

Artificial Intelligence as a Factor of Transformation in the Macedonian Tourism System

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Abstract

Artificial intelligence has increasingly emerged as a salient analytical component in contemporary tourism systems, particularly in small and medium-sized destinations characterized by high external dependence, seasonal volatility, and limited institutional capacity. While existing tourism scholarship predominantly examines artificial intelligence as a technological innovation associated with automation, personalization, and service efficiency, this paper conceptually reframes artificial intelligence as an analytical instrument embedded within tourism system governance. The purpose of the study is to examine how artificial intelligence contributes to the transformation of the Macedonian tourism system by extending analytical capacity in demand interpretation, destination visibility, and coordination of tourism flows.

The paper adopts a conceptual–analytical research design supported by empirical contextualization based on official statistical indicators and international tourism development benchmarks. No hypotheses are tested and no causal inference is pursued. Instead, the study combines a structured synthesis of recent literature indexed in the Web of Science Core Collection with descriptive analysis of tourism demand patterns, digital readiness indicators, and destination competitiveness measures relevant to North Macedonia. Empirical data are used illustratively to ground the conceptual argument in observed structural conditions rather than to generate statistical generalization.

The analysis demonstrates that artificial intelligence affects the Macedonian tourism system primarily through algorithmic mediation of demand, analytical restructuring of destination visibility, and indirect influence on managerial coordination. The paper's contribution consists in reinterpreting artificial intelligence as an analytically transformative factor situated within institutionally constrained tourism systems, offering added conceptual precision to discussions on smart tourism and analytical governance in small-scale tourism economies.

Keywords: artificial intelligence, tourism systems, North Macedonia, analytical instruments, destination management, digital demand, smart tourism governance

JEL Classification:
L83, O33, Z32, M15, C88, R58

Introduction

Contemporary tourism systems increasingly function under conditions of heightened uncertainty, volatile demand patterns, and expanding analytical complexity. Such conditions are especially evident in small tourism economies, where constrained market scale, strong seasonality, and reliance on external demand amplify managerial exposure to shocks and informational imbalance. The Macedonian tourism system exemplifies such a context, operating at the intersection of regional competition, high reliance on foreign visitors, and rapidly expanding digital intermediation.

The proliferation of digital platforms, online reservation systems, review mechanisms, and destination information services has fundamentally altered how tourism demand is generated, perceived, and managed. While these developments have expanded market access, they have simultaneously introduced new analytical challenges by shifting visibility, pricing signals, and consumer choice toward algorithmically mediated

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environments (Gretzel et al. 2021). The central challenge facing tourism management today is therefore not the absence of data, but the capacity to analytically interpret and govern complex, platform-driven demand structures.

Within this context, artificial intelligence has increasingly been promoted as a solution to analytical overload in tourism systems. Prior research has extensively documented applications of artificial intelligence in personalization, automation, and service enhancement. However, insufficient theoretical attention has been devoted to understanding artificial intelligence as an analytical instrument that reshapes managerial cognition and system-level coordination rather than as an autonomous decision-making entity.

This paper addresses this gap by conceptually examining artificial intelligence as a factor of transformation in the Macedonian tourism system. Instead of emphasizing technological deployment, the study focuses on how artificial intelligence restructures analytical capacity, mediates destination visibility, and alters coordination mechanisms within tourism governance. The purpose of the paper is to develop a theoretically grounded interpretation of artificial intelligence as an analytical extension of tourism management under conditions of institutional constraint and market asymmetry.

Theoretical Foundations of Artificial Intelligence in Tourism Systems

From a systems perspective, tourism destinations can be conceptualized as complex adaptive systems composed of heterogeneous actors, multi-layered information flows, and sensitivity to external disturbances. Management within such systems is characterized by bounded rationality, temporal pressure, and incomplete information, particularly when demand is shaped by external platforms and transnational mobility patterns (Buhalis and Sharma 2022).

Artificial intelligence intervenes in these systems not by replacing managerial judgment, but by extending analytical reach. Machine learning models, recommender systems, and predictive analytics enable the detection of latent demand patterns, behavioral regularities, and spatial-temporal pressures that exceed traditional analytical capacities (Li, Xu, and Li 2022). In this sense, artificial intelligence functions as an intermediary analytical layer that translates data complexity into structured interpretive signals.

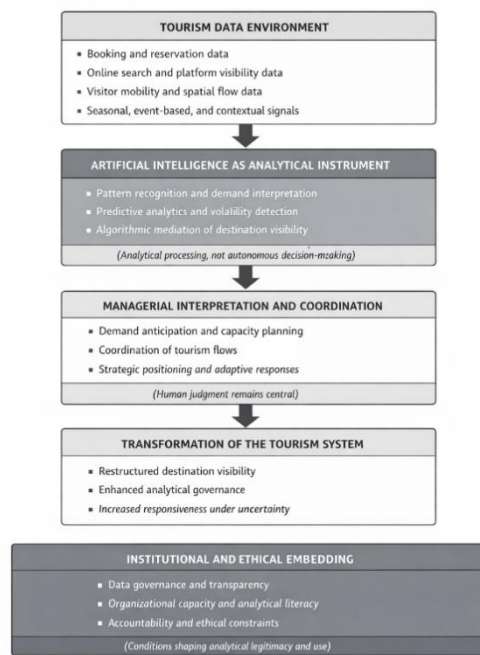
The theoretical contribution of this paper lies in integrating smart tourism research with theories of analytical rationality and system governance. While much of the literature emphasizes technological sophistication, the managerial relevance of artificial intelligence derives from its capacity to support anticipatory reasoning, comparative evaluation, and adaptive coordination within tourism systems (Gretzel et al. 2022). In small tourism economies such as North Macedonia, these analytical functions are particularly consequential due to limited institutional buffers and high dependence on external demand channels.

Crucially, artificial intelligence remains institutionally embedded. Analytical outputs acquire meaning only through organizational routines, governance frameworks, and normative constraints that shape interpretation and action (Floridi et al. 2022). Without institutional clarity and accountability, algorithmic mediation risks amplifying dependency on dominant platforms and weakening destination autonomy.

Conceptual Framework

The conceptual framework developed in this study is designed to clarify the role of artificial intelligence as an analytical instrument embedded within the Macedonian tourism system, illustrating how algorithmically mediated data processing supports managerial interpretation and coordination under conditions of demand volatility and institutional constraint.

Figure 1. Artificial Intelligence as an Analytical Instrument in the Macedonian Tourism System



Source: Author's conceptualization based on Gretzel et al. (2021), Buhalis and Leung (2023), Li et al. (2022), and Floridi et al. (2022).

Figure 1. Artificial Intelligence as an Analytical Instrument in the Macedonian Tourism System

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Building on the conceptual logic presented in Figure 1, Figure 2 further specifies the analytical mechanisms through which artificial intelligence supports managerial interpretation in the Macedonian tourism system.

Table 1. Artificial Intelligence as an Analytical Instrument in the Macedonian Tourism System

Analytical dimension	System components	Function of artificial intelligence	Implications for tourism management
Data environment	Booking and reservation records; online search behavior; platform visibility metrics; visitor mobility and spatial flow data; seasonal and contextual indicators	Structuring, integration, and interpretation of heterogeneous and high-volume tourism data	Establishment of an analytically coherent basis for interpreting demand dynamics and destination exposure
Analytical processing layer	Machine learning models; predictive analytics; pattern recognition systems; algorithmic ranking and recommendation mechanisms	Identification of latent demand patterns; anticipation of volatility; mediation of destination visibility	Reduction of informational asymmetry; enhancement of analytical interpretation without autonomous decision-making
Managerial interpretation	Destination management organizations; tourism enterprises; public tourism institutions	Translation of analytical outputs into actionable managerial insights	Demand anticipation; capacity planning; coordination of tourism flows; adaptive strategic responses
System-level effects	Destination competitiveness; coordination mechanisms; responsiveness to uncertainty	Indirect transformation through analytically informed management	Strengthened analytical governance; improved system responsiveness; restructured market positioning
Institutional embedding	Data governance frameworks; organizational capacity; accountability and ethical standards	Conditioning of analytical legitimacy and responsible use	Preservation of trust; transparency; institutional sustainability of AI-supported tourism management

Source: Author's conceptualization based on Gretzel et al. (2021), Buhalis and Leung (2023), Li et al. (2022), and Floridi et al. (2022).

The conceptual framework positions artificial intelligence as an analytical intermediary between the data environment of the tourism system and managerial interpretation. On the input side, heterogeneous data sources generated through bookings, online searches,

mobility patterns, and platform interactions constitute an analytically dense environment. Artificial intelligence processes this complexity through pattern recognition and predictive modeling, generating interpretive signals related to demand intensity, visibility, and spatial concentration. These signals inform managerial coordination rather than substitute decision making. The framework is enclosed within institutional and ethical boundaries that condition analytical legitimacy.

Methodology

The study is structured around a conceptual and analytical research approach complemented by empirical contextual grounding. The methodology does not pursue hypothesis testing, causal modeling, or statistical inference. Instead, it aims to clarify analytical mechanisms through which artificial intelligence contributes to tourism system transformation.

The research design consists of two components. The first component involves a structured synthesis of academic literature indexed in the Web of Science Core Collection published after 2020, with emphasis on artificial intelligence, smart tourism governance, and analytical decision support. The second component draws on descriptive indicators relevant to North Macedonia, including official tourism statistics, digital readiness measures, and international tourism development indices. These indicators are used illustratively to contextualize conceptual arguments rather than to validate empirical effects.

This approach is appropriate given the uneven empirical maturity of artificial intelligence adoption in the Macedonian tourism system and the need for theoretical clarification prior to empirical modeling.

Empirical Context: The Macedonian Tourism System

Official statistics indicate that tourism demand in North Macedonia is increasingly shaped by foreign visitors and digital intermediation. In November 2024, foreign tourists accounted for over two-thirds of total arrivals and more than sixty percent of overnight stays, highlighting strong exposure to external demand channels and platform-mediated visibility (State Statistical Office 2025). At the same time, internet usage exceeds eighty-seven percent of the population, suggesting widespread digital interaction on the demand side (World Bank 2024).

In international comparison, North Macedonia ranks eighty-seventh in the Travel and Tourism Development Index 2024, reflecting moderate competitiveness and structural constraints related to promotion, analytics, and institutional capacity (World Economic Forum 2024). These conditions frame artificial intelligence not as a luxury technology, but as an analytically consequential factor in destination positioning and demand interpretation.

Table 2. Selected Empirical Indicators Relevant to Artificial Intelligence–Driven Transformation of the Macedonian Tourism System

Indicator	Value	Reference year	Analytical relevance
Total tourist arrivals	66,701	2024 (November)	Indicates overall tourism activity and demand volume subject to digital mediation
Share of foreign tourists in total arrivals (%)	68.4	2024 (November)	Reflects strong exposure to international, platform-mediated demand
Total overnight stays	138,226	2024 (November)	Illustrates capacity utilization and seasonal concentration
Share of foreign tourists in overnight stays (%)	61.4	2024 (November)	Signals dependence on external demand and importance of digital trust mechanisms
Internet users (% of population)	87.2	2024	Proxy for domestic digital readiness and adoption of AI-supported services
Travel and Tourism Development Index (TTDI) score	3.53	2024	Composite indicator of tourism system competitiveness and structural capacity
TTDI global rank	87	2024	Contextualizes Macedonia's relative position in global tourism competitiveness
Digital demand pillar (TTDI)	Moderate performance	2024	Indicates scope for analytical enhancement through AI-supported visibility and promotion

Sources:

State Statistical Office of the Republic of North Macedonia (2025); World Bank (2024); World Economic Forum (2024).

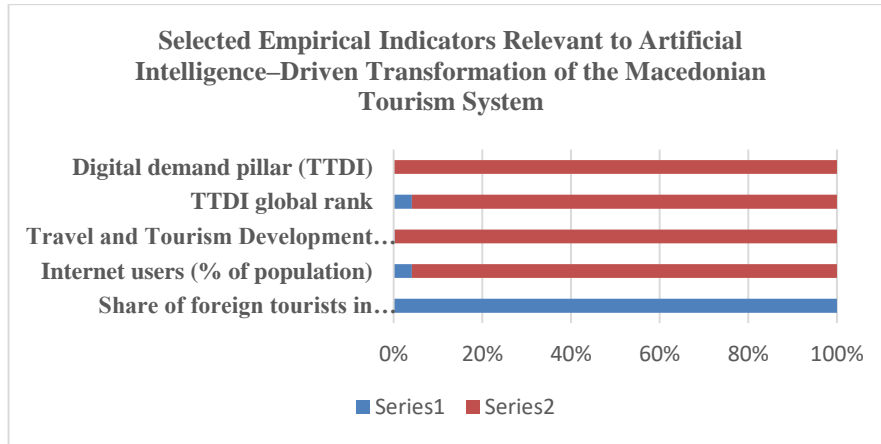


Figure 2. AI-Supported Analytical Mechanisms and Managerial Interpretation in the Macedonian Tourism System

Figure 2 illustrates the analytical sequence through which artificial intelligence processes heterogeneous tourism data and translates them into interpretable managerial insights within the Macedonian tourism system. The figure depicts artificial intelligence as an intermediary analytical layer that supports pattern recognition, demand anticipation, and interpretation of spatial-temporal dynamics, thereby assisting managers in decision-making related to capacity planning, coordination of tourism flows, and adaptive strategic responses. Importantly, the figure emphasizes that artificial intelligence does not operate as an autonomous decision-making system but functions as analytical support whose outputs require human interpretation within institutional and governance frameworks.

Table 3. Governance and Institutional Preconditions for Responsible Use of Artificial Intelligence in the Macedonian Tourism System

Governance dimension	Institutional scope	Current condition in North Macedonia	Relevance for AI-supported tourism management	Policy recommendations
Data governance	Public tourism institutions; destination management bodies; tourism enterprises	Fragmented data collection and limited interoperability across institutions	Constrains analytical coherence and reduces effectiveness of AI-supported demand interpretation	Establish interoperable tourism data standards and shared analytical repositories coordinated at national level

Governance dimension	Institutional scope	Current condition in North Macedonia	Relevance for AI-supported tourism management	Policy recommendations
Regulatory alignment	National legal framework; alignment with EU digital and data protection standards	Partial alignment through GDPR-related practices; absence of AI-specific regulation	Creates legal uncertainty for AI deployment in tourism services interacting with EU markets	Develop sector-specific guidelines aligned with the EU AI Act for tourism-related AI applications
Transparency and accountability	Tourism platforms; service providers; public communication channels	Limited formal requirements for disclosure of automated or AI-mediated interactions	Increases risk of reduced trust in digital tourism services and destination communication	Introduce mandatory disclosure of AI-mediated interactions in tourism-related digital services
Organizational capacity	Tourism enterprises; local authorities; destination management organizations	Uneven analytical literacy and limited internal expertise in advanced analytics	Restricts effective interpretation and use of AI-generated insights in decision-making	Implement capacity-building programs focused on analytical literacy and AI governance for tourism managers
Ethical oversight	Public sector governance; institutional norms	Ethics addressed indirectly through data protection, without sector-specific guidance	Leaves gaps in managing risks related to profiling, personalization, and algorithmic bias	Establish ethical guidelines for AI use in tourism, emphasizing non-discrimination and explainability
Strategic coordination	National tourism policy; inter-institutional coordination mechanisms	Strategy documents emphasize digitalization, but lack operational AI governance frameworks	Limits system-level transformation and coordinated analytical governance	Integrate AI governance explicitly into national tourism strategies and action plans

Governance dimension	Institutional scope	Current condition in North Macedonia	Relevance for AI-supported tourism management	Policy recommendations
International exposure	Engagement with EU tourism markets and digital platforms	High dependence on foreign digital intermediaries and platforms	Amplifies importance of adopting transparent and institutionally robust AI practices	Promote destination-level control over data and analytics while negotiating fair platform dependencies

Source: Author’s synthesis based on OECD (2021), Floridi et al. (2022), Gretzel et al. (2021), World Economic Forum (2024), and national policy context.

The governance dimensions summarized in Table 3 provide a concrete institutional interpretation of the conceptual argument developed throughout the paper and directly inform the concluding assessment. The table demonstrates that the transformative potential of artificial intelligence in the Macedonian tourism system is not primarily constrained by technological availability, but by governance capacity, institutional coordination, and regulatory clarity. Fragmented data governance, uneven organizational literacy, and the absence of sector-specific rules for artificial intelligence limit the extent to which analytical instruments can be translated into sustainable managerial value.

By explicitly linking analytical mechanisms to policy-oriented recommendations, Table 3 reinforces the central conclusion of the study: artificial intelligence functions as a factor of transformation in tourism only when embedded within transparent, accountable, and institutionally structured governance frameworks. The findings therefore support a shift in tourism policy orientation from technology acquisition toward analytical governance, emphasizing capacity building, regulatory alignment with European standards, and ethical oversight as preconditions for responsible and effective artificial intelligence use in the Macedonian tourism system.

Analysis and Discussion

The analysis identifies three analytically relevant mechanisms through which artificial intelligence transforms the Macedonian tourism system. First, algorithmic mediation reshapes destination visibility by prioritizing certain accommodations, routes, and experiences based on opaque ranking criteria. This alters competitive dynamics independently of intrinsic quality.

Second, artificial intelligence enhances analytical interpretation of demand volatility by identifying temporal sensitivities and emerging patterns that exceed manual analysis. This is particularly relevant in a system characterized by seasonality and event-driven fluctuations.

Third, artificial intelligence indirectly influences coordination by structuring the informational environment in which managerial decisions are made. However, the

effectiveness of these mechanisms depends on institutional capacity to interpret and govern analytical outputs. Without analytical literacy and governance standards, algorithmic signals risk being misinterpreted or passively accepted.

Challenges and Limitations

Despite its analytical potential, artificial intelligence adoption in the Macedonian tourism system faces structural limitations. Fragmented data governance, limited organizational capacity, and dependence on external platforms constrain analytical autonomy. Ethical and transparency concerns related to profiling, consent, and explainability further complicate adoption (OECD 2021; Floridi et al. 2022).

These challenges reinforce the argument that artificial intelligence constitutes a governance issue rather than a purely technical one.

Conclusion

This study has examined artificial intelligence as a factor of transformation in the Macedonian tourism system through a conceptual and analytically grounded lens. By reframing artificial intelligence as an analytical instrument embedded within tourism governance rather than as an autonomous technological solution, the paper contributes to a more precise theoretical understanding of how data-driven systems influence destination management under conditions of institutional constraint and demand volatility.

The analysis demonstrates that artificial intelligence exerts its transformative influence primarily through analytical mediation. As synthesized in Table 1, artificial intelligence restructures the relationship between heterogeneous tourism data and managerial interpretation by translating complex, platform-generated information into interpretable analytical signals. These signals inform demand anticipation, coordination of visitor flows, and strategic positioning without displacing human judgment. In this sense, artificial intelligence extends managerial rationality rather than substituting it, reinforcing the centrality of human interpretation in tourism management.

Empirical contextualization, summarized in Table 2, indicates that the Macedonian tourism system exhibits structural conditions that intensify the relevance of artificial intelligence as an analytical instrument. High dependence on foreign tourists, widespread digital connectivity, and moderate international competitiveness together create an environment in which destination visibility and demand coordination are increasingly shaped by algorithmic processes. These characteristics imply that artificial intelligence is already influencing tourism outcomes indirectly, regardless of whether its use is explicitly governed at the national or organizational level.

At the same time, the governance analysis presented in Table 3 reveals that the effective and responsible use of artificial intelligence in the Macedonian tourism system is constrained less by technological readiness than by institutional capacity. Fragmented data governance, limited analytical literacy, partial regulatory alignment with European frameworks, and insufficient transparency requirements reduce the ability of tourism institutions and enterprises to translate analytical potential into sustained managerial value. These constraints underscore that artificial intelligence adoption in tourism is fundamentally a governance challenge rather than a purely technical endeavor.

The findings of this study therefore support a shift in policy and management orientation. Rather than prioritizing the acquisition or deployment of artificial intelligence

technologies, tourism development strategies should focus on strengthening analytical governance. This includes establishing interoperable data standards, enhancing organizational capacity for analytical interpretation, aligning sectoral practices with European regulatory principles, and embedding ethical oversight into destination management structures. Without such institutional foundations, artificial intelligence risks reinforcing dependency on external platforms and amplifying existing asymmetries within the tourism system.

Conceptually, this paper advances the literature by articulating a framework in which artificial intelligence is understood as an analytically transformative factor whose value emerges only through institutional embedding and human-centered interpretation. By situating artificial intelligence within the structural realities of a small tourism economy, the study provides a basis for future empirical research and comparative analysis across destinations facing similar constraints. Ultimately, the transformation of tourism through artificial intelligence depends not on technological sophistication alone, but on the capacity of institutions to govern analytics in a transparent, accountable, and strategically coherent manner.

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