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Economic evaluation of ecotourism development based on saiga populations in Kazakhstan

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Abstract

The aim of this study is to develop and economically justify a model of a tourist ecozone for saiga conservation in saiga habitats. The study focuses on predicting the growth of the animal population, as well as increasing the flow of tourists to the selected areas of Kazakhstan. The paper calculates the investment attractiveness of a project to build infrastructure for tourists in the areas of animal distribution and migration. The study used a comprehensive approach to study the development of ecotourism in the region. Data for the period 2019-2024 were used for model building. Investment attractiveness was assessed using quantitative indicators NPV and IRR. The approach based on the integration of the methods used makes it possible to assess the investment attractiveness of ecotourism development in the region. The results show that there is a correlation between an increase in the number of tourists to protected areas and an increase in the saiga population in the same areas, so the development of ecotourism is attractive from an investment point of view. The project has a high degree of sustainability and a quick payback period. IRR = 34.5% with a payback period of less than 3.2 years. The projected growth of tourism revenues in the region by more than 3.8 times demonstrates the economic feasibility of investment in the ecozone. The novelty of the study lies in the author's modeling of the relationship between saiga population growth and the investment attractiveness of ecotourism development through a comprehensive assessment. The originality of the study lies in the identification of the correlation between the growth of tourist flow and the habitat of a particular wildlife species, and the construction of models for forecasting the development of the main components to determine the investment attractiveness. The results can be used to attract investment in the ecotourism sector and optimize management decision-making processes. A significant factor of sustainable development the ecological conservation of saiga populations is taken into account. The proposed solution can be used in different countries of the world to conserve saigas in their compact habitats.

Keywords: Ecology, Ecotourism, Forecasting, Innovation, Saiga population, Sustainable development.

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1. Introduction

Ecotourism is an important form of tourism for sustainable development, aimed at visiting natural areas for the purpose of studying, preserving, and observing nature. According to the International Ecotourism Society (TIES), this type of tourism is distinguished from mass tourism by three key principles: minimal environmental impact, support for local communities, and environmental education [1].

There are many examples of successfully implemented ecotourism projects to conserve endangered species. An example of implementing sound natural resource management while creating ecotourism opportunities is the return of native American wild horse species to the wild, which is both ecologically and economically viable [2]. Tourism revenue for elephant eco-hotels in Botswana goes toward elephant protection [3].

One of the wild animals on the Red List is the saiga, a species of antelope that, in ancient times, inhabited a vast territory from the foothills of the Carpathian Mountains and the Caucasus to Mongolia and Dzungaria [4]. Today, the dominant subspecies is found in the steppes and semi-deserts of Eurasia, but most of it is concentrated in Kazakhstan.

By 2005, the global saiga population had declined by more than 95% [5]. It is estimated that fewer than 70,000 individuals remained from the previous population of nearly 2 million by 2005, mainly due to poaching for meat and horns used in Chinese medicine [6]. A Memorandum of Understanding on the Conservation, Restoration and Sustainable Use of Saiga [7] was adopted on September 24, 2006, under the auspices of the Convention on Migratory Species of Wild Animals. It aimed to protect and restore the world's saiga population.

In 2024, the Kazakhstan Saiga Conservation Project was nominated for the Prince William Award, supported by the United Nations Environment Programme. The significance of this project is determined by its background: almost 50% of the 75 million hectares of prehistoric grasslands were degraded or destroyed due to overgrazing during the Soviet era to meet targets, leading to a dramatic decline in wildlife populations [8].

Today, saiga watching is a unique form of ecotourism, combining scientific interest, aesthetic pleasure, and contributions to conservation. Ecotourism in Kazakhstan is closely linked to nomadic culture, where respect for nature is part of the worldview, and saigas are a symbol of the Kazakh steppes.

It is expected that the results of this study will guide future research and can be adapted in different contexts to understand the investment mechanism in other ecotourism areas. In addition, relevant and practical models are provided to determine the investment attractiveness of ecotourism development and conservation of significant wildlife species to maintain biodiversity. This study also opens up opportunities for comparative and further research on ecotourism economics, financing, and sustainable development.

2. Literature Review

The concept of sustainable development has become a recognized goal for human society in the 21st century. Initially, the idea was seen as a strategy to combat environmental catastrophe resulting from excessive commercial exploitation of resources and environmental degradation. The focus was on maintaining an exceptional environment. Today, this idea has been expanded; it has high economic and social relevance. The evaluation of financial methods in many countries has proved that rapid financial growth has accelerated critical problems in terms of sustainable development, so now economic development is considered in conjunction with other areas [9].

Research on sustainable development [10-12] emphasizes the interconnection of economic, environmental, and social growth to enhance overall well-being while balancing intergenerational interests. The concept of sustainable development is often associated with the concept of sustainability, and thus both terms are used synonymously [13]. However, it is impossible to sustain infinite economic growth on a finite planet [14]. This position warns of an immeasurable problem in the social, political, economic, cultural, and environmental fields.

Economic sustainability is a system of production that meets current levels of consumption without jeopardizing future needs. Social sustainability is about equity, empowerment, accessibility, participation, cultural identity, and institutional stability. Environmental sustainability is the ability to maintain ecological balance in the natural environment of our planet and conserve natural resources to maintain the well-being of present and future generations [15].

Dissemination of the concept of sustainable development takes place through the transmission of information to raise awareness of the need to balance the environment, economy, and society. It aims to implement sustainable infrastructure, reduce environmental impact, and lower economic costs.

Investments aimed at generating positive environmental and social impacts along with financial returns are among the promising areas of economic development. Investors are seeking financially lucrative ecotourism finance projects that benefit the community and the environment [16].

Studies by Damodaran [17] and Brealey et al. [18] describe the underlying principles of investment project appraisal and the use of NPV and IRR. The development of ecozones in the habitats of rare species such as saigas requires an integrated approach that combines ecological, economic, and statistical methods of analysis. The principles outlined in Box et al. [19] for ARIMA and Hyndman and Athanasopoulos [20] for regression approaches allow us to predict ecosystem pressures and adjust business models.

Economic studies by Stronza et al. [21], Voronina et al. [22] and Aslanova [23] show that despite high initial costs, ecohotels can achieve profitability through premium pricing, government subsidies, and tax incentives for green projects, as well as indirect benefits such as improved image of the region and growth of related industries (e.g., sightseeing services).

The linkages identified in the review of the above research indicate that there is a need to move from general arguments to specific proposals and projects that are justified from an ecological-economic perspective. Understanding investment attractiveness can be critical to the development of the region's infrastructure and the development of ecotourism as a reliable source for implementing support measures for endangered species conservation.

The hypothesis of the study suggests that natural areas where saigas are densely populated may be attractive for ecotourism development, which could be used to derive economic benefits from the problem of saiga overpopulation.

3. Methodology

3.1. The Basis of the Study

The information base of the research consists of statistical and primary data for 2019-2024, obtained from open sources of the Ministry of Ecology and Natural Resources of the Republic of Kazakhstan and the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan.

The main saiga habitats are concentrated in the following regions of Kazakhstan:

- The Betpak-Dalinsk population (Central Kazakhstan) is distributed in the Irgiz-Turgai reservation, Ulytau Oblast. The largest grouping, approximately 1 million individuals, is represented here.
- The Volga-Ural population (Western Kazakhstan) is located in the territory of the Western Kazakhstan region, near the Ural River. Here, migration routes pass close to roads, which facilitates observation.
- The Ustyurt population of saigas (southwest Kazakhstan) lives in the Mangystau region, on the Ustyurt Plateau. However, this population is the smallest.

The Betpakdala and Volga-Ural saiga populations in the Kostanai and Turkestan regions were selected for analysis and calculations. It is among these two populations that there has been a significant, steady increase in the number of individuals. The other saiga habitats are small and not suitable for statistical analysis.

The main saiga populations live in the Saryagash and Kostanai resort areas of Kostanai and Turkestan provinces.

The Saiga Spirit of the Steppe programme has already been implemented as an ecotourism initiative in saiga habitats. This is a comprehensive initiative aimed at conserving saiga populations in Kazakhstan through ecotourism, research, and community involvement. The project is supported by the Association for the Conservation of Biodiversity of Kazakhstan (ACBK), the Committee of Forestry and Wildlife of the Republic of Kazakhstan, and international organizations (WWF, UNDP). This experience is proposed to be used for the development of ecotourism based on the construction of ecohotels and infrastructure in the forecast part of the study.

3.2. Methods

In this study, two key models are used for time series analysis and forecasting: ARIMA (Autoregressive Integrated Moving Average) and MLR (Multiple Linear Regression). Both techniques are used to identify dependencies in the data but have different theoretical bases and scopes of application.

1. The ARIMA model (autoregressive integrated moving average) is designed to analyze and forecast non-stationary time series. It includes three main components:

1) AR (p) - autoregressive part, which describes the dependence of the current value of the series on its previous values (1):

$$y_t = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t, \quad (1)$$

where c – is a constant (free term);
p – autoregressive order;
ϕ – coefficients;
ε – mistake;
t – moment in time.

2) I (d) – integrated part, which ensures stationarity of the series due to differentiation of order d.

3) MA (q) – a moving average that reads the effect of past errors on the current value (2):

$$y_t = \mu + \varepsilon_t + \theta_1\varepsilon_{t-1} + \theta_2\varepsilon_{t-2} + \cdots + \theta_q\varepsilon_{t-q}\ , \quad (2)$$

where μ – is the mean value of the process;
ε – mistake;
t – moment in time;
q – order of the moving average;
θ– coefficients.
The ARIMA construction process:

- Checking the series for stationarity (Dickey-Fuller test);
- Selection of parameters p, d, q using ACF and PACF;
- Model estimation (AIC, BIC) and residuals diagnostics (Ljung-Box test).

2. MLR (Multiple Linear Regression) model

Multiple linear regression (MLR) is used to analyze the effect of several independent variables X_1, X_2, ..., X_n on the dependent variable Y (3):

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon, \quad (3)$$

where β – regression coefficients;
ε – mistake;
n – order;
X – are the variables.
MLR Features:

- Suitable for analyzing cross-sectional data;
- Requires testing for multicollinearity (VIF test), heteroscedasticity (Breusch-Pagan test), and normality of residuals;
- Interpretation of the coefficients makes it possible to assess the strength and direction of the influence of factors.

A comparison of the two forecasting models is presented in Table 1.

Table 1.
Comparison of ARIMA and MLR approaches.

Criterion	ARIMA	MLR
Data type	Time series	Cross-referenced data
Objective	Forecasting	Assessing the impact of factors
Flexibility	Takes trends and seasonality into account	Requires linear assumptions

Source: model comparisons are based on the principles outlined in Box et al. [19] for ARIMA and Hyndman and Athanasopoulos [20] for regression approaches.

In the study, ARIMA is used to forecast the dynamics of the time series, and MLR is used to analyze the factors affecting the studied indicator. Combining these methods allows for obtaining more reliable and easily interpretable results. To assess investment attractiveness, the calculation of the net present value of the project is used (4).

$$NPV = -C_0 + \sum[CF_t / (1 + r)^t] \text{ для } t = 1 \text{ до } T, \quad 4)$$

where: C_0 – initial investment (at time t=0);
CF_t – net cash flow generated by the project at the end of period t;
r – discount rate reflecting the required return (%);
T – the life of the project (Y years).
All calculations were performed using the following software: JupiterBook, Python 3.10.

4. Results

4.1. Comparative Analysis of Saiga Population Dynamics and Tourism Indicators.

Between 2019 and 2024, saiga populations in Kazakhstan increased more than 10-fold, with the Volga-Ural and Betpak-Dalinsk populations being the main increases (Table 2).

Table 2.
Saiga population dynamics, thousand individuals.

Population	2019	2021	2022	2023	2024
Volga-Uralskaya	217.0	545.0	801.0	1190.0	1620.0
Betpak-Dalinskaya	111.5	290.0	489.0	745.3	1150.0

Source: Compiled by the author according to the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan Bureau of National Statistics [24].

Designated saiga populations occur in the Kostanai and Turkestan regions, including the Saryagash and Kostanai resort zones. Calculations have shown that the rate of growth in the number of tourists in these areas outstrips the rate of growth in the rest of Kazakhstan's tourist zones (Table 3).

Table 3.
Number of guests accommodated in temporary accommodation in resort areas, thousand people.

Resort area	Number of guests, thousand people					2024/ 2020
	2020	2021	2022	2023	2024	
Saryagash	17.7	30.3	39.4	56.1	71.4	4.0
Kostanay	4.5	10.9	16.5	14.0	17.5	3.9
Total of both areas with saigas	22.3	41.2	56.0	70.2	88.9	4.0
Other resort areas	3939.6	6011.6	8109.0	9231.8	10280.0	2.6

Source: compiled by the author according to the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan Bureau of National Statistics [25].

If we compare the average check per tourist, we can see similar dynamics (Table 4).

Table 4.
Average check per 1 person, USD/day.

Resort area	Check for 1 person					2024/ 2020
	2020	2021	2022	2023	2024	
Saryagash	11	51	43	32	36	3.2
Kostanay	26	38	43	45	77	3
Total of both areas with saigas	15	47	43	34	43	2.9
Other resort areas	43	47	60	70	81	1.9

Source: Compiled by the author according to the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan Bureau of National Statistics [25].

This analysis allows us to form the hypothesis that saiga population growth and the influx of tourists to the regions of Kazakhstan where saigas live may be linked.

4.2. Correlation And Regression Analysis of Saiga Population Dynamics and Tourism Indicators of Kazakhstan Regions.

To test the hypothesis that the increase in saiga population influences the increase in tourist numbers, we calculate correlation coefficients by resort zone (Table 5).

Table 5.
Correlation coefficients between saiga numbers and tourist flows in saiga habitats

Resort areas	Saryagash	Kostanay	Both zones
Correlation coefficient	0.899558	0.818940	0.892123

The correlation coefficients are over 80%, indicating a high correlation between the number of tourists and saiga numbers in these resort areas.

To assess the significance of the impact, let's make regression equations for each resort area and jointly.

Table 6 presents a regression equation showing the degree of correlation between the number of saigas and the number of tourists in the Saryagash resort area.

Table 6.
Regression equation for the Saryagash resort zone.

Parameter	coef	std err	*t*	P-value	[0.025 0.975]
const	120.45	45.32	2.66	0.012	[28.91, 211.99]
Saigk	0.85	0.12	7.08	<0.001	[0.60, 1.10]
R-squared					0.81
F-statistic					50.12 (p < 0.001)
Durbin-Watson					1.78

The analysis shows a statistically significant strong correlation between saiga numbers and tourist flow in the Saryagash resort area ($p<0.001$). Each additional saiga is associated with an increase in tourist flow of 0.85 units. The model explains 81% of the variation in the data, demonstrating high predictive power.

Table 7 shows the regression equation showing the degree of correlation between the number of saigas and the number of tourists in the Kostanai resort area.

Table 7.
Regression equation for the Kostanay resort zone.

Parameter	coef	std err	*t*	P-value	[0.025 0.975]
const	85.30	38.15	2.24	0.034	[7.25, 163.35]
Saigk	0.72	0.15	4.80	<0.001	[0.41, 1.03]
R-squared					0.67
F-statistic					23.04 (p < 0.001)
Durbin-Watson					1.65

In the Kostanay zone also revealed a significant positive relationship (p<0.001), but its strength is somewhat lower: the coefficient is 0.72 with R^2=0.67. This may indicate the need to develop additional factors of attractiveness for tourists in this region.

Table 8 presents a regression equation showing the degree of correlation between the number of saigas and the number of tourists in the Kostanai and Saryagash resort areas.

Table 8.
Regression equation for Saryagash and Kostanay resort zones (total).

Parameter	coef	std err	t	P-value	[0.025 0.975]
const	102.87	29.74	3.46	0.001	[42.65, 163.09]
Saigk	0.79	0.09	8.78	<0.001	[0.60, 0.98]
R-squared					0.76
F-statistic					77.12 (p < 0.001)
Durbin-Watson					1.72

The analysis of the overall data confirms a stable dependence between the studied variables (p<0.001) with a coefficient of 0.79. The model explains 76% of the variations, which indicates the reliability of the revealed regularity when aggregating data for both resort zones.

The results of the regression analysis also confirm that there is a correlation between saiga numbers and the number of tourists, indicating a high potential for ecotourism development in saiga habitats.

4.3. Forecast of Saiga Population and Tourist Flow in the Saiga Habitat Regions.

The ARIMA model is used to generate the saiga population forecast, and the MLR model is used to estimate the volume of tourists. The average receipt per tourist for 2024 is indexed to inflation expectations of 15% annually, resulting in the following data (Tables 9-12).

Table 9.
Number of guests accommodated in temporary accommodation in resort areas, thousand people.

Resort area	2024	2025	2026	2027	2028	2029
Saryagash	71410	82964	96285	109606	122926	136247
Kostanay	17533	21069	23854	26639	29424	32 209
Total of both areas with saigas	88943	104033	120139	136245	152350	168456

Source: Compiled by the author on the basis of the ARIMA model.

Forecasting the dynamics of tourist flow and saiga population for the period 2024-2029 allows us to assess the prospects for the development of ecotourism in Kazakhstan. As shown in Table 9, a steady increase in the number of visitors to the Saiga resort areas is expected. In particular, in the Saryagash zone, tourist traffic is projected to increase from 71.4 thousand people in 2024 to 136.2 thousand by 2029, indicating that these areas are highly attractive to tourists.

According to Table 10, saiga numbers will also continue to increase, with the total population expected to reach 5.6 million by 2029.

Table 10.
Saiga population, thousand individuals.

Population	2024	2025	2026	2027	2028	2029
Volga-Ural population	1620	1910	2255	2600	2945	3290
Betpak-Dala population	1150	1317	1570	1823	2077	2330
Total of both areas with saigas	2770	3227	3825	4423	5022	5620

Source: Compiled by the author based on the application of the ARIMA model.

This growth confirms the effectiveness of conservation measures and creates favorable conditions for further development of ecotourism.

Table 11.
Average check per 1 person, USD.

Resort areas	2024	2025	2026	2027	2028	2029
Saryagash	36	40	47	53	62	70
Kostanay	77	87	100	115	132	153
Total of both areas with saigas	113	127	147	168	194	223

Source: Compiled by the author based on the application of ARIMA model.

The average check per tourist (Table 11) in the forecast shows positive dynamics, which is associated with both inflationary processes and improvement in the quality of services.

Table 12.
Volume of services rendered in accommodation facilities by resort zones, thousand USD.

Resort areas	2024	2025	2026	2027	2028	2029
Saryagash	2523	3371	4499	5889	7596	9682
Kostanay	1332	1841	2397	3079	3910	4923
Total of both areas with saigas	3855	5212	6896	8968	11506	14605

Source: Compiled by the author based on the application of the ARIMA model.

As shown in Table 12, tourism income from the saiga habitat will increase more than 3.7-fold, from US$3.9 million in 2024 to US$14.6 million in 2029.

The forecast indicates that if the saiga population growth rate is maintained, by 2029, the volume of services provided by accommodation in resort areas will increase significantly, which enhances the investment attractiveness of these areas and creates prospects for the development of ecotourism.

4.4. Assessment of the Effectiveness of Organizing Tourist Ecozones with Saigas in the Saryagash and Kostanai Resort Areas

The revenue forecast is based on the following assumptions:

- Number of tourists (Table 9);
- Average check of $150 (generated from the ARIMA method is higher than that obtained in Table 11 because infrastructure development will lead to more tourists with higher incomes.
- Annual growth of 15% (expected inflation rate).

The project payback calculation is summarized in Table 13.

Table 13.
Calculation of project payback.

Year	Number of tourists, persons	Average check, $	Revenues, $	Operating expenses, $	Net cash flow, $
2025	104 033	150	15604950	5201650	10403300
2026	119 439	172.5	20588228	6281940	14306288
2027	136 165	198.4	26997664	7569250	19428414
2028	155 640	228.1	35425824	9117600	26308224
2029	178 486	262.3	46787878	10924300	35863578
2030	205 264	296.7	60922841	13335840	47587001

The results of the assessment of the investment attractiveness of the saiga population-based ecotourism project demonstrate its high economic efficiency. The calculations are based on the following key parameters:

- Discount rate: 12 % (corresponds to the weighted average cost of capital including subsidies);
- Implementation period: 6 years (2024-2029);
- Total investment: $7247,000.

The net present value (NPV) of the project was $51,237,865 with a simple payback period of only 2.5 years (discounted - 3.2 years). The internal rate of return (IRR) was 34.5%, which significantly exceeds the threshold of 12%. This indicates a high stability of the project to possible market fluctuations. Sensitivity analysis of the project to key parameters showed:

1. When tourist traffic decreases by 20%, NPV maintains a positive value ($38921400);
2. When operating costs increase by 25%, IRR remains at 28.7%;
3. Even with a 1-year increase in implementation time, the project remains economically viable (NPV $43156200).

In addition, it is advisable to implement a special environmental fee for tourists in these zones, amounting to 5% of the average check. Such a fee has demonstrated its effectiveness in practice. For example, national parks in Kenya and Tanzania have an environmental fee of 5-7% (according to IUCN, 2023), and UNESCO projects in Mongolia use a similar percentage.

Funds can be directed to a designated fund (e.g., the Nature-Human Balance Fund) that will:

- Finance environmental protection measures;

- To compensate farmers for the damage caused by saigas;
- Support the development of ecotourism.

With this approach, the amount of eco-collection for 6 years will be $10316369 (Figure 1).

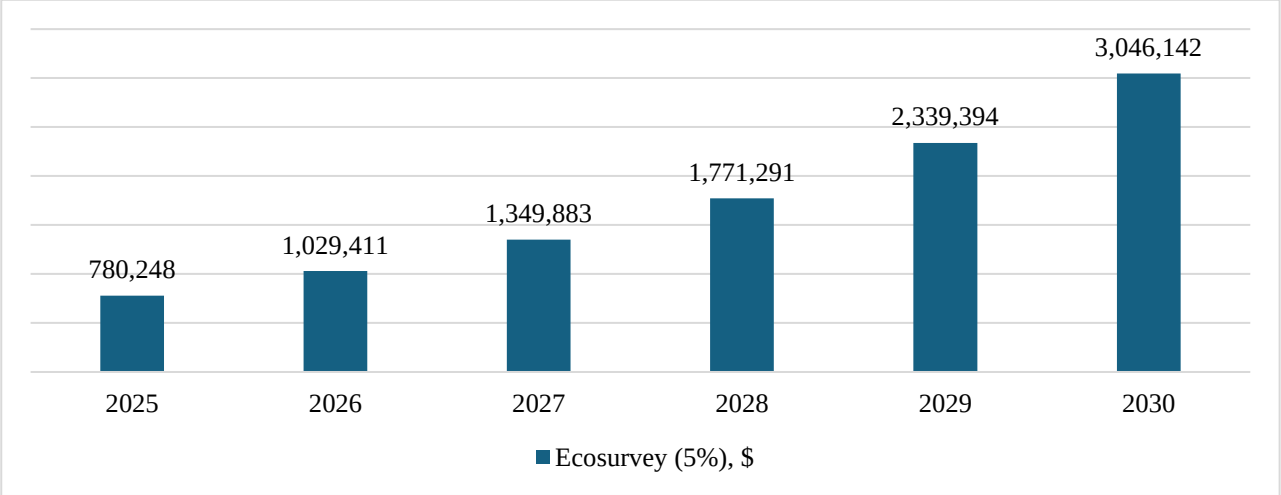

Figure 1.
Volume of eco-collection in saiga eco-zones. US$.

The investment calculations take into account the creation of infrastructure for saiga watching. This area could be considered a site for attracting investment to expand hotel construction. In this case, the construction should comply with certain requirements regarding design choices and sustainable materials. To conserve the saiga population, it should be considered that tourist infrastructure should be integrated into the surrounding area as much as possible. The use of natural materials such as adobe, reeds, and wood is recommended. Buildings should be low, blending in with the landscape—so-called 'invisible architecture'. This will allow observing one of the main principles of ecotourism—minimal impact on the environment.

5. Discussion

The proposed model of saiga ecozones focuses on predicting the growth of the animal population and increasing the flow of tourists to the selected areas of Kazakhstan. A calculation of the investment attractiveness of a project to develop infrastructure in areas of animal distribution and migration is presented. The results obtained develop and improve certain provisions that have been reflected in scientific papers.

A study on human-animal interactions [26] Shows the importance of integrating modern wildlife survey methods such as camera traps, satellite imagery of deforestation, and AI patrolling to predict conflicts with humans and optimize conservation. Studies have been conducted on elephant, crow, and buffalo sightings across India and Thailand. There is also a robust ecotourism certification system (Global Sustainable Tourism Council (GSTC)) based on strict criteria [27].

Ecotourism has the potential for economic development while maintaining the country's rich biodiversity asset base [28]. There is economic growth, increased income, and job creation for local people, including households that are not directly linked to tourism activities. There is a trade-off between conserving biodiversity, promoting economic development, and improving the standard of living in the region. Fully documenting economic benefits is a critical step towards making biodiversity conservation part of economic development and restoration plans.

Tourism can contribute not only economically but also socially to communities associated with protected areas. Both the benefits and disadvantages for local people should be considered. The main benefits for local people are employment, business opportunities, and income, while the main disadvantages are acculturation, abandonment of traditional lifestyles, and price inflation [29].

Assessing the suitability and economic viability of developing areas with compact habitats for protected animals is a prerequisite and a fundamental step in implementing ecotourism initiatives. A comprehensive assessment is necessary to make such decisions. In this direction, the present study is consistent with the findings of Zhang et al. [30].

In the scientific literature, we have not found any economic studies on the organization of ecotourism in saiga habitats. However, the conservation of saiga populations is reflected in the report on saiga conservation activities carried out by the Nature and Biodiversity Conservation Union (NABU) [31].

This report details the saiga conservation projects implemented by NABU in different countries. Key activities include community-based conservation through partnerships with local organizations such as Tabigi Orta, managing the Diyar hunting area, and piloting ecotourism. NABU also supports research on human-wildlife conflict, provides advice to decision-makers, develops educational materials, and actively participates in international discussions and agreements on saiga conservation.

A study by Yang et al. [32] examines the willingness of young people in China to participate in saiga conservation. They perceive the social importance of biodiversity conservation and are willing to participate in conservation activities. However, their limited experience of biodiversity conservation and lack of knowledge of saiga biology make them perceive

conservation activities as challenging. This could be an extension of the present study in the future. If channels for public participation in relevant activities are expanded and information campaigns and wildlife education are strengthened, greater economic benefits can be realized. Such activities will also help to increase interest in ecotourism and tourist flow.

Thus, our proposed model has the potential for further improvement to become a more universal tool for analyzing and managing sustainable development, not only for the region under consideration but also for the long-term growth prospects of the ecotourism sector as a whole.

6. Conclusions

The aim of this study was to assess the relationship between changes in saiga numbers and tourism indicators in order to predict the feasibility of organizing a tourist ecozone.

The overall result of this study is a systematic analysis and assessment of the effectiveness of ecotourism development in Kazakhstan in areas with compact saiga populations.

The data indicate that there is a correlation between saiga population growth and growth in tourist numbers in saiga habitats. The statistically confirmed high correlation (89.9%) between saiga population growth and tourism growth in the resort areas for 2020-2024 is evidence of the attractiveness of this wildlife species to tourists. The construction of a forecasting model for the key components of the project shows a steady increase in the number of tourists in the period 2025-2029. This confirms the hypothesis that it is economically feasible to organize ecotourism in saiga habitats.

The study has shown the investment attractiveness of ecotourism development in these territories. From an economic point of view, the project is profitable (IRR = 34.5% with a payback period of less than 3.2 years). The projected growth of tourism revenues in the region by more than 3.8 times (from $3.8 million to $14.6 million by 2029) demonstrates the economic feasibility of investment in ecotourism infrastructure. This creates a meaningful incentive for private investors and the state.

In addition, the construction of infrastructure to monitor saigas will ensure the conservation of a unique species of antelope. If properly implemented, such projects could reduce poaching, create new jobs, attract scientists, and make Kazakhstan one of the centers of ecotourism.

Overall, this study shows that the implementation of the proposed project will transform the region into a globally recognized center of responsible ecotourism, where the economic well-being of local communities is inextricably linked to the prosperity of the unique saiga population. The project reflects a cumulative model where conservation, research, education, and economic development reinforce each other. The future of ecotourism in the saiga range is a future of harmonious coexistence between humans and wildlife, based on knowledge, responsibility, and innovation.

The results suggest that active measures are needed to develop ecotourism. Attracting investment to develop saiga-watching infrastructure will contribute to the sustainable development of the region. The project could be adapted for other regions of the world with compact saiga populations.

7. Limitations and Future Research

This study has certain limitations due to data availability. choice of methodological approaches and assumptions.

Limited information on the revenues and expenditures of tourism enterprises. Financial and technological indicators can affect the accuracy of the results obtained. Although the models used take a comprehensive approach to predicting saiga population growth, they do not take into account biological and epidemiological factors. They also do not investigate changes in environmental legislation, geographical peculiarities of the development of specific territories, climatic, social, and demographic factors.

Certification and implementation of standards and programs of sustainable tourism for all market participants with a system of audit and certification, will develop ecotourism in the long term. Marketing research of the project is also needed. Developing not only observation of animals but also deep immersion in the steppe ecosystem and local culture. Creation of a strong brand “Saiga - a living symbol of the steppes of Kazakhstan” and certification of ecotours according to international standards (e.g., GSTC) will increase recognition and trust. This requires additional research.

In addition, future research should explore the potential use of tourism infrastructure as a base for research and studies. This approach could attract new target audiences, such as students and scientists, and increase the volume of services provided.

By addressing these limitations, future research can provide a deeper and broader understanding of ecotourism development in saiga habitats, leading to more effective and sustainable models for assessing and predicting the investment attractiveness of ecotourism development.

The findings of the study may serve as information for potential investors, ecologists, government agencies, international foundations, environmental protection organizations, and other stakeholders involved in ecotourism development in the region and wildlife protection.

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