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Environmental Sustainability and Carbon Footprint of Tourism: A Study of a Natural Park in Northeastern Kazakhstan

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Abstract: This study aims to assess the environmental sustainability and carbon footprint of tourism in Bayanaul State National Park (Kazakhstan) using the GSTC criteria and the Protocol on Greenhouse Gas Emissions. As part of the work, surveys and interviews were conducted with representatives of the tourism industry, administration officials and environmental organizations to analyze awareness of the principles of sustainable tourism, existing barriers and opportunities to increase sustainability. The results showed that the main contribution to the carbon footprint (530 tons of CO_2-eq.) is made by indirect emissions (57%) related to procurement and logistics as well as coal heating (20.5%). Based on the expert assessment method, key factors were identified, such as increased energy efficiency, the introduction of renewable energy sources, separate waste collection and recycling, the transparency of financial management and educational programs for tourists and employees. Based on these factors, a model of sustainable tourism management has been developed, adapted to regional peculiarities. This model provides for the active involvement of the state, business and the local community, and introduces mechanisms to reduce the carbon footprint and increase environmental sustainability. The theoretical contribution of the study is the adaptation of GSTC standards to the conditions of Kazakhstan and the development of a sustainable tourism management model that takes into account local characteristics. The results obtained provide a practical basis for reducing the negative impact of tourism on the environment, improving environmental sustainability and creating conditions for further research and the introduction of sustainable practices.

Keywords: sustainable tourism; carbon footprint; environmental sustainability; greenhouse gases; qualitative research

Academic Editor: Harry Coccossis

Received: 11 November 2024
Revised: 29 January 2025
Accepted: 12 February 2025
Published: 19 February 2025

Citation: Yessimova, D.; Faurat, A.; Belyi, A.; Yessim, A.; Sadykov, Z. Environmental Sustainability and Carbon Footprint of Tourism: A Study of a Natural Park in Northeastern Kazakhstan. *Sustainability* **2025**, *17*, 1723. https://doi.org/10.3390/su17041723

1. Introduction

In the context of global changes and an increased anthropogenic impact on the environment, there is a need to introduce sustainable technologies in all areas of activity. The tourism industry consumes a lot of electricity, water and other resources, generating waste (Kholijah, 2024) [1]. Tourism is responsible for a significant share of global greenhouse gas emissions, accounting for about 8% of global carbon emissions (Pilgreen et al., 2024) [2]. The problem of intensive tourism development is the increase in greenhouse gas emissions, especially in light of the global trend towards reducing carbon dioxide emissions by 2030 (United Nations Framework Convention on Climate Change (UNFCCC), 2015) [3]. In this regard, many countries are implementing environmentally sustainable business practices, a green economy and other approaches (Kholijah, 2024) [1]. As a result of optimizing the use

of resources, enterprises are able to minimize the negative impact on ecosystems, preserve biodiversity and reduce their carbon footprint (Kholijah, 2024) [1].

The World Tourism Organization has also called for the use of sustainable and constant practices in tourism development in order to reduce greenhouse gas emissions (Campos et al., 2022) [4]. The analysis of the carbon footprint as an environmental indicator has proved useful for the development and implementation of both managerial and environmental improvements, as well as for the formation of a green marketing strategy (Gallucci and Dimitrova, 2020) [5].

One of the practices of tourism development taking into account the environment is the sustainable development of tourism. Sustainable tourism is a critical approach that seeks to balance the economic benefits of tourism with the need to protect the environment and support local communities, as well as preserve cultural heritage (Guo et al., 2019; Kurniawan, 2024; Kumar & Thakur, 2023) [6–8]. Sustainable tourism policy plays a crucial role in addressing global environmental challenges and promoting sustainable development (Guo et al., 2019) [6]. It is believed that sustainable tourism initiatives can reduce the carbon footprint, protect ecosystems, boost economic growth and improve local communities (Li, 2024) [9]. This is very important, because there are studies that prove that with strict observance of environmental standards, tourist activity increases (Fernández, 2019) [10].

Among the various ways to implement sustainable development in a tourist destination, our attention is focused on the GSTC criteria for sustainable tourism presented by the Global Sustainable Tourism Council (GSTC), 2019 [11]. The GSTC criteria provide a universal standard for managing tourist destinations with a minimal impact on nature. In addition to environmental sustainability, these criteria include sections on climate change and greenhouse gas accounting.

Despite the existence of the GSTCS criteria, their use in the management of tourist destinations remains limited. In particular, there is little research on how these criteria can be adapted to reduce the carbon footprint, especially in countries with developing tourism, such as Kazakhstan.

In the Republic of Kazakhstan, according to the settlement agreements, it is planned to reduce the carbon footprint in all sectors, including tourism. According to the Strategy for Achieving Carbon Neutrality until 2060, approved by Decree of the President of the Republic of Kazakhstan, the medium-term goal is to reduce greenhouse gas emissions by 15% by 2030 relative to 1990 levels and subject to international support, by 25% (Adilet, 2023) [12]. Moreover, more than 70% of all emissions come from the fuel and energy sector, making it the main focus for reducing the country's carbon footprint (AIFC, 2023) [13]. However, the tourism industry in Kazakhstan is in a stage of development (Yessimova et al., 2024) [14], and it is important that reducing the carbon footprint does not lead to an increase in the cost of introducing new technologies to the detriment of the development of the industry.

Tourism in the republic is mainly concentrated in specially protected natural areas, where universal rules for the protection and preservation of the environment apply. The development of tourism in these territories is, therefore, difficult. It is necessary to propose measures that will take into account environmental protection activities in the territory of a tourist destination, as well as interaction with the tourism industry, contributing to the benefits of its development.

One such tourist site is Bayanauli State National Nature Park (BSNNP), located in the north-east of Kazakhstan and the center of attraction for tourists in the number of about 100 thousand people annually (Bureau of National Statistics of the Republic of Kazakhstan. Tourism statistics) [15].

Bayanaul is a mountain oasis on the steppe plains. The Nature Park operates in order to attract tourists as much as possible, but the quality of services provided remains low (Titkov, 2021) [16]. This is due to limited competition, as well as insufficient consideration of the environmental impact of tourism activities (Yessimova et al., 2024) [14].

For the further development of tourism in a specially protected natural area, it is necessary to introduce sustainable practices that will help the industry develop, and destinations that will not worsen environmental conditions but will increase their attractiveness.

The research question is that the government aims to reduce carbon dioxide emissions, but reducing this parameter alone cannot make tourism activities sustainable. Additional aspects need to be considered, including social factors and overall environmental sustainability (Papečkys & Jasinskas, 2024) [17]. To do this, the authors propose using the criteria for sustainable development outlined by the GSTC. These criteria have been developed as the basic principles for tourist destinations to become sustainable (Papečkys & Jasinskas, 2024) [17]. The criteria are positioned as a starting point for destinations to develop their own sustainable development programs. The comprehensive approach presented in this study will include achieving environmental sustainability, reducing the carbon footprint and adapting the principles to the current situation of a particular destination, which will gradually meet the needs of the tourist destination.

Thus, the purpose of this study is to use the GSTC criteria for sustainable tourism to develop a management model for a tourist destination that will have environmental sustainability and mechanisms to reduce its carbon footprint. To achieve this goal, it is necessary to solve the following tasks: to assess, based on a survey and interview, the current state of the environmental sustainability of the tourist destination of the Pavlodar region (1); to calculate the carbon footprint of Bayanaul National Park (2); to identify drivers and dependent factors that have an impact on improving environmental sustainability and reducing the carbon footprint using the direct expert assessment method (3); and to develop a management model for tourist facilities that takes into account the GSTC criteria and is aimed at reducing the carbon footprint.

The hypothesis of this study is that the development of a tourism destination management model based on the GSTC criteria for sustainable tourism, using various methods, will effectively take into account local ecosystem features and social factors, which will create the basis for increasing environmental sustainability and reducing the carbon footprint in tourist sites in Kazakhstan.

For the first time, the study focuses on assessing the carbon footprint of tourism in Kazakhstan and offers an adapted destination management model based on GSTC criteria. In addition, we emphasize the unique contribution of our research to its practical applicability, providing a framework for sustainable development that can be adapted to various tourist destinations.

The article consists of an introduction, a literature review, research results, discussion, and conclusions.

2. Literature Review

Addressing the carbon footprint of tourism requires a multifaceted approach that includes improved measurement techniques, public education and low-carbon strategies. The need to halve carbon emissions from the tourism sector by 2030, as outlined in the Glasgow Declaration on Climate Action for Tourism, underscores the urgency of this challenge (Wang, 2024) [18]. The carbon footprint of tourism is of serious concern in the context of global climate change, as the industry contributes significantly to greenhouse gas emissions (Wang et al., 2017) [19]. The United Nations World Tourism Organization estimates that carbon emissions from tourism activities will exceed 6.5 billion tons by 2025 (Yong-lian

et al., 2021) [20]. This impact is primarily due to transportation, accommodation and activities involving tourists, which together result in significant greenhouse gas emissions. As tourism continues to grow, its ecological footprint is also expanding, creating an urgent need for sustainable practices in the sector (Torres-Díaz, 2024) [21]. Research shows that the rapid development of society can lead to the pollution of natural resources, which highlights the importance of assessing the carbon footprint and potential of tourism to ensure sustainable tourism practices (Gangji, 2024) [22].

Calculating the carbon footprint is a critical aspect of environmental sustainability because it quantifies the total greenhouse gas emissions associated with a product or service throughout its lifecycle, allowing for the development of targeted emission reduction and resource optimization strategies (Zhao et al., 2017) [23].

Accommodation facilities play a crucial role in the formation of the carbon footprint. Accommodation facilities, especially hotels, are energy-intensive establishments that contribute significantly to greenhouse gas emissions. According to the World Travel and Tourism Council (WTTC), accommodations account for about 21% of the total carbon footprint of tourism, underscoring the need for effective measurement and management strategies (Grosbois & Fennell, 2011) [24].

In addition to direct emissions from energy use, the carbon footprint of accommodation facilities also covers indirect emissions related to the supply chain, including the production and transportation of goods and services. Research by Liu et al., 2017 [25] highlights that indirect carbon emissions can account for about 50% of the total emissions associated with tourist accommodation (Liu et al., 2017) [25].

Chan, 2021 [26] notes that hotels face numerous challenges in reducing their carbon footprint, including a lack of awareness and understanding of carbon accounting methods, as well as psychological barriers to implementing sustainable practices.

Research shows that different types of accommodation, such as hotels, hostels and eco-houses, have different levels of energy efficiency and carbon emissions (Dwyer et al., 2010) [27]. Eco-friendly accommodation options that prioritize sustainability through energy-efficient methods and renewable energy sources can significantly reduce their carbon footprint compared to traditional accommodation options. This is especially true in protected areas where the conservation of natural resources is of paramount importance.

Environmental sustainability is one of the main directions of sustainable tourism. This sustainability is increasingly recognized as a critical factor for the long-term viability of the industry. This recognition comes from a growing awareness of the environmental impacts associated with tourism activities, including resource depletion, pollution, habitat destruction, and the loss of biodiversity (Li, 2022; Zhu et al., 2019) [28,29].

The current discourse on environmental sustainability in tourism highlights several key aspects, including the awareness of sustainable tourism among tourism industry actors, the importance of stakeholder engagement and the need for effective management strategies (Yessimova et al., 2024) [14]. Stakeholders who are well informed about sustainable development issues and their implications for tourism are more likely to support and participate in sustainable initiatives (Hatipoğlu et al., 2016; Pilgreen, 2024) [2,30]. This highlights the need for educational programs and awareness campaigns aimed at increasing stakeholders' knowledge of the importance of environmental sustainability in tourism.

In their research, Ridho, 2024 [31] shows how sustainable practices that consider economic, social and environmental benefits contrast sharply with traditional tourism models, which often prioritize immediate financial benefits without considering long-term consequences (Ridho, 2024) [31]. This shift towards sustainable business practices is important for increasing sustainability in tourism destinations, especially in areas with rich biodiversity, where the potential of sustainable tourism can serve as an alternative

to environmentally harmful practices (Bentley and Halim, 2024; Jamil, 2024) [32,33]. The introduction of sustainable tourism practices can help balance the economic benefits of tourism with the need to protect natural ecosystems.

The standards of the Global Council for Sustainable Tourism (GSTC) play a key role in guiding the development of sustainable tourism by providing an integrated framework that takes into account the environmental, social and economic aspects of tourism. These standards serve as a guideline for tourism stakeholders, including destinations, businesses and travelers, to promote responsible practices that minimize negative impacts while maximizing benefits for local communities and ecosystems (Global Sustainable Tourism Council (GSTC), 2019) [11].

Compliance with GSTC standards not only enhances the credibility of the tourism business but also promotes a culture of accountability and transparency in the industry. The GSTC standards also promote the integration of sustainability into tourism planning and management. Bentley emphasizes that sound policy frameworks and regulations are vital to guide the development of sustainable tourism, and the GSTC standards provide a structured approach to achieve this goal (Bentley, 2024) [32].

To effectively adapt the GSTC criteria, it is essential to establish monitoring and evaluation systems that assess the sustainability of tourism initiatives. Pardo-López and García, 2024 [34] emphasize the need for clear guidelines to create effective sustainable tourism plans, emphasizing the importance of adapting GSTC management indicators into planning and monitoring frameworks.

3. Materials and Methods

3.1. Study Area

The research was conducted in the Pavlodar region, Republic of Kazakhstan (Figure 1). Bayanauli State National Nature Park is one of the natural tourism sites of the Pavlodar region.

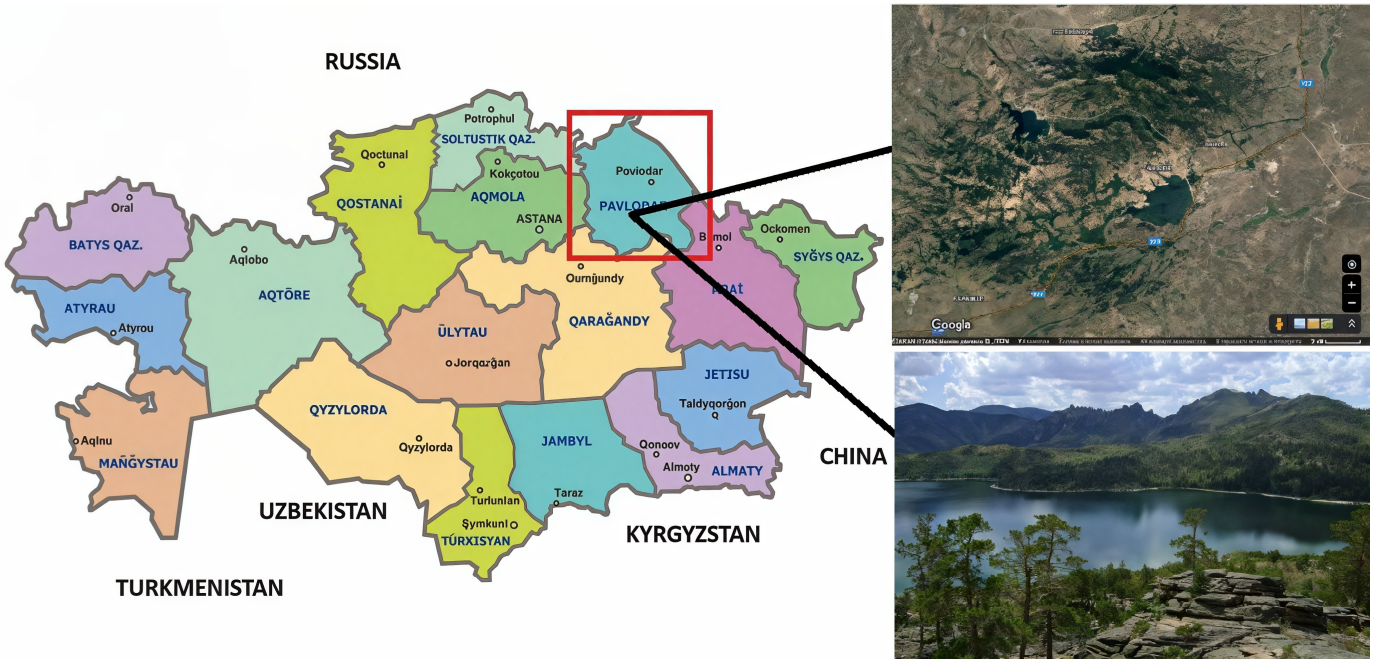

Figure 1. Pavlodar region on the map of Kazakhstan and Bayanaul National Park.

The State National Nature Park is a specially protected natural area created for the conservation of biological and landscape diversity, as well as for environmental, scientific, tourist and recreational purposes. There are zones on the territory of the park:

1. The protected area is 9074.0 ha (13.2%);
2. The ecological stabilization zone is 4695.0 ha (6.9%);
3. The area of tourist and recreational activities—15,244.6 hectares (22.3%)—includes areas for short- and long-term recreation and the creation of tourist routes, beaches, rental points;
4. The area of limited economic activity is 39,439.2 hectares (57.6%).

Sites for tourist and recreational activities can be provided for long-term use (5–25 years) to accommodate facilities such as recreation centers, hotels and museums (Republic of Kazakhstan, Law of the Republic of Kazakhstan "On Specially Protected Natural Areas") [35]. The authorized body that controls the territory is the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan.

The surroundings of Bayanaul are a climatic resort area, where the Bayanaul Nature Park has been established since 1985, the main attractions of which are nature. Bayanaul State National Nature Park is a priority tourist area according to the map of the Republic of Kazakhstan's tourism industry, which means that this area has a special development potential (Ministry of Culture and Sports of the Republic of Kazakhstan. Order No. 332 "On the approval of the touristification map of priority tourist areas in the Republic of Kazakhstan") [36].

The total area of the national park is 68,452.8 hectares, including 12,927 hectares covered with forest. The flora of the Bayanaul lowlands includes 474 species of vascular plants. A total of 51 species of boreal relics have been discovered here. The Bayanaul area is famous for its very interesting and peculiar objects created by nature in the process of wind and water erosion. Various stone sculptures, pillars, caves, mushroom-shaped stones, grottos and other natural stone structures attract attention and arouse admiration (Kadenova et al., 2008) [37].

This study assessed the attractiveness of Bayanaul National Park. It is revealed that Bayanaul State National Park is most appreciated for its picturesqueness and expressiveness, which received the highest ratings of attractiveness and were recognized by tourists at the "Excellent" level, emphasizing the natural beauty of the territory. The uniqueness and exoticism of the park are also highly appreciated, which indicates the rarity and strangeness of its natural sites that attract visitors. The cognitive value reflecting the educational potential of the park was highly objectively evaluated. These characteristics make Bayanaul attractive for ecological and cultural tourism, emphasizing its importance as a unique natural and educational site. The overall score was 77 points. Bayanaul National Park has a serious enough resource potential to accept a certain permissible recreational load, but this potential is not being used due to insufficient infrastructure and a lack of awareness of its possibilities in terms of tourism.

The main direction of the park's tourism is ecological tourism. Bayanauli region is also a key object of ethnocultural and historical tourism. The main stream of tourists today arrives for the purpose of beach holidays. The favorable period for these purposes begins in mid-June and ends at the end of August (1.5–2 months). The Bayanaul resort area is represented by lake basins of tectonic origin; the most picturesque lakes are Zhasybai—4.2 km^2, Sabyndykol—7.4 km^2 and Toraigyr—4.0 km^2. Winter holidays are represented by the Myrzshakol ski resort. The mountain system of Bayanaul National Park is also attractive for tourists. The highest mountain in the BSNNP is Mount Akbet (1022 m), the highest mountain peak in the Pavlodar region. Spiritual and religious tourism also has great potential in the Bayanaul region. In the Bayanaul region, there are objects that attract tourists such as the Mausoleum of Mashkhur Zhusup Kopeev, the

Mausoleum of Musa Shormanov, the cave of Konyr Aulie and the grave of Zhasybai batyr. The BSNNP has developed and officially approved 13 tourist routes, including 4 sightseeing trails (Government of Kazakhstan, Bayan-Aul National Park: History and significance) [38].

There are 52 recreation centers with a total capacity of 5188 places in the Bayanaul recreation area, including 5 departmental recreation centers and 2 children's health camps. However, studies (Titkov, 2021) [16] revealed that most of the accommodation facilities in the Pavlodar region have a high degree of physical deterioration. Low-quality and cheap materials are used in the construction and equipment of new accommodation facilities, which does not correspond to the world practice of the hotel industry (Titkov, 2021) [16]. During the summer holiday season, there are 15 restaurants and 8 retail outlets. It is also worth noting some seasonal growth points: On Lake Zhasybai, 99% of the accommodation facilities operate only in the summer season (Yessim, 2023) [39].

The number of tourists registered at locations in the natural park in 2021 was 35,436, in 2022—73,835 and in 2023—67,841, although the Bayanaul resort area has a projected potential of 450,000 tourists per year (Government of Kazakhstan State Program for the Development of the Tourism Industry of the Republic of Kazakhstan for 2019–2025) [40].

The study by Kairlyev, 2023 [41] revealed the lack of interest of authorized departments of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan in the development of the tourism industry in specially protected natural areas. A problematic issue related to the rejection of interest from entrepreneurs wishing to operate in protected areas by bureaucratic barriers in the form of administrative procedures has also been identified (Kairlyev, 2023) [41]. In addition, Bayanaul National Park does not have mechanisms for systematically accounting for environmental standards for sustainable tourism (Yessimova et al., 2024) [14]. Thus, the use of the expert method allowed us to identify the main areas that need to be improved, including waste management, infrastructure development and carbon footprint reduction.

3.2. Conducting a Survey Interview

The choice of survey participants and interviews was based on the objectives of the study. It was necessary to assess the current state of environmental sustainability in the Bayanaul Nature Park tourist destination by analyzing the implementation of GSTC criteria, as well as to assess the carbon footprint of enterprises, by obtaining data to calculate the carbon footprint of the hosting enterprise and identifying factors affecting the carbon footprint and the main directions for its reduction in the conditions of the Pavlodar region national park. The study was conducted in August–September 2024.

The industry's readiness to transition to sustainable tourism was assessed using a questionnaire compiled based on GSTC criteria. All the questions in the questionnaire and the interview were open. The collection of the questionnaire data consisted of anonymous surveys using links to Google forms based on questionnaires. The interview was conducted using the same questionnaires and questions as the anonymous survey. The interview format was structured, but it allowed for free discussion, which provided space for additional topics to be included.

The main categories of questions (meters) were based on the criteria of the section "environmental sustainability" (criteria D1–D12). Thus, the main dimensions, categories and questions that reveal them were identified (Table 1).

Table 1. The structure of the questionnaire and the interview.

Measurement	Category	Sample Questions
Monitoring and management (criteria D1)	Biodiversity monitoring	What measures and programs are being implemented in your destination to monitor and protect biodiversity?
	Transparency of income distribution	Is there a system in the destination that allows you to use the income from tourism to maintain and preserve natural resources? If so, what are the main mechanisms for distributing these funds?
	Tourist awareness	How are tourists and local businesses informed about the importance of preventing the spread of invasive species, and what efforts are being made to raise awareness about biodiversity conservation?
Tourist flow management (criteria D2)	Flow control	What measures are being taken to manage the flow of visitors and minimize their impact on natural sites, and how are these flows monitored?
	Informing tourists	Are there any recommendations in your destination on behavior at vulnerable natural sites, and how is compliance with these recommendations among tourists, tour operators and guides ensured?
Interaction with nature (criteria D3)	Regulation of interaction	What local, national and international laws and standards regulate wildlife interaction in your destination, and how are they implemented and monitored?
	Informing about the rules of interaction with nature	How do you ensure that visitors and tour operators are informed about the rules of interaction with wildlife and possible negative consequences, such as touching or feeding animals?
Conservation of species (criteria D4)	Laws and standards of interaction	What measures and systems are in place in your destination to comply with local, national and international standards for animal welfare and species conservation, especially regarding the trade and captivity of wild animals?
	Awareness of rare species	How are tourism businesses and visitors informed about the importance of avoiding trade in endangered species, and is information provided on the rules for purchasing wildlife souvenirs?

Table 1. *Cont.*

Measurement	Category	Sample Questions
Energy efficiency and resource management (criteria D5–D7)	Use of renewable energy sources	Do you use solar panels or other renewable energy sources? Are such initiatives being stimulated?
	Energy management	What measures are being taken to reduce energy consumption at tourism facilities?
	Water resources management	How is water resources management organized (purification, loss reduction)? How is water quality controlled?
	Informing tourists	How are tourists informed about water risk, minimization of water use, and quality of local water?
Waste and emissions management (criteria D8–D10)	Wastewater management	How is wastewater disposal organized?
	Waste sorting	Is there a waste sorting and recycling system?
	Accounting for greenhouse gas emissions	Do you calculate the carbon footprint of enterprises? Is there an emission reduction target?
	Green procurement	Do you use environmentally friendly goods and materials for building work?
Eco-friendly transport (criteria D11)	Using eco-friendly transport	Do you use low-carbon vehicles, such as electric cars?
Light and noise pollution (criteria D12)	Monitoring of pollution sources	Are the sources of noise and light pollution related to tourism being monitored?
	Mechanisms for filing complaints from residents	Are there mechanisms in place to allow local residents to report noise and light pollution, and what measures are being taken?

The basic information for calculating the carbon footprint of the pilot accommodation facility was collected using a questionnaire. The questions were related to energy consumption, heating, wastewater and transport used by the company. To assess indirect emissions, questions about purchased goods and services, the life cycle of goods and services, transportation of raw materials and waste generation are included. The list of information required to calculate the carbon footprint of the tourism sector of the Pavlodar region is presented in Table 2.

The reporting period covers one year: from 1 January to 31 December 2022. This is the first report for the included divisions, so it will be considered as the base report for all subsequent years.

The respondents included representatives directly involved in the development of tourism in the studied destinations and influencing its dynamics, including administrations of specially protected natural territories, private entrepreneurs in the field of tourism and related industries and various public, environmental and cultural organizations. The selection of participants for the interview was carried out on the basis of a preliminary analysis, which used data provided by the Department of Tourism and Entrepreneurship, Pavlodar, the administration of natural parks and reserves, business catalogs and Internet search results. At the initial interview stage, the circle of respondents gradually expanded.

Table 2. List of data for calculating the carbon footprint of the tourism industry of Pavlodar region.

№	Requested Information/Data	Units of Measurement				
1	How many incoming (non-residents of the Republic of Kazakhstan) and domestic tourists (residents of the Republic of Kazakhstan) did your district receive in 2023 and 2022 (welcome by month)?	People	Non-residents of the RK		Residents of the RK	
2	What kind of transport and how many tourists arrived?	People	Auto	Railway	Airline	Unknown
3	Specify the largest tourist accommodation in your area (names of hotels, sanatoriums, holiday homes, etc.)	Text				
4	What is the approximate amount of waste generated in your area from tourism enterprises? Note: If the volume is unknown from the tourism sector, then indicate the entire volume of waste generated in the area (with a note).	Tons/year				
5	What is the approximate amount of water consumption by tourism enterprises in your area?	m^3/year				
6	What is the approximate amount of electricity consumption by tourism enterprises in your area?	kWh/year				
7	What is the approximate amount of thermal energy consumption (Gcal/year) by tourism enterprises in your area? Note: If primary energy sources (coal, gas, fuel oil) are used to supply heat in the area, then specify their volume (tons/year or m3/year)	Gcal/year Tons/year m^3/year				

Meetings with local entrepreneurs who expressed interest in the research project were organized to discuss issues of sustainable tourism development. During the meetings held at the bases of enterprises and business organizations, the research group studied their activities and ideas for the development of tourism in specially protected natural areas. The composition of the interviewees was formed in such a way as to receive information from a variety of stakeholders most relevant to the research topic.

The criteria for including participants in surveys and interviews were based on focus groups. Various points of view were needed for the study: the administration of the tourist destination, management representatives, accommodation facilities, tourist centers, tour operators, travel agents, tourists, local residents and private entrepreneurs engaged in activities in this destination (Table 3).

The initial interviews were focused on identifying the personal views and approaches of the participants, after which their positions were clarified in the light of the concepts of sustainable tourism. A total of 19 respondents were interviewed. The questionnaires were provided by 32 respondents. A total of 51 people took part in the survey and interviews. The duration of the interview was 30–60 min, and the data-recording process was carried out manually in the field diary of the research group. The questionnaires were sent to state and local institutions of the Pavlodar region, groups on social networks and employees of the tourism sector.

Table 3. Socio-demographic profile of the respondents.

Interviewee	Age	Education	Representatives of Organizations and Enterprises
Management representatives	36–45 years old	Higher	Office of the mayor of Bayanaul district—2 representatives
Tourist destination Administration	46 years old	Higher	State Institution "Department of Physical Culture, Sports and tourism of Bayanaul district"
Tourist centers	28 years old	Secondary	Recreation center "Yelkonis", administrator
Tourist centers	56 years old	Secondary	Recreation center "Birch grove", director
Placement objects	32 years old	Higher	Guest house "Karagai alany", assistant manager
Tour operator	33 years old	Postgraduate specialty "Tourism"	Tour operator "Mixtour", director
Travel agent	25–35 years old	Postgraduate specialty "Tourism"	Travel agents—2 representatives: director and employee
Private entrepreneurs	36–55 years old		IE "Aityshev Nursultan", LLP "Akzhanym", IE "Zinnat", IE "Kashkeeva"
Local residents	48 years old	Secondary	Driver
	29 years old	Higher	Teacher
Tourists	37 years old	Postgraduate	Teacher
	20 years old	Higher unfinished	Student
	33 years old	Higher	Office worker
	57 years old	Secondary	Engineer

A qualitative analysis method was used to analyze the data on the survey and interview responses received. Content analysis is used to identify key themes and ideas. Next, the response was encoded and grouped by category.

The expert assessment method was used to identify and assess the factors affecting the environmental sustainability and carbon footprint of tourist destinations. The application of this approach is relevant in cases where a qualitative analysis of complex processes related to the opinion and experience of specialists is needed (Lin and Yang, 2021) [42].

The study involved 6 experts representing the academic community, tourism authorities and environmental organizations and the field of carbon footprint reduction. The experts were selected based on their professional experience and knowledge of the local context (Table 4).

The experts evaluated the proposed criteria according to a ranking system (from 1 to 10), where 1 indicated the minimum impact of the factor on sustainability and reduction of the carbon footprint, and 10 indicated the maximum. The assessment was conducted in the format of individual questionnaires, which made it possible to avoid the influence of participants on each other. The ranking method is an important decision-making tool in situations of limited resources and complex multi-criteria problems, which makes it a useful tool for assessing the sustainable development of tourism (Saparov, 2024) [43].

Table 4. Information about the expert group.

Expert	Field of Activity	Experience (years)
Expert1	Administration of SPNA	12
Expert 2	Carbon footprint reduction consulting	26
Expert 3	Academic research	14
Expert 4	Academic research	25
Expert 5	Travel company	10
Expert 6	The placement object	17

The data obtained were structured, and the factors were ranked by importance based on average expert estimates. This approach allowed us to identify key areas for improving environmental sustainability and reducing the carbon footprint. Further, by analogy with the MICMAC method, based on expert assessments, factors were identified, including drivers, connecting, dependent and autonomous factors, in order to identify the interaction of factors, as well as the order of their implementation. The drivers are the factors that will trigger all processes aimed at building resilience. Connecting factors are the second stage of actions that will ultimately lead to results (dependent factors) and goals (environmental sustainability and reducing the carbon footprint). Autonomous factors are those actions that do not directly affect processes but ultimately lead to a planned goal.

3.3. Calculation of Greenhouse Gas Emissions

To determine greenhouse gas emissions, our study used the currently widely used Greenhouse Gas Protocol (The Greenhouse Gas Protocol, 2004; 2011; 2013) [44–46]. One of the key components of the PC Protocol is its emphasis on the life cycle perspective when accounting for emissions (Laurent & Olsen, 2012) [47].

The Protocol standard divides emissions into direct and indirect ones, taking into account their source and place in the production chain: direct—from own assets, indirect—from related companies. The Protocol on Greenhouse Gases identifies three main emission coverage areas: (1) coverage 1—direct emissions originating directly from sources owned or controlled by the company (for example, from fuel combustion in boilers or vehicles); (2) coverage 2—indirect emissions from the production of purchased energy (i.e., electricity, steam, heat) that the company consumes; and (3) coverage 3—other indirect emissions that cover the entire life cycle of a company's products or services, from extraction of raw materials to disposal, which includes 15 different categories. Emissions were assessed in accordance with the Greenhouse Gas Protocol using three scopes (scopes 1, 2 and 3), which make it possible to estimate both direct and indirect greenhouse gas emissions (International standard, 2018; WRI and WBCSD, 2015) [48,49].

The object of the study is the accommodations of the recreation center located in Bayanaul State National Natural Park in the Pavlodar region in the north-east of Kazakhstan. The territory of the recreation center is 3.2 hectares of land. The room fund consists of 62 rooms located in the main building and detached houses.

When determining the carbon footprint, taking into account the production profile of organizations, calculations were made only of carbon dioxide (CO_2-eq.). Other greenhouse gases—methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride—were not taken into account.

The basic formula used to calculate the carbon footprint (tons of CO_2-eq.) is as follows:

GHG emissions = activity data (unit of activity) × emission factor (tons of CO_2-eq./unit of activity)

In this study, we employed OpenAI's ChatGPT to generate additional ideas and suggestions for refining the proposed model (https://chat.openai.com/). These suggestions were critically analyzed, validated and adapted by the research team to ensure their relevance and accuracy. The authors retain full responsibility for all interpretations and conclusions drawn in the study. The text has been edited using artificial intelligence, checking for grammatical, stylistic and punctuation errors, with paraphrasing by some of the authors to improve clarity and comprehension (https://chat.openai.com/) [50]. To search for relevant studies, Scite_ was used (https://scite.ai/) [51].

4. Results

4.1. The Current State of Environmental Sustainability of a Tourist Destination

As a result of the survey and interview, the following data were obtained, reflecting the level of environmental sustainability according to the GSTC criteria. After a content analysis of the results obtained, the main themes that were repeated in the respondents' responses were highlighted. These topics were highlighted in separate years and then grouped into categories (Table 5).

The criterion of monitoring and management (D1) shows that this destination takes into account all environmental aspects, as it is located in a protected area. The need to comply with all regulations and standards is a key element for ensuring the sustainable development of this territory. Reports are provided annually containing all necessary information on the state of the environment, compliance with established norms and standards and measures taken to protect natural resources in this destination.

There is a department of environmental education and tourism in the destination, which collects statistical information on the levels of visitor volume, visitor spending and employment and investment, as well as actual data on the distribution of economic benefits in the form of annual reports on the activities of Bayanaul State National Nature Park. The reports are stored in the department and are available for review when contacting the administration.

The main indicators included in the report are the use of the territory in tourist and recreational activities, which includes information about the number of visitors, the number of excursions, etc.; production and economic activities; and education and the expenditure of funds from the sale of goods and paid services provided by the national park. The main economic indicators tracked in the report are income from scientific, environmental education, recreational, tourist and limited economic activities.

Informing tourists and local businesses about the importance of preventing the spread of invasive species and preserving biodiversity is carried out through various initiatives. Information stands have been installed in this destination, which contain calls for nature conservation, especially with regard to fire protection measures. These stands serve as an important tool to raise awareness among both tourists and the local population about the need to take care of natural resources.

In addition, a fee is charged for visiting the park, but many tourists do not realize what exactly they are paying for admission. There is no clear information about where the collected funds go and how they are distributed. This creates a gap in understanding the importance of these contributions for the conservation of natural areas and the maintenance of environmental initiatives. Raising awareness on biodiversity conservation issues requires the active awareness and involvement of all stakeholders to ensure transparency and an informed attitude towards park fees.

Table 5. Compliance of codes with GSTC criteria and categories.

GSTC Criterion (Name and Code)	Category	Code and Name
D1: Monitoring and management	Biodiversity monitoring	D1.1: There is a monitoring and reporting system
	Transparency of income distribution	D1.2: The purpose of distributing the collected money is unknown
	Tourist awareness	D1.3: The reports are not made available to the general public D1.4: Stands have been set up to inform tourists
D2: Tourist flow management	Flow control	D2.1: The standards of recreational activity are observed
		D2.2: Tourist monitoring and payment acceptance at the entrance to the park
	Informing tourists	D2.3: Guides provide instruction on the rules. D2.4: There is no training for tour guides
D3: Interaction with nature	Regulation of interaction	D3.1: Laws on the protection of nature are respected
	Informing about the rules of interaction with nature	D3.2: There are stands with rules for tourists D3.2: There is no professional training for tour guides in interacting with nature
D4: Conservation of species	Laws and standards of interaction	D4.1: The laws are respected. Keeping animals without permission is prohibited.
	Awareness of rare species	D4.3: Stands and tour guides inform about rare species D4.3: There is no program to promote eco-friendly souvenirs
D5–D6: Energy efficiency and resource management	Use of renewable energy sources	D5.1: There are no solar panels or other renewable energy sources
	Energy management	D5.2: Energy-saving light bulbs Heating by burning coal
	Water resources management	D6.1: Water saving systems are not implemented D6.2: Sewage treatment plants are outdated
	Informing tourists	D6.3: Data on water use are not published
D8–D10: Waste and emissions management	Wastewater management	D8.1: Sewage treatment plants are outdated
	Waste sorting	D9.1: Waste sorting is not applied
	Accounting for greenhouse gas emissions	D10.1: Greenhouse gas emissions are not calculated
	Green procurement	D10.2: Green procurement has not been implemented
D11: Eco-friendly transport	Using eco-friendly transport	D11.1: Eco-friendly transport is not used
D12: Light and noise pollution	Monitoring of pollution sources	D12.1: Light and noise pollution are not taken into account
	Mechanisms for filing complaints from residents	D12.2: There is no interaction with the administration of the destination

The criterion of tourist flow management (D2) illustrates that to manage the flow of visitors and minimize their impact on natural objects in the destination, there are standards of recreational load, which are aimed at controlling the number of tourists and their

distribution along routes. However, there was no restriction on the number of visitors in any of the periods under review. This may be due to an insufficient influx of tourists, an insufficient consideration of the real flow or an orientation towards economic benefits to the detriment of environmental requirements.

Tourist flows are monitored at checkpoints at the entrance to the park, where the number of visitors is recorded. To inform tourists about the rules of behavior at vulnerable natural sites, such as botanical trails, local guides provide tourists with basic information about caring for the ecosystem. Information stands have also been installed, reminding of the rules of conduct on routes with a vulnerable ecosystem and the importance of nature conservation.

However, insufficient attention is paid to a detailed explanation of the impact of tourists on the ecosystem and the consequences of this influence. This reduces the effectiveness of educational activities and may negatively affect tourists' understanding of the need to comply with the recommendations. Raising awareness and responsibility on the part of tourists, tour operators and guides requires a more detailed approach to information support and regular explanation of the environmental consequences of their actions.

The criteria of interaction with nature and conservation of species (D3 and D4) show that interaction with wildlife in this destination is regulated by a number of national and international laws and standards that ensure the protection of rare and vulnerable species and prevent interference with the natural processes of the ecosystem. Among the main legal documents are national regulations, such as the Environmental Code of the Republic of Kazakhstan, which regulates the use of natural resources, the protection of biological diversity and the protection of rare species. Regarding international agreements, Kazakhstan is a party to the Convention on Biological Diversity and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which impose obligations to protect wild animals and prevent their exploitation.

The implementation and control of these laws is carried out through inspections and the monitoring of recreational activities, as well as a system of fines for the violation of environmental standards. Compliance with the rules of interaction with wildlife is monitored by environmental services and inspectors within the park. Keeping wild animals in captivity without appropriate permits is prohibited in the territory of the destination. Environmental authorities regularly carry out inspections to identify cases of illegal keeping and trade in wild species.

Within the framework of the criteria of energy efficiency and resource management (D5–D6), it was revealed that the destination lacks renewable energy sources, water saving systems and sufficient thermal insulation. This is primarily due to outdated infrastructure, as well as the use of coal for indoor heating.

Within the framework of the criteria of waste and emissions management (D8–D10), it was revealed that there is no waste sorting in the destination, and plastic products are widely used. Tourists are not familiar with and are not motivated to take an informed attitude towards waste. Businesses are not aware of the need to account for greenhouse gases, and they lack knowledge of how to make these calculations and generate climate impact reports.

The criterion of eco-friendly transport (D11) shows that ecological transport, as well as information about alternative transportation options, has not been implemented. The use of electric vehicles is very expensive, with a small number of tourists, so this is not being considered at the state or local level.

Data and instructions on light and noise pollution (light and noise pollution, D12) are not available. Generally accepted rules are followed, but there are no mechanisms for interaction with representatives of the administration.

In previous studies by the authors (Yessimova et al., 2024) [14], a survey on sustainable management and social well-being was conducted. The results of the study revealed the main barriers to the implementation of sustainable development criteria in tourism in Pavlodar region, as well as attitudes towards potential compliance with GSTC criteria. As a result of this study, it was revealed that, in general, representatives of the tourism industry are not motivated to implement a sustainable tourism strategy. However, because the tourist destination has the status of a specially protected natural area, the authors of our study suggests that this area of activity will meet loss resistance, since the main focus of the natural park is environmental protection.

4.2. Calculation of the Carbon Footprint of Enterprises in Bayanaul Region

As a result of calculations, it was revealed that the total greenhouse gas emissions of holiday homes amounted to 530 tons of CO_2-eq., of which more than half (57%) accounted for scope 3 (emissions in the value chain of a tourist product: the purchase of goods and services to serve tourists). Indirect emissions from scope 2 were related to the purchase of electricity amounting to 119 tons of CO_2-eq. (22.5%). Direct emissions (scope 1) of the facility were associated with heating in winter with coal and amounted to 108 tons of CO_2–eq. (20.5%) (Table 6).

Table 6. Results of the inventory of greenhouse gases (tons of CO_2 eq) of covers 1, 2 and 3, for the holiday home.

Sources of GHG	Tons of CO_2 eq.
Total (scope 1 + scope 2)	227
Total (scope 1 + scope 2 + scope 3)	529
Scope 1	108
Mobile sources	-
Stationary sources	108
Scope 2	119
Purchased electricity, market method	119
Scope 3	302
Category 1: Purchased goods and services	53
Category 3: Fuel and electricity life cycle (emissions not included in scope 1 or 2)	52
Category 4: Transportation of raw materials and purchased goods	108
Category 6: Waste generated	90

The main source of direct GHG emissions of scope of 1 for the recreational center is the burning of coal (108 tons/year); the organization does not have its own transport. The necessary electricity (121,466 kWh/year) is purchased from the territorial electric grid company from the national grid (scope 2).

The main sources of indirect emissions of scope 3 include category 4 emissions (transportation, including the arrival of visitors), amounting to 108 tons of CO_2-eq. (35.7%). Category 6 (waste generated) amounted to 90 tons of CO_2-eq. (29.7%). Category 1 (purchased goods and services) and category 3 (energy) accounted for 53 tons of CO_2-eq. (17.4%) and 52 tons of CO_2-eq. (17.2%), respectively.

Based on the inventory results, the most significant contribution to the total greenhouse gas emissions of holiday homes is made by direct coal burning during the heating season and waste management. Therefore, in order to reduce the carbon footprint, it is

recommended, first of all, to reduce the dependence on coal, improve waste management and pay special attention to green procurement.

4.3. Assessment of Factors of Sustainable Tourism Development

Based on the analysis of the response codes received and their categorization, as well as the results of calculations of the carbon footprint, the following were identified: the degree of implementation of the principles of environmental sustainability in the destination, the main challenges and gaps (Table 7).

Table 7. The degree of implementation of GSTC sustainable development criteria in the Bayanaul National Park destination.

Criterion	Degree of Implementation	Barriers and Challenges	Opportunities
D1: Monitoring and management	There is a monitoring and reporting system; stands for informing tourists	Unknown purpose of money distribution; limited availability of reports	Increased transparency; publication of reports to the public
D2: Tourist flow management	Standards of recreational activity are observed; monitoring of tourists and acceptance of payment	Lack of a code of practice for tour guides	Interaction with guides/tour operators on the management of visitors to natural sites
D3: Interaction with nature	Laws are respected; information is provided through guides	Lack of professional training for guides	Development and publication of rules of conduct in specially protected natural areas
D4: Conservation of species	Informing about rare species through booths and guides	Lack of a program to promote eco-friendly souvenirs; lack of recommendations for behavior in nature	Training programs for guides in interacting with animals and plants in specially protected natural areas
D5–D7: Energy efficiency and resource management	Using energy-saving technologies	Lack of renewable energy sources; high dependence on coal	Use of renewable energy sources; modernization of energy consumption systems
	There are no water saving systems; data on water use are not published and there is no drainage system	Outdated sewage treatment plants	Optimization of water resources, investments in modern technologies
D8–D10: Waste and emissions management	Partial accounting of emissions; no sorting	Outdated sewage treatment plants; lack of green procurement	Implementation of waste recycling systems; development of environmentally friendly procurement
D11: Eco-friendly transport	Eco-friendly transport is not used	High cost of implementation	Subsidies and incentives
D12: Light and noise pollution	General requirements for noise pollution	Lack of mechanisms for interaction with the administration	Introduction of standards for monitoring and interaction with the administration

As a result of the analysis of the degree of availability of principles of environmental sustainability, it was revealed that there are certain achievements in accordance with the GSTC criteria, but significant gaps in achieving the goal of sustainable development have been identified. Among the positive aspects, first of all, it is worth noting the availability of a monitoring and reporting system in the environmental sphere. Since the tourist destination is located in a specially protected area, the observance of norms and laws is respected and monitored by government agencies. Also, part of the funds collected from tourists for the use of natural parks is directed to environmental protection measures. Difficulties that limit progress towards environmental sustainability include the lack of

transparency in the allocation of funds raised and the inaccessibility of reporting to both the public and stakeholders. There is a disconnect between the administration, the local community, guides, businesses and tourists. In this regard, additional problems may arise in the interaction and transfer of the main strategies in the field of environmental protection from the administration of Bayanaul National Park to tourism enterprises, tour guides and tourists. In addition, major problems have been identified in the field of energy efficiency and resource management of the destination. To a greater extent, this is due to outdated infrastructure, such as an outdated water management system. Due to high costs, alternative energy sources, ecological transport and other modern technologies have not been implemented in the destination. Such implementations should be initiated by the state and investments should be attracted. Also, the problem of the destination is the lack of a waste recycling system, waste separation and any recommendations for students and entrepreneurs operating in the park.

As a result of the identified problems, it seems logical to propose approaches that can solve these problems: the introduction of educational initiatives and improved interaction between participants in the process, increased transparency of management processes and improved interaction with the local population and other stakeholders. Upgrading infrastructure, including the introduction of renewable energy sources, efficient water management and waste recycling systems, is also a priority. Special attention should be paid to attracting investments and subsidies from public and private sources aimed at supporting environmentally friendly transport and upgrading outdated sewage treatment plants.

Using the method of expert assessments of the survey and interview results, the degree of implementation and the problems regarding environmental sustainability in Bayanaul State Natural Park using the ranking method, the main factors that play an important role in improving environmental sustainability and reducing the carbon footprint in the destination were identified.

Thus, 10 leading factors (and the GSTC criteria) that have an impact on environmental sustainability were identified (Table 8). Only the factors that scored more than 6 points were taken into account, according to the results of the average assessment of all experts.

Table 8. Ranking of factors affecting environmental sustainability and reducing the carbon footprint of BSNNP.

№	Factor	Score
1	Stimulating the introduction of environmentally friendly technologies (D11.1)	9.8
2	Energy efficiency and renewable energy use (D5.1)	9.7
3	Accounting for greenhouse gas emissions (D8.3)	9.7
4	Waste management (D8.1, D8.2)	8.9
5	Training for calculating the carbon footprint (D8.3)	8.8
6	Green procurement (D10.2)	8.5
7	Training of guides and tour operators (D3.2)	7.3
8	Developing mechanisms for stakeholder engagement (D1.2, D1.4)	7.2
9	Improving transparency and accountability (D1.3)	6.9
10	Tourist information programs (D3.1, D4.2)	6.6

Experts gave the highest impact points to factors related to energy efficiency and the use of renewable energy sources (D5.1), accounting for greenhouse gas emissions (D8.3) and encouraging the introduction of environmentally friendly technologies (D11.1). The experts also noted such elements as waste management (D8.1 and D8.2) and accounting for greenhouse gas emissions (D8.3).

The learning factor for calculating the carbon footprint (D8.3) demonstrates the importance of reducing the carbon footprint, as well as waste management and green procurement. The factors of informing tourists (D3.1 and D4.2) and improving transparency and accountability (D1.3), although not having an impact, could not be excluded by the authors and experts, as many of the GSTC criteria included this aspect, especially in regard to informing the target consumer about the sustainable tourism of the destination where it is located as well as increasing stakeholder engagement.

Thus, based on the ranking of factors and an expert assessment of their impact on reducing the carbon footprint (by analogy with the MICMAC method), all factors were divided into four categories: drivers, connecting elements, dependent and autonomous (Table 9).

Table 9. Interaction factors in environmental sustainability management.

Driving factors
Energy efficiency and renewable energy use (D5.1)
Green procurement (D10.2)
Stimulating the introduction of environmentally friendly technologies (D11.1)
Training for calculating the carbon footprint (D8.3)
Linking factors
Training of guides and tour operators (D3.2)
Development of interaction mechanisms (D1.2, D1.4)
Improving transparency and accountability (D1.3)
Dependent factors
Waste management (D8.1, D8.2)
Accounting for greenhouse gas emissions (D8.3)
Autonomous factors
Tourist information programs (D3.1, D4.2)

According to experts, the main role in the implementation of criteria for sustainable tourism, as well as reducing the carbon footprint, is played by such drivers as increased energy efficiency, the introduction of renewable energy sources, the introduction of training for calculating the carbon footprint and the promotion of environmentally friendly technologies. These measures have a significant impact on other elements of the system.

Linking factors such as the training of guides and tour operators, the creation of mechanisms for stakeholder engagement and increased transparency of management play an important role in strengthening the links between the key elements. They ensure the coordination and integration of the work of stakeholders, including local communities and tourists.

Waste management and accounting for greenhouse gas emissions are among the dependent factors. Their functioning depends on the efficiency of the drivers and the coordination of connecting factors. For example, the implementation of waste management systems can be implemented through encouraging the introduction of environmentally friendly technologies (waste recycling) and training (waste sorting).

Autonomous elements such as tourist awareness programs play an important role in shaping environmentally responsible visitor behavior.

4.4. Development of a Model for Sustainable Tourism Development

The identification of factors made it possible to create a model of ecological sustainability of tourism adapted for Bayanaul State Natural Park (Figure 2). The structure of the model

repeats the hierarchy of interaction factors, and has the main driving forces, interaction elements and dependent factors, but also includes practical implementation mechanisms.

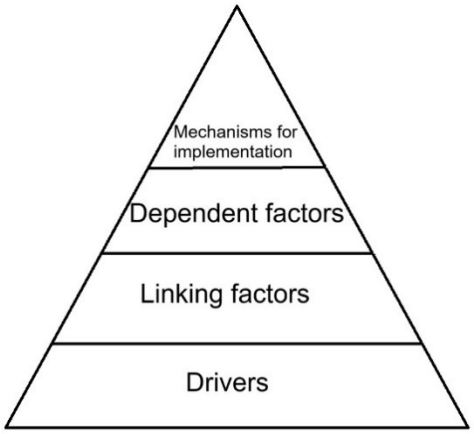

Figure 2. Structure of the model of ecological sustainability of tourism.

The model is based on an analysis of key factors identified based on expert assessments. The purpose of the developed model is to develop the main directions and recommendations that the destination must fulfill in order to increase sustainability and reduce its carbon footprint in the current conditions.

The sustainable tourism model is based on driving factors. The driving forces of the model include the introduction of energy-efficient solutions, the use of renewable energy sources and the development of environmentally oriented technologies, as well as training. These measures lay the foundation for transformation.

1. Drivers (the main driving factors).

Energy efficiency and the use of renewable energy (D5.1): replacement of equipment with energy-efficient solutions (e.g., LED lighting, energy management systems); elimination of heat loss through walls, windows, roofs and doors (e.g., insulation of buildings, installation of energy-saving windows and doors).

Green procurement (D10.2): development of sustainable procurement standards for the tourism industry; support for local suppliers of environmentally friendly goods and services.

Encouraging the introduction of environmentally friendly technologies (D11.1): providing tax incentives and subsidies for the introduction of environmentally friendly technologies.

Carbon footprint calculation training (D8.3): employee training in carbon footprint calculation techniques; monitoring greenhouse gas emissions; using the data obtained to develop emission reduction targets.

The next stage of the model is the elements of interaction and coordination (connecting factors). They provide communication between the various participants in the process. For example, the training of guides and tour operators enhances the environmental awareness and responsibility of tourists. The creation of working groups consisting of representatives of local communities, businesses and authorities and other stakeholders allows us to coordinate actions and develop joint solutions. In turn, the transparency of the destination's activities and regular information about the results of environmental initiatives contribute to the involvement of a wide audience, as well as the ability of this audience to influence management decisions.

2. Connecting factors (key elements of interaction).

Training of guides and tour operators on the rules of behavior in protected areas (D3.2): development of guide training programs focusing on the conservation of biodiversity and responsible behavior in nature (including waste management).

Development of mechanisms for interaction between stakeholders (D1.2 and D1.4): formation of working groups with the participation of business, authorities and local communities; holding regular meetings and discussions to jointly solve environmental problems.

Improving transparency and accountability (D1.3): developing mechanisms for publishing environmental reports; informing the public and tourists about the results of monitoring and the implementation of environmental goals.

The dependent factors in this model represent specific actions that will be implemented under the influence of the leading factors. Waste management and the control of greenhouse gas emissions depend on the successful implementation of the driving forces and the interaction of stakeholders. The efficient organization of waste recycling processes and the monitoring and publication of data on CO_2 emissions contribute to achieving environmental goals. These initiatives require support and coordination at all levels.

3. Dependent factors (elements that depend on other actions).

Waste management (D8.1 and D8.2): organization of waste sorting and recycling; training of employees and tourists on waste management.

Accounting for greenhouse gas emissions (D8.3): regular monitoring and reporting of CO_2 emissions; publication of data to increase transparency and stakeholder engagement; setting targets to reduce emissions.

The model also includes practical implementation mechanisms to achieve its goals. These include systematic monitoring, training programs and partnership development. Monitoring allows you to regularly assess the current state of the destination, identify problems and monitor the effectiveness of measures. The training promotes environmentally responsible behavior among employees and visitors. The partnership helps to pool efforts and resources to implement initiatives.

4. Implementation mechanisms (practical steps).

Training and education of staff and tourists;

Continuous monitoring to ensure measurable and manageable progress;

Development of partnerships in the form of integration of resources and efforts of various stakeholders.

Thus, the proposed model of sustainable tourism is a multi-level system focused on achieving the environmental sustainability of Bayanaul Park.

To develop such models, the authors propose a development method that adapts the criteria for a specific object or destination, as well as the stages of model implementation (Figure 3).

The process of creating a model begins with an analysis of the current state, including a detailed assessment of the level of implementation of GSTC criteria in the destination. The data obtained as a result of surveys, interviews and analysis of the existing infrastructure are used. Based on the analysis, a roadmap is being formed that takes into account all aspects of sustainable tourism. The action plan adapts to the specifics of the destination, including its environmental, social and economic conditions.

The implementation of the model begins with the launch of carbon footprint monitoring and the fulfillment of environmental goals. Mechanisms for tracking key indicators of sustainable development are being created, as are those for tracking interaction between various departments, including local governments, businesses and public organizations.

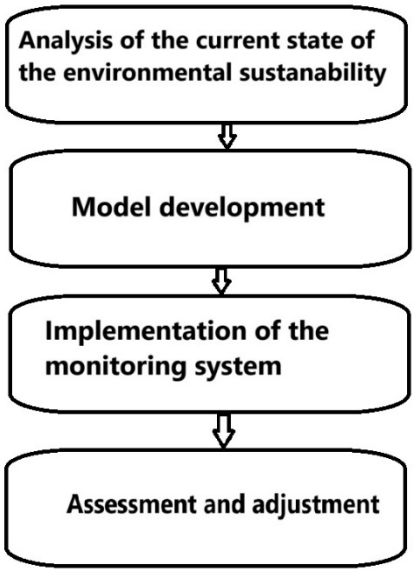

Figure 3. The process of developing and implementing a sustainable development model for a destination.

The final stage is an annual assessment of the effectiveness of the implemented measures. This includes analyzing monitoring data, evaluating the achievement of environmental goals and collecting feedback from participants. Based on the data obtained, strategies are adjusted, and changes are made to the action plan, which makes it possible to increase the effectiveness of the model. Ultimately, the implementation of the above recommendations will not only bring us closer to GSM standards but also strengthen the reputation of the destination as an environmentally responsible and attractive region for tourists.

5. Discussion

The results of our study confirm and refine the conclusions of other authors. For example, Liu et al., 2017 [25] focus on the significant contribution of tourist accommodation to the carbon footprint, especially as a result of indirect emissions. Our results confirm this: 57% of emissions come from scope 3, which highlights the importance of environmentally conscious procurement and reducing the carbon footprint through supply chain control. This is also consistent with the recommendations of Hassan et al., 2022 [52] illustrating that waste management and the use of sustainable technologies can significantly reduce emissions.

The problem of insufficient awareness of travel operators about the methods of calculating greenhouse gas emissions, noted by Chan, 2021 [26], is confirmed by our study. We also identified the need to introduce educational programs in Bayanaul National Park in order to eliminate this barrier.

A study by Wang et al., 2017 [19] confirms the key role of waste sorting and recycling systems for sustainable tourism. However, our results show that such systems have not yet been implemented, which remains a significant barrier for the region. The problem of insufficient transparency in the distribution of income from tourism, noted by Zhu et al., 2019 [29], is also characteristic of the destination under study. This reduces the trust and involvement of stakeholders, which confirms the need to increase the transparency of management.

Our research data confirm the importance of implementing the GSTC criteria to achieve sustainable development. Yessimova et al., 2024 [14] note that such criteria provide a framework for assessing the state of sustainability. Our study highlights that the use of renewable energy sources proposed by Gangji, 2024 [22] plays a crucial role in reducing the

carbon footprint. In addition, the adaptation of international standards, as emphasized by Yang et al., 2023 [53], should take into account regional peculiarities, a method that was implemented in our model for Bayanaul National Park.

The present study stands out in several unique aspects. We have clearly divided emissions by coverage (1, 2 and 3), which makes it possible to make accurate recommendations. We have adapted the GSTC taking into account the features of Bayanaul and developed a practical roadmap. We also identified key drivers such as energy efficiency and green procurement, connecting elements such as party interaction and dependent factors such as waste management. These aspects allow us to propose a new approach to improving the environmental sustainability of tourism in Kazakhstan.

6. Conclusions

The research identified gaps and opportunities in managing the environmental sustainability of tourist facilities by applying GSTC standards and assessing the carbon footprint of tourism enterprises. The analysis highlights the relevance of sustainable tourism in the context of global climate change and the need to adapt international standards to national specificities.

Despite the existing measures aimed at protecting natural resources in Bayanaul State National Park, problems remain such as insufficient transparency in the distribution of income from tourism, outdated infrastructure, including coal heating and the lack of separate waste collection systems, and low awareness of tourists about the principles of sustainable tourism. The analysis of the carbon footprint revealed that more than half of the emissions (57%) are indirect emissions related to procurement and logistics. This highlights the need for a responsible approach to supply chain management.

The integration of energy-saving technologies such as LED lighting and energy management systems, as well as the transition to renewable energy sources, is recommended. To improve environmental literacy, it is proposed to develop educational programs for both tourists and employees of the tourism industry. In addition, it is important to modernize waste management by introducing separate collection and recycling systems. An important step will be to ensure transparency in the use of tourism revenues, which can increase the trust of the local community and tourists, as well as attract investments for the implementation of environmental projects.

The theoretical contribution of this study is to adapt the international GSTC standards to the conditions of Kazakhstan and integrate the carbon footprint assessment across all coverage areas (1, 2 and 3) into the overall sustainable tourism management model. For the first time, a management model has been developed that not only takes into account the environmental and social characteristics of the region but also offers specific measures to reduce the carbon footprint. This approach can become the basis for further research and practical implementation in other conservation areas.

Practical recommendations are of interest to the administration of a tourist destination and entrepreneurs seeking to make their business more sustainable and competitive. In addition, they are important for environmental organizations, including authorized bodies responsible for environmental protection and tourism development.

Future research will focus on the process of implementing the proposed model, assessing its long-term impact on environmental and socio-economic aspects and developing universal approaches to adapt it to other conservation areas.

The study has certain limitations. It is focused on one site, Bayanaul State National Park, which requires the adaptation of proposals for other regions. In addition, the emissions analysis considered only carbon dioxide, excluding other greenhouse gases, which may limit the completeness of the environmental assessment. Also, the lack of complete

statistical information on tourist flows reduces the possibility of accurate forecasting and analysis of seasonal loads.

In conclusion, it should be noted that this study represents an important contribution to the development of sustainable tourism, providing a theoretical framework and practical recommendations for improving environmental sustainability and reducing the carbon footprint. The application of the proposed measures can significantly improve the situation in Bayanaul National Park, as well as create a basis for further research and the introduction of similar approaches in other regions.

Author Contributions: Conceptualization, D.Y.; methodology, Z.S.; validation, A.B.; formal analysis, A.Y.; investigation, A.F. and A.B.; data curation, A.B. and Z.S.; writing—original draft preparation, A.F. and A.Y.; supervision, D.Y.; project administration, D.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP19676336).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are contained within the article.

Acknowledgments: We acknowledge the use of OpenAI's ChatGPT, to provide supplementary ideas during the model development process. These ideas were carefully reviewed and integrated into the study by the authors and experts in the field. AI did not contribute to the analysis or interpretation of the research data. We also acknowledge the use of ChatGPT (https://chat.openai.com/) as an auxiliary tool to identify improvements in the writing style, as well as for the coherence and clarity of the content. Authors affirm AI did not participate in the analysis of information. The entire process of writing the manuscript was carried out by the authors, as was the identification of goals and objectives, selection of methods, processing of results, analysis and formulation of conclusions and recommendations. We also acknowledge the use of Scite_ (https://scite.ai/) to find relevant research and the most recent articles in the area of study. Then, the authors independently selected the most suitable articles for analysis in this study.

Conflicts of Interest: The authors declare no conflicts of interest.

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