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SUSTAINABLE DEVELOPMENT MANAGEMENT IN THE TOURISM INDUSTRY IN THE CONTEXT OF DIGITALIZATION OF THE ECONOMY

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ABSTRACT

The rapid digitalisation of the global economy has transformed the tourism industry by enhancing destination competitiveness, improving service quality, and increasing the efficiency of resource utilisation. However, empirical evidence on how digitalization influences the sustainable development of tourism through macroeconomic performance remains limited in Kazakhstan. This study investigates the relationship between key Tourism Satellite Account (TSA) indicators and the sustainable development of Kazakhstan's tourism industry in the context of economic digitalization. The study employs official Tourism Satellite Account data for the period 2020–2025 obtained from the Bureau of National Statistics of the Republic of Kazakhstan. A quantitative research design was adopted using comparative and dynamic analyses, Pearson correlation analysis, ordinary least squares (OLS) regression, the integral TSA index, elasticity analysis, and time-series forecasting. The results reveal substantial growth in tourism performance, with domestic tourism consumption increasing from 807.2 to 3,380.0 billion tenge, tourism expenditure rising from 568.9 to 2,800.0 billion tenge, and tourism gross value added expanding from 560.0 to 1,400.0 billion tenge between 2020 and 2025. Correlation analysis demonstrates a very strong positive association between tourism expenditure and gross value added ($r = 0.97$, $p < 0.001$), while the regression model exhibits high explanatory power ($R^2 = 0.94$). The integral TSA index indicates a continuous transition toward a sustainable tourism development model, reaching its highest level in 2025. Elasticity analysis shows an average coefficient of approximately 0.40, suggesting that a 1% increase in tourism expenditure generated less than a 1% increase in tourism value added. Furthermore, time-series forecasting projects that the number of visitors served in accommodation establishments will reach approximately 2.22 million by 2028, confirming sustained growth in Kazakhstan's tourism industry under ongoing digital transformation.

INTRODUCTION

The relevance of this study stems from the fact that, in the current context of global digital transformation, the tourism economy is undergoing fundamental changes associated with the introduction of digital technologies, platform solutions, and intelligent management systems. The tourism industry, being one of the most sensitive to external shocks, requires a transition from an extensive development model to a sustainable one that balances economic, environmental, and social factors. In this regard, digitalisation serves not only as a tool for improving the efficiency of tourism services but also as a key factor in the development of sustainable tourism destinations, ensuring the optimisation of tourist flow management, reducing the burden on natural resources, increasing the transparency and accessibility of services, and developing new forms of interaction between market participants.

This issue is particularly significant in the context of the Republic of Kazakhstan, where the tourism industry possesses significant, yet under-utilized, potential. The country's vast geographical extent, diverse natural and climatic zones, and cultural heritage create favourable conditions for tourism development. However, systemic limitations remain, including infrastructural heterogeneity, insufficient digital integration, weak coordination between industry participants, and limited digital competencies. Under these conditions, the transition to a sustainable tourism development model is impossible without an effective management system based on digital technologies and data.

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The practical significance of this study lies in the potential application of the obtained results to improve mechanisms for state and regional management of Kazakhstan's tourism industry. Developing approaches to integrating digital solutions into sustainable tourism management systems will improve the efficiency of regional tourism, enhance the quality of tourism services, ensure a more rational distribution of tourist flows, and reduce environmental impacts.

Thus, the study of sustainable tourism management in the context of Kazakhstan's economic digitalization is timely and relevant from both scientific and practical perspectives, as it aims to address the challenges of enhancing the industry's competitiveness, ensuring its sustainability, and integrating it into the global digital tourism space.

To identify the nature of the relationships among tourism indicators, a Pearson correlation analysis was conducted. This method allowed us to quantify the strength of the relationship between tourism expenditure, domestic and inbound tourism, and gross value added indicators.

To assess the impact of tourism demand factors on the industry's economic performance, an ordinary least squares (OLS) regression analysis was used. The study constructed an econometric model of the relationship between gross value added in tourism and tourism expenditure, which enabled us to estimate the influence coefficients, assess the model's statistical significance (R^2, t-statistic, p-value), and confirm the presence of causal relationships.

In recent years, against the backdrop of economic globalisation and the world community's openness to information, interest in the theoretical and methodological aspects of organising tourism activities has increased.

In modern literature, sustainable tourism development is increasingly considered not separately from digitalization, but as a result of their mutual reinforcement: digital platforms, mobile services, big data, IoT, AR/VR, digital marketing and analytics tools are becoming not just promotion channels, but mechanisms for increasing the environmental, economic and social sustainability of destinations (El Archi et al., 2023; Karim et al., 2025; Myrovali et al., 2025). In reviews of 2023–2025, it is emphasised that digitalisation makes it possible to manage tourist flows, reduce transaction costs, increase service transparency, strengthen the involvement of local communities, and improve the quality of management decisions at the destination level (Wu et al., 2024; Bekele & Raj, 2024; Diaz-Castillo & Pacheco-Pumaleque, 2025).

Digital solutions are currently a key element in the development of tourism at all stages of the value chain (Pencarelli, 2020). Harnessing tourism's beneficial contributions to achieving sustainable development goals and mitigating the sector's negative impacts requires close cooperation and proactive action from all tourism stakeholders (Scheyvens & Cheer, 2022). Digital transformation has become a crucial element for tourism enterprises to maintain competitive advantages and achieve sustainable development (Streimikiene et al., 2021).

The purpose of the study is to determine whether the empirical literature consistently supports the conclusion that there is a relationship between key indicators of the Tourism Auxiliary Account (TSA) and the sustainable development of Kazakhstan's tourism industry in the context of economic digitalisation. Methodologically, the article employs systematic review, descriptive analysis, and comparative synthesis of empirical results. The work is carried out as follows. The next section examines the theoretical and empirical literature and identifies unresolved issues. The Materials and Methods section explains how digitalisation affects tourism's sustainable development using macroeconomic indicators. The Results section summarises the verified data using tables and figures. During the discussion, the main patterns are interpreted, and hypotheses are evaluated. The final section presents a description of the research contribution, its limitations, and directions for future research. In the course of the research, the following hypotheses were identified:

H_1: Does the economic growth of the tourism industry affect the growth of gross value added in tourism, consumption and spending;

H_2: Is there a relationship between tourism spending and gross value added, indicating the crucial role of tourism demand in the development of the industry

H_3: Does the empirical literature confirm that there is a relationship between the key indicators of the Tourism Auxiliary account (TSA) and the sustainable development of the tourism industry in Kazakhstan in the context of the digitalization of the economy

LITERATURE REVIEW

Digital transformation is redefining travel concepts and driving increased travel-related needs (Hsu, 2021), while also opening new opportunities for value creation and profitability in the tourism sector by shifting value from traditional companies to new players (Morrison, 2022). This revolution involves the creation of new products and services, as well as the introduction of new culture, structure, methods, innovations, and technologies (Giotis & Papadionysiou, 2022). The constant changes in the market, as well as intense competition, force companies to be flexible and adaptable. Firms operating in the tourism industry must be well prepared to address the challenges that arise at different levels. Managerial and technological innovations can play a significant role in a company's profitability, sustainability, and longevity. Therefore, the objective of this article is to analyse the role of innovation and the key elements that influence a firm's ability to manage it (such as corporate strategy, organisational structure, management style, human resource management, the innovation process, and knowledge management). According to Giotis and Papadionysiou (2022), an appropriate management style, appropriate personnel, and a pleasant work environment characterisedcharacterized by collaboration between employees and managers enhance a firm's ability to innovate.

The concept of sustainable development can be interpreted in different ways (McNeill, 2000), but at its core lies an approach to development that seeks to balance diverse and often competing needs with an awareness of the environmental, social, and economic constraints we face as a society (Hariram et al., 2023). Agenda 21 recognized tourism as "an exemplary form of economic development that should improve the quality of life of the host community, provide high-quality experiences for visitors, and maintain the quality of the environment on which both the host community and the visitor depend." Economy, environment, and society are usually prioritized when discussing the principles of sustainable

development (Bobylev & Grigoryev, 2020; De Lucia et al., 2020).

Sustainable development entails the responsible use of natural, cultural, and other tourism resources by the present generation to preserve these resources for the benefit of future generations (Fitri et al., 2024; Falatoonitoosi et al., 2022; Zhu et al., 2021). In modern conditions, the role of sustainable development in increasing the competitiveness of tourist destinations is becoming increasingly important (Cucculelli & Goffi, 2016; Sadykov et al., 2025). The implementation of sustainable development practices is currently one of the most important tasks facing policymakers and managers of tourist destinations. Sustainable tourism management must maintain a high level of tourist satisfaction, provide a meaningful consumer experience, raise awareness of sustainable development issues, and promote sustainable practices.

At the same time, researchers point out that the effects of digitalization are not automatic: without institutional coordination, digital infrastructure, and personnel training, it does not translate into sustainable industry growth (Khosravi et al., 2025).

Some studies examine the digital transformation of tourism as a factor in quality and competitiveness. Here, the emphasis is on how the digital economy influences tourism through several channels: improved service availability, product personalization, increased efficiency in booking and communication, greater destination manageability, and stronger branding (Luo & Wang, 2025; Cheng, 2026). In 2024–2026, there are works in which digitalization is considered not only as a set of technologies but also as a management ecosystem that influences the quality of the tourism offer, the sustainable branding of the territory, and the achievement of the SDGs (Zeqiri et al., 2025; Alhaddar & Kummitha, 2025). This is especially important for Kazakhstan, where tourism is developing amid spatial fragmentation, infrastructure heterogeneity, and a high role for state institutions (Sakhanova et al., 2025).

An important aspect of the relationship between tourism and digital technologies is the effective management of financial resources in the tourism industry. Research by Chen et al. (2023) emphasizes that the optimal allocation and intelligent direction of financial resources contribute to a more efficient use of social resources. Proper financial management in the tourism industry can lead to increased revenue and improved quality of tourism services.

According to Kulmaganbetova et al. (2019), the effectiveness of leveraging innovation potential is determined not only by the level of scientific research and development but also by the complex of relevant technical, production, organizational, marketing, and financial operations involved in innovation processes.

Other studies are related to smart tourism/smart destinations. Research shows that the sustainability of tourist destinations is increasingly supported by "smart" management tools: mobile applications, platform solutions, digital navigation, predictive analytics, digital service channels, generative AI, and IoT (Samancioglu et al., 2024; Birenboim et al., 2023). These tools help distribute tourist flows more evenly, improve safety, optimize the use of natural and infrastructure resources, and foster a more sustainable model of tourism product consumption (Sgroi & Modica, 2024). For Kazakhstan, this block is especially significant, since most of the potential is concentrated in natural and cultural destinations, where issues of carrying capacity, seasonality and spatial accessibility are critical (Aktymbayeva et al., 2023).

In the works on Kazakhstan for 2024–2025, the same limitations recur: fragmentation of the digital ecosystem, weak data integration, insufficient representation of the tourism business on global platforms, a deficit of digital competencies, uneven infrastructure across regions, and institutional barriers to coordination. At the same time, studies and official materials also record a positive shift: eQonaq, a national tourism portal, QR navigation, and digital tourism forums are developing in the country, and the agenda of sustainability, innovation, and digital integration of the industry is being strengthened in the 2023–2029 policy. This allows us to conclude that in Kazakhstan, the issue is no longer the need for digitalization per se, but rather the development of a sustainable development management system in which technologies are integrated into institutional, infrastructural, and regional tourism policies.

While international literature is already actively studying digital platforms, sustainable branding, AR/VR, security, and rural and mountain tourism, there are relatively few empirical studies for Kazakhstan that simultaneously combine digitalization, sustainability, regional differences, institutional governance, and measurable socio-economic impact (Sharma et al., 2026; Succurro, 2026).

The growing use of the internet and technological advances have transformed communication (Jansson, 2022), as well as the collection and dissemination of information within the tourism industry. With the proliferation of smartphones and other electronic devices, rapid technological advancements have enhanced visitor experiences, increased satisfaction, and expanded tourism businesses' access to information (Misganaw & Singh, 2020; Zollo et al., 2022).

One of the key factors determining the sustainable development of tourism in a country, as noted by Tribe and Liburd (2016), is the creation and continuous improvement of an information space within the tourism system. Consequently, to ensure the sustainable development of tourism in a given country, it is important to thoroughly understand the processes occurring across various contextual spaces. These spaces are where tourists spend their time (destinations) or integrate their perceptions of the two previous spaces (information spaces).

MATERIALS AND METHODS

As part of a study on sustainable development management in the tourism industry in the context of Kazakhstan's digitalization economy, a combination of general scientific and economic-mathematical methods was used to provide a comprehensive analysis of the dynamics and interrelations of key industry indicators:

Comparative and dynamic analysis methods were used to assess changes in key macroeconomic indicators of the Tourism Account (TSA) of the Republic of Kazakhstan for 2020–2025, including consumption, expenditure, and gross value added in tourism. Growth rates were calculated to assess the intensity of the industry's development, enabling the identification of recovery phases and the transition to sustainable development.

To comprehensively assess the level of development of the tourism industry, an integral indexing method was used

to calculate the integral TSA index. This was accomplished by normalizing the indicators (min–max method) and then aggregating the values, thereby combining disparate indicators into a single, unified indicator.

Additionally, an elasticity coefficient was calculated to assess the sensitivity of gross value added to changes in tourism expenditure. This indicator was used to analyze the effectiveness of transforming tourism demand into economic outcomes and to identify structural constraints on the industry's development.

The study's database included official statistical data from the Republic of Kazakhstan, as well as materials from international organizations on tourism and the digital economy. Data processing and modelling were conducted using statistical and econometric methods.

The use of these combined methods ensured the reliability and validity of the results. It facilitated the development of practical recommendations to improve the sustainable development of the tourism industry in the context of Kazakhstan's economic digitalization.

RESULTS

In 2024–2025, the tourism industry's technological priorities will shift toward analytics-oriented solutions: artificial intelligence and Big Data are becoming key drivers of sustainable development, ensuring greater efficiency in managing tourist flows, delivering personalized services, and reducing operating costs. At the same time, infrastructure technologies (IoT, 5G) underpin the development of the concept of "smart" tourism destinations, while automation and robotics enhance the industry's operational resilience (Figure 1).

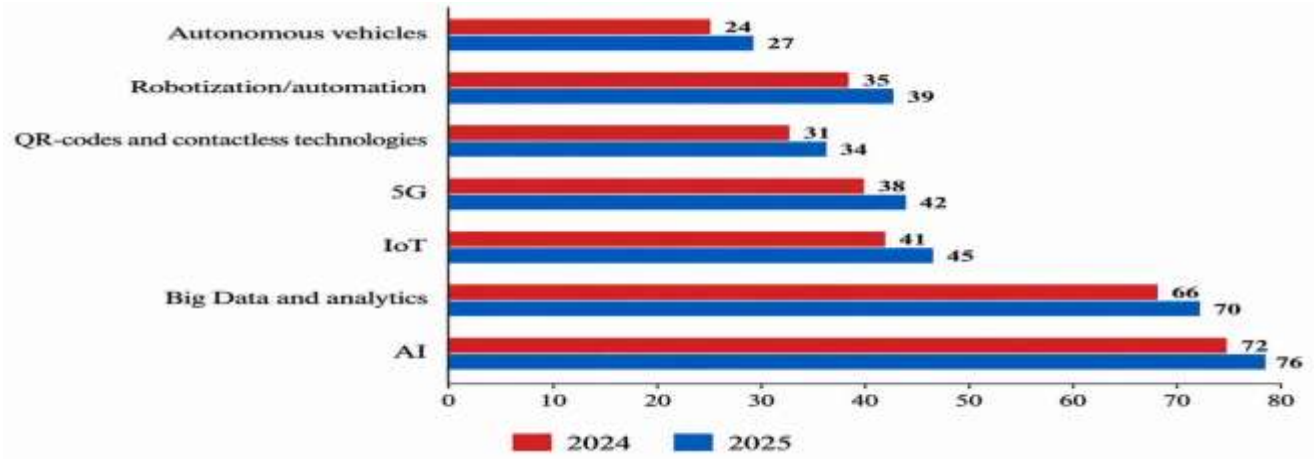

Figure 1. Technologies impacting the tourism business in the next 5 years

Conducting an econometric analysis allows us to assess the effectiveness of transforming investment resources into tourism industry development outcomes, including increased infrastructure potential, improved quality of tourism services, and enhanced destination competitiveness. Furthermore, the analysis allows us to identify structural shifts in the tourism development model, driven by the introduction of digital technologies, institutional transformations, and the implementation of state policy on sustainable development, thereby providing a basis for formulating evidence-based management decisions (Table 1).

Table 1. Key macroeconomic indicators characterizing the contribution of tourism to the economy of the Republic of Kazakhstan for 2020–2025

Year	Domestic tourism consumption, billion tenge	Expenditures related to tourism within the country, billion tenge	Including inbound tourism expenditures, billion tenge	Including domestic tourism expenditures, billion tenge	GVA in tourism industries (GVAOT), billion tenge	GVA in tourism (GVANT), billion tenge
2020	807,2	568,9	233,1	335,8	2800,0	560,0
2021	1131,0	786,4	324,5	461,9	2871,0	572,5
2022	2087,6	1595,2	804,4	790,8	3270,1	1001,0
2023	2759,6	2233,7	1172,3	1061,4	3283,2	1184,4
2024	3050	2450	2227,4	1609,0	3600	1280,0
2025	3380	2800	4232,0	2440,0	3900	1400,0

Analysing the growth rates of key macroeconomic indicators in the tourism industry is an important tool for assessing the industry's development dynamics amid economic digitalisation. Unlike absolute values, growth rates allow us to identify the intensity of change, identify phases of industry development, and assess the sustainability of established trends. This is particularly relevant for Kazakhstan's tourism sector, which has been undergoing structural changes in recent years due to both post-crisis recovery and the active implementation of digital technologies.

Researching the growth rates of tourism accounting indicators (Tourism Statistical Accounting System – hereinafter

TSA), such as tourism consumption, expenditure, and gross value added, allows us not only to capture quantitative dynamics but also to identify qualitative changes in the industry's operating model. Specifically, analysing growth-rate dynamics enables the identification of periods of accelerated development, stabilisation, or deceleration, as well as the assessment of the impact of external and internal factors, including digitalisation, institutional transformations, and changes in the structure of tourism demand. In the context of managing the sustainable development of the tourism industry, comparing the growth rates of various indicators is particularly important, as this allows us to assess the effectiveness of transforming tourism demand into economic results:

$$T = \frac{Xt - Xt-1}{Xt-1} * 100 \quad (1)$$

Thus, the analysis of growth rates is an important element of econometric research aimed at identifying patterns of tourism industry development in Kazakhstan and substantiating management decisions in the context of the digital economy (Table 2).

Table 2. Growth rates of tourism indicators, %

Year	Consumption	Expenses	Gross value added generated directly by tourism activities
2021	40,1	38,2	2,2
2022	84,6	102,9	74,8
2023	32,2	40,0	18,3
2024	10,5	9,7	8,1
2025	10,8	14,3	9,4

An analysis of the growth rates of key indicators in the tourism industry of the Republic of Kazakhstan revealed an overall positive trend in development and identified the stages of recovery and subsequent stabilization. However, growth rate analysis reflects only quantitative changes and does not fully assess the degree of interrelationship between the key economic indicators of the tourism account.

Therefore, a more in-depth study of the nature of the relationships between tourism activity indicators, particularly between the volume of tourist expenditure and the formation of gross value added in tourism, is necessary. Assessing these relationships is fundamental to understanding the industry's performance and identifying key factors for its sustainable development in the context of economic digitalisation.

To address this issue, the study uses correlation analysis to quantitatively assess the strength and direction of the relationship among the indicators under consideration. Using the Pearson correlation coefficient, it is possible to determine the extent to which changes in tourism demand translate into economic outcomes in the industry, as well as to confirm or refute the hypothesis of a stable relationship between them (Table 3).

Table 3. Pearson correlation matrix of key indicators of the tourism industry of the Republic of Kazakhstan

Indicator	Consumption	Expenses	Inbound tourism	Domestic tourism	Total gross value added of all tourism-related industries	Gross value added generated directly by tourism activities
Consumption	1,000	0,99	0,97	0,(8	0,94	0,96
Expenses	0,99	1,000	0,98	0,99	0,95	0,97
Inbound tourism	0,97	0,98	1,000	0,95	0,93	0,96
Domestic tourism	0,98	0,99	0,95	1,000	0,94	0,96
GVAOT	0,94	0,95	0,93	0,94	1,000	0,98
GVANT	0,96	0,97	0,96	0,96	0,98	2,000

Correlation analysis revealed stable and statistically significant relationships between key macroeconomic indicators of Kazakhstan's tourism industry (very high correlation, r = 0.97). High correlation coefficients indicate that tourism development is systemic, with growth in tourism demand, including domestic and inbound, directly translating into increased gross value added. This confirms the industry's efficiency and its ability to generate economic benefits in the context of digitalization.

A regression model was constructed, as follows:

$$Y = a + bX, \quad (2)$$

Y = 120 + 0,46X

A correlation analysis revealed a strong positive relationship between key tourism industry indicators, specifically between tourism spending and gross value added, and demonstrated a strong statistically significant relationship between tourism spending and gross value added ($r = 0.97$; $p < 0.001$). However, the identification of a high degree of correlation does not permit a full assessment of the nature and strength of the causal relationships between variables, nor does it allow determination of the contribution of individual factors to the final result (Table 4).

Table 4. Model quality

Indicator	Value
R^2	0.94
t(b)	9.8
p-value	< 0.001

A correlation and regression analysis revealed a strong statistically significant relationship between tourism spending and gross value added ($r = 0.97$; $p < 0.001$). The resulting regression model confirms that tourism demand is a key factor in the industry's economic performance.

The calculated integrated TSA index demonstrates the progressive development of Kazakhstan's tourism industry, with its peak value reached in 2025. This indicates the emergence of a sustainable development model, the strengthening role of tourism in the economy, and the increased efficiency of converting tourism demand into added value.

With the digitalization of the economy and the transition to a sustainable development model, there is a need to apply integrated assessment methods that combine diverse indicators into a single, comprehensive indicator. This approach provides a more holistic view of the tourism industry, simultaneously taking into account the dynamics of consumption, spending, and added value creation. In this regard, it is advisable to calculate the integrated tourism account index (TSA), which aggregates key macroeconomic indicators into a single framework and assesses the overall development of the tourism industry in the Republic of Kazakhstan. Using this index makes it possible to identify sustainable growth trends, compare year-over-year development dynamics, and assess the effectiveness of translating tourism demand into economic outcomes in the context of economic digitalization. For this purpose, the following data were normalized:

$$Z = \frac{X - Xmin}{Xmax - Xmin}, \quad (3)$$

$$TSA\ Index = \frac{Zconsumption + Zexpenses + ZGVA}{3}, \quad (4)$$

The results of the TSA Index calculation are shown in Figure 2.

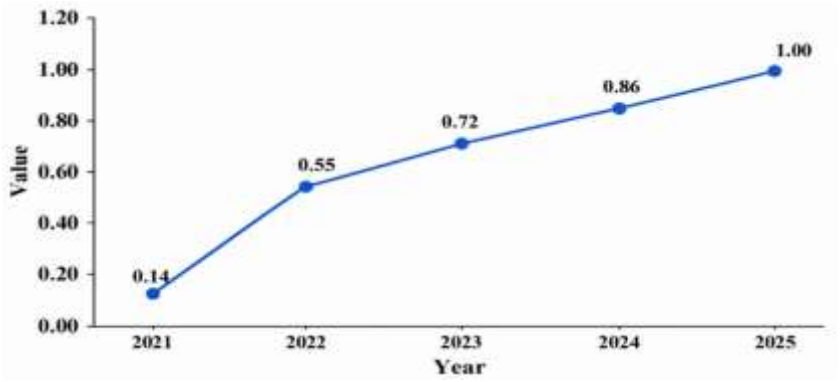

Figure 2. Results of the TSA Index calculation

The results of the integrated TSA index calculation showed a steady positive trend in the development of the tourism industry in the Republic of Kazakhstan, reflecting growth in tourism consumption, expenditure, and gross value added. The resulting index values indicate the industry's gradual transition from the recovery phase to the sustainable development phase, as well as an increase in its economic significance in the national economy. However, the integrated TSA index only assesses the overall level of industry development and does not fully reveal the mechanisms underlying the economic impact. Specifically, it does not reflect the effectiveness of transforming tourism demand into value-added outcomes in the context of economic digitalisation and the management of sustainable development.

Therefore, it is necessary to deepen the analysis by assessing elasticity, which allows us to determine the sensitivity of gross value added to changes in tourism expenditure using the formula:

$$E = \frac{\Delta Y / Y}{\Delta X / X}, \quad E = \frac{\Delta Y}{\Delta X} * \frac{X}{Y} \quad (5)$$

where:

Y - gross value added generated directly by tourism activities;

X - tourism expenses.

This indicator allows us to quantify the industry's performance, identify structural constraints, and assess the potential to improve resource efficiency. The elasticity calculation by year is presented in Table 5.

Table 5. Calculation of elasticity by year

Year	ΔX (expenses)	ΔY (GVA)	Elasticity
2021	+217,5	+12,5	0,04
2022	+808,8	+428,5	0,73
2023	+638,5	+183,4	0,46
2024	+216,3	+95,6	0,37
2025	+350	+120	0,40

Calculating the elasticity coefficient revealed that the relationship between tourism expenditure and gross value added in tourism is inelastic. The average elasticity was approximately 0.40, indicating that a 1% increase in tourism expenditure resulted in less than 1% growth in value added. This points to structural constraints in the industry related to the efficient transformation of demand into economic results.

The increase in elasticity in 2022–2023 reflects the industry's recovery and greater resource efficiency, while the subsequent stabilization of the indicator in 2024 signals a transition to a sustainable, albeit less intensive, growth model.

The results obtained during the study indicate a steady positive trend in the development of the tourism industry in the Republic of Kazakhstan, accompanied by growth in key macroeconomic indicators and an increasing role of tourism in the national economy. However, the identified characteristics, including the inelasticity of the relationship between tourism expenditure and gross value added, as well as structural and institutional constraints, indicate the need to improve industry governance mechanisms. In the context of the digitalization of the economy, the transition from quantitative growth to a qualitatively oriented development model based on improved resource efficiency, the implementation of digital technologies, and the formation of an integrated tourism ecosystem is particularly important. One of the key indicators of actual tourist activity and the level of infrastructure utilization is the number of visitors served at accommodation facilities. This indicator characterises the intensity of tourism resource utilisation and the level of demand for accommodation services, and serves as the basis for assessing the industry's effectiveness. Furthermore, the dynamics of changes in the number of visitors served is an important basis for economic and statistical analysis and the construction of forecast models that help determine the development prospects of the tourism sector, identify demand trends, and substantiate strategic planning in the context of the digital transformation of the economy (Figure 3).

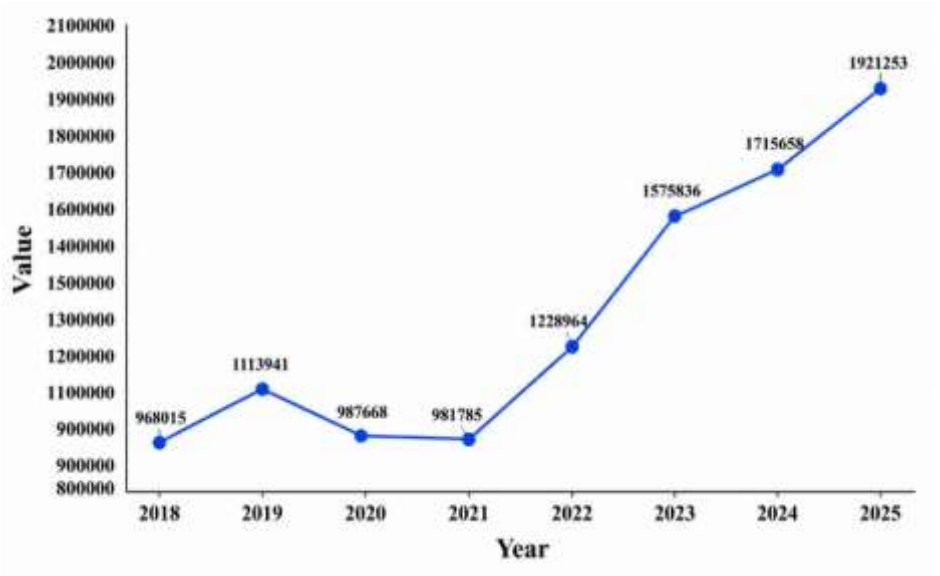

Figure 3. Number of visitors served in accommodation areas, people

To construct forecast values for the "Number of Visitors Served in Accommodation Venues" indicator (in people), we will analyse the corresponding time series for the period 2018-2025.

First, we will use the mean comparison method to identify the presence of a trend in the time series. This algorithm assumes that the original time series is divided into two approximately equal parts based on the number of series members, with each part considered an independent sample population. If the time series exhibits a trend, the means calculated separately for each population should differ significantly. If the discrepancy is insignificant and random, then the time series does not exhibit a trend in the mean. Therefore, testing the null hypothesis (H_0:) about the presence of a trend in the series under study is reduced to testing the hypothesis that the means of the two populations are equal, that is:

$$H_0: \bar{y}_1 = \bar{y}_2$$
$$H_1: \bar{y}_1 \neq \bar{y}_2$$

Due to the small number of observations, we tested the proposed hypothesis using the nonparametric Mann-Whitney test. The results of the hypothesis test are presented in Table 6.

Table 6. Results of comparison of two means

Indicator	Average for the first group	Average for the second group	Z-Statistic	p-value
y_1 vs. y_2	1013602,25	1610427,75	-2,31	0,021

Since the resulting Z-statistic is significant (p-value < 0.05), it can be concluded that there is a mean trend in the time series. To approximate the original time series, a first-degree polynomial was chosen as the growth curve:

$$y_t = a_0 + a_1 t + \varepsilon_t, \quad (6)$$

The model parameters were estimated using the ordinary least squares method. This resulted in the following trend model:

$$y_t = 685768{,}54 + 139165{,}88t$$

To test the adequacy of the model, a series of residuals was examined, i.e., the discrepancy between the levels calculated by the model and actual observations. The following properties of the residual component were checked: equality of the mathematical expectation to zero, independence of successive levels of the series of residuals, their randomness, and compliance with the normal distribution law.

During the test, the equality of the mathematical expectation of the levels of the series of residuals to zero was determined (H_0: $|e| = 0$). Student's t-statistic is constructed:

$$t_{observ.} = \frac{|\overline{e}|}{S}\sqrt{n} = 0{,}000$$

Thus, $t_{observ.} < t_{crit.} = 2.36$, then, with 95% probability, we accept our hypothesis.

When testing for independence (absence of autocorrelation), the observed value of the Durbin-Watson dw test was determined:

$$dw = \frac{\sum_{t=2}^{n}(e_t - e_{t-1})^2}{\sum_{t=1}^{n} e_t^2} = 0{,}894$$

Since the value fell within the interval d_2=1.32<dw<2, this criterion can be used to conclude that the independence property is satisfied. This means there is no autocorrelation in the time series; therefore, the model is adequate according to this criterion.

To test the randomness of the residuals, the "peak" criterion was used—the observed value, which turned out to be equal to $p_{observ} = 2$.

$$p_{crit.} = \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$$

$$p_{crit.} = \left[\frac{2}{3}(8-2) - 1{,}96\sqrt{\frac{16*8-29}{90}}\right]$$

$p_{crit.} = \left[4 - 1{,}96\sqrt{\frac{99}{90}}\right]$.

$p_{crit.}$ = [4-1,96*1,049] = [4-2,056] = 1,944 ≈ 2

Thus $p_{observ.} > p_{crit.}$, Therefore, the residual series can be considered random.

The conformity of the residual series to the normal distribution is particularly important for the validity of constructing point and interval forecast values. For verification, the RS-test was used, the observed value of which is equal to:

$$RS = \frac{e_{max-e_{min}}}{S} = 2{,}33$$

The resulting value falls between the tabulated criteria boundaries: $2{,}67 < RS < 3{,}69$. Therefore, with 95% certainty, we can assert that the hypothesis of a normal distribution of the residual series is accepted, and in this case, it is permissible to

construct predicted values.

To assess the accuracy of the model, the average relative approximation error was calculated:

$$E_{rel.} = \frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t}\cdot 100\% = 7{,}9\%,$$

A value that indicates an acceptable level of model accuracy.

Thus, the model is of sufficient quality and can be used for forecasting.

To calculate the point forecast, the corresponding factor values were substituted into the constructed model $t = n + k$. To construct an interval forecast, a confidence interval was determined at the significance level $\alpha = 0{,}05$. The width of the confidence interval was calculated using the formula:

$$U(k) = S_e t_\alpha \sqrt{1 + \frac{1}{n} + \frac{\left(n+k-\overline{t}\right)^2}{\sum_{t=1}^{n}\left(t-\overline{t}\right)^2}} \qquad (7)$$

The results of constructing point and interval forecasts for 2026-2028 are presented in Table 7.

Table 7. Point and interval forecasts of the indicator “Number of visitors served in accommodation locations” for 2026-2028

Year	Point forecast, thousand tenge	Interval forecast, thousands of tenge	
		Max	Min
2026	1938261,46	1420697,81	2455825,12
2027	2077427,35	1522849,22	2632005,47
2028	2216593,23	1620624,59	2812561,86

The obtained values indicate continued positive growth in tourist flow. The projected level could reach 2.2 million people by 2028. This reflects the sustainable development of Kazakhstan's tourism industry amid the digitalization of the economy. Interval estimates confirm variability in the indicator due to external and internal factors, but the overall trend remains upward.

Thus, the sustainable development of Kazakhstan's tourism industry in today's environment must be based on further digitalization of infrastructure, the use of data to forecast demand, and the development of adaptive management mechanisms to enhance the industry's competitiveness and investment attractiveness. The results obtained can serve as a basis for developing strategic tourism management solutions aimed at long-term sustainable growth and Kazakhstan's integration into the global tourism landscape. This requires developing and implementing measures to strengthen the tourism industry's resilience, enhance its competitiveness, and adapt to global market challenges.

DISCUSSIONS

The use of innovative and digital solutions helps travel companies not only attract new customers but also improve satisfaction and loyalty among existing ones. The emphasis on building loyalty is significantly less on flexibility and personalization, as consumers increasingly expect travel companies to understand and meet their personal needs at the right time. Innovative financing methods that facilitate the digitalization of tourism show the following trends (Table 8).

Table 8. Methods of innovative financing in the development of digitalization of tourism

No.	Financing methods	Justification
1	Research and Development (R&D)	- Innovative financial instruments aimed at funding research and development projects in digital technologies for tourism; - Grants and investments can stimulate the creation of new digital solutions, such as apps, virtual tours, and virtual reality technologies.
2	Startups and incubators	- Financing startups specializing in innovative tourism technologies can facilitate the emergence of new players in the industry; - Investment-supported incubators and accelerators can stimulate the development of technology startups in the tourism sector.
3	Infrastructure and services	- Funding for the creation and modernization of digital infrastructure in tourist areas, including high-speed internet, mobile apps, and electronic platforms; - Development of digital services for tourists, such as online booking, mobile guides, and information exchange platforms.
4	Training and professional development	- Investments in digital skills training for tourism industry employees; - Support for professional development programs for tourism businesses aimed at the effective use of digital tools.
5	Marketing and promotion	- Funding digital marketing campaigns to promote tourist destinations through online channels; - Investing in innovative advertising methods, such as virtual and augmented reality

Investments in the tourism industry are investments in the future. They help create a sustainable, competitive economy focused on long-term development and open engagement with the world.

Modern approaches to managing sustainable tourism development shift from traditional planning methods to focused management models grounded in digital technologies, analytical tools, and platform solutions. Therefore, investments in tourism infrastructure, including accommodation, food services, entertainment, and recreation, are key indicators of the industry's development and reflect the economy's readiness to implement digital and sustainable practices.

Analysing investment dynamics in the tourism industry in the context of economic digitalisation allows us to identify patterns in the development of sustainable tourism potential, prioritise areas for development, and evaluate the effectiveness of management decisions. In today's environment, studying the relationship between investment patterns (in accommodation infrastructure, entertainment, and related services) and the level of development of the tourism industry is particularly important. This makes it possible to identify key drivers of sustainable growth and substantiate areas for improving the management system using digital technologies. In the context of globalization and the digital transformation of the global economy, the tourism industry is becoming not only a tool for international economic integration but also an element of digital ecosystems that facilitate interaction among market participants through platform solutions and data. Tourism development facilitates cross-border flows of services, capital, and information, and strengthens the integration of national tourism systems into the global digital space. In this context, a quantitative assessment of the degree of integration of Kazakhstan's tourism industry into the international market, accounting for the level of digitalization and the sustainability of its development, is particularly important.

Innovative financing is becoming a key driver of digital tourism development, facilitating the adoption of new technologies, enhancing the tourist experience, and creating competitive advantages for the tourism industry. The more the state invests in innovative financing, the greater the development of digitalization in tourism in Kazakhstan (Figure 4).

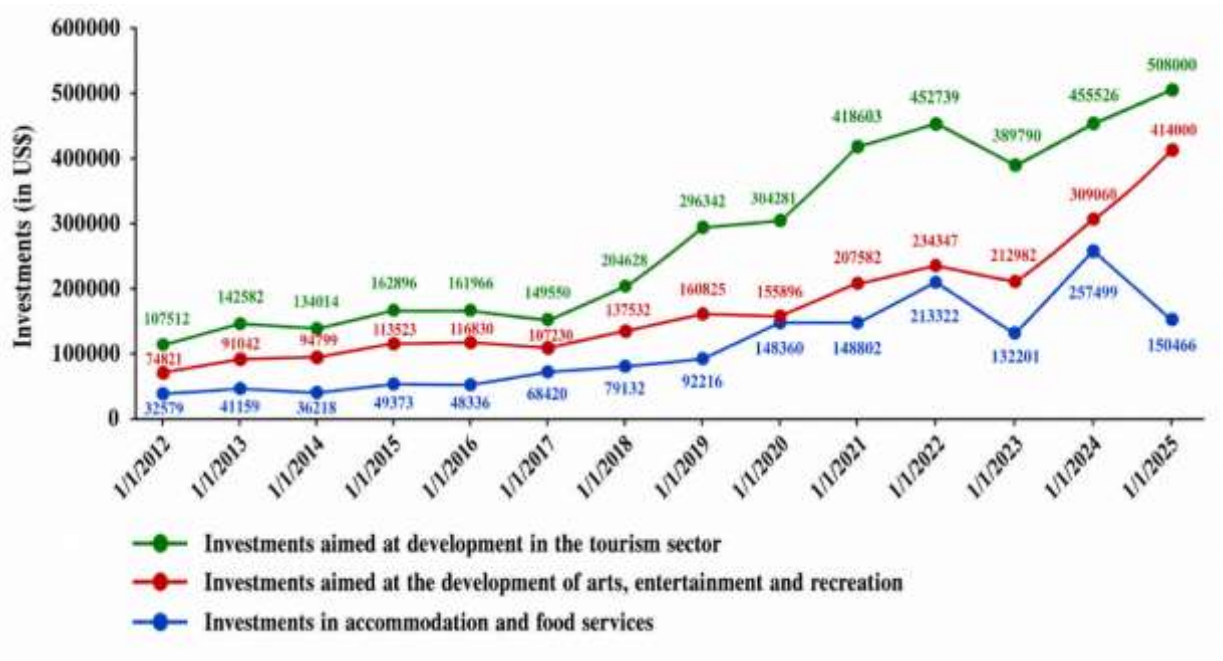

Figure 4. Innovative Financing in Tourism, million tenge

In 2024–2025, positive investment trends in Kazakhstan's tourism industry will continue, though growth is gradually slowing, indicating the industry's transition to sustainable development. The entertainment and recreation sector continues to make the largest contribution to investment, reflecting a focus on diversifying the tourism product and increasing its attractiveness.

The regression analysis showed that investments in the accommodation and food service sector have the greatest impact on the development of Kazakhstan's tourism industry. The high coefficient of determination indicates a close relationship between the development of accommodation infrastructure and overall tourism investment. Investments in entertainment and recreation also contribute to the industry's development, but their impact is more moderate. This confirms that basic tourism infrastructure is a key driver of sustainable growth in the tourism sector.

CONCLUSIONS

The study revealed that the tourism industry in the Republic of Kazakhstan has demonstrated sustainable, positive development from 2020 to 2025, moving from a post-crisis recovery phase to a stage of stable growth. An analysis of key tourism sales account (TSA) indicators revealed a significant increase in consumption and expenditure, as well as growth in tourism's gross value added, demonstrating the industry's expanding economic role.

The results of the correlation analysis confirmed a close relationship between tourism expenditure and gross value added ($r \approx 0.97$), indicating the decisive role of tourism demand in the industry's development. The regression model

demonstrated high explanatory power ($R^2 \approx 0.94$) and statistical significance, confirming that increased tourism expenditure improves economic performance.

The calculation of the integrated TSA index showed a consistent improvement in the tourism industry's development, peaking in 2025, indicating the emergence of a sustainable growth model. However, elasticity analysis revealed an inelastic relationship ($E \approx 0.40$), indicating structural constraints and inefficient conversion of tourism demand into added value.

An economic and statistical analysis of the "Number of Visitors Served in Accommodations" indicator for 2018–2025 revealed a steady positive trend in the development of Kazakhstan's tourism industry. A comparison of average values confirmed a statistically significant growth trend, and the constructed linear model showed that the annual increase in tourist flow averages approximately 139,000 people. Projections for 2026–2028 indicate a further increase in demand for accommodation services, reflecting the industry's gradual recovery and transition to sustainable growth.

Thus, despite the positive trend, the development of Kazakhstan's tourism industry requires greater resource efficiency and improved management mechanisms, especially amid the digitalization of the economy.

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