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DIGITALIZATION OF INTERNATIONAL TOURISM: THE ROLE OF ARTIFICIAL INTELLIGENCE AND BIG DATA IN MANAGING TOURIST DEMAND

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Abstract

This article examines sources of tourism demand data (search queries, social media, transactions, mobile positioning, and platform data), analytical and machine learning methods for demand forecasting and management, and institutional implementation conditions (data spaces, statistical standards, data governance, and privacy and bias risks). It is shown that the combination of multi-source data and AI improves the accuracy of short- and medium-term demand forecasts and enables a transition from reactive to proactive management, provided that high -quality validation, model transparency, and compliance with data protection requirements are ensured.

Keywords: International tourism, digitalization, big data, artificial intelligence, demand forecasting, Google Trends, mobile data, social media, destination management, data governance.

Introduction

The scientific novelty of the article lies in the comprehensive analysis of tourist demand management in international tourism based on the integration of big data and artificial intelligence, with the justification of the transition from retrospective statistics to a proactive, data-centric model of management decision-making.

International tourism is currently developing in an environment of accelerated digitalization: a significant portion of the travel lifecycle (searching for ideas, comparing destinations, booking, paying, navigating on-site, and reviewing) has

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migrated to digital channels and platforms. This is leading to an increase in the volume and diversity of data on traveler behavior and the market as a whole: from search queries and clicks to transactions, geolocation traces, and user-generated content. As a result, demand management (demand) Tourism management is shifting from retrospective statistics to more operational analytics that allow for the assessment of tourist intentions and reactions in near real time. This shift is directly reflected in international analytical materials on tourism policy and statistics, which emphasize the potential of alternative data sources (including digital ones) to improve the timeliness and detail of tourism monitoring and eliminate the "blind spots" of traditional reporting [1].

At the same time, the role of artificial intelligence is growing as a set of methods for transforming arrays of heterogeneous data into forecasts and management decisions. For the tourism industry, AI is important not only as a tool for service automation (chatbots, personalization), but also as a technology for supporting decisions in marketing, pricing, flow management, and risk management. At the intergovernmental level, this is reflected, in particular, in the OECD's policy document for the G7, which considers AI as a driver of innovation and sustainable tourism development and describes key opportunities and risks for tourists, businesses, destinations, and the government [1].

Managing tourism demand in the international context is complicated by high volatility (seasonality, events, transport disruptions, visa changes, epidemiological and geopolitical shocks), as well as the complexity of value chains (air carriers, OTAs, hotels, attractions, urban infrastructure). Therefore, there is a growing need for short-term forecasting tools and early detection of demand shifts, enabling the reallocation of marketing budgets, capacity management, and the mitigation of the risk of overselling popular destinations. In this context, big data is becoming a source of high-frequency indicators, and AI is a mechanism for identifying nonlinear patterns and signals that are difficult to capture with traditional models. This logic -"data → forecast → decision" - is emphasized in OECD materials, where alternative data and analytical tools are considered the basis for better policy and management at the national and subnational levels.

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Mobile data (mobile occupies a special place positioning data) and other sources of digital mobility that allow us to assess movements, length of stay, and spatial distribution of flows. At the level of official tourism statistics, the use of big Data has been discussed for several years now: Eurostat has emphasized that tourism is one of the domains where big data-based innovations are among the first to emerge, but requires consideration of the cross-border nature of data, legal and ethical constraints, and international comparability of methods [2]. Thus, the digitalization of tourism is not only a question of technology, but also a question of institutions: rules for data exchange, compatibility, trust, and transparency. This institutional line is currently being strengthened by the formation of industry "data spaces". In the European Union, one of the areas of focus is the initiative of a common European data space for tourism, the goal of which is to stimulate data exchange and innovation in the tourism ecosystem (destination management organizations, companies, platforms, researchers) while adhering to the principles of governance and interoperability [3]. In parallel, an applied data management framework for the European Tourism Data Space (ETDS) is emerging, which describes the tasks of trusted exchange and the organizational "architecture" of interaction between participants.

Taking the above into account, it is logical to view the digitalization of international tourism as a transition to a data-centric demand management model, where decisions are made based on: multi-source digital traces (search, platforms, transactions, mobility, social media), AI methods and advanced analytics for forecasting and scenario planning, institutional mechanisms for data exchange and management.

The purpose of the article is to reveal the role of AI and big data in managing tourist demand in international tourism, to describe the main data sources and typical analytical approaches, and to identify limitations (representativeness, privacy, data drift) and conditions for successful implementation (data governance, compatibility, model validation).

The digitalization of tourism has led to the development of a wide range of alternative data sources reflecting tourists' intentions, behavior, and actual movements. In the scientific literature, such data is collectively referred to as "big data". tourist demand data and are considered as a supplement to, rather

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than a replacement for, traditional tourist statistics (arrivals, overnight stays, expenditure) [2].

The key features of big data are its high update rate, spatial detail, and the ability to analyze behavior at different stages of the tourism cycle. This makes it particularly valuable for short-term forecasting and operational demand management, a point repeatedly emphasized in studies on tourism economics and management [4,5].

The most common sources can be grouped into several categories (Table 1).

Table 1 - Main sources of big data on tourism demand and their analytical potential

Data source	Brief description	Application in demand management	Restrictions
Search queries (Google Trends, Baidu Index)	Reflect intentions and interest in directions	Early demand identification, short-term arrival forecasting	Indirect nature, sensitivity to noise
Social media (X/ Twitter, Instagram, reviews)	User-generated content, emotions, and destination images	Image analysis, event effects, forecasting	Selection bias, language and cultural differences
Platform and transaction data (OTA, payments)	Actual bookings, prices, cancellations	Yield management, dynamic pricing	Data confidentiality, commercial sensitivity
Mobile data (MPD)	Geolocation and user movements	Evaluation of flows, length of stay, congestion	Legal and ethical restrictions
Multi-source Internet data	A combination of different digital traces	Improving forecast accuracy	Complexity of integration and validation

In scientific research, search data is considered one of the most robust proxy indicators of tourism demand. Google indexes have been shown to Trends statistically significantly improve forecasts of international arrivals compared to models based only on official statistics [6].

Mobile data holds a special place in measuring actual demand and tourist flows. Eurostat and the UN view mobile data as a promising source for assessing inbound and domestic tourism, the spatial distribution of visitors, and seasonal peaks, while emphasizing the need for strict anonymization and methodological comparability [2].

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In recent years, the emphasis has shifted to multi-source models, where search queries, social media, and transaction data are used together. Research in Annals of Tourism Research shows that such integration improves the robustness of forecasts in conditions of high demand volatility and external shocks [5].

Thus, big data expands the toolkit for measuring tourism demand, providing earlier and more detailed signals than traditional statistics. However, its practical application requires institutional readiness, transparent methodologies, and an awareness of the limitations of representativeness and privacy.

Forecasting tourist demand is a key management task in international tourism, as demand is characterized by high seasonality, sensitivity to external shocks, and nonlinear dynamics. In this context, artificial intelligence (AI) methods are considered an extension of traditional econometric approaches, allowing for increased forecast accuracy by processing large amounts of heterogeneous data and identifying hidden patterns [4].

In the scientific literature, AI in tourism demand forecasting is primarily applied to time series and regression problems with a large number of factors. The most common machine learning methods include artificial neural networks, random forests, and gradient-based models. Boosting , which demonstrates better results than classical ARIMA models in the presence of nonlinearities and interactions between variables [7]. AI is particularly effective when incorporating alternative data sources: search queries, online booking data, and social media.

A separate area of research involves the use of recurrent neural networks (LSTM, GRU) for modeling tourism time series. These models are capable of accounting for long-term dependencies and complex seasonal effects, as confirmed by empirical studies of international tourist arrivals and hotel occupancy [8]. It is also emphasized that the advantages of deep learning are primarily evident with long and high-frequency data series, while for short series, classical or hybrid models remain more robust.

A key contribution of AI is the ability to forecast and nowcast tourism demand in the short term. By integrating search data and other digital traces, machine learning models can detect changes in demand at early stages, even before official statistics are available. This is particularly significant for international tourism, where data release lags can reach several months [6].

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At the same time, research emphasizes the need for caution in the application of AI. Key limitations include the risk of overfitting, limited interpretability of complex models, and forecast instability during structural shifts (e.g., during crises). Therefore, the literature recommends using hybrid approaches that combine econometric models and AI methods, as well as paying particular attention to validation procedures and the comparability of results [4].

Therefore, the role of artificial intelligence in forecasting tourism demand is not to completely replace traditional methods, but to expand the analytical toolset of management by processing big data, increasing the accuracy of short-term forecasts, and supporting more proactive management decisions.

The use of big data and artificial intelligence (AI) is shifting tourism demand management from a reactive approach based on post-hoc statistics to a proactive decision-making model. Scientific and applied literature emphasizes that Big Data Data and AI make it possible not only to forecast demand but also to actively influence it through marketing, pricing, and tourist flow management [5]. A key feature of this management is the integration of predictive models into the management processes of destination management organizations (DMOs), tourism companies, and government agencies. Based on tourists' digital footprints, demand scenarios are generated, which are used to reallocate resources, smooth out seasonality, and reduce the risk of infrastructure overload. Big Application Practice Data and AI in tourism are concentrated in several functional areas (Table 2).

Table 2 - Big Application Data and AI in Managing Tourism Demand

Direction of management	Data and methods used	Management effect
Destination Marketing	Search queries, social media , ML segmentation	Early identification of target markets, optimization of marketing budgets
Income and price management	Platform and transactional data, ML models	Dynamic pricing, revenue growth
Management of tourist flows	Mobile data (MPD), spatial analytics	Reducing congestion, increasing destination sustainability
Crisis and adaptive management	Multi-source data, nowcasting	Rapid response to demand shocks
Strategic planning	Long-term forecasts based on Big Data	Support for investment decisions

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In the field of Big Marketing Data and AI are used to analyze tourist intentions and dynamically segment markets. Search data and social media make it possible to identify changes in interest in destinations even before actual trips, enabling the adjustment of advertising campaigns in near real time [6].

Revenue management AI is used to analyze online booking data and implement dynamic pricing. Research shows that machine learning improves the accuracy of short-term demand forecasts and facilitates more efficient rate and capacity management, particularly in the hotel and airline sectors [9].

Separate meaning Big Data AI and mobile devices are used to manage the spatial distribution of tourists and the sustainable development of destinations. Mobile data allows for assessing the density and routes of tourist flows, identifying bottlenecks, and planning measures to alleviate them [2]. Combined with predictive models, this creates the basis for managing visitor numbers at popular sites and minimizing the negative effects of mass tourism.

International organizations emphasize that the successful application of such approaches is only possible with the presence of a developed data management system that ensures transparency, protection of personal information and comparability of data across countries [1].

So, Big Data and AI are becoming tools for integrated tourism demand management, linking forecasting, operational decisions, and strategic planning into a single digital system.

Despite the significant potential of big data and artificial intelligence (AI) in managing tourism demand, their practical application is fraught with risks and methodological limitations. Ignoring them can lead to distorted forecasts and ineffective management decisions, particularly in international tourism with its highly volatile and heterogeneous markets.

1. Representativeness and data bias. Big data is typically generated not for statistical purposes, but as a byproduct of digital services. Search queries, social media, and platform data reflect the behavior of only a subset of tourists and are subject to demographic, cultural, and regional biases. The literature emphasizes that such data should be considered as proxy indicators of demand and used in conjunction with official statistics, not in isolation.

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2. Privacy and legal restrictions. The use of mobile and transactional data is associated with privacy risks and requires strict adherence to the principles of anonymization, minimization, and lawful processing. International organizations point out that the lack of transparent rules for access and data exchange limits the scalability of Big Data -based solutions. Data , especially in cross-border tourism.

3. Data instability and drift. Digital sources are subject to structural changes: search engine algorithms, platform rules, and user behavior evolve. As a result, AI models may lose accuracy when transferred over time or between markets. Research in tourism demand forecasting emphasizes the need for regular model updates and testing their resilience to external shocks.

4. Interpretability and managerial applicability. Complex machine learning and deep learning models often have limited interpretability, which reduces trust in the results for management and business. The scientific literature recommends using hybrid approaches that combine AI and traditional econometric models, as well as explainable AI methods.

5. Requirements for data quality and management. Effective use of Big Data and AI are only possible with a developed data management system (data governance), including quality standards, documentation of sources, comparability of indicators, and transparent validation procedures. The OECD emphasizes that institutional readiness, not access to algorithms, is the key factor in the successful implementation of digital solutions in tourism management.

Overall, Big Data and AI should be viewed as decision support tools whose effectiveness depends on the quality of the data, methodological rigor, and institutional conditions for their use.

Big Data and AI are becoming the core of digital management in international tourism, enabling earlier detection of changes in intentions and demand, more accurate forecasting of traffic loads and economic impacts, optimization of marketing and pricing, and sustainable flow management. The most promising approach is a multi-source data architecture (search + platforms + transactions + mobility) combined with hybrid models (econometrics + ML) and a strong data management framework (quality, privacy, standards, interoperability). Practical benefits are achieved by moving from "analytics for reporting" to a

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forecast → decision → outcome measurement link at the business and destination levels.

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