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PLS-PM MODEL FOR SUSTAINABLE DEVELOPMENT OF ECOTOURISM: CASE STUDY OF ULYTAU NATURE PARK

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ABSTRACT

This article is devoted to a comprehensive study of the factors influencing the development of ecotourism in the Ulytau Nature Park, Kazakhstan. The authors use an integrated methodology that combines quantitative (statistical analysis) and qualitative (Analytic Hierarchy Process, survey of the local population) methods of analysis. The purpose of the study is to develop a model that allows predicting the development of ecotourism and justifying strategic decisions for its sustainable development.

As a result of the survey, 8 key factors affecting the development of ecotourism were identified: perceived environmental sustainability, perceived social cost, perceived economic benefits, maximizing community participation, long-term planning, community-centered economy, sense of place, and support for tourism development. Both subjective estimates (Analytic Hierarchy Process) and objective statistical data were used to determine the weights of these factors. Comparative analysis revealed discrepancies between subjective assessments and objective indicators, especially in the perception of the region's image.

The main result of the study is the development of a qualitative model that uses logistic regression to assess the impact of factors on the development of ecotourism. This model, which considers both subjective and objective data, allows to simulate various scenarios and predict the development of the industry. The results obtained make it possible to identify priority areas for the development of ecotourism in Ulytau and develop recommendations for the creation of a sustainable and socio-economically effective model for the development of ecotourism both for Ulytau and for other regions with similar conditions. The article contributes to the existing body of knowledge on sustainable tourism development by offering a multidimensional data-driven approach that goes beyond theoretical discussions.

Keywords: *ecotourism, Sustainable Development, PLS-SEM, PLS-PM, Ulytau Nature Park*

1. INTRODUCTION

Sustainable development of ecotourism has become an important direction in the modern world, given the growing need to protect the environment and its resources (Puška et al., 2019). Ecotourism, as a form of tourism, focuses on the interaction of man with nature, offering tourists to

discover a unique ecosystem, preserve it and at the same time enjoy communicating with nature (Huseyn & Abasova, 2024; Gabor et al., 2023).

The Ulytau Nature Park, which has a rich biodiversity and cultural heritage, is a unique platform for exploring the possibilities of integrating ecotourism into sustainable development strategies. Ecotourism not only contributes to the economic well-being of local communities, but also plays a key role in protecting the environment and maintaining the natural balance.

However, with the increase in tourist flows, there is a need to develop and apply methods to minimize the negative impact on the environment and promote the development of local communities.

The PLS-PM (Partial Least Squares Path Modeling) model is a powerful tool used in socio-economic and management research to analyze the complex relationships between variables. In the context of sustainable ecotourism development, this model allows to effectively assess the impact of various factors, such as economic, social and environmental aspects, on the success and sustainability of ecotourism initiatives. Using this model, it is possible to find out how different elements of the system interact with each other and how they affect the achievement of sustainable development goals (Bihun, R., Lytvyn, 2022).

PLS-PM makes it possible to create multidimensional models that allow not only to study, but also to predict the results in the field of ecotourism. For example, it is possible to study how raising awareness among local community about the importance of ecotourism affects their participation in tourism projects and the development of local businesses (). It is also possible to assess the impact of environmental initiatives on tourist satisfaction and, as a result, on repeat visits (Febryano et al., 2022). This information can be extremely useful for developers, government agencies managing ecotourism, as well as for businessmen engaged in delivering services in this area.

PLS-SEM effectively tests hypotheses, allowing to assess the statistical significance of model parameters and establish cause-and-effect relationships. In addition, many of the factors that affect ecotourism are latent and cannot be measured directly. PLS-SEM operates with such variables using indicators that reflect latent characteristics.

It is also important to note that PLS-SEM is a nonparametric method that is resistant to data distribution disruptions, which are often found in the social sciences. The usability of the package adds value, as it provides a simple interface and a rich set of features for SEM analysis (Usakli, A., & Kucukergin, K., 2018).

The Sustainable Tourism Attitudes Scale (SUS-TAS) was used to measure residents' attitudes towards sustainable tourism. This scale provides a structured tool to obtain quantitative data on ecotourism perceptions, assessing aspects such as environmental sustainability and social impacts (Škuflić & Bašić, 2024). In addition, SUS-TAS is a proven tool with a high level of validity and reliability, which increases the scientific rigor of the results (Radukic et al., 2019). Overall, the combination of PLS-SEM and SUS-TAS provided researchers with both quantitative and qualitative data, contributing to a better understanding of the complex relationships between factors influencing local support for ecotourism.

An important aspect in the implementation of the PLS-SEM model is the need to collect and analyze data on the various components of the eco-tourism experience. This can include surveys of tourists regarding their perceptions and satisfaction, as well as data on the impact of tourism on local ecosystems and communities (Solekah et al., 2023). This approach helps to create a more complete picture of the current situation and identify areas for improvement (Valle, P., & Assaker, G., 2016).

In addition, the use of the PLS-SEM model can increase the level of cooperation between different stakeholders, including local communities, governments and the private sector. Sustainable

development of ecotourism requires synergy of efforts of all these groups, and PLS-SEM can serve as a basis for the development of integrated strategies and programs that will take into account the interests of all participants.

The SMART-PLS statistical package, using the Structural Modeling Equation (SEM), allows the study to be conducted by addressing the complex relationships between variables that support ecotourism development, where SEM is ideally suited to analyze such models. This method allows simultaneous assessment of direct and indirect effects, as well as the influence of latent variables such as Perceived social costs, which improves the accuracy of the analysis (Sanches Fernandes, et al., 2018).

In this context, it is important not only to conduct quantitative analysis, but also to qualitatively understand local conditions, human factors and cultural context, which ultimately contributes to the creation of sustainable ecotourism practices.

Further, the principles of the PLS-SEM model are considered, as well as examples of its application in the study of various aspects of sustainable development of ecotourism in the Ulytau Nature Park. The authors Mussina K.P., Seidualin D.A., Mukanov A.Kh. (2024) used a mixed approach combining qualitative and quantitative methods, where a survey of 389 residents of the Ulytau region was conducted using the Structural Modeling Equation (SEM). The study also used the Sustainable Tourism Attitude Scale (SUS-TAS). In the process of applying the PLS-SEM model, 5 hypotheses were obtained:

Hypothesis 1: The environmental perception of residents has a positive effect on the support of ecotourism.

Hypothesis 2: The economic benefits of ecotourism contribute to its support by the local population.

Hypothesis 3: The perceived social cost of ecotourism affect the attitude of the local population to its development.

Hypothesis 4: The level of participation of residents in decision-making on the development of ecotourism has a positive effect on their support.

Hypothesis 5: The perception of the cultural heritage of the local population increases the level of support for ecotourism.

The authors believe that the above hypotheses and the collected data and methods in the article "Modeling the community-based ecotourism development in the Ulytau National Park " require further testing in order to form a holistic view of the factors contributing to the development of ecotourism in the Ulytau region.

As part of the current study, a hierarchical model was created to analyze the factors affecting ecotourism in the Ulytau area. This model was adapted to the study and included 8 main factors, which were detailed through 38 criteria collected as a result of a survey of Ulytau residents. Key factors influencing ecotourism include perceived environmental sustainability, perceived social cost, perceived economic benefits, maximizing community participation, long-term planning, community-centered economy, sense of place, and support for tourism development.

To better understand the impact of these factors on the development of ecotourism, the study used Analytical Hierarchy Process (AHP) and statistical analysis methods to determine the relative importance of each of the factors. Comparison of the results revealed differences between the subjective perceptions of residents and objective data, which once again emphasizes the importance of integrating quantitative and qualitative methodologies. This study serves as a basis for the development of further strategies aimed at the sustainable development of ecotourism

in the region, taking into account both the views of the local population and the objective conditions conducive to the successful implementation of ecotourism initiatives (Saaty T., 1985).

1. 1. LITERATURE REVIEW

The works of the various authors were used to develop and substantiate various aspects of the partial least quadratic structural model (PLS-SEM) application method in research practice, especially in the field of tourism and hotel management.

Müller, Schuberth and Henseler (2018) proposed a PLS path modeling approach for the study of technologies in tourism and tourist behavior, which made it possible to consider the influence of technological factors on tourism preferences. Shmueli et al. (2019) developed guidelines for assessing the predictive power of PLS-SEM models, which is important for assessing the accuracy of predictions in travel marketing. Sarstedt et al. (2020) discussed the stability testing of structural models in PLS-SEM, which can help to ensure the reliability of conclusions in tourism research.

Yang et al. (2021) presented an advanced self-compliance model for predicting repeat visit intentions of Chinese tourists, considering gender moderation, which is important for marketing strategies. Usakli and Kucukergin (2018) looked at the application of PLS-SEM in the hospitality industry, highlighting its relevance for optimizing management processes. Valle and Assaker (2016) analyzed the use of PLS-SEM in tourism research, which provided confidence in its application to study complex relationships. Kumar and Purani (2018) covered the issues of model specification in PLS-SEM, which is critical for the correct construction of research models. Hair et al. (2019) have shared guidelines for the application and reporting of PLS-SEM results, which helps to ensure transparency and reproducibility of studies.

Russo (2022) provided an overview of the application of PLS-SEM in the field of software engineering, which demonstrates its versatility in various fields of research. Finally, Hair et al. (2019) conducted an updated evaluation of PLS-SEM in information systems research, which can be adapted to develop new methods in the field of hotel and tourism management. All these papers have directly contributed to a deeper understanding of the application of PLS-SEM in a variety of contexts, making them an important resource for researchers in the tourism and hospitality industries.

The book by Joseph F. Hair Jr., et al (2022) entitled “Partial Least Squares Structural Equation Modeling (PLS-SEM) Using R” is a comprehensive practical guide to the use of PLS-SEM in R. The authors, leading experts in the field, offer a clear and concise introduction to the methodology, its benefits and application in various interdisciplinary sciences, such as marketing, management, economics and social sciences. The book presents multi-group analysis, mediation, and moderation to help researchers put PLS-SEM into practice.

The article by Nordin, M., et al (2022) examines the impact of changing perceived value on ecotourism satisfaction while visiting a National Park. The study is conducted using PLS-SEM and analyzing data collected from tourists visiting a National Park in Morocco.

The results show that perceived value, consisting of functional, emotional, social, and environmental value, has a positive effect on tourist satisfaction. The study also reveals that functional value is the most significant factor influencing satisfaction. The authors conclude that in order to increase the satisfaction of ecotourists, it is important to emphasize the functional advantages of the park, as well as its emotional, social and environmental value. The article is of practical importance for National parks, as it helps to understand how to increase tourist satisfaction and ensure their repeated visit to the park.

The authors Buryukina P.A. and Vlasova I.V. (2012) demonstrate that the PLS method allows

to separate and quantify the components of a mixture, even if their absorption spectra overlap greatly. The method is based on the construction of latent variables that describe the main changes in the spectra and on their use to build a calibration model.

The article presents the results of the analysis of model dye mixtures, which confirm the effectiveness of the PLS method for solving the problems of spectrophotometric analysis of mixtures with similar absorption spectra. The article is a practical guide to the application of the PLS method in spectrophotometry and can be useful for specialists working in the field of analytical research and other interdisciplinary fields where it is necessary to analyze factors with similar spectra.

The article "SWOT-ANP-FANP hybrid model for identifying priority strategies for sustainable ecotourism development in Djerdap National Park, Serbia" by Arsić, S., Nikolić, D., & Živković, Ž. (2017) presents an integrated approach to the sustainable ecotourism development strategies in Djerdap National Park in Serbia.

The authors combine methods of SWOT analysis, Analytical Network Procedure (ANP) and Functional Analytical Network Procedure (FANP) to identify strengths, weaknesses, opportunities and threats to ecotourism, identify priorities and assess interdependencies between factors.

The ANP model allows to take into account the relationships between SWOT elements, and FANP is used to rank strategies based on their importance and feasibility. The authors propose a set of priority strategies for the sustainable development of ecotourism in the Djerdap National Park, which include raising awareness of the importance of ecotourism, developing infrastructure for eco-tourism, developing partnerships with local communities, resource management and biodiversity protection.

The article demonstrates how an integrated approach using SWOT-ANP-FANP can be used to develop effective strategies for sustainable ecotourism development in national parks.

The paper by Monecke & Leisch (2012) presents the PLS-SEM package for the R programming language, designed to perform analysis of structural equations using the partial least squares (PLS-SEM) method. The article describes the functionality of the PLS-SEM package, including the ability to build models with reflexive and formative measures, evaluate models using bootstrapping, and visualize the results. The authors demonstrate the application of PLS-SEM on an example of analyzing the impacting customer satisfaction. The article is a valuable resource for researchers using PLS-SEM and offers a simple and convenient solution for analyzing structural equations in the R environment.

The article by Nitzl (2016) examines the application of PLS-SEM in management accounting research. The author emphasizes that PLS-SEM, due to its flexibility and ability to work with complex models, is becoming an increasingly popular tool in this field between variables.

The author also offers directions for future developments of PLS-SEM theory in the context of management accounting, including a deeper study of causal relationships, the inclusion of time dependencies, and the development of more complex models. The paper is a valuable resource for management accounting researchers who want to use PLS-SEM in their work, as well as for professionals in the field of structural equation modeling methods interested in applying PLS-SEM in various fields science.

The authors Hair et al. (2014) present PLS-SEM as a promising tool for business research, they highlight the advantages of PLS-SEM over traditional methods for modeling structural equations, including its ability to work with complex models consisting of a large number of variables, the ability to use both formative and reflexive measures, and a more flexible approach to data analysis.

The article also discusses the basic principles of PLS-SEM and its application in various areas of business research, including marketing, management, strategic analysis, and innovation. The authors present practical recommendations for the use of PLS-SEM and discuss the mistakes that may arise while using it.

The article is a valuable resource for business researchers who want to familiarize themselves with the PLS-SEM method and understand its potential for solving practical problems.

Fong, L. and Law, R. (2013) examine the application of least squares (PLS-SEM) to model structural equations in the field of tourism research. The authors emphasize that PLS-SEM is a powerful tool for studying complex relationships between variables in the context of tourism. The article provides a step-by-step guide to the application of PLS-SEM, including:

- formation of a research model,
- determination of latent variables and their indicators,
- model evaluation and interpretation of the results. The authors focus on the advantages of PLS-SEM, such as the ability to work with small samples, nonlinear relationships and multiple dependent variables. They also discuss the limitations of the method and offer recommendations for its application in the context of tourism research.

An article by Khan, G., Sarstedt et al. (2019) focuses on the methodological aspects of least-squares (PLS-SEM) partial differential structural equation modeling. PLS-SEM is a statistical technique used to analyze complex relationships between variables, especially in cases where traditional structural equation modeling (SEM) may not be appropriate. The article discusses the specifications of the model, methods for estimating, evaluating the model and interpreting the results, comparing PLS-SEM with other statistical methods, innovations within PLS-SEM and best practices for PLS-SEM applications. Authors can provide practical recommendations for conducting research using PLS-SEM.

A paper by Sarstedt, et al (2014) focuses on a data analysis technique called partial least squares (PLS-SEM). The authors explain how PLS-SEM can be useful for family business researchers.

PLS-SEM allows to study the complex relationships between various factors that affect a family business, such as leadership style, family culture and financial performance.

The main advantage of PLS-SEM is that it can analyze data with a small number of observations, which is especially important for research on family businesses. The authors also emphasize that PLS-SEM helps shape theoretical concepts and identify new connections between factors.

The article concludes that PLS-SEM is a valuable tool for data analysis in family business research, allowing researchers to gain a deeper understanding of the complex relationships in this area.

In a research article published in the journal Sustainability, authors Carvache-Franco, M., Carrascosa-López, C., & Carvache-Franco, W. (2022) explain the research approach, including data collection methods (surveys or interviews), population sampling, and analytical methods used to identify different motivations among ecotourists. The results of segmentation analysis are presented, allowing the identification of different types of ecotourists based on their basic motivations (e.g., admiration for nature, adventure, cultural immersion, etc.). The findings are interpreted in the context of the existing literature on ecotourism motivation, the implications for marketing and management strategies in the Posetec-Maladeta Nature Park are discussed, and the potential benefits of targeted marketing initiatives for specific segments are considered.

Dobričić, M., et al (2022) present a comprehensive approach for identifying priority strategies for the development of ecotourism in the Uvac Special Nature Reserve, Serbia. The authors ap-

ply the combined SWOT-AHP method, which combines the analysis of Strengths, Weaknesses, Opportunities and Threats (SWOT) with the Analytic Hierarchy Process (AHP). First, a SWOT analysis is carried out, identifying the key factors affecting the development of ecotourism in the region. In the second and third stages, AHP is used to determine the weights for SWOT components and groups, reflecting their relative importance. At the final stage, ecotourism development strategies are formulated, which are then ranked by importance using the obtained weights. The purpose of the study is to demonstrate the effectiveness of Multi-Criteria Decision-Making (MCDM) in the context of strategic planning. The authors show that the combined SWOT-AHP method is a valuable tool for determining priority areas for the development of ecotourism in specially protected natural areas.

Wu, X., et al (2022), in their article "Destination Management for Ecotourism Activity Using Analytical Hierarchy Process" published in the journal Scientific Programming, describe the challenges and opportunities of ecotourism destination management to achieve sustainability and maximize the visitor experience. In the article, the AHP method is considered as a decision-making tool, the authors break down complex problems into hierarchical levels and compare the criteria with each other to find a priority solution. The results of AHP application that contribute to the effective management of ecotourism destinations in order to ensure sustainability and visitor satisfaction are discussed.

Akbulak, C., & Cengiz, T. (2014) explore the development opportunities of ecotourism in the Historical Troya National Park in Turkey. The authors apply the hybrid A'WOT method, which combines SWOT analysis with an Analytical Hierarchy Process (AHP). The analysis identifies both the strengths and weaknesses of the park, as well as the opportunities and threats to its development. important for sustainable development. As a result, specific recommendations are offered to attract tourists, protect the environment and improve infrastructure.

In the article, Ronizi, S., Mokarram, M., & Negahban, S. (2020) explore the application of Multi-Criteria Decision-Making (MCDM) to select the best location for ecotourism development in the eastern and central part of Fars province in Iran. The authors apply various factors influencing the selection of a suitable area for ecotourism, such as biodiversity, availability of infrastructure, natural resources, cultural characteristics, and social aspects.

With MCDM, they compare and rank different potential locations to find the best one for the development of sustainable ecotourism that minimizes negative environmental impacts and maximizes benefits for the local community.

The method of an Analytical Hierarchy Process (AHP) is presented in the monograph by T. Saaty (1990) as a more effective tool for solving multi-criteria problems than the traditional approach based on linear logic. AHP allows to structure complex problems, including both tangible and intangible factors, through a hierarchical structure.

Unlike logical chains, AHP avoids subjective combinations of different conclusions and allows to find compromises between factors lying in different hierarchical levels.

AHP provides a closed-loop logic design that helps to analyze complex problems and find the best solution. The method also allows for the inclusion of the researcher's knowledge and imagination in the analysis, balancing mathematical rigor and human experience (Nguyen & Tuyen, 2024).

Particular attention is paid to group work: AHP brings together different opinions through pairwise comparisons and provides a rational basis for collective decision-making.

In addition, AHP can be used to resolve conflicts between people, organizations, or even countries that share common goals, making it a universal tool for decision-making in complex situations.

1. 1. 1. METHODOLOGY

Analysis of the existing literature: A systematic approach was used to conduct a comprehensive literature review on the topic of qualitative modeling and development of ecotourism in Natural Parks. Relevant sources were searched in leading scientific databases such as Web of Science, Scopus and Google Scholar. The sample included articles published in peer-reviewed academic journals over the past 20 years are systematized and analyzed into the following thematic groups (Table 1):

Table 1. Comparison of characteristic values obtained by PCA and threshold values obtained by the parallel analysis

Thematic groups	Authors
Partial Least Squares Method (PLS-SEM):	Hair, J. et al. (2022), Nordin, M. et al. (2022), Monecke & Leisch (2012), Nitzl (2016), Hair, Sarstedt, Hopkins & Kuppelwieser (2014), Fong & Law (2013), Khan, Sarstedt et al. (2019), Sarstedt et al. (2014)
Analytical Hierarchy Method (AHP):	Akbulak & Cengiz (2014), Wu, X. et al. (2022), Dobričić et al. (2022), Saaty (1990)
Multi-criteria decision-making (MCDM):	Ronizi, Mokarram & Negahban (2020), Dobričić et al. (2022)
SWOT-analysis	Akbulak & Cengiz (2014), Dobričić et al. (2022)
Other methods of analysis	Buryukina & Vlasova (2012), Arsić, Nikolić & Živković (2017)
How-to guides	Hair et al. (2022): A practical guide to PLS-SEM using R, Monecke & Leisch (2012), Buryukina & Vlasova (2012)

Source: as shown in the right column

Qualitative interviews: In-depth interviews were conducted with key stakeholders, including residents, representatives of tourism businesses, local authorities, and ecotourism experts.

Observation: observations were made of the tourist infrastructure, the ecological state of the region and the interaction of residents with tourists.

Focus groups: focus groups were held with representatives of various groups of the region's population.

System analysis: the key factors influencing the development of ecotourism in Ulytau were identified. A partial least square model was created, considering the specifics of the region, its historical, cultural and natural features.

A survey: a well-recognized research tool employed to investigate residents' attitudes towards ecotourism development in the Ulytau National Park. To ensure the reliability of SEM model a random sample of at least 200 observations was required. The survey procedures took place from November 2023 to December 2023 among residents of Ulytau region. As a result, 389 valid responses of residents were collected using the Qualitrics platform.

The design of the questionnaire included questions regarding socio-demographic characteristics, as well as items adapted from the Sustainable Tourism Attitude Scale (SUS-TAS).

All the data was cleaned for further analysis performed in the SMART-PLS version 4.0 statistical package, including structural equation modeling (SEM) and bootstrapping to test the hypotheses. The items of the SUS-TAS scale were modified for the purposes of the study focused on ecotourism and were translated into native languages of residents in Ulytau. The effectiveness of these actions was validated on a small sample while performing a pilot testing of the questionnaire.

A rigorous combination of data collection and data analysis tools and techniques determined a

comprehensive understanding of factors influencing ecotourism development in Ulytau and allowed to create a practical model to promote sustainable ecotourism development in the region.

Sustainable Tourism Attitude Scale (SUS-TAS)

The SUS-TAS scale for assessing attitudes toward sustainable tourism was adopted in the study, serving as a fundamental tool to evaluate the attitudes of local communities towards sustainable ecotourism development. Previous studies confirmed its reliability and validity in measuring subjective attitudes of local community's attitudes towards sustainable development (Jeelani P. et al. (2023), Zhang Y. at al. (2015), Ercan S.T. and Dogan G (2013), Choi H.S.C. and Sirakaya E. (2006).

The scale consists of seven sustainability constructs, including environmental sustainability, economic benefits, sociocultural impact, community-level benefits, visitor satisfaction, long-term planning, and community engagement.

The support of the residents is key in maintaining sustainability of tourist destinations. The positive attitude of the local community significantly affects the success of tourism development in the area. This includes engaging in activities of tourism development, increasing awareness, cooperation in implementation of tourism development plans (Hien et al., 2023; Hasana et al., 2022; Obradović et al., 2023; Lai et al., 2006).

Numerous research has examined the factors affecting residents' support for tourism development worldwide. In Gunung Chiremai National Park, Indonesia, authors Nugroho, and Numata found that community awareness of economic benefits and participation had a strong impact on residents' support. Conversely, negative perceptions were an obstacle to residents' support in Cappadocia, Turkey (Nugroho and Numata, 2020; Dedeoğlu B.B. et al., 2023).

The community affection, participation and commitment were found the key predictors of residents' tourism development support in rural area of Malaysia. Among factors most impacting residents' support towards tourism development in the Republic of Serbia such factors as perceived benefits, quality of life and attachment to the community were identified (Khalid S. et al., 2019; Bajrami D.D. et al., 2020).

Community empowerment had a positive impact on residents' support of tourism development in northern Pakistan. Economic and socio-cultural benefits were determined as the most crucial factors influencing residents' support for tourism development in rural Midwestern areas (Khalid et al., 2019; Yu et al., 2018).

A research of Vietnamese case study explored the factors influencing residents' support for tourism development among which social and environmental impacts were identified as key factors in Ba Be National Park. While in the Phong Dien district of Can Tho City, residents' support was mostly affected by attachment to the community, cost-benefit compromises, participation, social benefits, and personal benefits (Huong and Lee, 2017; Quoc Nghi, 2017).

2. RESULTS

The study included development of a model for studying the factors affecting ecotourism development in the Ulytau region, using the analytical Analytical Hierarchy Process (AHP) and statistical analysis. During the process, a hierarchical model was created, including 8 factors and 38 criteria based on the results of a survey of the local population. The next step involved the use of AHP and statistical analysis to determine the weights of factors reflecting their impact on the development of ecotourism. The result of the study was a comparison of weights obtained by AHP and statistical analysis to assess the consistency between the subjective opinions of residents and objective data.

Based on the results of the survey held among residents of the Ulytau Nature Park, a hierarchi-

cal model of factors affecting the development of ecotourism in the region was built.

Table 2 presents the results of factor analysis conducted by PLS-SEM (Partial Least Squares Structural Equation Modeling) for survey data on attitudes towards tourism development in Ulytau. The selected PLS-SEM model allows to build complex models with several latent variables (factors) and their interactions. The table shows factor loads (λ), which show the strength of the relationship between individual questionnaire items (observed variables) and the corresponding latent variables (factors). A high factor load (close to 1 or -1) means a strong relationship, and a low (close to 0) means a weak relationship.

Table 2 itself does not give a final result. It provides only intermediate results of factor analysis - factor loads. These loads are the basis for further analysis within the PLS-SEM model.

Table 2. Questionnaire items with Factor Loading codes and values (λ)

Items			Description
The following statements are intended to assess your opinion on the environmental sustainability of tourism development in Ulytau. Please select the extent to which you agree or disagree with each statement.			
Perceived Environmental sustainability (PES)	PES1	0,735	Regulatory environmental standards are needed to reduce the negative impacts of tourism development in Ulytau
	PES2	0,816	The community environment of Ulytau must be protected now and for the future
	PES3	0,835	The diversity of the nature of Ulytau must be valued and protected
	PES4	0,867	Tourism in Ulytau needs to be developed in harmony with the natural and cultural environment
	PES5	0,845	Proper tourism development in Ulytau requires that wildlife and natural habitats be protected at all times
	PES6	0,893	Tourism development in Ulytau must promote positive environmental ethics among all parties that have stake in tourism
	PES7	0,752	Tourism must protect the community environment
	PES8	0,844	I believe that tourism in Ulytau must improve the environment for future generations
The following statements are intended to assess your opinion regarding the perceived social cost of tourism development in Ulytau. Please select the degree of your agreement or disagreement with each statement.			
Perceived social cost (PSC)	PSC1	0,863	The quality of my life will deteriorate due to the further development of tourism in Ulytau
	PSC2	0,850	I often feel annoyed by the development of tourism in the community
	PSC3	0,801	The development of tourism in Ulytau will lead to damage to the surrounding nature and rural areas
	PSC4	0,834	My community will be overcrowded due to the further development of tourism
	PSC5	0,904	I believe that the quality of social interaction in my community has deteriorated because of tourism
	PSC6	0,844	The development of tourism in Ulytau will lead to a change/ loss of traditional culture.
The following statements are intended to assess your opinion regarding the Perceived economic benefits of tourism development in Ulytau. Please select the extent to which you agree or disagree with each statement.			

Perceived economic benefits (PEB)	PEB1	0,852	The development of tourism in Ulytau will lead to an increase in investment, further development and improvement of infrastructure.
	PEB2	0,893	The development of tourism in Ulytau will contribute to increasing the income and living standards of the local population.
	PEB3	0,907	Tourism development in Ulytau will lead to increased employment opportunities for the local community
	PEB4	0,823	Tourism generates substantial tax revenues to the local government
The following statements are intended to assess your views on community engagement in tourism development in Ulytau. Please select the extent to which you agree or disagree with each statement.			
Maximizing Community (MCP)	MCP1	0,813	Tourism decisions must be made by all members of my community, regardless of a person's background
	MCP2	0,859	Full participation of everyone in the community in tourism-related decisions is a must for the successful development of tourism
	MCP3	0,812	Residents of Ulytau should have an opportunity to be involved in tourism development and management
The following statements are intended to assess your opinion on long-term planning for tourism development in Ulytau. Please select the extent to which you agree or disagree with each statement.			
Long-term planning (LTP)	LTP1	0,832	I believe that we need to take a long-term view when planning for tourism development in Ulytau
	LTP2	0,862	I believe that successful management of tourism requires an advanced planning strategy in Ulytau
	LTP3	0,857	I believe tourism development needs well-coordinated planning
	LTP4	0,806	I think residents must be encouraged to assume a leadership role in tourism planning committees
	LTP5	0,859	Tourism development plans should be continuously improved in Ulytau
The following statements are intended to assess your views on the formation of a community-oriented economy as a result of tourism development in Ulytau. Please select the extent to which you agree or disagree with each statement.			
Community-Centered Economy (CCE)	CCE1	0,820	I think tourism businesses should hire at least one-half of their employees from within the local community of Ulytau
	CCE2	0,844	The tourism industry should be required to obtain at least one-half of their goods and services from within the local community
	CCE3	0,866	The tourism industry must contribute to community improvement funds in Ulytau
The following statements are intended to assess your opinion regarding attachment to the Ulytau community. Please select the extent to which you agree or disagree with each statement.			
Sense of place (SOP)	SOP1	0,815	Living in my community reflects who I am.
	SOP2	0,886	It means a lot to me to live in this community.
	SOP3	0,693	I am attached to the place where I live.
	SOP4	0,791	I feel like I'm part of my community.

The following statements are intended to assess your opinion regarding the support of tourism development in Ulytau. Please select the extent to which you agree or disagree with each statement.			
Tourism development Support (TDS)	TDS1	0,851	I will be happy to support tourism initiatives that are sustainable for my community
	TDS2	0,777	I am willing to take active participation in the creation of plans and strategies connected with tourism in Ulytau
	TDS3	0,841	I am ready to take part in the promotion of initiatives for environmental education and environmental protection in Ulytau
	TDS4	0,852	I would support the further development of tourism in my community
	TDS5	0,794	I would like Ulytau to attract more tourists

Source: Using the quantitative approach and the SUSTAS scale, the analysis of 389 questionnaires of residents of the Ulytau district was carried out using the PLS-SEM method (Mussina, K.P., et al., 2024)

The criterion in Table 2 only shows how well the individual questions of the questionnaire reflect each of the selected factors. Based on this, it is possible to draw conclusions about which aspects of tourism (environmental, social, economic) are the most significant for respondents.

In addition to surveying the local community in Ulytau, the study included an analysis of statistical data on the Ulytau region including eight indicators:

1. Private investment in the tourist complex (InvP)
2. Public investment in the tourism complex (InvST)
3. Public investment in the environment (InvSE)
4. Level of summer and winter tourism development (Summer, WinT)
5. Infrastructure (Inf)
6. Image of the region
7. Ecology (Eco)
8. Profitability of the tourist complex (Profit)

As a result of the surveying the local community based on the Analytical Hierarchy Process (AHP), indicator weights were determined, which are percentages reflecting the importance of indicators for the development of ecotourism in the region.

To determine the weight coefficients of indicators important for the development of ecotourism in the Ulytau region, the method of Analytical Hierarchy Process (AHP) was applied. Processing the data of 389 questionnaire surveys made it possible to obtain matrices of paired comparisons (Table 3). The data obtained, which are percentages of the importance of the indicators, were further analyzed using the spectral analysis presented in Table 4.

The method of Analytical Hierarchy Process (AHP) made it possible to obtain the following data, which were then analyzed using spectral analysis. The resulting matrices of paired comparisons have a maximum error of no more than 8%.

Table 3. Survey results

#	Indicators	Weight
1	InvP	0,10723189
2	InvST	0,10687812
3	InvSE	0,06763273
4	Summer,WinT	0,05691028
5	Inf	0,15256775
6	Image	0,28350474
7	Eco	0,04690315
9	Profit	0,17837135

Source: Author`s calculation

The calculation was performed in Microsoft Excel. The analysis of Table 3 demonstrates the results of weighting the indicators affecting the development of ecotourism in the Ulytau region. Each indicator (InvP, InvST, InvSE, Summer, WinT, Inf, Image, Eco, Profit) received its own weight coefficient, reflecting its relative importance. Image (the image of the region) has the highest weight (0.2835), followed by Profit (profit, 0.1784) and Inf (infrastructure, 0.1526). The lowest weights were obtained for the indicators Eco (environmental, 0.0469) and InvSE (investment in social infrastructure, 0.0676). It is important to note that the maximum error of the pairwise comparison matrices does not exceed 8%, which indicates that the data obtained are sufficiently reliable.

When analyzing statistical data (Table 4) using spectral analysis, particularly a matrix of paired comparisons (Hosmer, D. W., & Lemeshow, S., 2000), it was found that indicators influencing the development of ecotourism in the region have the following effects:

Table 4. Statistical data

#	Indicators	Weight
1	Private investment in the tourist complex (InvP)	0,1287625
2	State investment in the tourist complex (InvST)	0,1287625
3	State investment in the environment (InvSE)	0,1954987
4	The level of summer and winter tourism development (Summer,WinT)	0,1111976
5	Infrastructure (Inf)	0,1103904
6	Image of the region (Image)	0,1111912
7	Ecology (Eco)	0,1013085
8	Profitability of the tourist complex (Profit)	0,1128886

Source: Author`s calculation

Comparing the results of Tables 3 and 4, the following conclusions can be drawn:

1. On private investment in the tourist complex (InvP) –

   $\mathcal{E}_1 = |0,107-0,129| = 0,012$, i.e. about 1.2% difference between the results of the questionnaire and statistical data;

2. On state investments in the tourist complex (InvSE) –

   $\mathcal{E}_2 = |0,107-0,129| = 0,012$, i.e. about 1.2% difference between the results of the questionnaire and statistical data;

3. On state investments in the environment (InvSE) –

   $\mathcal{E}_3 = |0,07-0,196| = 0,126$, i.e. about 12.6% of the difference between the results of the questionnaire and statistical data;

4. By the level of development of summer and winter tourism (Summer, WinT) –

   $\mathcal{E}_4 = |0,057-0,111| = 0,054$, i.e. about 5.4% difference between the results of the questionnaire and statistical data;

5. Infrastructure (Inf) –

   $\mathcal{E}_5 = |0,153-0,110| = 0,043$, i.e. about 4.3% difference between the results of the questionnaire and statistical data;

6. By the image of the region (Image) –

   $\mathcal{E}_6 = |0,284-0,111| = 0,173$, i.e. about 17.3% of the difference between the results of the questionnaire and statistical data;

7. Ecology (Eco) –

   $\mathcal{E}_7 = |0,047-0,101| = 0,054$, i.e. about 5.4% difference between the results of the questionnaire and statistical data;

8. By the profitability of the tourist complex (Profit) –

   $\mathcal{E}_8 = |0,178-0,113| = 0,065$, i.e. about 6.5% of the difference between the results of the questionnaire and statistical data.

Conclusion on the above calculations, considering the economic sphere are as follows.

The analysis of statistical data and survey results revealed that there is a slight difference between the perception of residents and actual statistical data on a number of indicators affecting the development of ecotourism in the Ulytau region.

In particular, the difference between the results of the questionnaire and statistical data is:

- About 1.2% for private investment in the tourism complex and public investment in the environment.
- About 5.4% for the level of development of summer and winter tourism, as well as ecology.
- About 4.3% for infrastructure.
- About 6.5% for the profitability of the tourist complex.

The most significant difference is observed in the image of the region (about 17.3%), which can be explained by the subjectivity of perception, limited statistical data, the influence of local factors and the dynamism of the image. Residents may have different views on the image of the region, and the available data may be incomplete or outdated. Local factors such as media coverage and tourist reviews can quickly affect the image, which is not always reflected in statistics. In addition, the image of the region is constantly changing, and experts may have more up-to-date information.

Considering the economic sphere, these results show that residents attach great importance to factors such as the profitability of the tourist complex and public investment in the environment. This highlights the need for further investment in these areas to stimulate the development of ecotourism in the region.

To build a qualitative model, subjective assessments and opinions of stakeholders, in this case, local residents, were taken into account. It allows to assess the impact of various factors on the development of ecotourism in Ulytau. The qualitative model described in the project is built on the basis of logistic regression.

8 key factors influencing the development of ecotourism were identified:

- InvP - Private investment in the tourist complex
- InvST - Public investment in the tourism complex

- InvSE - Public Investments in the Environment
- Summer, WinT - Level of development of summer and winter tourism
- Inf – Infrastructure
- Image - Image of the region
- Eco – Ecology
- Profit - Profitability of the tourist complex

To build a qualitative model, data on factors were obtained using two methods:

- Analytical Hierarchy Process (AHP): Using a survey of local residents, subjective estimates of the impact of each factor were obtained.
- Statistical analysis: Objective data on factors are collected from various sources.

The next step in building a qualitative model was the creation of a logistic regression model, which describes the relationship between factors and their impact on the development of ecotourism, which is built as follows:

A) A linear regression is built in the form of

$$t = a + bx$$

In this case, the coefficients **a,b** are determined by the equations

$$b=\frac{\bar{t}\cdot\bar{x}-\bar{t}\bar{x}}{(\bar{x})^2-\overline{x^2}},\ a=\frac{\bar{t}\bar{x}\cdot\bar{x}-\bar{t}\cdot\overline{x^2}}{(\bar{x})^2-\overline{x^2}}$$

Now the logistics function the following is taken

$$X_j=\frac{1}{1+e^{-t}}=\frac{1}{1+e^{-(a+bx_i)}} \quad (1)$$

As is known [1], in the qualitative model, a triplet consisting of triples

$$sign(Xj,\ DXj,\ DDXj),\ j=\overline{1,n} \quad (2)$$

Here *DXj* it means a derivative of $\frac{dXj}{dXi}$ the logistics function (1), and, accordingly, the *DDXj* second derivative. Each of the 8 indicators has 10 values, 9 of which are determined by the hierarchy analysis method based on the results of the questionnaire, and the 10th values are determined using statistical data (Peng, C. et al., 2002)

Table 5. Comparison of the weights of factors influencing the development of ecotourism in the Ulytau region, obtained using the Analytical Hierarchy Process method (AHP) and statistical analysis

	InvP	InvST	InvSE	Sum,WinT	Inf	Image	Eco	Profit
	X1	X2	X3	X4	X5	X6	X7	X8
1	0,045293	0,182467	0,181896	0,081543	0,141656	0,144343	0,157123	0,065680
2	0,238680	0,22885	0,132080	0,08418	0,118888	0,093046	0,049621	0,054656
3	0,124730	0,044228	0,032870	0,039835	0,044451	0,389732	0,032870	0,291284
4	0,080728	0,083656	0,025955	0,032634	0,208549	0,331056	0,021061	0,216360
5	0,065388	0,131429	0,103170	0,028663	0,198913	0,340920	0,017679	0,113838
6	0,131596	0,045140	0,027602	0,033264	0,155683	0,377974	0,027602	0,201139
7	0,120424	0,046797	0,025169	0,041790	0,147324	0,347560	0,023917	0,247019
8	0,061659	0,158746	0,039434	0,052517	0,182935	0,245570	0,046480	0,212660
9	0,100397	0,038478	0,037619	0,118232	0,170788	0,284923	0,041212	0,208352
10	0,128763	0,128763	0,195499	0,111198	0,110390	0,111191	0,101308	0,112889

Source: Author`s calculation

Based on these values, a linear regression is constructed between the factors of the indicators, i.e. the values of the coefficients are determined *a,b*, then the values of the logistic function (1) are determined. As an example, one of the calculations is presented below.

Table 6. Calculation of weights for ecotourism development factors using a logistic regression model

Xi	Xi^2	Xj	Xi*Xj	b	a	a+bx	exp(-a-bx)	g1(x)	g(x)
0,045293	0,002051	0,182467	0,008264	1,4807094	0,029427	0,096492	0,908017	0,524104	0,065513
0,23868	0,056968	0,228850	0,054622	1,4807094	0,029427	0,382843	0,68192	0,594559	0,074320
0,124730	0,015558	0,044228	0,005517	1,4807094	0,029427	0,214117	0,807254	0,553326	0,069166
0,080728	0,006517	0,083656	0,006753	1,4807094	0,029427	0,148961	0,861602	0,537172	0,067146
0,065388	0,004276	0,131429	0,008594	1,4807094	0,029427	0,126247	0,881397	0,531520	0,066440
0,131596	0,017318	0,04514	0,00594	1,4807094	0,029427	0,224282	0,799089	0,555837	0,069480
0,120424	0,014502	0,046797	0,005635	1,4807094	0,029427	0,20774	0,812419	0,551749	0,068969
0,061659	0,003802	0,158746	0,009788	1,4807094	0,029427	0,120726	0,886277	0,530145	0,066268
0,100397	0,010080	0,038478	0,105114	1,4807094	0,029427	0,178086	0,83687	0,544404	0,068051
0,128763	0,131071	0,959791	0,210228	1,4807094	0,029427	0,220087	0,802449	0,554801	0,069350
1,097657	0,262141	1,919582	0,420456						
0,109766	0,026214	0,191958	0,042046						

Source: Author`s calculation

Here is another table that differs significantly from Table 6.

Table 7. Calculation of weights for the Infrastructure (Inf) factor using a logistic regression model

Xi	Xi^2	Xj	Xi*Xj	b	a	a+bx	exp(-a-bx)	g1(x)	g(x)
0,045293	0,002051	0,141656	0,006416	-0,41815	0,193857	0,174917	0,839526	0,543618	0,067952
0,238680	0,056968	0,118888	0,028376	-0,41815	0,193857	0,094052	0,910236	0,523496	0,065437
0,124730	0,015558	0,044451	0,005544	-0,41815	0,193857	0,141700	0,867881	0,535366	0,066921
0,080728	0,006517	0,208549	0,016836	-0,41815	0,193857	0,160100	0,852059	0,539940	0,067492
0,065388	0,004276	0,198913	0,013006	-0,41815	0,193857	0,166515	0,846610	0,541533	0,067692
0,131596	0,017318	0,155683	0,020487	-0,41815	0,193857	0,138829	0,870377	0,534652	0,066831
0,120424	0,014502	0,147324	0,017741	-0,41815	0,193857	0,143501	0,866320	0,535814	0,066977
0,061659	0,003802	0,182935	0,011280	-0,41815	0,193857	0,168074	0,845291	0,541920	0,067740
0,100397	0,010080	0,170788	0,017147	-0,41815	0,193857	0,151875	0,859096	0,537896	0,067237
0,128763	0,016580	0,110390	0,014214	-0,41815	0,193857	0,140014	0,869346	0,534946	0,066868
1,097657	0,147650	1,479577	0,151048						
0,109766	0,014765	0,147958	0,015105						

Source: Author`s calculation

As can be seen from Table 6, the signs of the coefficients *a,b*, are positive, and in Table 7, the sign of the coefficient *b* is negative, while the sign of the coefficient *a* is positive.

Next, let's define the derivative of functions (1)

$$X_j^{'} = \left[\left(1+e^{-(a+bx_i)}\right)^{-1}\right]^{'} = (-1)\left(1+e^{-(a+bx_i)}\right)^{-2} \times \left(e^{-(a+bx_i)}\right)^{'} = (-1)\left(1+e^{-(a+bx_i)}\right)^{-2} \times (-b)\left(e^{-(a+bx_i)}\right) = \frac{be^{-(a+bx_i)}}{\left(1+e^{-(a+bx_i)}\right)^{2}}$$

i.e. *sign*(*Xj, DXj, DDXj*), $j = \overline{1,n}$ is determined by the sign of the coefficient *b*.

The same is true for a second-order derivative

$$X_j^{'}=[(1+e^{(a+bx_i))^{-1}}]'\left(\frac{b\times e^{-(a+bx_i)}}{(1+e^{-(a+bx_i)})^2}\right)'=\frac{b\times e^{-(a+bx_i)'}\times(1+e^{-(a+bx_i)})^2-b\times e^{-(a+bx_i)}[(1+e^{-(a+bx_i)})^2]'}{(1+e^{-(a+bx_i)})^4}=$$

$$\frac{-b^2\times e^{-(a+bx_i)}\times\ (1+e^{-(a+bx_i)})^2-b\times e^{-(a+bx_i)}\left[-2be^{-(a+bx_i)}\left(1+e^{-(a+bx_i)}\right)\right]}{(1+e^{-(a+bx_i)})^4}=$$

$$\frac{-b^2\times e^{-(a+bx_i)}\times(1+e^{-(a+bx_i)})+2b^2\times e^{-2(a+bx_i)}}{(1+e^{-(a+bx_i)})^3}=\frac{-b^2\times(e^{-(a+bx_i)}+e^{-2(a+bx_i)})}{(1+e^{-(a+bx_i)})^3}$$

Then

$$sign\ (Xj,\ DXj,\ DDXj) < 0$$

at any *b*.

Using the signs of the coefficients *a,b*, for example, from Tables 5 and 6, we get the following Table 8.

Table 8. Matrix of signs of factors interaction

Model Factors InvP		X1 InvST	X2 InvSE	X3 Sum, WinT	X4 Inf	X5 Image	X6 Eco	X7 Profit	X8
X1	InvP			(+,+.-)		(+,-.-)		(+,-.-)	
X2	InvST	(+,+.-)			(+,+.-)		(+,-.-)	(+,+.-)	(+,-.-)
X3	InvSE		(+,+.-)			(+,-.-)	(+,-.-)	(+,+.-)	(+,-.-)
X4	Sum, WinT	(+,+.-)		(+,+.-)		(+,-.-)	(+,-.-)	(+,+.-)	(+,-.-)
X5	Inf		(+,+.-)				(+,+.-)	(+,-.-)	(+,-.-)
X6	Image	(+,-.-)							(+,+.-)
X7	Eco						(+,-.-)		
X8	Profit	(+,-.-)		(+,+.-)	(+,+.-)		(+,-.-)	(+,-.-)	

Source: Author`s calculation

Table 8 shows that for symmetrical cells, the triplets of which are different, there is an asymmetry in the signs of the interaction of factors. This means that the direction of interaction of factors in these cells is different.

It is important to note: (+,+.-) means that the correlation is positive, but not very strong. (+,-.-) - means that the correlation is negative, but not very strong.

3. DISCUSSION

A positive correlation means that the factors are moving in the same direction. A negative correlation means that the factors are moving in opposite directions.

Implication:

1. Let's analyze the expression (+,+.-). The first + means the sign of the variables, which are positive for all variables. The second + means the positive impact of this factor in connection with another factor on the development of Ecotourism. The third sign shows the type of growth, namely, convex upwards, i.e. the impact on the development of Ecotourism does not occur at a rapid pace, but more smoothly. All this means that Ecotourism will have its maximum development.
2. Let's analyze the expression (+,-.-). The first + means the sign of the variables, which are positive for all variables. The second means the negative impact of this factor in connection with another factor on the development of Ecotourism. The third sign shows the

type of growth, namely, convex upwards, i.e. the impact on the development of Ecotourism does not occur at a rapid pace, but more smoothly. All this means that Ecotourism will have its maximum development.

3. Let's analyze the meaning of the difference in symmetrical triplets, for example, (+,+.-) and (+,-.-):

   - in the first triplet (+,+.-) the development of Ecotourism occurs as in case 1), and in the second triplet, the development of Ecotourism occurs as in case 2). This means that the impact of indicators on Ecotourism development depends on the orders of interdependence of these indicators. This means that the activities of a travel company depend on the approach. For example, for a couple of cases (Image, Profit) and (Profit, Image), it is necessary to follow the approach from Image to Profit, and not vice versa. This applies to symmetrical triplets such as

(InvSE, Profit) - (Profit, InvSE); (Sum, WinT, Profit) - (Profit, Sum, WinT)

Table 9. Matrix of factors

Model Factors		X1	X2	X3	X4	X5	X6	X7	X8
	InvP	InvST	InvSE	Sum, WinT	Inf	Image	Eco	Profit	
X1	InvP								
X2	InvST								
X3	InvSE								(+,-.-)
X4	Sum, WinT								(+,-.-)
X5	Inf								
X6	Image								(+,+.-)
X7	Eco								
X8	Profit			(+,+.-)	(+,+.-)		(+,-.-)		

Source: Author`s calculation

Note that for many symmetrical triplets, the order of the approaches is not necessary.

4. CONCLUSION

This research work presents a comprehensive model for assessing the factors affecting ecotourism development in the Ulytau Nature Park. The study used a robust methodological approach, including both quantitative and qualitative methods, to gain a deep understanding of the subject matter. The results of the study highlight the complex interplay of various factors and provide valuable information for researchers, government agencies and practitioners seeking to develop sustainable ecotourism in protected natural areas. The study is structured around three key stages, each of which contributes to a more holistic understanding of the development of ecotourism in Ulytau:

Step 1: Initial Survey and Identification of Factors

The initial stage of the study included conducting a comprehensive survey among residents of the Ulytau region. The survey collected data on the perception and attitude of residents to the development of ecotourism. This stage served to identify the key factors affecting the development of ecotourism in the region. The survey tool also included elements adapted from the Sustainable Attitudes Scale for Tourism (SUS-TAS) to assess attitudes towards sustainability. The researchers identified 8 key factors and 38 criteria important for the sustainable development of ecotourism in Ulytau. These factors encompass the environmental, social and economic aspects of sustainable development. The use of SUS-TAS has provided a standardized and validated

approach to measuring attitudes towards sustainable tourism, enhancing the reliability of the results obtained. A total of 389 valid responses were received and analyzed. This stage lays a solid foundation for subsequent stages, setting the stage for more in-depth analysis. These quantitative data, collected from a large sample, provided statistical power and validity.

Step 2: Factor weights using ANR and statistical analysis

The second phase focused on determining the relative weights of each of the nine factors identified in the first phase. To do this, the researchers used two methods: the analytical hierarchy process (AHP) and spectral analysis of statistical data. The AHP method is used to determine the relative weights of the identified factors based on the subjective judgments of local residents. Spectral analysis complements AHP by providing an objective estimate of weights using statistical data. This dual strategy helps reduce the potential distortions associated with using each method individually, ensuring reliable results. The combination of subjective (AHP) and objective (statistical) estimates has created a robust and balanced approach to weighing these important factors. This comparison allowed the researchers to identify discrepancies between subjective opinions and objective data, highlighting areas that require further study.

Stage 3: Development and analysis of a qualitative model

The final phase of the study integrated the results of the previous two phases. The researchers built a qualitative model using logistic regression to understand the relationship between the identified factors and the development of ecotourism. The model includes both subjective (AHP) and objective (statistical) weights, creating a holistic and balanced picture of the situation. This model is a powerful tool for predicting the trajectory of ecotourism development in the Ulytau region. Analysis of this logistic regression model showed that the influence of some factors is more significant than others. In addition, it helped uncover the complex interactions between variables and shed light on potential synergies or conflicts between them.

The study revealed several key findings with significant implications for the sustainable development of ecotourism in Ulytau:

Impact of various factors: The study found that various factors, including private and public investment, community engagement, environmental considerations, and infrastructure development, play different roles in the development of ecotourism. The model quantifies the relative importance of these factors, providing practical information for decision-makers.

Discrepancy between subjective and objective data: A comparison of AHP weights and statistical weights reveals areas where residents' subjective perceptions do not fully match objective data. This highlights the importance of considering both subjective perceptions and objective data when making decisions in tourism planning and management, which underlines the dynamic nature of regional perceptions and the need to use subtle strategies to manage them.

Logistic Regression Model: A qualitative model built through logistic regression provides a valuable tool for policymakers and practitioners to model the impact of different interventions on the development of ecotourism. This model allows different scenarios to be tested and thus helps guide the decision-making process.

Recommendations for the sustainable development of ecotourism: Based on the results obtained, recommendations were made for the development of sustainable ecotourism in the Ulytau Nature Park. These include strategic investments in infrastructure, community empowerment programs and effective environmental management strategies.

This study makes a significant contribution to the development of ecotourism. The comprehensive approach and rigorous methodology used in the study guarantee the validity and reliability of the results obtained. The development of a quality model represents a valuable contribution

that can be applied to other protected areas. The study's emphasis on cooperation and stakeholder participation deserves special attention. By considering both objective data and subjective perceptions, the study provides a more complete understanding of the complex dynamics associated with the sustainable development of ecotourism.

The uniqueness of the article lies in the comparison of subjective assessments (based on a survey of opinions of residents) with objective statistical data. This makes it possible to identify discrepancies between the perception of residents and the real situation, which is important for adjusting development strategies. Most studies focus on either one or the other type of data, missing the opportunity to identify these inconsistencies and use them for more accurate planning. This makes it possible to simulate different scenarios and make more informed decisions. Many studies are limited to describing the influence of factors, without moving on to the construction of predictive models.

Although the study focuses on Ulytau, the developed model and methodology can be adapted and applied to other natural parks with similar conditions, which increases the practical value of the work.

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