When the square root of average variance extraction exceeds the value of inter-construct correlations, discriminant validity is established. To evaluate the discriminant validity, we employed three criteria. The Fornell-Larcker criteria, cross-loadings, and HTMT ratio are examples [120,121]

The Fornell-Larcker criteria findings are shown in **Table 2**. The Fornell-Larcker criteria states that inter-construct correlations with values smaller than the square root of average variance extraction show discriminant validity [122]. Table 2's diagonal values represent the square root of AVE and have greater values than the construct correlations.

Table 2. Fornell-Larcker Criterion

Constructs	Blg	ETCD	ETC	EE	Mob	SEO	SM
Blogging	**0.735**						
Community Development	0.416	**0.846**					
Environmental Conservation	0.457	0.718	**0.788**				
Environmental Education	0.550	0.656	0.639	**0.829**			
Mobile Applications	0.526	0.420	0.448	0.467	**0.850**		
Search Engine Optimization	0.508	0.376	0.420	0.463	0.478	**0.796**	
Social Media	0.559	0.499	0.534	0.575	0.661	0.570	**0.723**

Loadings on additional structures are less relevant than cross-loadings on the outer loading of the pointers on the connected construct. **Table 3** shows the cross-loadings for all constructs and shows which ones have the highest factor loading on the linked elements. The outer loading of the indicators on the linked construct is bigger than the other construct loadings in **Table 3**. All constructs' discriminant validity was found to be sufficient in these tests.

Table 3. Cross loadings of the items

Items	Blg	ETCD	ETC	EE	Mob	SEO	SM
Blog1	0.682	0.292	0.302	0.378	0.371	0.306	0.357
Blog3	0.611	0.223	0.209	0.297	0.361	0.309	0.391
Blog4	0.841	0.320	0.354	0.460	0.442	0.449	0.452
Blog5	0.783	0.365	0.434	0.454	0.379	0.409	0.444
ETC1	0.317	0.473	0.783	0.459	0.343	0.284	0.390
ETC2	0.377	0.515	0.779	0.536	0.357	0.310	0.408
ETC3	0.361	0.537	0.771	0.439	0.327	0.277	0.370
ETC4	0.346	0.561	0.803	0.469	0.354	0.375	0.439
ETC5	0.373	0.535	0.797	0.478	0.338	0.385	0.438
ETC6	0.372	0.664	0.819	0.581	0.394	0.364	0.483
ETC7	0.370	0.660	0.765	0.551	0.351	0.310	0.408
ETCD1	0.316	0.848	0.659	0.516	0.329	0.289	0.395
ETCD2	0.361	0.872	0.591	0.583	0.369	0.292	0.437
ETCD3	0.360	0.838	0.604	0.562	0.346	0.359	0.421

Items	Blg	ETCD	ETC	EE	Mob	SEO	SM
ETCD4	0.368	0.826	0.579	0.555	0.373	0.330	0.430
ETEE1	0.476	0.583	0.588	0.860	0.382	0.427	0.481
ETEE2	0.458	0.572	0.534	0.847	0.396	0.431	0.512
ETEE3	0.450	0.547	0.530	0.849	0.384	0.369	0.491
ETEE4	0.441	0.468	0.459	0.754	0.389	0.299	0.417
Mob3	0.436	0.278	0.327	0.367	0.837	0.382	0.507
Mob4	0.466	0.342	0.382	0.393	0.885	0.421	0.563
Mob5	0.438	0.430	0.420	0.423	0.828	0.412	0.602
SEO1	0.404	0.366	0.394	0.369	0.416	0.765	0.509
SEO2	0.426	0.304	0.330	0.375	0.327	0.811	0.421
SEO3	0.350	0.258	0.299	0.382	0.339	0.799	0.398
SEO4	0.434	0.252	0.301	0.345	0.437	0.807	0.476
SM1	0.479	0.430	0.417	0.433	0.572	0.458	0.764
SM10	0.426	0.345	0.387	0.408	0.530	0.414	0.740
SM2	0.517	0.424	0.403	0.494	0.524	0.442	0.780
SM3	0.416	0.353	0.374	0.376	0.437	0.408	0.728
SM4	0.429	0.337	0.370	0.427	0.555	0.449	0.762
SM5	0.442	0.343	0.380	0.395	0.521	0.483	0.791
SM6	0.292	0.325	0.427	0.403	0.441	0.335	0.667
SM7	0.234	0.289	0.243	0.317	0.316	0.297	0.562
SM8	0.350	0.370	0.436	0.454	0.369	0.394	0.682

Table 2. (*Continued*)

Table 4 shows the Heterotrait-monotrait (HTMT) findings; values less than 0.85 in the HTMT table imply that discriminant validity has been established (Baier, Kline, & Feeny, 2020). According to **Table 4**, all HTMT values were less than 0.85, showing high discriminant validity. Thus, convergent and discriminant validity analyses revealed the measuring items' validity and reliability, allowing hypothesis testing.

Table 4. Heterotrait-monotrait (HTMT) ratio.

Constructs	BLG	CD	EC	EE	MA	SEO
Community Development	0.518					
Environmental Conservation	0.552	0.811				
Environmental Education	0.698	0.763	0.729			
Mobile Applications	0.695	0.489	0.517	0.561		
Search Engine Optimization	0.661	0.441	0.485	0.555	0.586	
Social Media	0.698	0.565	0.592	0.66	0.77	0.668

4.2. Assessment of structural model

Once the outer models' measurements have been proven to be accurate and valid, the technical or inner models are reviewed. It would be necessary to investigate the model's capacity to foresee outcomes and the linkages between its various components [123]. In other words, a structural model evaluation is utilised to

validate the asserted link within the inner model. **Figure 3** depicts the measuring model for this investigation, which includes the independent, dependent, and mediating variables. The Goodness of Fit, Effect Size (2), Coefficient of Determination (R^2) of endogenic concepts, and Path Coefficients are used in this study to identify the hypothesised linkages between constructs.

The R^2 number reflects how effectively the suitable model takes changes in the dependent variables into account; the greater the R^2 value, the better the structural model predicts the hypothesised model. PLS-SEM is commonly used to increase R^2 since it attempts to explain the endogenous latent variable. R^2 has a range of 0 to 1, with values of 0.75, 0.50, and 0.25 indicating sizeable, moderate, and modest calculation precision, respectively [122]. The R^2 values for endogenous constructs are shown in **Table 5**.

Table 5. Coefficient of Determination (R^2) of Endogenous Constructs

Construct	R Square	R Square Adjusted	Effect
Ecotourism		0.472	Moderate

According to the current study's findings, ecotourism has a modest R^2 score of 0.472. In order to measure model fitness, the current study looked at the R^2 values of each endogenic 0.48component and the structural level impact size of a predictor latent construct. This study's effect size (f^2) may show if the missing construct has a major impact on the endogenous components. The magnitude of the effect is calculated by multiplying R^2 by the proportion of change in the endogenous latent variable that remains unaccounted. [124] categorised values between 0.02-0.14, 0.15-0.34, and higher than 0.35 as having modest, moderate, or substantial impacts. The values for each route are listed in Table 6. The f^2 value for each path is shown in **Table 6**. The effect size ranges between 0.003 for blogging and destination photos and 0.238 for social media destination images.

Table 6. Quality of structural model

Endogenous constructs	R2	Q2	Exogenous constructs	f2	VIF
Community Development	0.286	0.197	Blogging	0.02	1.654
			Mobile_Applications	0.008	1.916
			Search_Engine_Optimization	0.005	1.621
			Social_Mdia	0.057	2.201
Environmental Conservation	0.335	0.202	Blogging	0.029	1.654
			Mobile_Applications	0.008	1.916
			Search_Engine_Optimization	0.011	1.621
			Social_Mdia	0.065	2.201
Environmental Education	0.417	0.279	Blogging	0.087	1.654
			Mobile_Applications	0.003	1.916
			Search_Engine_Optimization	0.013	1.621
			Social_Mdia	0.077	2.201

4.2.1. Goodness-of-Fit index

The model's fitness was assessed using the Goodness-of-Fit (GOF) method. The GOF index measures the entire model fit, ensuring that the model adequately explains the empirical data. GOF values range from 0 to 1, with GOF>0.100 indicating a minor effect, GOF>0.250 indicating a medium effect, and GOF>0.36 indicating a strong effect and global structural model validation. "A good model fit demonstrates that a

model is frugal and reasonable." (Henseler, Hubona, & Ray, 2016). We used the following equation to access the Goodness-Of-Fit.

$$GOF = \sqrt{Average \ R^2 \times Average \ communality}$$

Table 7 shows the GOF estimates in detail for this research. For this investigation, the GOF index was 0.665. This suggests that empirical data is suited for its purpose and has a high level of prediction power. This indicates that the data is consistent with the suggested model and has a high predictive potential than baseline values.

Table 8 contains the complete GOF estimates for this investigation. For this investigation, the GOF index was 0.563. This shows the fitness of empirical data and has a high prediction power. This indicates that the data fit the suggested model and has significant predictive potential when compared to baseline values.

Table 7. Goodness of Fit (GOF) index

Constructs	AVE	R^2
Community Development	0.716	
Environmental Education	0.687	0.48
Environmental Conservation	0.622	
Blogging	0.54	-
Mobile Applications	0.723	-
Social Media	0.523	-
SEO	0.634	-
Average Communalities (AVE)	0.635	
Average R^2	0.48	
AVE x R^2	0.305	
$GOF = \sqrt{Average \ R^2 \times Average \ communality}$	0.552	

4.2.2. The Standardized Root Mean Square Residual (SRMR)

Finally, for PLS path modelling, we used two of the most used model fit criteria: the "Normed Fit Index" (NFI) and the "Standardised Root Mean Square Residual" (SRMR). The saturated model's SRMR was 0.078, whereas the estimated model was 0.079. Meanwhile, the saturated model's NFI was 0.912, while the estimated model's NFI was 0.900. Threshold values for SRMR0.08 and NFI>0.90 were recommended as signs of good model fit, and the study's model fit is satisfactory, as shown in **Table 8**.

Table 8. Fit Summary

Criterion	Saturated Model	Estimated Model
SRMR	0.078	0.079
d_ULS	7.005	7.829
d_G	0.850	1.395
Chi-Square	26220.323	26545.890
NFI	0.912	0.900

The route coefficient is used by PLS-SEM to assess the strength and importance of expected linkages among latent elements. Structural model connections are derived using standardised values ranging from -1

to +1, with coefficients near +1 indicating a strong positive link and coefficients near -1 indicating a strong negative connection.

4.2.3. Hypothesis testing

These route coefficients are also known as OLS beta coefficient coefficients (Ordinary Least Square). To assess the importance of predicted connections, the bootstrapping technique is utilised to get the empirical t-value for the route coefficients. As a result, the importance of the significance is critical, as it would require managerial attention. **Table 9** outlines the hypothesis testing results. This research model might look at the connection among blogging, mobile apps, SEO, social media, and ecotourism. **Figure 4** depicts the structural model's results.
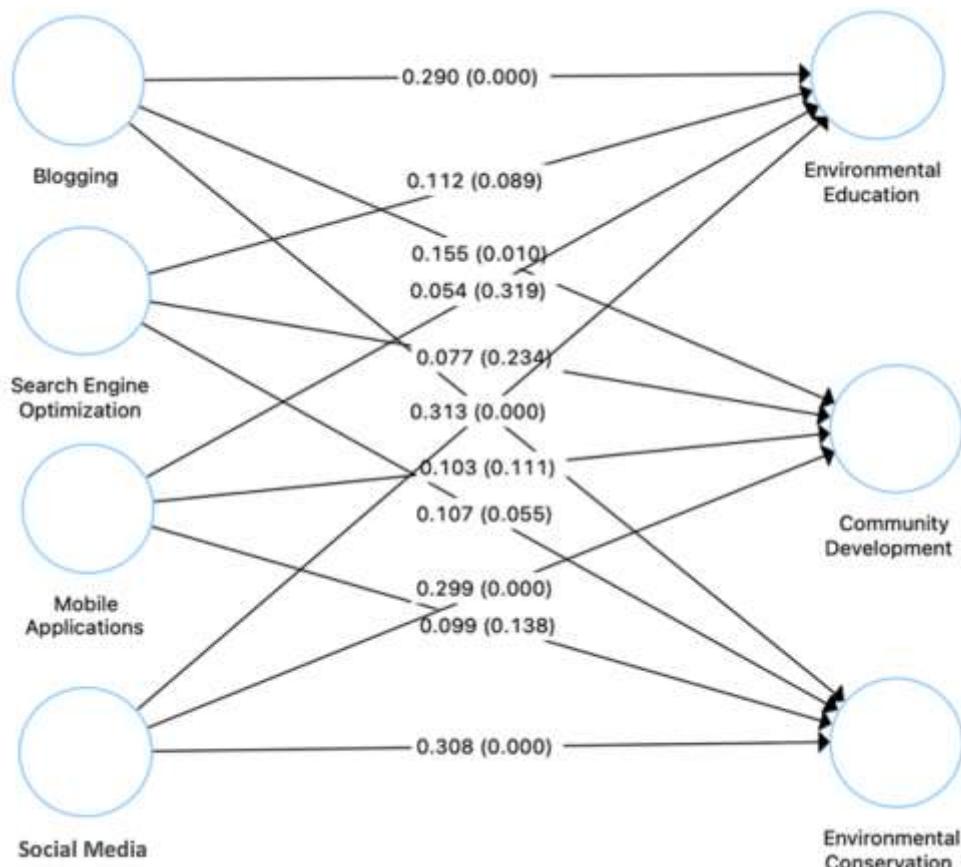

Figure 4. Structural model

The present study proposed four key hypotheses to investigate the relationship among the variables. Given to the H1, the path coefficient for blogging (community development) was stated as 0.155. The p-value was reported as 0.000, which indicates that any number less than 0.05 is significant (H1). According to the outcomes of this study, Hypothesis H1 was accepted, and blogging favors community development.

Table 9. Hypothesis testing

Hypothesis	Path Coefficient	Standard Deviation	T Statistics	P Values	LCL 2.50%	UCL 97.50%	Results
Blogging -> Community Development	0.155	0.060	2.570	0.010	0.041	0.269	Supported
Blogging -> Environmental Conservation	0.178	0.056	3.198	0.001	0.066	0.288	Supported
Blogging -> Environmental Education	0.290	0.057	5.104	0.000	0.191	0.394	Supported

Hypothesis	Path Coefficient	Standard Deviation	T Statistics	P Values	LCL 2.50%	UCL 97.50%	Results
Mobile Applications -> Community Development	0.103	0.065	1.593	0.111	-0.026	0.219	unsupported
Mobile Applications -> Environmental Conservation	0.099	0.067	1.483	0.138	-0.030	0.226	unsupported
Mobile Applications -> Environmental Education	0.054	0.054	0.997	0.319	-0.050	0.158	unsupported
Search Engine Optimization -> Community Development	0.077	0.065	1.192	0.234	-0.038	0.214	unsupported
Search Engine Optimization -> Environmental Conservation	0.107	0.056	1.918	0.055	0.000	0.221	unsupported
Search Engine Optimization -> Environmental Education	0.112	0.066	1.702	0.089	-0.009	0.242	unsupported
Social Media -> Community Development	0.299	0.079	3.812	0.000	0.152	0.460	Supported
Social Media -> Environmental Conservation	0.308	0.073	4.230	0.000	0.160	0.446	Supported
Social Media -> Environmental Education	0.313	0.072	4.380	0.000	0.164	0.449	Supported

"Blogging has an impact on environmental conservation," according to Hypothesis H2. The Path coefficient for blogging and environmental conservation was 0.178, the t-value was 3.198, and the p-value was 0.140, which was not significant at any value less than 0.288, according to Table 9. According to the outcomes of this study, Hypothesis H2 was accepted. In addition, H3 stated that blogging positively impacts environmental education. The path coefficient for blogging and environmental education is 0.290, the t-value is 5.104, which is above the threshold value of 1.96, and the p-value is 0.000, which is regarded as significant at any value less than 0.05—hereby, H3 is accepted.

Furthermore, H4 stated that SEO is positively related to environmental conservation. The path coefficient for value is 0.107, the t-value is 1.918, less than the threshold value and the p-value is 0.055. However, the H4 is not supported for the current study. Also, the hypothesis (H5) that SEO is related to community development was rejected; the path coefficient value was 0.077, t-value was 1.192, and the p-value was 0.234. Besides this, the Hypothesis (H6) was rejected; according to H6, SEO is positively related to environmental education. The path coefficient was 0.112, the t-value for H6 was 1.702, which is less than the threshold value of 1.96 and the p-value was recorded as 0.089. Moreover, the H7 stated that mobile applications positively affect environmental conservation. The path coefficient for H7 was 0.099, the t-value was 1.483, which is less than 1.96 of the threshold value, the p-value was 0.138, which is above 0.005. hence the H7 was rejected. In addition, H8 stated that mobile applications are positively related to community development. The path coefficient for H8 was 0.103, the t-value was 1.593, which is less than 1.96 of the threshold value, the p-value was 0.111, which is above 0.05. So, the H8 was rejected. Also, the H9 stated that mobile applications were positively related to environmental education. The path coefficient value was 0.054. t-value was 0.997, less than the 1.96 threshold value, and the p-value was 0.319, above 0.005. So, the H9 was not supported. Finally, H10 stated that social media is positively related to environmental conservation. The path coefficient for H10 was 0.308, the t-value was 4.230, which is above 1.96 of the threshold value, and the p-value was 0.000, which is above 0.05. Hypothesis 10 was accepted. In addition, hypothesis 11 stated that social media positively influenced community development. The H11 was supported because the path coefficient value was 0.299, t-value was 3.812, above 1.96, and the p-value was 0.000, below 0.05. Also the H12 was accepted, and it stated that social media is positively related to environmental education. The H12 was supported because the path coefficient value was 0.313, t-value was 4.380, above 1.96, and the p-value was 0.000, below 0.05.

4.3. Neural network analysis

This study employs a multi-analytical technique by combining SEM with neural network analysis, one of the most important artificial intelligence approaches. According to (Wan & Merwe, 2001), an artificial neural network (ANN) is "a massively parallel distributed processor made up of basic processing units with a neural predisposition for accumulating experimental information and making it available for application." Artificial Neural Networks are more resilient than linear models and can outperform classic statistical approaches such as Multiple Regression Analysis. However, the "black box" nature of neural networks renders them unsuitable for hypothesis testing and assessing causal linear and non-linear interactions. In this study, a two-step strategy is employed: first, SEM is used to evaluate the overall research model and find important hypothesised predictors, which are then used as inputs to the neural network model used in the second stage to establish the relative relevance of each predictor variable. Knowledge collected by Artificial Neural Networks is stored in synaptic weights, which are the strengths of interneuron connections, during the learning process. However, when it comes to creating accurate predictions and capturing complicated nonlinear interactions, PLS-SEM has limits [125]. This is where the hybrid model's second stage, the Artificial Neural Network (ANN), comes in handy. Even in the lack of strong theoretical assumptions, ANN is a powerful machine learning approach capable of capturing complex patterns and correlations in data [126]. The impacts discovered in the first step may be further studied and confirmed using ANN, taking into account additional factors that may influence ecotourism behaviour [127].

A two-stage hybrid model combining PLS-SEM and ANN provides a comprehensive and robust analytical framework [128]. PLS-SEM contributes to the theoretical underpinnings and early linkages, whereas ANN improves prediction powers by capturing nonlinearities and detecting possible extra-significant components [129]. This hybrid technique provides for a more comprehensive grasp of the research issue and enhances prediction accuracy, hence increasing the study's overall methodological rigour .[130]. In this effort, we used a feed-forward back-propagation multilayer perceptron (MLP), a highly used and standard. In a neutral network, typical hierarchical levels include one input, one or more hidden layers, and one output layer as shown in figure 5. The complexity of solving the model dictates the number of hidden layers. A single hidden layer may represent any continuous function, while two hidden layers are required for discontinuous functions. Because of the nature of the research, only one hidden layer mode was employed. Several neurons in the input layer represent the dependent variables, and neurons in the output layer represent the dependent variables. This research consists of three dependent variables that encourage us to run ANN three times, each with one output neuron to access the model more efficiently.

To optimise the correctness of training consequences, all inputs and outputs were normalised from 0 to 1. To minimise overfitting, tenfold cross-validation was performed, with 80% of the data used for network training and the remaining 20% for testing [131]. Table 10 displays the Root Mean Square Error (RMSE) of all ten neural networks' training and testing data sets, as well as the averages and standard deviations for both data sets. The average RMSE of 0.025 to 0.085 demonstrates the prediction's accuracy.
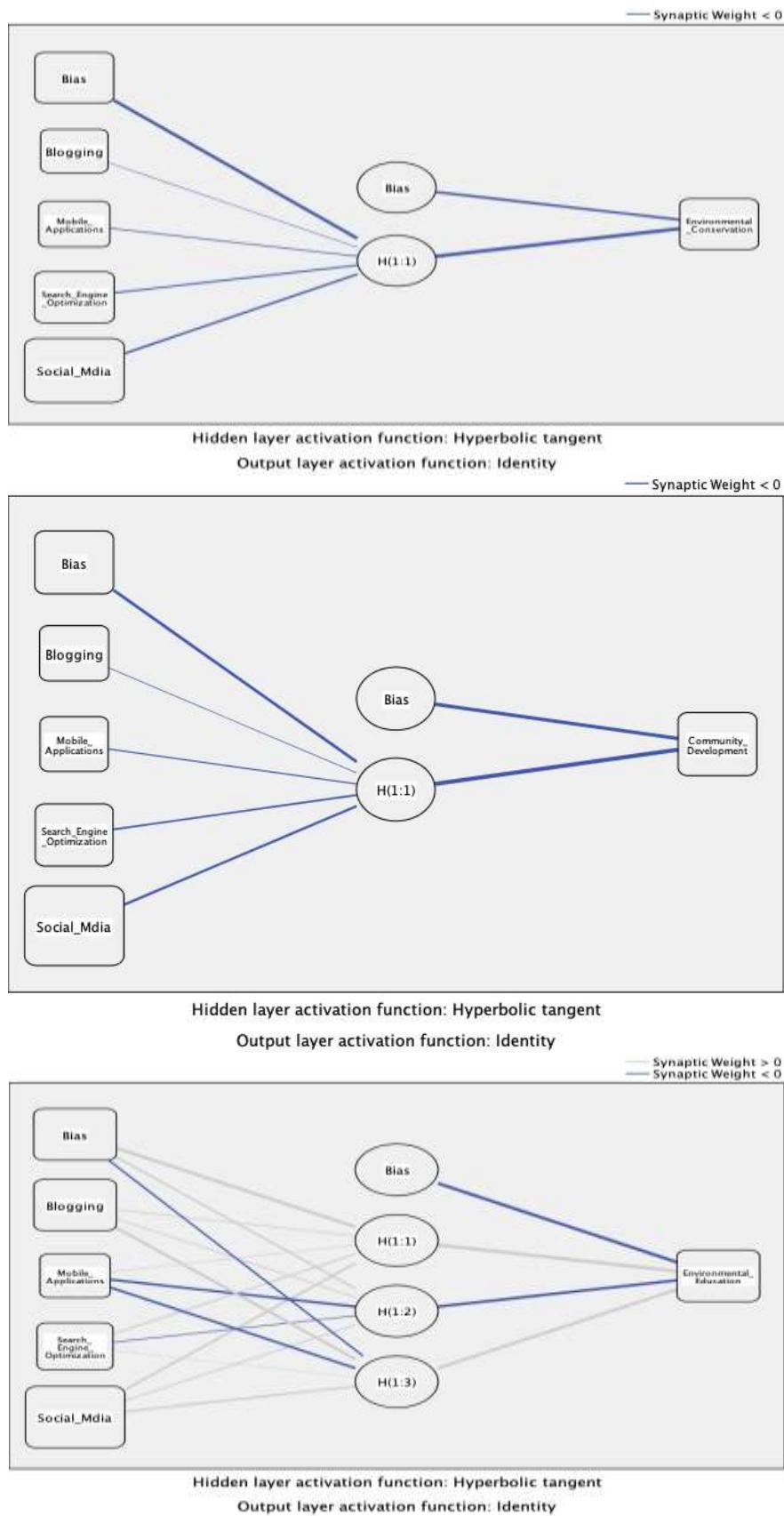
Figure 5. Single Layer ANN: Figure showing neural network results of the constructs

Table 10. Artificial neural network

Neural Network	Model A (R2=65%				Model B (R2=65%				Model C (R2=65%			
	Training		Testing		Training		Testing		Training		Testing	
	N	RMSE	N	RMSE	N	RMSE	N	RMSE	N	RMSE	N	RMSE
ANN1	240	0.045	113	0.068	241	0.091	112	0.069	243	0.047	110	0.039
ANN2	255	0.083	98	0.041	241	0.096	112	0.092	241	0.009	112	0.052
ANN3	241	0.066	112	0.033	242	0.064	111	0.137	257	0.037	96	0.056
ANN4	241	0.051	112	0.061	257	0.092	96	0.033	237	0.026	116	0.057
ANN5	242	0.045	111	0.091	240	0.064	113	0.123	243	0.031	110	0.048
ANN6	257	0.073	96	0.016	246	0.079	107	0.099	249	0.024	104	0.044
ANN7	240	0.038	113	0.008	248	0.107	105	0.048	231	0.007	122	0.059
ANN8	246	0.065	107	0.026	252	0.107	101	0.023	248	0.070	105	0.049
ANN9	248	0.066	105	0.090	249	0.049	104	0.137	239	0.021	114	0.051
ANN10	252	0.069	101	0.019	254	0.101	99	0.092	244	0.044	109	0.046
Average	246	0.06	107	0.041	247	0.085	106	0.085	243	0.025	110	0.05

A sensitivity analysis of three models has been reported in **table 11** to evaluate the relative importance of digital marketing strategies such as mobile applications, Blogging, SEO, and social media marketing about dependent variables such as community development, environmental conservation, and education. The normalised importance is the ratio of the importance of each predictor to the highest importance value [132]. Results for model one indicates that the social media marketing strategy has the highest average normalised importance score of 0.390, followed by SEO with a score of 0.231, Blogging score at 0.195 and mobile application with a score of 0.184 for the output neuron of environmental conservation. Model two results show results for output neuron of community development, indicating that social media marketing strategy has the most significant average normalized relevance score of 0.50, blogging at 0.216, SEO at 0.150, and mobile application with a normalized importance value of 0.133. While for Environmental education, the normalized relative importance of social media is 0.454, blogging 0.308, SEO 0.176, and mobile application is 0.062.

Table 11. Sensitivity analysis

Neural Network	Model A (Environmental Conservation)				Model B (Community Development)				Model C (Environmental Education)			
	BLG	MA	SEO	SM	BLG	MA	SEO	SM	BLG	MA	SEO	SM
ANN1	0.109	0.153	0.252	0.485	0.182	0.184	0.147	0.486	0.258	0.066	0.153	0.524
ANN2	0.159	0.228	0.343	0.270	0.189	0.132	0.185	0.495	0.304	0.133	0.151	0.412
ANN3	0.164	0.222	0.282	0.331	0.175	0.108	0.151	0.565	0.317	0.073	0.218	0.392
ANN4	0.120	0.241	0.379	0.260	0.166	0.132	0.253	0.448	0.336	0.069	0.156	0.439
ANN5	0.153	0.242	0.187	0.417	0.316	0.110	0.019	0.556	0.325	0.014	0.200	0.461
ANN6	0.294	0.098	0.115	0.493	0.286	0.167	0.204	0.343	0.270	0.075	0.231	0.424
ANN7	0.143	0.150	0.218	0.489	0.204	0.170	0.170	0.456	0.155	0.028	0.257	0.559
ANN8	0.266	0.200	0.203	0.331	0.198	0.111	0.067	0.624	0.453	0.022	0.048	0.477
ANN9	0.199	0.132	0.323	0.347	0.111	0.175	0.146	0.568	0.356	0.125	0.106	0.413

Neural Network	Model A (Environmental Conservation)				Model B (Community Development)				Model C (Environmental Education)			
	BLG	MA	SEO	SM	BLG	MA	SEO	SM	BLG	MA	SEO	SM
ANN10	0.344	0.169	0.009	0.478	0.328	0.040	0.161	0.470	0.301	0.016	0.240	0.443
Average Normalized Importance	0.195	0.184	0.231	0.390	0.216	0.133	0.150	0.501	0.308	0.062	0.176	0.454
	50%	47%	59%	100%	43%	27%	30%	100%	68%	14%	39%	100%

Table 11. (*Continued*)

BLG= blogging, MA= Mobile Applications, SEO= search engine optimization, SM= social media

5. Discussion and conclusion

The study's findings demonstrated that digital marketing platforms impact the growth of ecotourism behaviour among tourists. Over the years, the concept of ecotourism behaviour has evolved dramatically. Environmental conservation, education, and community development have recently merged to generate the ecotourism behaviour construct. Our findings emphasized the importance of digital platforms in developing a sense of environmental conservation, vital for environmental education, and playing a significant role in community development that lowers environmental damage. According to the results of PLS-SEM and ANN, social media is the most critical platform for forming ecotourism behaviour among tourists. It contributes to environmental education, a feeling of resource conservation, and community development. Visitors use these social media sites to communicate and disseminate the information on ecotourism behaviour [133]

Blogging is most important for environmental education and has a minor impact on community development. Also [134] showed that blog visitor evaluations are significant sources of information that influence perceptions and behaviour toward ecotourism. The current study also looked at blogging as a strategy for developing ecotourism behaviour; the results are congruent with [135]. Furthermore, [135,136] found that blogs are becoming an increasingly significant source of information in the growth of travel and ecotourism and that tourists trust various blogging sites for travel.

Mobile applications play an essential part in environmental conservation, but they are less likely to impact environmental education. The research findings [136] on mobile applications as a promotional tool for a tourist offer in protected areas back up the present study's findings on mobile apps and ecotourism. [19] came to the same conclusion in their research on mobile applications and ecotourism. The apps are generally used for making reservations and looking up costs and support the conclusions of the current study on mobile applications and ecotourism. Mobile applications are extensively used for travel and reservations, and literature supports the relevance of mobile applications and the ecotourism link [137]. Similarly, search engine optimisation is critical for disseminating environmental preservation and conservation messages but negatively impacts community development. Tourists are primarily motivated by personal reasons when deciding whether to engage in ecotours and how to behave throughout the trip. They can utilise digital marketing strategies to engage in ecotourism behaviour and use social media to share their experiences during excursions to natural areas.

5.1. Theoretical implications

It adds to planned behaviour theory by broadening its applicability to encompass digital marketing techniques and ecotourism behaviour. Furthermore, the study investigates the theoretical implications of the technology acceptance model in terms of digital marketing techniques, destination image, and ecotourism behaviour. This study addresses a gap in the literature by investigating the influence of digital marketing in boosting ecotourism behaviour and improving visitors' attitudes.

The findings of the current study hold significant implications for the conservation of the natural environment and the promotion of sustainable ecotourism behaviour among tourists, particularly through the utilization of digital marketing tools during tours. In the context of Pakistan, the northern region, despite its limited resources and relatively underdeveloped status, possesses great potential for the development of ecotourism behaviour. However, the growing popularity of tourism has led to an increase in resource extraction activities, resulting in deforestation in many natural areas.

To address this challenge, digital marketing strategies can play a crucial role in raising awareness and fostering a better understanding of the importance of conserving natural areas. Through the use of digital media platforms, environmental education can effectively convey messages of responsible behaviour, thereby contributing to the long-term growth and development of both visitors and the local communities in the northern regions.

Social media and blogging have emerged as widely utilized tools for disseminating information related to ecotourism, offering an excellent opportunity for local residents to leverage these platforms to promote the local natural environment, enhance the destination image, and showcase cultural values to tourists. Moreover, such digital marketing efforts not only benefit the local economy but also communicate a strong message to tourists regarding the importance of ethical behaviour during their visits.

Finally, the findings of this study have important implications for the government's policies regarding Pakistan's goals of a billion-tree tsunami and a clean and green Pakistan. Given that Pakistan's tourism industry primarily focuses on attracting tourists to natural sites, environmental concerns pose a threat to the conservation of these areas through ecotourism. To address this, the government can implement measures such as limiting the number of high-carbon-emitting cars in these regions and promoting the use of bicycles and low-emission vehicles to reduce the carbon footprint.

Data Availablity Statement

Data available on request due to privacy/ethical restrictions

Conflict of interest

The author declares no conflict of interest

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