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Comparative analysis of lived experiences of domestic and international tourists in the context of urban smart tourism along Tehran's Nofel Loshato axis (District 11)

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Abstract

Smart tourism in dynamic urban centers, particularly in historical–cultural destinations, requires rigorous investigation of its constraints and determinants due to marked differences in tourists' lived experiences. The present study examines the smart tourism paradigm along Tehran's Nofel Loshato axis, where a significant gap is observed between the experiences of domestic and international tourists. Adopting a descriptive-analytical strategy and a mixed-method (quantitative and qualitative), the research collected data through 200 purposive questionnaires with high reliability (Cronbach's alpha > 0.875) and applied Pearson correlation tests, Friedman ranking, and interpretive structural modeling (ISM) for analysis. The statistical findings reveal a profound divergence in the perception of smart tourism dimensions: international tourists prioritize affective components such as digital and physical security, advanced service personalization, and multilingual capabilities, whereas domestic tourists focus more on cognitive–behavioral aspects, including ease of access to local information and data credibility. ISM analysis, as the methodological innovation of this research, clearly identifies structural and governance-related challenges, such as the absence of an integrated governance model (CH13), limitations of key platforms (CH10), and inefficient access infrastructures (CH5), as root variables shaping weaknesses in digital literacy. The results confirm a positive relationship between the six dimensions of smart tourism and destination success, underscoring the need to prioritize smart environment and smart mobility. The study proposes a phenomenologically informed conceptual model and a hierarchical structure of barriers that can underpin place-based strategies and managerial reforms for emerging destinations, aligning with the standards of scholarly research articles.

Keywords

District 11 of Tehran
Interpretive structural modeling (ISM)
Lived experience
Nofel Loshato axis
Tourism experience
Urban smart tourism

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1. Introduction

In recent years, fundamental transformations in urban tourism, driven by the influence of communication technologies and the rapid pace of urbanization, have led to the emergence of new models, such as smart tourism (Kulbaeva et al., 2024). Urban smart tourism is a concept that goes beyond the mere application of advanced technologies; it is grounded in the multifaceted and complex interactions between tourists and the urban environment. This approach encompasses the creation of customized experiences, dynamic data exchange, and the development of collaborative infrastructures, which together aim to continuously enhance residents' quality of life and strengthen the foundations of urban sustainability. Thus, urban smart tourism is regarded not only as a technological innovation but as a comprehensive and integrated system for the sustainable management and development of cities over the long term ("Developing Sustainable Smart Cities," 2023; Salmi & Hmioui, 2024). In this context, given the historical, cultural, and administrative significance of the Nofel Loshato axis, combined with its excellent accessibility to key centers such as the City Theater, museums, embassies, and heritage sites, it holds high potential to become a hub for urban smart tourism. It has attracted special attention from urban planners (Statistical Yearbook of Tehran City, 2024). Despite these capacities, the primary challenge lies in the differing lived experiences of Iranian and foreign tourists, as well as their modes of interaction with smart urban services (Wang & Guo, 2025). These disparities stem from cultural differences, expectations, levels of technological familiarity, and access to services (Ghaderi et al., 2025; Pai et al., 2024). Studies on the perception of smart services in Nofel Loshato reveal that non-local tourists generally expect advanced infrastructure, service personalization, and high levels of information security (Singh et al., 2025); however, Iranian tourists tend to focus more on ease of use and the quality of basic information (Normandi-Pour et al., 2025). Moreover, the digital and cultural divide, limited multilingual services, and the mismatch between local applications and the needs of foreign tourists have diminished their satisfaction and willingness to return (Nukpezah et al., 2025). Motivational differences and variations in the emotional, behavioral, and sensory dimensions of experience further underscore the necessity for in-depth analysis and practical solutions (Moliner Tena et al., 2024). The absence of comprehensive and comparative studies focused specifically on Nouvel Louchato, coupled with the predominant research emphasis on broader technological aspects or exemplary spaces, such as museums, has compounded challenges in the localized planning (Vicol, 2025).

Therefore, conducting this research holds practical and policy significance for urban managers and technology developers, as a precise understanding of the lived experiences of both domestic and international tourists enables the design of targeted services and infrastructures, enhancement of destination experience, and elevation of competitive advantage (Parnell et al., 2023; Ivars-Baidal et al., 2023). From a scientific standpoint, the principal innovation of this study lies in its phenomenological approach and qualitative methodology, which focus on the lived experiences of both domestic and foreign tourists and undertake a comparative analysis within a defined cultural-historical context. This study aims to bridge the experiential gap in smart tourism, referring to the multilayered and meaningful differences in perception, interaction, technology use, and spatial experience quality among two or more tourist groups. This gap arises when groups encounter different experiences of smart urban spaces due to their cultural, cognitive, digital literacy, travel expectation, or environmental familiarity differences. Hence, the experiential gap in smart tourism reflects a division in the quality of lived experience between domestic and foreign tourists and can serve as an indicator for assessing experiential justice, smart service efficiency, and urban planning quality, while presenting a novel theoretical model to advance place-based smart tourism strategies in Iranian cities. The central research questions focus on identifying the differences in how two groups of tourists utilize smart urban services and exploring approaches to bridge this gap, thereby creating a satisfying and meaningful urban tourism experience for both groups. In recent years, the paradigm of urban tourism has shifted under the influence of the Fourth Industrial Revolution from traditional models toward smart patterns. However, the primary challenge in many developing metropolises is not merely the lack of technological infrastructure but rather the "mismatch" between smart services and the "lived experience" and actual needs of tourists. This gap deepens, especially in destinations rich in cultural and historical heritage but lagging or underperforming in their smart and interactive service layers.

The cultural-historical axis of Nofel Loshato in Tehran's District 11 serves as a living laboratory for examining the challenges in transitioning to smart tourism. The

selection of this area for the present study rests on several strategic and locational reasons that make a case study indispensable:

- Semantic density and transnational uses: This axis inherently possesses high potential to attract both international and domestic tourists due to the presence of key artistic centers (such as City Theater and Vahdat Hall), embassies (acting as points of contact for foreign tourists), and a valuable historic fabric. However, evidence suggests that this latent capacity remains unrealized due to the absence of smart layered infrastructure.
- Infrastructure-performance paradox: Nofel Loshato enjoys favorable physical accessibility and central location within Tehran, yet initial observations reveal that data infrastructure and digital services—such as smart navigation, augmented reality for historical buildings, and multilingual services—are markedly weak or fragmented. This contradiction between "physical richness" and "digital poverty" makes this axis an ideal case for diagnosing barriers to smart development.
- Audience duality: This area intersects two distinct tourist groups—domestic cultural and artistic visitors seeking sensory and nostalgic experiences, and foreign tourists, present because of embassies and the historic environment, whose needs focus on digital security and accessibility. Ignoring the differing lived experiences of these groups in existing platforms has led to the failure of previous smart projects.

Therefore, the core research question is: Despite Nofel Loshato's high potential to become a flagship smart tourism district, why does a profound gap persist between the services provided and user expectations, both domestic and foreign? Have current smart development models adequately addressed the perceptual differences and security information needs of foreign tourists alongside the sensory-access needs of domestic visitors? Failure to answer these questions in this specific locale risks wasting urban resources and undermining Tehran's global branding opportunity in one of its most politically and culturally important corridors. Accordingly, this research focuses on this distinct spatial context to uncover structural and experience-based obstacles that have hindered the realization of true smartness at the cultural heart of the capital.

2. Theoretical foundations

Urban smart tourism, as an emerging branch within the tourism field, creates an interface between the physical space and the city's digital environment by leveraging information and communication technologies (ICT), the Internet of Things (IoT), big data, and artificial intelligence to personalize and optimize tourist services and experiences (Díaz-Parra et al., 2023). This approach focuses not only on technology-driven service delivery but also on the dynamic and multi-directional interaction among tourists, technology, and urban structures, aiming to enhance experience quality, sustain destination viability, and improve residents' quality of life. Within this framework, tourists' lived experience holds a fundamental position, as the sensory, emotional, and behavioral dimensions of their encounter with a smart environment play a decisive role in shaping satisfaction, loyalty, and motivation for future visits (Sihombing & Antonio, 2023). From a theoretical perspective, urban smart tourism integrates advanced technical systems with socially oriented concepts, stressing efficiency alongside principles of sustainability, equitable access, and public participation (Buckley, 2022). Specialized literature distinguishes between smart tourism and smart cities ("Rethinking Tourism Models in the Platform Era of the Sharing Economy," 2022). Although they overlap in terms of technological and digital infrastructures (Yang, 2022), their fundamental difference lies in smart tourism's focus on human experience and tourist-centered interactions (Zhang et al., 2022). Key subsystems of this tourism type include cloud services, connected IoT networks that facilitate data exchange among infrastructures and users, and mobile platforms offering customized services, which collectively enable the creation and management of experience-oriented data (Novianti et al., 2022). Research findings indicate that cultural, economic, and perceptual differences between domestic and international tourists significantly influence how they use smart technologies and evaluate service quality (Tang et al., 2022). Within this field, the locally rooted and identity-rich context—particularly the historic-cultural axis of Nouvel Louchato in Tehran—has gained special importance due to its spatial diversity and complex infrastructure. This setting demands a phenomenological and comparative approach for a deeper understanding of tourists' lived experience patterns (Keertika et al., 2021).

The present study is founded on the intersection of three theoretical pillars: urban smart tourism, tourist lived experience, and a comparative framework. Its conceptual model is designed to provide an in-depth

analytical explanation of tourists' experiences within the context of smart urban services (GadAllah, 2022). Smart tourism, as the fourth generation of transformation in the tourism system, emphasizes moving beyond mere technological focus toward structural intelligence, continuous innovation, and comprehensive sustainability. By integrating physical and digital spaces through technologies such as the Internet of Things, big data, and artificial intelligence, it generates interactive, personalized, and real-time experiences for tourists (Zekan, 2022). At the urban scale, this approach strategically utilizes smart city infrastructure to optimize resource management—such as transportation and energy—while simultaneously enhancing the quality of experience for visitors and the urban life for residents. Examples of this intelligence are observable in cultural contexts like Nouvel Louchato, where multilingual, location-based services, advanced technological infrastructures, and active local stakeholder collaboration effectively shape the tourist experience (Richards, 2022). On the other hand, the concept of tourist lived experience, rooted in phenomenology, goes beyond satisfaction measures and quantitative service evaluations to address subjective interpretation, internal emotions, and individual meaning-making related to presence in a tourism site (Khudaverdi, 2022). This notion encompasses cognitive, emotional, sensory, and behavioral dimensions, all of which are deepened through smart technologies (Mkpojiogu et al., 2022). Interaction with the smart environment ranges from easier access to information and enhanced feelings of security to the emergence of pleasure, mental calmness, and sensory stimulation through technologies such as augmented reality (Turner, 2023). These multifaceted layers form the perceptual framework necessary for analyzing lived experience within smart tourism systems (Grumadaitė & Jose, 2024). The concept of lived experience in urban studies and smart urbanism marks a paradigmatic shift, moving attention away from purely technical and infrastructural aspects of technology toward understanding its profound impact on individuals' and communities' lives (Parnell et al., 2023; Developing Sustainable Smart Cities, 2023). In this perspective, a smart city is not merely a collection of discrete technologies but is defined as a perceptual space where human-environment interactions are redefined through digital systems. The ultimate goal is to enhance well-being and create meaningful, desirable, and efficient experiences for residents (Singh et al., 2025). Accordingly, measuring the success of a smart city requires moving beyond traditional technological efficiency metrics to encompass qualitative assessments of citizens' lives (Díaz et al., 2024). Inspired by phenomenology and environmental psychology, this research proposes a coherent four-dimensional model to explain and assess lived experience within the smart context. Acting as perceptual filters, these dimensions shape how residents interpret and engage with six standard smart city components: people, governance, mobility, living, environment, and smart economy (Supriadi et al., 2025; Bingöl & Yang, 2025). The cognitive dimension in interacting with a smart city relates to the mental and perceptual infrastructures involved in understanding and processing the environment. In this dimension, technologies are tasked to transform raw data into applied knowledge by providing three key stages of information access, thereby effectively facilitating the process of learning and understanding the urban context (Pai et al., 2024; Tang et al., 2022). The success of smart systems, such as intelligent transportation information platforms or smart governance systems, depends on their ability to reduce ambiguity and provide transparency and explainability in algorithmic functions to citizens, fostering cognitive trust (Koo et al., 2025; GadAllah, 2022). The emotional dimension focuses on internal reactions, feelings, and the sense of belonging that residents experience within the smart environment (Li et al., 2023). A principal criterion here is the overall sense of security, encompassing both physical safety enabled by smart surveillance and digital security, including data privacy, especially relevant in governance and smart economy components (Salmanian & Abedi, 1400; Ghaderi et al., 2025). Additionally, service personalization in the domains of smart living and smart people plays a vital role in strengthening the sense of belonging and satisfaction by transforming citizens from passive recipients into active, identity-bearing participants in urban development (Wang & Guo, 2025; Turner, 2023). The sensory dimension examines the quality of multi-sensory interaction with the environment through technology. This aspect goes beyond mere visual or touchscreen engagement to incorporate augmented reality, advanced visual interfaces, and ambient audio systems, creating a rich interactive experience (Nguyen et al., 2025; Buckley, 2022). The impact of intelligent environmental components—such as lighting management and air quality—on citizens' sensory perception and visual pleasure (Bernabeu-Bautista et al., 2023) is directly evaluated in this dimension, elevating lived experience from purely

functional to an aesthetic and immersive one (Grofelnik & Kovačić, 2023). The behavioral dimension addresses the practical outcomes of lived experience, assessing how technology influences citizens' actions (Li et al., 2023). Key indicators in this dimension include facilitating decision-making and performance—for instance, optimizing routes in smart mobility or streamlining transactions in the smart economy—and ultimately, promoting users' willingness to reuse services and engage actively in civic platforms (Novianti et al., 2022; Grumadaitė & Jose, 2024). When citizens achieve a suite of favorable cognitive, emotional, and sensory experiences (Zou et al., 2023), their behavior tends toward place loyalty, increased participation in smart governance platforms, and repeated use of services, marking the ultimate criterion for smart city success aligned with sustainable development (Nukpezah et al., 2025; Sustacha et al., 2023). Taken together, these four dimensions provide an integrated and scholarly framework that enables a comprehensive, human-centered evaluation of the performance of the six key smart city components. They emphasize that a true smart city enhances its citizens' lived experience (Ionescu & Sârbu, 2024; Salmi & Hmioui, 2024). Over the past decade, numerous global studies have examined various facets of smart tourism, focusing on the role of emerging technologies, tourist psychology, and sustainability in shaping experiences and managing destinations (Klepej & Marot, 2024). For instance, Lan et al. (2021), in their study titled "Examining tourism experience and designing personalized smart tourism programs based on tourist psychology," demonstrated that smart travel solutions rooted in tourist psychology significantly influence the quality of their experiences. Their findings highlight tourists' preference for destinations that offer high security and authentic natural landscapes, showing how smart services can markedly enhance travel experiences.

2.1. Research background

Zhao and Zhang (2021) focused on the role of data and digital tools in developing rural tourism in their article "The path to rural tourism revitalization from the perspective of smart tourism," proposing a conceptual framework for achieving smart rural tourism. Similarly, Balina (2022), in the study "The concept of smartness in rural tourism," demonstrated that smartphones play a key role in enhancing rural tourists' experiences and facilitating the use of information technology-based services, particularly during pre- and post-travel stages.

José Francisco and colleagues (2023), through a meta-analysis in their research titled "The role of technology in enhancing tourism experience in smart destinations," confirmed the positive impact of technology on tourism experiences. Their findings highlighted that information provision and interaction are the most influential factors in improving visitor satisfaction, although security and privacy concerns remain major challenges.

Karasu et al. (2023), in the article "Sustainable mobility and smart rural tourism," emphasized the shift from a purely technological approach toward a sustainability-oriented perspective. They proposed an indicator-based framework for assessing the sustainability of smart mobility in rural tourism. They demonstrated that enhancing green mobility plays a crucial role in achieving the goals of sustainable development.

Sustacha and colleagues (2024), in their study "Impact of smartness on customer-based brand equity in rural tourism destinations," employed PLS-SEM modeling and analyzed the data from 406 respondents. They found that smart management directly influences destination awareness and perceived quality, with tourist loyalty mediated through mental image and destination quality. Their research underscored the importance of sustainability, governance, and local participation in shaping rural destination branding.

Finally, Kou et al. (2025), in their article "Assessing the interaction between trust dynamics, personalization, and ethical AI practices in the adoption of smart tourism technologies," focused on the United Arab Emirates. They examined the country's transformation through its adoption of artificial intelligence as a foundation for sustainable urban and tourism development. They demonstrated that national strategies such as "Smart Dubai" and "Sharjahverse" have facilitated the attraction of investment, enhanced data governance, and created a hybrid model of technological independence and cultural identity.

In recent years, numerous studies in Iran have focused on exploring the relationship between sustainable smart tourism development and the economic, social, and managerial dimensions of tourism destinations. Ataei et al. (2024), in their study titled "Analyzing the impact of sustainable smart tourism development on the economic growth of selected tourism destinations," employed an econometric model to demonstrate that sustainable smart tourism significantly influences the economic growth of destinations in East and West Asia. Their findings suggest that the increased value-

added by the tourism industry strengthens local economies, while environmental pollution has a negative impact on economic growth. Moreover, East Asian countries, through innovative planning approaches in smart development, have outperformed tourism destinations in West Asia.

Ghafoorian (2023), in the research "Strategies for realizing smart tourism in Mashhad using scenario analysis," applied a SWOT model and concluded that realizing smart tourism requires joint investment by public and private sectors in smart city infrastructures, support from science and technology parks for innovative tourism ideas, and collaboration between administrative bodies and telecommunication companies for tourism data analysis and processing.

At the rural level, Souraki et al. (2022), in their study "Identifying and analyzing barriers to transitioning from traditional structures to smart platforms in rural tourism destinations of Ben-Rood, Isfahan," found that local businesses' distrust of online platforms and the limited online booking facilities of eco-lodges are among the main obstacles to developing a smart tourism platform in rural areas. Their MICMAC analysis revealed that the variables influencing this transition have a tightly linked and directive relationship.

Paygah and Pourghannad (2021), in their study "Investigating the role of smart growth in sustainable tourism development," emphasized the necessity of developing smart urban spaces as a response to urban environmental challenges. Their results showed that urban smart tourism, acting as a link between physical and digital infrastructures, enhances tourism experiences through information technology and facilitates tourists' decision-making processes.

In this vein, Salmanian and Abedi (2021), in the research "Attention to virtual cities: A novel approach to sustainable development of smart city management and strengthening security in tourism" (case study: District 21, Tehran), argued that intelligent urban management and the creation of virtual cities can effectively enhance tourist security and realize sustainable development. However, weaknesses in inter-organizational cooperation and engagement with virtual citizens have challenged the full attainment of security and sustainability goals in this area.

Despite these capacities, a review of existing literature indicates that most previous studies on tourist experience and smart tourism planning in urban destinations have been one-dimensional, limited to transnational contexts, and predominantly focused on technology or satisfaction metrics. This research gap provides a suitable foundation for conducting comparative studies between domestic and foreign tourists, especially within urban settings in Iran. Simultaneously analyzing the experiences of Iranian and non-Iranian tourists in a specific area of Tehran, namely the Nofel Loshato axis, to design an operational smart tourism development plan has, to date, not been systematically addressed. Accordingly, the conceptual framework of this study is based on a comparative and phenomenological analysis of the cognitive, emotional, and behavioral dimensions of tourist experience within the smart tourism context of this axis. In this model, the tourist group (domestic or foreign) is considered the independent variable, and dimensions of lived experience serve as dependent variables; these dimensions are evaluated in relation to infrastructures, types of services, and modes of interaction with urban technologies to provide a deep understanding of similarities and differences in tourists' experiences within this cultural-urban setting. The macro-level approach employed in this research provides a clearer explanation of the dynamics underlying the urban smart tourism experience. It enhances the theoretical foundation necessary for policymaking and future program design.

2.2. Theoretical framework and conceptual model of the study

Recent smart tourism literature has moved beyond a purely technical focus on infrastructure to emphasize the concepts of "value co-creation" and "lived experience" (Wang et al., 2025). According to the "service-dominant logic" theory, smart technology creates value only when it enhances the quality of tourists' interactive experiences within the destination context (Normandipour et al., 2025). Therefore, this study adopts a phenomenological approach as its core theoretical foundation (Cai et al., 2025). This framework views technology not as an end in itself but as a means to deepen individuals' perceptual awareness and meaning-making processes about the urban environment, specifically within the Nofel Loshato axis.

To operationalize this approach and measure lived experience in a smart context, the model organizes lived experience into four main dimensions derived from the relevant literature:

- Cognitive dimension: Encompasses ease of access to information, learning, and understanding of the environment via technology (Grumadaitė & Jose, 2024).
- Emotional dimension: Includes digital/physical security feelings and a sense of belonging derived

from service personalization (Díaz et al., 2024).

- Sensory dimension: Involves multi-sensory engagement through augmented reality and visual interactions with the smart environment (Kulbaeva et al., 2024).
- Behavioral dimension: Covers facilitation of decision-making and willingness to revisit.

These four dimensions serve as filters through which the performance of the six standard smart city components—governance, people, environment, mobility, living, and smart economy—is evaluated. The central focus of this study's theoretical framework is the concept of "smart tourism experience gap." Theories suggest that tourists' cultural backgrounds and levels of technological readiness are key determinants of their interaction with these dimensions. The study's theoretical model rests on the assumption that foreign tourists prioritize "security and infrastructure dimensions," whereas domestic tourists focus more on "accessibility and content dimensions." Based on these foundations, the conceptual model illustrates that the "realization of a smart destination" (dependent variable) depends on the interaction between "urban infrastructures" and the "tourist's lived experience." In this model, structural challenges—such as governance and infrastructure identified through ISM analysis—act as moderating variables that differently affect the quality of experience for the two tourist groups (domestic and foreign).

Table 1: Conceptual model framework of the study

Smart city indicators	Alignment with smart tourism and tourists' lived experience	Components	References
Smart economy	Value creation, innovation, and competitiveness in tourism services	- Electronic payment systems: Convenience and security in financial transactions (important for foreign tourists) - Service personalization: Offering travel packages and targeted discounts based on tourist data - Service innovation: Diversity and quality of native tourism applications	(Bender et al., 2025) (Wang & Guo, 2025) (Ghaderi et al., 2025) (Supriadi et al., 2025) (Kumar, 2025) (Nagapur, 2025) (Nguyen et al., 2025) (Singh et al., 2025) (Koo et al., 2025) (Sustacha et al., 2023)
Smart people	Tourist and local community interaction, education, and creativity	- Tourist digital skills: The ability of tourists to use smart tools - Participatory engagement: The possibility of providing feedback and submitting user-generated content - Cultural acceptance: The local community's capacity to interact constructively with technology to welcome tourists	
Smart governance	Urban service management, transparency, and integration	- Information integration: Coordination among various systems (transportation, cultural, security) - Transparency and accessibility: Ease of access to legal information and tourism regulations - Emergency support: Availability of emergency response and 24-hour assistance systems	
Smart mobility	Smart access, transportation, and logistics infrastructure	- Real-time transportation information: Providing maps and schedules for smart buses and taxis - Parking infrastructure and access: Intelligent management of parking spaces along the Nofel Loshato axis - Multimodal services: The ability to plan trips combining different transportation methods	
Smart environment	Resource efficiency, waste management, and environmental quality	- Environmental sensors: Monitoring air pollution and noise along the axis (impacting the lived experience) - Energy and waste management: Smart system's awareness-raising for tourists regarding optimal consumption - Environmental sustainability: Providing eco-friendly transportation options (such as smart bicycles)	
Smart living	Quality of life, social well-being, tourist safety, and health	- Digital security: Protection of tourists' privacy and personal data (high sensitivity for foreigners) - Physical security: Presence of smart surveillance systems and a sense of safety along the axis - Health and hygiene: Easy access to medical information and healthcare services through smart platforms - Multilingual services: Providing content and support in international languages (essential for foreign tourists)	

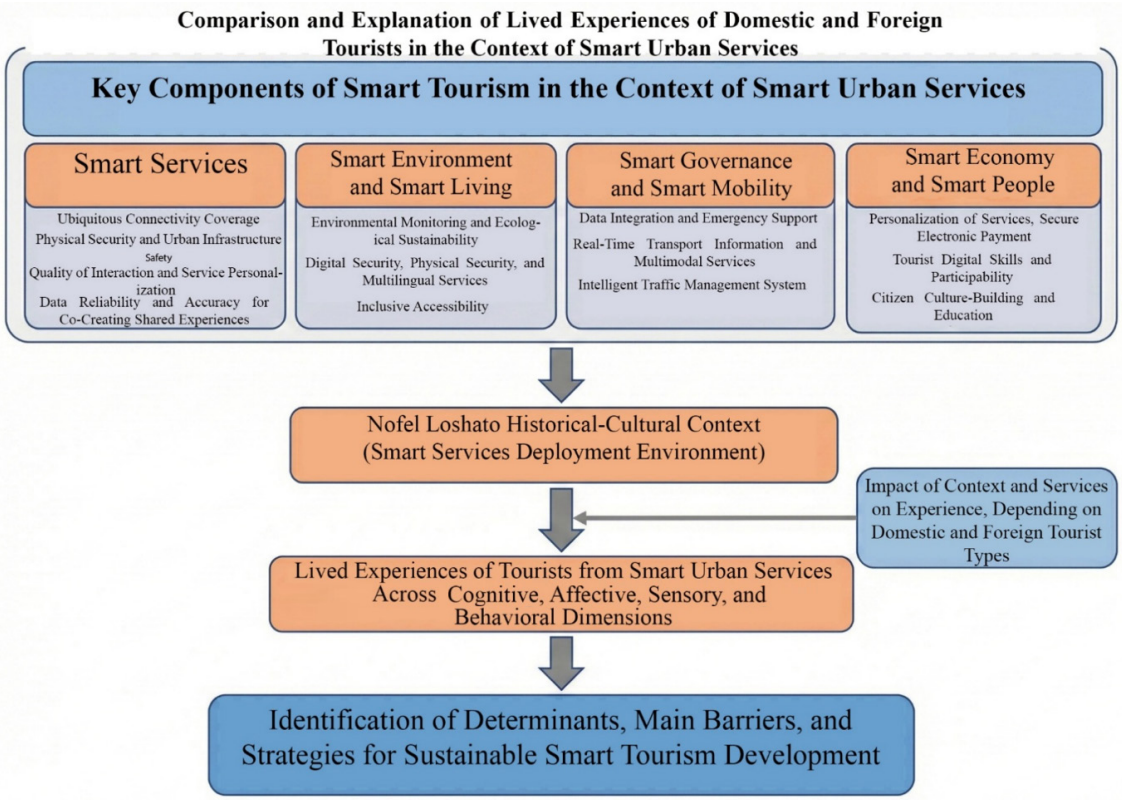

Figure 1: Conceptual model of the research

3. Research methodology

This study is applied in purpose and employs a descriptive-analytical approach along with mixed methods (quantitative and qualitative) for execution. The primary objective is to compare the experiences of domestic and foreign tourists along the Nofel Loshato axis, to identify key influencing factors and barriers to realizing smart tourism. Descriptive data were gathered through library research and document analysis, while analytical data were collected via survey methods using questionnaires. Relevant urban smart tourism indicators were first extracted from theoretical literature and operationalized into measurable scales, forming the basis of the questionnaire. The final questionnaire was distributed to 200 tourists in the Nofel Loshato study area—100 foreign and 100 domestic—with foreign responses collected online and domestic ones in the field (noting distinct questionnaires tailored to each group). Cronbach's alpha coefficients, as shown in Table 1, were 0.875 for the 15 domestic tourist items and 0.910 for foreign tourists, indicating high reliability and internal consistency for measuring dependent variables. Data analysis utilized SPSS software. Quantitative analysis included Friedman's test for component ranking and Pearson correlation for variable relationships. To identify the hierarchical structure of smart tourism development challenges within the mixed-methods framework, interpretive structural modeling (ISM) was applied. ISM converts pairwise relationships among challenges into a self-interaction matrix and reachability matrix, enabling calculation of two key indices: driving power and dependence power. This classifies challenges into root/driver, linkage, and dependent/outcome levels, facilitating managerial strategy prioritization based on each factor's structural role in Nofel Loshato.

The study area, as depicted in Figures 1-3, encompasses parts of Ferdowsi (Tehran District 12) and Enghelab (District 11) neighborhoods, bounded north by Enghelab Street, south by Jomhoori Eslami Street, east by North Lalehzar Street, and west by Valiasr Street. Selection criteria included historic fabric and prominent cultural attractions, adequate infrastructure for smart tourism like efficient public access networks, need for tourism intelligence enhancement given the axis's political-economic significance, and the researcher's familiarity with its unique features and needs, enabling deeper, more authentic analysis.

Table 2: Cronbach's Alpha for questionnaire items

Cronbach's alpha coefficient	Number of questions (domestic tourists questionnaire)
0/875	15
Cronbach's alpha coefficient	Number of items (foreign tourists questionnaire)
0/910	15

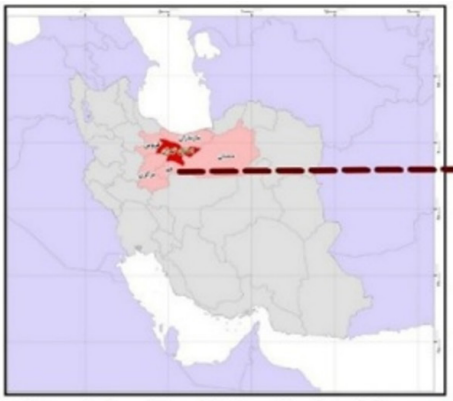

Figure2: Location of Tehran Province in Iran

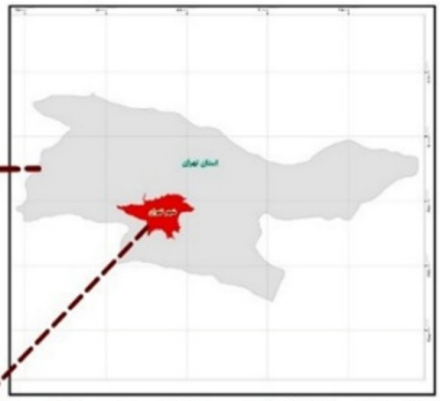

Figure 3: Location of Tehran City in Tehran Province

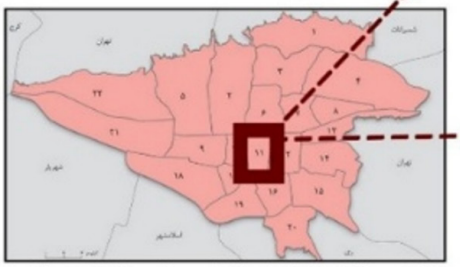

Figure 4: Location of District 11 in Tehran City

Figure 5: Boundaries of Nofel Loshato Street

Map Scale 1:380,000

4. Findings

Based on the data aggregated from the research questionnaire, the total number of participants in the data analysis process amounted to 200 individuals, equally divided into two cohorts: foreign and domestic tourists. In the foreign tourist group, women constituted 53% (equivalent to 53 individuals), and men accounted for 47% (equivalent to 47 individuals). Conversely, the gender distribution among domestic tourists was relatively different, with women demonstrating a more prominent presence, making up 63% (63 individuals), while men constituted 37% (37 individuals) of the domestic sample. This variation in gender ratio may reflect a higher proportion of women within the domestic tourist population compared to the foreign group. Furthermore, the age distribution among the two examined cohorts also exhibited notable differences. Foreign tourists were predominantly young and middle-aged, with 38% of them being under 25 years old, 22% falling within the 25- to 35-year range, and 35% within the 35- to 45-year range. The remaining 5% were aged above 45, indicating a scarce presence of older tourists in this group. In contrast, the age distribution among domestic tourists showed greater balance and a higher reliance on the presence of middle-aged and older individuals: 24% were under 25 years old, 36% were between 25 and 35, 29% were between 35 and 45, and 11% were above 45 years old. This distribution is relatively more balanced and relies on the greater presence of middle-aged and older people among domestic tourists.

Figure 6. Gender composition of iranian and international tourists

Figure7. Age cohorts of iranian and international tourists

As one of the important tourist centers in Tehran, the Nofel Loshato axis is considered a dynamic destination for domestic and foreign tourists, with its cultural, historical, and social diversity. The results obtained from examining the level of satisfaction, as shown in Figures 7 and 8, indicated that over 90% of respondents evaluated the hospitality and friendly behavior of the residents as favorable. This factor can serve as a fundamental competitive advantage in attracting, retaining, and fostering tourist loyalty. Furthermore, over 85% of tourists reported satisfaction with the attractiveness and authenticity of the area's historical and cultural sites, which underscores the critical importance of the cultural heritage component in shaping the overall tourism experience. Despite these strengths, the issue of accommodation stand out as one of the most significant areas of tourist dissatisfaction. Weaknesses in hygiene and cleanliness level, limited amenities, and the disparity between price and service quality were among the factors that had diminished tourist satisfaction with lodging facilities. The quality of public transportation also received lower scores across indicators, including punctuality, comfort, fleet condition, and information dissemination. This issue had negatively impacted the evaluation, particularly by foreign tourists. Another challenge was the lack of infrastructure adaptation in transportation and tourist spaces for individuals with physical disabilities; the absence of specialized equipment and inadequate staff training had led to a high level of dissatisfaction among this specific group. In the realm of security, some tourists, especially foreign visitors, reported concerns regarding nighttime safety, petty theft, and a lack of police presence. The status of public health and the limited access to public restrooms were also prominent weaknesses highlighted in the evaluations. From an economic perspective, although the prices of goods and services were generally rated at a medium level, a segment of the tourists deemed the prices to be high relative to the quality of services received. Nonetheless, a propensity for repeat visits was observed among approximately 75% of domestic tourists and nearly 65% of foreign tourists. This demonstrates the relative satisfaction of tourists and the potential capacity of the Nofel Loshato axis for further development of urban tourism. In summary, while characteristics such as the rich cultural heritage, the vibrant social atmosphere, and the hospitality of the populace are considered strengths of this axis, the improvement of accommodation quality, the enhancement of public transportation systems, and the strengthening of health and security indicators are necessary prerequisites for increasing tourist satisfaction and achieving sustainable tourism development in this area.

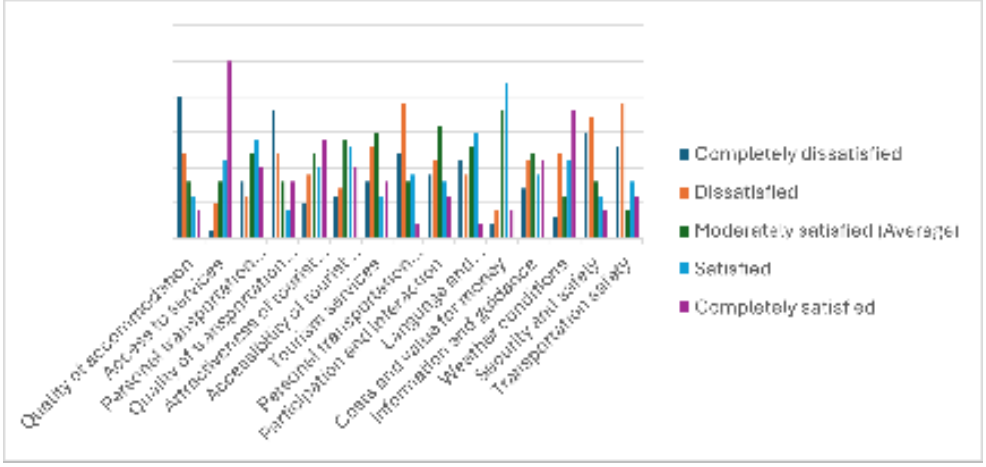

Figure 8. Exploring Iranian tourists' perceptions of the Nofel Loshato axis in Tehran's District 11

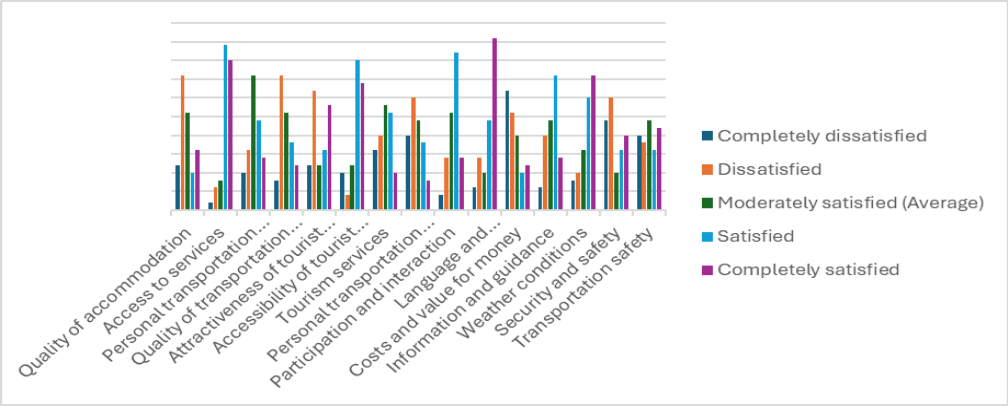

Figure 9. Exploring international tourists' perceptions of the Nofel Loshato axis in Tehran's District 11

In this section, the Pearson correlation coefficient was employed to assess the degree of association between the research indicators and the level of smart tourism realization in the studied area. This test was selected due to the interval nature of the variables and the potential for examining a linear relationship between them. As demonstrated in Table 2, the statistical analysis performed indicates the correlation between the surveyed indicators and the components of smart tourism within the given area. The results show that by improving the quality and the status of the research indicators in the selected area, the level of achievement in smart tourism significantly increases. In other words, the enhanced performance of the infrastructural, service, and technological indicators along the Nofel Loshato axis has a direct and positive correlation with the degree to which smart tourism objectives are attained.

Table 3. Analysis of the relationship between research indicators and smart tourism

Indicator	Correlation coefficient	Statistical significance
Smart economy	0/885	0/000
Smart mobility	0/898	0/000
Smart people	0/857	0/000
Smart environment	0/844	0/000
Smart governance	0/869	0/000
Smart living	0/899	0/000

The results of the Friedman test, performed to rank the influential indicators in the development of smart tourism, demonstrated that the categories were statistically significant at a level less than 0.05 ($p < 0.05$) and specifically equaled to 0.000 ($p = 0.000$). Consequently, the indicators exhibited meaningful differences from one another. According to Table 3, the Chi-square value was found to be 307.072.

Table 4. Chi-square value

Statistical significance	0/000
Chi-square value	307/072
Sample size	200

In Table 5, an examination of the mean ranks from the Friedman test indicates that among the influential indicators for the development of smart tourism, the highest mean rank belongs to the "Smart environment" indicator with a value of 3.65. This is followed by the "Smart transportation" indicator with a mean rank of 2.87. Conversely, the lowest rank corresponds to the "Smart governance" indicator, which yielded a mean rank of 1.64.

Table 5. Mean ranks of the Friedman test

Indicators influencing the development of smart tourism	Mean rank	Rank
Smart mobility	2/87	2
Smart people	2/44	3
Smart environment	3/65	1
Smart economy	2/25	4
Smart living	1/97	5
Smart governance	1/64	6

Structural self-interaction matrix (ISM) for smart tourism challenges in the Nofel Loshato axis

Step 1: In this matrix, the mutual relationships between the challenges were assessed based on the direct influence of one challenge on another.

Table 6. Structural self-interaction matrix (SSIM)

Code	Description of challenges	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13
CH1	Limitations of the international FinTech ecosystem	-	V	X	X	O	X	O	V	X	X	O	X	V
CH2	Crisis of uncertainty in cross-border transactions	A	-	V	X	V	X	X	A	V	A	A	X	V
CH3	Shortage of accommodation units meeting international standards	O	O	-	X	O	V	O	O	V	O	O	X	A
CH4	Unsatisfactory urban environmental sustainability and deterioration of quality of life	O	O	A	-	X	V	X	A	O	X	X	V	O
CH5	violability of access infrastructures and platform limitations	V	X	A	O	-	V	A	A	V	V	V	A	V
CH6	Inadequacy in air transport capacities	O	O	X	V	X	-	X	O	V	X	O	A	O
CH7	Deficiencies in communication skills and multilingual capabilities	O	O	O	O	O	O	-	A	V	O	V	O	A

Code	Description of challenges	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13
CH8	Public reluctance to purchase and use smart Products	X	X	O	X	O	X	X	-	V	X	V	O	O
CH9	Lack of a smart place branding strategy and weakness in marketing	O	X	O	O	X	O	O	O	-	A	X	X	V
CH10	Filtering and restrictions on key platforms	O	O	O	X	V	O	X	V	V	-	V	X	V
CH11	Low digital literacy and resistance to innovation adoption	O	X	X	O	X	O	X	X	O	O	-	V	A
CH12	Gap in smart infrastructure in public facilities	V	V	O	X	X	X	O	V	V	X	X	-	V
CH13	Absence of an integrated governance model	O	O	V	V	O	V	O	V	V	V	V	V	-

Table 7. Key to symbols (based on the ISM model)

Symbol	Meaning	Description of the relationship
V	i influences j	The challenge in row i directly influences the occurrence or intensity of the challenge in column j.
A	j influences i	The challenge in column j directly influences the occurrence or intensity of the challenge in row i.
X	Both influence each other reciprocally	The challenges i and j have a mutual, two-way influence on each other (reciprocal relationship).
O	No relationship exists	The challenges i and j are not related to each other in terms of influence.
–	Self-interaction	The diagonal cells that represent the relationship of the challenge to itself and are usually left blank.

Step 2: The second step in interpretive structural modeling (ISM) was to convert this ISM into a reachability matrix. In the subsequent phase of interpretive structural modeling (ISM), the structural self-interaction matrix (SSIM) was transformed into the reachability matrix. This conversion involved replacing the symbols (V, A, X, O) with binary values (0 and 1) and applying the transitivity rule to discover and map indirect relationships.

Table 8. Reachability matrix

Code	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13
CH1	1	1	0	0	0	0	0	1	0	0	0	0	1
CH2	1	1	1	0	1	0	0	1	1	1	1	0	1
CH3	0	0	1	0	0	1	0	0	1	0	0	0	1
CH4	0	0	1	1	0	1	0	1	0	0	0	1	0
CH5	1	0	1	0	1	1	1	1	1	1	1	1	1
CH6	0	0	0	1	0	1	0	0	1	0	0	1	0
CH7	0	0	0	0	0	0	1	1	1	0	1	0	1
CH8	1	1	0	0	0	0	0	1	1	0	1	0	0
CH9	0	1	0	0	0	0	0	0	1	1	0	0	1
CH10	0	0	0	0	1	0	0	1	1	1	1	0	1

Code	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13
CH11	0	0	0	0	0	0	0	0	0	0	1	1	1
CH12	1	1	0	0	0	0	0	1	1	0	0	1	1
CH13	0	0	0	1	0	0	1	1	1	1	1	1	1

In this step, the transitivity rule was applied and the reachability matrix was calculated. This principle states that if challenge A influences B and B influences C, then A indirectly influences C as well (B → C implies A → C & A → B).

Table 9. Final reachability matrix

CODE	CH1	CH2	CH3	CH4	CH5	CH6	CH7	CH8	CH9	CH10	CH11	CH12	CH13
CH1	1	1	1	0	0	0	0	1	1	0	1	0	1
CH2	1	1	1	0	1	0	0	1	1	1	1	0	1
CH3	0	0	1	0	0	1	0	0	1	0	1	1	1
CH4	0	0	1	1	0	1	0	1	1	0	1	1	1
CH5	1	1	1	0	1	1	1	1	1	1	1	1	1
CH6	0	0	1	1	0	1	0	0	1	0	1	1	1
CH7	0	0	0	0	0	0	1	1	1	0	1	0	1
CH8	1	1	0	0	0	0	0	1	1	0	1	0	1
CH9	0	1	0	0	0	0	0	0	1	1	1	0	1
CH10	1	1	1	0	1	1	1	1	1	1	1	1	1
CH11	0	0	0	0	0	0	0	0	0	0	1	1	1
CH12	1	1	1	0	0	0	0	1	1	0	1	1	1
CH13	1	1	1	1	1	1	1	1	1	1	1	1	1

Step 3: Using the Final Reachability Matrix calculated previously, the subsequent step in ISM was to determine the level partitioning of challenges. This required calculating two key sets for each challenge:

- Reachability set (R_i): The set of challenges that were influenced by challenge i (the rows 1 in the matrix).
- Antecedent set (A_i): The set of challenges that influenced challenge i (the columns 1 in the matrix).

Based on the final reachability matrix computed in the previous step, we proceeded with determining the reachability set (R_i), the antecedent set (A_i), and the level partitioning to identify the key variables (the driver and dependent variables).

Table 10. Reachability analysis

Code	Description of challenge	Reachability set (R_i)	Antecedent set (A_i)
CH1	Limitations of the international Fin-Tech ecosystem	{CH1, CH2, CH3, CH8, CH9, CH11, CH13}	{CH1, CH2, CH5, CH8, CH10, CH12, CH13}
CH2	Crisis of uncertainty in cross-border transactions	{CH1, CH2, CH3, CH5, CH8, CH9, CH10, CH11, CH13}	{CH1, CH2, CH5, CH10, CH12, CH13}
CH3	Shortage of accommodation units meeting international standards	{CH3, CH6, CH9, CH11, CH12, CH13}	{CH1, CH2, CH3, CH4, CH5, CH10, CH12, CH13}
CH4	Unsatisfactory urban environmental sustainability and deterioration of quality of life	{CH3, CH4, CH6, CH8, CH9, CH11, CH12, CH13}	{CH4, CH6, CH13}

Code	Description of challenge	Reachability set (R_i)	Antecedent set (A_i)
CH5	violability of access infrastructures and platform limitations	{CH1, CH2, CH3, CH5, CH6, CH7, CH8, CH9, CH10, CH11, CH12, CH13}	{CH2, CH5, CH10, CH13}
CH6	Inadequacy in air transport capacities	{CH3, CH4, CH6, CH9, CH11, CH12, CH13}	{CH3, CH4, CH5, CH13}
CH7	Deficiencies in communication skills and multilingual capabilities	{CH7, CH8, CH9, CH11, CH13}	{CH5, CH10, CH13}
CH8	Public reluctance to purchase and use smart Products	{CH1, CH2, CH8, CH9, CH11, CH13}	{CH1, CH2, CH4, CH5, CH7, CH8, CH10, CH12, CH13}
CH9	Lack of a smart place branding strategy and weakness in marketing	{CH2, CH9, CH10, CH11, CH13}	{CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8, CH9, CH10, CH12, CH13}
CH10	Filtering and restrictions on key platforms	{CH1, CH2, CH3, CH5, CH6, CH7, CH8, CH9, CH10, CH11, CH12, CH13}	{CH2, CH5, CH9, CH10, CH13}
CH11	Low digital literacy and resistance to innovation adoption	{CH11, CH12, CH13}	{CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8, CH9, CH10, CH11, CH12, CH13}
CH12	Gap in smart infrastructure in public facilities	{CH1, CH2, CH3, CH8, CH9, CH11, CH12, CH13}	{CH3, CH4, CH5, CH6, CH11, CH12, CH13}
CH13	Absence of an integrated governance model	{CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8, CH9, CH10, CH11, CH12, CH13}	{CH1, CH2, CH3, CH4, CH5, CH6, CH7, CH8, CH9, CH10, CH11, CH12, CH13}

Level partitioning is performed by finding the intersection of the reachability set and the antecedent set (R_i \cap A_i) and comparing it with the reachability set (R_i).

Result of the level partitioning (completing the steps to the end): Following the iterative application of this process, the challenges are classified hierarchically. The final results are included here.

Table 11. Level partitioning

Level	key Variables	Variable type	Description of challenges
I	CH11	Dependent	Weak digital literacy and resistance to adopting innovation in local businesses
	CH7	Dependent	Deficiencies in communication skills and multilingual capabilities of the workforce
II	CH9	Dependent	Lack of a smart place branding strategy and weaknesses in digital marketing
	CH8	Linkage	Public reluctance to purchase and use smart products
III	CH1	Linkage	Limitations of the international FinTech ecosystem and operational risk-taking
	CH2	Linkage	Crisis of uncertainty in cross-border transactions and disruptions in the supply chain
IV	CH3	Driver	Severe shortage of accommodation units with international standards and low city capacity
	CH6	Driver	Inadequacy in air transport capacities as the city's "gateway"
V	CH4	Driver	Unsatisfactory urban environmental sustainability and deterioration of the tourism quality of life
VI	CH12	Driver	Smartification gap in public facilities
VII	CH5	Driver	Violability of access infrastructure and restrictions on the use of global platforms
	CH10	Driver	Filtering and restrictions on key platforms used by global tourists
Lowest level	CH13	Driver	Absence of an integrated governance model and fragmentation in stakeholder management (root variable)

The ISM (interpretive structural modeling) table encompasses seven levels, with the descriptions indicating the influence relationships.

Table 12. Hierarchical structural reachability analysis and level partitioning of the ISM model

Level	Challenge variables	Variable description and type
I	CH11, CH7	Dependent variable: Highest susceptibility to influence, lowest driving power (outcomes)
II	CH9, CH8	Linkage/dependent variable: High susceptibility to influence
III	CH1, CH2	Linkage variable: Moderate driving power and unstable dependency
IV	CH3, CH6	Driver variable: Driving power greater than dependency
V	CH4	Driver
VI	CH12	Driver
VII	CH5, CH10, CH13	Root/independent variable: Highest driving power and lowest dependency (root causes)

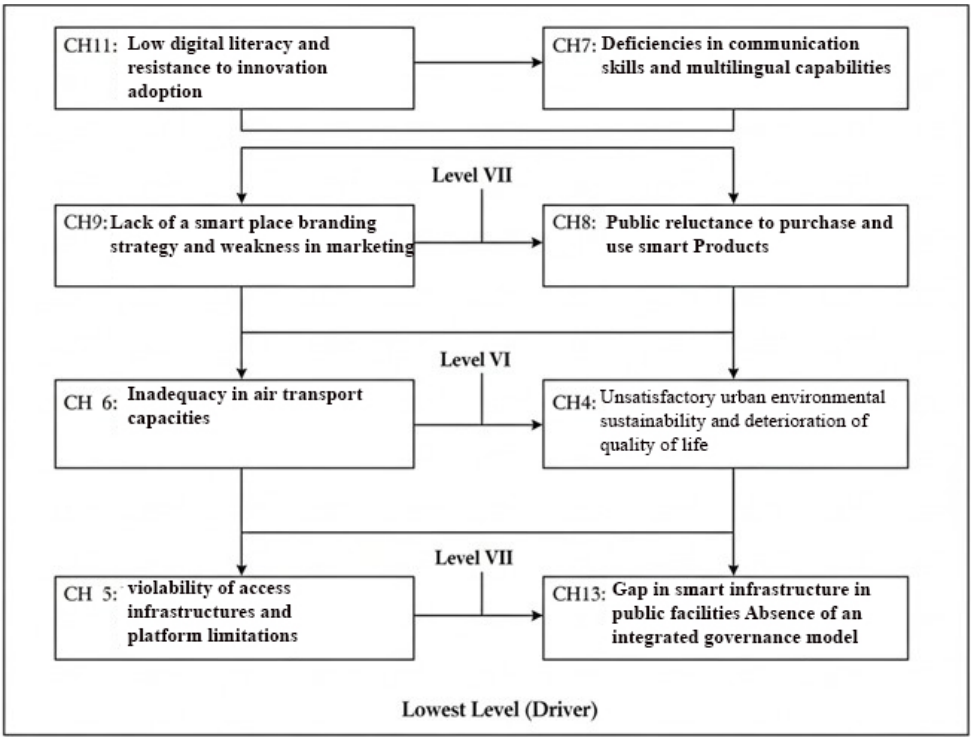

Figure 10. Hierarchical structural diagram of the ISM model

This hierarchical structure clearly displays the main findings:

Lowest level (root variables – Level VII)

The challenges at this level are the root variables that have high driving power and low dependence:

- CH13 (integrated governance): This is the most fundamental root challenge. Resolving the problem of the lack of an integrated governance model is a prerequisite for improvement across nearly all higher levels.
- CH5 (violability of access infrastructure) and CH10 (platform filtering): These two challenges represent infrastructural and regulatory issues that directly impact higher levels, such as the financial constraints (CH1 and CH2) and the adoption of smart technologies (CH8 and CH9).

Middle levels (driving and link variables – Levels IV to VI)

These challenges often act as driving variables or link variables (being both influential and dependent):

- CH12 (smartification gap) and CH4 (urban environment sustainability): These challenges necessitate fundamental infrastructural and urban investment and directly affect the quality of the

visitor experience.

- CH1, CH2 (financial constraints): These variables act as link variables in level III; That is, they both affect and are affected by root variables such as CH13 and CH5.
- Highest level (dependent variables – Levels I and II)

These challenges are the dependent variables, characterized by low driving power and high dependence:

- CH11 (weakness in digital literacy) and CH7 (weakness in language proficiency): These are consequences of the deficiencies in the lower levels. For instance, weak digital literacy (CH11) is a direct result of inadequate access infrastructure or extensive platform filtering (CH5, CH10).

For the development of smart tourism in Tehran, strategies must focus on the driving variables located at levels VII to IV (especially CH13), as resolving these issues will automatically mitigate the problems associated with the dependent variables at levels I and II.

The primary intervention strategies should focus on resolving the most fundamental root challenges (levels VII and VI) to ensure improvement across the entire smart tourism ecosystem in Tehran.

Table 13. Strategy focused on governance and regulatory reform (levels VII and VI)

Driver challenges	Key policy strategy	Proposed executive actions
CH13: Lack of an integrated governance model (root cause)	Establishment of a unified management institution (unified smart tourism governance)	Establishment of a permanent task force or committee with special executive powers, involving the Municipality, Cultural Heritage Organization, Tourism Police, and the Ministry of Communications, to align policies and coordinate the implementation of smartification projects.
CH10: Filtering and restrictions on key platforms	Facilitation of vital access for tourists	Negotiation and implementation of localized technology-based plans or providing special tourism SIM cards with unrestricted access to essential travel platforms (such as maps, hotel booking, and key social networks) during their stay in Iran.
CH5: violability of access infrastructures	Development and enhancement of communication networks in tourism areas	Significant enhancement of internet speed and stability (especially 4G/5G) in all tourist, historical, and accommodation centers, along with provision of free and secure public Wi-Fi services in high-traffic urban areas.
CH12: Smartification gap in infrastructure	Implementation of connected infrastructure projects	Deployment of IoT sensors in museums and public transportation, development of a comprehensive urban super-app for tourists, and smartification of parking and ticketing systems.

Table 14. Strategy focused on financial infrastructure and investment (levels IV and III)

Driver challenges	Key policy strategy	Proposed executive actions
CH1, CH2: Limitations of the international FinTech ecosystem	Development of alternative and localized financial mechanisms	Establish Prepaid Tourist Card systems with easy and guaranteed currency conversion capabilities, and collaborate with domestic FinTechs to provide internal electronic payment gateways for tourism businesses.
CH3: Shortage of standardized accommodation units	Standardization and facilitation of investment in the accommodation sector	Formulate tax incentives and credit facilities for the renovation and upgrading of existing hotels and expedite the issuance of permits for the construction of new accommodation centers compliant with international safety and smart service standards.
CH6: Inadequacy in air transportation	Improvement of the airport arrival experience	Invest in the smartification of the airport (such as multilingual information kiosks, intra-airport transport systems, and electronic security/passport services).

By focusing on the strategies outlined above, the problems at Levels I and II will naturally diminish. Nevertheless, supplementary actions can also be employed.

Table 15. Focus on reducing dependence (addressing dependent variables)

Dependent challenge	Supplementary strategy	Linkage to drivers
CH11 (weakness in digital literacy)	Implementation of digital education and empowerment programs	Reducing dependence on CH5 and CH10 (infrastructure and access) by providing targeted training courses for small businesses to utilize the existing platforms
CH7 (deficiency in communication skills)	Mandatory specialized language training	Complementing CH3 (accommodation standardization): Granting standard certification to hotels and agencies contingent upon having a minimum number of personnel proficient in key foreign languages
CH9 (weakness in branding)	Targeted digital marketing strategy	Utilizing the improvement of CH5 and CH10 (platform access) for the production of high-quality multilingual content and global advertising campaigns

The final stage of the ISM analysis involves analyzing driving power and dependence power. This is done by calculating the driving power and dependence power of each challenge through the sum of the rows and columns in the final reachability matrix. This calculation helps to accurately position each challenge on a two-dimensional diagram (or matrix) for final classification.

Table 16. Analysis of driving and dependence power

Code	Description of challenges	Driving power (sum of rows)	Dependence power (sum of columns)
CH1	Limitations of the international FinTech ecosystem	7	8
CH2	Crisis of uncertainty in cross-border transactions	9	10
CH3	Shortage of accommodation units meeting international standards	7	10
CH4	Unsatisfactory urban environmental sustainability and deterioration of quality of life	8	4
CH5	violability of access infrastructures and platform limitations	12	6
CH6	Inadequacy in air transport capacities	8	5
CH7	Deficiencies in communication skills and multilingual capabilities	5	5
CH8	Public reluctance to purchase and use smart products	7	9
CH9	Lack of a smart place branding strategy and weakness in marketing	6	12
CH10	Filtering and restrictions on key platforms	12	7
CH11	Low digital literacy and resistance to innovation adoption	3	13
CH12	Gap in smart infrastructure in public facilities	8	9
CH13	Absence of an integrated governance model	13	13

Based on the driving power (Y-axis) and the dependence power (X-axis), the challenges are positioned within four key quadrants.

Table 17. Challenges in the four key quadrants

Quadrant	Quadrant name	Feature	Challenges placed
I	Dependent	Low driving power, High dependence power (outcomes)	CH11, CH7, CH9, CH8, CH1, CH2, CH12, CH3
II	Linkage	High driving power, High dependence power (unstable)	CH13
III	Autonomous/driver	High driving power, Low dependence power (root causes)	CH5, CH10, CH4, CH6
IV	Autonomous	Low driving power, Low dependence power (lower significance)	No Challenge was placed in this model

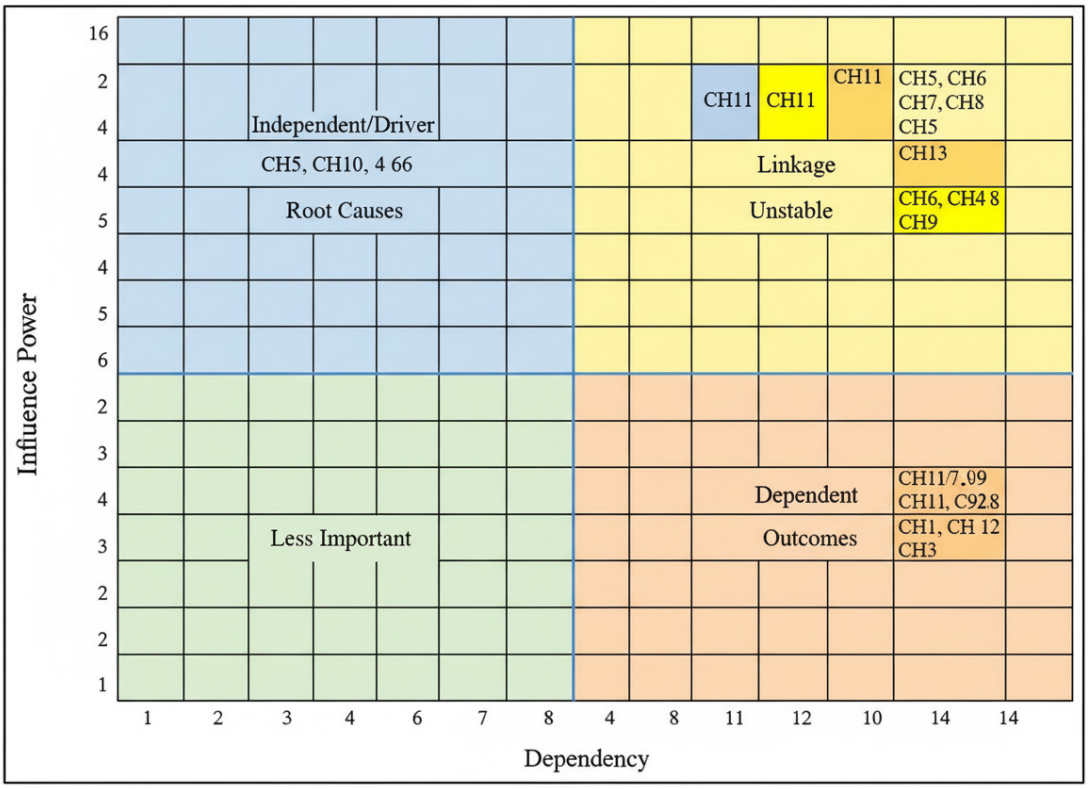

Figure 11. MICMAC analysis of driving and dependence power in the four key quadrants

The MICMAC analysis enhances the hierarchical findings of the ISM with greater precision, classifying the challenges into quadrants based on their driving and dependence power.

A. Root/driving variables (drivers)

CH5, CH10, CH4, and CH6: These variables have the highest priority for policy intervention. They exert the greatest influence on the overall system while having the lowest level of dependence on other factors.

- CH5 (violability of access infrastructure) and CH10 (filtering): These variables are the core issues in the realm of technology and macro-level policy-making, and their resolution directly affects financial variables (CH1, CH2) and public adoption (CH8).
- CH4 (unfavorable urban environment sustainability) and CH6 (inadequacy of air transport): These are central challenges concerning physical infrastructure and urban environmental quality, which act as preconditions for attracting smart tourists.

B. Linkage variables

CH13 (integrated governance): This challenge is positioned at the center of the diagram, falling into the linkage quadrant, with a driving power of 13 and a dependence power of 13. This signifies that CH13 is highly influential on other challenges and, simultaneously, highly susceptible to influence from them (especially from CH5 and CH10).

Any effort to resolve CH13 requires simultaneous coordination with improvements to the driving infrastructures, such as CH5 and CH10, as this variable is unstable and sensitive, and the slightest change within it could lead to unpredictable outcomes.

C. Dependent variables

CH11, CH7, CH9, CH8, CH1, CH2, CH12, and CH3: This group constitutes the largest segment of challenges. They represent the consequences and outcomes of the deficiencies within the driving variables.

Direct efforts to resolve these challenges (such as digital literacy training (CH11) or branding (CH9)) will be ineffective and waste resources without addressing the root issues of CH5, CH10, and CH13.

The combined ISM/MICMAC analysis definitively indicates that the primary focus of strategic actions for developing smart tourism in Tehran must be on structural and policy reforms (CH13, CH5, CH10), which are situated at the lowest levels of the hierarchy.

Prioritization of smart tourism challenges in the Nofel Loshato axis (ISM/MICMAC)

The core findings of this study highlight a structural and governance crisis, indicating that the obstacles to developing smart tourism in Tehran are fundamentally rooted in infrastructural, legal, and macro-governance

issues, rather than merely in practical skills or superficial amenities.

1. Root causes (driving variables – driving power)

The primary focus for intervention must be on these four challenges, which exhibit the highest driving power and the lowest dependence, and are situated within levels V through VII of the ISM structure.

Table 18. Key challenges of the driving variables

Code	Key challenge	Strategic orientation
CH13	Lack of an integrated governance model (the most fundamental root factor)	Institutional reform: Establish a single strategic body with full authority to align urban, communication, and tourism policies.
CH5	violability of access infrastructure (internet access)	Communication infrastructure: Unconditional investment in internet stability and speed, and provision of open access for tourists in key urban areas.
CH10	Filtering and Restriction on Key Platforms	Regulatory facilitation: Review policies related to access to global platforms for international users and domestic stakeholders in the tourism industry.
CH4	Unfavorable urban environment sustainability (pollution and traffic)	Smart urban management: Utilize technology to mitigate air pollution, manage traffic, and improve the quality of the urban environment as a precondition for destination appeal.

2. Linkage and unstable variables (linkage variables)

These factors possess high driving power and high dependence power and are located in the center of the MICMAC diagram. Their resolution is critically necessary, but must be addressed concurrently with the resolution of the driving challenges, as they are inherently unstable.

Table 19. Key challenges of the linkage and unstable variables

Code	Key challenge
CH1	Limitations of the international FinTech ecosystem
CH2	Uncertainty crisis in cross-border transactions

3. Outcomes and results (dependent variables)

The challenges in this group, such as CH11 (weakness in digital literacy) and CH7 (deficiency in language proficiency), are situated at the highest levels of the ISM structure. These are the outcomes of unresolved root challenges.

Focusing solely on training and education (CH11 and CH7) without addressing the fundamental governance and infrastructural issues (CH13, CH5, and CH10) constitutes a mere waste of resources. By improving the underlying infrastructure, the necessity and motivation for industry stakeholders to organically enhance their digital literacy will naturally increase.

Table 20. Strategic priority

Priority	Type of intervention	Core challenges
first	Root reform (fundamental)	CH13, CH5, CH10 (governance, access, and filtering)
Second	Infrastructural investment	CH4, CH6, CH12 (urban environment, transportation, and facility smartification)
Third	Financial and linkage reforms	CH1, CH2 (international financial and banking system)

5. Discussion and conclusion

The analysis of the present study's findings on Tehran's Nofel Loshato axis confirms the existence of a significant gap in perception and lived experience between domestic and international tourists within the context of smart tourism. It also unveils the deeper governance and infrastructural layers that underpin these differences, using a mixed-methodological approach comprising descriptive statistical analysis, Friedman ranking, Pearson correlation, and

interpretive structural modeling (ISM). The necessity of this research primarily stems from the urgent need to understand the dual dimensions of lived experience. While domestic tourists focus more on functional aspects such as efficiency, ease of access, and the availability of localized information (the subjective dimension), international tourists—due to their prior familiarity with global infrastructures—hold higher expectations regarding digital and physical security, advanced personalization, and multilingual service capability, all of which enhance their existential and emotional engagement. This heterogeneity in expectations necessitates the adoption of destination management strategies (DMOs) centered on personalization. Addressing the study's research question concerning key influencing factors, the analytical results indicate that all six dimensions of smart tourism bear a positive and significant relationship with achieving a smart destination. However, the Friedman ranking reveals that enhancing the quality of the smart environment and smart transportation represents the highest operational priority. This finding, when compared to previous studies, supports frameworks based on mass tourism management approaches, which regard the improvement of physical infrastructure and urban sustainability as essential prerequisites for adopting smart technologies. It also aligns with the emphasis on the critical role of sustainability in shaping positive tourist experiences. The analysis of data from the Nofel Loshato axis further highlights a meaningful experiential gap between domestic and international tourists in the context of urban smart tourism. International visitors, being more acquainted with global smart infrastructures, expect more than mere accessibility—they prioritize digital and physical security, advanced personalization, and multilingual services. Conversely, domestic tourists place greater value on ease of access, information quality, and psychological comfort in their travel experience. These findings are consistent with previous studies, such as those of Singh et al. (2025) and Wang and Guo (2025), which demonstrate that cultural differences and levels of technological readiness significantly influence the smart tourism experience. Furthermore, the Friedman ranking suggests that enhancing the quality of smart environment and smart transportation—as key priorities—aligns with sustainable tourism management frameworks and the research of Moliner Tena et al. (2024), who identified environmental sustainability as a prerequisite for creating positive experiences. The ISM model clearly reveals the root barriers to smart tourism development, namely issues related to integrated governance structures, accessibility infrastructures, and platform constraints. These challenges have priority over skill-related outcomes such as low digital literacy, emphasizing that education alone, without institutional and structural reforms, cannot be effective. The findings of this study, therefore, critique earlier, more limited approaches that reduced barriers to superficial factors and, consistent with the results of Nukpezah et al. (2025), underscore the importance of analyzing the deeper governance and legal layers. Based on a phenomenological approach, the present study further confirms the existence of a significant and structural gap in the expectations and lived experiences of domestic and international tourists along Tehran's Nofel Loshato axis. While domestic tourists tend to assess smart services primarily through the lens of efficiency and cognitive ease of access, international tourists—highly sensitive to digital security, data privacy, and emotional personalization—evaluate service performance at a more existential and affective level. This duality in perception provides a conceptual foundation for analyzing the mismatch between experiential outcomes and the inherent capacities of place. In this section, the indicators of the study and the level of smart tourism realization are compared against the spatial and managerial capacities of the Nofel Loshato axis to justify the validity of the results within this specific urban context.

Smart governance: The paradox of high capacity and weak implementation

The Nofel Loshato axis—due to the concentration of key cultural, artistic, and political venues such as Tehran City Theater, Vahdat Hall, and several embassies—possesses one of the highest inherent potentials for developing an inter-sectoral and multilevel smart governance model. This is because the coordination required among diverse institutions, such as the Municipality, the Ministry of Culture and Islamic Guidance, the Ministry of Foreign Affairs, and security agencies, is greater here than in most other parts of the city. Nevertheless, the smart governance dimension received one of the lowest mean scores among the six dimensions analyzed, representing the weakest level of realization. This striking mismatch between the strategic capacity of place and management performance should be considered the most critical outcome of the study. The interpretive structural modeling (ISM) analysis

attributes this gap to two root drivers in the model: the absence of an integrated destination management organization (DMO) and fragmentation in cross-sectoral decision-making. The low score in this dimension does not stem from a lack of technology but rather from inefficiencies in policy-making and coordinated data and service management, which critically undermine the credibility and sustainability of any smart development initiative in this corridor.

Smart transportation: Neglecting environmental advantages

From the perspective of physical accessibility and central location—being close to two metro lines and bus transit systems—and with its high walkability potential, the studied axis ranks among the most spatially advantaged areas of the city. These environmental advantages provide ideal prerequisites for implementing smart navigation systems, shared bicycle services, and real-time information platforms. Despite these strong capacities, the performance scores for this component—particularly within sensory and behavioral dimensions—remain below expectations. This indicates a clear gap in leveraging environmental assets. The low ranking of this component reflects weaknesses in operationalizing smart technologies to enhance the physical experience. Specifically, deficiencies in deploying real-time information systems, insufficient use of innovative pedestrian navigation technologies, and inadequacy of services for people with special needs or limited mobility have prevented the existing spatial capacities from being converted into a desirable smart experience.

Smart people and economy: Influence of root barriers

The analysis indicates that components such as "digital literacy of tourists" and "diversity and quality of smart financial services," which form the core of smart people and economy, although they scored relatively higher than the governance dimension, remain heavily influenced by underlying structural barriers. The ISM model strongly suggests that any advancement in the smart economy of this axis—particularly concerning secure international transactions and content marketing—depends on overcoming infrastructural and managerial constraints. Restrictions and filtering of key platforms (CH10) and the violability of access infrastructures (access to the internet) (CH5), as driving variables, directly negatively impact the private sector's investment capacity and the exploitation of economic potential (such as marketing artistic events at the City Theater).

Smart environment: Underutilization of the historic fabric

The Nofel Loshato axis, endowed with a valuable historical fabric, compact yet concentrated green spaces, and a high potential for pedestrian activity, requires and is well-suited to smart environmental management. Intelligent monitoring of noise pollution, air quality, and optimized energy management in heritage and commercial buildings has the potential to enhance urban life quality and the well-being of visitors. However, as with the transportation dimension, the smart environment ranks among the top operational priorities in the Friedman analysis. This indicates that despite clear needsa and spatial capacities, the actual level of implementation and utilization of smart systems for waste management, building energy optimization, and real-time environmental monitoring remains very limited. This gap stems primarily from financial and structural governance barriers. The absence of stable funding mechanisms for smart environmental projects—such as monitoring sensors and intelligent waste management systems—and the lack of incentive policies to encourage private and resident participation in environmental preservation through technology have collectively deprived the area's historic fabric of the benefits of a smart environment. Consequently, tourists' lived experiences are marked by lower-than-expected perceptions of air quality and environmental cleanliness.

Smart living: Absence of personalization and digital social interaction

The smart living dimension is highly dependent on the concentration of cultural and recreational land uses—such as theaters, museums, and galleries—along the Nofel Loshato axis. This area inherently holds great potential for providing smart social services, ensuring public safety, and facilitating cultural interactions through digital platforms (including ticketing systems, event reservation platforms, and augmented reality cultural guides). However, the scores obtained—particularly in the domains of digital social interaction and multilingual safety services—indicate a low level of realization for this dimension. The observed gap clearly demonstrates that the area's cultural assets have not been effectively utilized to create a holistic and intelligent living experience for temporary urban visitors. The challenges associated with this sector are

directly linked to the structural drivers identified earlier, such as platform filtering and unstable access infrastructures. The absence of robust, multilingual local social platforms has left the emotional and social dimensions of tourists' lived experiences—especially for international visitors—largely unaddressed. Moreover, deficiencies in the provision of digital security services and the lack of smart emergency information systems have diminished tourists' sense of safety and trust, reducing the concept of "smart living" along this axis to a nominal, rather than functional, reality.

The comparative analysis presented above strongly substantiates the validity of the study's results. The findings of this research go beyond a mere description of smartness levels; they analytically demonstrate that the core challenge of the Nofel Loshato axis lies not in a lack of spatial capacity, but in managerial, structural, and institutional deficiencies that have impeded the effective utilization of those capacities. Accordingly, the study not only measures the degree of smartness but also deconstructs the structural reasons behind the mismatch between thematic potential and spatial realization.

The quantitative findings of this study, alongside field observations, reveal a profound qualitative challenge along the Nofel Loshato axis that can be described as a "paradox of experience." Physically and functionally, the area presents a rich, dynamic, and international narrative due to the presence of prominent centers such as Tehran City Theater and several embassies. Yet, the analysis of lived experiences reveals that, in the digital layer, this space suffers from a kind of "silence" and "illiteracy." For international tourists, this disjunction between the "visual allure of the space" and the "invisibility of digital services"—resulting from platform restrictions and limited data accessibility—produces a sense of cognitive insecurity, transforming the travel experience from one of "joyful discovery" into "an exercise in digital survival." In contrast, while domestic tourists do not face linguistic barriers, the lack of integration among smart services (such as parking and event notifications) creates friction within their visiting experience. Thus, enhancing the qualitative dimension of the Nofel Loshato route cannot be achieved solely through physical interventions such as paving or street furniture design. Rather, it requires the establishment of a "digital infrastructure layer" that can provide personalized information and services, along with the historical and artistic richness of the environment, so that the "spirit of place" becomes tangible and understandable for tourists in a virtual realm as well.

Ultimately, the main strength and key innovation of this study lie in its departure from purely descriptive and quantitative analyses through the application of the interpretive structural modeling (ISM) approach to identify the most fundamental challenges underlying smart tourism development. The ISM model clearly demonstrated that issues such as the absence of an integrated governance model (CH13), the filtering and restriction of key digital platforms (CH10), and the violability of access infrastructures (CH5) occupy the lowest levels of the hierarchical structure—functioning as foundational and driving variables within the system. This insight constitutes the distinctive contribution of the present research compared with previous studies. Unlike many earlier works that have focused primarily on training tourists or practitioners (e.g., improving digital literacy) as remedial strategies, this study argues scientifically that such factors represent dependent variables—manifestations rather than causes—of the deeper structural and managerial challenges identified above. More precisely, as long as access restrictions (CH10) and weaknesses within the international FinTech ecosystem (CH1)—which act as connecting variables—remain unresolved, even the most advanced smart services will remain functionally inaccessible to international tourists, leading only to waste resource.

The final synthesis indicates that advancing smart tourism along the Nofel Loshato axis requires a strategic and integrated planning framework operating simultaneously on three levels:

1. Fundamental governance reform to address managerial fragmentation and establish an integrated model capable of resolving root challenges.
2. Facilitation of access infrastructures and the international FinTech ecosystem to effectively attract and serve foreign tourists.
3. Prioritization of smart transportation and urban environmental quality as essential prerequisites for enhancing both the cognitive and emotional dimensions of the tourist experience.

Ultimately, given the persistent gap between domestic and international lived experiences, the formulation of adaptive and personalized management strategies to address the distinct expectations of these two tourist groups is not merely an option—but a scientific and operational necessity to ensure the long-term competitiveness and sustainability of this urban destination.

5.1. Strategic recommendations and policy implications

The following recommendations directly address the root challenges identified by the ISM model and outline a long-term strategic approach for urban managers and policymakers.

Table 21. Strategic recommendations and policy implications

Context	Policy/structural recommendation	Linkage to root-level findings derived from interpretive structural modeling (ISM).
Smart governance (as the main driver)	Establishing an integrated Destination Management Organization (DMO) through the creation of an inter-sectoral coordination task-force, with the participation of the District Municipality, the Cultural Heritage Authority, and security agencies, to enable unified decision-making on data sharing and the standardization of services.	Addressing factor CH13 (lack of an integrated governance model) and countering institutional fragmentation
Digital infrastructure	Facilitating tourism technology access: Developing a national or regional guideline to eliminate or reduce restrictions (filtering) on key platforms required by domestic and international tourists, aimed at enhancing emotional and cognitive experiences.	Addressing factors CH10 (platform restrictions and filtering) and CH5 (violability of access infrastructures)
Smart economy	Mandating standardized financial services: Formulating regulations to encourage or require shops and service centers along the Nofel Loshato axis to accept cross-border digital payment methods, thereby facilitating transactions for international tourists.	Enhancing the digital security component and strengthening the behavioral experience of international tourists
Smart people	Designing tailored "digital tourism literacy packages" for the local community: Conducting training workshops for merchants, local guides, and staff at cultural centers (City Theater) to optimize the use of smart platforms and provide basic multilingual services, with emphasis on data privacy protocols.	Reducing deficiencies in local community digital literacy and enhancing data security, which is a key concern for international tourists.
	Establishing a cultural content co-creation platform: Launching an interactive, preferably multilingual system where domestic and international tourists can share their narratives, images, and experiences from the Nofel Loshato historical fabric.	Strengthening the social and emotional dimensions of lived experience and leveraging the site's cultural capacities for producing valuable content
Smart living	Implementing a multi-level emergency alert and response system: Installing intelligent surveillance systems capable of detecting unusual hazards and establishing an emergency hotline with automatic language detection for tourists to enable rapid response.	Direct response to international tourists' high sensitivity to digital and physical security (the primary priority in the findings)
	Developing personalized event apps: Launching a unified application for event information and ticket sales for cultural events (such as City Theater performances) with the capability to personalize recommendations based on visitors' past attendance history and individual interests.	Addressing the gap in delivering personalized services and intelligently leveraging the artistic capacities of the Nofel Loshato axis.
	Establishing navigation and information systems for individuals with special needs: Equipping main pedestrian routes and cultural centers with intelligent audio and tactile guidance systems to enhance physical and informational accessibility.	Enhancing the behavioral and emotional dimensions while strengthening the inclusivity of the smart people component
Smart environment	Deployment of an environmental quality monitoring sensor network: Installation of smart sensors along the Nofel Loshato axis for real-time monitoring of air pollution, noise pollution, and light intensity, with online display of results on public platforms.	Responding to the high priority of improving the smart environment (ranking findings) and enhancing tourists' sensory experience of the urban environment
	Smart waste and energy management systems: Installation of smart waste bins with compaction and fill-level notification capabilities, and the use of intelligent sensors to optimize energy and water consumption in public and heritage buildings.	Assisting sustainable development and addressing deficiencies in managerial investment in environmental infrastructures
	Environmental augmented reality (AR) projects: Designing AR platforms that visually and interactively display the environmental impacts of tourists' and residents' actions to enhance public awareness.	Promoting the cognitive and sensory dimensions and encouraging responsible environmental behavior within the historic fabric

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The first author: 50%
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Conflict of Interest

The authors declare that there is no conflict of interest.

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