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Article

From Capacity Expansion to System Coordination: An Audit and Evaluation Framework for Uzbekistan's Tourism Infrastructure Indicators

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Abstract: Tourism infrastructure is central to Uzbekistan's economic diversification, but expanding hotels or telecommunications networks does not automatically translate into tourist flows and local economic value. This paper develops an indicator-based audit of five official tourism and connectivity indicators from the Integrated System of Open Statistical Information (SIAT) of Uzbekistan for 2015–2025: hotel establishments, bed capacity, visitors accommodated, and internet and mobile subscriptions per 100 inhabitants. Each indicator is classified as a stock or a flow and as telecommunications access or digital adoption in tourism, and growth rates are calculated separately for the expansion (2015–2019), shock (2019–2020) and recovery (2020–2025) periods. Between 2015 and 2025, hotel establishments increased from 661 to 2,257, beds from 34.9 thousand to 88.1 thousand, and internet subscriptions from 26.6 to 94.7 per 100 inhabitants. In 2020, visitors fell by 67.96% while accommodation capacity continued to grow, showing that installed capacity and actual utilization must be measured separately. Visitor numbers in 2025 were 54.3% above the 2019 level, equivalent to average annual growth of 7.5%, far below the 36.93% rate obtained from the 2020 low point. Subscription indicators capture population-level access, are bounded and cannot serve as proxies for digital adoption by tourism enterprises. The paper proposes policy monitoring indicators and an identification strategy for a future regional panel test of complementarity between physical capacity and digital connectivity.

Keywords: *Uzbekistan; tourism infrastructure; digital connectivity; accommodation capacity; infrastructure complementarity*.

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1. Introduction

Tourism infrastructure is a key pillar of Uzbekistan's economic diversification strategy, it also determines whether the economic potential inherent in historic cities, cultural landscapes, and emerging destinations can be fully realized. However, the core policy challenge lies not merely in the number of hotels constructed or the extent of telecommunications network coverage, but rather in how a region can translate its infrastructure supply into accessible tourism services, sustainable visitor demand, and economic value that remains within the local community. This transformation depends on the systematic coordination of facility provision, information flow, human capital, and market access [1]. Dwyer and Kim likewise identify these elements among the determinants and indicators of destination competitiveness [2].

Traditional investments are often pursued separately, organized along departmental or administrative lines. While lodging projects can expand accommodation capacity and digital infrastructure can enhance connectivity for households and businesses, neither automatically translates into an increase in tourist traffic. If lodging facilities lack an online presence, digital booking options, or comprehensive navigational information, they remain difficult for potential tourists to discover. Conversely, even with convenient internet access, a satisfying travel experience cannot be guaranteed if the quality of accommodation or the level of service is inadequate. Therefore, the value of one type of infrastructure depends on the availability and effective utilization of another [3]. In smart tourism, this interdependence is reflected in the integration of physical and digital infrastructure [4].

Since 2016, Uzbekistan has undergone a series of reforms, including the simplification of visa procedures, the introduction of currency convertibility, and targeted investments in tourism infrastructure. Between 2015 and 2025, there have been notable shifts in accommodation capacity, visitor numbers, and access to both fixed and mobile broadband. Existing research on tourism development in Central Asia often focuses on efficiency measurement and community engagement—for instance, by examining the input-output efficiency of the hotel sector in Samarkand and Bukhara [5]. This paper, by contrast, integrates physical capacity and digital connectivity into a single framework, employing an indicator-based audit to bridge conceptual propositions with subsequent empirical analysis.

Physical and digital infrastructure play different roles in this process. The transport system plays an important role in destination development [6]. Transport infrastructure has also been shown to be an important determinant of international tourist flows [7]. Yet physical capacity sets only the upper limit of what a destination can receive, and new rooms and beds may have low marginal productivity unless they are supported by distribution, transport, information and services. Digital technologies reduce the costs of searching, booking, paying and coordinating among travelers, businesses and destination organizations [8]. The smart tourism literature accordingly treats them as a coordinating input within destination ecosystems rather than as an end product [9]. In economic terms, this interdependence corresponds to complementarity, or supermodularity, in which the marginal return to one input does not decrease as the level of the other rises [10]. Higher visitor numbers, however, cannot be equated with sustainable development, because spatial concentration, revenue leakage, environmental pressure and governance capacity shape who benefits from tourism [11].

This paper has three objectives and contributions: First, it establishes an analytical framework that distinguishes between capacity, usage, access, and the digital adoption of tourism services. Second, it audits five SIAT indicators based on a consistent set of rules and identifies the boundaries of comparability resulting from the shocks experienced in 2020. Third, it proposes a strategy for identification and inference in future regional panel studies, without carrying out the actual regression estimations.

2. Materials and Methods

Data and Indicators:The descriptive analysis utilizes data from the Integrated System of Open Statistical Information (SIAT), maintained by the State Committee of the Republic of Uzbekistan on Statistics; the relevant online indicators were accessed in October 2026. Internet subscriptions per 100 inhabitants are taken from SIAT indicator 1.06.02.0031 [12]. Mobile cellular subscriptions per 100 inhabitants are taken from indicator 1.06.02.0028 [13]. The number of hotels and similar accommodation establishments is taken from indicator 2.04.11.0045 [14]. The number of places in these establishments is taken from indicator 2.04.11.0044 [15]. The number of visitors accommodated is taken from indicator

2.04.11.0046 [16]. This paper presents annual national-level time series; the construction of regional panel data is addressed later in the text.

The first step involves indicator extraction and metadata verification. SIAT codes, units of measurement, reference time points, and statistical coverage are recorded for each item. The number of hotel establishments is treated as a measure of facility stock; the number of lodging places (in terms of bed capacity) is reported in thousands (multiply the original value by 1,000 to obtain the actual number of beds); the number of tourist arrivals is reported in thousands; and telecommunication subscriptions are expressed per 100 inhabitants.

The second step involves the classification of indicators. Each of the five indicators is classified according to two dimensions: "stock/flow" and "telecommunications access/digital adoption in tourism." The results of this classification are presented in the rightmost column of Table 1. In this paper, the terms "hotel establishments," "beds," "number of tourists hosted," "telecommunications access," and "digital adoption in tourism" are used consistently. The "number of tourists hosted" refers specifically to guests registered at collective accommodation establishments; it is not equivalent to the number of international tourist arrivals.

Table 1. Official SIAT Indicators and Their Rational Interpretations

Indicator	**SIAT Code**	**Unit / Definition**	**Variable Type**
Hotels and similar accommodation establishments	2.04.11.0045	Number of establishments; Facility stock	Stock
Number of hotels and similar accommodation places (bed places)	2.04.11.0044	Thousand places; Bed places need to be multiplied by 1,000	Stock
Visitors accommodated in hotels and similar establishments	2.04.11.0046	Thousand persons; Registered accommodation guests	Flow
Internet subscriptions per 100 inhabitants	1.06.02.0031	Subscriptions per 100 inhabitants	Stock (Access)
Mobile subscriptions per 100 inhabitants	1.06.02.0028	Subscriptions per 100 inhabitants	Stock (Access)

Note: Definitions are based on official SIAT online metadata and classification values, as consulted in October 2026. Data pages for individual indicators can be found in the references.

The third step involves identifying anomalous years and calculating growth rates. The year 2019 serves as a structural baseline, while 2020 is treated separately and excluded from the estimation of trends and overall growth rates; the growth rate for the 2020–2025 period is presented solely to illustrate the rebound from the post-shock trough. The compound annual growth rate (CAGR) is defined as CAGR = (V_t/V_0)^(1/n) − 1, and the annual rate of change is defined as g = (V_t/V_{t−1}) − 1. This analysis presents findings in three segments: the CAGR for 2015–2019, the annual rate of change for 2019–2020, and the CAGR for 2020–2025.

Indicator Auditing and Rules for Handling Anomalous Years: The global travel disruptions in 2020 led to a contraction in both international and domestic passenger flows, driven by border controls and travel restrictions [17]. Stock variables are influenced by projects under construction and existing contracts, exhibiting a degree of inertia; flow variables, by contrast, are directly exposed to demand shocks. Consequently, installed capacity and actual utilization are measured and reported separately. Before conducting cross-period comparisons, verify the scope of regional statistics, changes in classification,

and any revision records pertaining to the pandemic period. The year 2020 is treated as a distinct shock point in the tables, and no structural baseline is constructed for it.

Utilization caliber: The annual number of tourists received per bed is divided by the annual number of tourists received by the number of beds to measure the tourist turnover corresponding to the bed; Room-night occupancy rate is calculated by dividing the number of room-nights sold by the number of available room-nights; bed-night utilization rate is calculated by dividing the number of bed-nights sold by the number of available bed-nights. The ratio of annual visitor volume to bed capacity does not account for length of stay, seasonality, or the number of nights available; therefore, it cannot serve as a substitute for room-night occupancy rates or bed-night utilization rates. In this paper, where data on the number of nights are unavailable, only turnover volume is reported, with the associated limitations noted.

3. Results

Classification of Indicators and Comparability Boundaries: Table 1 categorizes hotel establishments and bed capacity as "stock" and "capacity" indicators, visitor arrivals as "flow" indicators, and internet and mobile phone subscriptions as "telecommunications access" indicators (a subset of stock indicators). Access-related indicators are measured per 100 inhabitants and are subject to an upper limit; capacity-related indicators are absolute counts with no upper limit. Consequently, the growth rates of these two categories are not directly comparable. Furthermore, telecommunications access indicators are not equivalent to the adoption of digital technologies in tourism.

Table 2. National Tourism and Connectivity Indicators for Uzbekistan

Indicator	**2015**	**2019**	***2020 (Shock Year)***	**2025**
Hotel establishments (number)	661	1,051	*1,156*	2,257
Bed places (thousands)	34.9	46.7	*50.4*	88.1
Visitors accommodated (thousand persons)	1,325.2	2,193.4	*702.8*	3,383.7
Internet subscriptions (per 100 inhabitants)	26.6	48.8	*58.4*	94.7
Mobile subscriptions (per 100 inhabitants)	66.0	71.0	*75.9*	97.3

Data source: SIAT, National Statistics Committee of the Republic of Uzbekistan (indicator sources are listed in the Methods section). Due to the impact of global travel disruptions in 2020, this year is not used as a baseline for identifying trends.

The number of registered visitors dropped sharply in 2020 to around 703,000, while the number of available accommodation units remained at a high level, which highlights the empirical importance of the difference between installed capacity and actual utilization. The volume of visitors can be affected by demand shocks without influencing the amount of accommodation infrastructure available. The recovery and subsequent growth in registered visitor numbers underscore the importance of reporting both capacity and utilization metrics when assessing the performance of policy.

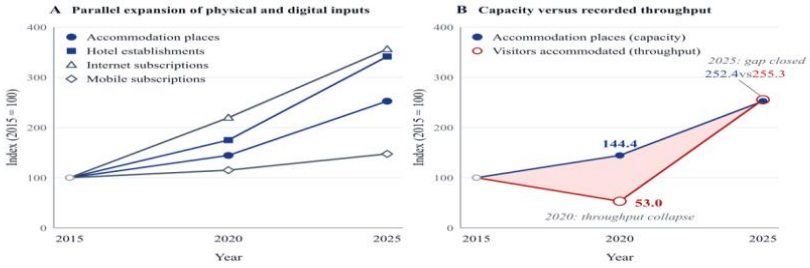


Figure 1. Parallel expansion of accommodation capacity and digital connectivity, and the utilization gap between installed capacity and recorded visitor throughput, Uzbekistan, 2015–2025.

Note. Both panels show indices computed from Table 2 with 2015 = 100. The shaded area in Panel B marks the gap between installed bed capacity and visitors accommodated; it is descriptive and does not identify a causal effect.

Table 3. Growth Rates by Period

Indicator	2015-2019 (CAGR)	2019–2020 (annual change)	2020–2025 (CAGR, from trough)
Hotel establishments	12.29%	9.99%	14.32%
Bed places	7.55%	7.92%	11.82%
Visitors accommodated	13.43%	−67.96%	36.93%
Internet subscriptions per 100 inhabitants	16.38%	19.67%	10.15%
Mobile subscriptions per 100 inhabitants	1.84%	6.90%	5.09%

Note: The 2019–2020 column reports single-year rates of change, not compound annual growth rates.

Expansion phase (From 2015 to 2019): the compound annual growth rates (CAGR) for hotel establishments, bed capacity, tourist arrivals, internet subscriptions, and mobile phone subscriptions were 12.29%, 7.55%, 13.43%, 16.38%, and 1.84%, respectively.

Shock Phase(Between 2019 and 2020): the rate of change was -67.96% for tourist arrivals, 9.99% for hotel establishments, 7.92% for bed capacity, 19.67% for internet subscriptions, and 6.90% for mobile phone subscriptions.

Recovery period(From 2020 to 2025): the compound annual growth rates (CAGR) for hotel establishments, beds, tourist arrivals, internet subscriptions, and mobile phone subscriptions were 14.32%, 11.82%, 36.93%, 10.15%, and 5.09%, respectively. The figure of 3,383.7 thousand visits in 2025, compared to 2,193.4 thousand visits in 2019, represents an increase of 54.3%—an average annual growth rate of 7.5%—which is far lower than the 36.93% rate calculated using the low-point baseline.

In 2025, there were 94.7 internet subscriptions and 97.3 mobile phone subscriptions; the corresponding figures for 2015 were 26.6 and 66.0. The number of hotel establishments increased from 661 to 2,257, while the number of beds rose from 34.9 thousand to 88.1 thousand.

4. Discussion

During expansionary periods, various indicators tend to rise in tandem; therefore, complementarity cannot be determined solely based on growth rates. The sharp decline in flows alongside a continued increase in stocks in 2020 demonstrates that demand shocks can exert an independent influence on actual utilization. The rebound in visitor numbers from 2020 to 2025 cannot be directly interpreted as a long-term trend. When an adoption metric approaches its upper limit—expressed as a percentage of the population—the observed slowdown in growth may simply reflect the constraints of the measurement scale; this does not necessarily mean that tourism enterprises have reached full adoption of digital tools. Continued penetration of digital access is occurring alongside a recovery in demand.

Policy evaluation should integrate accommodation support, connectivity infrastructure development, and services for getting listings online, with the sequencing of these initiatives tailored to address regional bottlenecks. For small-scale providers, support includes online listing, reservation management, multilingual descriptions, navigational information, digital payments, and training. Monitoring covers actual guest-nights, available bed-nights, standardized occupancy rates, local employment, and income retention. Table 4 presents the policy instruments and monitoring indicators.

Table 4. Policy Instruments and Monitoring Indicators Based on Complementarity

Policy Issue	Coordination Tool	Proposed Evaluation Metrics
New accommodations are difficult to discover in the market	Bundling support for appropriately scaled accommodations with connectivity development and online booking services	Number of active bookable listings; Verified digital bookings
Existing rooms are underutilized	Investing in destination marketing, itinerary planning, and service quality support prior to issuing new construction subsidies	Bed nights sold / Available bed nights; Seasonality index
Small businesses are excluded from digital markets	Providing shared training, translation, digital payment, and platform participation support	Small business participation rate; Revenue of local suppliers
Growth is concentrated in a few cities	Connecting secondary destinations through transportation, itineraries, and online visitor information	Share of regional tourist nights; Attraction pressure indicators
Tourism growth lacks local economic inclusivity	Incorporating business, workforce, and community metrics into project evaluations	Survival rate of newly established businesses; Employment; Local income

Note: Metrics such as the number of active, bookable listings and verified digital booking volumes must be obtained through administrative records, data linkages with platforms, or specialized surveys.

Janzakov et al. analyze and estimate the input-output efficiency of the hotel industry in Samarkand and Bukhara, focusing on the relative efficiency between given inputs and outputs. Starting from the condition of supermodularity, this paper examines the statistical definitions of capacity, traffic, and access metrics, and identifies testable elements for assessing complementarity. These two aspects address, respectively, whether input allocation is efficient and whether the available metrics are sufficient to support a test for complementarity.

Research on smart tourism, as discussed in the Introduction, often uses internet or mobile subscription rates as a proxy variable for digitalization. The indicator audit in this paper reveals that metrics based on a "per 100 population" scale—which capture telecommunications access only at the population level—are subject to an upper-bound constraint. Such metrics fail to reflect the adoption of online listings, booking management, and digital payment systems by tourism enterprises. Consequently, using subscription rates as a direct measure of digitalization in the tourism sector may lead to an overestimation of the economic impact of connectivity.

Follow-up research should establish a comparable panel covering a total of 14 regions in the Republic of Karakalpakstan, 12 states and the city of Tashkent, unify SIAT codes, units, regional identifiers, and missing value rules, check statistical coverage and historical revisions, and test the consistency of regional sums with national numbers. Physical capacity and telecommunications access should be prioritized as component indicators; if a composite index is constructed, standardization rules must be established in advance, and the results for the individual components should be reported alongside it. The proposed model relates the logarithm of the number of registered overnight visitors to lagged physical capacity, digital access, and their interaction term, while incorporating regional and year fixed effects as well as a vector of control variables.

When there are only 14 clusters, it is recommended to report bias-adjusted cluster-robust tests [18]. Bootstrap-based procedures such as the wild-cluster bootstrap also improve inference with few clusters [19]. The restricted wild-cluster bootstrap can be implemented efficiently in standard software [20]. The influence of individual clusters on the findings should also be examined.

5. Conclusion

This paper constructs a framework for the coordinated allocation of tourism infrastructure based on the condition of supermodularity, and conducts a descriptive audit

of five SIAT (Tourism Infrastructure and Access/Adoption) indicators for Uzbekistan from 2015 to 2025. The results reveal disparities in measurement scales and shock responses among accommodation capacity, visitor volume, and telecommunications access; the shocks experienced in 2020, in particular, clearly distinguish between stocks and flows. Stocks versus flows, and access versus adoption, must be measured separately; access indicators-even when normalized per 100 people-cannot serve as a proxy variable for the adoption of digital technologies in tourism. Future research should examine the mechanisms of complementarity using comparable regional panel data.

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